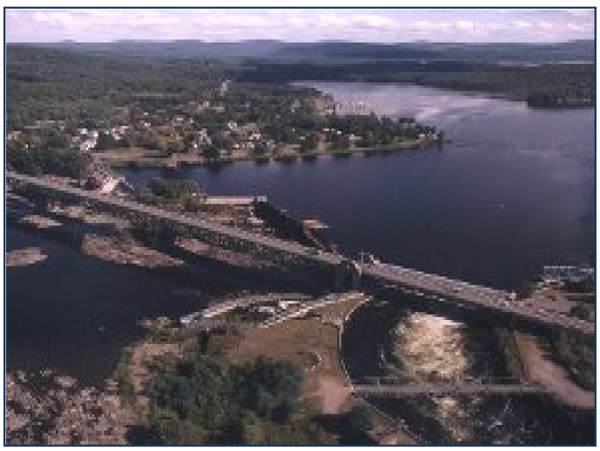
REVISED STUDY PLAN

FOR THE
TURNERS FALLS HYDROELECTRIC PROJECT (NO. 1889)
AND
NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT (NO. 2485)



AUGUST 14, 2013

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1-D	one dimensional
2-D	two dimensional
ADCP	Acoustic-Doppler Current Profiler
AIR	Additional Information Request
AMC	Appalachian Mountain Club
ANOVA	Analysis of Variance
APE	Area of Potential Effect
ARLAC	Ashuelot River Local Advisory Committee
ASMFC	Atlantic States Marine Fisheries Commission
AWWA	American Whitewater Association
BSTEM	Bank Stability and Toe Erosion Model
CEII	Critical Energy Infrastructure Information
CFD	Computational Fluid Dynamics
CFR	Code of Federal Regulations
cfs	cubic feet per second
CPUE	Catch per Unit Effort
CRASC	Connecticut River Atlantic Salmon Commission
CRJC	Connecticut River Joint Commissions
CRSEC	Connecticut River Streambank Erosion Committee
CRWC	Connecticut River Watershed Council
CRUISE	Connecticut River Unimpacted Streamflow Estimation
CT	Connecticut
CTDEEP	Connecticut Department of Energy and Environmental Protection
CY	cubic yards
°C	degrees Celsius
°F	degrees Fahrenheit
ft	foot or feet
ft^2	square feet
DO	dissolved oxygen
DEM	Digital Elevation Model
DRTU	Deerfield River Chapter of Trout Unlimited
DVR	Digital Video Recorder
EA	Environmental Assessment
ECP	Erosion Control Plan

ESA	Endangered Species Act
EWI	Equal Width Increment
FERC or Commission	Federal Energy Regulatory Commission
FIS	Flood Insurance Study
FPA	Federal Power Act
FirstLight	FirstLight Hydro Generating Company
FCD	Franklin Conservation District
FRCOG	Franklin Regional Council of Governments
FCRP	Friends of the Connecticut River Paddlers
FRR	Full River Reconnaissance
FSF	Four Star Farms
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPD	gallons per day
GPS	global positioning system
HEC-RAS	Hydraulic Engineering Center- River Analysis System
HPMP	Historic Properties Management Plan
HSI	Habitat Suitability Index
IFIM	Instream Flow Incremental Methodology
IHA	Indicators of Hydrologic Alteration
ILP	Integrated Licensing Process
ISO-NE	ISO New England
KPC	Keith Paper Company
kW	kilowatt
kWH	kilowatt-hour
LCCLC	Landowners and Concerned Citizens for License Compliance
LIS	Long Island Sound
m	meter
MA	Massachusetts
MAEOEEA	Massachusetts Executive Office of Energy and Environmental Affairs
MAFBF	Massachusetts Farm Bureau Federation Inc.
MADFW	Massachusetts Division of Fish and Wildlife
MAWMA	Massachusetts Water Management Act
MADEP	Massachusetts Department of Environmental Protection
MBI	Midwest Biodiversity Institute
MESA	Massachusetts Endangered Species Act

mi	mile
mg	milligram
MGD	million gallons per day
MHC	Massachusetts Historical Commission
MIPAG	Massachusetts Invasive Plant Advisory Group
mi^2	square miles
ml	milliliter
msl	mean sea level
MVA	megavolt ampere
MW	megawatt
MWH	megawatt-hour
NEPA	National Environmental Policy Act
NEE	New England Environmental
NE FLOW	New England Flow
NEFU	New England Farmers Union
NEIWPCC	New England Interstate Water Pollution Control Commission
NITHPO	Narragansett Indian Tribal Historic Preservation Office
NH	New Hampshire
NHDES	New Hampshire Department of Environmental Services
NHDHR	New Hampshire Division of Historic Resources
NHESP	Natural Heritage and Endangered Species Program
NHFGD	New Hampshire Fish and Game Department
NID	National Inventory of Dams
Northfield Mountain Project	Northfield Mountain Pumped Storage Project
NMFS	National Marine Fisheries Service
NPDES	National Pollution Discharge Elimination System
NPS	National Park Service
NR	National Register
NRHP	National Register of Historic Places
NHESP	Natural Heritage and Endangered Species Program
NOI	Notice of Intent
NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Unit
NEBA	New England Biking Association
NU	Northeast Utilities
NWI	National Wetland Inventory

OHWM	Ordinary High Water Mark
PAD	Pre-Application Document
PCBs	polychlorinated biphenyls
PHABSIM	Physical Habitat Simulation Model
Plan	Sediment Management Plan
PME	Protection, Mitigation and Enhancement
PIT	Passive Integrated Transponder
PSD	Particle Size Distribution
PSP	Proposed Study Plans
PVPC	Pioneer Valley Planning Commission
QAPP	Quality Assurance Project Plan
RM	River mile
RRA	River Residents Association
RSP	Revised Study Plan
RTE	Rare, Threatened, and Endangered
RTK	real time kinematic
S&A	Simons and Associates
SAV	submerged aquatic vegetation
SCORP	State Comprehensive Outdoor Recreation Plan
SD1	Scoping Document 1
SGCN	Species of Greatest Conversation Need
SHPO	State Historic Preservation Officer
SSC	suspended sediment concentration
TCP	Traditional Cultural Properties
TDS	total dissolved solids
TFC	Turners Falls Company
TMDL	Total Maximum Daily Load
THPO	Tribal Historic Preservation Officer
TN	total nitrogen
TNC	The Nature Conservancy
TP	total phosphorus
TSS	total suspended solids
TU	Trout Unlimited
Turners Falls Project	Turners Falls Hydroelectric Project
UMass	University of Massachusetts at Amherst
USACE	United States Army Corps of Engineers

USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VANR	Vermont Agency of Natural Resources
VT	Vermont
VTDEC	Vermont Department of Environmental Conservation
VTFWD	Vermont Fish and Wildlife Department
VRC	Vermont River Conservancy
VY	Vermont Yankee Nuclear Power Plant
WMECO	Western Massachusetts Electric Company
WMA	Wildlife Management Area
WPA	Wetlands Protection Act
WSEL	Water Surface Elevation
WUA	Weighted Usable Area
YOY	young-of-the-year

1.0 INTRODUCTION

FirstLight Hydro Generating Company (FirstLight) has initiated with the Federal Energy Regulatory Commission (FERC or Commission) the process of relicensing the 67.709-megawatt (MW) Turners Falls Hydroelectric Project (Turners Falls Project) and the 1,119.2 MW Northfield Mountain Pumped Storage Project (Northfield Mountain Project) (see Figure 1.0-1). FirstLight is applying for license renewal using the FERC's Integrated Licensing Process (ILP). The license for the Turners Falls 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.

As part of the ILP, FERC conducted a public scoping process during which various resource issues were identified. On October 31, 2012, FirstLight filed its Pre-Application Document (PAD) and Notice of Intent (NOI) with the FERC. The PAD included FirstLight's preliminary list of proposed studies. On December 21, 2012, FERC issued Scoping Document 1 (SD1) and preliminarily identified resource issues and concerns. On January 30 and 31, 2013, FERC held scoping meetings for the FirstLight Projects. In accordance with the FERC regulations, site visits typically occur at the same time as the scoping meetings. However, in this case, FERC accelerated the timing of the site visits to avoid a winter site visit to afford an opportunity for on-water tours. Thus, FERC held site visits of the Turners Falls Project, Northfield Mountain Project, on-water Turners Falls Impoundment and the upper reservoir on October 4, 5, and 11. Per the FERC regulations, written comments on the PAD and SD1, and formal study requests were due at FERC by March 1, 2013. Appendix A contains all of the stakeholder comment letters that were submitted on or by March 1, 2013. Appendix B contains the matrix summarizing the stakeholder comments submitted on or before March 1 and FirstLight's responses.

FERC issued Scoping Document 2 (SD2) on April 15, 2013. FirstLight filed its Proposed Study Plan (PSP) on April 15, 2013 and per the Commission regulations held a PSP meeting at the Northfield Visitors Center on May 14, 2013. Thereafter, FirstLight held ten[1] resource-specific study plan meetings to allow for more detailed discussions on each PSP and on studies not being proposed. In addition, FirstLight met with the Narragansett Tribe on June 6, 2013 to discuss proposed studies. FirstLight agreed at these meetings to update the PSP and file with the Commission a single *Updated PSP*. On June 28, 2013, FirstLight filed with the Commission an *Updated PSP* to reflect further changes to the PSP based on comments received at the meetings. The same was posted to FirstLight's website.

On or before July 15, 2013, stakeholders filed written comments on the *Updated PSP*. Appendix H contains all of the stakeholder comment letters that were submitted by July 15, 2012. Table 1.0-1 shows by resource category the Revised Study Plan (RSP) number, RSP title, stakeholder name and an "X" was placed under those studies where comments were provided. Two additional studies are proposed in this RSP based on comments received including a *Sediment Management Study* (Study No. 3.1.3) and a *Traditional Cultural Properties Study* (Study No. 3.7.3). In addition to the stakeholders listed in Table 1.0-1 the following other comments were provided, but do not appear in Table 1.0-1:

- A nearby resident requested a noise study and provided supporting arguments for the study. As stated in the PSP and *Updated PSP* and as supported by the additional information FirstLight filed on June 28, 2013 relating to this matter, FirstLight is not proposing to conduct a noise study.

- Seven individuals requested that FirstLight conduct a feasibility study of a closed-loop system at the Northfield Mountain Project. For the reasons set forth in the *Updated PSP* and as explained at

[1] The ten meetings were held on May 14, 15, 21, and 22, and June 4, 5, 11, 12, and 14 and August 8.

the numerous study plan meetings to date, FirstLight is not proposing to evaluate a closed-loop system.

- The fire chief from Montague, MA provided comments relative to effects of low water levels on first responders to the Turners Falls Impoundment.

- The Nolumbeka Project Inc. provided comments on the *Updated PSP* as noted in Table 1.0-1, and requested a Traditional Cultural Property (TCP) Study, which is being proposed in the RSP.

- The Narragansett Indian Tribal Historic Preservation Office (NITHPO) did not file official comments with FERC; however, by letter dated July 14, 2013 (see Appendix H) they requested FirstLight and TransCanada to enter into a cultural resources agreement, to be renegotiated on an annual basis, which would cover funding for: database development and maintenance, facility rental and equipment, cultural resource field survey personnel, including expenses, a senior archaeologist research consultant, and tribal cultural resource oversight. The NITHPO copied FERC on its email request to FirstLight and TransCanada. FirstLight has responded to the Tribe's request by letter dated August 14, 2013.

More detailed information on each RSP is provided in Section 3 of this document. Each RSP includes the following sections per the FERC regulations:

- General description of proposed study;
- Study goals and objectives;
- Resource management goals of agencies/tribes with jurisdiction over resource;
- Existing information and the need for additional information;
- Nexus between project operations and effects on the resource to be studied;
- Study methodology [including study area];
- Level of effort and cost; and
- Schedule.

Additionally, Section 4 of this document describes study requests that FirstLight did not adopt. FirstLight's rationale for why certain study requests were not adopted is also provided. In many instances, the proposed study did not have a nexus to project operations and effects and would not inform the development of license requirements. In other cases, less costly methodologies were available to gather the requested information.

Table 1.0-1: Stakeholder Comments Provided on Updated Proposed Study Plan

No.	Study Name	USFWS	NMFS	USEPA	MADEP	MADFW	NHESP	NHDES	VANR	NPS	AWWA	NE FLOW	AMC	CRWC	TNC	TU	FRCOG	FCD	LCCLC	Town of Northfield	Karl Meyer	Nolumbeka	VT SHPO
Geology and Soils																							
3.1.1	2013 Full River Reconnaissance		X		X			X						X			X	X	X	X			
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability		X		X			X						X			X	X	X	X			
3.1.3	Sediment Monitoring Study (NEW)			X																			
Water Resources																							
3.2.1	Water Quality Monitoring Study				X			X						X									
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot	X	X				X	X						X	X						X		
Aquatic Resources																							
3.3.1	Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station	X	X			X	X							X	X	X					X		
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad	X	X			X								X		X					X		
3.3.3	Evaluate Downstream Passage of Juvenile American Shad	X	X			X								X		X					X		
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls	X	X			X			X					X		X							
3.3.5	Evaluate Downstream Passage of American Eel	X	X			X								X		X					X		
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	X	X			X			X					X							X		
3.3.7	Fish Entrainment and Turbine Passage Mortality Study	X	X			X			X					X		X					X		
3.3.8	Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays	X	X			X								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											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			X			X					X	X								
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			X								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					X									
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment	X							X					X									
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Area	X	X			X			X					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 and Backwater Area Access and Habitat	X							X					X									
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms	X	X			X								X		X							
3.3.19	Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace	X												X		X					X		
Terrestrial Resources																							
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources	X												X								X	
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitats													X									
Wetlands, Riparian and Littoral Resources																							
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	X					X	X															
Recreation and Land Use																							
3.6.1	Recreation Use/User Contact Survey					X				X	X	X	X	X								X	
3.6.2	Recreation Facilities Inventory and Assessment										X	X	X	X									
3.6.3	Whitewater Boating Evaluation					X					X	X	X	X									
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats									X	X	X	X	X									

No.	Study Name	USFWS	NMFS	USEPA	MADEP	MADFW	NHESP	NHDES	VANR	NPS	AWWA	NE FLOW	AMC	CRWC	TNC	TU	FRCOG	FCD	LCCLC	Town of Northfield	Karl Meyer	Nolumbeka	VT SHPO
3.6.5	Land Use Inventory									X				X								X	
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use													X									
3.6.7	Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use									X		X	X	X									
Cultural Resources																							
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 (NEW)																					X	
Developmental Resources																							
3.8.1	Evaluate the Impact of Current and Proposed Future Modes of Operation on Flow, Water Elevation and Hydropower Generation							X						X									

FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

N

0 0.5 1 2 Miles

Figure 1.0-1
Turners Falls Project and Northfield Mountain Project Boundary Map

Path: W:\gis\maps\revised_study_plan\Figure 1.0-1.mxd

2.0 FERC ISSUED PAD DEFICIENCIES AND ADDITIONAL INFORMATION REQUESTS

In addition to making their study requests, FERC issued PAD deficiencies as well as additional information requests (AIRs) to supplement the content of the PAD. These deficiencies and AIRs are addressed below.

2.1 FERC PAD Deficiencies

2.1.1 Project Facilities and Operation (FERC Deficiency #1a and #1b)

FERC Def #1a: Please provide the dependable capacity of the Turners Falls Project and the Northfield Mountain Pumped Storage Project and the basis for the determination of the dependable capacity as required per § 5.6(d)(2)(iii)(E) of the regulations.

FirstLight Response: According to *Civil Engineering Guidelines for Planning and Designing Hydroelectric Developments* published by the American Society of Civil Engineers in 1989, dependable capacity is defined as "*the load-carrying ability of a power plant under adverse load and flow conditions*." For a standard hydroelectric facility, these conditions would be present during a period of high electrical demand and low flow.

The contracted capacity for the Turners Falls Project with ISO-New England is 68.2 MW (61.8 MW at Cabot and 6.4 MW at Station No. 1). If there were no storage capacity in the Turners Falls Impoundment, the dependable capacity would be lower and would be based on the lowest flow period, which occurs in September (see Figure page 4-30 of the PAD). The highest electrical demand months were estimated from Northfield generation data (see Page 3-33 of PAD) as a true indicator of demand or "adverse load". For the period 2000-2009, September was the third highest generation (demand) month, behind July and August. For purposes of this analysis, it was assumed that September reasonably represents a low flow/high demand period. The September median flow at the Turners Falls Dam for the period 1941 to 2010 is approximately 4,008 cfs (see page 4-30 of PAD). Assuming all 4,008 cfs is passed through Cabot Station under a net head of approximately 60 feet; the estimated dependable capacity of the Turners Falls Project (without storage capacity) would be approximately 17.7 MW.

The contracted capacity for the Northfield Mountain Project with ISO-New England is 1,124.0 MW, which assumes a full upper reservoir.

FERC Def #1b: Please provide land use maps which include key features as required per § 5.6(d)(2)(ii) of the regulations.

FirstLight Response: Land cover maps were included in the PAD on a larger scale in Figure 4.1.1-1. Land use data is readily available in Massachusetts through the Mass-GIS; land use data is not available for New Hampshire or Vermont. Figure 2.1.1 (a-g) provides a series of land use maps on a smaller scale than that provided in the PAD.

2.1.2 Geology and Soils (FERC Deficiency #2a, #2b, and #2c)

FERC Def #2a: The PAD describes the soils and occurrences; however, it does not provide descriptions of chemical characteristics, erodibility and potential mass movement as required by § 5.6(d)(3)(ii)(B) of the Commission's regulations. Therefore, to the extent known, please provide a description of chemical characteristics, erodibility and potential mass movement of soils in each project's area.

FirstLight Response: Section 4.2.3 of the PAD contains a discussion of soil types and mapping from Vernon Dam to the Cabot tailrace including the identification of the ten most common soil series found in the Project boundary (PAD Table 4.2.3-1). Although general characteristics of each soil series were included in the PAD, quantitative data pertaining to the chemical and physical properties and erodibility were not discussed. As such, please find the following enclosed in Appendix C:

- Chemical properties including cation-exchange capacity, effective cation-exchange capacity, and pH;
- Physical properties including percent sand, silt, and clay, saturated hydraulic conductivity, organic matter, and erosion factors (Kw, Kf, and T factors); and
- Potential erosion hazard

Soil erodibility factors contained in Appendix C include both the K and T factors. K factor values typically range from 0.02 (least erodible) to 0.64 (most erodible) and can be divided into two sub-categories, Kw and Kf factors. The Kw factor is calculated by taking into consideration the whole soil, while the Kf factor only considers the fine-earth fraction (<2.0 mm diameter). Soil properties affecting the K factor, and therefore the erodibility, can include texture, organic matter content, structure, infiltration, and permeability. The T factor is the maximum amount of annual sheet and rill erosion that permits the fertility and productive capacity of the soil to be maintained indefinitely. T factor values range from 1 ton per acre per year for the most fragile soils, to 5 tons per acre per year for soils that can sustain more erosion without significant productive rainfall. Soil properties affecting T factor values include texture, permeability, available water capacity, and depth to restrictive layer such as rock, clay, or gravel (NRCS, 2013, http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm). Data included in Appendix C is parsed based on soil profile depth.

In addition to the NRCS data referenced above, FirstLight has conducted years of river bank erosion studies along the Turners Falls Impoundment resulting in numerous filings with the FERC. As part of the Erosion Control Plan, FirstLight has conducted Full River Reconnaissance (FRR) surveys every 3-5 years since 1998. During these surveys, information such as bank height, bank slope, bank erosion, bank material, and degree of vegetation is collected. In addition to the FRRs, FirstLight recently filed long term monitoring transects within the Turners Falls Impoundment showing geomorphic changes over the last 10+ years. Thus, very specific information on erodibility is contained in these reports.

FERC Def #2a: Additionally, section 5.6(d)(3)(ii)(C) specifies that the PAD provide information on the erosion within the project area. However, while the PAD provides information on erosion around the Turners Falls reservoir, it did not provide any information on the presence of erosion, mass soil movement, slumping or other forms of instability along the bypass reach or the project's power canal. Therefore, pursuant to section 5.6(d)(3)(ii)(C)(2) of the Commission's regulations please provide a description of all known erosion sites within the Turners Falls project's bypass reach and/or along its power canal, and to the extent known, a determination as to the cause of the erosion. The description of each site should include the length of shoreline affected by erosion, the height of the eroded area, and the soil type.

FirstLight Response: FirstLight performed an aquatic mesohabitat study that encompassed the Turners Falls Bypass Reach during 2012. This work entailed walking the bypass reach from the Turners Falls Dam to the Cabot tailrace. The substrate within the bypass reach is primarily bedrock controlled with few areas containing fine substrate; the river-right embankments are naturally armored, high and steep-sided. The river-left embankments are primarily lined with buildings. No areas along the bypass reach river banks were found to be eroding.

FirstLight conducts annual inspections of the power canal in a partially dewatered state every September. During 2007-2009, Kleinschmidt Associates investigated an area within the Turners Falls power canal where a slough had formed along the eastern dike (about 400 feet downstream of where the power canal begins to widen) and actions to fix the issue were taking place. The erosion responsible for creating the slough was attributed to considerable sediment buildup toward the western side of the canal, which caused the water velocity along the east bank to be higher than originally intended. The original depth of the west side of the canal was 14 feet, but the sediment accumulation since the canal was built had created a large area where the depth was shallow enough for geese to stand. Additionally, the scouring in the vicinity of the slough was 17 feet below the water level of the canal during dewatering inn 2007; by 2008, the scoured hole was 20 feet deep. Removal of sediment from the west bank to the scoured area, along with the addition of stone to stabilize the sediments, resulted in the hole being filled with 42,700 cubic yards (CY) of fill. It was concluded that the work completed in 2009 was a success, with improved flow distribution and lower velocities along the eastern dike. Also, armoring likely increased the stability of the dike with reduced potential for future sloughing. A 300 foot long section of scour at the downstream end of the filled in area was not considered a priority due to being shallow and was not filled in; it is a potential location for future redistribution of silt. A report was filed by Kleinschmidt Associates ("Canal Maintenance Completion Report", July 2009) under Critical Energy Infrastructure Information (CEII).

FERC Def #2b: As specified in § 5.6(d)(3)(ii)(C), please provide a description of reservoir shorelines within the Northfield Mountain upper reservoir. The description should include a description of soils, geometry, and existing armoring and stabilization measures.

FirstLight Response: The shoreline of the Northfield Mountain Reservoir is approximately 3.5 miles long. The majority of the shoreline is the rockfill embankment, but there are also four natural ridges. The 3.5 mile shoreline is comprised of approximately 2.2 miles of rockfill embankment, 0.8 miles of more natural (primarily udorthents, or human disturbed) soils and 0.5 miles of excavated bedrock (near the intake). The United States Department of Agriculture's online Web Soil Survey application was queried for soil identification and description, for the approximately 0.8 miles of udorthent soil. An area at the northern end of the reservoir is identified as Woodstock-Millsite-Rock outcrop complex. This soil, which comprises about 1,000 feet of the shoreline, consists of very rocky and rocky soils and rock outcrop. The Soil Survey Report also identified an area about 1800 feet long on the west shore and an area about 1400 feet long on the northeast shore, along natural ridge areas, which consist of generally very fine sand to fine sandy loam. There is some grass and other low growing vegetation on the north shore and west shore areas identified above. The northeast shore area is generally free of vegetation. The upstream face of the embankment consists of large stone fill, with an overall slope of approximately 1:1.8 (V:H), though the upper portion of the slope is somewhat steeper at about 1:1.5 (V:H). There is little to no vegetation growing along this portion of the shoreline, except at very low elevations in some areas, where sediment has deposited.

The upper reservoir, intake channel and intake structure are in the Dry Hill gneiss, which is quite durable and hard rock material. The rocks comprising the west flank of the Northfield Mountain are part of the hard crystalline metasedimentary complex. Near the crest of the mountain, the Dry Hill granite gneiss crops out with the average layering dips from 10° to 12° to the N68°W. Stratification around the project suggests that the ancient sedimentary sequence was metamorphosed by intrusive sills, perhaps from the east. Past studies have indicated that the Dry Hill is considered as an igneous unit, which intrudes the Poplar Mountain formation. The upper portion of the Dry Hill appears to be much less highly metamorphosed, with massive strata separated by thin interbeds of dark biotite and hornblende. Additional information on the geology of the Northfield Mountain Project is included in Section 4.2.2 of the PAD.

FERC Def #2c: As specified in § 5.6(d)(3)(ii)(B), please provide a description of the sediment management in the Northfield Mountain upper reservoir, including monitoring, removal and disposal.

FirstLight Response: On February 15, 2012 FirstLight submitted for FERC approval a *Sediment Management Plan* for the Northfield Mountain Project. As part of this plan, FirstLight has committed to monitoring suspended sediment concentration in the Northfield Mountain Project intake and discharge under a range of operating and ambient river conditions; monitor suspended sediment concentration in the Turners Falls Impoundment at the Route 10 Bridge under a range of flow and water level elevation conditions; conduct bathymetric mapping of the upper reservoir to estimate annual sediment accumulation rates and locations; and, at the end of the monitoring period (2015) propose measures to address the entrainment of sediment into the Project works during upper reservoir drawdown or dewatering activities. For a detailed description of sediment monitoring activities please refer to the *Sediment Management Plan*[2].

2.1.3 Water Resources (FERC Deficiency #3)

FERC Def #3: Please provide the Northfield Mountain upper reservoir maximum, minimum and mean depth as well as the shoreline length as required per § 5.6(d)(3)(iii)(H) of the regulations.

FirstLight Response: As described in Section 3.2.2 of the PAD, the upper reservoir has a gross storage capacity of 17,050 acre-feet and a surface area of approximately 286 acres at a water surface elevation of 1000.5 feet. The mean depth is calculated to be 59.6 feet. Based on the most recent bathymetric survey of the upper reservoir conducted in 2012, the maximum depth in the upper reservoir is approximately 120 feet when the reservoir is full.

The shoreline of the upper reservoir is approximately 3.5 miles long.

2.1.4 Recreation and Land Use (FERC Deficiency #4)

FERC Def #4: For Turners Falls Fishway Viewing Area and Bennett Meadow Wildlife Management Area (WMA) please address the ownership information as specified in § 5.6 (d)(3)(viii)(A).

FirstLight Response: FirstLight owns in fee the Turners Falls Project fish viewing area and the Bennett Meadows Wildlife Management Area.

2.1.5 Aesthetic Resources (FERC Deficiency #5)

FERC Def #5: The PAD did not provide information on the description of aesthetic and visual characteristics of the Turners Falls Project dam and adjacent facilities as required by § 5.6(d)(3)(ix). Please provide this information with accompanying photos (if available).

FirstLight Response: As described in Section 3.2.1 of the PAD, the Turners Falls Dam consists of two individual concrete dams—Gill Dam and Montague Dam—that are connected by a natural rock island known as Great Island. The 630-foot-long, approximately 35-foot-high Montague Dam connects Great Island to the west bank of the Connecticut River and includes four gates 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.

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[2] FirstLight filed its *Sediment Management Plan* with FERC on July 15, 2011.

The power canal gatehouse is located on the Montague side of the Connecticut River, forming the abutment for connecting the Montague Dam spillway. The structure is approximately 214 feet long and has masonry and reinforced concrete foundations with a brick walled superstructure.

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.

An aerial image of the dam, gatehouse, and upstream ends of the power canal and bypass reach is shown in Figure 2.1.5a. The Gill-Montague Bridge just below Turners Falls Dam provides limited views of the dam and bypass reach.

Station No. 1 is located approximately 0.8 miles downstream from the dam along the bypass reach, where it is connected to the power canal via an approximately 700-foot-long by 100-foot-wide branch canal. The powerhouse consists of brick masonry on concrete foundations and has eight intake bays—each 15 feet wide for a total intake width of 120 feet—narrowing to four penstock outlets. Figure 2.1.5b shows a view of Station No. 1 from the bypass reach. The powerhouse can generally only be viewed by the public from the bypass reach (access to the powerhouse is gated).

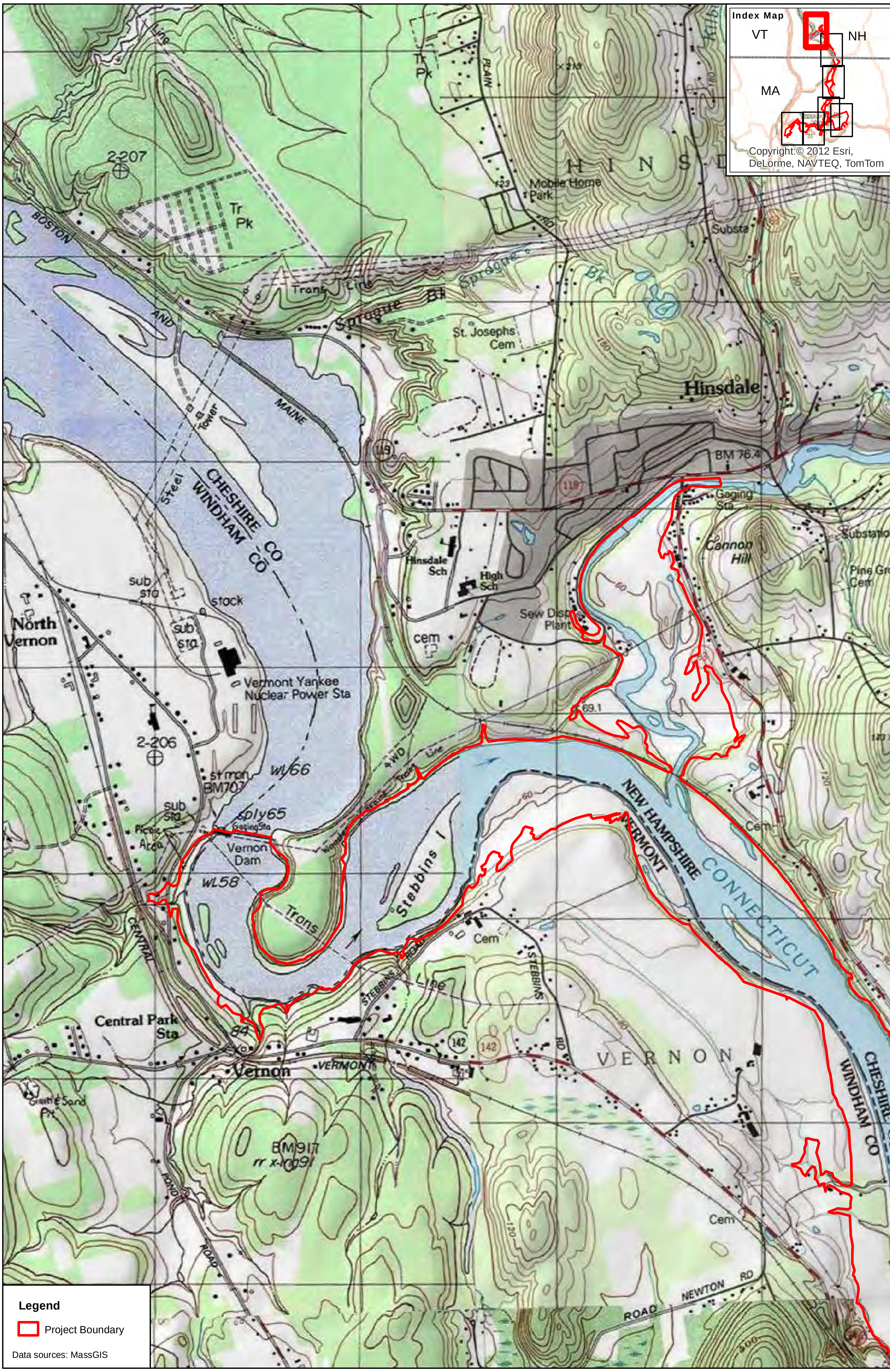
Cabot Station is located at the downstream terminus of the power canal. The powerhouse is a brick and steel structure set on a concrete substructure on a rock foundation, with an intake opening 217 feet wide by 31 feet high. Adjacent to the powerhouse are eight wooden spillway gates. An upstream view of Cabot Station from the Tailwater area is shown in Figure 2.1.5c. As with Station No. 1, the powerhouse can generally only be viewed by the public from the bypass reach (powerhouse access is gated).

2.1.6 Cultural Resources (FERC Deficiency #6)

FERC Def #6: Please provide a description of existing discovery measures for locating, identifying, and assessing the significance of resources as specified in § 5.6(d)(3)(x)(B). Please provide available information on Indian traditional cultural and religious properties as specified in § 5.6(d)(3)(x)(C).

FirstLight Response: FirstLight consults with the applicable State Historic Preservation Office (SHPO), whenever FirstLight proposes to undertake ground-disturbing activity within the Turners Falls Project and Northfield Mountain Project boundaries that require a state or federal permit, in order to locate, identify, and assess the significance of either known or currently unknown cultural resources. In addition, prior to granting permission to others for non-Project uses of Project lands and waters, FirstLight consults with the applicable SHPO in accordance with the procedures of Article 43 of the Turners Falls Project license and Article 52 of the Northfield Mountain Project license. The purpose of such consultation is to determine whether such grants of permission or ground disturbing activity have the potential to adversely affect historic properties.

There are no known Indian traditional cultural properties (TCPs) or religious properties within the Turners Falls Project and Northfield Mountain Project boundaries. One property – The Turners Falls Sacred Ceremonial Hill Site – was determined eligible for inclusion in the National Register of Historic Places as a TCP in 2008. No portion of this ceremonial site is located in either of the Projects' boundaries.



FirstLight Power Resources
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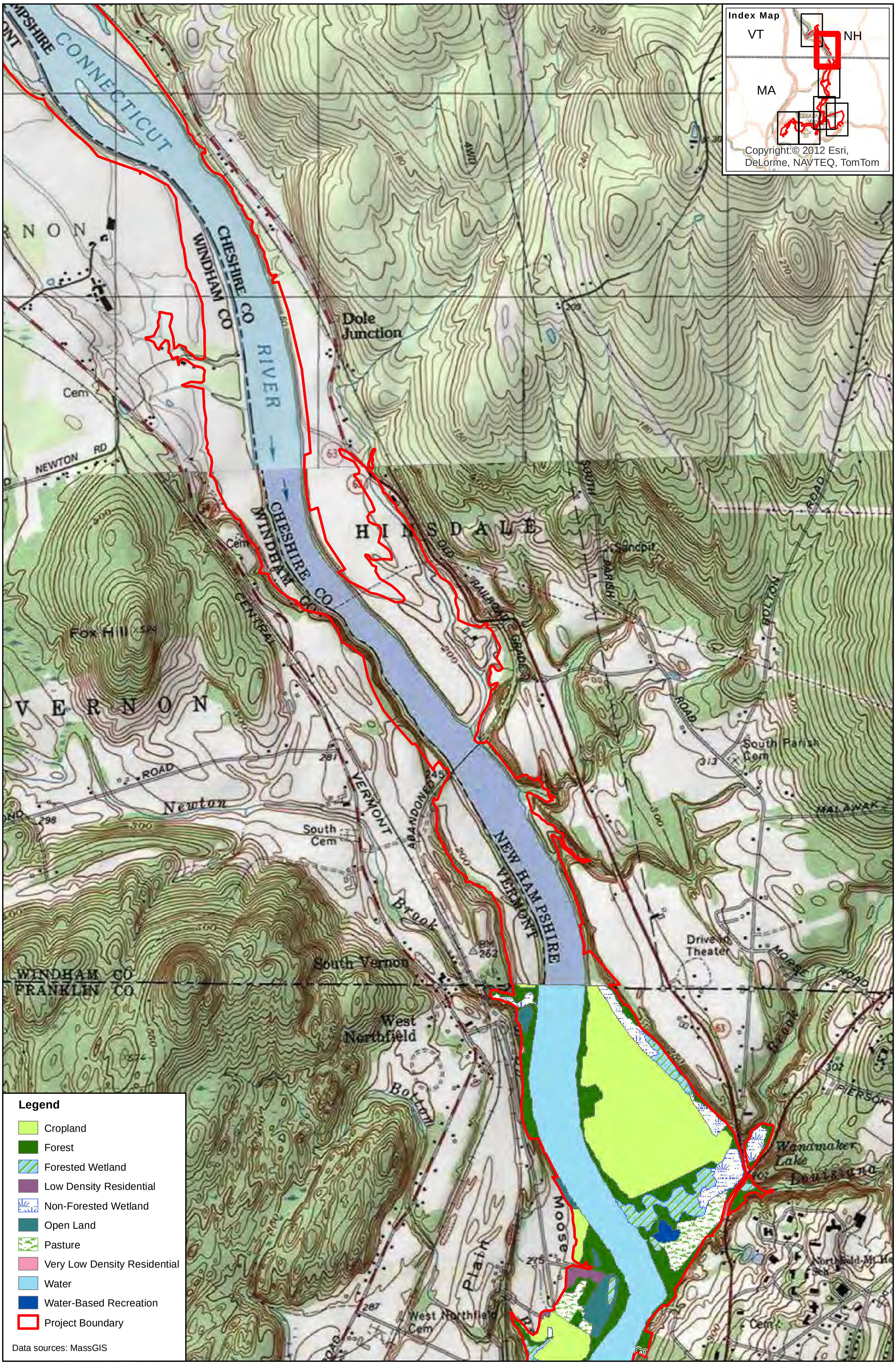
FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

0 750 1,500 3,000 Feet

FIGURE 2.1.1 a
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 1 of 7

Path: W:\gis\maps\revised_study_plan\Figure 2.1.1 (a-g).mxd



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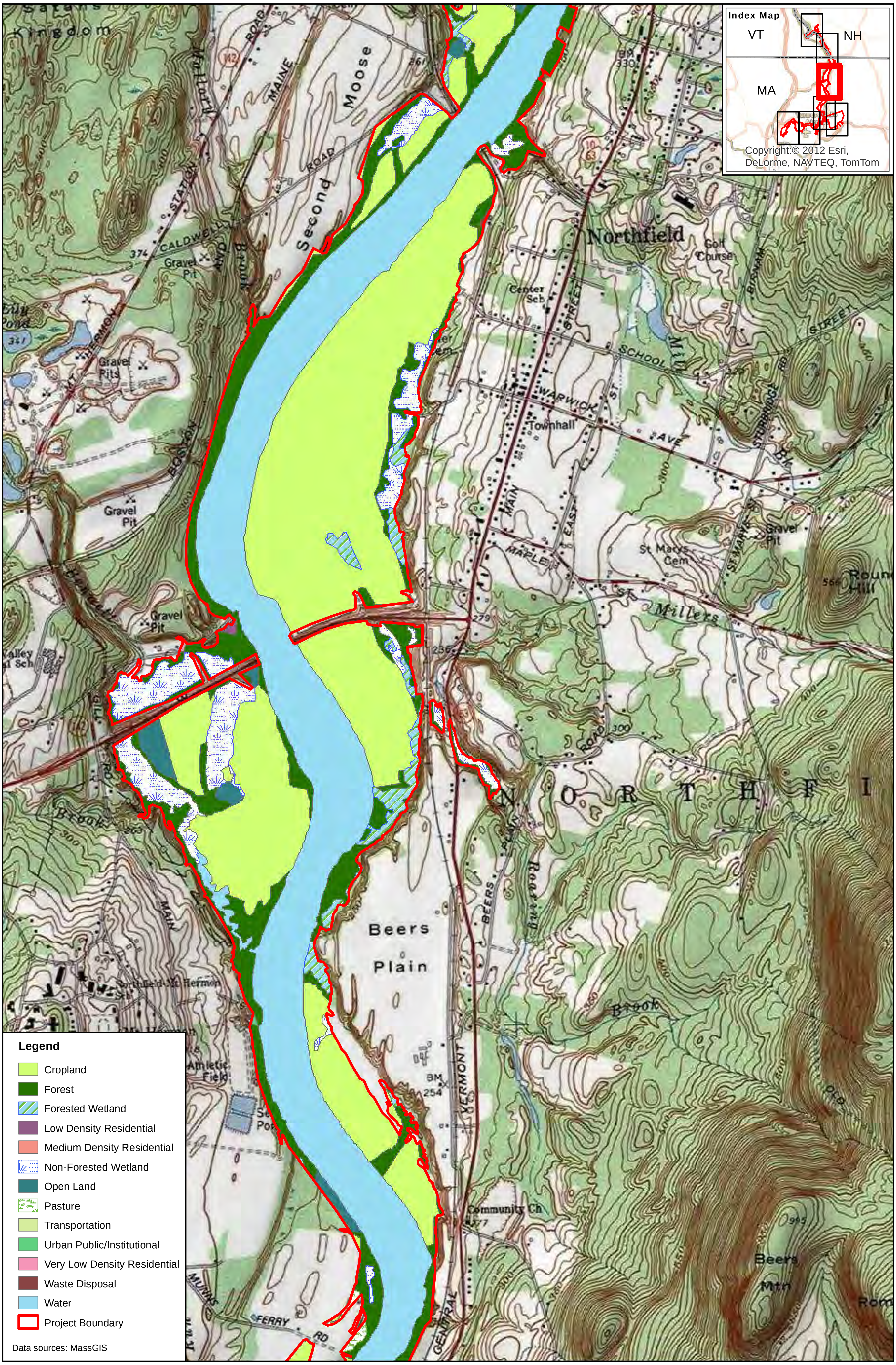
REVISED STUDY PLAN

0 750 1,500 3,000 Feet

FIGURE 2.1.1 b
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 2 of 7

Path: W:\gis\maps\revised_study_plan\Figure 2.1.1 (a-g).mxd



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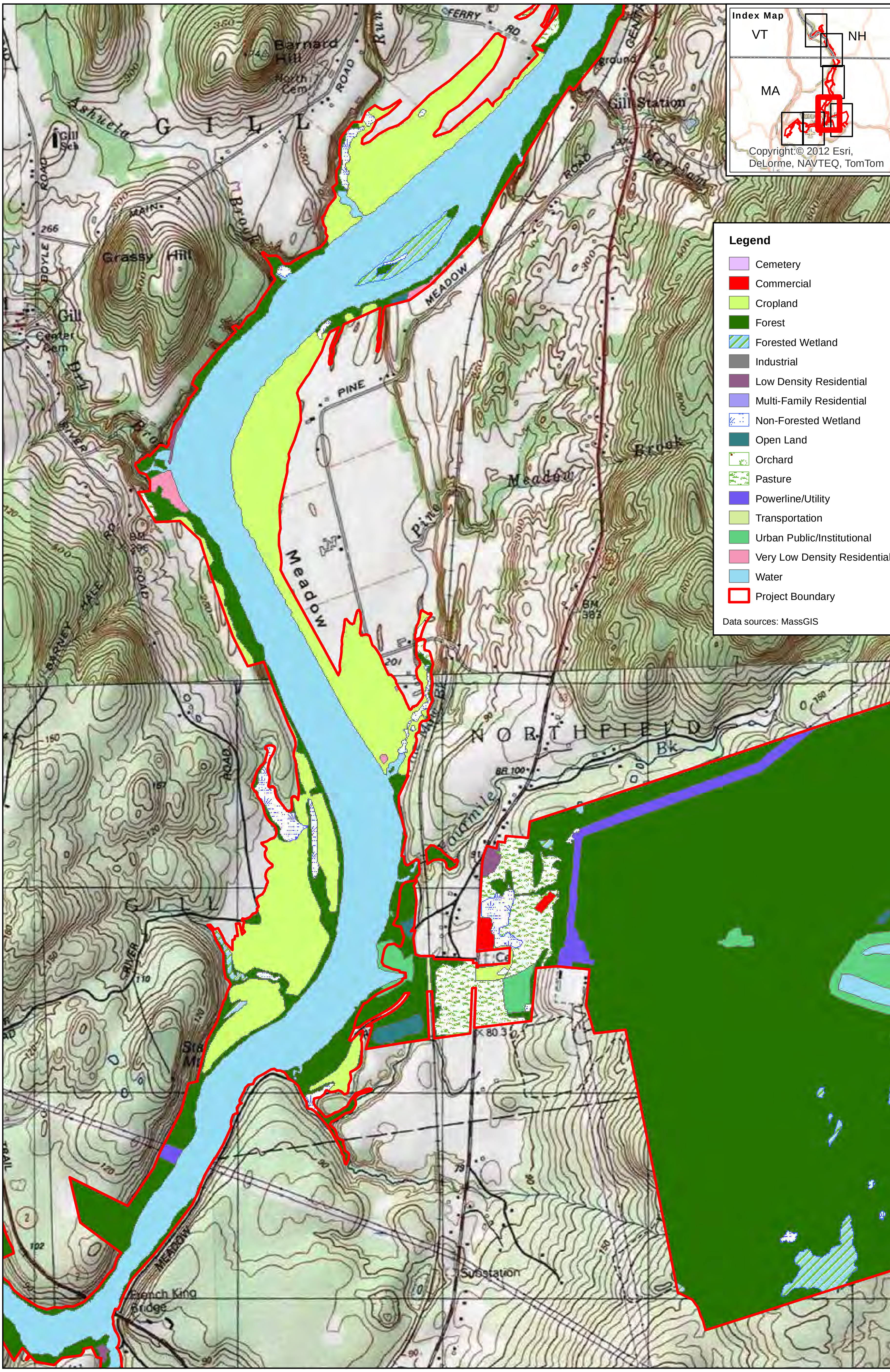
REVISED STUDY PLAN

0 750 1,500 3,000 Feet

FIGURE 2.1.1 c
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 3 of 7

Path: W:\gis\maps\revised_study_plan\Figure 2.1.1 (a-g).mxd



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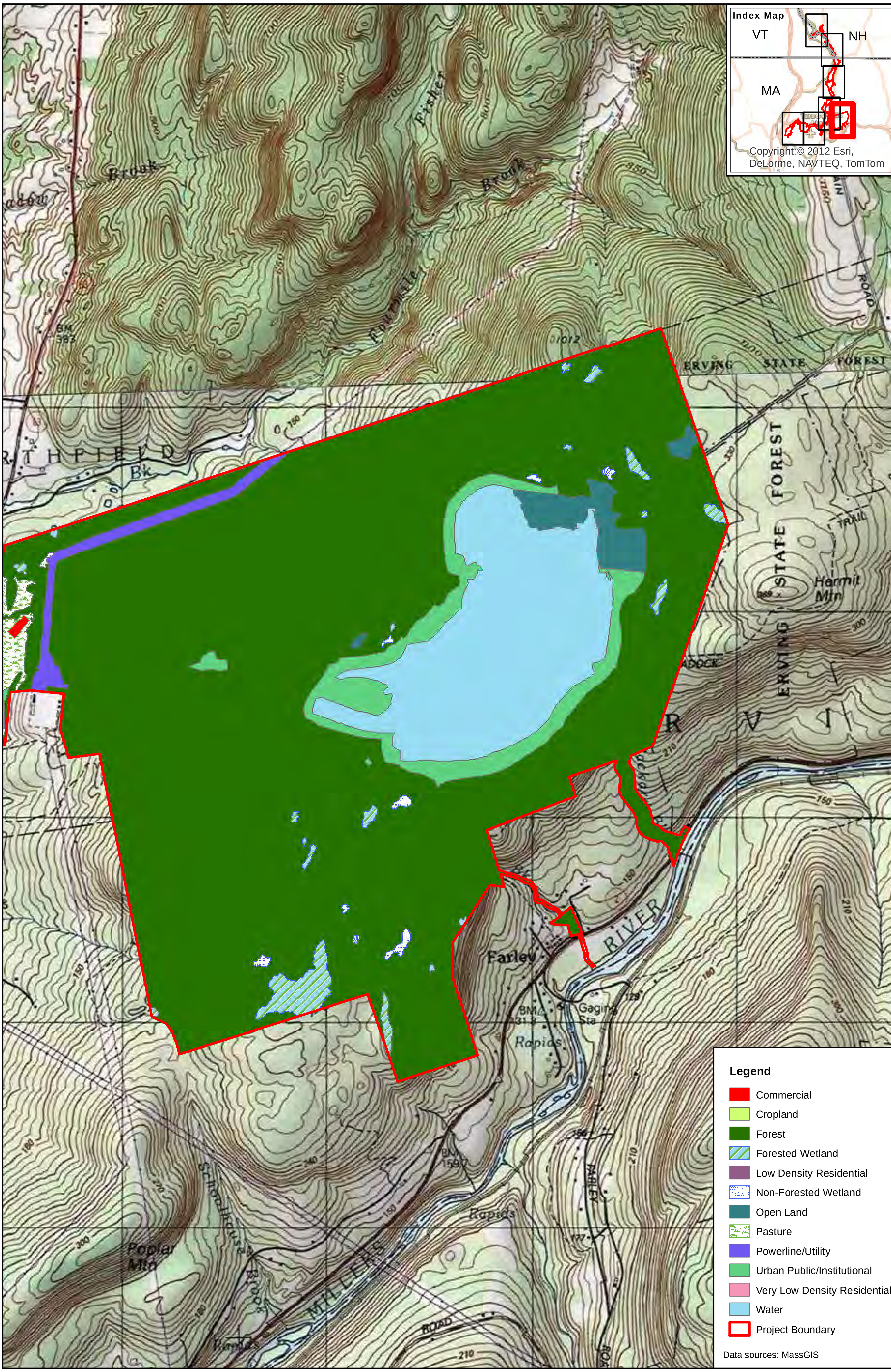
FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

0 750 1,500 3,000 Feet

FIGURE 2.1.1 d
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 4 of 7

Path: W:\gis\maps\revised_study_plan\Figure 2.1.1 (a-g).mxd



FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

FirstLight Power Resources
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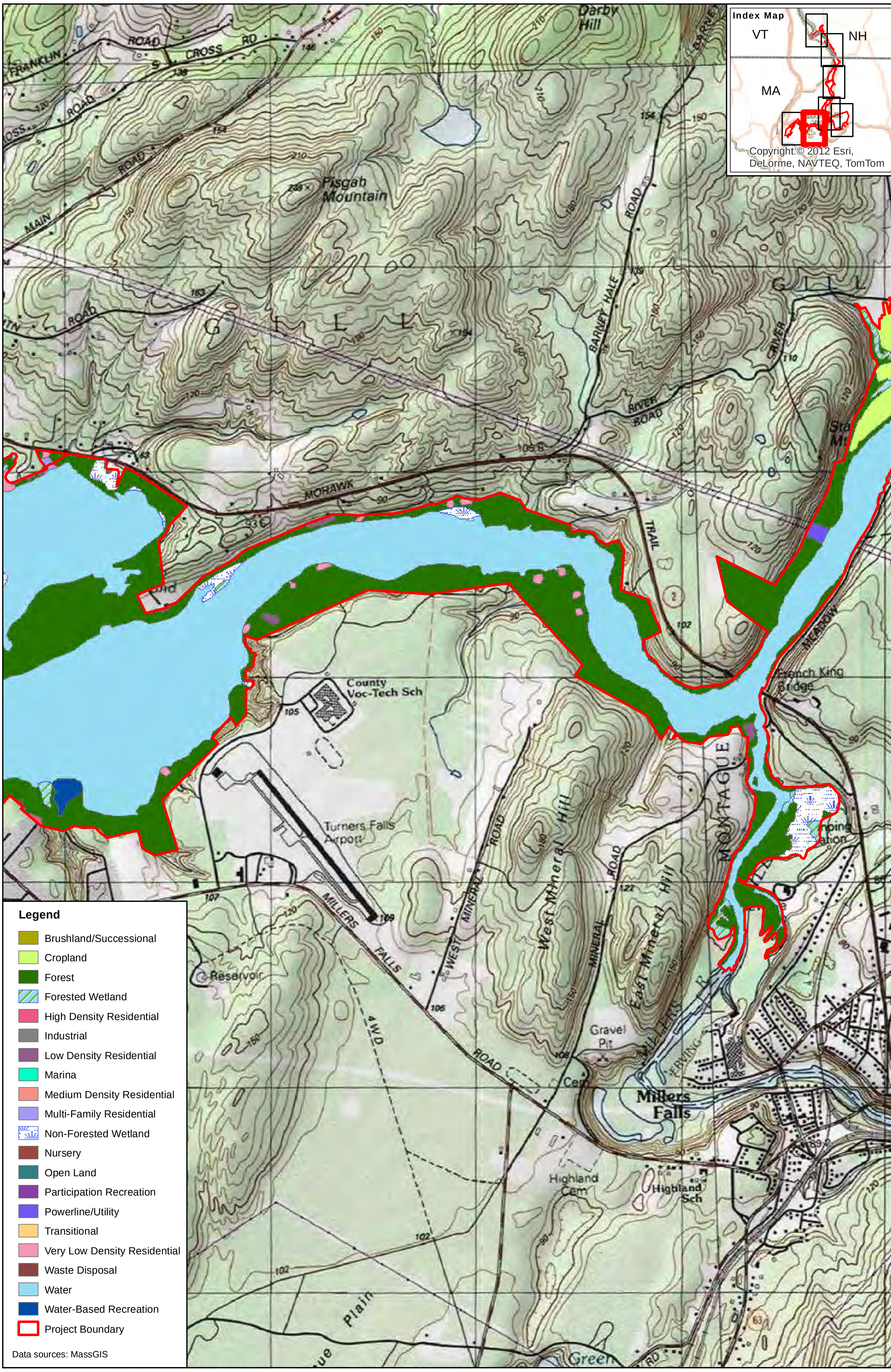
0 750 1,500 3,000 Feet

FIGURE 2.1.1 e
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 5 of 7

Path: W:\gis\maps\revised_study_plan\Figure 2.1.1 (a-g).mxd



FirstLight Power Resources

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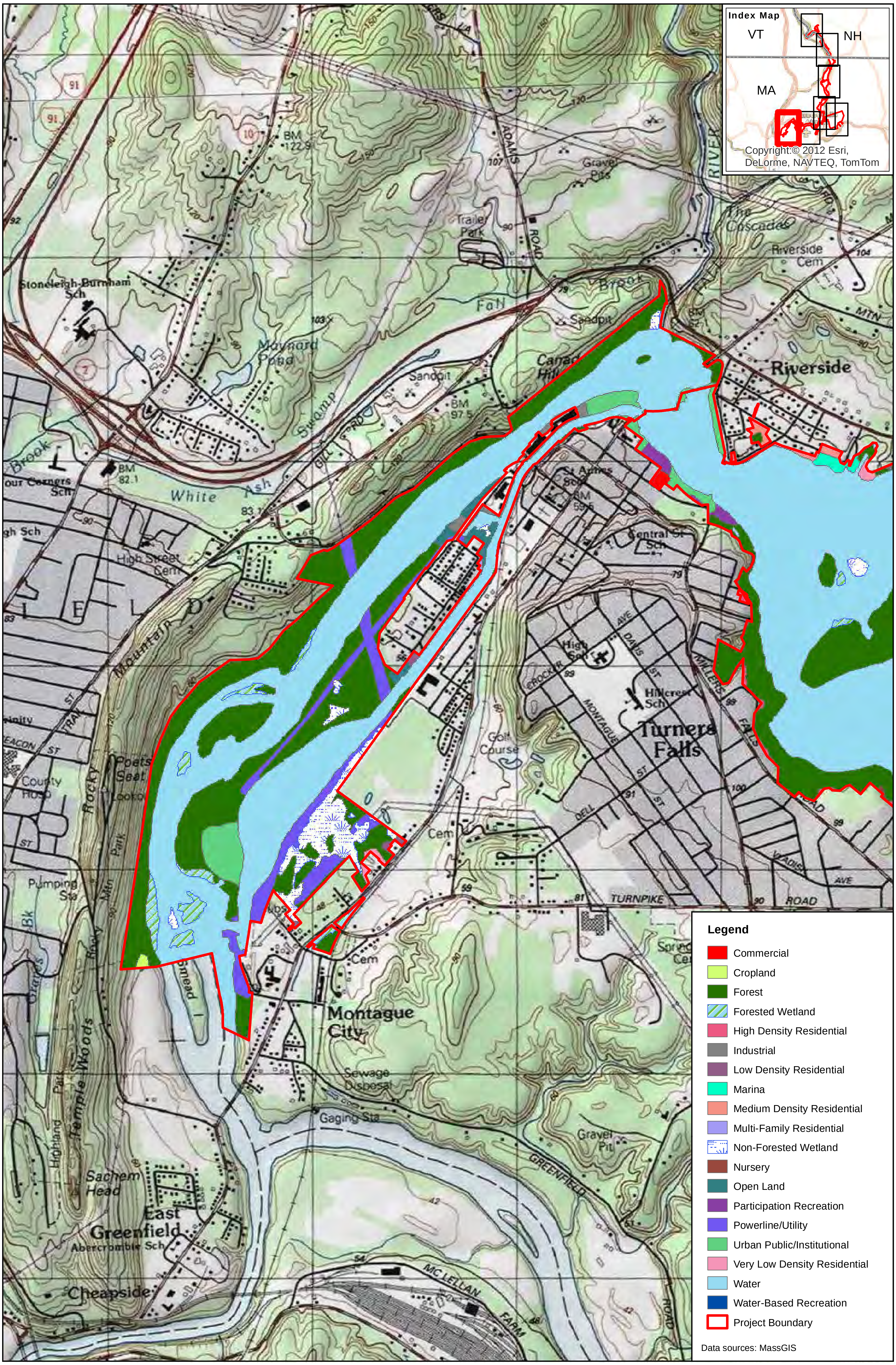
FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

0 750 1,500 3,000 Feet

FIGURE 2.1.1 f
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 6 of 7

Path: W:\gis\maps\revised_study_plan\Figure 2.1.1 (a-g).mxd



FirstLight Power Resources GDF SUEZ

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FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

0 750 1,500 3,000 Feet

FIGURE 2.1.1 g
Turners Falls Project and Northfield Mountain Project Land Use Maps
Page 7 of 7

Path: W:\gis\maps\revised_study_plan\Figure 2.1.1 (a-g).mxd

Figure 2.1.5 (a-c): Photographs of Turners Falls Dam and Adjacent Facilities

Figure 2.1.5a – Turners Falls Dam, Bypass Channel, and Power Canal (looking downstream)

Figure 2.1.5b – View of Station No. 1 from Bypass Channel

Figure 2.1.5c – Upstream View of Cabot Station from Tailwater Area

2.2 Turners Falls FERC Additional Information Requests

2.2.1 Proposed Changes to Project Operation (FERC AIR #1)

FERC AIR #1: In the PAD you identify alternatives you will consider through the licensing process for potential changes to facilities and operation of the Turners Falls Project including the following: (1) upgrade Station No. 1 with new or rehabilitated turbines, (2) close Station No. 1 and add a turbine generator at Cabot of similar hydraulic capacity to Station No. 1's, and (3) use the full hydraulic capacity of Cabot Station turbines. However, you do not describe the extent or range of the possible modifications to the hydraulic capacity of Cabot Station and Station No. 1. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please provide detail on the physical and operational changes contemplated at the Turners Falls Project.

FirstLight Response: The combined hydraulic capacity of Cabot Station (13,728 cfs) and Station No. 1 (2,210 cfs) is approximately 15,938 cfs. The maximum hydraulic capacity of the power canal is approximately 18,000 cfs. In addition to Cabot Station and Station No. 1 there are other water entities having water rights to withdraw water from the canal including: Southworth Paper (115 cfs), Turners Falls Hydro, LLC (288 cfs), and a minimal amount of water used by the United States Geological Service (USGS) Conte Anadromous Fish Laboratory. Thus, any increase in hydraulic capacity would be no more than 18,000 cfs less 15,938 cfs, plus water needed for other canal users, or less than approximately 2,000 cfs. Not until studies[3] are conducted will FirstLight have a better sense of whether to propose additional hydraulic capacity, and if so, whether the additional hydraulic capacity would be located at Cabot or Station No. 1.

2.2.2 Cultural Resources (FERC AIR #2)

FERC AIR #2: In section 5.2.10 of the PAD you propose to conduct a Phase IA Archaeological Survey and Historic Structures Survey of the APE. You also indicate that FirstLight may propose to conduct a Phase IB archaeological and an intensive-level architectural level survey, depending on the results of the Phase IA investigation and after consultation with the Massachusetts, New Hampshire, and Vermont SHPOs. However, you have not provided a map specifically defining the APE, and we are unclear on how you would specifically carry out the various tasks involving your proposed study.

Include in your study proposal that you would also consult with the Vermont, Massachusetts, and New Hampshire SHPOs, and any involved Indian tribe or other interested parties in formulating each of the tasks listed below. As a result, we ask you to include the following in your study proposal for cultural resources:

a) Define an APE for the project that would include all lands enclosed by the project boundary including both in-water and on-shore project lands and facilities, and lands or properties outside the project boundary where project operations or other project-related activities may directly or indirectly cause changes in the character or use of historic properties, if any historic properties exist. Your study proposal should also include a record of consultation with the Vermont, Massachusetts, and New Hampshire SHPOs, involved Indian tribes, and other interested parties regarding the APE (Once you have defined your APE, send your APE definition and APE map to the Vermont, Massachusetts, and New Hampshire SHPOs and seek their concurrence. The APE

[3] The study that will best inform potential changes to the hydraulic capacity of the Turners Falls Project is Study No. 3.3.1 *Conduct Instream Flow Habitat Assessment in the Bypass Reach and below Cabot Station*, as described later in this document.

definition and map should be included in your study proposal, along with a record of consultation.). Include a detailed map showing all aspects of the APE, including designations of land ownership**.**

b) Include the specific techniques on how you would carry out the Phase IA investigation, in addition to any other methods (if needed) by which other cultural resources that may be directly or indirectly affected by the project will be inventoried. Your proposal should include methods for inventorying all archaeological and historic resources that may lie within the APE, including project facilities, non-project architectural resources, and properties of traditional religious or cultural significance. Attention should be given on the assessment of the Turners Falls Ceremonial Site and proposed Great Falls Native Cultural Park, and potential project-related effects to these places (see Town of Montague filing, dated February 6, 2013 and filed on February 20, 2013).

c) Develop and include in your study proposal a process for evaluating the National Register of Historic Places (National Register) eligibility of all cultural resources during the field inventory stage, and afterwards, through additional second season field investigations (If necessary: If all National Register eligibility determinations cannot be done in either the first or second season of field investigations, a program to follow-up on completing all National Register eligibility determinations of properties located within the APE could be developed and included in the Historic Properties Management Plan (HPMP).), including a strategy for examining, testing, or excavating cultural resources. This process should take into account applicable guidelines and standards promulgated by the Vermont, Massachusetts, and New Hampshire SHPOs.

d) Elaborate on what methods you would use to identify any existing project-related effects (both direct and indirect) on historic properties recorded during the field inventory, and determine how project operations may affect or potentially affect them.

e) Include in any study report: (1) a background section on previous work in and around the APE; (2) a culture history of the research area; (3) definition and map of the APE; (4) methods used for the archival research and field pedestrian survey and how the APE was systematically inventoried; (5) the results of the survey and detailed descriptions of the cultural resources found (including a table depicting type of cultural resources, age, property location, and land ownership associated artifacts, existing and potential effects, and National Register eligibility status); (6) results of National Register evaluations for all cultural resources located within the APE(In consultation with the involved parties, once you have determined which cultural resources may, or may not be eligible for the National Register, submit your evaluations to the Vermont, Massachusetts, and New Hampshire SHPOs (as applicable) for concurrence.); and (7) site or resource specific descriptions of existing and potential project-related effects on cultural resources considered to be eligible for inclusion in the National Register. Put a statement in your study proposal you will also prepare a HPMP in consultation with the involved parties and will file a draft HPMP along with your preliminary licensing proposal, and a final HPMP with your final license application (Note that once the Commission finds the HPMP to be final, we would attach it to a programmatic agreement and after noticing the Advisory Council on Historic Preservation, we would execute the programmatic agreement with the Vermont, Massachusetts, and New Hampshire SHPOs, if the Advisory Council on Historic Preservation declines to participate. Execution of the programmatic agreement would evidence that the Commission has resolved any potential adverse effects to historic properties involved with the proposed project.). Among other things, the HPMP should provide site-specific measures to resolve any potential project-related adverse effect to historic properties located within the project’s APE. You should use the Guidelines for the Development of Historic Properties Management Plans for FERC

Hydroelectric Projects, developed by the Advisory Council on Historic Preservation and Commission in May 2002.

f) Provide a schedule for carrying out all of the various tasks involving your study, including the filing of draft and final reports and HPMPs.

g) Provide estimated costs associated with the various tasks in your study, along with the costs of report production and crafting the HPMP.

FirstLight Response: Sections 3.7.1 and 3.7.2 of the RSP contain FirstLight's study plans for the proposed Phase IA Archaeological Survey and Historic Structures Surveys. FERC's AIR requests that the study plans include a definition of the Area of Potential Effect (APE) and a record of consultation with the Vermont, New Hampshire, and Massachusetts SHPOs on the proposed definition of the APE. Typically, however, consultation with the SHPOs regarding an APE, occurs in conjunction with a SHPO's review of the cultural resources study plans so that the SHPOs will have a context in which to determine an APE. The study plans proposed herein include a proposed definition of the APE. During a study plan meeting held on June 12, 2013, the Vermont SHPO indicated that a 10-meter wide APE along waterway shorelines for archaeology has been used for hydroelectric relicensing projects in Vermont. Section 3.7.1 and 3.7.2 of this RSP contain proposed APE maps for archaeology and for historic structures, respectively. The study plans also include a proposal to consult with the Vermont, New Hampshire, and Massachusetts SHPOs and the Narragansett Tribal Historic Preservation Officer (THPO) on the precise definition of the APE for the Projects.

FERC's AIR requests that the study plans should give attention to the assessment of the Turners Falls Ceremonial Site, the Town of Montague's proposed Great Falls Native Cultural Park and potential project-related effects to these places. The Turners Falls Ceremonial Site is located well away from the Projects. To the extent that any historic properties within the APE are identified during the course of archaeological studies undertaken in connection with the relicensing that may have a connection to the Great Falls Native Cultural Park, FirstLight will discuss these properties in its archaeological survey reports.

FERC's AIR also requests that the cultural resources study plan provide estimated costs associated with the various tasks in the study plan, along with the costs of report production and crafting the HPMP. The study plans include costs for conducting the Phase IA Archaeological Survey, Historic Structures Survey and the TCP Study. These costs include the costs of report production. To the extent that an HPMP is necessary, FirstLight has also provided an estimate for the crafting of an HPMP. This cost will need to be refined after cultural resources surveys are complete and results are available to inform the need for and, if needed, the development of an HPMP.

2.2.3 Socioeconomic (FERC AIR #3)

FERC AIR #3: In PAD section 4.11.1., you cite a document referred to as "PVPC". However, you do not provide the complete citation. Therefore, so that we may fully understand the supporting documentation for the PAD, please provide the complete citation for the PVPC reference in PAD section 4.11.1. If this document is not readily available to the public please provide a copy of the document.

FirstLight Response: The information was obtained from the Pioneer Valley Planning Commission, and is currently available to the general public. The citation is:

Pioneer Valley Planning Commission (PVPC). (n.d). Profile of the Region – The Pioneer Valley. Retrieved from http://www.pvpc.org/about/profileofregion.shtml on 3/13/2013.

2.2.4 Recreation and Land Use (FERC AIR #4)

FERC AIR #4: In the PAD, the current project boundary maps are presented. However, it is difficult to discern ownership and extent of shoreline buffer from the maps and associated narrative in the PAD. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please describe the project boundary (i.e., is it a metes and bounds survey, and elevation contour, or some combination), and shoreline buffer (e.g., typical distance from normal reservoir elevation to the project boundary, vegetative cover types).

In the PAD, there is no information on the recreation facilities and public access and use on the unnamed island located to the west of the power canal and east of the bypassed reach of the Connecticut River. The PAD also lacks information regarding how access to the island may be restricted by project uses. During the scoping meetings, we learned that the island is accessible by two walkway bridges which are currently closed. Therefore, please provide information on the ownership and management of the walkway, bridges, and an explanation of why the bridges are closed.

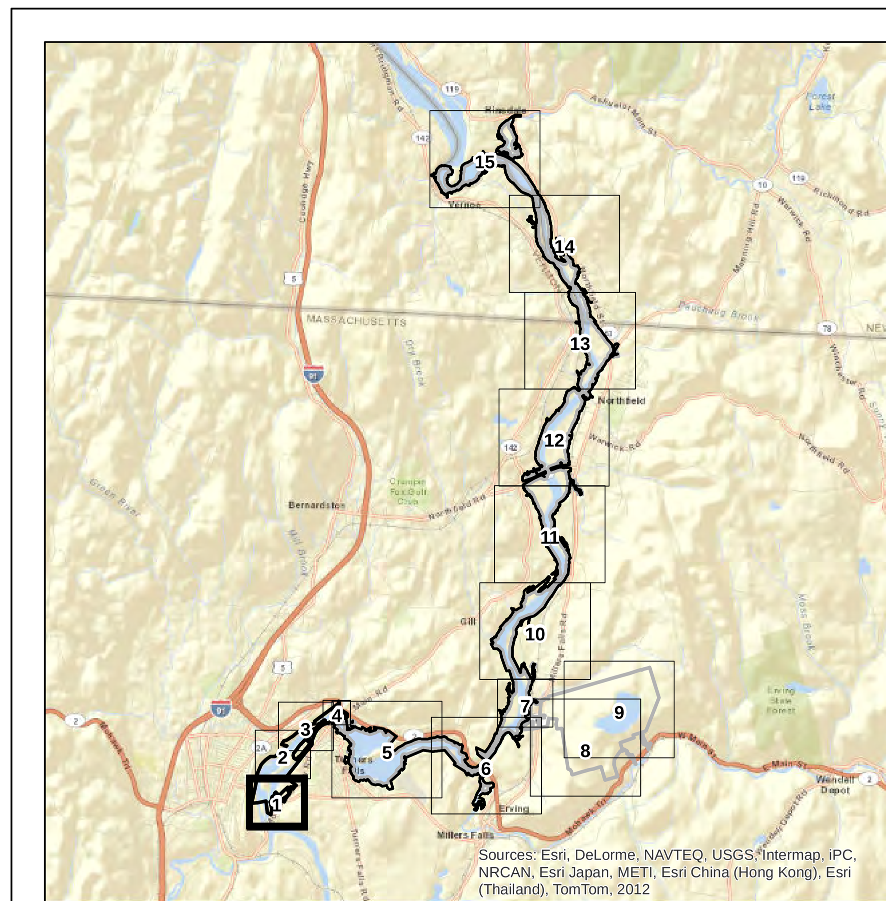
FirstLight Response: Detailed aerial maps of the Turners Falls and Northfield Projects showing the Projects' boundaries by metes and bounds survey and/or contour elevations, shoreline buffers, and location of recreational facilities associated with the Projects are contained in Figures 2.2.4-1 to 2.2.4-15.

The first walkway bridge is the Strathmore Footbridge. In an 1873 indenture between Turners Falls Company (TFC), predecessor to the Licensee, and Keith Paper Company (KPC), predecessor to the Town of Montague in which TFC conveyed land to KPC, TFC agreed to "*forever maintain a suitable bridge over said canal*." After the canal was lengthened and widened in the early 1900's, TFC and KPC reached a new agreement, which was recorded in a 1912 indenture. In this indenture was a lease that allowed TFC and its successors, for a period of 99 years, to maintain and operate a drain or tunnel (Keith drainage pipe) across KPC's land from the canal to the westerly edge of the Connecticut River. In consideration of this, TFC agreed to construct and maintain a steel footbridge from Canal Street to the mill for the purpose of traveling to the mill and carrying "*property, goods and merchandise*." The mill side of the bridge ends in the mill's second floor. The obligation to maintain the footbridge lasted the duration of the lease. Paper production at the mill stopped in 1994 when the then current mill owner (International Paper) shut down operations. The lease expired March 31, 2011 and the Strathmore footbridge was closed. FirstLight retains title to the footbridge. The Strathmore Bridge has never been used or needed for project purposes.

The second bridge is known as the IP Bridge. The IP Bridge resides just downstream of FirstLight's canal headgate house for the power canal. This bridge was present before the canal enlargement and was also modified. Another International Paper Company mill was located on the island near the headgate house, and this bridge was used for mill access. Unlike the Strathmore footbridge, the IP Bridge was built for vehicular use. The bridge is currently posted for a weight limit of 20 ton (2 axle truck) and 30 ton (3 axle truck) with a posted speed limit of 10 miles per hour. The bridge is gated to restrict vehicular access although it is available for emergency use up to the ratings posted. In addition, FirstLight allows pedestrian access across the bridge for recreation purposes, such as fishing access. FirstLight retains title to the IP Bridge.

The State of Massachusetts owns and maintains three other bridges that provide access to the island. The Fifth Street Bridge provides for vehicular access to the industrial end of the island from the Town of Montague for mill access and deliveries. The Sixth Street bridge, located just downstream of the Fifth Street bridge and the Eleventh Street bridge located just downstream of the Sixth Street bridge, are used to access a residential area on the island, the USGS Conte Research Laboratory, the Turners Falls Project No. 1 Station, Branch Canal, Cabot Woods recreation areas, and the back gate of Cabot Station.

The locations of the five bridges are depicted on Figure 2.2.4 -3 and Figure 2.2.4-4.



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary

N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds

ELEV. 207.6 FT — Project Boundary Elevation Contour

N

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FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-1

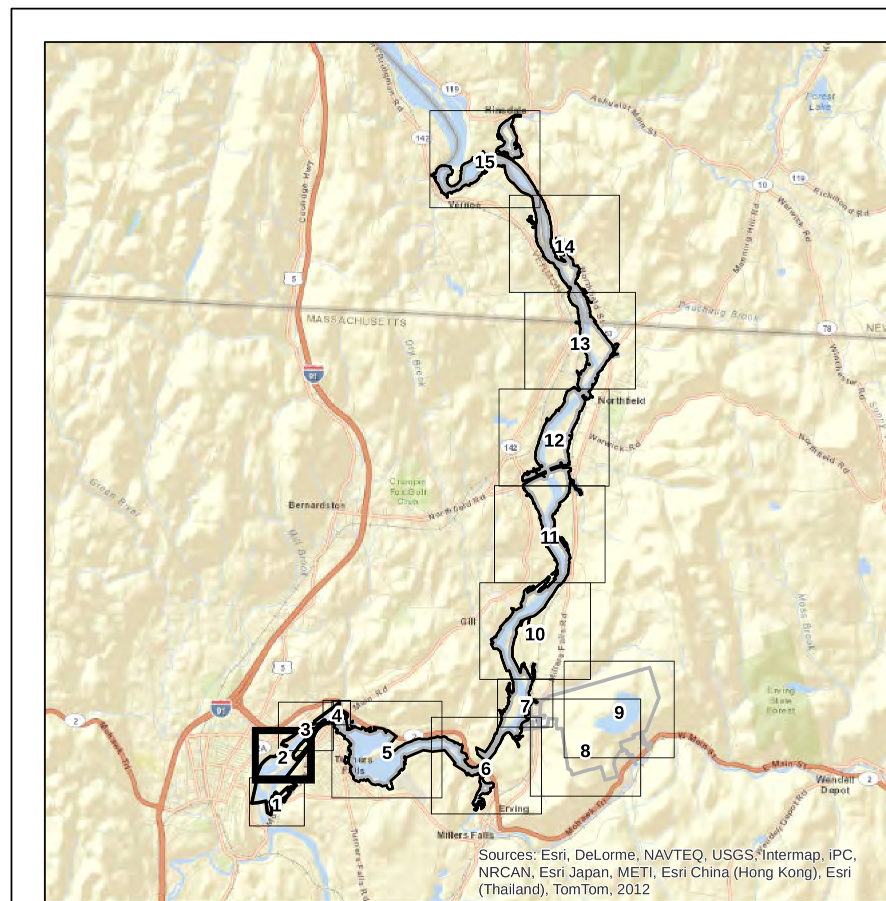
SHEET 1 OF 15

200 100 0 200 400 600 800 Feet

1 inch = 200 feet

When printed full size (28"X40")

1:2,400



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary

N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds

ELEV. 207.6 FT — Project Boundary Elevation Contour

N

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REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-2

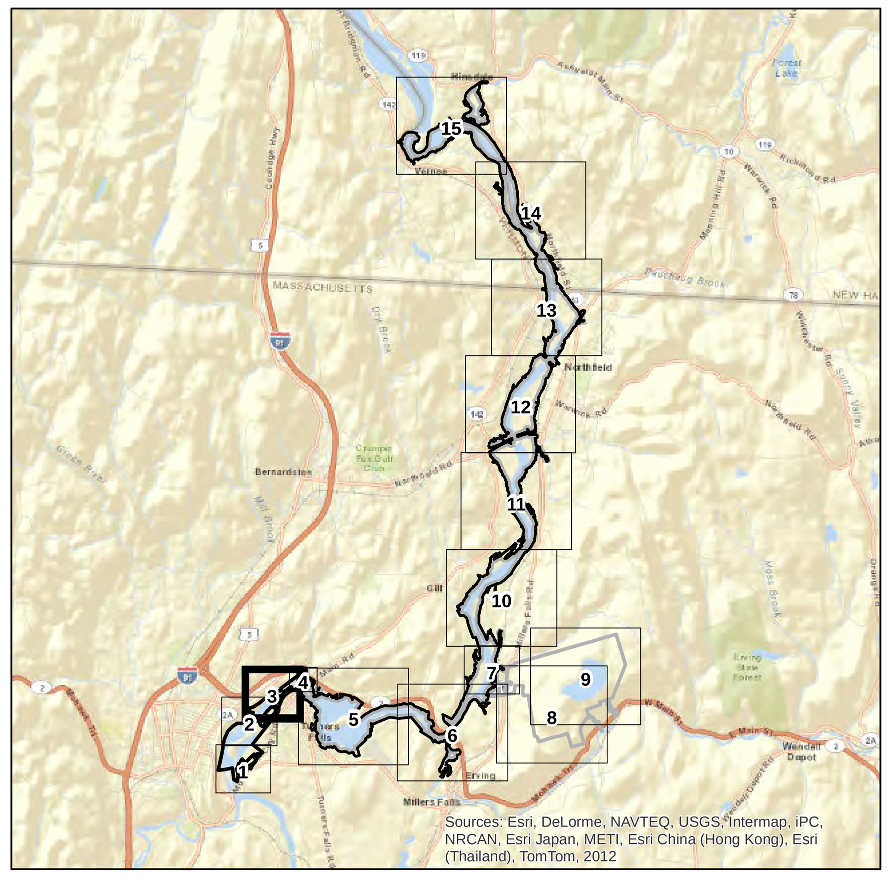
SHEET 2 OF 15

200 100 0 200 400 600 800 Feet

1 inch = 200 feet

When printed full size (28"X40")

1:2,400



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.0 FT — Project Boundary Elevation Contour

N

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FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-3

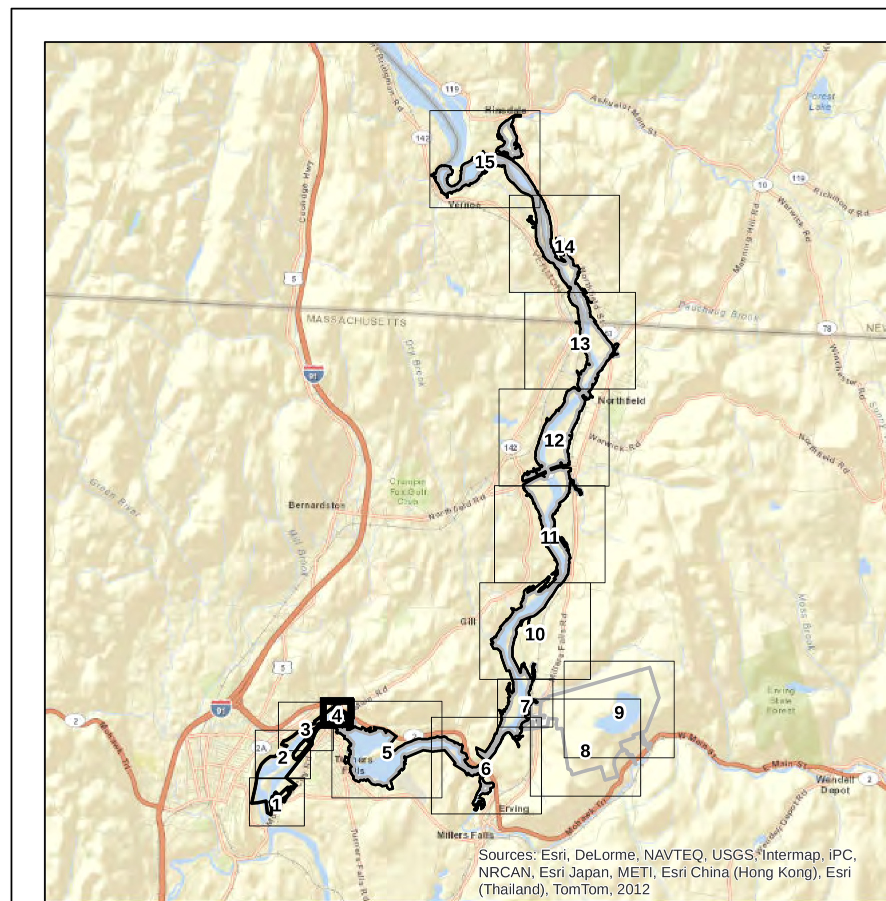
SHEET 3 OF 15

200 100 0 200 400 600 800 Feet

1 inch = 200 feet

When printed full size (28"X40")

1:2,400



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.6 FT — Project Boundary Elevation Contour

N

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FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-4

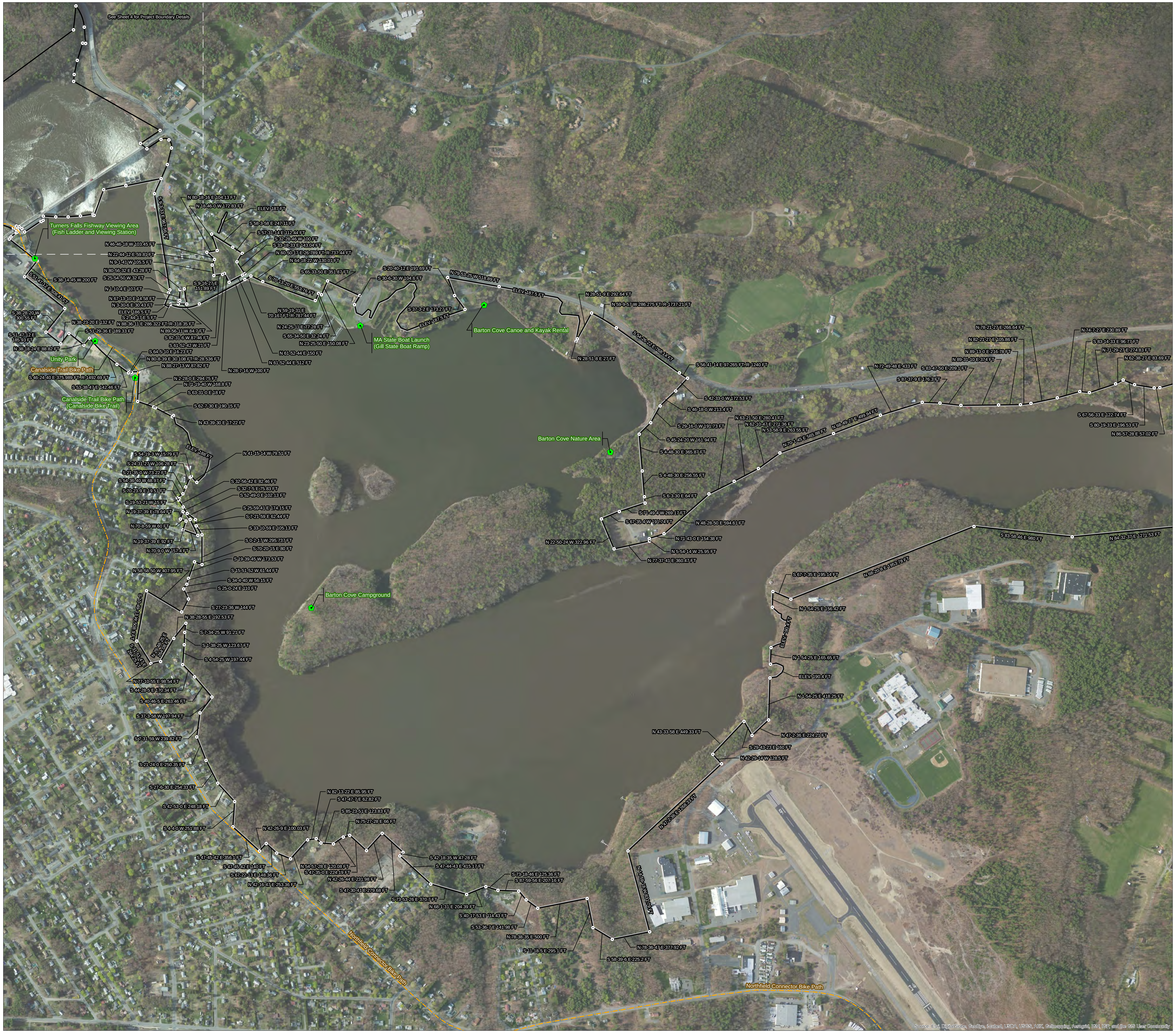
SHEET 4 OF 15

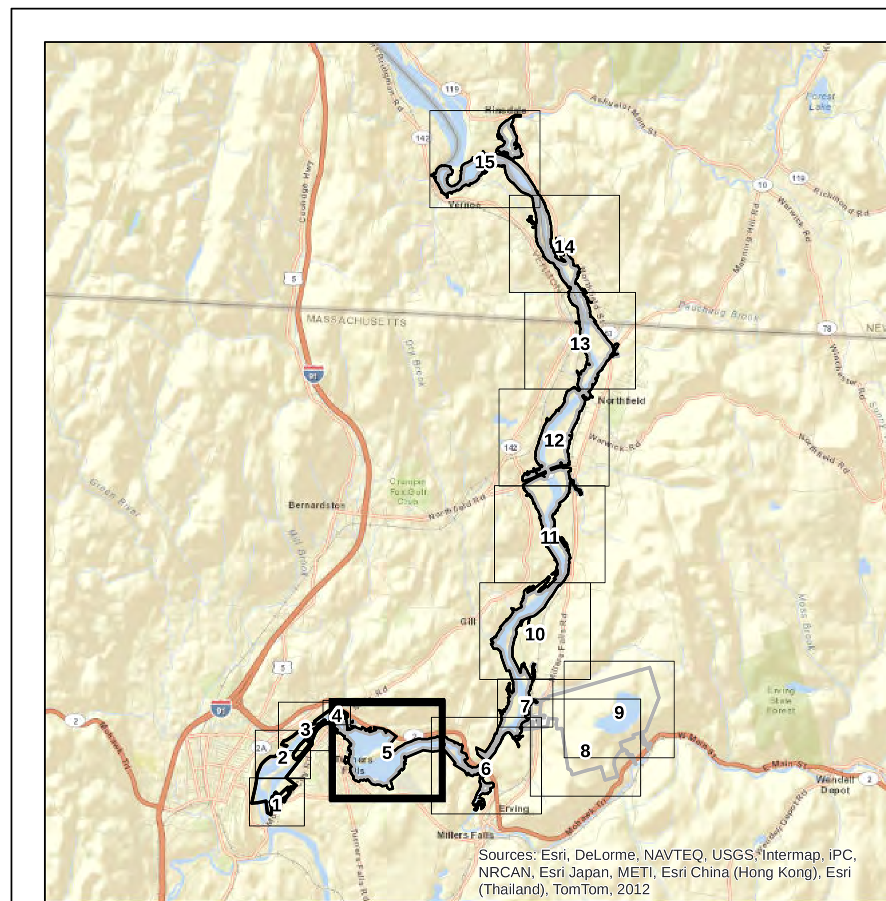
100 50 0 100 200 300 400 Feet

1 inch = 100 feet

When printed full size (28"X40")

1:1,200





Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.6 FT — Project Boundary Elevation Contour

N

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FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-5

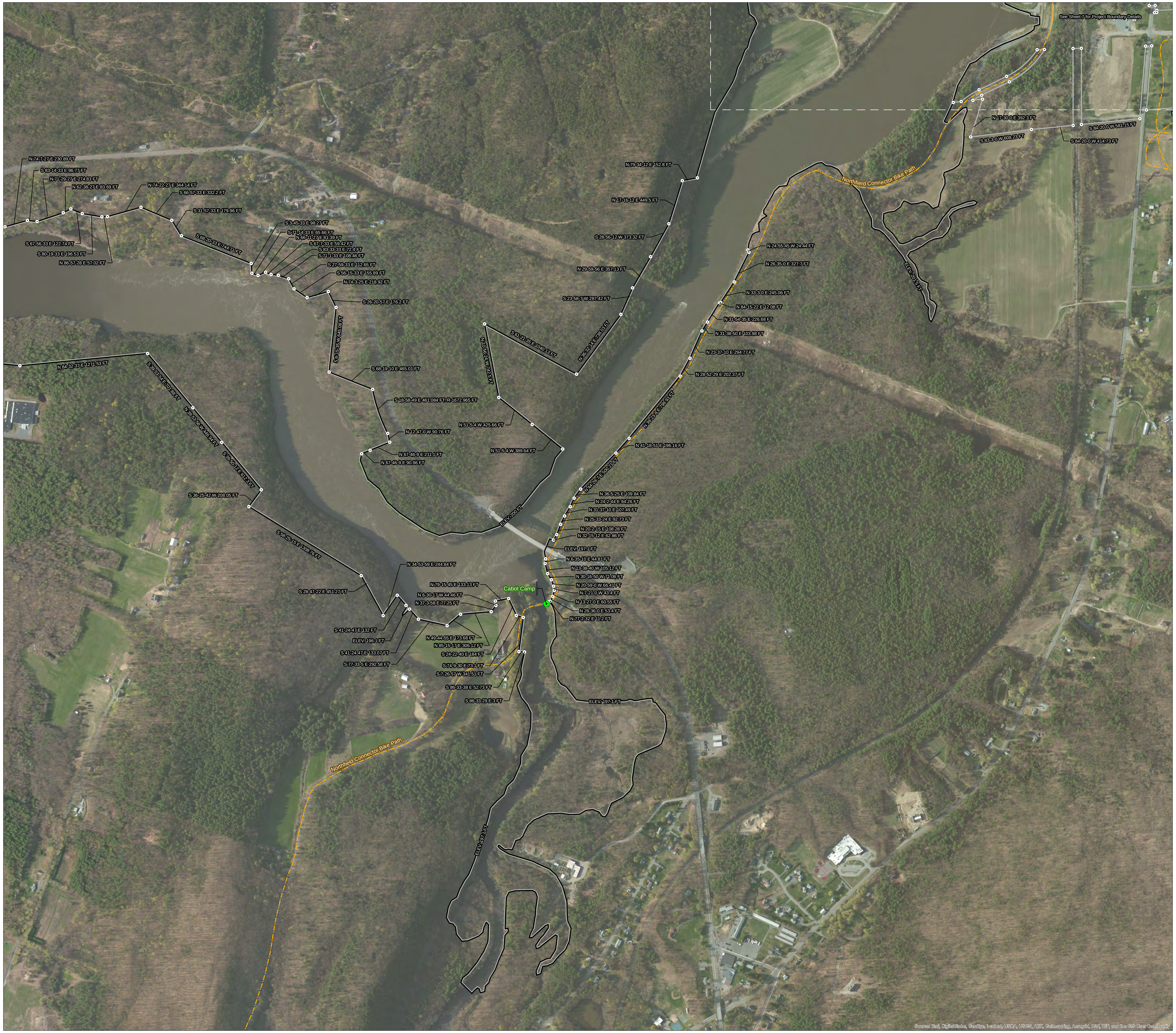
SHEET 5 OF 15

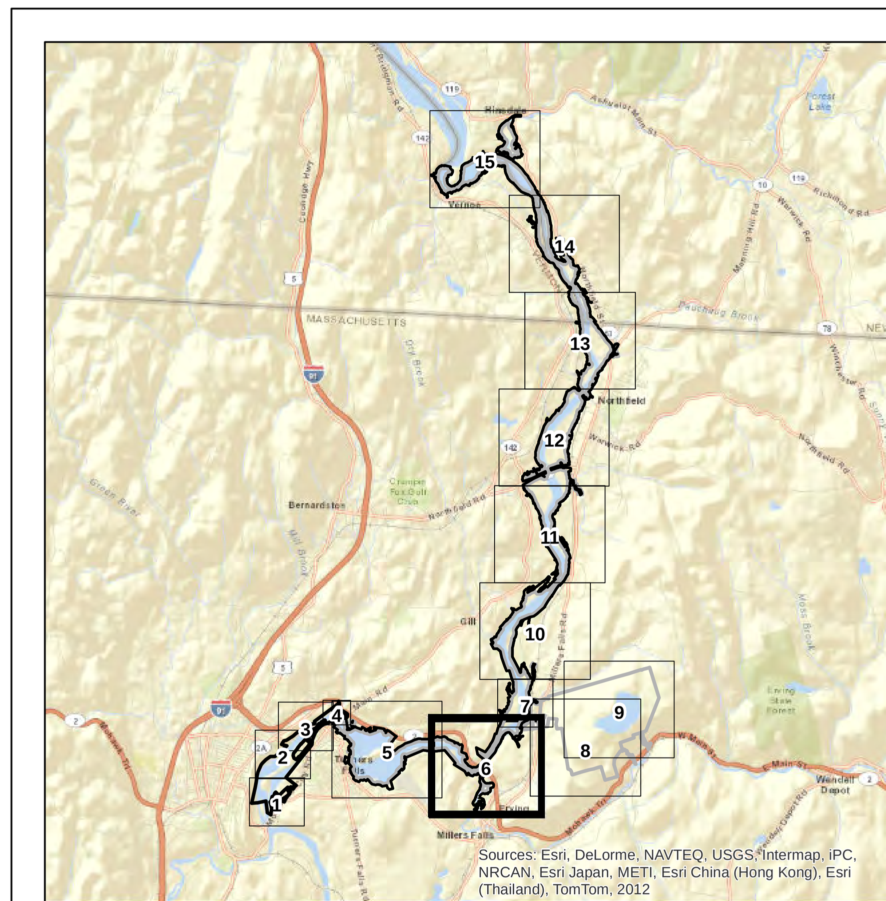
400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800





Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.8 FT — Project Boundary Elevation Contour

N

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FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-6

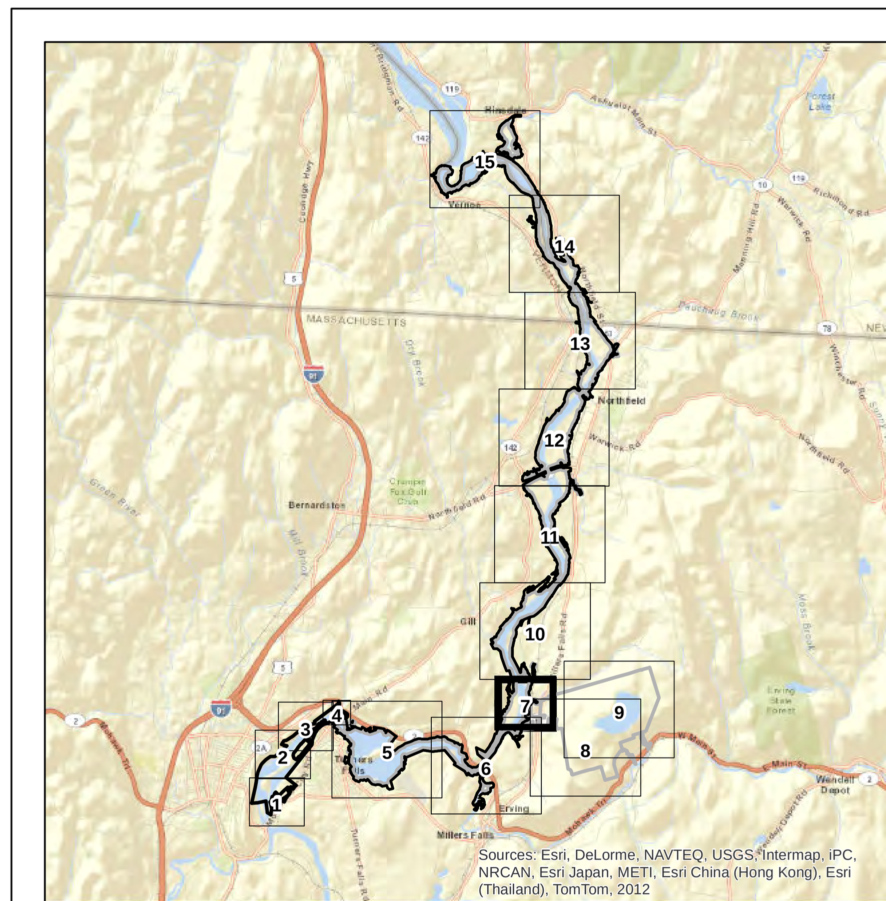
SHEET 6 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.8 FT — Project Boundary Elevation Contour

N

FirstLight Power Resources
GDF SUEZ

FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-7

SHEET 7 OF 15

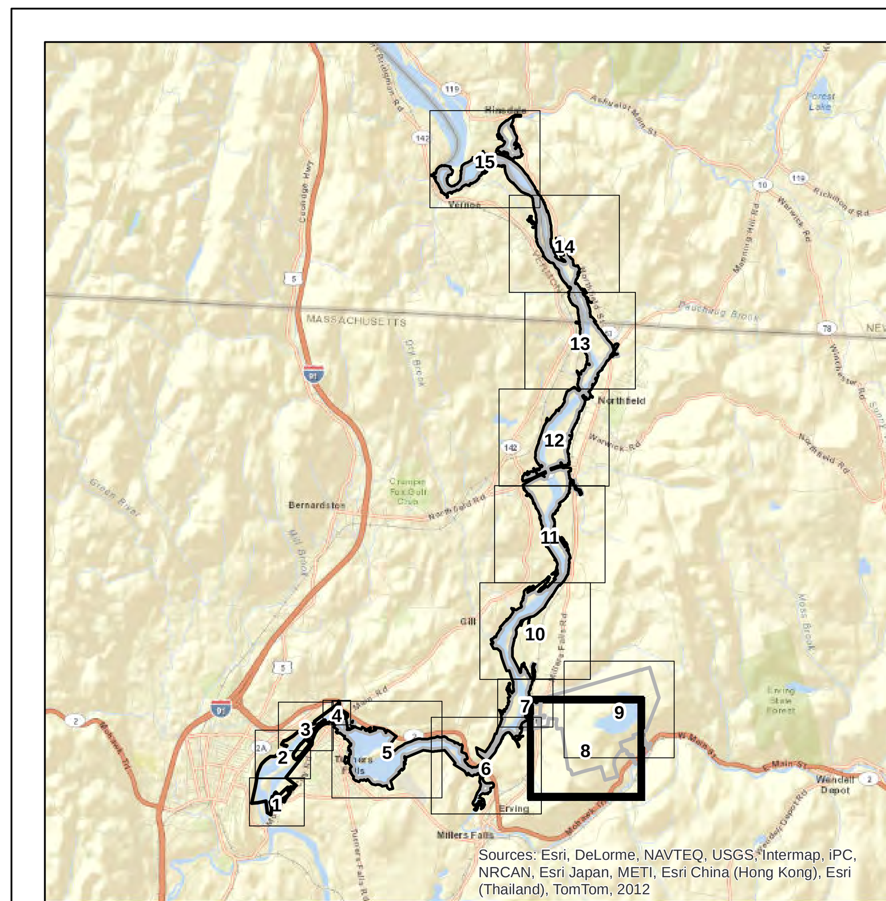
200 100 0 200 400 600 800 Feet

1 inch = 200 feet

When printed full size (28"X40")

1:2,400

Path: W:\gis\maps\revised_study_plan\Figure 2.2.4.mxd



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.6 FT — Project Boundary Elevation Contour

N

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REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-8

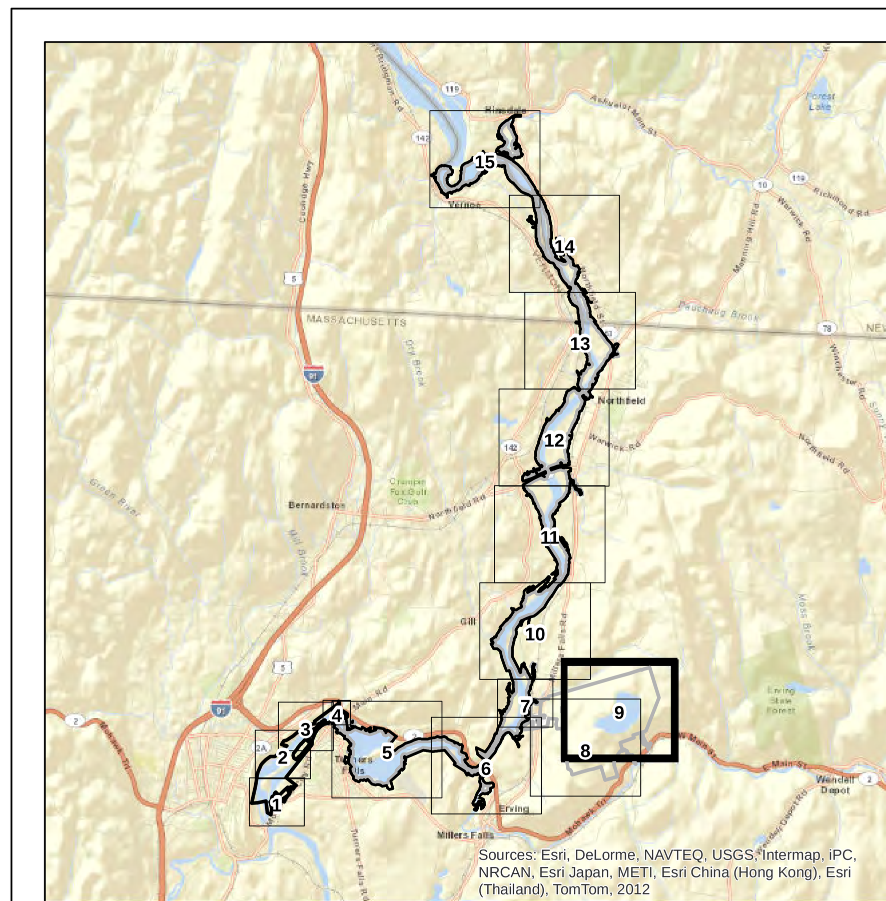
SHEET 8 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary

N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds

ELEV. 207.8 FT — Project Boundary Elevation Contour

N

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FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-9

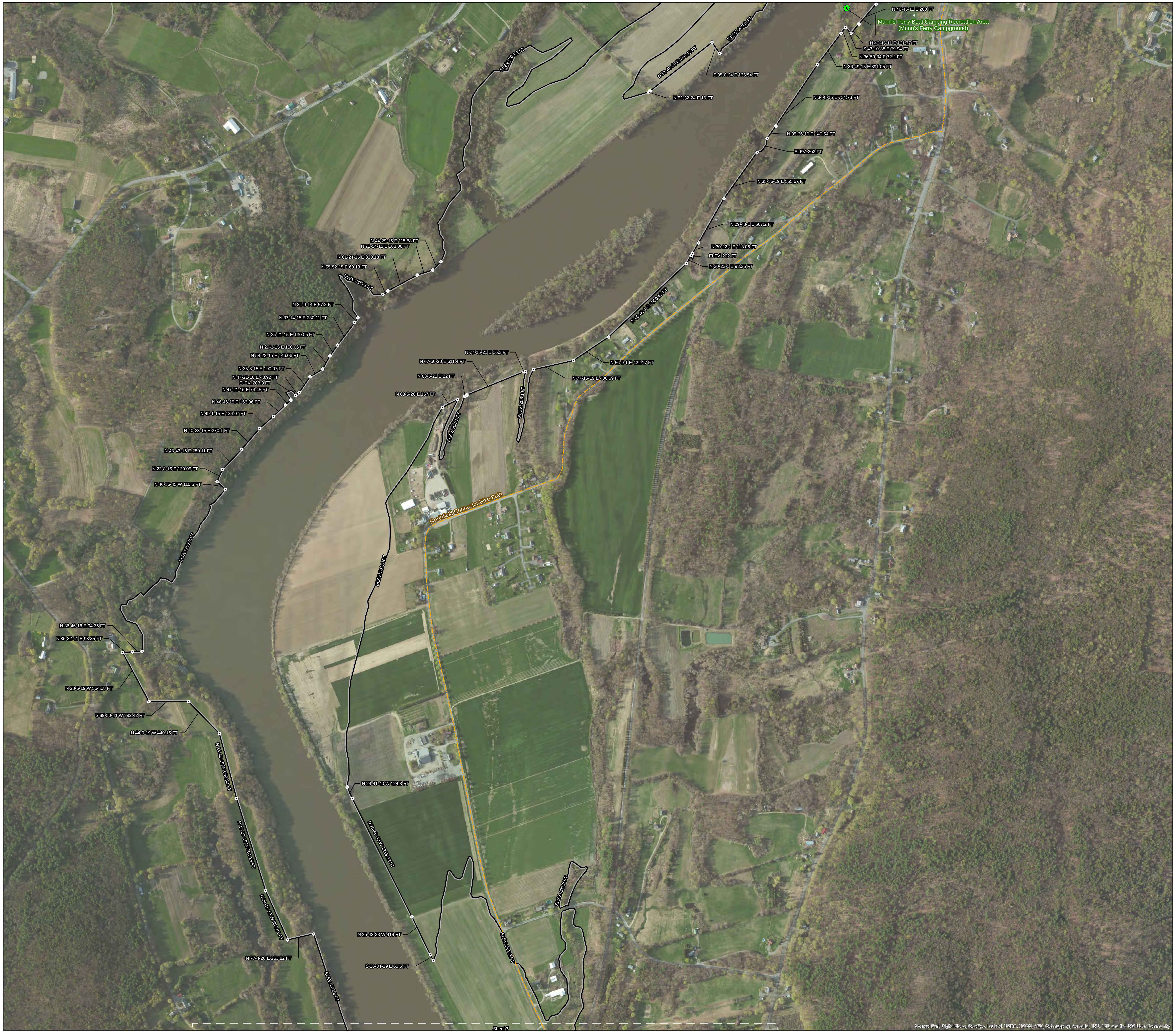
SHEET 9 OF 15

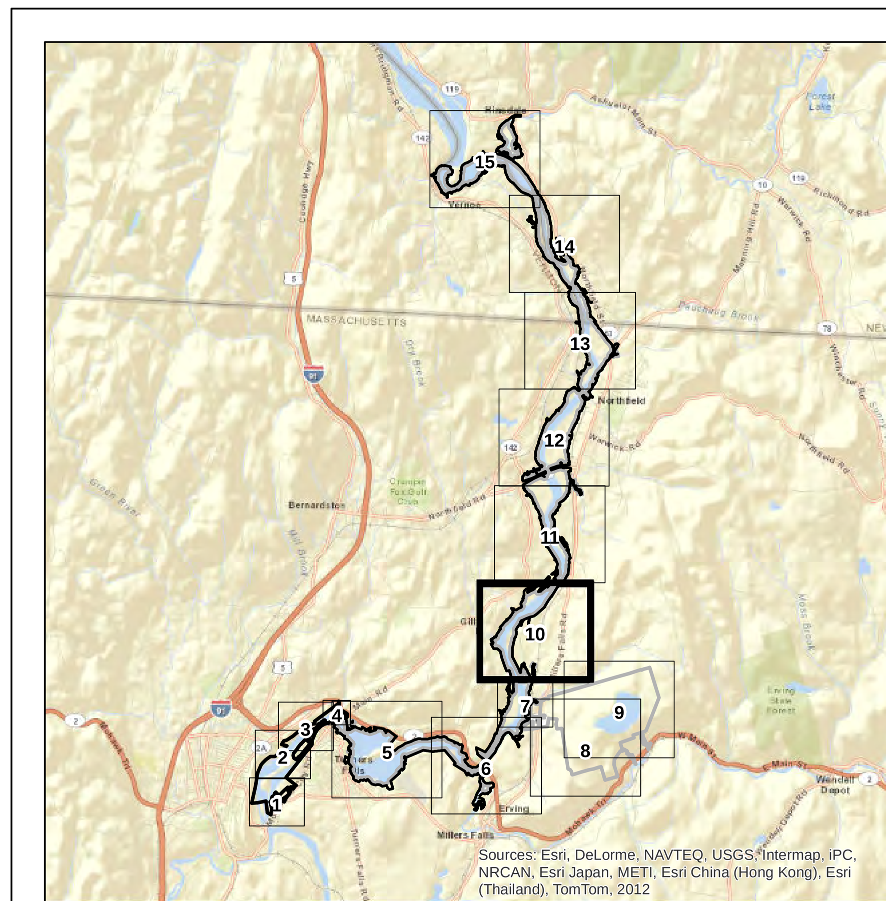
400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800





Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.6 FT — Project Boundary Elevation Contour

N

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REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-10

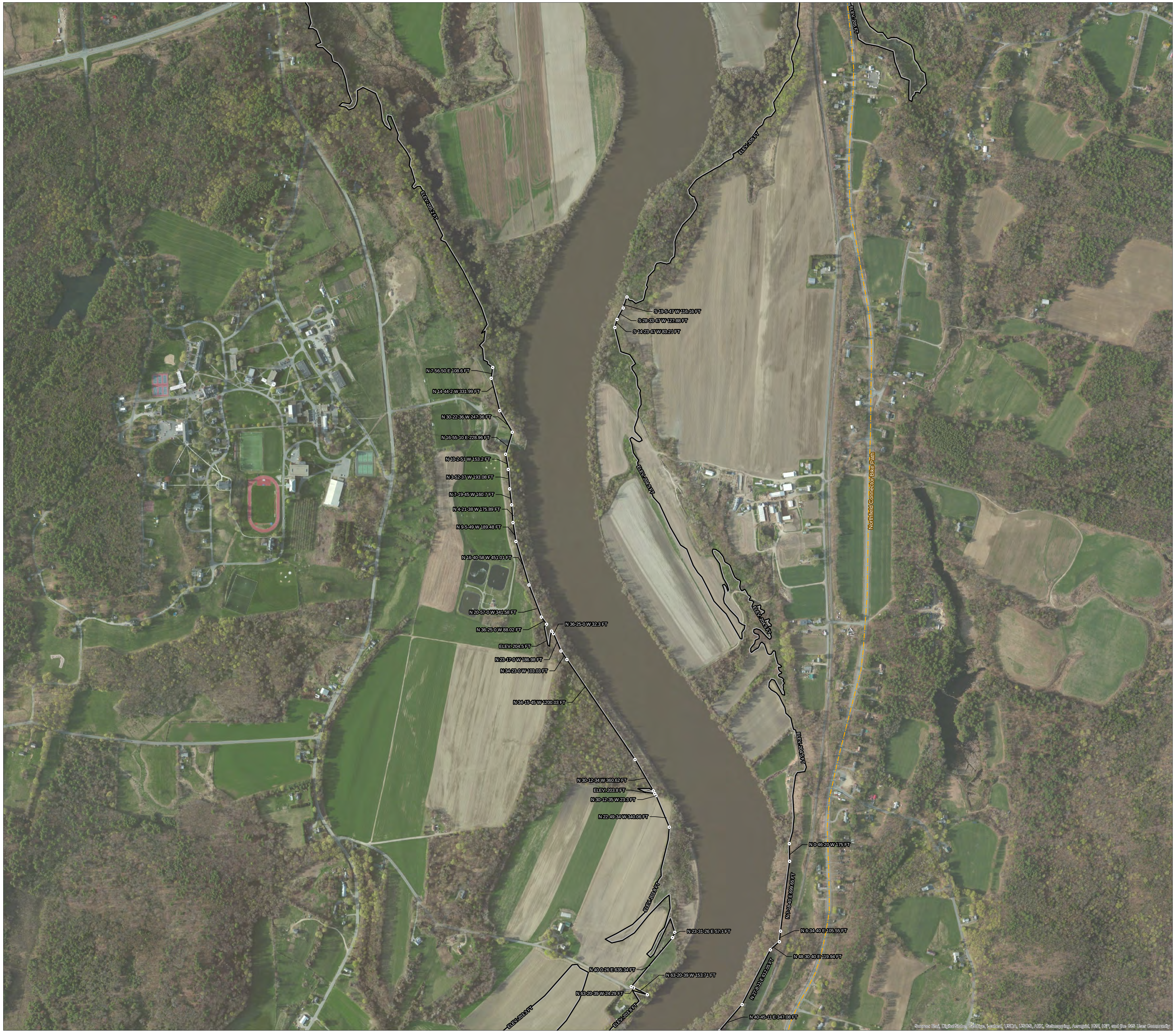
SHEET 10 OF 15

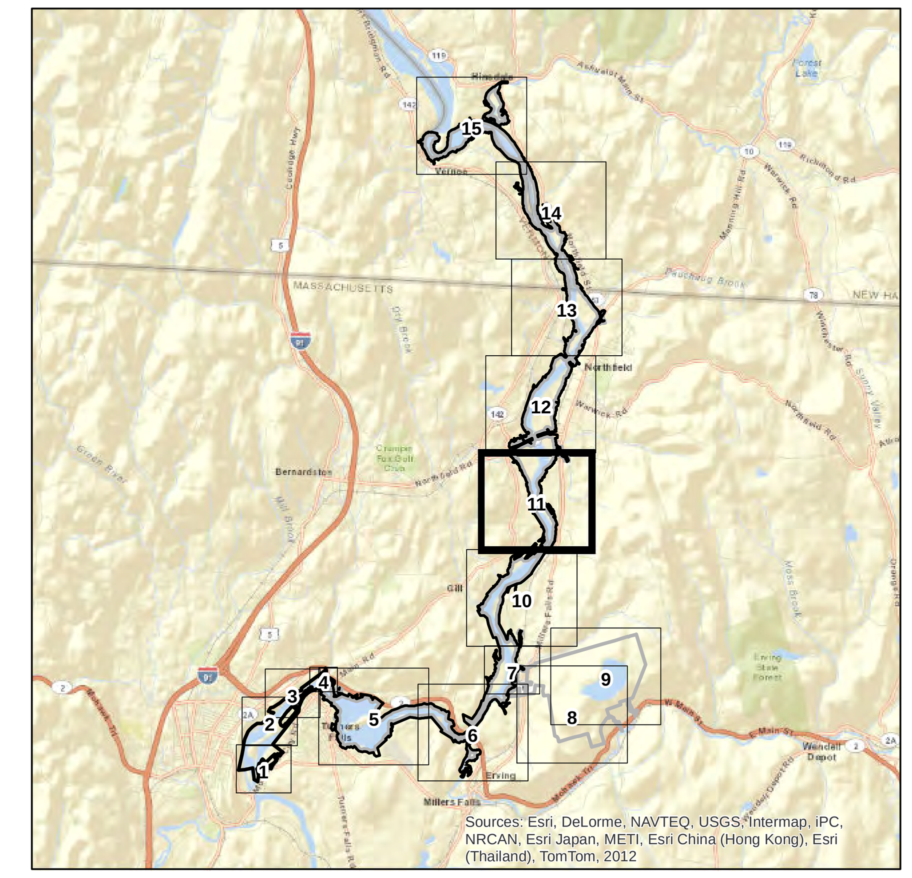
400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800





Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary

N 24-31-15 E 134.5 FT Project Boundary Survey Metes and Bounds

ELEV. 207.6 FT Project Boundary Elevation Contour

N

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REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-11

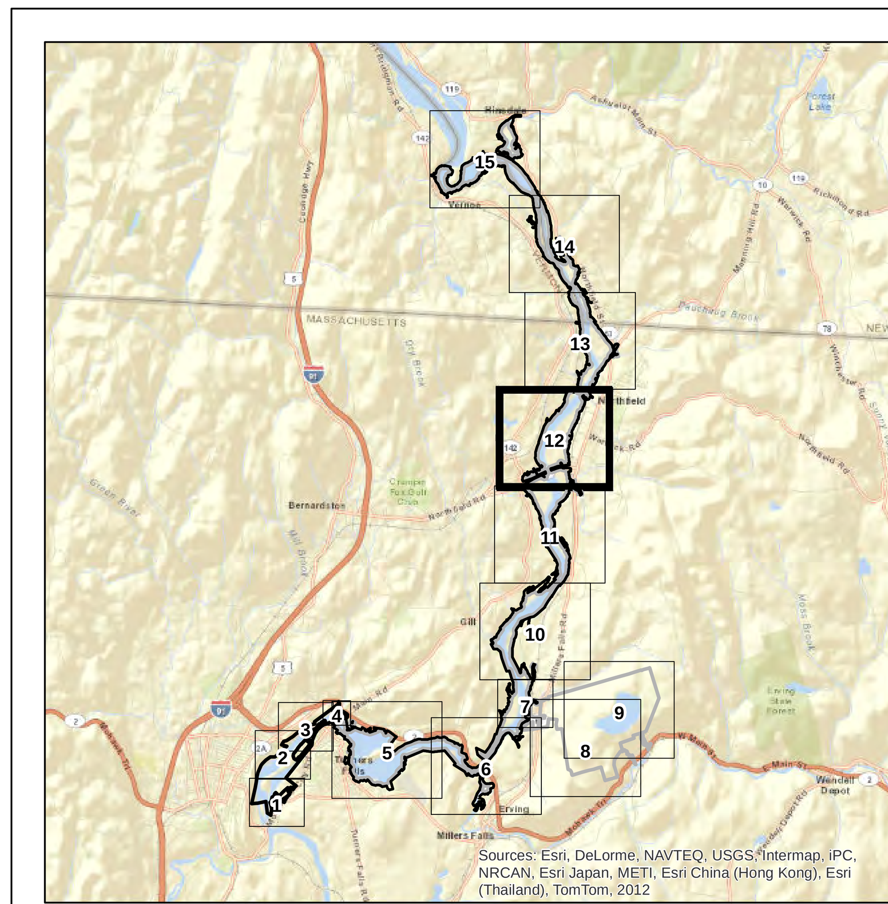
SHEET 11 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.6 FT — Project Boundary Elevation Contour

N

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REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-12

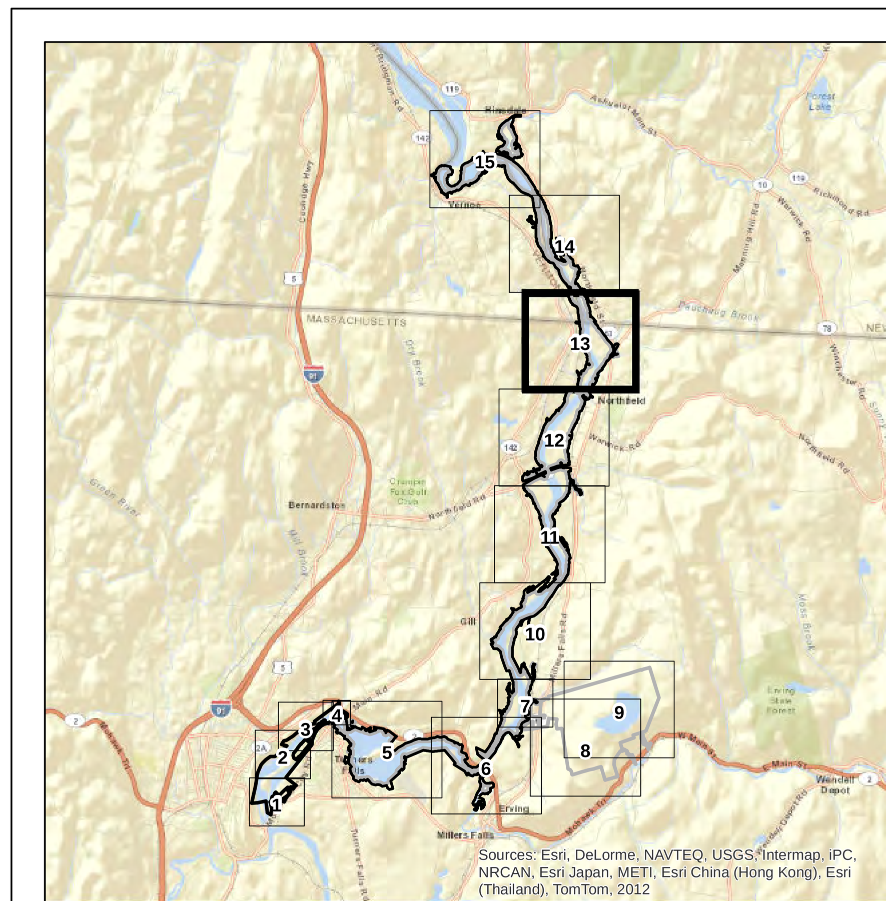
SHEET 12 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.8 FT — Project Boundary Elevation Contour

N

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FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-13

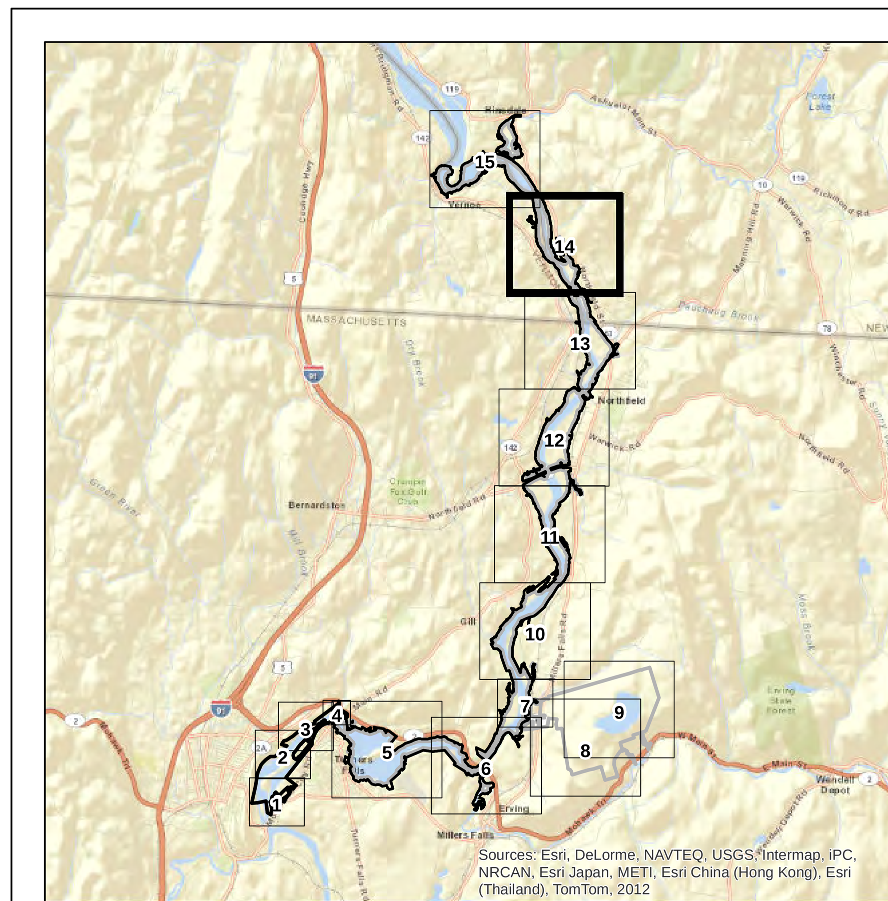
SHEET 13 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary

N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds

ELEV. 207.6 FT — Project Boundary Elevation Contour

N

FirstLight Power Resources

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FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-14

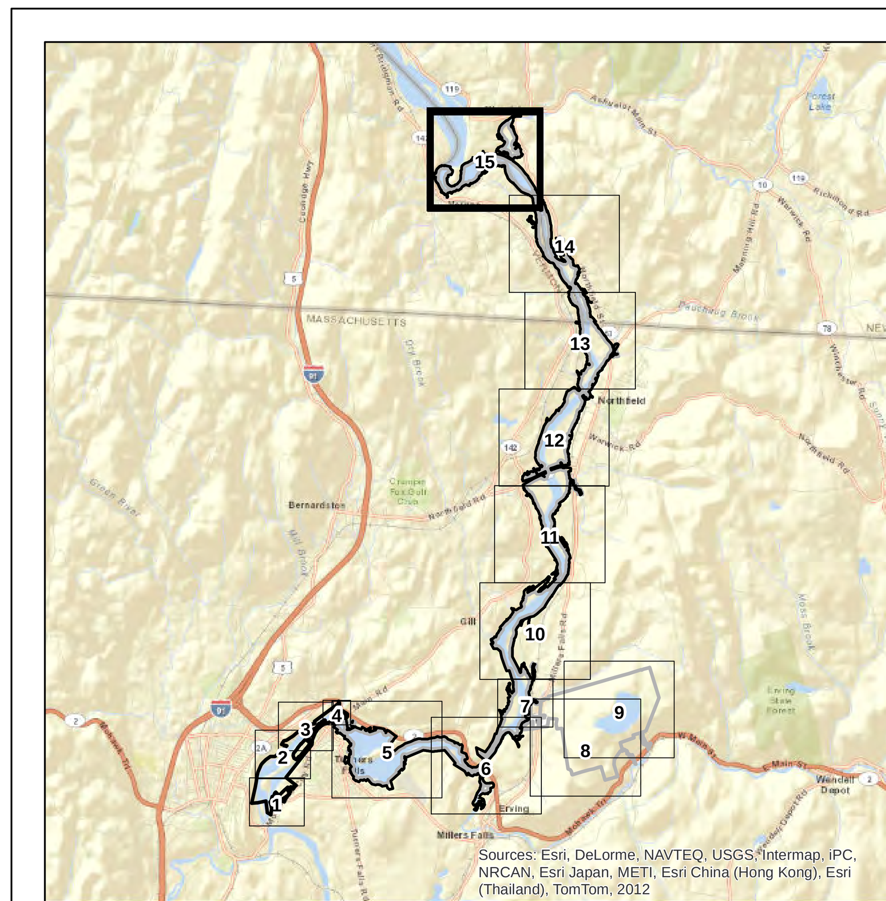
SHEET 14 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800



Legend

- Recreation Facility
- Project Trail
- Northfield Mountain Pumped Storage Project Boundary
- Turners Falls Hydroelectric Project Boundary
- N 24-31-15 E 134.5 FT — Project Boundary Survey Metes and Bounds
- ELEV. 207.8 FT — Project Boundary Elevation Contour

N

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FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT
TURNERS FALLS HYDROELECTRIC PROJECT
DETAILED PROJECT BOUNDARY MAP

FIGURE 2.2.4-15

SHEET 15 OF 15

400 200 0 400 800 1,200 1,600 Feet

1 inch = 400 feet

When printed full size (28"X40")

1:4,800

2.3 Northfield Mountain Pumped Storage Project FERC Additional Information Requests

2.3.1 Proposed Changes to Project Operation (FERC AIR #5)

FERC AIR #5: In the PAD you propose potential changes to facilities and operation of the project including the following: (1) utilize more storage in the Northfield Mountain Project's upper reservoir and, (2) increase the unit and station capacity. However, you do not describe the extent of possible modifications to the hydraulic capacity and to the storage operations within the upper reservoir. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please provide detail on the physical and operational changes contemplated at the Northfield Mountain Pumped Storage Project.

FirstLight Response: Relative to the Northfield Mountain Project, the maximum additional increase in hydraulic capacity when operating in a generation mode would be approximately 2,000 cfs, or 500 cfs/turbine for potential total station hydraulic capacity of approximately 22,000 cfs (compared to 20,000 cfs currently). Based on preliminary analysis, under a maximum hydraulic capacity of approximately 22,000 cfs, the station capacity would increase from the 1,168 MW to approximately 1,174 MW.

Relative to storage operations, the upper reservoir is licensed to fluctuate between 1000.5 feet msl and 938 feet msl, a total fluctuation of 62.5 feet. As noted in the PAD, the upper reservoir was originally designed to safely retain water up to elevation 1004.5 feet, msl and can be drawn down to elevation 920 feet, msl. The increase in fluctuation provides for an additional 3,009 acre-feet of storage and 1,990 MWHs of energy. FirstLight will be conducting further analysis to determine the feasibility of utilizing more upper reservoir storage capacity.

2.3.2 Recreation and Land Use (FERC AIR #6)

FERC AIR #6: In the PAD, the project boundary maps are presented. However, it is difficult to discern ownership and extent of shoreline buffer from the maps and associated narrative in the PAD. Therefore, so that we may fully understand and evaluate your proposal and determine the appropriate studies needed, please describe the project boundary (i.e., is it a metes and bounds survey, and elevation contour, or some combination), and shoreline buffer (e.g., typical distance from normal reservoir elevation to the project boundary, vegetative cover types).

FirstLight Response: Detailed aerial maps of the Turners Falls and Northfield Projects showing the Projects' boundaries by metes and bounds survey and/or contour elevations, shoreline buffers, and location of recreational facilities associated with the Projects are contained in Figures 2.2.4-1 to 2.2.4-15.

2.3.3 Cultural Resources (FERC AIR #7)

FERC AIR #7: In section 4.10.4 of the PAD, you state that, by letter dated September 30, 2011, the Massachusetts SHPO has recommended that a qualified cultural resources consultant research and compile the information necessary to identify historic and archaeological resources and archaeologically sensitive areas within the project's APE. In section 5.2.10 of the PAD you propose to conduct a Phase IA Archaeological Survey and Historic Structures Survey of the APE. You also indicate that FirstLight may propose to conduct a Phase IB archaeological and an intensive-level architectural level survey, depending on the results of the Phase IA investigation and after consultation with the Massachusetts, New Hampshire, and Vermont SHPOs. However, you have not provided a map specifically defining the APE, and we are unclear on how you would specifically carry out the various tasks involving your proposed study. As a result, in your study proposal for cultural resources we ask you to include the same information, specific to the Northfield Mountain Project, as outlined above for the Turners Falls Project. Include in your study proposal that you would also consult with the Vermont, Massachusetts, and New Hampshire SHPOs, and any involved Indian tribe or other interested parties in formulating each of the tasks.

FirstLight Response: Sections 3.7.1 and 3.7.2 of the Proposed Study Plan contain FirstLight's study plans for the proposed Phase IA Archaeological Survey and Historic Structures Surveys. FERC's AIR requests that the study plans include a definition of the APE and a record of consultation with the Vermont, New Hampshire, and Massachusetts SHPOs on the proposed definition of the APE. Typically, however, consultation with the SHPOs regarding an APE, occurs in conjunction with a SHPO's review of the proposed study plans so that the SHPOs will have a context in which to determine an APE. The study plans proposed herein include a proposed definition of the APE. The study plans also include a proposal to consult with the Vermont, New Hampshire, and Massachusetts SHPOs and the Narragansett THPO regarding the precise definition of the APE for the Projects.

FERC's AIR requests that the study plans should give attention to the assessment of the Turners Falls Ceremonial Site and the Town of Montague's proposed Great Falls Native Cultural Park and potential project-related effects to these places. The Turners Falls Ceremonial Site is located well away from the Projects. To the extent that any historic properties within the APE are identified during the course of archaeological studies undertaken in connection with the relicensing that may have a connection to the Great Falls Native Cultural Park, FirstLight will discuss these properties in its archaeological survey reports.

FERC's AIR also requests study plans provide estimated costs associated with the various tasks in the study plan, along with the costs of report production and crafting the HPMP. The study plans include costs for conducting the Phase IA Archaeological Survey, Historic Structures Survey, and TCP Study. These costs include the costs of report production. To the extent that an HPMP is necessary, FirstLight has also provided an estimate for the crafting of an HPMP. This cost will need to be refined after cultural resources surveys are complete and results are available to inform the need for and, if needed, the development of an HPMP.

3.0 PROPOSED STUDIES

As noted in Table 1.0-1, FirstLight received comments from several stakeholders on the Updated PSP. Shown in Section 3.9 is a matrix that includes the following: Study No., Study Name, Commenter, Summarized Comment, and FirstLight's Summary Response. In some instances, the comments provided on the Updated PSP were lengthy. In these cases, the comments were summarized, while more direct comments were taken verbatim from the comment letters. Emphasis was placed on summarizing what the stakeholder was seeking relative to the study plan modification.

3.1 Geology and Soils

3.1.1 2013 Full River Reconnaissance Study

General Description of Proposed Study

FirstLight is required by FERC under the current license to conduct a Full River Reconnaissance (FRR) Study every 3-5 years in accordance with the Northfield Mountain Project's Erosion Control Plan (ECP) (S&A, 1999) and to satisfy compliance requirements associated with the Turners Falls Project and Northfield Mountain Project licenses. The next FRR is slated for fall 2013. With the impending relicensing effort and timing of the next FRR, FERC contacted FirstLight and indicated that the 2013 FRR should be folded into the relicensing studies.

Prior to FERC contacting FirstLight, FirstLight had been working with the Franklin Regional Council of Government (FRCOG), Connecticut River Watershed Council (CRWC), and Landowners and Concerned Citizens for License Compliance (LCCLC) on crafting a Quality Assurance Project Plan (QAPP). The goal of the QAPP is to ensure consistency with data collection methods. A draft version of the QAPP/FRR was circulated to the FRCOG, CRWC and LCCLC for review and comment, and a meeting was held to discuss comments received.

Due to the fact that the QAPP/FRR is now incorporated into the FERC relicensing process, FirstLight developed this study plan based on FERC's study plan criteria. This work plan reflects comments received from the Massachusetts Department of Environmental Protection (MADEP) during a meeting on March 26, 2013, comments received from stakeholders during Study Plan meetings on May 15, 2013 and June 14, 2013, and stakeholder comments filed with FERC on or before July 15, 2013. In addition to the Updated PSP, the QAPP has also been revised to reflect stakeholder comments. As part of this study, stakeholders should also review the updated QAPP for the FRR found in Appendix D.

The proposed FRR study calls for conducting a boat and land-based survey along the riverbanks of the Turners Falls Impoundment to document riverbank features, characteristics, and types, stages, and indicators of erosion. The 2013 FRR is designed to document riverbank features and characteristics as observed in 2013 and is not designed to determine the cause(s) of erosion; that issue is addressed in Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability*.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the 2013 FRR study is to identify and define riverbank features and characteristics and the types, stages, indicators[4], and extent of erosion throughout the Turners Falls Impoundment. Erosion classifications will occur at a reconnaissance level without reference to the cause of erosion. In order to accomplish this goal, the following objectives are proposed:

[4] For the purpose of this study, the type of erosion is defined as the specific active erosion process or processes occurring at a given location (e.g. falls, topples, slides, etc.). The stage of erosion is defined as the point on the temporal or process scale of erosion that a given bank is currently at (e.g. active erosion, eroded, stable, etc.). Indicators of potential erosion (e.g. leaning trees, tension cracks, etc.) are processes or characteristics of a riverbank that contribute to the instability of the bank; these are used to determine locations where future erosion may occur.

- Conduct a land-based investigation of the riverbanks and islands to document indicators of potential erosion and potential bank instability;
- Identify land-use practices within 200 feet of the riverbank and islands from Turners Falls Dam to Vernon Dam;
- Identify and define riverbank features and characteristics such as bank slope, height, sediment composition, and vegetation using clearly defined, and easily repeatable, classification techniques;
- Identify and define the type, stage, indicators, and extent of erosion in the Turners Falls Impoundment using clearly defined, and easily repeatable, classification techniques;
- Identify and map the location(s) of sensitive receptors, including important wildlife habitat, along the riverbanks and islands of the impoundment;
- Spatially define, using a global positioning system (GPS), the transition points where riverbank characteristics or features change from one classification to another;
- Create video and photographic documentation of all riverbanks classified including geo-referenced video and reproduction of the photo log used by Field Geology Services as part of the report titled *Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT* (FGS, 2007);
- Conduct an evaluation of past bank stabilization projects and provide recommendations for future projects based on the results of the FRR;
- Conduct data evaluation based on the features identified in the field including, but not limited to: distribution and summary statistics, assessment of changes in riverbank conditions in context of the "*Erosion Control Plan for the Turners Falls Pool of the Connecticut River*" (ECP) (S&A, 1999), and evaluation of change in riverbank conditions since previous FRRs;
- Create various maps and geospatial datasets based on the information gathered in the field. Maps generated will include, but not be limited to: riverbank features and characteristics, erosion type, erosion stage, extent of erosion, potential bank instability, land-use, and riverbank stabilization site locations (current and recommended); and
- Develop a final report describing and summarizing the findings of the 2013 FRR including all data evaluation, mapping, and field documentation.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

FirstLight is required to conduct a FRR every 3-5 years as part of the current license requirements of the Northfield Mountain and Turners Falls Projects. Given the impending relicensing effort and timing of the next FRR (November 2013), FERC contacted FirstLight and FERC indicated that the 2013 FRR should be folded into the relicensing.

Resource management goals of the Agencies and stakeholders related specifically to this effort include: developing a methodology to classify and map erosion in the Turners Falls Impoundment that is based on the types, stages, and indicators of erosion; incorporate the recommendations of the Field Geology Services report titled, *Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT* (FGS, 2007) into the FRR methodology; document and describe the changes to banks upstream and downstream of riverbank restoration projects; and to develop a methodology that is clearly defined and easily reproducible.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

In 1998, Simons & Associates (S&A) developed the "*Erosion Control Plan for the Turners Falls Pool of the Connecticut River*" (ECP) (S&A, 1999). As part of the ECP, FRR studies were conducted in 1998, 2001, 2004, and 2008 to document existing riverbank features and characteristics. The ECP and FRR studies are readily available for use as support documentation or as tools to compare past and present riverbank conditions.

Extensive research has been conducted evaluating erosion along the Connecticut River in the Turners Falls Impoundment; such research includes:

Connecticut River Joint Commissions and Trails Conservation Assistance Program of the National Park Service through the Connecticut Valley Partnership. (1996). *River Dynamics and Erosion.* Charlestown, NH: Author.

Field Geology Services. (2004). *Fluvial Geomorphology Assessment of the Northern Connecticut River, Vermont and New Hampshire.* Farmington, ME: Author.

Field Geology Services (FGS). (2007). *Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT.* Farmington, ME: Author.

New England Environmental (NEE). (2001). *Erosion Control Plan for the Turners Falls Pool of the Connecticut River*. Amherst, MA: Northeast Utilities Service Company.

New England Environmental (NEE). (2005). *Erosion Control Plan for the Turners Falls Pool of the Connecticut River, 2004 Full River Reconnaissance.* Amherst, MA: Northeast Utilities Service Company.

Simons & Associates (S&A). (1999). *Erosion control plan for the Turners Falls Pool of the Connecticut River.* Prepared for Northeast Utilities. Midway, UT: Author.

Simons & Associates (S&A). (2009). *Full river reconnaissance – 2008: Turners Falls Pool, Connecticut River*. Prepared for FirstLight Power Resources. Midway, UT: Author.

Simons & Associates (S&A). (2012a). *Analysis of Erosion in Vicinity of Route 10 Bridge Spanning the Connecticut River*. Prepared for FirstLight Power Resources, Midway, UT: Author.

Simons & Associates (S&A). (2012b). *Riverbank Erosion Comparison along the Connecticut River*. Prepared for FirstLight Power Resources, Midway, UT: Author.

Simons, D.B., Andrew, J.W., Li, R.M., & Alawady, M.A. (1979). *Connecticut River Streambank Erosion Study: Massachusetts, New Hampshire, and Vermont*. Waltham, MA: US Army Corps of Engineers (USACE).

Western Massachusetts Electric Company, (1995), *Long Term Riverbank Plan for Connecticut River between Vernon, VT and Turners Falls, MA.* Author.

US Army Corps of Engineers (USACE). (1991). *General investigation study - Connecticut River streambank erosion*. Waltham, MA: USACE, New England Division.

Project Nexus (18 CFR § 5.11(d)(4))

The Connecticut River is an alluvial river, subject to natural processes that result in dynamics such as lateral shifting, erosion, and deposition. These natural processes and the dynamic responses of the river may be further affected by land-use practices, modified flow/water level regime, motorized boating, and other factors. Due to the variety of factors, the riverbanks along the Connecticut River, not just in the Turners Falls Impoundment, have a history of being susceptible to erosion. In accordance with the existing license requirements of the Turners Falls and Northfield Mountain Projects, a reconnaissance level survey of the Turners Falls Impoundment was conducted in 1998 to map riverbank characteristics and prioritize erosion sites to be considered for stabilization. As a result of this work, the "*Erosion Control Plan for the Turners Falls Pool of the Connecticut River*"(ECP) was developed by Simons and Associates (S&A, 1999). The ECP requires FirstLight to conduct FRR studies every 3-5 years to continually monitor erosion conditions throughout the impoundment. As part of the FERC relicensing of the Turners Falls and Northfield Mountain Projects, the Commission has requested that the 2013 FRR be folded into a relicensing study.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The 2013 FRR methodology was revised to address comments made by Agencies and stakeholders at Study Plan meetings held on May 15, 2013 and June 14, 2013 as well as comments filed with FERC on or before July 15, 2013. The methodology outlined below was designed such that the classification criteria for riverbank characteristics and types, stages, and indicators of erosion are clearly defined and can be easily reproduced.

The 2013 FRR methodology has been divided into several tasks and subtasks designed to effectively and efficiently accomplish the goals and objectives previously outlined in this study plan. As such, study methods will consist of the following tasks:

- Task 1: Land-Based Observations
- Task 2: Classify Riverbank Features, Characteristics, and Erosion
- Task 3: Spatially Define Riverbank Transition Points
- Task 4: Video and Photographic Documentation
- Task 5: Riverbank Stabilization Projects
- Task 6: Final Report, Data Analysis, and Deliverables

In order to show the full range of conditions that are observed within the Turners Falls Impoundment, and to be consistent with previous FRRs, the 2013 FRR will include the entire length of the impoundment from Vernon Dam to Turners Falls Dam. Islands within the Turners Falls Impoundment will also be included in this study. While reviewing the methodology it is important to note that the FRR is a reconnaissance level survey intended to provide an overview of riverbank conditions in the impoundment.

Task 1: Land-Based Observations

Based on comments received from various Agency and stakeholder groups a land-based assessment of the Turners Falls Impoundment riverbanks has been added to the 2013 FRR. Observations made as part of this evaluation will include identifying and defining areas of slope instability and potential future erosion as well as land-use assessments of adjacent properties.

Task 1a: Identify and Define Indicators of Potential Erosion

A land-based assessment of the riverbanks in the Turners Falls Impoundment will be implemented in order to identify and define indicators of potential erosion and bank instability. This assessment will include the entire Turners Falls Impoundment from the Vernon Dam to the Turners Falls Dam, including islands, except in areas where: 1) access is not possible or the area is impassible; 2) access is unsafe as determined by the field crew; or 3) bank conditions do not warrant assessment (.e.g., bedrock areas). The field survey will be conducted by a fluvial geomorphologist/hydraulic engineer, geotechnical engineer, and riverbank stabilization/environmental consultant during the fall of 2013 prior to the boat-based survey described in Task 2.

Field observations will be based on the criteria found in Table 3.1.1-1 and will include: 1) gathering basic positional attribute information of the features identified; 2) identifying the locations of sensitive receptors; and 3) identifying and investigating indicators of potential erosion or bank instability that would not be readily visible from a boat. Indicators of potential erosion (excluding tension cracks) such as exposed roots, creep, overhanging banks, and notching are anticipated to be more easily identifiable from a boat than from walking along the riverbanks. As a result, these features will not be investigated in-depth as part of this task but will instead be included in the boat-based survey discussed in Task 2b. The primary focus of the land-based assessment will be to identify the location of and investigate tension cracks or other indicators of potential erosion that will not be clearly identifiable from a boat. For the purpose of this study tension cracks are defined as a cracks formed at the top edge of a bank that potentially could lead to topples or slides (FGS, 2007). Figure 3.1.1-1 depicts an example of a tension crack.

Classification of the type(s), stage(s), and extent of erosion will not be included in this task as they will be more easily identified from a boat and therefore are included in Task 2b. However, if during the field investigation any types of erosion are observed that may not be easily identifiable from a boat those features will be documented. Classifications of the type of erosion that may be conducted as part of this task will follow the same methodology identified in Task 2b. Detailed discussion regarding the type(s), stage(s), indicators, and extent of erosion can be found in Task 2b, Table 3.1.1-2, 3.1.1-3, and 3.1.1-4.

Sensitive receptors, such as important wildlife habitat located at or near the riverbank, will be identified during both the boat and land-based surveys. The riverbank stabilization/environmental consultant will be responsible for the identification of these features. Sensitive receptors that will be documented will include, but not be limited to, bank swallow colonies, kingfisher nests, eagle nests, and prime odonate and mussel habitat.

When conducting the land-based assessment, the field crew will walk along the top of the banks to identify and note the location of tension cracks, sensitive receptors, or other features that may not be visible from a boat. The locations of these features will be captured via sub-meter GPS where satellite coverage will allow[5]. If GPS data collection is not possible, the location of the features will be approximated on field maps using aerial imagery. All field observations will be entered into a data-logger or recorded on field datasheets similar to Table 3.1.1-1. Geo-referenced digital photographs will be taken to document the features identified in the field and as a means of data control and reference checking.

[5] Due to extensive vegetation and tree cover found throughout the Turners Falls Impoundment (even in the fall) satellite coverage may be difficult to obtain in some areas and GPS data collection may not be possible.

Task 1b: Land-use Mapping

In addition to identifying and defining indicators of potential erosion, the land-uses of all properties adjacent to the riverbank will be identified as part of the land-based assessment.

Prior to field investigation, existing aerial imagery will be used to: 1) determine the width of riparian buffers; 2) develop a list of predetermined land-use categories that will be used during field classification; and 3) identify other pertinent land use information that may be useful during the field survey. MassGIS land-use layers may also complement preliminary analysis of the land-uses within the study area. As part of the land-based assessment, land-uses will be mapped for an area of approximately 200 feet horizontally from the top of the slope. The assessment will also determine the specific agricultural land-use in 2013 such as row or crop cover, measurement of riparian areas, and other land-use data not apparent from the aerial imagery or MassGIS layer(s). All observations will be stored on a data-logger or recorded on field datasheets similar to Table 3.1.1-1. The start and end points of land-use segments will be captured via sub-meter GPS where satellite coverage will allow. If GPS data collection is not possible, the location of the features will be approximated on field maps using aerial imagery.

The results of the land-use mapping combined with aerial imagery, MassGIS layers, and property ownership information obtained from the Town Assessor's in VT, NH, and MA will be combined to develop a geospatial dataset from which a series of land-use maps and land-use analyses will be generated. Areas that are observed to have a direct correlation between adjacent land-use and erosion will be documented. These areas will be investigated in greater detail in Study No. 3.1.2.

Table 3.1.1-1: Connecticut River – Turners Falls Impoundment Riverbank Classifications for Land-based Survey

RIVERBANK FEATURE POSITIONAL ATTRIBUTES						
Right or Left Bank[6]						
Coordinates *(Start-End)*						
Distance from River						
Height above River						
Sensitive Receptors	*Descriptions of important wildlife habitat use on or near the riverbanks such as bank swallow colonies, kingfisher nests, eagle nests, prime odonate and mussel habitat, etc.*					
Adjacent Land Use						
EROSION CLASSIFICATION[7]						
Type(s) of Erosion	Falls – Undercut	Falls – Gullies	Topples	Slide or Flow	*Planar Slip* *Rotational Slump* *Flow*	
Indicators of Potential Erosion	Tension Cracks	Exposed Roots	Creep/ Leaning Trees	Overhanging bank	Notching	Other
Notes						

[6] As looking downstream

[7] Refer to Task 2 (Tables 3.1.1-3 and 3.1.1-4) for a complete list of classification definitions. Erosion types and indicators of erosion (excluding tension cracks) will be more easily identified by boat and therefore will not be a primary focus of the land-based survey. The primary objective of the land-based survey is to identify the locations of tension cracks, adjacent land-use, and other features that would not be easily identifiable from a boat. The methodology defined in Task 2 will not be duplicated as part of this task.

Figure 3.1.1-1: Example of Tension Cracks

(FGS, 2007)

Task 2: Classify Riverbank Features, Characteristics, and Erosion

The classification criteria and methodology discussed below are based on the approaches that have been utilized in previous FRRs, comments received from various Agencies and stakeholders as well as recommendations of Field Geology Services in the report titled, "*Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT*" (FGS, 2007).

The purpose of this task is to identify and define the features and characteristics of the riverbanks in the Turners Falls Impoundment from the Vernon Dam to the Turners Falls Dam, including islands (Task 2a), and to classify each riverbank segment based on the type(s), stage(s), indicators, and extent of erosion (Task 2b). The classifications conducted as part of this task will be boat-based and will occur following completion of the land-based assessment (Task 1) but simultaneously with Tasks 3 and 4. The methodology described below is specific to the boat-based portion of the FRR which will be conducted independently of, but complimentary to, the land-based assessment discussed in Task 1. FirstLight is proposing to conduct the boat survey portion of the FRR in late fall (mid-November) 2013 during leaf off conditions.

The classification methods contained in this section have been clearly defined with proper support documentation to ensure that the methodology can be easily and accurately reproducible.

Task 2a: Identify and Define Riverbank Features and Characteristics

A boat survey will be conducted to identify and define features and characteristics of the riverbanks in the Turners Falls Impoundment. Classification will be based on the criteria found in Table 3.1.1-2 which contains pre-determined classification categories based on observations made during past FRRs. Classification categories found in Table 3.1.1-2 include bank slope, height, sediment composition, and vegetative cover. Each riverbank will be classified based on one attribute per characteristic. For example, riverbank X has a Slope of "Vertical", Height of "High", Sediment composition of "Boulders", and degree of vegetative cover of "Sparse". Table 3.1.1-3 provides definitions and descriptions of each classification.

Based on past FRRs it has been observed that riverbanks in the Turners Falls Impoundment generally consist of an upper and lower bank. Upper banks are often above water except during high flows, while lower banks are frequently or partially submerged. In order to accurately capture the characteristics of the entire riverbank, classification will be completed for both upper and lower bank characteristics. Table 3.1.1-2 includes classification categories for the upper and lower banks.

Riverbank segments will be developed based on observation of common characteristics for each feature within the segment. Transition points, or end points, from one riverbank segment to another, where characteristics of any riverbank features change, will be captured via sub-meter GPS, data-logger, and laser range-finder (Task 3). For example, if a 500 ft stretch of both upper and lower riverbank exhibits a consistent bank slope, height, sediment composition, degree of vegetative cover, and extent of erosion then that 500 ft stretch would be identified as one riverbank segment. Sub-meter GPS, data-logger, and laser range-finder would then be used to collect the coordinates of the start and end point of that segment. This method would be repeated for all riverbank segments throughout the study area. Erosion classifications, discussed in Task 2b, will be conducted for each riverbank segment.

Sensitive receptors, such as important wildlife habitat located at or near the riverbank, will be identified during the boat and land-based surveys. The riverbank stabilization/environmental consultant will be responsible for the identification of these features. Features that will be documented will include, but not be limited to, bank swallow colonies, kingfisher nests, eagle nests, and prime odonate and mussel habitat. The location of sensitive receptors will be collected via sub-meter GPS where satellite coverage will allow. If GPS collection is not possible, locations will be approximated on field maps using aerial imagery. Descriptions of each habitat will be entered into the data-logger or included on field datasheets. Geo-referenced video and/or photographs will be taken at all sensitive receptor sites as a method of reference checking and data control.

Observations made as part of this task will occur from a boat approximately 50-100 ft from shore, or closer if possible. In order to ensure consistent identification during this assessment a field datasheet will be developed based on Table 3.1.1-2 and Table 3.1.1-4. The field datasheet will be carried with the field crew and referenced when classifying riverbank characteristics. Field observations will be entered into a data-logger or recorded on field datasheets. Geo-referenced video will be taken to document the features identified in the field and as a means of data control and reference checking (Task 4).

The identification of riverbank characteristics and the establishment of riverbank segments is consistent with the approach used during past FRRs. Consistency between FRRs will provide a basis for comparison of 2013 results with past FRR efforts for riverbank features and characteristics that remain consistent.

Task 2b: Identify and Define the Type(s), Stage(s), Indicators, and Extent of Erosion

While conducting Task 2a, an erosion classification will be conducted of each riverbank segment. A typical sequence of assessment would generally entail: 1) classifying the characteristics of a given riverbank segment based on the criteria found in Table 3.1.1-2; 2) collecting the transition points of the bank segment via sub-meter GPS; 3) conducting an erosion classification of the bank segment; and 4) moving on to the next riverbank segment and repeating steps 1-3.

The erosion classification will be based on the criteria found in Table 3.1.1-2 and will include identification of the type(s), stage(s), indicators, and extent of erosion. Indicators of potential erosion such as exposed roots, creep, overhanging banks, and notching will be identified as part of this task. Indicators of potential erosion, such as tension cracks, that are not clearly visible from the boat will be investigated and identified in greater detail as part of the land-based assessment discussed in Task 1. Table 3.1.1-3 and 3.1.1-4 contain detailed descriptions, photos, profiles, and plan views of the criteria that will be used for the erosion classification.

Types of erosion identified in the field are based on the recommendations made by FGS, 2007 and will consist of: 1) Falls (which can be classified as Undercuts or Gullies); 2) Topples; and 3) Slides or Flows. Slides can be further subdivided into subcategories Planar slip and Rotational slump. It should be noted that Field lists Slides and Flows as two separate types of erosion, however, given the fact that the FRR is a reconnaissance level survey, it may be difficult for field personnel to make the differentiation between a slide, planar slip, rotational slump, or flow in the field. As such, for the purpose of this study, Slides and Flows have been combined into one category. If field personnel can easily identify and make the differentiation between the specific type of Slide or Flow (e.g. planar slip, rotational slump, etc.) those observations will be noted on the data-logger or field data sheet. Definitions of each type of erosion can be found in Table 3.1.1-3 while photos, profiles, plan views, and descriptions can be found in Table 3.1.1-4. Each type of erosion present in a given riverbank segment will be identified and noted.

Based on the recommendation of FGS, 2007 the 2013 FRR will incorporate an assessment of the indicators of potential erosion or bank instability that are present in a given riverbank segment. Indicators of potential erosion that will be identified include: 1) tension cracks (Task 1b); 2) exposed roots; 3) creep; 4) overhanging bank; 5) notching; and 6) other indicators. Definitions and descriptions of these features can be found in Table 3.1.1-3 and Table 3.1.1-4.

Indicators of potential erosion included in this study are based on the classifications proposed in FGS, 2007 with some additions. It should be noted that Field classifies creep as a type of erosion and leaning trees as an indicator of erosion, however, based on the definition provided by Field in Table 3.1.1-4 creep is typically defined by the presence of tree trunks that are bent downslope at the base. Based on this definition, creep has been classified as an indicator of potential erosion for the purpose of this study. The classification of “other” as an indicator of potential erosion (Table 3.1.1-2) will be utilized if the field crew observes potential erosion features that do not fit into one of the predefined classifications. Any features noted as “other” will be described in detail on field data sheets or in the data-logger. All indicators of potential erosion in a given riverbank segment will be documented and noted.

The 2013 FRR will also include classifying the temporal or process stage(s) of erosion of each riverbank segment based on the recommendations of FGS, 2007. While Field did recommend a template for erosion stage classifications, the template was based on a hypothetical sequence of erosion composed of various types of erosion. Field’s sequence described the process of a riverbank eroding and then eventually becoming more stable after the riverbank slope has decreased in steepness and a beach has formed to protect the slope. This process occurs through an ongoing temporal riverbank transition process during stages of stability and erosion or instability. What Field had labeled as stages of erosion were actually types of erosion through the processes of riverbank evolution. These various types of erosion are already included in the erosion classification and, as such, Field’s recommended stages of erosion will not be adopted for this study. Temporal or process stages of erosion that will be included in the 2013 FRR will include: 1) Potential Future Erosion; 2) Active Erosion; 3) Eroded; and 4) Stable. Definitions and descriptions of each stage of erosion can be found in Table 3.1.1-3. A temporal or process stage of erosion will be assigned to each bank segment identified in Task 2a based on the type(s) of erosion and indicators of potential erosion present in that segment.

Given that multiple stages of erosion may occur at the same location or within a riverbank segment, all stages of erosion present in a segment will be identified and noted, however, for classification purposes only the dominant stage of erosion for each bank segment will be used to classify that specific segment. For example, if a bank segment contains various levels of all four stages of erosion but Potential Future Erosion is the dominant stage, that bank segment would be classified as Potential Future Erosion.

The extent of current erosion will be classified based on the amount of active erosion present over the total surface area in a given riverbank segment. Indicators of potential erosion will not be factored into determining the extent of current erosion as these indicators do not represent current erosion. Classification categories will include: 1) None/Little; 2) Some; 3) Some to Extensive; and 4) Extensive. Table 3.1.1-3 provides descriptions of each extent classification. The extent of current erosion will be based on the approximate percentage of active erosion occurring over the total surface area of a given riverbank segment. In addition, field observations of the riverbank segment will be compared to representative photographs depicting the four extent classifications as an additional form of reference checking. Photographs of the riverbanks taken during a preliminary investigation of the Turners Falls Impoundment in November 2012 during leaf off conditions will be used for this comparison. Through the qualitative approximation of the percent of active erosion present combined with the comparison of field observations with the representative photographs a determination will be made as to the extent of current erosion present. To ensure accurate and consistent classification, field personnel will be equipped with field datasheets which will contain descriptions and photographs of each extent classification. This approach is consistent with the recommendations of FGS, 2007 in regard to identifying the type of erosion as well as being consistent with the methodology used for previous FRRs and the level of effort required to conduct a reconnaissance level survey. Representative photographs that will be used for this comparison are included in the appendices of the QAPP (Appendix D).

All erosion classifications conducted as part of this task will occur from a boat approximately 50-100 ft from shore, or closer if possible. In order to ensure consistent identification during this assessment a field datasheet will be developed based on Table 3.1.1-2, 3.1.1-3, 3.1.1-4, as well as the representative photographs included in the appendices of the QAPP (Appendix D). The field datasheet will be carried with the field crew and referenced when conducting the erosion classification. Field observations will be entered into a data-logger or recorded on field datasheets. Geo-referenced video will be taken to document the features identified in the field and as a means of data control and reference checking (Task 4).

Table 3.1.1-2: Connecticut River – Turners Falls Impoundment Riverbank Classifications for Boat-based Survey

UPPER RIVERBANK CHARACTERISTICS[8]						
Upper Riverbank Slope	Overhanging *>90°*	Vertical *90°*	Steep *(>2:1)*	Moderate *(4:1-2:1)*	Flat *(<4:1)*	
Upper Riverbank Height *(total height above normal river level)*	Low *(<8 ft.)*	Medium *(8-12 ft.)*	High *(>12 ft.)*			
Upper Riverbank Sediment	Clay *(.001-.062mm)*	Silt/Sand *(.062-2 mm)*	Gravel *(2-64mm)*	Cobbles *(64-256mm)*	Boulders *(256-2048mm)*	Bedrock
Upper Riverbank Vegetation	None to Very Sparse *(<10%)*	Sparse *(10%-25%)*	Moderate *(25%-50%)*	Heavy *(>50%)*		
Sensitive Receptors	*Descriptions of important wildlife habitat use on or near the riverbanks such as bank swallow colonies, kingfisher nests, eagle nests, prime odonate and mussel habitat, etc.*					
LOWER RIVERBANK CHARACTERISTICS						
Lower Riverbank Slope	Vertical *90°*	Steep *(>2:1)*	Moderate *(4:1-2:1)*	Flat / Beaches *(<4:1)*		
Lower Riverbank Sediment	Clay *(.001-.062mm)*	Silt/Sand *(.062-2 mm)*	Gravel *(2-64mm)*	Cobbles *(64-256mm)*	Boulders *(256-2048mm)*	Bedrock
Lower Riverbank Vegetation	None to Very Sparse *(<10%)*	Sparse *(10%-25%)*	Moderate *(25%-50%)*	Heavy *(>50%)*		
Sensitive Receptors	*Descriptions of important wildlife habitat use on or near the riverbanks such as bank swallow colonies, kingfisher nests, eagle nests, prime odonate and mussel habitat, etc.*					
EROSION CLASSIFICATION						
Type(s) of Erosion	Falls – Undercut	Falls – Gullies	Topples	Slide or Flow	*Planar Slip* *Rotational Slump* *Flow*	
Indicators of Potential Erosion	Tension Cracks	Exposed Roots	Creep/ Leaning Trees	Overhanging bank	Notching	Other
Stage(s) of Erosion	Potential Future Erosion	Active Erosion	Eroded	Stable		
Extent of Current Erosion	None/Little *(<10%)*	Some *(10%-40%)*	Some to Extensive *(40%-70%)*	Extensive *(>70%)*		

[8] All quantitative classification criteria (e.g. slope, height, vegetation, extent, etc.) will be based on approximate estimates made during field observations of riverbanks. The FRR is a reconnaissance level survey that will not include quantitative field measurements of characteristics.

Table 3.1.1-3: Riverbank Classification Definitions

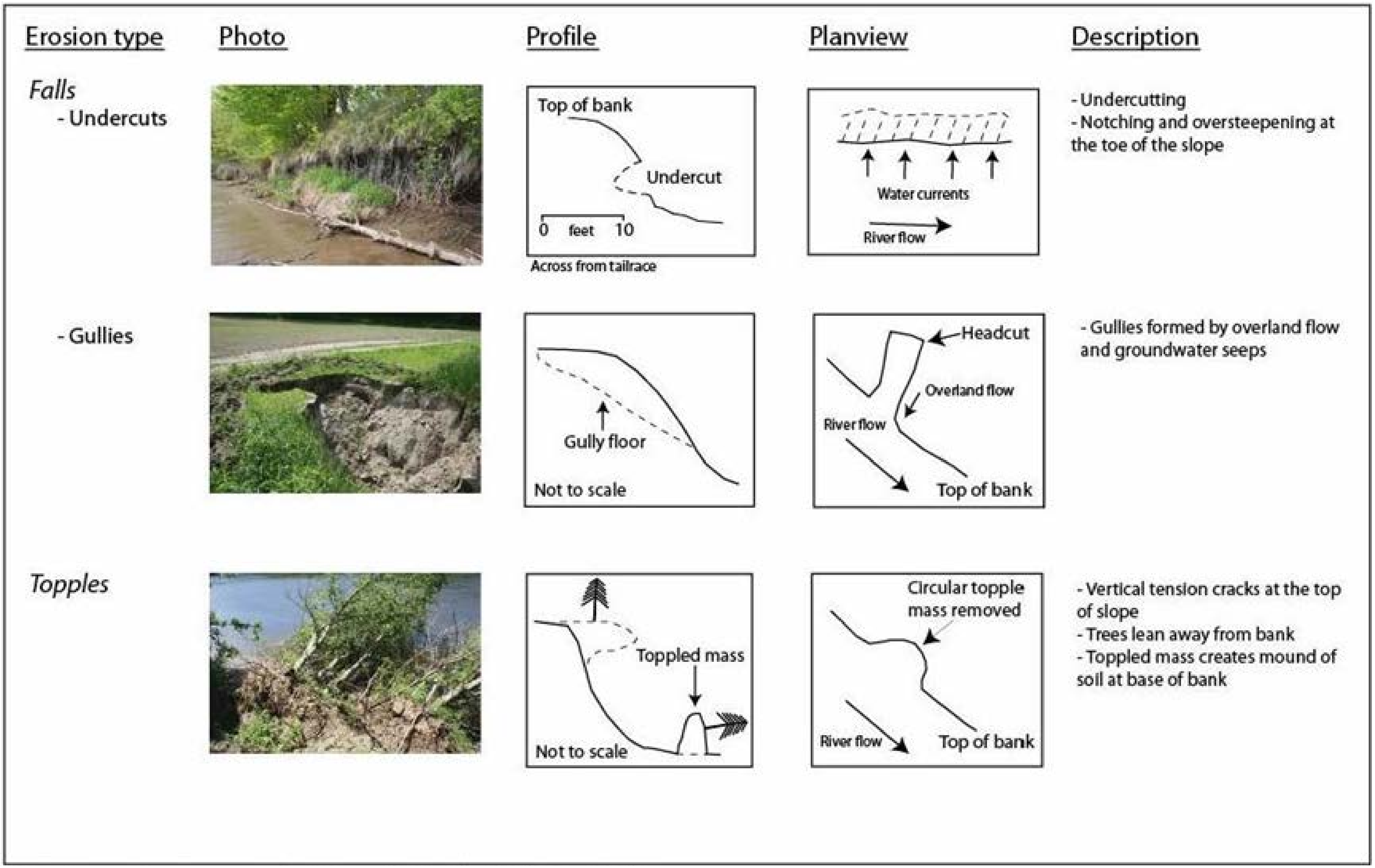
RIVERBANK CHARACTERISTICS *(Upper and Lower)*[9]	
Riverbank Slope	**Overhanging** – any slope greater than 90º
	Vertical – slopes that are approximately 90º
	Steep – exhibiting a slope ratio greater than 2 to 1
	Moderate – ranging between a slope ratio of 4 to 1 and 2 to 1
	Flat – exhibiting a slope ratio less than 4 to 1[10]
Riverbank Height	**Low –** height less than 8 ft above normal river level[11]
	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	Descriptions of important wildlife habitat use on or near the riverbank such as bank swallow colonies, kingfisher nests, eagle nests, prime odonate and mussel habitat, etc.
EROSION CLASSIFICATIONS	
Type(s) of Erosion[12]	**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.
Stage(s) of Erosion	**Potential Future Erosion –** riverbank segment exhibits multiple or extensive indicators of

[9] All quantitative classification criteria (e.g. slope, height, vegetation, extent, etc.) will be based on approximate estimates made during field observations of riverbanks. The FRR is a reconnaissance level survey that will not include quantitative analysis.
[10] Beaches are defined as a lower riverbank segment with a flat slope
[11] For the purpose of this study, Normal Water Level will be defined as water levels within typical pool fluctuation levels, but below Ordinary High Water (186').
[12] FGS, 2007

	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**[13] **–** 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

[13] 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.

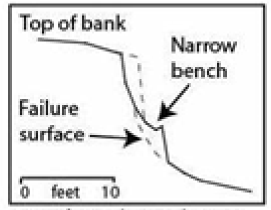
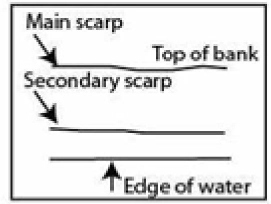
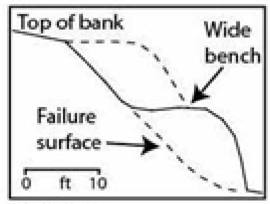
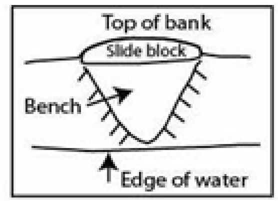
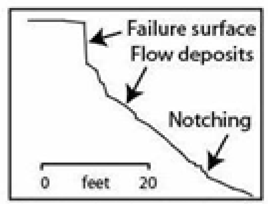
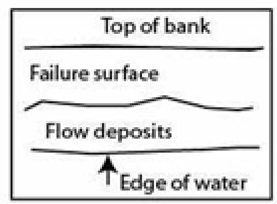
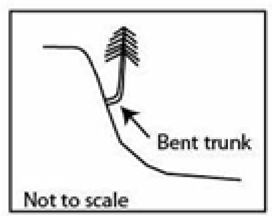
Table 3.1.1-4: Types of Erosion Occurring in the Turners Falls Impoundment and their Characteristics



Erosion type	Photo	Profile	Planview	Description
Falls - Undercuts		Top of bank Undercut 0 feet 10 Across from tailrace	Water currents River flow	- Undercutting - Notching and oversteepening at the toe of the slope
- Gullies		Gully floor Not to scale	Headcut Overland flow River flow Top of bank	- Gullies formed by overland flow and groundwater seeps
Topples		Toppled mass Not to scale	Circular topple mass removed River flow Top of bank	- Vertical tension cracks at the top of slope - Trees lean away from bank - Toppled mass creates mound of soil at base of bank

(FGS, 2007)

Table 3.1.1-4: Types of Erosion Occurring in the Turners Falls Impoundment and their Characteristics (continued)

Erosion type	Photo	Profile	Planview	Description
Slides - Planar slip		 Across from tailrace (Split River)		- Vertical tension cracks at top of slope - Top surface of slide mass has flatter slope than rest of bank (narrow bench) - Trees lean in towards bank - Trees can remain in growth position despite sliding
- Rotational slump		 Munns Ferry		- Vertical tension cracks at top of slope - Deeper seated than slips - Trees lean in towards bank - Arcuate failure surfaces
Flows - Grain flows		 Downstream RR Bridge in VT (Kendall)		- Colluvial deposits created by flows accumulate at base of slope to form concave up surfaces
Creep			Not applicable	- Tree trunks bent downslope at base

(FGS, 2007)

Task 3: Spatially Define Riverbank Transition Points

As an integral part of classification of a riverbank segment (Task 2), the locations of transition points, or end points, from one riverbank segment to another will be captured via sub-meter GPS, data-logger, and laser range-finder (Task 3). Classification of features (Task 2), mapping of transition points, and video and photographic documentation (Task 4) will occur from a boat approximately 50-100 ft from the bank line, or closer if possible.

The individual conducting the classification (Task 2, Table 3.1.1-2) will select a point of transition from one riverbank segment to another and "shoot" this point with the laser range-finder to determine the distance and azimuth to the riverbank from the boat. At the same time, the sub-meter GPS unit will collect the position of the boat. The distance and azimuth from the laser range-finder is automatically entered into the data-logger. The data-logger will then conduct an offset using the combination of these three measurements (boat GPS location, distance, and azimuth) to calculate the coordinates of the transition point. Once the offset has been conducted the data-logger will alert the user that the coordinates of the transition point were stored successfully. This process will be repeated at each transition point. Appendix A and B of the QAPP (Appendix D) provide specifications for the sub-meter GPS and laser range-finder models that have been selected for this survey.

All GPS data will be collected using a standard coordinate system such as NAD 83 State Plane or UTM coordinates. The accuracy of the sub-meter GPS is assumed to be within one meter; however, the accuracy of any GPS in the field can vary depending on several factors including satellite availability, multipath interference (i.e. trees), and the differential correction solution. To test the positional accuracy of the GPS/laser range-finder system a known, fixed point will be located on the bank from a slow moving boat. The GPS unit and laser range-finder will then be used to collect the location of the known point. The point will be surveyed multiple times and the difference in location will be determined.

The number of riverbank segments identified will depend on the frequency of transitions between various features and classifications observed in the field. There is no set distance of segmentation along the river[14]; however, segments shorter than 20 ft will not be captured due to accuracy limitations of the equipment.

The location of sensitive receptors (important wildlife habitat) will also be mapped via sub-meter GPS.

Task 4: Video and Photographic Documentation

As a means of data control and reference checking, video and photographic documentation will be taken of all riverbank segments identified in Tasks 2 and 3. Geo-referenced video of all riverbanks will be taken from a boat at an appropriate distance from the bank line so that the image of the riverbank fills most of the screen while still including the necessary perspective of the water line and some water. This work will be conducted immediately prior to or following classification of the riverbank (Task 2). If questions arise regarding how a riverbank segment was classified the videos and photos depicting the specific features and characteristics present can be referenced. Geo-referenced photographs will be taken to document observations of selected riverbank features and characteristics as part of the land-based survey (Task 1). Additionally, the photo log created as part of FGS, 2007 will be reproduced, to the best extent possible, during summer 2014. Given that the 2007 photo log was collected in the summer, reproduction of the

[14] Previous FRRs have resulted in a range of segment lengths from 20 ft to over 4,000 ft, with average segment lengths from 480 ft to 1,267 ft. The 2008 FRR resulted in the smallest average segment length of the various FRRs compared (*"Response to Field Geology Services' 2011 'Detailed Analysis of the 2008 Full River Reconnaissance of the Turners Falls Pool on the Connecticut River,' July 2012."*)

photo log in the summer of 2014, as opposed to the fall 2013, will allow for direct comparison between the photo logs.

Task 4a: Geo-referenced Video

Geo-referenced video technology will be utilized to capture digital video images of the riverbanks as well as the coordinates where each video image was taken. The output video images and spatial locations will document and verify what the riverbanks looked like during the 2013 FRR and provide an additional source of quality control and reference checking.

The geo-referenced videotaping will be conducted using Red Hen Systems equipment; this equipment is the same equipment that was utilized for the 1998, 2001, 2004 and 2008 FRRs. Red Hen Systems will provide the hardware and software necessary to collect the geo-referenced video in the FGS, import the field collected data to a desktop, and generate web-based maps for analysis and to aid in the decision making process (Task 5). Components of this system include: the VMS-HDII (which includes the VMS-333 geo-referencing equipment); a compatible digital video camera; and MediaMapper Software. Appendix C of the QAPP (Appendix D) provides detailed information on this system. Additional information can be found on the Red Hen Systems website (http://www.redhensystems.com).

Task 4b: Re-collection of 2007 Photo Log

The riverbank photo log completed by Field Geology Services as part of the report titled *"Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT"* (FGS, 2007) will be repeated as part of the 2013 FRR and/or in conjunction with field activities associated with Study No. 3.1.2. The replication of the 2007 photo log will be done as closely as possible to the original photos within the context of FRR or Study No. 3.1.2 field activities.

Given that the 2007 photo log was collected during summer conditions (June 15-21, 2007), the reproduction of this photo log will occur during the summer 2014, as opposed to fall 2013, in order to ensure consistency and that direct comparisons can be made. Once collected, comparisons between the 2007 and 2014 photo logs will be made to identify changes visible along the banks (FGS, 2007). If deemed relevant, digital image logs taken in 2001 and 2004 may also be incorporated into this analysis where the bank position can be confirmed relative to the photo log (FGS, 2007).

Task 5: Riverbank Stabilization Projects

The 2013 FRR will provide an evaluation of each of the restoration projects constructed to date as part of the ECP (S&A, 1999) as well as recommendations for potential future stabilization projects. Descriptions of the successes and failures of each design, construction implementation, revegetation, invasive species concerns, and long term maintenance recommendations will be included in this assessment. Recommendations for potential future projects will be based on the findings of the 2013 FRR mapping.

Task 5a: Evaluation of Past Bank Stabilization Projects

Each of the bank stabilization projects constructed since 1996 will be evaluated in 2013 to determine if the primary goals of erosion control, reduction of sediment supplied to the river, bank stability, and the establishment of native vegetation have been achieved. If it is determined these goals have not been met, the reasons for the failure(s) will be explored. Construction methods, site contractors, materials used, access routes, construction techniques, and plant materials have evolved between 1996 and 2013. As part of this assessment, each of these criterion and methods will be evaluated. The various techniques or methods that have been used will be discussed based on their relative success or failure in meeting the primary goals previously mentioned. Recommendations for any future bank stabilization projects will be provided based on the long term successes or failures of the previously constructed projects. Items to be evaluated will include: cultural resources; wildlife habitat; construction staging; construction access; construction equipment; specified materials; land clearing; bank grading; vegetation establishment; invasive species; long-term operations and maintenance and stability assessments, and the time of year of construction.

Task 5b: Recommendations for Future Bank Stabilization Projects

The data collected during the 2013 FRR will provide a comprehensive classification of bank erosion including identifying the locations of active and potential future erosion in the Turners Falls Impoundment. Based on these data, a hierarchy for future stabilization work will be developed. When developing this hierarchy it is important to note that not all project sites can or should have intervention. The results of this task will provide a list and map of those locations where future bank stabilization projects may be considered. In addition, specific construction techniques will be recommended where appropriate.

Task 6: Final Report, Data Analysis, and Deliverables

Once all field efforts and post-processing are completed, data analysis and map generation of the 2013 FRR field data will be conducted. Data analysis will include, but not be limited to, the development of summary statistics of riverbank classifications based on Table 3.1.1-1 and Table 3.1.1-2, assessment of trends or correlations between adjacent riverbank characteristics, land-use and erosion, and comparisons of riverbanks conditions with past FRRs.

ArcGIS datasets (shapefiles or geodatabases) will be developed and populated utilizing the field data collected gathered as part of Tasks 1, 2, and 3 (i.e. GPS points, field observations, etc.). All spatial analysis and map generation will occur using ArcGIS software. The raw field data (i.e. GPS points, field data sheets, data-logger files, photographs, and videos) will be stored in a secure location as a means of data control and reference checking. Geo-referenced video from the boat-based survey and geo-referenced photographs from the land-based survey will be available, upon request, in documenting and analyzing riverbank conditions.

Transition points collected via GPS as part of Task 3 will be used to develop a GIS layer containing the spatial segmentation of the riverbanks in the Turners Falls Impoundment. The attribute table(s) of this GIS layer(s) will be populated with the information gathered from Tables 3.1.1-1 and 3.1.1-2. Summary statistics and maps for each category found in these tables will be developed. In areas where erosion phenomena exist, riverbank characteristics identified in Table 3.1.1-2 will be analyzed to determine if a correlation or trend exists between specific riverbank characteristics and erosion. Land-use data compiled as part of Task 1 will also be analyzed for correlations or trends with erosion features present.

A comparison of the 2013 FRR will be made to the previous FRRs using summary statistics and analysis in ArcGIS to the extent comparisons can be made considering differences in features and characteristics, as well as differences in survey technology and accuracy. Comparison efforts will include analyzing changes in the length of riverbank shoreline experiencing erosion, severity of erosion, length of riverbank stabilization, success of erosion remediation efforts, identification of new erosion areas, etc. The purpose of these comparisons is to evaluate the temporal trends in riverbank erosion and to determine if equilibrium of erosion and stabilization is developing.

Comparisons of the 2013 FRR with past FRRs will address differences in methods and the accuracy of the technology used in collecting the spatial component of the data. Comparisons with previous FRRs can be made due to the fact that each FRR is internally consistent regarding the characterization of riverbank segments and overall length of river covered in mapping. Summary statistics can be compared between each FRR conducted over time based on identifying identical or reasonably similar categories from one FRR to another on an overall length or percentage basis. However, a direct comparison of maps and spatial data in GIS software is not appropriate unless the differences in survey equipment and techniques are quantitatively addressed and incorporated into the analysis. To conduct a direct comparison without this key step may result in erroneous analysis and invalid conclusions. Additionally, given the expanded nature of the 2013 FRR, not all 2013 field data can be compared to previous FRRs due to the fact that previous FRRs may not have identified a given characteristic (e.g.,. stage of erosion, indicators of potential erosion, etc.).

Mapping developed as part of this task will include, but not be limited to, maps depicting riverbank characteristics, types, stages, and extents of current erosion, indicators of potential erosion, adjacent land-use, and the location of bank stabilization projects. Figure 3.1.1-2 depicts an example of riverbank characteristic maps that have been included in past FRR reports. 2013 FRR mapping will follow previous FRR mapping styles so that data are comparable. A list of maps that may be included with the final report can be found at the end of this section. All maps will be developed in ArcGIS.

Following the completion of data analysis and map generation, a final report documenting the methodology and results of the 2013 FRR will be developed. Specifically, the report will include: summary statistics of riverbank features and characteristics; data-logging and field forms; photographs; overall assessment of erosion within the Turners Falls Impoundment; long term trends and comparison of FRRs over time; evaluation of existing stabilization projects; sediment deposition at stabilization sites and recommendations for future preventative maintenance and bank stabilization work; summary of land-based erosion evaluations; recommendations for riparian buffers based on the land use mapping and adjacent erosion; and recommendations for avoidance or protection of sensitive receptors and significant wildlife habitat areas.

Deliverables in the final report will include:

<u>Task 1 – Land-Based Observations</u>

- A map of the location of tension cracks and other indicators of potential erosion that are collected as part of this task;
- Sensitive receptors map (wildlife habitat);
- Land-use mapping;
- Documentation of correlations between adjacent land-uses and erosion;
- Geo-referenced photographs; and
- Data logging and field forms

<u>Task 2 – Classify Riverbank Features, Characteristics, and Erosion</u>

- Riverbank characteristic maps including: slope, surficial sediment/substrate, height, and vegetation;
- Riverbank segments map;
- Riverbank erosion classification maps including: erosion types, erosion stages, indicators of potential erosion, and extent of current erosion;

- Sensitive receptors map (wildlife habitat);
- Summary statistics of riverbank characteristics and erosion features;
- Documentation of correlations between specific riverbank characteristics and erosion; and
- Data logging and field forms

<u>Task 3 – Spatially Define Riverbank Transition Points</u>

- Development of a spatial segmentation dataset of the riverbanks in the Turners Falls Impoundment;
- GPS data points denoting the start and end points of all riverbank segments;
- GPS data points denoting the location of sensitive receptors; and
- Data logging and field forms

<u>Task 4 – Video and Photographic Documentation</u>

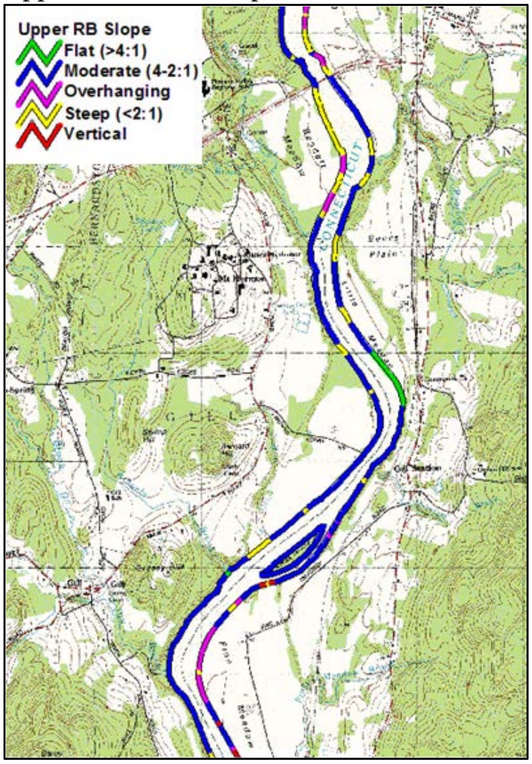
- Geo-referenced video of the entire Turners Falls Impoundment;
- Geo-referenced photographs of ground-based observations;
- Updated 2007 photo log of riverbanks; and
- Comparison of 2007 and 2014 photo logs, where applicable

<u>Task 5 – Riverbank Stabilization Projects</u>

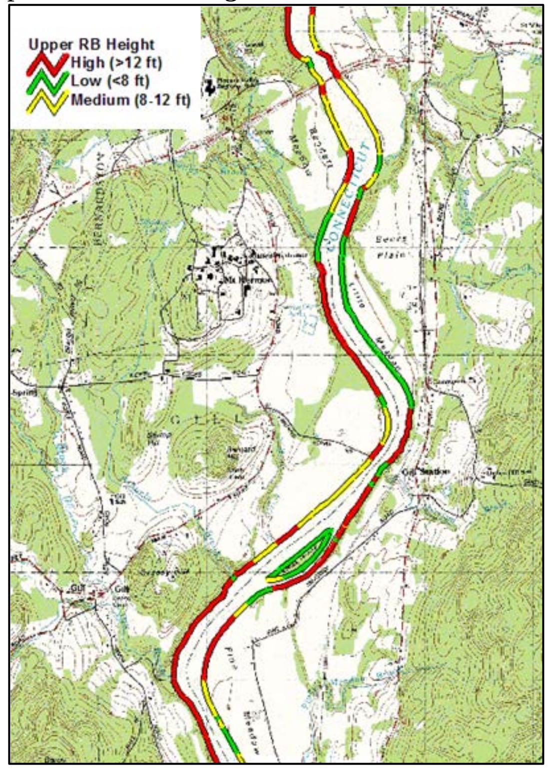
- Evaluation of existing bank stabilization projects;
- Recommendations for future preventative maintenance projects;
- Recommendations for future bank stabilization projects;
- Maps denoting the locations of all past, present, and potential bank stabilization projects; and
- Geo-referenced photographs

Figure 3.1.1-2: 2001 FRR maps for Height, Slope, Vegetation, and Material

Upper Riverbank Slope – Section 3

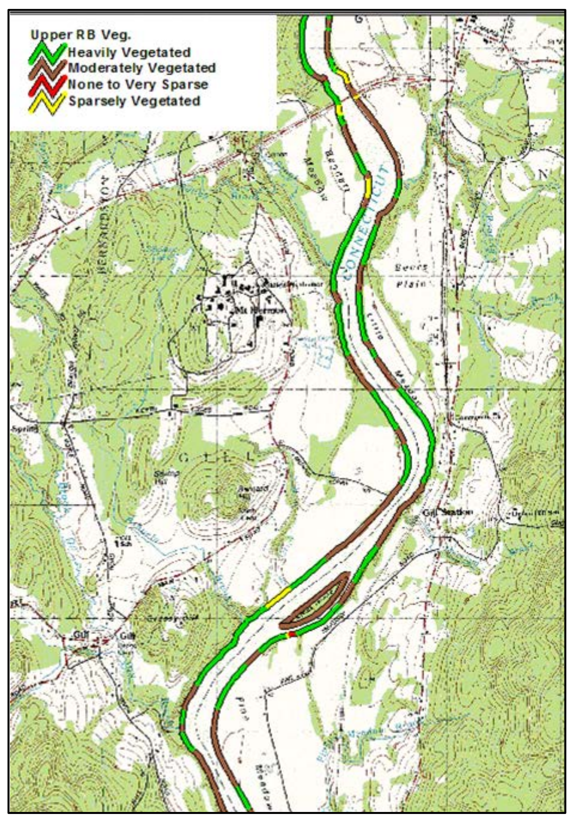


Upper Riverbank Height – Section 3



Lower Riverbank Sediment – Section 2

Upper Riverbank Vegetation – Section 3



Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort defined above is adequate to conduct a comprehensive full river reconnaissance study. The estimated cost for this study is between $300,000- $450,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight is proposing to initiate land-based studies (Task 1) in the early fall of 2013. Boat based, full river mapping (Tasks 2, 3, and 4) will be conducted in the late fall (mid November 2013) during leaf-off conditions. Recollection of the 2007 photo log originally created by Field will be conducted during the summer 2014 in order to allow for consistent comparison of photo logs. Based on the ILP schedule, and assuming there is no dispute with this particular study, FERC would issue its study plan determination letter by September 13, 2013 which would allow sufficient time to conduct the November 2013 FRR. If an agency with mandatory conditioning authority disputes this particular study, FERC would not issue its study plan determination letter until December 12, 2013. Thus, FirstLight would have to delay conducting the 2013 FRR until 2014.

FirstLight is seeking to file the final report for the FRR in September 2014, as opposed to April 2014, to match the timeline for filing other relicensing studies and to allow for the inclusion of the photo log which will be collected and analyzed in the summer 2014. As such, FirstLight submitted a request for extension to FERC on June 27, 2013.

Literature Cited

Field Geology Services (FGS). (2007). *Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT.* Farmington, ME: Author.

Simons & Associates (S&A). (1999). *Erosion control plan for the Turners Falls Pool of the Connecticut River.* Prepared for Northeast Utilities. Midway, UT: Author.

Simons & Associates (S&A). (2009). *Full river reconnaissance – 2008: Turners Falls Pool, Connecticut River*. Prepared for FirstLight Power Resources. Midway, UT: Author.

3.1.2 Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability

General Description of Proposed Study

This study was requested by the MADEP; however, several other stakeholders (FRCOG-2[15], NMFS-14, CRWC-2, FCD-2, Town of Gill-2, and LCCLC-2a) had a similar study request containing many of the same study objectives and elements as the MADEP. The latter group requested the study entitled: "Study the Impact of Operations of the Northfield Mountain Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River". FirstLight is addressing many of their study objectives/elements in this study. Study objectives/elements proposed by the stakeholders in their initial study requests but not included in this study plan are summarized in Section 4.0 *Studies Not Included in the RSP*- see Study No. 4.1.2.

This study calls for collectively looking at all available data and applying various analyses methods to make a determination as to whether the erosion and/or bank instability is caused, in whole or combined with other factors, by hydropower operations.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to evaluate and identify the causes of erosion in the Turners Falls Impoundment and to determine to what extent they are related to Project operations. In order to accomplish this goal, the following objectives are proposed:

- Conduct a thorough data gathering and literature review effort of existing relevant data to identify data gaps;
- Conduct field investigations and field data collection to fill data gaps. Gather the field data required to conduct detailed analyses of the causes of erosion and forces related to them;
- Develop an understanding of the historic and modern geomorphology of the Connecticut River. A historic geomorphic assessment will be conducted to provide context for analyzing the modern geomorphology of the Connecticut River;
- Identify the causes of erosion present in the Turners Falls Impoundment, the forces associated with them, and their relative importance at a particular location. Conduct various data analyses to gain a better understanding of these causes and forces;
- Identify and establish fixed riverbank transects that will be representative of the range of riverbank features, characteristics, and conditions present in the Turners Falls Impoundment;
- Conduct detailed studies and analyses of erosion processes at the fixed riverbank transects;
- Evaluate the causes of erosion using the field collected data and the results of the proposed data analyses. This evaluation will include quantifying and ranking all causes present at each fixed riverbank transect as well as in the Turners Falls Impoundment in general; and
- Develop a final report that will summarize the findings of this study and the methods used.

[15] The "-2" refers to the stakeholders' study request number.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

MADEP notes that the goal of this study is to conduct a focused investigation of bank instability in the Turners Falls Impoundment. The results of the study should provide information sufficient to enable staff to understand current and proposed effects of water level fluctuations, both natural and anthropogenic, and to identify sites where biostabilization techniques or other measures may be beneficial to water quality. MADEP additionally notes that the purpose of this study will be to focus attention and resources on that fraction of the banks in the Turners Falls Impoundment which are scientifically established to be susceptible to repeated soil wetting and drying.

The information gathered as part of the requested study will be used by MADEP to assist in issuing a Water Quality Certification that complies with the State and Federal Clean Water Acts.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Extensive research has been conducted evaluating the causes and effects of erosion along the Connecticut River in the Turners Falls Impoundment; such research includes:

Connecticut River Joint Commissions and Trails Conservation Assistance Program of the National Park Service through the Connecticut Valley Partnership. (1996) *River Dynamics and Erosion.* Authors.

Field Geology Services. (2004). *Fluvial Geomorphology Assessment of the Northern Connecticut River, Vermont and New Hampshire.* Farmington, ME: Author.

Field Geology Services. (2007). *Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT*. Farmington, ME: Author.

Northrop, Devine and Tarbell, Inc. 1991. *Connecticut River Riverbank Management Master Plan* (Draft). Northeast Utilities Service Company, Inc.

Simons & Associates. (1998). *Erosion Control Plan for Turners Falls Pool of the Connecticut River (Draft).* Western Massachusetts Electric.

Simons & Associates. (1998). *Long Term Riverbank Plan for the Turners Falls Pool of the Connecticut River.* Author.

United States Army Corps of Engineers. (1979). *Connecticut River Streambank Erosion Study Massachusetts, New Hampshire, Vermont.* Author.

United States Army Corps of Engineers. (1991). *General Investigation Study- Connecticut River Streambank Erosion.* Waltham, MA: USACE, New England Division.

Woodlot Alternatives. (2007). *Connecticut River Hydraulic Analysis Vernon Dam to Turners Falls Dam.* Author.

In addition, the following information is available to help inform this study:

- Bathymetric mapping of the Turners Falls Impoundment was completed in 2006.

- On January 22, 2013, FirstLight filed with FERC plan maps showing the location of 22 transects located in the Turners Falls Impoundment. Also provided were cross-section plots of these transects that have been surveyed twice annually since 1998. Note that these transects were selected for two primary purposes (1) they were relatively evenly spaced along the entire impoundment from Vernon Dam to Turners Falls Dam and (2) most were located at sites where erosion was occurring.
- Section 4.2.3 of the PAD contains a discussion of soil types and mapping from Vernon Dam to the Cabot tailrace including the identification of the ten most common soil series found in the Project boundary (PAD Table 4.2.3-1). Soils maps along the riverbanks were included in the PAD. As part of FERC's AIR (see Section 2.0) for the top ten most common soils, FirstLight has included the following data in Appendix C[16]:
    - Soil chemical properties such as: depth, cation-exchange capacity, effective cation-exchange capacity, and pH.
    - Soil physical properties such as: percent sand, silt, and clay, moist bulk density, saturated hydraulic conductivity, shear and compressive strength, available water capacity, linear extensibility, organic matter and erosion factors (Kw, Kf, and T).
- FirstLight maintains paper copies of its log sheets that include hourly data on flows, water elevations and generation. Paper copies of these log sheets have been converted to electronic data for the period 2000-2010. The following log sheet data will be used for this study and others:
    - Flow information from TransCanada relative to the Vernon discharge will be added to flows from the USGS gages on the Ashuelot and Millers River to estimate total inflow. The estimated total inflow is commonly termed as "Naturally Routed Flow" on FirstLight's log sheets. Estimated flows passed through the gatehouse[17] and estimated flows passed over Turners Falls Dam[18] are also available.
    - FirstLight maintains water level recorders (hereinafter termed "monitors") on the same vertical datum in the Turners Falls Impoundment at the following four locations a) immediately below Vernon Dam, b) directly below the Northfield Mountain tailrace, c) at the boat barrier buoy line approximately 1,500 feet upstream of the Turners Falls Dam and d) at the Turners Falls Dam (see Figure 4.3.1.3-1 in the PAD for locations). For purpose of this study, these four monitors are termed "long-term monitors" and have historically been set to record the WSEL every hour; however, they can be set to record the WSEL more frequently.
- FirstLight also maintained water level monitors, on the same vertical datum, from approximately May 1 through mid-August 2012 at two additional locations in the Turners Falls Impoundment - at West Northfield Road (near the VT/NH/MA border) and at the Route 10 Bridge (see Figure 4.3.1.6-1 in PAD for locations). For the purpose of this study, these two monitors are termed "short-term monitors".
- Two hydraulic models of the Turners Falls Impoundment are available using the 2006 bathymetry including a steady-state (flow does not vary with time) one-dimensional HEC-RAS model and a two-dimensional steady-state RIVER2D model.

[16] The soil information was obtained from the United States Natural Resources Conservation Service.
[17] Flows through the gatehouse are based on rating curves which relate the magnitude of the gate opening and Turners Falls Impoundment elevation at the dam to the magnitude of discharge.
[18] Flows passed via the bascule gates or tainter gates are based on rating curves which relate the magnitude of the gate position and Turners Falls Impoundment elevation at the dam to the magnitude of discharge.

- Pressure transducers were used to measure water surface elevation (WSEL) fluctuations in the impoundment and groundwater near Bennett Meadow on the west bank just below the Route 10 Bridge. One transducer was placed in the impoundment, and three (52 ft, 65 ft and 210 ft from the river) were placed in monitoring wells along a line perpendicular to the riverbank. The field work was conducted from mid-July 1997 through February 1998. These data provide information on the groundwater elevation and hydraulic gradient.
- Hydraulic (near shore velocity), bank material sampling, and suspended sediment sampling were conducted over a range of flow conditions from 1997 through 2011. These data provide information on velocity, hydraulic shear stresses, particle size distributions, and sediment transport.
- Boat wave data was collected at several locations on July 12-13, 1997 and July 26-27, 2008. Temporary staff gages were installed to document wave amplitude and frequency using videotape. Suspended sediment samples were also collected in the area where the waves impacted the shoreline.
- Two reports addressing riverbank erosion were filed with FERC on January 8, 2013 as follows:
    - Simons & Associates. (2012). *Riverbank Erosion Comparison along the Connecticut River*. Prepared for FirstLight. Midway, UT: Author.
    - Simons & Associates. (2013). *Analysis of Erosion in Vicinity of Route 10 Bridge Spanning the Connecticut River*. Prepared for FirstLight. Midway, UT: Author.
- Continuous suspended sediment concentration (SSC) data has been collected by FirstLight since late 2012 at the Route 10 Bridge (approximately hourly). SSC equipment installed on the north and south service mains inside the Northfield Mountain Powerhouse (water used for generation and pumping) has experienced technical difficulties and is being relocated to the Northfield Mountain Tailrace in 2013. Continuous SSC sampling will continue through at least 2014. Readers should refer to Study No. 3.1.3 *Northfield Mountain Project Sediment Management Plan* for further details on the SSC study.

Project Nexus (18 CFR § 5.11(d)(4))

Due to a variety of factors, the riverbanks along the Connecticut River, not just in the Turners Falls Impoundment, have a history of being susceptible to erosion. The Connecticut River is an alluvial river; that is, one which deposits clay, silt, sand, gravel or similar detrital material, and is therefore subject to dynamics such as lateral shifting, erosion, and deposition. These natural processes and the dynamic responses of the river may be further affected by land-use practices, modified flow/water level regime, motorized boating, and other factors.

The Connecticut River in the Turners Falls Impoundment is also impacted by three hydroelectric projects which discharge or draw water from the river for hydropower generation. These Projects are (from downstream to upstream): the Turners Falls Project, Northfield Mountain Project, and Vernon Hydroelectric Project. All three Projects can operate as peaking facilities when flows are within the hydraulic capacity of the facilities, which can directly impact water level fluctuations in the Turners Falls Impoundment. When flows exceed the hydraulic capacity of the Vernon and Turners Falls Projects, the projects are operated as run-of-river projects. This study will evaluate the causes of erosion in the Turners Falls Impoundment and determine if the erosion that is present is due to project operations.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The methodology for this study was revised to address comments made by Agencies and stakeholders at Study Plan meetings held on May 15, 2013 and June 14, 2013 as well as comments filed with FERC on or before July 15, 2013. Study methods outlined below were designed to provide a thorough investigation of the causes of erosion in the Turners Falls Impoundment in a manner consistent with generally accepted scientific practice. In order to provide a clearly organized methodology that will accomplish the goals and objectives previously stated, study methods have been divided into several tasks and subtasks. Specific study tasks will include:

- Task 1: Data Gathering and Literature Review;
- Task 2: Geomorphic Understanding of the Connecticut River;
- Task 3: Causes of Erosion;
- Task 4: Field Studies and Data Collection;
- Task 5: Data Analyses;
- Task 6: Evaluation of the Causes of Erosion; and
- Task 7: Report and Deliverables

In order to show the full range of conditions present in the Turners Falls Impoundment, this study will include the entire length of the impoundment from Vernon Dam to Turners Falls Dam. The fluvial geomorphologist/hydraulic engineer and geotechnical engineer will collectively look at all available data and apply various analysis methodologies to make a determination as to whether the erosion and/or slope instability present is caused, in whole or in combination with other factors, by hydropower operations.

Task 1: Data Gathering and Literature Review

Prior to conducting field investigations or data analyses a thorough data gathering and literature review effort will be made to provide a foundation for this study. Extensive research and data collection efforts have been conducted within the Turners Falls Impoundment over the past several decades which will assist this study. Existing data that will be utilized includes: hydrology, existing and proposed WSEL monitors, hydraulic modeling, and previous FRRs. A full list of available data that will be utilized for this study is summarized in the "Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))" section.

Upon completion of all data gathering and literature review, data gaps will be identified. Field data collection conducted as part of Task 4 will be based on these data gaps and may include collecting missing relevant information or updating relevant out-of-date datasets. Field studies currently described in Task 4 are based on a preliminary review of the existing data. Data collected in the field will be combined with pertinent existing data to conduct the analyses described in Task 5 and ultimately the evaluation and quantification of the causes of erosion discussed in Task 6.

Task 2: Geomorphic Understanding of the Connecticut River

In order to have a full understanding of the various processes at work in the Turners Falls Impoundment it is important to have an understanding of the geomorphic setting of the Connecticut River. This task will entail summarizing the historic and modern geomorphology of the Connecticut River, providing background information on the dynamic nature of alluvial rivers, discussing the general characteristics of the drainage basin (channel dimensions, tributaries, etc.), and comparing the present state of various reaches of the Connecticut River, and/or tributaries, with the Turners Falls Impoundment.

Analysis and discussion of the historic geomorphology of the Connecticut River will be conducted through the review of historical aerial imagery, topographic maps, photographs, surveys, plans, and/or archival studies and literature. The goal of this assessment will be to provide readers with context when discussing the modern geomorphology of the river. Stakeholders have requested multiple historical analyses comparing changes in riverbank conditions dating back to before the Turners Falls Dam was raised, multiple statistical analysis quantifying the amount of soil lost to erosion in the Turners Falls Impoundment, as well as other specific historical analyses. This task will include significant discussion of the historic geomorphology of the Connecticut River as part of the larger effort in this study plan to assess the current forces that influence erosion. The statistical analysis that compares conditions in the Connecticut River prior to raising the Turners Falls Dam, as requested by the stakeholders, will not be helpful in assessing current effects because it will not provide information on natural flow interaction with Connecticut River plan form.

Discussion of the modern geomorphology and the dynamic nature of alluvial rivers will be centered on present day conditions of the Connecticut River and the Turners Falls Impoundment. As part of this effort, FirstLight will summarize the principal potential causes of riverbank erosion, including natural processes and anthropogenic causes, which occur within a river corridor.

Task 3: Causes of Erosion

The geomorphic assessment of the Connecticut River (Task 2) will identify and summarize the principal potential causes of riverbank erosion present in the Turners Falls Impoundment. 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 (e.g. removal of riparian vegetation, cattle grazing to the river's edge, heavily traveled recreation trails);
- Animals (such as nesting burrows);
- Wind Waves;
- Seepage and piping;
- Freeze-thaw; and
- Ice or debris

The causes of erosion identified above, as well as any additional causes identified at the conclusion of Task 2, will form the basis for all field studies (Task 4) and data analyses (Task 5). Field studies and data analyses currently included in this study plan are based on the preliminary causation list above. The methodology described throughout this study plan has been developed to gain a thorough understanding of the various causes of erosion, the forces associated with them, and their relative importance at a particular location.

Causes of erosion throughout the study area could be due to a single source or combination of sources. A fluvial geomorphologist/hydraulic engineer and a geotechnical engineer will collectively evaluate the cause, or causes, of riverbank erosion at each fixed riverbank transect and throughout the Turners Falls Impoundment. In-depth data analyses and the study of causation will be limited to those causes, and the forces associated with them, which are deemed to be most prevalent throughout the impoundment (i.e. primary causes) as determined by the fluvial geomorphologist/hydraulic engineer and geotechnical engineer. Secondary causes of erosion will be identified and evaluated, but will not be analyzed as thoroughly as primary causes.

Based on past experience conducting geomorphic assessments on the Connecticut River, and other alluvial rivers, as well as from a preliminary investigation of existing documentation it is anticipated that the potential primary causes of erosion in the impoundment will include, in no particular order:

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

Secondary causes of erosion such as animals, wind waves, seepage and piping, freeze-thaw, and ice or debris may be present at specific locations, however, it is anticipated that these causes will have minimal to no influence on erosion in the Turners Falls Impoundment. These secondary causes will be analyzed sufficiently to determine their relative contribution to erosion, but not to the level of detail and specificity as the primary causes of erosion with site-specific, detailed data collection and analysis. As such, the methodology proposed in Tasks 4, 5, and 6 is focused on the potential primary causes of erosion listed above. If other primary causes of erosion are identified following the completion of Tasks 2 or 4, those causes, and the forces associated with them, will be analyzed accordingly.

Although this study will examine the causes of erosion throughout the entire Turners Falls Impoundment, the most detailed analyses and associated data collection will be focused at the selected fixed riverbank transects described in Task 4. Fixed riverbank transects selected for detailed analysis will be representative of the range of riverbank features, characteristics, and conditions found throughout the Turners Falls Impoundment. Fixed riverbank transects may include some or all of the 22 permanent transects described in the "Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))" section as well as additional transects, if deemed necessary.

Following the completion of all field activities, the contribution of the various causes of erosion present in the impoundment will be quantified and ranked based on the data analyses described in Task 5.

Task 4: Field Studies and Data Collection

Field studies and data collection will be conducted based on the needs identified from the data gap analysis (Task 1). The field studies discussed in this section are based on anticipated data needs identified following a preliminary review of the existing data.

Field efforts identified as part of this task include: 1) installation of proposed water level monitors; 2) 2013 FRR and evaluation of the 22 permanent transects; and 3) Land-based evaluation of fixed riverbank transects. Although the 2013 FRR will be conducted as Study No. 3.1.1, the findings of that study will be used in multiple analyses described in Task 5 and therefore is discussed briefly here. Evaluation of the 22 permanent transects, as well as other preliminary land-based assessments unique to this study, will be conducted in conjunction with the land-based survey discussed in Study No. 3.1.1 *2013 Full River Reconnaissance.*

Task 4a: Install Proposed Water Level Monitors in the Turners Falls Impoundment

At the May and June 2013 study plan meetings, stakeholders requested additional water level monitors be placed in the impoundment for two primary purposes: 1) to have a better understanding of the rate of change in the water surface elevation (WSEL) and 2) to have greater coverage throughout the length of the impoundment. Similar concerns were raised regarding Study No. 3.2.2- *Hydraulic Study of the Turners Falls Impoundment, Bypass Reach and below Cabot*, where additional water level monitors were sought to validate the existing hydraulic model. As a result of these comments, FirstLight is proposing to install additional monitors in the impoundment as noted in Table 3.1.2-1[19]. Table 3.1.2-1 includes descriptions of the proposed[20] and existing water level monitors in this area. For a figure denoting the locations of the proposed water level monitors refer to Study No. 3.2.2.

FirstLight believes that the number of proposed and existing water level monitors installed in the impoundment will be sufficient to accomplish the goals and objectives of this study. All hydraulic controls in the impoundment will be monitored by either a proposed or existing water level monitor, thus enabling the hydraulic model to be used to estimate the WSEL at riverbank erosion locations where water level monitors were not installed.

The proposed and existing[21] water level monitors will be set to record the WSEL every 15 minutes in order to understand the rate of change in WSEL as requested by stakeholders at the study plan meetings. Water level monitors will be installed from approximately August 2013 until November 2013[22] to capture a range of low and high flows as well as operating conditions at the Vernon, Northfield Mountain, and Turners Falls Projects. The proposed monitors will be surveyed to the same datum as the existing water level monitors. The information obtained as part of this task will be used in Task 5 to evaluate water elevation and flow data as well as in other aspects of this study.

Table 3.1.2-1: Proposed and Existing Water Level Monitors in Turners Falls Impoundment

Proposed Location of Water Level Recorder- (see HEC-RAS Transect No.)	Description	Rationale
Turners Falls Dam	Existing Gage: Located at Turners Falls Dam	

[19] Note that Table 3.1.2-1 is the same table appearing in Study No. 3.2.2.
[20] FirstLight will seek to install the water level monitors as outlined in the table; however, if access is not granted to land, some re-location may be required.
[21] FirstLight typically records the WSEL at the existing monitors every hour; however, the monitors can be set to record the WSEL every 15 minutes.
[22] NMFS and CRWC comment letters on the Updated PSP requested that the recorders be installed for a full calendar year. Because the purpose of the monitoring is to obtain representative data with which to validate a model, FirstLight believes the additional measurement time is not useful, so long as representative flows are measured during the proposed period. However, if a range of flows, from approximately 5,000 cfs (equaled or exceeded approximately 80% of the time annually- see Figure 4.3.1.2-17 of PAD) to 30,000 cfs (equaled or exceeded approximately 12 % annually- see Figure 4.3.1.2-17 of PAD), cannot be attained during the August-November 2013 period, then the monitors would be pulled over the winter and reinstalled by approximately March 15, 2014 (or when conditions are safe) to capture the 2014 spring runoff. FirstLight is concerned about the safety of personnel working on or near the river during the winter period as access to some of the water level recorders can only be achieved by boat and for that reason does not propose that the monitors be used in the winter months.

Proposed Location of Water Level Recorder- (see HEC-RAS Transect No.)	Description	Rationale
Transect No. 486.259: Turners Falls Boat Barrier Line	Existing Gage: Located just upstream of Turners Falls Dam	Located approximately 20,000 feet or 3.8 miles downstream of the approximate narrowest channel width at French King Gorge.
Transect No. 26986.3: Northfield Tailrace	Existing Gage: Located in Northfield tailrace	Located approximately 1.3 miles upstream of French King Gorge.
Transect No. 33486.3: Located upstream of Northfield Tailrace	Proposed Gage: Located approximately 6,500 feet upstream of the Northfield Tailrace	At the May 14 meeting a question was raised that when Northfield is generating does it create a backwater upstream of the tailrace. This gage is positioned to record changes in the WSEL potentially due to Northfield operation. This gage may provide assistance in Study No. 3.1.2 to evaluate the rate of change in water level fluctuations.
Transect 56926: Located at Route 10 Bridge	Proposed Gage: Route 10 Bridge. Located approximately 5.7 miles above the Northfield Tailrace	This location had a monitor in 2012 and was repeated.
Transect No. 71986.3: Located upstream of a Schell Memorial Bridge, near West Northfield Road	Proposed Gage: Located approximately 8.5 miles upstream of Northfield Tailrace	This location had a monitor in 2012 and was selected because the river width narrows and could act as a hydraulic control – water levels start to rise at this approximate location based on Figure 3.2.2-2.
Transect No. 92986.3: Located below Stebbins Island	Proposed Gage: Located approximately 5,500 feet below lowermost section of Stebbins Island	This gage would pick up the WSEL just below Stebbins Island. The reason for installing this monitor (Transect No. 92986.3) and the next one upstream (Transect 102986) is the original hydraulic modeling (filed with FERC in 2013) showed that the influence of the Turners Falls Project on WSEL extended to approximately below Stebbins Island. These two monitors are proposed to verify these original findings.
Transect No. 102986: Located above Stebbins Island	Proposed Gage: Located approximately 2,500 feet above uppermost section of Stebbins Island	This gage would pick up the WSEL just above Stebbins Island.
Vernon Tailrace: Located immediately below Powerhouse	Existing Gage	

Task 4b: Full River Reconnaissance

The 2013 FRR will be conducted as Study No. 3.1.1; however, the results of the FRR will be used in multiple aspects of this study and therefore is included in this methodology. Assuming no study disputes, work on the 2013 FRR will be initiated in fall 2013 and will include both a land and boat based survey. The primary goal of the FRR is to identify and map riverbank characteristics (including vegetation, slope, height, and sediment composition), current erosion processes, indicators of potential erosion and bank instability, as well as adjacent land-use and sensitive receptors (important wildlife habitat) throughout the entire Turners Falls Impoundment. All field work conducted as part of this effort will be completed by a geotechnical engineer, fluvial geomorphologist/hydraulic engineer, and riverbank stabilization/environmental consultant. The 2013 FRR study methodology and deliverables are described in greater detail in Study No. 3.1.1.

Field assessment and evaluation of the 22 permanent transects will be conducted by the fluvial geomorphologist/hydraulic engineer and geotechnical engineer in conjunction with the land-based assessment of the FRR. Assessment of the 22 permanent transects will include identifying all riverbank features and characteristics, types, stages, indicators, and extent of erosion, and adjacent land-use as discussed in Tables 3.1.1-1 and 3.1.1-2 in Study No. 3.1.1. Geo-referenced photos and/or videos will be taken at each location for data control and reference checking.

Data collected as part of the FRR and permanent transect assessment will be reviewed and analyzed prior to the commencement of Task 4c. The results of this analysis will be used, in conjunction with other pertinent data, in selecting the final list of fixed riverbank transects where detailed study and analyses will occur as discussed below.

Task 4c: Identification and Examination of Fixed Riverbank Transects

In order to gain a thorough understanding of the causes of erosion, the forces associated with them, and their relative importance at a particular location, FirstLight will identify and select a number of fixed riverbank transects where detailed study and analyses will occur. The selection of the fixed transects will be based on field observations made during the 2013 FRR, analysis of the 2013 FRR data, and field examination of the 22 permanent transects currently established in the impoundment (Task 4b). The fixed transects selected for detailed study will be representative of the range of riverbank features, characteristics, and conditions found throughout the Turners Falls Impoundment.

The first potential set of locations that could be used as fixed riverbank transects are the 22 permanent transects established in the 1990s and located throughout the impoundment in areas where erosion had been known to occur. The data from channel geometry surveys of the transects dating back to the 1990s could be useful in examining the extent of riverbank changes over time compared to: 1) riverbank features and characteristics; 2) location along the impoundment; and 3) historic operation, hydrology, and hydraulics. In order to determine if some or all of the permanent transects are representative of the riverbank features, characteristics, and conditions found throughout the impoundment, comparisons will be made between the results of the 2013 FRR and the results of the assessment of the 22 permanent transects discussed in Task 4b.

In order to be representative of the riverbank conditions found in the impoundment, the final list of fixed transects should include:

- Locations where riverbanks are stable (including one site where bank stabilization has occurred as a result of the ECP (S&A, 1999) and one site where that is naturally stable);
- Locations where the potential for future erosion is low;
- Locations where the potential for future erosion is high; and
- Locations where active erosion is occurring

Due to the nature of this study, it is anticipated that the majority of the final fixed transects will be in areas where active erosion is occurring or where the potential for future erosion is high.

In addition to being representative of riverbank conditions, the final list of fixed riverbank transects will be representative of the various riverbank features and characteristics present. Table 3.1.2-2 presents a matrix of riverbank features and characteristics found along the Turners Falls Impoundment. Special attention will be paid to categories that are highlighted in yellow as those characteristics are indicative of areas where active erosion is most likely to be occurring or the potential for future erosion could be high. Given that riverbank segments have characteristics from multiple categories present at a given location (e.g. vegetation, sediment, slope, etc.) the final locations of the fixed transects will be based on representative combinations of the features and characteristics contained in this matrix. Some duplication of characteristics will occur for those characteristics that are of the most interest (i.e. the highlighted categories).

Based on the results of the comparison of the 2013 FRR and the assessment of the permanent transects it may be found that: 1) the 22 permanent transects are adequate for this study; 2) the 22 permanent transects do not provide a representative dataset; or 3) the 22 permanent transects are duplicative and consist of a number of sites that have very similar features, characteristics, and/or conditions. If it is found that the 22 permanent transects do not provide a representative range of sites, a list of additional fixed riverbank transects will be identified. Conversely, if it is found that any of the 22 permanent transects are duplicative, those sites will be removed from consideration to avoid duplicating efforts.

It is anticipated that the final list of fixed riverbank transects that will be used for the detailed study and analyses described in this study plan will be based on a combination of some or all of the 22 permanent transects and additional sites identified by the fluvial geomorphologist/hydraulic engineer and geotechnical engineer. The total number of fixed riverbank transects that will be used for this study will be unknown until the field investigation discussed in Task 4b and the preliminary review of the field collected data is completed.

Table 3.1.2-2: Connecticut River – Turners Falls Impoundment Riverbank Features/Characteristics Matrix[23]

Upper Riverbank Slope	Overhanging *>90°*	Vertical *90°*	Steep *(>2:1)*	Moderate *(4:1-2:1)*	Flat *(<4:1)*	
Lower Riverbank Slope	Vertical *90°*	Steep *(>2:1)*	Moderate *(4:1-2:1)*	Flat / Beaches *(<4:1)*		
Upper Riverbank Sediment	Clay *(.001-.062mm)*	Silt/Sand *(.062-2 mm)*	Gravel *(2-64mm)*	Cobbles *(64-256mm)*	Boulders *(256-2048mm)*	Bedrock
Lower Riverbank Sediment	Clay *(.001-.062mm)*	Silt/Sand *(.062-2 mm)*	Gravel *(2-64mm)*	Cobbles *(64-256mm)*	Boulders *(256-2048mm)*	Bedrock
Upper Riverbank Height	Low *(<8 ft.)*	Medium *(8-12 ft.)*	High *(>12 ft.)*			
Degree Upper Riverbank Vegetation	None to Very Sparse *(<10%)*	Sparse *(10%-25%)*	Moderate *(25%-50%)*	Heavy *(>50%)*		
Lower Riverbank Vegetation	None to Very Sparse *(<10%)*	Sparse *(10%-25%)*	Moderate *(25%-50%)*	Heavy *(>50%)*		
Extent of Current Erosion	None/Little *(<10%)*	Some *(10%-40%)*	Some to Extensive *(40%-70%)*	Extensive *(>70%)*		

Once the final list of fixed riverbank transects has been established geo-referenced digital photographs will be taken and a matrix will be filled out showing which transects are associated with which riverbank features, characteristics, and conditions. In addition, an evaluation will be conducted prior to further field investigation of the transects. The assessment will include:

- Analysis of soils including, but not limited to, classification, structure, parent materials, texture, hydric regime, position on landscape, and engineering dynamics such as susceptibility to slope failure;
- Determination if similar soil characteristics are present at current erosion sites and/or sites of potential bank instability;
- Predict the WSEL at each fixed riverbank transect under a variety of conditions using the hydraulic model. Conditions will include:
  - Different downstream boundary conditions at Turners Falls Dam (ranging from 176 to 185 feet msl, the FERC licensed range);
  - Different magnitudes of flow; and

[23] See Study No. 3.1.1 Task 2 for a detailed discussion and definitions of the characteristics contained in this table. While erosion, or the potential for erosion, could occur in areas that exhibit the characteristics that are not highlighted, based on past experience conducting similar geomorphic assessments it has been found that those categories which are highlighted are typically known to be indicative of the characteristics found where erosion is most likely to occur or the potential for erosion could be high. As such these categories will be the primary focus when selecting the locations of fixed riverbank transects. Non-highlighted categories were included to cover relatively stable conditions to complete a range from eroding to stable transects for study.

    - Different Project (Vernon, Northfield Mountain, Turners Falls) operating conditions

- Estimate near-bank shear stress at each transect using the hydraulic model

The purpose of the hydraulic model analysis is to evaluate the range of fluctuations due to various anthropogenic and natural causes. In order to understand the processes and causes of erosion in the impoundment it will be important to understand the range of water level fluctuation due to Project (Vernon, Northfield Mountain, Turners Falls) operations and naturally high flows at each transect. Study No. 3.2.2 contains detailed discussion on how the hydraulic model will be run.

At the conclusion of the evaluation, the fluvial geomorphologist/hydraulic engineer and geotechnical engineer will conduct a second site visit to the fixed riverbank transects for detailed data collection and analysis. Field personnel will be equipped with a pentop computer, or similar technology, pre-loaded with geo-referenced aerial imagery of the Turners Falls Impoundment and GIS layers showing soils mapping, land-use classifications, and other pertinent geospatial data. The pentop computer will provide quick and easy access to reference data collected as part of Task 4b and from the in-house evaluation. The field computer will also provide field personnel with a means to enter additional notes or observations made during the survey.

All fixed riverbank transects will be surveyed and their endpoints monumented to allow for future survey and direct comparison of geomorphic changes at the transects. Slope instability and erosion will be assessed in greater detail than during the reconnaissance level survey conducted in Study No. 3.1.1. Bank soil characteristics will be verified based on visual assessment of the riverbanks to confirm the findings of the in-house evaluation. The riverbanks will be vertically subdivided into at least two categories: the upper riverbank (frequently above water) and the lower riverbank (frequently submerged) and soil types categorized for each. Sediment samples will be taken and analyzed for particle size distribution. To the extent that different soil layers are visible, samples will be collected and analyzed for each layer. A photographic log of the transects will be obtained and a sensitive receptors overlay will be mapped at each transect. Sensitive receptors could include habitat for bank-nesting birds, rare species occurrences, vegetated shallows, or other sensitive factors such as archeological sites.

Amplitude, frequency, speed of boat waves, and the observations on the effects of waves on the riverbank will be collected as part of the evaluation of the hydrodynamic forces due to boat waves (Task 5b). A staff gage will be placed in the riverbank so the amplitude of waves can be measured. The riverbank area in the vicinity of the staff gage will be videotaped to document the rate of rise and fall of the water level and the frequency of waves. Boat traffic information will be documented at the time of the field work and supplemented by boat traffic data from the recreation study. Erosion associated with boat waves will be documented photographically and through measurements of the amount of erosion.

In addition to the field collected data discussed above, model input data needed for the Bank-Stability and Toe-Erosion Model (BSTEM) (Task 5a), that does not currently exist, will be collected as part of this task. Data collected in the field will include: 1) a direct, in-situ bore hole shear test using a hand auger will be conducted at each selected site to determine effective cohesion, angle of internal friction, pore-water pressure, and bulk unit weight; 2) determination of the erodibility coefficient using a submerged jet test; 3) collection of sediment samples to be analyzed for particle size distribution as related to critical shear analysis using Shield's criteria; and 4) information on vegetation, root structure, and density. The borehole shear test provides direct, drained shear-strength tests on the walls of the borehole. To the extent that different sediment layers are found either through surficial observation or from the bore holes, the various layers will be sampled and analyzed for particle size distribution.

Task 5: Data Analyses

Pertinent existing data listed in the "Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))" section will be combined with the field collected data discussed in Task 4 to conduct the various data analyses proposed in this task. Sub-tasks contained in this task include:

- Task 5a: Geotechnical Analysis of Hydrodynamics of Flow and Water Level Fluctuations;
- Task 5b: Evaluation of Hydrodynamic Forces Due to Boat Waves; and
- Task 5c: Spatial Analysis

As mentioned in Task 3, only those causes of erosion that are considered primary causes will be analyzed at the detailed study sites as part of this task. Based on a preliminary investigation of existing data it is anticipated that potential primary causes of erosion will include:

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

The analyses described below are based on this preliminary list. If other primary causes of erosion are identified following the completion of Tasks 2 and 4, those causes, and the forces associated with them, will be analyzed accordingly.

In order to quantitatively identify and rank the causes of erosion in the Turners Falls Impoundment, a thorough understanding of the forces associated with each primary cause must be developed. The results of the data analyses proposed in this task will provide an understanding of: 1) the magnitude of forces; 2) the vertical location on the riverbank; 3) the longitudinal location; 4) the duration of forces; 5) the various types of riverbank materials; and 6) the geotechnical and physical properties of the bank materials in resisting erosion.

The Bank-Stability and Toe-Erosion Model (BSTEM) will be utilized to understand the effects of hydraulic shear stress due to flowing water and the impact of water level fluctuations as related to the constant wetting and drying of the banks (Task 5a) . Comparisons of the energy of boat waves versus the energy of flow and analysis of the intensity, duration, and elevation of boat waves will be conducted to understand the hydrodynamic forces of boat waves and their impact on riverbanks (Task 5b). For causes of erosion that are not the direct result of forces acting against a riverbank, various spatial analyses will be conducted to evaluate trends and correlations between adjacent land-use and anthropogenic influences to the riparian zone (Task 5c).

Following completion of this task, the evaluation of the various causes of erosion will be conducted by integrating analysis of the magnitude, duration, and location of forces as related to each primary cause of erosion, combined with results of the BSTEM model, to quantify the relative percentages of the primary causes of erosion at each fixed riverbank transect as well as throughout the Turners Falls Impoundment.

Task 5a: Geotechnical Analysis of Hydrodynamics of Flow and Water Level Fluctuations

The Bank-Stability and Toe-Erosion Model (BSTEM) will be used to develop a combined understanding of the fluvial and geotechnical processes related to riverbank erosion caused by the hydraulic shear stress due to flowing water and the repeated wetting and drying of the riverbank due to water level fluctuations. BSTEM was developed by the USDA-ARS National Sedimentation Laboratory[24] to determine the factor of safety for multi-layer streambanks and as a tool for making reasonably informed estimates of hydraulic erosion of the bank and bank toe.

Methods simulated in the model include horizontal layers (Simon *et al.*, 2000), vertical slices with tension crack (Morgenstern and Price, 1965), and cantilever failures (Thorne and Tovey, 1981). The model can be adapted to incorporate the effects of geotextiles or other bank stabilization measures that affect soil strength and accounts for the strength of up to five soil layers, the effect of pore-water pressure (both positive and negative), confining pressure due to streamflow, and soil reinforcement and surcharge due to vegetation. The BSTEM Model is primarily intended for use in studies where bank toe erosion threatens bank stability. The model estimates boundary shear stress from channel geometry and considers critical shear stress and erodibility of two separate zones with potentially different materials: the bank and bank toe (USDA-ARS, 2013).

The BSTEM model utilizes a wide variety of input data. Pertinent existing data (Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))) and field collected data (Task 4b) that will be used for this model will include:

- Channel geometry data;
- Bank layer thickness;
- Bank material characteristics (such as particle size, friction angle, cohesion, saturated unit weight, ϕ^b (angle representing the relation between the shear strength and matric suction), critical shear, and erodibility coefficient);
- Flow characteristics over time (slope, depth, duration);
- Ground water table depth;
- Output results from various plots and analyses of water elevation and flow data (Attachment A); and
- Output results from the one dimensional (HEC-RAS) and two dimensional (RIVER2D) hydraulic models of the Turners Falls Impoundment (e.g. velocity data)

Additional field data collection associated with the BSTEM model will be conducted as part of Task 4c and include:

- A direct, in-situ bore hole shear test using a hand auger from which the cohesive properties of the apparent effective friction angle will be identified;
- Determination of the bulk density of the soil present on the riverbank(s);
- Determination of the erodibility coefficient using a submerged jet test;

[24] *"Iterative Bank-Stability and Toe-Erosion Modeling for Predicting Streambank Loading Rates and Potential Load Reductions,"* 2010, Andrew Simon, Research Geologist, USDA-ARS, National Sedimentation Laboratory, Oxford, MS, Natasha Bankhead, Research Geologist, USDA-ARS, National Sedimentation Laboratory, Oxford, MS, and Robert Thomas, Research Associate, Department of Civil and Environmental Engineering, University of Tennessee, Knoxville, TN

- Collection of sediment samples to be analyzed for particle size distribution as related to critical shear analysis using Shield's criteria; and
- Information on vegetation, root structure, and density

Soils data identified above will be collected for the various layers of soil found at the selected sites. Vegetation data collected as part of Study No. 3.1.1 and the evaluation of the fixed riverbank transects will be used in the model to analyze the effect of vegetation on the erosion processes present. Additional data on tension cracks (Study No. 3.1.1) and pore water pressures (positive and negative) may be collected as part of this effort.

Data collection and analyses associated with this task will occur at some or all of the fixed riverbank transects discussed in Task 4c . The total number of transects where BSTEM data collection and analyses will occur will be based on the amount of transects required to develop a model representative of the characteristics present in the impoundment. The location and exact number of transects will be determined by the results of the field studies described in Tasks 4b and 4c; as such, the total number of transects included in this task will be unknown until the completion of these tasks.

In order to understand the relationship between water elevation and flow throughout the impoundment various plots will be developed and analyzed. Data utilized as part of this evaluation will include: existing and proposed water level monitors, USGS flow data, and FirstLight project operations data. Plots that will be developed will include annual hydrographs, evaluation of the range of WSEL over various time periods, evaluation of daily WSEL fluctuations, and hydrographs of WSEL versus flow. In addition, analysis of flow and WSEL data to correlate project operations will be conducted. The results and output data from these plots and analyses will be used in the BSTEM model. Attachment A contains a complete list of the plots and analyses proposed as part of this effort.

Shear stresses due to the tractive force of flowing water will be calculated as a function of the velocity of flow and compared to critical shear stress based on particle size using the Shield's relationship[25]. Hydrodynamic forces due to water level fluctuations will account for the rate of change of water level over time and the range of the overall fluctuations. The analysis of overall forces resulting from the water level changes in the river itself will use the rates of water movement related to seepage and the rate of change in water level in the soil matrix.

In order to analyze the hydraulic shear stress related to erosion associated with this phenomenon, sediment samples from the fixed riverbank transects will be collected and analyzed to determine particle size distribution. Particle size distribution will be calculated using a sieve analysis in a laboratory. Shear stress exerted by flowing water will be calculated based on near-bank velocities using the Shield's criteria. Shield's criteria relates velocity to the particle size of sediment at the point of incipient motion; in other words, it is utilized to compute the size of sediment that begins to be eroded and transported as a function of velocity or shear stress. Velocities will be calculated at the fixed riverbank transects over a range of flow conditions based on the results of hydraulic modeling (HEC-RAS and RIVER2D).

[25] As explained in numerous texts such as *"Sediment Transport Technology, Water and Sediment Dynamics"* (Simons, D.B. and F. Senturk, 1992) and *"River Engineering for Highway Encroachments, Highways in the River Environment,"* (Hydraulic Design Series Number 6, Publication No. FHWA NHI 01-004, 2001, E.V. Richardson, D.B. Simons and P.F. Lagasse)

Steady state one dimensional (HEC-RAS) and two dimensional (RIVER2D) hydraulic models exist for the Turners Fall Impoundment based on bathymetry data collected in 2006[26]. The HEC-RAS model will be used to: 1) simulate a range of flows and different downstream boundary conditions; 2) conduct analyses to determine the flow at which hydraulic control of the impoundment shifts from the Turners Falls Dam to other hydraulic controls (such as the French King gorge[27]); 3) predict the minimum, maximum and normal impoundment levels, Ordinary High Water Mark (OHWM), and min/max daily ranges at those locations where erosion exists or has the potential to exist[28]; and 4) predict the rate of WSEL change at existing erosion and potential bank instability locations. Rate of change predictions will be conducted by using the model in an unsteady state (flow varies with time).

The RIVER2D model yields information on the relationship between flow and near-bank velocity. Both HEC-RAS and RIVER2D modeling will be used to analyze near-bank velocity to determine shear stress along the bed and riverbanks. RIVER2D computes velocity vectors showing the magnitude and direction of velocity across the channel at each node representing the channel geometry. Of particular interest are the velocity vectors in the near-bank region where the flow of water directly affects the bank. At the fixed riverbank transects, the velocity vectors will be determined over a range of flow conditions. The near-bank velocity will be used to compute hydraulic forces in the vicinity of the riverbanks in lieu of a general shear stress calculation acting across the entire width of the river. Results of RIVER2D will allow the analysis to focus on the region of the flow next to the banks where flowing water exerts hydraulic forces that directly affect the riverbanks.

Once all input data has been gathered or collected BSTEM will compute: 1) the factor of safety as it varies over the hydrograph; 2) bank failure width and volumes; 3) sediment loading; and 4) changes in bank geometry due to mass-wasting and erosion over time.

An important factor in the analysis of riverbank stability includes the evaluation of repeated wetting and drying of riverbank soils due to water level fluctuations. Water within the soil matrix can affect the unit weight of the soil mass as well as the internal strength which is related to friction between soil particles. Water level variations in the river due to runoff events or hydropower operations can affect the pressure gradient. When water levels are high, water is driven into the riverbank. Conversely, when water levels are low, water drains from the riverbank. The free drainage or movement of water through the soil matrix reduces the potential for excess pore pressure to build up and decreases the effective normal stress of the soil. To the extent that pore pressure builds up as river water levels decrease, the reduced strength of the soil, coupled with the added weight of the saturated soil, may exceed the strength of the soil matrix such that the factor of safety (ratio of forces resisting failure to those causing failure) becomes sufficiently low that failure occurs. Typically, when failure occurs it is in the form of some type of mass-wasting where blocks of material break away from the riverbank and fall, slide, or slip under the influence of gravity.

[26] See Study No. 3.2.2 *Hydraulic Study of Turners Fall Impoundment, Bypass Reach and below Cabot Station* for discussion on the HEC-RAS hydraulic modeling proposed for the impoundment

[27] On February 22, 2013, FirstLight filed hydraulic modeling results of the Turners Falls Impoundment which showed that hydraulic control of the river shifts to the French King Gorge at a flow of approximately 30,000 cfs. This analysis will be re-confirmed after the model is calibrated and validated to the existing and proposed water level monitors.

[28] Note that water level monitors will not be placed at all locations where erosion exists or has the potential to exist. The water level monitors are designed to calibrate the hydraulic model so that changes in WSEL can be accurately determined at any location covered by the model. Accordingly, the hydraulic model will be used to predict the range of WSEL fluctuations attributable to project operations and naturally high flows at locations that are eroding or subject to erosion.

Conversely, if water levels in the river are higher, a negative pore water pressure (matric suction) exists which increases the strength of the riverbank and decreases the effective weight of the soil matrix thus reducing the forces tending to cause failure. These processes of water in the soil as related to strength of the soil are incorporated into the BSTEM model.

In order to fully understand the impacts of repeated wetting and drying of a riverbank, the relationship between river WSEL and groundwater level must be investigated. This relationship was developed by collecting impoundment WSEs and adjacent groundwater levels near the Route 10 Bridge. At this location, three groundwater wells were placed perpendicular to the riverbank at a distance of 52, 65, and 210 feet from the bank. Elevation data in the impoundment and wells were collected on an hourly basis from July 13, 1997 to February 28, 1998. During this time period the flow ranged from a few thousand cfs to approximately 80,000 cfs, representing a wide range of hydrologic conditions. In addition, riverbank sediment samples were collected and laboratory analyses conducted to determine the particle size distribution of the riverbank soil.

Based on this analysis it was found that groundwater elevations were typically higher than the river's elevation indicating a general trend of water flowing from the riverbank to the impoundment. The groundwater level data showed that the rise and fall of water level in the ground closely followed the pattern of impoundment WSEL changes. Given that the riverbank soils predominantly consist of sand and the pattern of groundwater variations closely matched that in the impoundment indicates there is a relatively free exchange of water into and out of the riverbanks. This detailed set of river and groundwater data and soils characteristics, including shear strength, erodibility, bulk density, and particle size distribution, will be utilized in developing data for BSTEM. If it is determined that additional groundwater level data is required for the model, field data collection will occur at a representative number of sites as part of Task 4c.

BSTEM model runs will be conducted such that the relative strength of forces and contribution of primary causes can be teased out and analyzed individually. BSTEM includes analysis from a geotechnical perspective (accounting for soil strength properties, soil moisture, and gravitational forces as a result of fluctuating water levels) as well as from a hydraulic perspective (shear stress due to flowing water related to critical shear stress of sediment particles). Field data will provide sediment particle size distributions, sediment layers, shear strength, and erodibility information. Model sensitivity will be tested by adjusting sediment property model parameters and input data to test various causational factors. For example, by running the model with and without water level fluctuations or with and without flowing water, as well as with a range of sediment strength and erosion parameters, an understanding of the relative contribution of various causes of erosion will be developed.

In addition, calibration of model parameters will be conducted by running the model with historic water level variations and flows for specific fixed riverbank transects where channel geometry surveys show riverbank changes over time. These calibration runs will further develop an understanding of riverbank erosion at each transect as well as throughout the impoundment. The combination of sensitivity tests and calibration runs will provide a means to tease out the relative strength of forces and contribution of primary causes of erosion such as the hydraulic shear stress due to flowing water and water level fluctuations due to hydropower operations.

Task 5b: Evaluation of Hydrodynamic Forces Due to Boat Waves

The results of the analyses described in this subtask will be used to understand the impact of boat waves, and the forces associated with them, on the riverbanks in the impoundment. Hydrodynamic forces due to the presence of boat waves will be evaluated using the horizontal and vertical velocity of water movement as well as a comparison of the energy and tractive force of the approaching wave(s) with the energy of the streamflow itself.

Data that will be collected as part of this task will include amplitude, frequency and speed of boat waves as well as the observed effects of waves on the riverbank. Data will be collected in 2014 at a sub-set of the fixed riverbank transects (2 to 3 sites) over a range of flow conditions. The total number and location of transects where data collection will occur will be determined based on the results of the field studies described in Tasks 4b and 4c; as such, the location and number of transects will be unknown until the completion of these tasks. Boat wave and erosion data collected in 1997 and 2008 will also be used in this analysis. The existing data was collected at two locations with one set of data collected at a low flow and one at a higher flow.

A staff gage will be placed in the riverbank so the amplitude of waves can be measured. The riverbank area in the vicinity of the staff gage will be videotaped to document the rate of rise and fall of the water level and the frequency of waves. Boat traffic information will be documented at the time of the field work and supplemented by boat traffic data from the recreation study. Erosion associated with boat waves will be documented photographically and through measurements of the amount of erosion

Once all pertinent field data has been collected a comparison will be made of wave energy to the energy or stress caused by flowing water. Observations of the effect of boat waves along with wave dynamics and erosion in the Turners Falls Impoundment will be evaluated. Analysis of the impact of boat waves on riverbanks will be conducted from several perspectives including: 1) physical processes; 2) intensity; 3) frequency and duration; 4) elevation; and 5) energy/shear stress. These various perspectives will be integrated to develop an understanding of the physical processes of boat waves and their effect on riverbank erosion in the Turners Falls Impoundment.

The description and analysis of the physical processes will consider the intensity, duration, and elevation of the wave(s). Intensity will include the velocity of impact and the rate of rise and fall of the water level. The rate of rise and fall associated with the passage of a flood wave as well as from hydropower operations will be analyzed and compared. The translational velocities and rates of rise and fall will also be compared to critical velocity for sediment movement from a shear stress perspective.

The location where the waves occur with respect to water surface elevation also plays a significant role in the potential for erosion. Waves breaking on a relatively flat slope on a lower riverbank (beach) will result in relatively small amounts of sediment movement and cutting; however, waves breaking on a steep upper bank can result in undercutting and progressive mass wasting. The duration of time when boat waves occur will be compared to the duration of flow events and normal project operation conditions. Flow and elevation-duration analyses for the boating season will be conducted as part of this task.

The energy and tractive force of the boat wave(s) will be compared to the energy and tractive force of the streamflow itself. The field collected and existing data will be used to develop a relationship between the energy of boat waves and the amount of boat traffic. Flow energy will be determined using a standard power equation relating energy to the magnitude of flow (in the near-bank region), the slope of the water surface (elevation drop), and unit weight of water.

The approach described above is consistent with generally accepted scientific practice and is similar to the techniques and methods used in Hill *et al.*, 2002 and Maynord *et al.*, 2008.

Task 5c: Spatial Analysis

In some cases, the cause, or causes, of erosion cannot be readily evaluated relative to the force(s) present. In these instances the cause(s) of erosion must be evaluated spatially. Spatial analysis of riverbanks where these causes may be present will be conducted based on various GIS datasets and geoprocessing tools, aerial imagery, 2013 FRR results, as well as other pertinent data. The land-use mapping conducted as part of Study No. 3.1.1 will be especially relevant to this effort as adjacent land-use practices and anthropogenic influences to the riparian zone may directly contribute to, or be the primary cause of, erosion in a given area.

Task 6: Evaluation of the Causes of Erosion

Following the completion of Task 5, the fluvial geomorphologist/hydraulic engineer and geotechnical engineer will analyze the results of all data analyses conducted in Task 5 to evaluate the causes of erosion in the Turners Falls Impoundment. This evaluation will include quantifying and ranking the primary causes of erosion present at each fixed riverbank transect as well as in the Turners Falls Impoundment in general.

Based on past experience conducting FRRs and other geomorphic evaluations of the Connecticut River, it is anticipated that potential causes of erosion found in the impoundment 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 (e.g. removal of riparian vegetation, cattle grazing to the river's edge, heavily traveled recreation trails);
- Animals (such as nesting burrows);
- Wind Waves;
- Seepage and piping;
- Freeze-thaw; and
- Ice or debris

As mentioned in Task 3, only those causes of erosion that are considered primary causes will be analyzed and evaluated with detailed, site-specific studies. Based on a preliminary investigation of existing data it is anticipated that potential primary causes of erosion will include:

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

As such, the analyses described in Task 5, and the evaluation and quantification described in this task, will be based on this preliminary list. Secondary causes of erosion that are believed to have minimal to no impact on erosion (such as animals, wind waves, seepage and piping, freeze-thaw, and ice or debris) will not be included in this assessment; however, any secondary causes that are identified during field surveys

(Task 4) will be qualitatively described and noted. If other primary causes of erosion are identified following the completion of Tasks 2 and 4, those causes, and the forces associated with them, will be analyzed and evaluated accordingly.

The evaluation of the various causes of erosion will be conducted by integrating analysis of the magnitude, duration, and location of forces as related to each primary cause of erosion, combined with results of the BSTEM model, to quantify the relative percentages of the primary causes of erosion.

The magnitude of forces will be determined by the various analysis techniques discussed in the individual sections of Task 5. As part of these independent analyses, BSTEM will be calibrated utilizing data collected at fixed transects. These data will contain information regarding the change in riverbank geometry since the 1990s which can be used to evaluate the effect of geotechnical and hydraulic processes. The previously described BSTEM sensitivity analysis (Task 5a) will provide a means to tease out the relative strength of forces and contribution of primary causes of erosion such as the hydraulic shear stress due to flowing water and water level fluctuations due to hydropower operations.

The duration of forces will be based on the available project operations data from 2000-2010 that show the hourly variations of water level and flow. This data will be supplemented by water level data currently being collected to calibrate the hydraulic model (Study No. 3.2.2). A combined flow/water surface elevation duration analysis will provide the elevation or location of forces as well as their duration. Hydraulic interpolations to any location where site-specific data are being collected will be conducted through interpretation of results from hydraulic modeling (HEC-RAS and RIVER2D).

The overall evaluation of the primary causes of erosion will consider: 1) the magnitude of forces; 2) the vertical location on the riverbank; 3) the longitudinal location; 4) the frequency and duration of forces; 5) the various types of riverbank materials; and 6) the geotechnical and physical properties of bank materials in resisting erosion. Table 3.1.2-3 provides a list of each potential primary cause of erosion and the analyses that will be used to evaluate their contribution to erosion at each fixed riverbank transect and throughout the impoundment.

Table 3.1.2-3: Potential Primary Causes of Erosion and Related Analyses

Potential Primary Cause of Erosion	Analyses
Hydraulic shear stress due to flowing water	• BSTEM – shear stresses due to tractive force of flowing water • Hydraulic models (HEC-RAS, RIVER2D) • Evaluation of water elevation and flow • Geotechnical investigation of soil properties and critical shear stress
Water level fluctuations due to hydropower operations	• BSTEM – pore pressure analysis related to the repeated wetting and drying of the riverbank • Hydraulic models (HEC-RAS, RIVER2D) • Evaluation of water elevation and flow • Geotechnical investigation of soil properties • Analysis of the rate of rise and fall associated with the passage of a flood wave compared to the rate of rise and fall from hydropower operations
Boat waves	• Physical processes including intensity, duration, and elevation of the wave(s) • Energy Comparison • Shear Stress • Water level fluctuations • Geotechnical investigation of soil properties and critical shear stress
Land Management Practices & Anthropogenic influences	• Geospatial GIS analyses • Aerial Imagery analysis • Analysis of correlation between land-use data and riverbank conditions/characteristics

The results of the analyses used in Task 5, and listed in Table 3.1.2-3, will be used to understand the forces related to each primary cause of erosion, including the magnitude, duration, and location of those forces on a given riverbank. By understanding the effect the forces of each primary cause of erosion have on a riverbank, the causes of erosion can be then be quantified and ranked on a site by site basis based on the forces that are present. Given that the fixed riverbank transects selected for this study are representative of all features, characteristics, and conditions found in the impoundment, primary causes of erosion can then be extrapolated for the whole impoundment. This extrapolation will also take into consideration how hydraulic forces vary throughout the impoundment and the spatial distribution of riverbank features, characteristics, and conditions. The end result of this task will be the quantification, based on relative percentages, of the primary causes of erosion at each fixed riverbank transect and in the Turners Falls Impoundment overall.

This approach is consistent with generally accepted scientific practice and follows the basic approach of USACE, 1979 where the various causes of erosion were evaluated by comparing them to the tractive force due to flow. In addition, the vertical location on the riverbank where these various forces act are an important factor in understanding and evaluating the erosion process as explained in the above referenced report and supporting scientific literature.

Task 7: Report and Deliverables

A final report will be prepared which will include: discussion and summary of all data (previously existing and field collected); geomorphologic assessment of the Connecticut River (historic and modern); discussion of the fixed riverbank transect selection process; discussion of field methods used; analysis of various erosive forces; analysis and discussion of the causes of erosion; and evaluation and discussion of analysis results.

The final report will include various maps, figures, photographs, and any other pertinent information used in determining the causes of erosion in the Turners Falls Impoundment. Field collected data, GIS datasets, raw model input data and results will be made available upon request.

Study reports will be filed in accordance with the ILP schedule and FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD and FERC's SD1.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed methods and level of effort defined above is consistent with generally accepted scientific practice and adequate to conduct a thorough investigation of the causes of erosion in the Turners Falls Impoundment. The estimated cost for this study is approximately between $400,000 and $500,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight is proposing to conduct the initial portion of the field activities (evaluation of the 22 permanent transects) in fall 2013 in conjunction with the field efforts identified in Study No. 3.1.1 *2013 Full River Reconnaissance*. Data gathering, literature review, and the geomorphic assessment of the Connecticut River will occur throughout the fall and winter 2013-2014. Fixed riverbank transects will be selected during the winter or early spring 2014. Field studies and data collection at the fixed riverbank transects will be conducted in spring-summer 2014. Analyses discussed in Task 5 will be conducted at the conclusion of all field activities and data post processing.

Study reports will be filed in accordance with the ILP schedule and FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD and FERC's SD1.

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Attachment A – Evaluation of Water Elevation and Flow Data

In order to understand the relationship between water elevation and flow throughout the impoundment various plots will be developed and analyzed. Data utilized in this task will include: existing and proposed water level monitors, USGS flow data, and FirstLight project operations data. Plots that will be developed will include annual hydrographs, evaluation of the range of WSEL over various time periods, evaluation of daily WSEL fluctuations, and hydrographs of WSEL versus flow. In addition, analysis of flow and WSEL data to correlate project operations will be conducted.

Existing Water Level Monitors – Annual Hydrographs of Turners Falls Impoundment Elevations versus Flow

For each long term monitor, hourly hydrographs (time vs. WSEL) of the WSEL will be plotted for each year between 2000 and 2010 on the same figure[29]. For each short term monitor, 15-minute hydrographs of the WSEL will be plotted for the data collected in 2012 on the same figure[30]. Shown on the other y-axis on these plots will be the Vernon discharge, natural routed flow and flow recorded at the USGS gage in Montague City, MA. The purpose of these plots is to have an understanding of: 1) the relationship between the magnitude of streamflow and WSEL fluctuation and 2) to allow for the comparison of WSELs at the four long-term and two short-term monitors.

Existing Water Level Monitors – Evaluation of the Range of Turners Falls Impoundment Elevations on a Monthly (and Annual) Basis

Using the hourly (4 long-term monitors) or 15 minute (2 short-term monitors) WSEL data for the available period of record, a table of the mean, median, maximum and minimum WSEL will be computed on a monthly basis. In addition, monthly (and annual) WSEL duration curves will be developed using the available period of record (already conducted in PAD for the long-term gages). The intent of the analysis is to have an understanding of: 1) the range of impoundment elevations on a monthly basis and 2) the comparative difference in the range of impoundment elevation at the 4 long term monitors.

Existing Water Level Monitors – Evaluation of the Maximum Daily Fluctuation of Turners Falls Impoundment Elevations on a Monthly (and Annual) Basis

The magnitude of fluctuation (the difference between the maximum and minimum elevation) occurring on a daily basis in the impoundment will be computed. FirstLight proposes to parse the WSEL data to approximate the range of WSEL fluctuation due to project operations versus those attributable to naturally high flows. The following analysis will be conducted:

- Using the full period of WSEL data at each monitor (4 long term, 2 short term), compute the minimum and maximum elevation each day. In the case of the long-term monitors the minimum and maximum elevations will be based on the hourly data[31], whereas the short-term monitors will be based on 15-minute data. The maximum and minimum elevation will be subtracted to yield the maximum range of daily fluctuation or “delta” each day. The “delta” will then be used to:

[29] There will be a total of 11 graphs (one for each year between 2000 through 2010) that will include the four long term monitors.
[30] There will be one graph for 2012 that will include the four long term monitors (which will be based on hourly data) and the two short term monitors (which will be based on 15-minute data).
[31] Historically, FirstLight records the WSEL every hour; no WSEL data is available on a 15-min increment.

  - Develop a "delta" duration curve for the period of record. Monthly and annual delta duration curves will be developed regardless of the magnitude of flow in the impoundment.
  - Develop annual hydrographs showing the delta for the period of record at the long-term (2000-2010[32]) and short-term (2012) monitors. Also plotted on a secondary y-axis will be the Vernon discharge, naturally routed flow and Montague USGS gage flow.

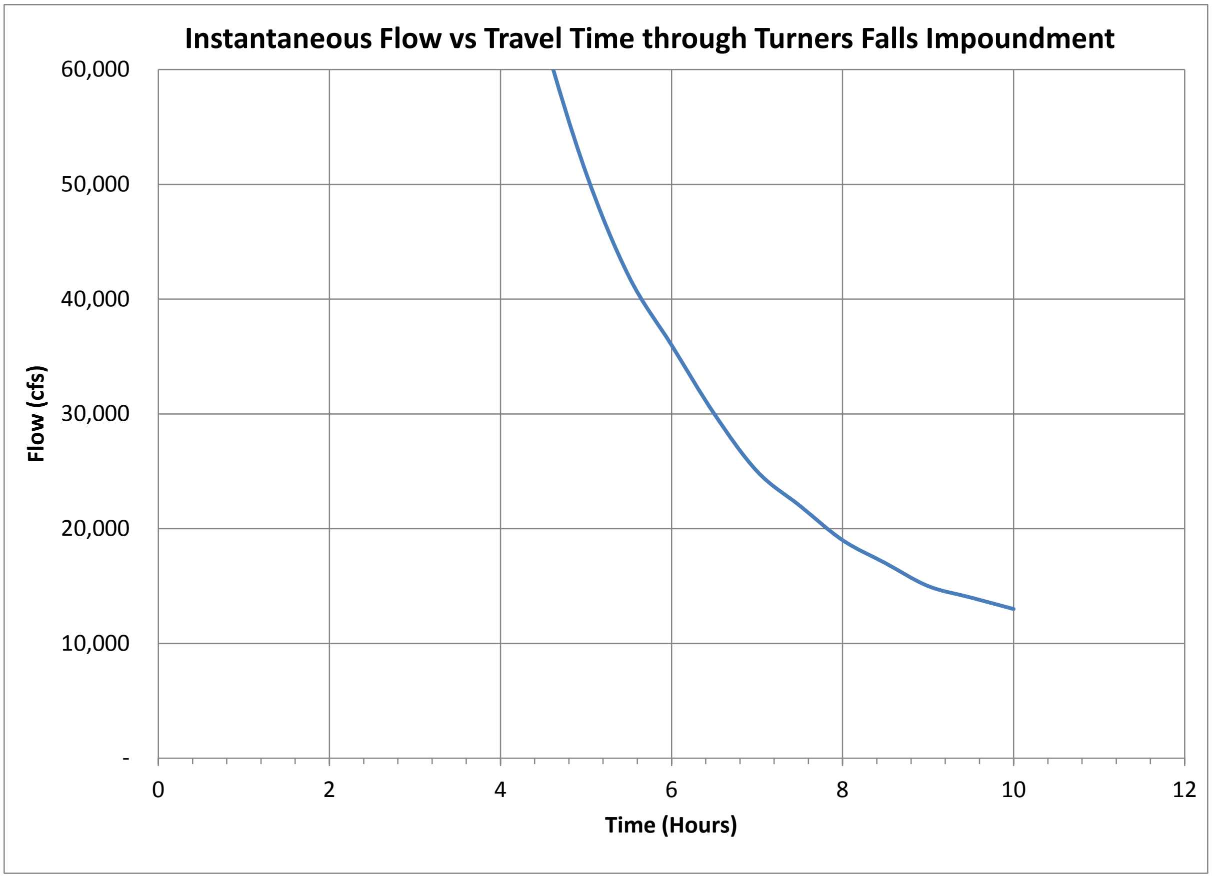
- FirstLight proposes to conduct the same analysis as above, but would use only those WSELs when water is <u>not</u> discharged at Turners Falls Dam (spill). Note that FirstLight has hourly records of Turners Falls Dam discharges for the same 2000-2010 period of record. The logic for parsing the WSEL data in this fashion is that when spill occurs, FirstLight has no ability to "regulate" the impoundment elevation. In this case, the analysis of WSEL will be focused on those periods when FirstLight can regulate the impoundment elevation. Again, the analysis would include the same two sub-bullets as listed above.

<u>Proposed and Existing Water Level Monitors – Hydrographs of Turners Falls Impoundment Elevations versus Flow</u>

For the proposed water level monitors (and four long-term monitors) 15-minute hydrographs (time vs. WSEL) of the WSEL will be plotted for the period the monitors are installed. This is essentially the same analysis as that found in the Existing Water Level Monitors – Annual Hydrographs of Turners Fall Impoundment Elevations versus Flow section previously discussed, but is instead based on WSEL data collected in 2013. Shown on the other y-axis on these plots will be the Vernon discharge, naturally routed flow and flow recorded at the USGS gage in Montague City, MA. The purpose of these plots is to have an understanding of: 1) the relationship between the magnitude of streamflow and WSEL fluctuation and 2) to allow for the comparison of WSELs at the various monitors.

NOAA indicated in their comment letter on the Updated PSP that hydrologic routing times should be factored into the analysis. NOAA states that it does not make sense to line up the WSEL from downstream water level recorders with the exact same time stamp as the Vernon release time stamp. FirstLight proposes to evaluate a subset of WSEL data collected in 2012 and 2013, over a range of flows, to verify travel times. This evaluation is needed to calibrate the unsteady hydraulic model. FirstLight also proposes to assess the WSEL data in 2010 when Northfield was not operating (one less variable) to have a better understanding of routing times. Specifically, the time stamp for the peak discharge will be recorded at the Vernon tailrace recorder. The peak discharge at the remaining three monitors further downstream will be time stamped to understand the routing lag and to verify FirstLight's routing time estimates as shown in the insert.

[32] Per the June 14, 2013 meeting, stakeholders want to understand the range of fluctuation when Northfield was not operating for part of 2010. The proposed analysis includes 2010. This analysis will provide an indication of the range of fluctuation caused by sources other than Northfield.



<u>Proposed Water Level Monitors – Evaluation of the Maximum Daily Fluctuation of Turners Falls Impoundment Elevations</u>

Similar to the Evaluation of the Maximum Daily Fluctuations of Turners Falls Impoundment on a Monthly (and Annual) Basis section previously discussed, the delta (difference in minimum and maximum WSEL each day) will be computed for the proposed water level monitors (and four long-term monitors) for the period August through November 2013. Delta duration curves and delta hydrographs will be developed using the full period of record. Also, similar to previously discussed evaluation, delta duration curves and delta hydrographs will be parsed to include only those periods when Turners Falls Dam is not spilling.

<u>Analysis of Flow and WSEL Data to Correlate Project Operations and WSEL Fluctuations</u>

Flow data from the Montague City USGS gage and Deerfield River USGS gage (at West Deerfield) will be used to provide context on the magnitude, timing, frequency and duration of flows. Mean daily flows from the Deerfield River gage will be subtracted from the Montague City gage. The resultant flows will be further adjusted by a straight-line drainage area proration to estimate the mean daily flow at Turners Falls Dam. As shown in the PAD, annual and monthly flow duration curves have been developed. FirstLight will develop a mean daily average annual hydrograph for the period after several USACE flood control facilities were constructed, to understand the magnitude of flow throughout the year, relative to the hydraulic capacity of the Turners Falls, Northfield Mountain and Vernon hydroelectric projects. In addition, using the post-USACE instantaneous peak flow data, a flood frequency analysis (Log Pearson Type III) will be conducted to predict the 2-, 10-, 50- and 100-year flood flows at the Turners Falls Dam.

FirstLight records the Vernon Dam discharge, inflows from the Ashuelot and Millers Rivers, Turners Falls "spill" and gatehouse discharge on an hourly basis. The magnitude of generation or pumping (MW) at the Northfield Mountain Project can be converted to flow based on an approximate MW versus cfs curve. Thus, all of the flow inputs (Vernon, tributaries, and Northfield generation) and outputs (Northfield pumping, gatehouse discharge, and dam spill) to the impoundment are available. For the period the proposed monitors (and 4 long term monitors) are operable in 2013 (or additional time periods), various plots will be developed to help correlate project operations and naturally high flows with WSELs. Numerous hourly hydrographs showing flow inputs and outputs to the impoundment, along with WSEL monitoring data will be used to help correlate WSEL fluctuations with project operations and naturally high flows.

Although the water level monitors will be in place for a portion of 2013, they will likely not "record" all possible combinations of flows and Project (Vernon, Northfield Mountain, and Turners Falls) operations. To evaluate various flows and Project operational conditions that are not "recorded" with the water level monitors, the hydraulic model will be used.

3.1.3 Northfield Mountain Project Sediment Management Plan

General Description of Proposed Study

Background

On May 1 2010, FirstLight drained the Upper Reservoir as part of a plan to perform maintenance at the Northfield Mountain Project. During the dewatering it became apparent that the Upper Reservoir intake channel sediment had dislodged and migrated into the water conveyance tunnels and into the Connecticut River. FirstLight initiated silt removal from the Upper Reservoir intake channel, tailrace tunnel and the lower pressure shaft elbow and unit penstocks. The silt clearing in the tailrace tunnel was halted in response to an USEPA Administrative Order issued August 4, 2010. Further sediment clean-up in the Connecticut River occurred. The extended outage lasted from May 1 until the project returned to service on November 21, 2010.

Article 20 of the existing FERC license for the Northfield Mountain Project requires FirstLight to take reasonable measures to prevent soil erosion and stream siltation resulting from construction, operation, or maintenance of the Project. In response to the siltation event, FERC had requested a plan and/or procedures designed to avoid or minimize the entrainment of silt into the project's works during similar drawdowns needed in the future. Similarly, the USEPA Administrative Order requested a report identifying measures FirstLight would adopt to prevent discharges of sediments to the Connecticut River associated with draining the Upper Reservoir.

On July 15, 2011, FirstLight filed with FERC a Sediment Management Plan (Plan) which was developed in consultation with the USEPA and MADEP. The Plan contained proposed methods to assess sediment dynamics in the Upper Reservoir and Turners Falls Impoundment from 2011 through 2014 and called for submitting annual reports of the findings. At the end of the study period, FirstLight would evaluate options to minimize or avoid the entrainment of sediment from the Upper Reservoir to the Connecticut River.

The main components of the Plan included:

- conducting annual bathymetric surveys in the Upper Reservoir to determine the annual change in sediment volume;
- collecting turbidity and total suspended solids (TSS) data routinely at the Route 10 Bridge in the Turners Falls Impoundment and at the Northfield Mountain Project (when pumping and generating), and;
- submitting a year-end report of the findings.

FirstLight began implementing the Plan in 2011 and filed its first report with FERC on December 1, 2011 summarizing the bathymetric survey and sediment monitoring data. In the 2011 report, FirstLight also stated it was in the process of making technical improvements and revisions to the sediment sampling methodology. Specifically, FirstLight proposed to install equipment to continuously measure suspended sediment concentrations (SSC) at the Route 10 Bridge and Northfield Mountain Powerhouse[33] in lieu of using turbidity measurements as a surrogate for TSS.

[33] FirstLight would sample water from service water line to collect SSC data during pumping and generating cycles.

On December 6, 2011, FERC acknowledged receipt of the 2011 report and specified that FirstLight should file the revised Plan by February 15, 2012 after consultation with the MADEP and USEPA. A draft of the revised Plan was provided to the MADEP and USEPA by letter dated December 22, 2011. The MADEP submitted comments on the Plan to FirstLight on January 17, 2012.

The revised Plan was filed with FERC on February 15, 2012. The USEPA submitted comments on the revised Plan to FirstLight on February 16, 2012. The comments primarily related to the technical nature of the SSC sampling equipment and USEPA's requirement that a Quality Assurance Project Plan (QAPP) be developed by FirstLight prior to sampling. FERC approved the revised Plan on March 28, 2012. FirstLight provided an initial draft of the QAPP to the USEPA on June 28, 2012. The USEPA provided comments to FirstLight on July 31, 2012. FirstLight addressed the USEPA's comments and submitted Revision 1 of the QAPP to USEPA, MADEP, and FERC on October 19, 2012. From June-December 2012 FirstLight conducted continuous SSC monitoring at the Route 10 Bridge and at the Northfield Mountain Powerhouse. On November 30, 2012, FirstLight filed its *Sediment Management Plan- 2012 Summary of Annual Monitoring* with USEPA, MADEP and FERC.

As a result of experience gained during the 2012 monitoring efforts, combined with the recommendations of the SSC monitoring equipment manufacturer, FirstLight modified[34] certain aspects of the methodology outlined in the QAPP Revision 1 for the 2013 monitoring season. At a meeting on June 24, 2013, FirstLight presented these changes to USEPA and MADEP. USEPA requested that QAPP Revision 1 be updated to reflect the modifications proposed in 2013 and subsequent years. On August 14, FirstLight provided QAPP Revision 2 (see Appendix I) to MADEP and USEPA. Note that FirstLight also proposed in QAPP Revision 2 that the Plan be extended through 2015.

The methodology provided in this study plan reflects the most up-to-date sampling plan and QAPP Revision 2.

Study Request

In the USEPA's comment letter on the Updated PSP, they note "EPA believes that the work being carried out during the Plan for the Northfield Mountain Project must be fully integrated into the FERC licensing process for the project." FirstLight is addressing the USEPAs request in this study plan.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The purpose of the study is to better understand sediment transport and dynamics between the Connecticut River and Upper Reservoir. After a few years of monitoring SSC and conducting annual bathymetric surveys in the Upper Reservoir, FirstLight will evaluate management measures to avoid or minimize the entrainment of silt into the Project works and Connecticut River during future Upper Reservoir drawdowns.

[34] The major modification entailed moving the SSC monitoring equipment contained within the Northfield Powerhouse to the Northfield tailrace as described later.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goal is to avoid or minimize the entrainment of silt from the Upper Reservoir to the Connecticut River, which could impact water quality.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

As noted above, FirstLight is required to file with FERC annual reports by December 1 of the same year. The following reports have been filed with FERC:

- December 1, 2011- Sediment Management Plan- Report of 2011 Activities and Notification of Proposed Technical Changes.
- November 30, 2012- Sediment Management Plan- Report of 2012 Activities.

Project Nexus (18 CFR § 5.11(d)(4))

The Northfield Mountain Project pumps water and entrained sediments from the Connecticut River to the Upper Reservoir. Entrained sediments can subsequently deposit in the Upper Reservoir. Lowering of the Upper Reservoir elevation for maintenance purposes could result in dislodging accumulated sediment and thus impact water quality.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Continuous Monitoring of Suspended Sediments

FirstLight proposes to collect SSC data in 2013, 2014 and 2015 at the following locations and using the following equipment.

- Connecticut River just upstream of the Route 10 Bridge (see Figure 3.1.3-1). The equipment includes one LISST-Streamside monitor manufactured by Sequoia Scientific, Inc. (Sequoia). Specifications of this equipment can be found at the following web link: http://www.sequoiasci.com/product/lisst-streamside/

- Connecticut River in the Northfield Mountain Tailrace (see Figure 3.1.3-1 and Figure 3.1.3-2). The equipment includes two LISST-HYDRO monitors manufactured by Sequoia. Specifications of this equipment can be found at the following web link: http://www.sequoiasci.com/product/lisst-infinite/

LISST-StreamSide – Connecticut River – Route 10 Bridge

Sampling in the vicinity of the Route 10 Bridge will provide sediment transport data in the Turners Falls Impoundment. A continuously recording sampler (LISST-Streamside) will be installed to measure SSC and Particle Size Distribution (PSD). The sampling interval will be set to a minimum of one sample per hour. The sampler pumps river water from a single fixed location in the Connecticut River at which time PSD (microns) and volume concentration (µl/L) will be measured.

Since sediment concentration is known to vary laterally across the river and vertically with depth above the river bed, point sample data will also be collected (LISST-100X, described in more detail below) to develop a correlation over a range of flow conditions between the overall suspended sediment transport through the entire cross-section compared to the continuous sampling at the single, fixed location. The combination of a single fixed location to provide sediment concentrations coupled with sampling of the entire cross-section through a range of flow conditions over a relatively short period of time provides the best combination of data to develop a good understanding of both the temporal variations in sediment transport from the fixed sampling location, along with the lateral and vertical distribution of sediment transport through the cross-section so a coefficient can be applied to the temporal data.

LISST-HYDRO – Northfield Mountain Tailrace

To monitor SSC moving into and out of the Upper Reservoir, two continuous samplers will be installed at the Northfield Mountain Project Tailrace (see Figure 3.1.3-2). One HYDRO device will be installed on the North side of the tailrace while the other will be installed on the South side. These locations will allow for representative samples to be collected during both pumping and generating cycles. During pumping, the water within the tailrace may contain sediment that is pulled into the system from the Connecticut River through the intake. During generation, the water that is being discharged from the Upper Reservoir back to the river may similarly contain sediment.

In May-June 2012 the HYDRO devices were installed inside the Northfield Mountain Powerhouse directly inline on Project service water intake/discharge pipes using available service water taps. Data collection was attempted from June-December 2012 with limited success. After extensive troubleshooting by FirstLight and the equipment manufacturer it was determined that the pressure from the service water line was too great for the HYDRO devices to adequately collect samples and that maintaining the configuration proposed in the QAPP Revision 1 was not likely to yield sufficient usable data. Following extensive investigation it was determined that installation of the HYDRO devices in the Northfield tailrace would allow for representative samples to be taken during pumping and generating cycles without the difficulties related to high pressure experienced in the Powerhouse.

Once installed, the LISST-HYDROs will pump river water from a single fixed location (one location/pump per HYDRO) in the Northfield Mountain Tailrace at which time PSD (microns) and volume concentration (µl/L) will be measured. The sampling interval will be set to a minimum of once every 30 minutes.

Additionally, point and transect sample data will also be collected at the Northfield Mountain Tailrace to develop a correlation over a range of flow conditions and pumping and generating cycles between the overall suspended sediment transport through the entire cross-section compared to the continuous sampling at the LISST-HYDROs (described in more detail below).

LISST-100X – Connecticut River – Route 10 Bridge and Northfield Mountain Tailrace

To account for the variation of SSC and PSD both vertically in the water column and laterally across the river, FirstLight will collect data at evenly-spaced points across the river to develop a relationship between the LISST-StreamSide and HYDRO continuous samplers and the overall sediment transport through the study reaches. To determine the relationship between the data collected by the automatic pumping-type samplers and the overall SSC through the cross-sections, concentrations determined from the pumping samplers will be compared with the corresponding concentrations determined from a complete depth integrated cross-section sample over a wide range of flows. This relationship will then be used to adjust the pumped sample results, if necessary. In addition, adjustments to the continuous sampling locations in the water column may occur to more accurately reflect the concentration across the cross-sections.

In order to collect the necessary samples, a LISST-100X sensor (specifications on this equipment can be found at the following web link: http://www.sequoiasci.com/product/lisst-100x/) will be utilized. A crane and reel for cable suspension will be used for data collection at the Route 10 Bridge; data collection at the Northfield Mountain Tailrace will occur by boat. Point samples using the Equal Width Increment (EWI) method over a range of flow conditions (from low to high flow) and over a range of operating conditions (i.e. pumping and generating) will be collected. Measurements conducted will include PSD (microns) and volume concentration (µl/L) consistent with both the LISST-StreamSide and LISST-HYDROs.

Point samples will also be taken using the LISST-100X at the LISST-StreamSide and LISST-HYDRO drain hoses concurrently with a sampling event at these instruments to allow for a direct comparison of the data collected. The LISST-100X point sample will serve as an additional quality control check of the data collected at the LISST-StreamSide and LISST-HYDROs.

All LISST-100X data collection will occur in spring 2013 and fall 2013 or spring 2014 only. Data collection during these two periods will provide sufficient information to determine any variations in SSC and PSD in the water column and laterally across the river.

Task 2: Laboratory Samples

Water samples will be collected for laboratory analysis of TSS and SSC from the LISST-StreamSide and LISST-HYDRO drain hoses over a range of flows and river conditions, or at a minimum of once per month. All samples will be taken concurrently with a LISST sampling event to ensure direct comparisons can be made. Results of the laboratory analysis will be used as an additional quality control check of the data collected by the LISST equipment as well as for conversion from volume concentration to mass, if deemed necessary.

Task 3: Reporting

In accordance with FERC's Order Approving Sediment Management Plan (March 28, 2012), FirstLight is required to file an annual report with the USEPA, MADEP, and FERC no later than December 1 of each sampling year summarizing the previous calendar years monitoring results. Note that since sampling has been extended until 2015, the report for that year is due no later than December 1, 2015. As noted in the Plan, after several years of sampling to gain a better understanding of the sediment dynamics, FirstLight agreed to develop measures to minimize the entrainment of accumulated sediment into the project works and discharge to the Connecticut River during drawdown or dewatering activities. Those measures would be included in the 2015 report.

Per the licensing schedule, Updated Study Reports must be filed with FERC by September 12, 2015, while the final Sediment Management Plan report must be filed by December 1, 2015. To meet this schedule, FirstLight will provide the report by September 12, 2015 based on the information it has collected to date. FirstLight will also file a report on December 1 per FERCs original order, which would include any additional field data collected after September 2015. It is not likely that the data collected after September 2015 will change FirstLight's measures to minimize the entrainment of accumulated sediment into the project works.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort for years 2013 through 2015 is between approximately $150,000 and $180,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Conceptual Schedule

The two LISST-HYDRO samplers and the LISST-StreamSide sampler will continuously collect data from spring through fall when air temperatures are expected to be above freezing. Based on consultation with the manufacturer, it may also be possible to sample during the winter if freezing of sampling components can be prevented. However, FirstLight cannot commit to attempting to sample wintertime SSC because any attempts to sample during that time would be experimental and may be impractical even to attempt.

The conceptual schedule for monitoring and sample collection is as follows:

- Spring 2013: Re-install LISST-StreamSide
  - Post-installation: Weekly data download, equipment check, and cleaning
  - Collect grab samples from LISST-StreamSide drain hose during LISST-StreamSide sample collection over a range of flows and river conditions, or at a minimum of once per month

- Summer 2013: Install LISST-HYDROs
  - Post-installation: collect grab samples from LISST-HYDRO drain hoses during LISST-HYDRO sample collection over a range of flows, or at a minimum of once per month
  - Weekly review of data, periodic equipment check and maintenance

- Fall 2013 or Spring 2014: LISST-100X
  - Over the course of one month (over a range of flows and river conditions), collect weekly point and transect measurements from the Route 10 Bridge and at the Northfield Mountain Tailrace
  - Over the course of one month (over a range of flows and river conditions), collect weekly point measurements from the LISST-StreamSide and LISST-HYDRO drain hoses. Point samples will be collected at the same time as LISST-StreamSide and LISST-HYDRO sample collection to allow for direct comparisons of the data.
  - Based on river conditions and other logistical factors the LISST-100X sampling may take place in the fall 2013 or the spring 2014. LISST-100X sampling will not be conducted in 2015.

- Late Fall 2013:
  - Remove LISST-HYDRO and StreamSide samplers to avoid freezing temperatures

- December 1, 2013:
  - File annual summary report with MADEP, USEPA and FERC.

- 2014-2015:
  - Conduct additional seasons of continuous suspended sediment monitoring following the 2013 schedule outlined above.

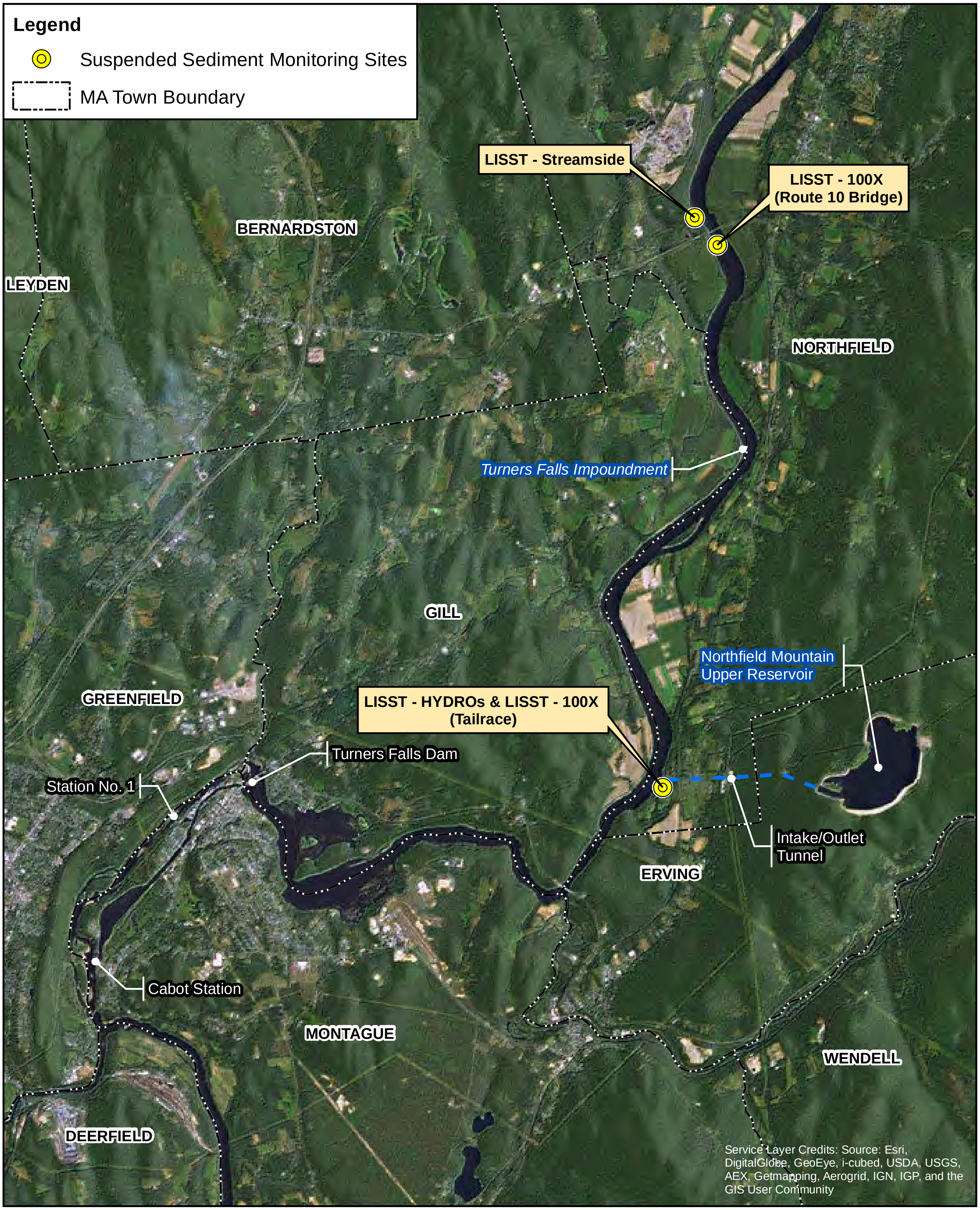


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Figure 3.1.3-1: Suspended Sediment Concentration Sampling Locations

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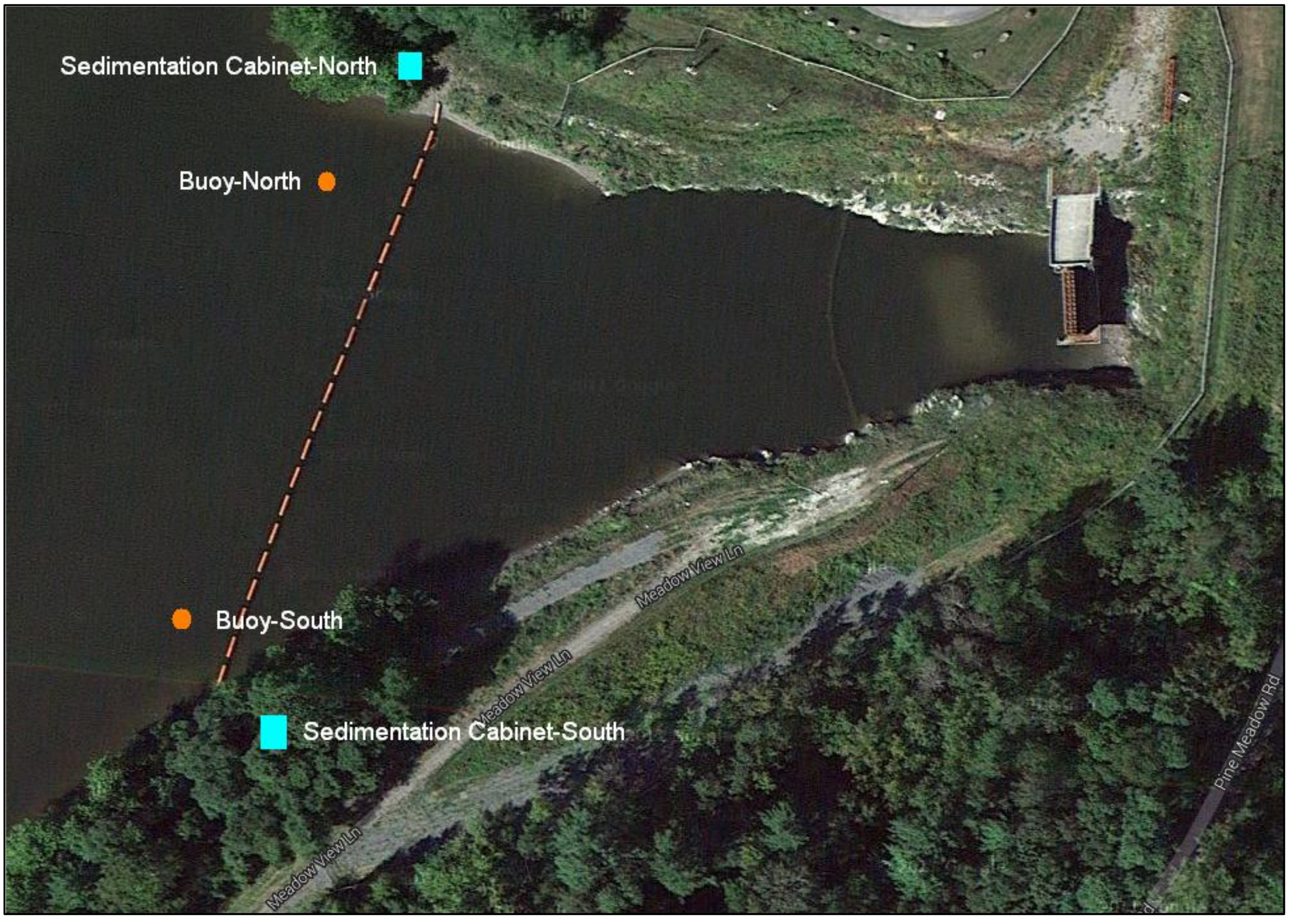
Figure 3.1.3-2: Suspended Sediment Concentration Sampling Locations in Northfield Tailrace



3.2 Water Resources

3.2.1 Water Quality Monitoring Study

General Description of Proposed Study

Several stakeholder groups submitted water quality study requests to FirstLight. Water quality monitoring requests were received from MADEP, USFWS, CRWC, FRCOG, Town of Gill, LCCLC, VANR and NHDES.

The MADEP, USFWS, and CRWC study requests were similar and requested that the applicant conduct a water quality survey of the Turners Falls Impoundment, bypass reach, power canal, and tailrace reach in order to determine whether state water quality standards are being met under all currently-licensed operating conditions (i.e., during periods of generation and non-generation). MADEP, USFWS, and CRWC request that FirstLight collect continuous water temperature and dissolved oxygen (DO) data including biweekly DO and temperature profiles in the Connecticut River from April 1 through November 15, and monthly DO and temperature profiles within the upper reservoir from June through September. FirstLight is proposing continuous temperature and DO sampling, along with biweekly vertical profiles within the Connecticut River. As an alternative to periodic profile sampling in the upper reservoir, FirstLight proposes to monitor water temperature and dissolved oxygen in the Northfield Mountain Project discharge. These methods will be consistent with and therefore comparable to continuous data collected upstream and downstream of the tailrace, and can directly assess the impact of the discharge on water temperature and dissolved oxygen in the Connecticut River.

MADEP, USFWS, and CRWC also requested that impoundment sediment adjacent to the Turners Falls Dam should be analyzed for metals and polychlorinated biphenyls (PCBs). As described in the existing information, benthic sediment was sampled in the Turners Falls Impoundment and upper reservoir in August 2010 as part of the USEPA consent order to inform FirstLight's dredging operations. The samples were analyzed for metals, organics, pesticides, and PCBs, and the results were compared to MADEP regulatory standards. FirstLight is not proposing to conduct sediment sampling as part of this study.

Town of Gill, FRCOG, and LCCLC submitted similar requests for a water quality study, and included a request for monthly samples of total suspended solids and turbidity within the upper reservoir. FirstLight is not proposing to add turbidity or TSS to the water quality study plan because suspended sediment data are already being collected under FirstLight's *Sediment Management Plan* as described under Study No. 3.1.3 (see existing information section).

VANR and NHDES requested a more focused water quality study to determine if project operations are causing or contributing to violations of New Hampshire and/or Vermont state water quality standards. Their request for continuous data was linked to low flow periods and included additional parameters such as nutrients and chlorophyll a. FirstLight has proposed a sampling location in the Connecticut River upstream of the Massachusetts border which would be representative of inflow conditions to the Project. Sample parameters at this location will include temperature and DO, consistent with the sampling locations throughout the remainder of the Project study area. FirstLight is not proposing to collect data on nutrient parameters in the Connecticut River upstream of the Massachusetts border because these parameters are not consistent with MADEP's request and would not provide useful information if collected from a limited area.

In NHDES' comments on the Updated PSP, they again requested FirstLight to collect nutrient parameters. NHDES requested the collection of weekly nutrient parameters (total phosphorus, nitrite/nitrate, Kjeldahl nitrogen and chlorophyll-a at a sampling site in the 5.5 mile reach below Vernon Dam in NH/VT.

FirstLight is not proposing to collect nutrient parameters because of the reasons stated above. In addition, as noted by MADEP at the May 14, 2013 meeting, the State of Massachusetts has no water quality standards for nutrients and MADEP stated in their comment letter on the Updated PSP that "establishing the quantity of nutrients released from the Project site serves little purpose."

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The objectives of this study are to:

- Characterize water temperature and DO within the Turners Falls Impoundment, bypass channel, power canal, and below Cabot Station.
- Determine potential impacts of the Turners Falls Project and Northfield Mountain Project on water temperature and DO.
- Compare collected data with applicable state water quality standards.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The MADEP is responsible for issuing a water quality certification to FirstLight for the continued operation of the projects under Section 401 of the Clean Water Act. The MADEP has designated the Connecticut River as a Class B river for its entire length in Massachusetts, and the river is assigned the designated uses of habitat for fish, other aquatic life and wildlife, and primary and secondary contact recreation, 314 CMR 4.05(3)(b). The anti-degradation provisions of 314 CMR 4.04 require protection of all existing and designated uses of water bodies, and maintenance of the level of water quality needed to protect those uses.

The USFWS water quality goals are to: 1) Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats; and 2) Minimize current and potential negative project operation effects on water quality and aquatic habitat.

Part of the project area is within New Hampshire, and the NHDES establishes and administers surface water quality standards for New Hampshire; the Connecticut River within the New Hampshire portion of the project area is Class B water. The NHDES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained. The Connecticut River is also classified by the state of Vermont as Class B cold water fish habitat, which should be managed to achieve and maintain a level of quality that fully supports aquatic biota and habitat, although criteria for Vermont are, in some cases, different than New Hampshire.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Water Quality Data and Reports

A multitude of federal, state and local organizations have studied the water quality of the Connecticut River in the vicinity of the Projects, including the following:

Carr, J. W. & Kennedy, L. E. (2008). *Connecticut River watershed 2003 water quality assessment report* (Rep. No. 34-AC-2). Worcester, MA: Massachusetts Department of Environmental Protection, Division of Watershed Management.

Connecticut River Joint Commissions (CRJC). (2009). *Connecticut River management plan – Wantastiquet region.* Charlestown, NH: Author.

Deacon, J., Smith, T., Johnston, C., Moore, R., Weidman, R., & Blake, L. (2006). *Assessment of total nitrogen in the Upper Connecticut River basin in New Hampshire, Vermont, and Massachusetts, December 2002-September 2005* (Scientific Investigations Report 2006-5144). Reston, VA: US Geological Survey.

Donlon, Andrea. (2008). *Volunteer water quality monitoring program annual report 2007*. GreenFGS, MA: Connecticut River Watershed Council.

Donlon, Andrea. (2009). *Volunteer water quality monitoring program annual report 2008*. GreenFGS, MA: Connecticut River Watershed Council.

Hellyer, Greg. (2006). Connecticut River fish tissue contaminant study 2000 – Ecological and human health risk screening. North Chelmsford, MA: US Environmental Protection Agency, New England Regional Laboratory. Retrieved from: http://www.epa.gov/region1/lab/reportsdocuments/ctriverftr2000/

Hickey, K. & Shanahan, P. (2012). *Review of Vermont Yankee Thermal Discharge Permit Requirements and Analysis of Connecticut River Water Temperature and Flow*. Acton, MA: HydroAnalysis.

Matusky & Skelly Engineers. (1993). *Hydrodynamic and thermal modeling studies*. Berlin, CT: Northeast Utilities Services Company.

US Fish and Wildlife Service, Personal Communication, Ken Sprankle. Raw data of temperature monitoring in the Turners Falls Impoundment in 2010.

Need for Additional Water Quality Data

The state and federal resource agencies have requested a study of current water quality of the Connecticut River within the Project area. The results of the study should provide information sufficient to enable agencies to understand water quality conditions at the Project.

Sediment Contaminant Data

In their comment letters on the Updated PSP, MADEP and CRWC requested that impoundment sediment sampling be conducted just above the Turners Falls Dam and be analyzed for metals and PCBs. FirstLight believes that sediment data already collected from the Connecticut River and analyzed for various contaminants contains sufficient data to address this issue. Below is a summary of the sediment sampling.

On July 15, 1993, USGS collected a sediment sample at the USGS gage in Montague City, located on the Connecticut River below the confluence with the Deerfield River. The sample was tested for PCBs and metals. The findings were compared to the MADEP regulatory reporting standards applicable to soil (RCS-1) as defined in the Massachusetts Contingency Plan. The results showed that the concentration of PCBs and metals, with the exception of nickel (34 ppm), was below RCS-1 standards. Massachusetts has no separate reporting standard for sediments.

On August 12, 2010, FirstLight collected a sediment sample on river left just below the Northfield Tailrace (at nearly the same location as the USEPA sample Sed 4 collected on August 26, 2010 as shown Figure 3.2.1-1 below). The sample was analyzed for metals including mercury, pesticides, semi-volatile organic compounds, and PCBs. The results were again compared to MADEP regulatory reporting standards (RCS-1). The results showed that the concentration of metals, pesticides, metals, semi-organic compounds and PCBs were all below RCS-1 standards.

On August 26, 2010, USEPA collected five sediment samples – two near the Northfield Tailrace and three in the Upper Reservoir- as shown in Figure 3.2.1-1. The samples were collected as part of the USEPA consent order to inform FirstLight's dredging operations. The samples were analyzed for metals including mercury, pesticides, and PCBs. The results were again compared to MADEP regulatory reporting standards (RCS-1). The results showed that the concentration of PCBs and pesticides were all below RCS-1 standards. Naturally occurring metals were detected in all of the samples at levels below the RCS-1 standards, with the exception of nickel. Nickel concentration in some samples modestly exceeded the RCS-1 standard (20 ppm), but on average the nickel concentrations were below the standard. MADEP is currently seeking input on raising the regulatory standard for nickel and has formally proposed raising the RCS-1 standard to 700 ppm. If the new standard being proposed by MADEP were to be passed, nickel concentrations in the tested sediments would be well below the new standard. In any event, it appears the nickel is naturally occurring and unrelated to project operations. If requested, the sediment sampling data will be made available.

After the 2010 silt incident, the dredged material from just below the Northfield Tailrace and from the intake channel of the Upper Reservoir were trucked and placed on a peninsula adjacent to the Upper Reservoir and near its intake as shown in Figure 3.2.1-2. The source of sediment comprising the peninsula all originated from the Connecticut River. Tighe and Bond, on behalf of FirstLight, collected the following sediment samples of the peninsula:

- On December 12, 2011, samples TB-1 through TB-5 were obtained. The borings were advanced to a maximum depth of 40 inches below grade. A composite sample was collected from each boring and homogenized in the field. The samples were analyzed for antimony, arsenic, beryllium, cadmium, chromium (trivalent and hexavalent), copper, lead, nickel, selenium, silver, thallium, zinc and mercury.

- On March 26, 2012, samples TB-6 through T-17 were obtained to further characterize the sediment. Sediment samples were collected in four-foot increments to a maximum depth of 20 feet below grade. Bedrock refusal was encountered at most boring locations. Each sample was homogenized in the FGS, sent to the same laboratory, and the same parameters were sampled.

The laboratory results were again compared to the MADEP regulatory standards (RCS-1). The only parameter exceeding the RCS-1 standard in any sample was nickel (range of 8.9-26 ppm). However, there average concentration of nickel was 18.6 ppm, below the RCS-1 standard.

In CRWCs comments on the Updated PSP they note that the August 2012 testing "represents a single day from sediment inside the tunnel, older sediment dug when they first drained the reservoir, sediment near the tailrace and across the river on the bank". Sediment contained in the Upper Reservoir and inside the tunnel originated from the Connecticut River. The bulk of sediments tested represent any influx of potential contaminants from the approximate 6,770 square mile watershed above the Connecticut River at the Northfield Tailrace. Whether sampling was conducted over multiple days or a single day is immaterial. In fact, as described above, samples were collected on multiple days resulting in over 24 sediment samples of Connecticut River in the vicinity of the Turners Falls and Northfield Mountain Projects. Furthermore, "older" and deeper sediment is more likely to contain hazardous materials than recently deposited sediments, since the incidence of industrial pollution has declined significantly since the passage of modern environmental laws 30- 40 years ago.

Finally, FirstLight is unaware of any reported PCB leaks or spills from Turners Falls or Northfield Mountain Projects. .

Project Nexus (18 CFR § 5.11(d)(4))

Operation of the Turners Falls Project and Northfield Mountain Pumped Storage Project may directly impact water quality through the use of water for hydropower generation.

The investigation area includes the following:

- The 20-mile Turners Falls Impoundment from the Project Boundary to the Turners Falls Dam.
- The Northfield Mountain Project Tailrace.
- The 2.7 mile long bypass from the Turners Falls Dam to the confluence with Cabot Station.
- The Turners Falls Power Canal.
- The Connecticut River downstream of Cabot Station.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

As recommended by the MADEP, water temperature and dissolved oxygen will be assessed in relation to project operations from spring through fall. If river flow and temperature conditions are representative of an "average" or "low" water year, then one year of data collection should be sufficient to perform the study. If conditions are not representative (i.e., a "wet" or cool year) then a second year of data collection may be necessary. Two types of sampling will be performed: 1) continuous temperature and DO monitoring, and 2) periodic vertical profiles of temperature and DO.

Task 1: Develop Sampling Plan

MADEP states that a proposed water quality sampling plan is to be submitted to MADEP for approval prior to sampling and should be developed in consultation with MADEP and USFWS. Once the FERC Study Plan Determination is issued, which would detail the elements of the water quality study, FirstLight will prepare a detailed sampling plan consistent with FERC's determination for review and approval by MADEP. The sampling plan will include quality assurances procedures to be followed during the study execution.

In NHDES' comments on the Updated PSP, they requested water quality sampling plan (including water quality procedures) for the sampling conducted in NH be submitted to NHDES for approval prior to sampling. FirstLight agrees to provide NHDES with the requested sampling plan for the two continuous DO/temperature monitoring stations located in NH/VT.

Task 2: Dissolved Oxygen and Temperature Monitoring

Temperature and DO will be recorded every 15 minutes using *in situ* water quality meters at nine proposed locations within the project area (Table 3.2.1-1) during the periods described below. The sampling locations are shown in Figure 3.2.1-3, Figure 3.2.1-4, and Figure 3.2.1-5. Water temperature will be collected from April 1 through November 15. DO measurements will be collected from the same locations during the summer low flow, high temperature period, June 1 through September 30. Meters installed in impounded waters will be suspended from surface buoys and deployed to 25% of the depth of the sampling location. In the bypass reach, canal, and downstream sampling locations, the meters will be installed mid-channel, mid-depth, as practical.

Spot measurements of DO and temperature will be taken during deployment, bi-weekly site visits, and upon retrieval to verify meter accuracy. Weather and flow[35] conditions will be noted.

The water quality meters will be visited approximately once every other week, at which time data will be downloaded, the meter checked for calibration, and then re-deployed. The meter locations will be geo-referenced using GPS.

Task 3: DO and Temperature Profiles

To examine the vertical trends in temperature and DO within the Turners Falls Impoundment, bi-weekly vertical profiles of temperature and DO concentration will be recorded at three locations as shown in Figure 3.2.1-6 and described as follows: 1) the deepest location within the impoundment located downstream of the French King Gorge, 2) a relatively deep area of the impoundment upstream of the Northfield Mountain tailrace, a 3) a relatively deep area of the impoundment downstream of the Northfield Mountain tailrace (at the boat barrier). Bathymetric data indicate that the deepest location is approximately 125 feet deep.

Starting at the surface, measurements of temperature and DO will be collected at 1.0 meter depth increments[36]; the depth of a thermocline or chemocline (DO) will be recorded. Vertical profiles will be collected approximately once every other week starting in early April 2014 through mid November 2014, for a total of approximately 16 profiles, concurrent with Task 2.

In NHDES comment letter on the Updated PSP, they requested weekly DO and temperature profiles at a sampling station in NH. FirstLight believes that the three proposed sampling locations is more than sufficient to characterize the DO and temperature profiles and the timing of stratification with the Turners Falls Impoundment.

Task 4: Report

A report will be prepared describing the monitoring methods and the results. An assessment of the potential effects of Turners Falls Project and Northfield Mountain Project operations on water quality will be discussed. For this assessment, FirstLight will provide hourly operations data during the duration of the continuous DO and temperature monitoring, including:

- Turners Falls Impoundment elevations as measured at the Vernon Tailrace, Northfield Mountain Tailrace, and Turners Falls Dam;
- Periods when Northfield Mountain is pumping, generating, or idle;
- Periods when Cabot Station and Station No. 1 are generating or idle;
- Discharges from Turners Falls Dam (spill), and;
- “Natural Routed Flow” through the Turners Falls Impoundment (estimate of flow at Turners Falls Dam).

The report will be submitted as part of the Initial Study Report as per the ILP process schedule. A tentative table of contents for the water quality report follows:

[35] Flow conditions in the Turners Falls Impoundment will be based on the estimated discharge from the Vernon Hydroelectric Project, intervening inflow from the Ashuelot and Millers River USGS gages, estimated discharge over the Turners Falls Dam, and the Connecticut River at Montague USGS gage.
[36] Because Station No. 6 is extremely deep, the vertical profile measurement intervals will be collected every 1.0 meter starting at the surface, until a homothermous condition is encountered in the hypolimnion.

- Introduction
- Project Operations
- Hydrology and Weather Conditions
- Water Quality Monitoring Methods
- Water Quality Monitoring Results
- Discussion/Conclusions

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Projects on water quality in the Project area. The estimated cost for this one-year study is between approximately $70,000 and $90,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests.

A draft sampling plan developed under Task 1 will be provided to MADEP and USFWS in late 2013 once the FERC Study Plan Determination is issued. The sampling plan will provide more detail on the scope of work approved in the Study Plan Determination. Field work for this study is planned to occur from April through November 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Table 3.2.1-1: Proposed Water Quality Sampling Locations

Station No.	Type	Location	Comments
		Connecticut River- Turners Falls Impoundment	
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 Discharge; 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 until homothermous hypolimnion is encountered
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	
8	Continuous	Upstream of Station No. 1	Mid-channel, mid-depth
9	Continuous	Within pool upstream of Rock Dam; downstream of Station No. 1	Mid-channel, mid-depth
		Turners Falls Power Canal	
10	Continuous	At the 11th Street Bridge	Mid-channel, mid-depth
		Connecticut River- Below Cabot Station	
11	Continuous	Below the Cabot Station tailrace, upstream of Deerfield River confluence	Thalweg, mid-depth.

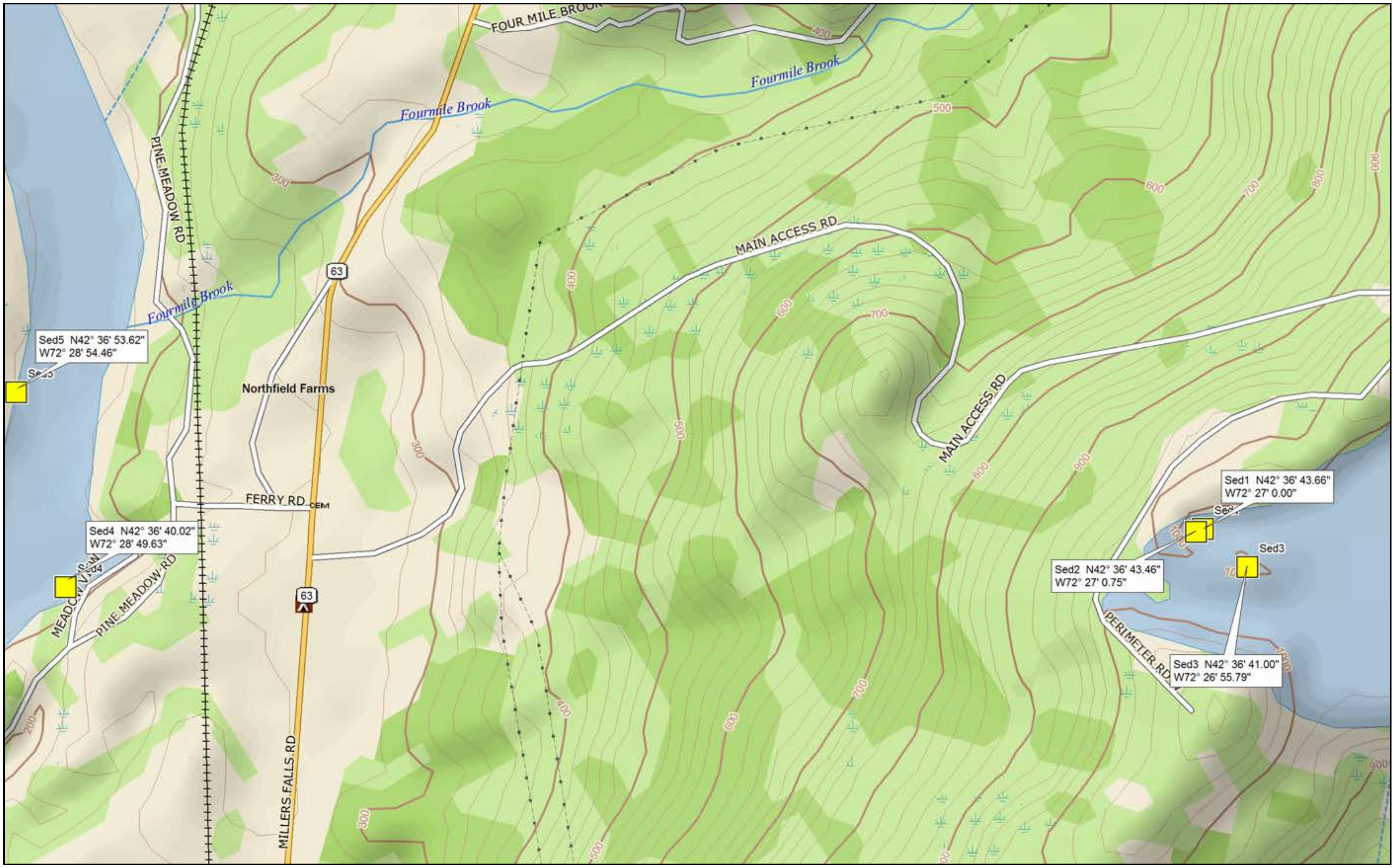


Figure 3.2.1-1: USEPA Sediment Sampling Locations

Figure 3.2.1-2: FirstLight Sediment Sampling Locations

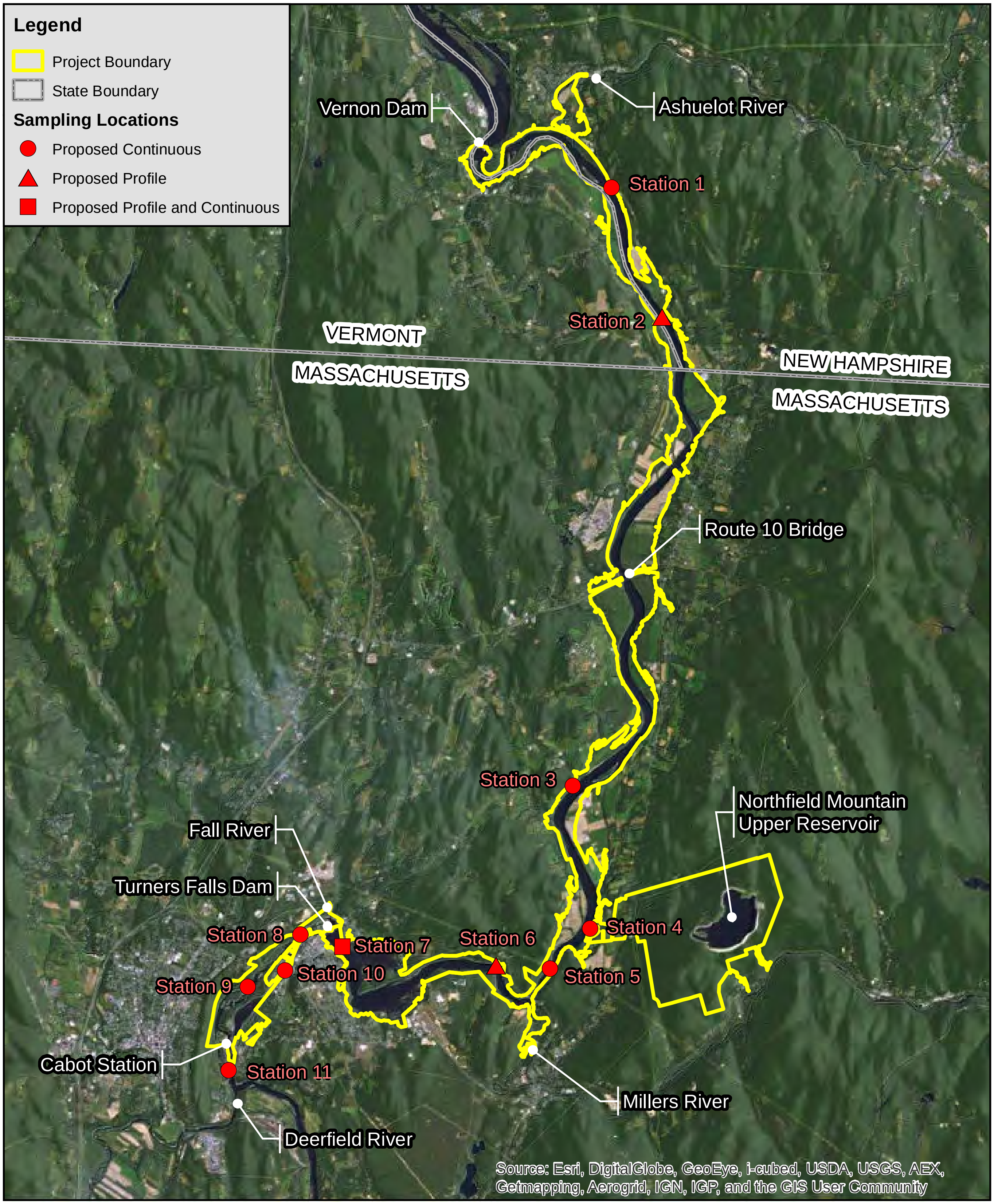


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Figure 3.2.1-3
Overview of Proposed Water Quality Sampling Locations

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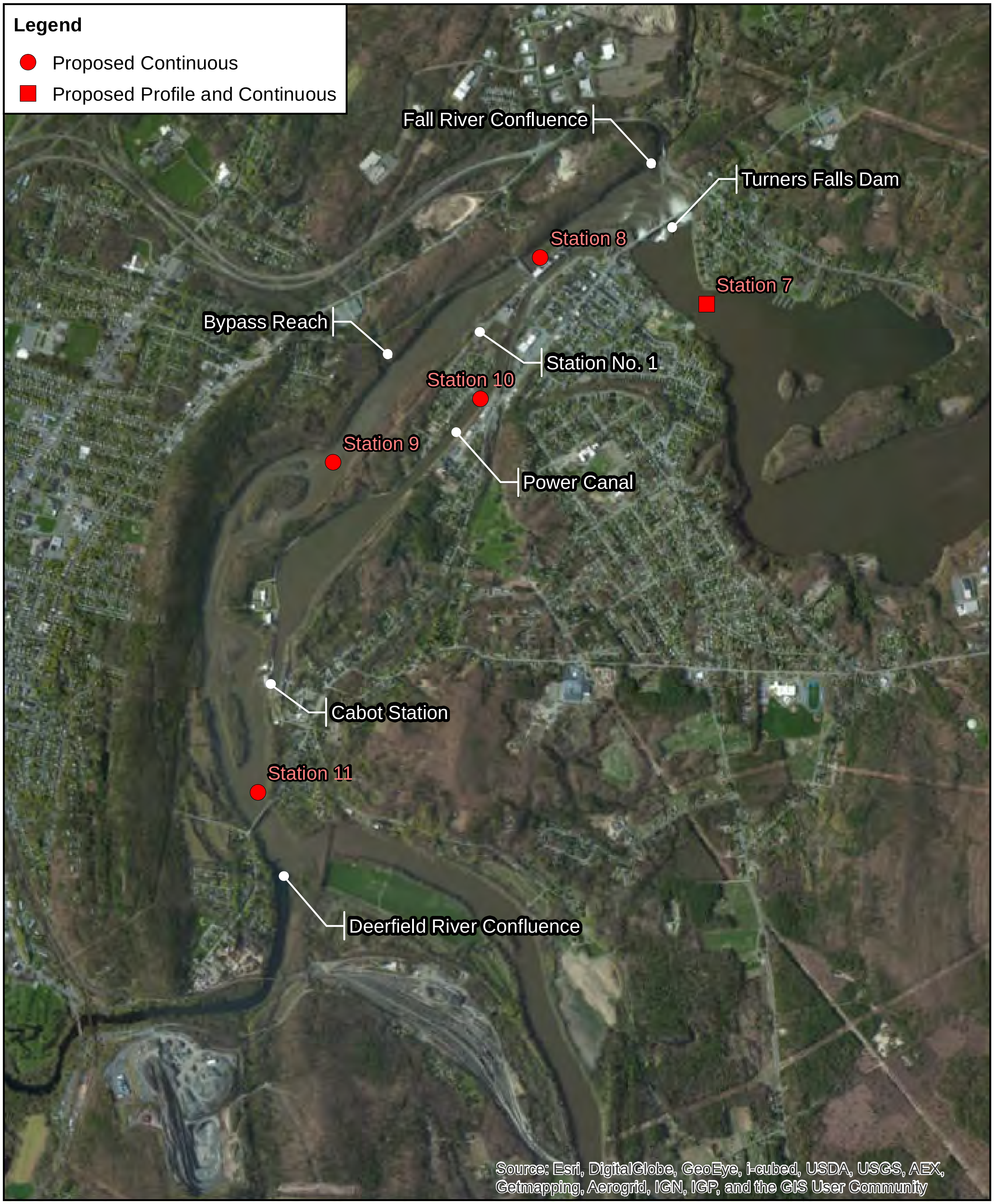

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Figure 3.2.1-4
Proposed Water Quality Sampling Locations Near Turners Falls Dam

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Revised Study Plan

Figure 3.2.1-5
Proposed Water Quality Sampling Locations Near the Northfield Mountain Tailrace

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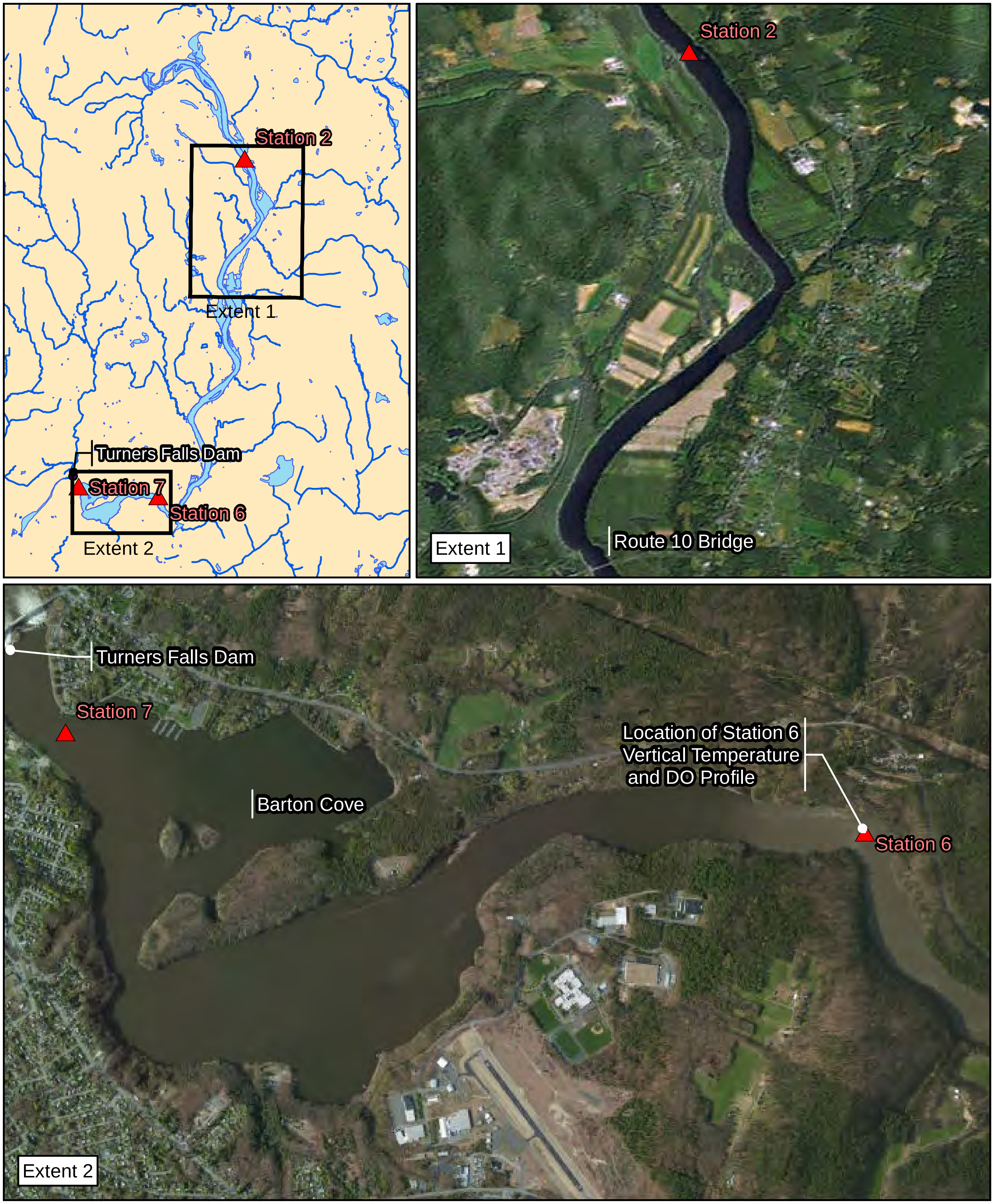

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FIRSTLIGHT POWER RESOURCES

Revised Study Plan

Figure 3.2.1-6
Turners Falls Impoundment Vertical Profile Locations

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3.2.2 Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot Station

General Description of Proposed Study

Background

Numerous stakeholders requested studies to evaluate how water level fluctuations associated with the Turners Falls Project and Northfield Mountain Project impact various environmental, geologic and recreational resources. Those studies include:

- Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability.*

- Study No. 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.*

- Study No. 3.3.10 *Assess Operational Impacts on Emergence of State Listed Odonates in the Connecticut River.*

- Study No. 3.3.13 *Impacts of the Turners Falls Project and Northfield Mountain Project Operations on Littoral Zone Fish Habitat and Spawning.*

- 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 Habitats.*

- Study No. 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* (includes rare plants and tiger beetles).

- Study No. 3.6.6 *Assessment of Effects of Project Operation on Recreation and Land Use.*

Water level fluctuations in the Turners Falls Impoundment can be a function of:

- Hydropower operations including peaking releases from the Vernon Hydroelectric Project, Northfield Mountain Project Pumping and Generating Cycles, and peaking operations at the Turners Falls Project.
- Boat wakes (boat wakes are temporary and result in localized, brief water level fluctuations).
- Natural flow variability. More specifically, water levels in the Turners Falls Impoundment will naturally rise and fall when flows exceed the hydraulic capacity of the hydropower facilities.

Water level fluctuations below Cabot Station can be a function of:

- Hydropower operations including peaking releases from the Vernon Hydroelectric Project, Northfield Mountain Project Pumping and Generating Cycles, and peaking operations at the Turners Falls Project.
- Peaking operations of several hydroelectric facilities on the Deerfield River.
- Boat wakes (boat wakes are temporary and result in localized, brief water level fluctuations).
- Natural flow variability, when the hydraulic capacity of the Turners Falls Project is exceeded.

Study Description

FirstLight proposes to develop a hydraulic model of the Turners Falls Impoundment[37] and of the Connecticut River from Turners Falls Dam to Holyoke Dam. The proposed hydraulic model is the US Army Corps of Engineers' one-dimensional HEC-RAS. The purpose of the hydraulic model is to determine, for a given flow, the corresponding water surface elevation (WSEL) at a given location within the river- typically at a transect in the hydraulic model. In addition to predicting the WSEL for a given flow, the model also yields information on the river's depth and mean channel velocity at a given location (transect).

The HEC-RAS model can be run in both a steady state mode (flow is constant) and unsteady state mode (flow varies over time such as a hydrograph). FERC has requested that FirstLight develop an unsteady state HEC-RAS model in the Turners Falls Impoundment, bypass reach, power canal, and below Cabot Station to the upper limit of the Holyoke Impoundment. FirstLight proposes to develop two hydraulic models covering the a) Connecticut River from Turners Falls Dam upstream to Vernon Dam and b) Connecticut River from Holyoke Dam upstream to Turners Falls Dam. FirstLight maintains a nearly constant elevation in the power canal, except for periods of dewatering (refer to pages 4-93 through 4-97 showing power canal elevation duration curves). As the PAD elevation duration cures show there is very little WSEL fluctuations in power canal (duration analysis of 10 years of hourly elevations). Given the power canal's limited WSEL fluctuations, FirstLight does not believe a hydraulic model of the power canal is warranted.

<u>Study Goals and Objectives (18 CFR § 5.11(d)(1))</u>

The objectives of the hydraulic modeling study include:

- Provide WSEL (depth) and mean channel velocity information to help inform other environmental, geologic and recreation studies as listed above. For example, a study will be conducted to locate spawning habitat in the Turners Falls Impoundment. As part of that study, data will be collected on the depth of the spawning habitat. The hydraulic model results will be used by that study to assess whether Turners Falls Impoundment fluctuations could impact spawning habitat.

- An existing hydraulic model of the Turners Falls Impoundment will be used to determine the affect of a) the Vernon Hydroelectric Project, b) the Northfield Mountain Project, c) the Turners Falls Project d) naturally occurring high flows, and e) all three projects operating collectively on water level fluctuations in the Turners Falls Impoundment.

- An additional hydraulic model will be developed from the Turners Falls Dam downstream to Holyoke Dam to determine the effect of a) the Turners Falls Project, b) the Deerfield River Project, c) naturally occurring high flows and d) operations at Holyoke Dam on water level fluctuations. The rationale for extending the model to the Holyoke Dam is twofold. First the model requires a "downstream boundary condition". In this case the downstream boundary condition could be set at the FERC-licensed range of allowable fluctuation at Holyoke Dam of 1.2 feet (99.47 to 100.67 ft NGVD). The other reason for extending the model to Holyoke Dam is

[37] As noted later, FirstLight has already developed a hydraulic model of the Turners Falls Impoundment and filed on February 22, 2013 a report. Based on the model findings, FirstLight will propose to reduce the current Project Boundary.

that operation (1.2 foot fluctuation) and hydraulic controls between Holyoke Dam and Rainbow Beach may influence water levels where the Puritan Tiger beetle is known to occur.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

FERC and many resource agencies requested studies to evaluate the impact of project operations – specifically WSEL fluctuations -- on environmental, geologic and recreational resources. This hydraulic modeling study will provide information on the relationship between WSEL fluctuations and project operations.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information- Turners Falls Impoundment Hydraulic Model

FirstLight has conducted numerous studies in the Turners Falls Impoundment related to erosion. One such study was conducted by Field Geology Services for use in studying fluvial processes/shoreline erosion in the Turners Falls Impoundment. To support the Field study, in 2006, a bathymetric map and two hydraulic models of the Turners Falls Impoundment were developed by Woodlot Alternatives Inc. (Woodlot) as summarized in the report entitled: *Connecticut River Hydraulic Analysis, Vernon Dam to Turners Falls Dam* (Woodlot, July 2007). The two hydraulic models include the one-dimensional HEC-RAS model, and the two-dimensional RIVER2D model.

As explained in FirstLight's report entitled: *Hydraulic Modeling Assessment of the Turners Falls Impoundment (*FirstLight, January 2013*)*[38], FirstLight updated the existing HEC-RAS model for use in evaluating the upstream influence of the Turners Falls and Northfield Mountain Projects. As noted in the report, the influence ends approximately 9,000 feet below Vernon Dam and thus FirstLight is proposing to modify its Project boundary. No new additional information is needed to develop a hydraulic model of the Turners Falls Impoundment.

At the May 14 study plan meeting, FERC requested further verification of the existing hydraulic model. FERC specifically requested that additional water level recorders be placed in the Turners Falls Impoundment at locations where the hydraulic grade line changes considerably, such as the area near Stebbins Island. The intent is to validate the existing HEC-RAS model with additional water level recorders at key locations.

Existing Information- FirstLight's Water Level Recorders (River Stage)

River stage and flow data at various locations are available to help calibrate hydraulic models. The following sections summarize the data available to assist in hydraulic model calibration.

As noted in the PAD, FirstLight maintains WSEL monitors[39] that record hourly[40] at the following locations in the Turners Falls Impoundment:

[38] This report was filed with FERC on February 22, 2013.
[39] All of the FirstLight WSEL monitors are on the same vertical datum.
[40] Historically, FirstLight has recorded the WSEL from the four existing monitors hourly as this is a fine enough time scale for day-to-day operations and management of their hydropower facilities. However, the four existing monitors can record every 15 minutes, if desired. For purposes of this study and others, the four existing monitors will be set to record every 15 minutes.

- Immediately below Vernon Dam in the tailrace;
- In the Northfield Mountain tailrace;
- At the boat barrier located approximately 1,500 feet upstream of the Turners Falls Dam, and;
- At the Turners Falls Dam.

In addition to the long-term WSEL monitors noted above, FirstLight maintained additional WSEL monitors for a portion of 2012 as described in the PAD (Section 4.3.2.6 2012 Water Level Monitoring Baseline Study) at the following locations:

- In the Turners Falls Impoundment at the Route 10 Bridge and West Northfield Road;
- In the bypass channel above and below Station No. 1 (although the period of available data is limited due to vandalism);
- In the Connecticut River below Cabot Station at the Route 116 Bridge and across from Rainbow Beach.

Existing Information- Additional Flow and Water Elevation Data

There are four USGS gages in the Project area as listed in Table 3.2.2-1.

Table 3.2.2-1: USGS Gages in Proximity to the Project Area

Gage No.	Gage Name	Drainage Area	Notes
01161000	Ashuelot River at Hinsdale, NH	420 mi^2	Drains into the Turners Falls Impoundment approximately 2.1 miles below Vernon Dam. A US Army Corps of Engineers Flood control facility is located above the gage (Surry Mountain Dam).
01166500	Millers River at Erving, MA	372 mi^2	Drains into the Turners Falls Impoundment immediately below the French King Bridge or approximately 3.9 miles upstream of Turners Falls Dam. A US Army Corps of Engineers Flood control facility is located above the gage (Birch Hill Dam).
01170000	Deerfield River near West DeerFGS, MA	557 mi^2	Upstream of the gage are two seasonally operated reservoirs (Somerset and Harriman Reservoirs) and several peaking hydroelectric projects.
01170500	Connecticut River at Montague City, MA	7,860 mi^2	Located approximately 1,000 feet downstream from the Deerfield River confluence and approximately 0.74 miles below Cabot tailrace.

In addition to the USGS gages, FirstLight estimates flow at the following locations:

- Turners Falls "Naturally Routed Flow", which is a sum of the Vernon discharge, and flow contributions from the Ashuelot and Millers Rivers (pending the magnitude, the computation of "Naturally Route Flow" can be lagged).

- Flow through the gatehouse is estimated based on the gate rating curves and head differential between the WSEL monitored at the Turners Falls Dam Impoundment elevation and Keith's Bridge located in the power canal.

- Flow passed by the Turners Falls Dam is estimated based on the Turners Falls Dam Impoundment elevation and the rating curves of the bascule and tainter gates.

Existing Hydraulic Model- Flood Insurance Studies

Flood Insurance Studies (FIS) of the Connecticut River are available through the Federal Emergency Management Agency (FEMA). The FIS is used to show the area of inundation under various flood flows such as the 100-year flood. FEMA developed hydraulic models of the Connecticut River, including the reach between Turners Falls Dam and Holyoke Dam. The most recent hydraulic modeling was conducted in the early 1980s and most likely used the USACE's HEC-2 model, the predecessor to HEC-RAS. FirstLight will secure the original HEC-2 input files, and convert them over to the HEC-RAS model to develop a hydraulic model of the reach between Turners Falls Dam and Holyoke Dam. As described below, FirstLight is proposing to reconstruct the hydraulic model developed by FEMA for use in this relicensing effort.

Existing Hydraulic Model of the Connecticut River in the Northampton Area- Corps of Engineer Model

At the May 14 study plan meeting, The Nature Conservancy indicated that a HEC-RAS model had been originally developed by the US Army Corps of Engineers, which was subsequently updated (transects further widened) by The Nature Conservancy, in the Northampton area of the Connecticut River. The geographic extent of the model is shown in Figure 3.2.2-1. The model covers approximately 7 miles (60+ transects) of the reach below Cabot and will be incorporated into the proposed HEC-RAS model. Transects for the model were collected by the Corps in the fall 2011. Note that this area covers Rainbow Beach, an area of concern for tiger beetles.

Instream Flow Study Transects

FirstLight is proposing to accelerate Study No. 3.3.1 *Conduct Instream Flow Habitat Assessments in the Bypass and below Cabot Station* such that field data is collected in 2013. As part of that study, FirstLight is collecting depth, velocity and WSEL data at transect locations yet to be determined[41]. The field work will also include measuring the total flow at these transects. The information collected for this study could be used to supplement the hydraulic model proposed below for the reach below Turners Falls Dam. Note that the instream flow study work in 2013 will be limited to the reach from Turners Falls Dam to approximately the Deerfield River confluence. Instream flow study work in the reach below the Deerfield River confluence will occur in 2014 after a mussel survey of this same reach is completed in 2013. The mussel survey study will inform potential locations for transect placement.

Upland Topography

To develop a hydraulic model, the topography of upland areas (river banks and floodplain) is needed, particularly when simulating flood flows. If upland information is needed, FirstLight will rely on the existing upland mapping obtained from USGS National Map Viewer- more specifically, the USGS 10 meter digital elevation model (DEM).

Need for Additional Information

As noted above, FirstLight needs to obtain the FIS hydraulic models developed for the reach between Turners Falls Dam and Holyoke Dam. The hydraulic models are likely in paper format and will require re-entering the data in HEC-RAS. FirstLight is proposing to re-develop the FIS hydraulic models in lieu of developing an original model for the following reasons: a) the cost associated with conducting

[41] Transects will be located in areas that will be evaluated for fish, host fish, macroinvertebrates, and state/federally-listed mussels.

bathymetric mapping in the approximate 35-mile reach between Turners Falls Dam and Holyoke Dam is very expensive; and b) re-developing the FIS hydraulic model will provide sufficient information on the relationship between river stage and flow; and c) FirstLight installed water level monitors at two locations (Route 116 Bridge and at Rainbow Beach) in this reach during a portion of 2012 and there is also a long term water level monitor at the USGS gage at Montague. Thus, information is already available on the relationship between Turners Falls and Deerfield River Project operations and river stage.

As noted above, FERC has requested that water level recorders be placed in the Turners Falls Impoundment at key locations to verify the HEC-RAS hydraulic modeling results.

Project Nexus (18 CFR § 5.11(d)(4))

Project operations result in water level fluctuations in the Turners Falls Impoundment and below Cabot Station. These fluctuations may have an impact on various environmental, geologic and recreational resources.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Connecticut River Hydraulic Model from Vernon Dam to Turners Falls Dam

Task 1: Update Turners Falls Impoundment HEC-RAS model

The existing Turners Falls Impoundment HEC-RAS model does not include major tributary inflows, namely the Ashuelot and Millers Rivers. To date, the HEC-RAS model has been used to predict the WSEL under a constant (steady) flow throughout the length of the impoundment- meaning the flow at the Vernon tailrace is the same as the flow at Turners Falls Dam. FERC has requested that the HEC-RAS hydraulic model be operated in an unsteady mode allowing for time varying flow. To simulate time varying flow, the model would require updates including the Vernon Hydroelectric Project discharge hydrograph and flows recorded at the Ashuelot and Millers Rivers USGS gages. In addition, the model will require updates to reflect when water is leaving the impoundment (Northfield pumping) and when water is added to the impoundment (Northfield generating).

FirstLight records on its log sheets hourly Vernon discharges, and Ashuelot and Millers River flows based on the USGS gages to estimate the "Naturally-Routed Flow" through the impoundment. In addition, the log sheets include the hourly magnitude (MW) of pumping and generating, which can be converted to an approximate flow using a ratio of design flow (cfs) to capacity (kW) for both pumping and generating (see page 4-33 of PAD).

Task 2: Installation of Water Level Recorders in Turners Falls Impoundment for Model Verification

As noted above, FERC requested at the May 14 study plan meeting that water level recorders be placed in the Turners Falls Impoundment to further validate the hydraulic model. Figure 3.2.2-2 shows the channel bed and water surface profile (WSP) from the existing HEC-RAS model for flows of 15,938 (Turners Falls Hydraulic Capacity), 30,000 cfs 60,000 cfs and 100,000 cfs (this same figure was filed with FERC on February 22, 2013). More noticeable changes in the WSP were located to determine where water level recorders would be placed. Figure 3.2.2-3 (4 maps) shows the transect locations from the HEC-RAS model along with proposed[42] water level recorder locations (see Table 3.2.2-2 below). Note that each transect shown on Figure 3.2.2-3 is numbered- those numbers match the WSP (x-axis) in Figure 3.2.2-2.

Table 3.2.2-2: Proposed and Existing Water Level Monitors in Turners Falls Impoundment

Proposed Location of Water Level Recorder- (see HEC-RAS Transect No.)	Description	Rationale
Turners Falls Dam	Existing Gage: Located at Turners Falls Dam	
Transect No. 486.259: Turners Falls Boat Barrier Line	Existing Gage: Located just upstream of Turners Falls Dam	Located approximately 20,000 feet or 3.8 miles downstream of the approximate narrowest channel width at French King Gorge.
Transect No. 26986.3: Northfield Tailrace	Existing Gage: Located in Northfield tailrace	Located approximately 1.3 miles upstream of French King Gorge.
Transect No. 33486.3: Located upstream of Northfield Tailrace	Proposed Gage: Located approximately 6,500 feet upstream of the Northfield Tailrace	At the May 14 meeting a question was raised that when Northfield is generating does it create a backwater upstream of the tailrace. This gage is positioned to record changes in the WSEL potentially due to Northfield operation. This gage may provide assistance in Study No. 3.1.2 to evaluate the rate of change in water level fluctuations.
Transect 56926: Located at Route 10 Bridge	Proposed Gage: Route 10 Bridge. Located approximately 5.7 miles above the Northfield Tailrace	This location had a monitor in 2012 and was repeated.
Transect No. 71986.3: Located upstream of Schell Memorial Bridge, near West Northfield Road	Proposed Gage: Located approximately 8.5 miles upstream of Northfield Tailrace	This location had a monitor in 2012 and was selected because the river width narrows and could act as a hydraulic control – water levels start to rise at this approximate location based on Figure 3.2.2-2.
Transect No. 92986.3: Located below Stebbins Island	Proposed Gage: Located approximately 5,500 feet below lower most section of Stebbins Island	This gage would pick up the WSEL just below Stebbins Island. The reason for installing this monitor (Transect No. 92986.3) and the next one upstream (Transect 102986) is the original hydraulic modeling (filed with FERC in 2013) showed that the influence of the Turners Falls Project on WSEL extended to approximately below Stebbins Island. These two monitors are proposed to verify these original findings.
Transect No. 102986: Located above Stebbins Island	Proposed Gage: Located approximately 2,500 feet above upper most section of Stebbins Island	This gage would pick up the WSEL just above Stebbins Island.
Vernon Tailrace: Located immediately below Powerhouse	Existing Gage	

[42] FirstLight will seek to install the water level monitors as outlined in the table; however, if access is not granted to land, some re-location of recorders may be required.

The proposed and existing[43] water level monitors will be set to record the WSEL every 15 minutes. FirstLight will install these water level monitors from approximately August 2013 until approximately November 2013[44] to capture a range of low and high flows and to capture a range of operating conditions at the Vernon, Northfield and Turners Falls hydropower facilities. The water level monitors will be surveyed to the same datum as the existing water level recorders.

In addition to the water level monitors, FirstLight will maintain hourly log sheets that will record the following data during the same period the water level monitors operate:

- Vernon Discharge (cfs)
- Northfield Pump and Generation (kW) - this will be converted to flow through a ratio of design flow (cfs) to design capacity (kW)
- Station No. 1 Generation (kW) – again this will be converted to flow
- Cabot Station Generation (kW)- again this will be converted to flow
- Flow recorded at USGS gages on the Ashuelot and Millers Rivers will be recorded

The log sheet information will be used along with the water level recorder data to help validate the model- see the following task.

Task 3: Model Verification and Calibration

Using the WSEL data obtained in Task 2, FirstLight will validate the hydraulic model to measured WSELs. The hydraulic model will be calibrated to measured WSELs in the Turners Falls Impoundment for select flows. The HEC-RAS model will be operated as steady state with no pumping or generating occurring at Northfield such that flow conditions through the length of the impoundment are relatively steady for several hours. FirstLight has developed a relationship between flow and travel time (in hours) through the Turners Falls Impoundment. As a guide, at flows less than 20,000 cfs, the travel time is approximately 10 hours, and at flows near 80,000 cfs, the travel time is approximately 4 hours. Ideal conditions would be if discharges from Vernon are relatively constant for 12+ hours and Northfield is idle. The HEC-RAS model will be operated for a given flow and the WSELs measured at FirstLight monitoring locations will be compared to the model results. If needed, calibration will consist of adjusting Manning n values (roughness) or adjusting contraction/expansion coefficients within reasonable measures such that the measured and modeled WSELs are reasonably close.

NHDES' comment letter on the Updated PSP requested that the hydraulic model be calibrated to not only WSEL, but also measured velocities. As described under Task 6 below, for the hydraulic model extending from Turners Falls Dam to Holyoke Dam, FirstLight will use mean channel velocity data obtained from the instream flow study transects to further validate that hydraulic model. However, for the hydraulic model extending from Vernon Dam to Turners Falls Dam, FirstLight is not proposing to collect velocity

[43] FirstLight typically records the WSEL at the existing monitors every hour; however, the monitors can be set to record the WSEL every 15 minutes.
[44] NMFS' comment letter on the Updated PSP requested that the recorders be installed for one year. If a range of flows, from approximately 5,000 cfs (equaled or exceeded approximately 80% of the time annually- see Figure 4.3.1.2-17 of PAD) to 30,000 cfs (equaled or exceeded approximately 12 % annually- see Figure 4.3.1.2-17 of PAD), cannot be attained during the August-November 2013 period, then the monitors would be pulled over the winter and reinstalled by approximately March 15, 2014 (or when conditions are safe) to capture the 2014 spring runoff. FirstLight is concerned about personnel safety working on or near the river during the winter period as access to some of the water level recorders can only be achieved by boat.

information to further calibrate the model. FirstLight believes that the 2006 bathymetry coupled with the measured WSEL at nine monitoring transects is more than sufficient to reasonably calibrate the hydraulic model. In addition, in those areas where velocity is more critical, such as near the Northfield tailrace where 2D modeling is proposed (Study No. 3.3.9), velocity data will be obtained. In sum, FirstLight does not believe that the level of effort needed to collect additional velocity measurements at transects in the Turners Falls Impoundment is warranted.

Task 4: Unsteady Flow Model

Once the model is calibrated, it will be updated to simulate unsteady flow conditions. In this case, time varying flows will be simulated to determine changes in the WSEL at select locations in the Turners Falls Impoundment. Several production runs/sensitivity analyses will be conducted to evaluate various sources relative water level influences. For example, a time varying discharge hydrograph from Vernon Station will be simulated while the Northfield Mountain Project remains idle to determine the contribution of water level fluctuations caused by Vernon Station. Similarly, a constant discharge hydrograph from Vernon Station will be simulated while the Northfield Mountain Project is operated as a pump or generator. Finally, other combinations of flows and operating conditions at the facilities will be evaluated. A matrix of proposed model runs is included in Table 3.2.2-3. Output from the model will include WSEL and mean channel velocities[45] for the flows simulated.

Connecticut River Hydraulic Model from Turners Falls Dam to Holyoke Dam

Task 5: Contact FEMA and Obtain FIS Hydraulic Model

FirstLight will contact FEMA to obtain the FIS studies in those communities located between Turners Falls Dam and Holyoke Dam. Experience indicates that FIS studies conducted in the early 1980s were conducted using HEC-2, the predecessor to HEC-RAS. Note that the energy equations and computations between both models are the same, although HEC-RAS has more features and graphical displays. It is likely that the original HEC-2 input files are retained on microfiche. FirstLight will obtain the microfiche, and print out the input files. The input files contain the following information which will entered into the HEC-RAS model:

- Channel transect coordinates.
- Mannings "n" values.
- Distance between transects.
- Bridge geometry[46].
- Expansion and contraction coefficients.
- Flood flows.

Task 6: Development of HEC-RAS model and Model Calibration

The data on the printed input files will be entered into the HEC-RAS model. The FIS will be re-constructed and validated by simulating the 100-year flood flow to ensure that the HEC-RAS model

[45] Note that HEC-RAS model can calculate velocities laterally across the transect based on conveyance. These velocities will reflect mean channel velocity for the transect.
[46] FirstLight will contact MassDOT to obtain any bridge information (pier shape, low chord, etc.) to determine if the bridge data contained in the HEC-2 model reflects today's bridge geometry.

output—specifically, the water surface profile—reasonably matches that shown in the FIS. Once the model reasonably matches the 100-year water surface profile, it will used to simulate various steady state flows similar to the methodology described above. For example, one of the flows simulated will be a relatively constant flow throughout the 35-mile long reach experienced during the period for which FirstLight has WSEL data at the Route 116 Bridge and Rainbow Beach. The measured WSEL at these two locations and at the Montague USGS gage will be compared to that predicted by the model. Similar to above, the model will be calibrated by adjusting Manning n values or expansion/contraction coefficients within reasonable measures.

Once the FIS is recreated and calibrated, it will be updated to include the HEC-RAS transects included in the Corps/TNC hydraulic model as described above. Any FIS transects in this reach (see Figure 3.2.2-1) will be replaced with the more up-to-date transects from the Corps/TNC model. The hydraulic model will be re-run again to determine if measured WSELs reasonably match model WSELs.

As part of Study No. 3.3.1 *Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station*, FirstLight will be obtaining additional transect and geomorphic data to support this study. For those locations where transects are obtained, they too will be added into the HEC-RAS model. Also, Study No. 3.3.1 requires collecting stage discharge relationships at transects (final locations to be determined) that will be added into the model. These data, along with the WSEL monitoring data obtained in 2012 will be used to calibrate the model to observed WSELs.

As noted above, in NHDES' comment letter on the Updated PSP they requested that the hydraulic model be calibrated to not only the WSEL, but also measured velocities. Calibrating the model to both measured velocities and WSEL would require measuring cellular velocities across transects. Study No. 3.3.1 *Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station* includes collecting cellular velocity data in certain reaches where 1-D modeling is proposed. At the 1-D modeling reaches, transects will be located and cellular velocity (and subsequently mean channel velocity), WSEL and total flow will be measured. For this hydraulic model and at the instream flow study transects, the mean channel velocity, WSEL and total flow will be used to validate the hydraulic model.

Task 7. Unsteady Flow Model

After calibration, the model will be updated to simulate unsteady flow conditions. Time varying flows will be simulated to determine WSEL changes at select locations in the 35-mile long reach. Sensitivity analyses will be conducted to evaluate the effect of various sources on water level fluctuations. In this case, water level fluctuations could be a function of, or influenced by, the Turners Falls Project, the Deerfield River Project, and the WSEL maintained at Holyoke Dam. For example, a time varying discharge hydrograph from the Turners Falls Project will be simulated while flows from the Deerfield River remain stable to determine the effect of the Turners Falls Project operations on water level fluctuations. Similarly, a constant discharge hydrograph from the Turners Falls Project will be simulated while the Deerfield River Project discharges vary. Finally, other combinations of flows, operating conditions at the Turners Falls and Deerfield River Project, and starting downstream boundary conditions (Holyoke Dam elevation) will be evaluated. A matrix of proposed model runs is included in Table 3.2.2-4. Output from the model will include WSEL and average channel velocities for various flows.

Task 8: Report

A comprehensive report will be developed to include the following:

- Introduction
- Project Layout

- Summary of Existing Data
    - Existing USGS Gage Flow
    - Flow in Power Canal and Passed at Turners Falls Dam
    - Water Level Recorders
- Hydraulic Modeling
    - Connecticut River between Vernon and Turners Falls Dams
    - Connecticut River between Turners Falls and Holyoke Dams
    - Steady State Modeling
    - Calibration (including approach for model calibration)
    - Unsteady State Modeling
- Findings
- References

Upon request, FirstLight will provide interested stakeholders with the HEC-RAS files (geometry files, flow files, plan files and project files), and associated GIS files.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Projects on water level fluctuations. The HEC-RAS model of the Connecticut River between the Vernon and Turners Falls Dams is essentially complete with the exception of calibrating to observed WSELs and simulating unsteady flow conditions. More time will be spent developing the HEC-RAS model of the Connecticut River between Turners Falls and Holyoke Dams. The estimated cost of this study is between $100,000 and $120,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013; this particular study was discussed in much greater detail on May 14th in the afternoon.

As noted above, FirstLight will install water level recorders in 2013 (August-November) at the locations shown in Figure 3.2.2-3 in the Turners Falls Impoundment for use in validating and calibrating the hydraulic model. Model verification and validation would be conducted in 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Table 3.2.2-3: Turners Falls Impoundment Hydraulic Model- Proposed Model Production Run Matrix

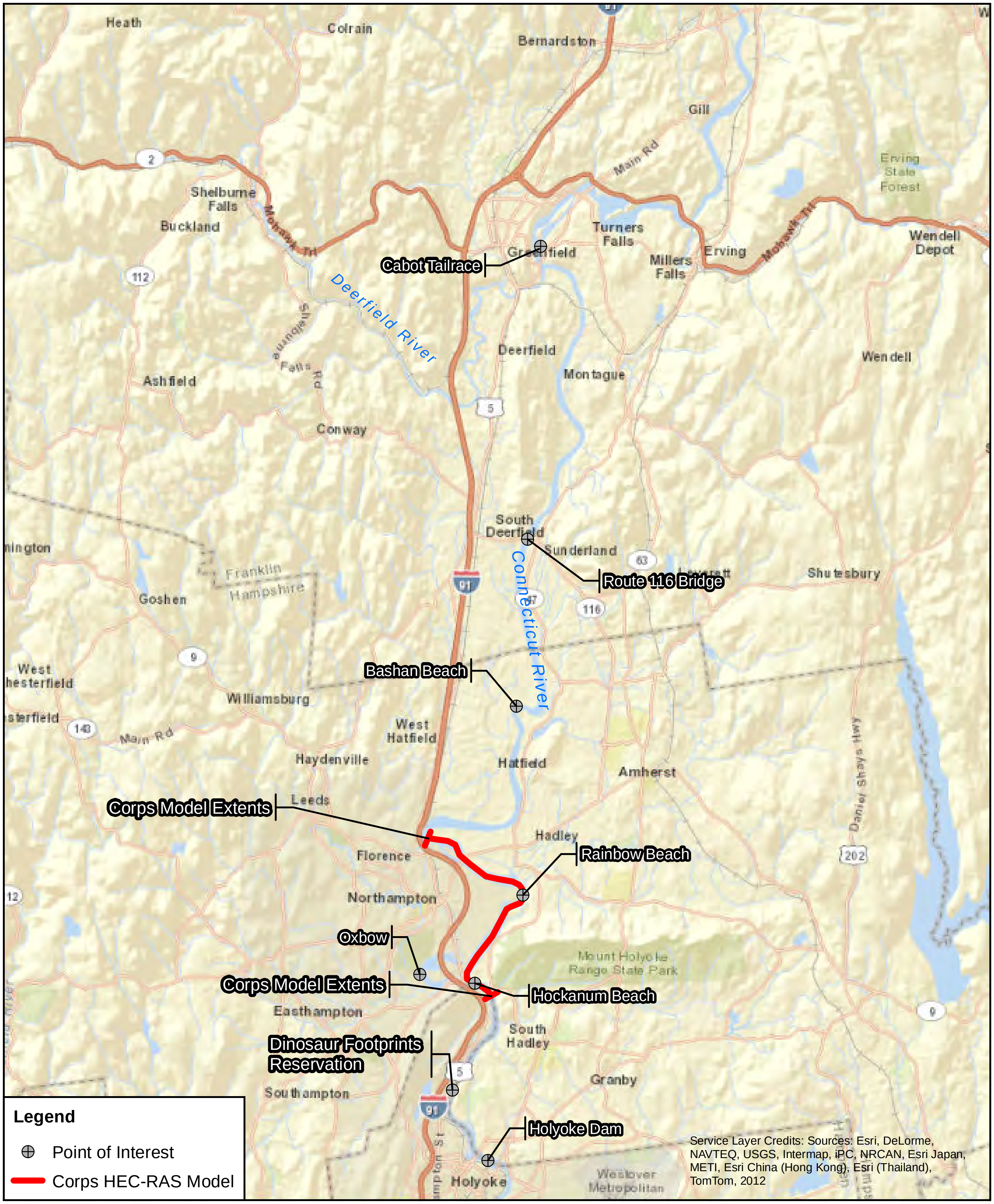
Scenario No.	Vernon Project		Northfield Mountain Project			Turners Falls Project		Turners Impoundment Elev at Dam	
	Max Gen Flow	Min Flow	Max Gen Flow	Max Pump Flow	Off	Max Gen Flow[2]	Min Flow[3]	Max Imp. Elev.	Min Imp. Elev.
Flow (cfs)	17,130[1]	1,250	20,000	15,200		15,938	1,433	185 ft	176 ft
1	X		X			X		X	
2	X		X			X			X
3	X		X				X	X	
4	X		X				X		X
5	X			X		X		X	
6	X			X		X			X
7	X			X			X	X	
8	X			X			X		X
9	X				X	X		X	
10	X				X	X			X
11	X				X		X	X	
12	X				X		X		X
13		X	X			X		X	
14		X	X			X			X
15		X	X				X	X	
16		X	X				X		X
17		X		X		X		X	
18		X		X		X			X
19		X		X			X	X	
20		X		X			X		X
21		X			X	X		X	
22		X			X	X			X
23		X			X		X	X	
24		X			X		X		X

[1]Source: TransCanada Vernon PAD, Table 2.1.1- Project Summary
[2]Max generation flow would include having both Cabot and Station No. 1 operating at its full hydraulic capacity of 15,938 cfs.
[3]Min flow would include having Station No. 1 operate at the current FERC licensed minimum flow below the project of 1,433 cfs.

Table 3.2.2-4: Connecticut River below Cabot Station Hydraulic Model- Proposed Model Production Run Matrix

Scenario No.	Turners Falls Project		Deerfield River Project- Station No. 2		Holyoke Project		Holyoke Impoundment Elev at Dam	
	Max Gen Flow[1]	Min Flow[2]	Max Gen Flow[3]	Min Flow[4]	Max Gen Flow[5]	Min Flow[6]	Max Imp. Elev.[7]	Min Imp. Elev.[7]
Flow (cfs)	15,938	1,433	1,450	200	14,850	4,300 cfs	100.67 ft	99.47 ft
1	X		X		X		X	
2	X		X		X			X
3	X		X			X	X	
4	X		X			X		X
5	X			X	X		X	
6	X			X	X			X
7	X			X		X	X	
8	X			X		X		X
9		X	X		X		X	
10		X	X		X			X
11		X	X			X	X	
12		X	X			X		X
13		X		X	X		X	
14		X		X	X			X
15		X		X		X	X	
16		X		X		X		X

[1]Max generation flow would include having both Cabot and Station No. 1 operating at its full hydraulic capacity of 15,938 cfs.
[2]Min flow would include having Station No. 1 operate at the current minimum flow below the project of 1,433 cfs.
[3]Max generation flow would include having the lowermost hydroelectric project on the Deerfield River, Station No. 2, operate at its maximum hydraulic capacity of 1,450 cfs.
[4]Min flow would include having the lowermost hydroelectric project on the Deerfield River, Station No. 2, pass its FERC licensed minimum flow of 200 cfs, guaranteed from storage.
[5]Max generation would include having the Holyoke Project operating at its full hydraulic capacity of approximately 14,850 cfs (includes canal, Hadley Units 1 and 2).
[6]Min generation would include having the Holyoke Project pass at its FERC licensed minimum flow, which varies seasonally from 840-1,300 cfs in the bypass and 400 to 3,000 cfs to the canal system. For hydraulic modeling purposes, a flow of 4,300 cfs (1,300 + 3,000 cfs) will be applied.
[7]Per correspondence with Paul Ducheney of Holyoke Gas and Electric, the current fluctuation at Holyoke Dam ranges from 99.47 feet NGVD to 100.67 feet NGVD, a 1.2 foot fluctuation.



FirstLight Power Resources
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FIRSTLIGHT POWER RESOURCES

Revised Study Plan

0 2 4 8 Miles

Figure 3.2.2-1: Geographic Limits of Corps HEC-RAS Model

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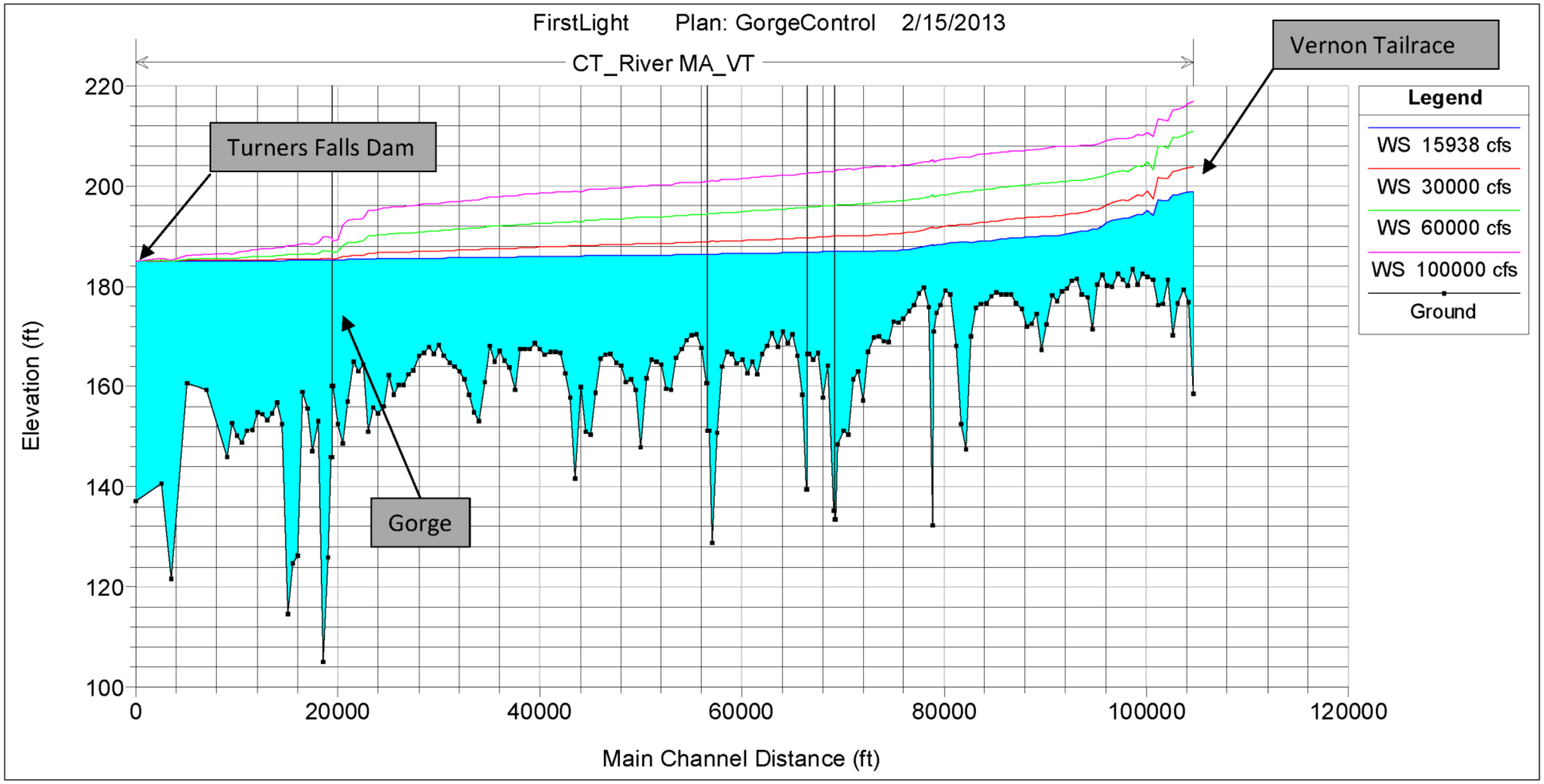
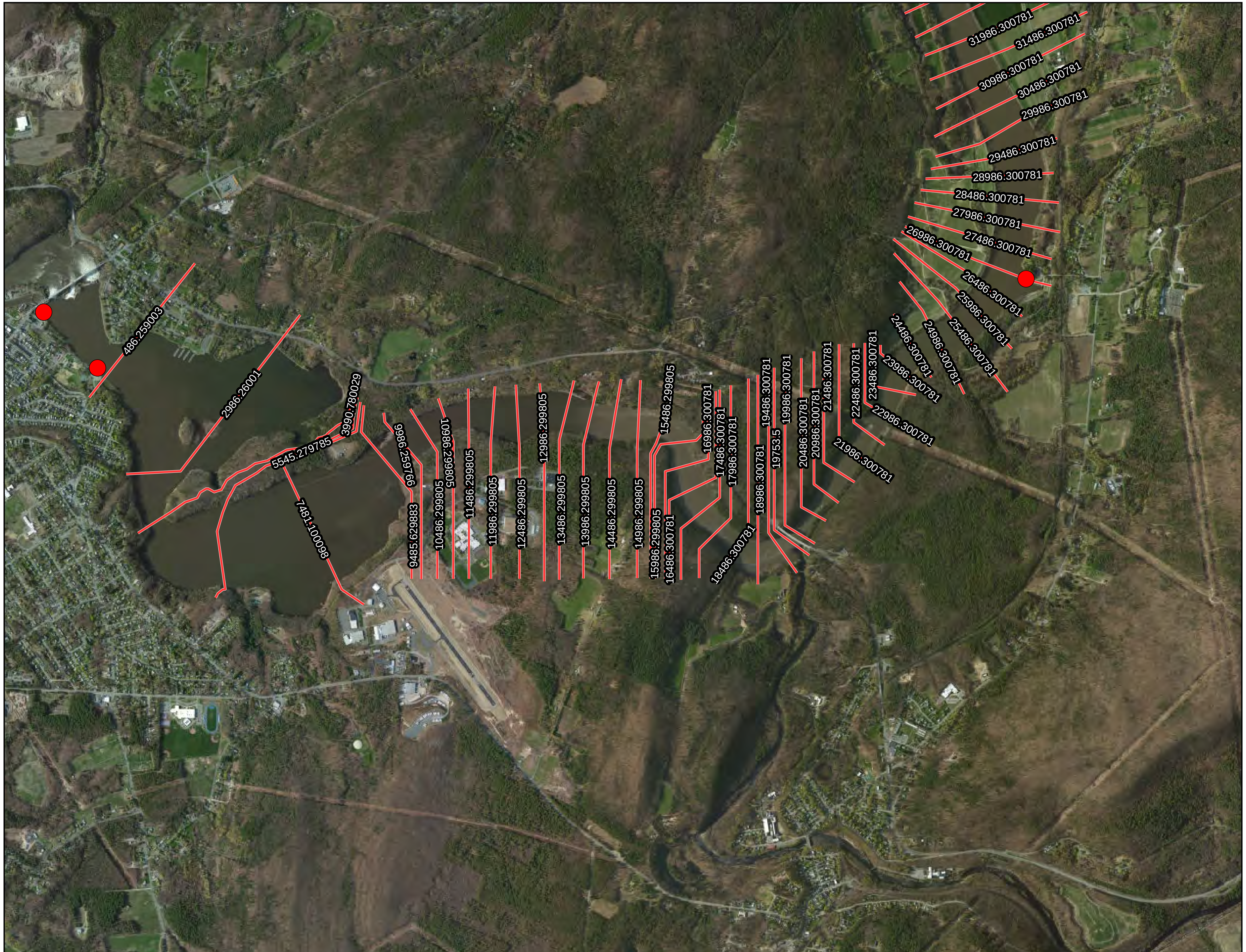
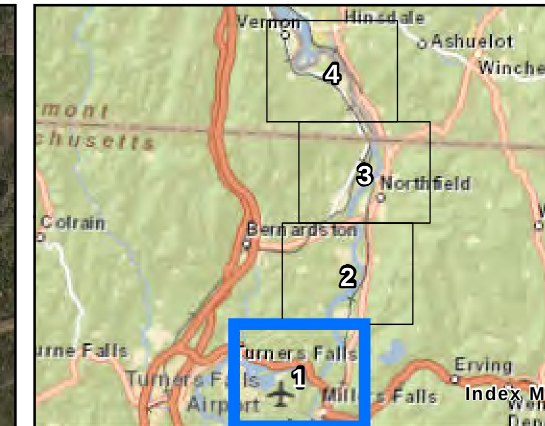


Figure 3.2.2-2: Turners Falls Impoundment from Turners Falls Dam to Vernon Tailrace- Water Surface Profile for Various Flows





FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN
HYDRAULIC STUDY OF
TURNERS FALLS IMPOUNDMENT
Figure 3.2.2-3
Plan Map of Turners Falls Impoundment
HEC-RAS Transect Numbers
Page 1 of 4

Legend

- Cross Section
- Existing Water Level Recorder
- Proposed Water Level Recorder

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

0 1,000 2,000 4,000 Feet
1 inch = 2,000 feet

FirstLight Power Resources
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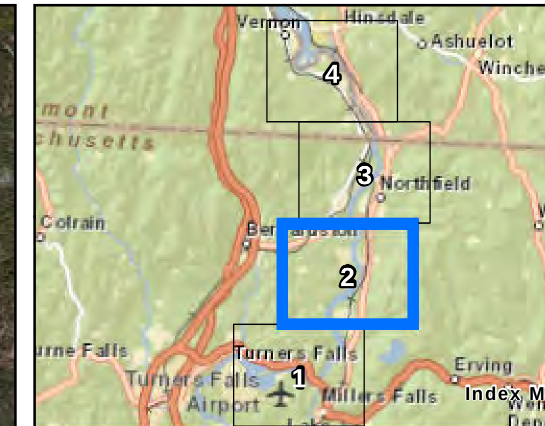

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN
HYDRAULIC STUDY OF
TURNERS FALLS IMPOUNDMENT

Figure 3.2.2-3
Plan Map of Turners Falls Impoundment
HEC-RAS Transect Numbers
Page 2 of 4

Legend

- Cross Section
- Existing Water Level Recorder
- Proposed Water Level Recorder

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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1 inch = 2,000 feet

FirstLight Power Resources
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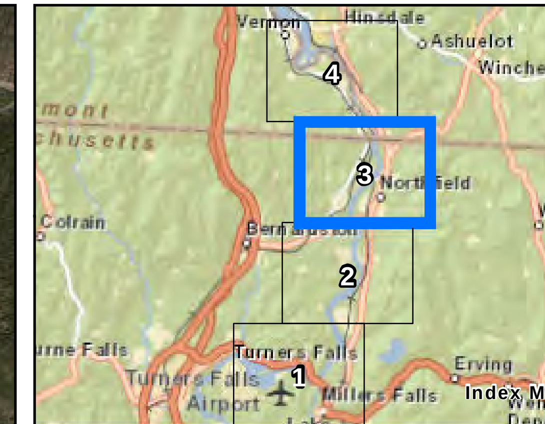

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN
HYDRAULIC STUDY OF
TURNERS FALLS IMPOUNDMENT

Figure 3.2.2-3
Plan Map of Turners Falls Impoundment
HEC-RAS Transect Numbers
Page 3 of 4

Legend

- Cross Section
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- Proposed Water Level Recorder

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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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1 inch = 2,000 feet

FirstLight Power Resources
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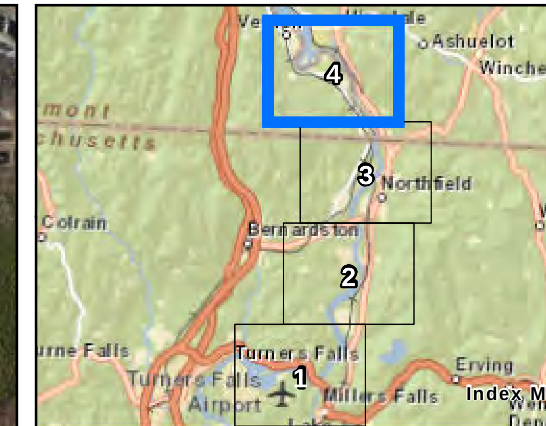

FIRSTLIGHT POWER RESOURCES
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HYDRAULIC STUDY OF
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Figure 3.2.2-3
Plan Map of Turners Falls Impoundment
HEC-RAS Transect Numbers
Page 4 of 4

Legend

- Cross Section
- Existing Water Level Recorder
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N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

0 1,000 2,000 4,000 Feet
1 inch = 2,000 feet

FirstLight Power Resources
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3.3 Fish and Aquatic Resources

3.3.1 Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station

General Description of Proposed Study

USFWS, NOAA, MDFW, NHFG, CRWC, TNC and TU requested that a habitat-based field study, such as the Instream Flow Incremental Methodology (IFIM) be conducted in the Turners Falls bypass reach and in the Connecticut River downstream of Cabot Station. An IFIM study is proposed to quantify the relationship between station operation and aquatic habitat.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The purpose of the study is to assess the potential effects of the range of discharges from Turners Falls Dam, Station No. 1, and Cabot Station on wetted area and aquatic habitat suitability in the Connecticut River between Turners Falls Dam and Cabot Station (the bypass reach) and below Cabot Station downstream to the Route 116 Bridge in Sunderland, MA.

For the reach between the Route 116 Bridge and Dinosaur Footprints Reservation, the assessment will focus on any state or federally listed mussels (which are known to exist as described later).

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals identified are to:

- Determine an appropriate flow regime that will protect and enhance the aquatic resources in the bypassed reach between Turners Falls Dam and the Cabot Station discharge.
- Determine an appropriate flow regime that will protect and enhance the aquatic resources from the Cabot tailrace of the Turners Falls Project downstream to the Route 116 Bridge in Sunderland, MA.
- Determine an appropriate flow regime that will protect state or federally listed mussel resources between the Route 116 Bridge in Sunderland and Dinosaur Footprints Reservation.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Habitat Mapping

In 2012, aquatic habitat mapping and water level monitoring were conducted at the following locations:

- In the Connecticut River bypass reach from Turners Falls Dam to Cabot Station, and;
- In the Connecticut River from Cabot Station approximately 30+ miles downstream to a natural hydraulic control located in the vicinity of the Dinosaur Footprints Reservation (see Figure 3.3.1-1).

The 2012 aquatic habitat mapping report entitled "*Aquatic Mesohabitat Assessment and Mapping*" prepared by FirstLight (2012) was filed with FERC on January 8, 2013. It also can be found on FirstLight's relicensing website at http://www.northfieldrelicensing.com.

Water Level Monitors

- From approximately late April 2012 through October 2012, FirstLight installed continuously recording water level monitors that measured the water surface elevation (WSEL) every 15 minutes. Two monitors were placed in the bypass reach from Turners Falls Dam to below Cabot Station (although vandalism was an issue), and three monitors were placed below Cabot Station (at the existing Montague USGS gage, at the Route 116 Bridge in Sunderland, and near Rainbow Beach in Northampton). See Figure 3.3.1-2 for a map showing the monitor locations below Cabot Station. All monitors were surveyed to a common vertical datum to allow for comparison.

- Attachment A includes weekly plots of WSELs at the Montague USGS gage, Route 116 Bridge and Rainbow Beach and the flow as recorded at the Montague USGS gage during April through October 2012. As the weekly plots show, WSEL fluctuations attenuate moving from upstream to downstream. When the flow is within the approximate hydraulic capacity of the Turners Falls Project, WSEL fluctuations near the Montague gage are on the order of 4 feet, whereas near Rainbow Beach WSEL fluctuations attenuate to approximately 1 foot.

Hydraulic Model

As part of Study No. 3.2.2, FirstLight is developing a HEC-RAS hydraulic model of the Connecticut River from Turners Falls Dam to Holyoke Dam. This model will rely on previously collected transect data including: a) past flood insurance studies, b) data collected in the Northampton area for The Nature Conservancy/Corps of Engineers HEC-RAS model, and c) any new transects collected as part of this instream flow study. As described in Study No. 3.2.2, the model will be calibrated and updated to simulate unsteady flow conditions.

Freshwater Mussels

A freshwater mussel survey was conducted in the Turners Falls Impoundment, bypass reach, and canal as a baseline study in 2012 (Biodrawversity, 2012), which was filed with FERC on January 8, 2013. No state or federally listed mussel species were detected in any of these areas.

Per the FERC license for the Holyoke Hydroelectric Project, freshwater mussel studies are required over a 12 year period (2003-2014), with interim reports required every four years and a final report in 2014. The mussel survey area extends from Dry Brook (Sunderland) to the Holyoke Dam, plus the Holyoke Dam bypass reach and power canals. The most recently published mussel survey in this reach was filed with FERC in March 2010, with the field work occurring in 2009. Note that a mussel survey of this same reach is being conducted in August 2013; however, results have not been published.

The 2009 mussel survey included 13 study sites, with Site 1 being in the Holyoke Dam bypass channel and Sites 2-13 in the Holyoke Impoundment. Figure 3.3.1-3 shows the locations of Sites 2-13 along with the name of the state-listed mussel and number (count) detected. The only state-listed mussel detected was the yellow lampmussel. Other non-listed species were also detected. Table 3.3.1-1 identifies the location, number of yellow lampmussels detected at each site, and the distance the site is located upstream of Holyoke Dam—see Figure 3.3.1-3. Also overlaid on Figure 3.3.1-3 are the limits of the hydraulic model (and model transects) developed by The Nature Conservancy, which covers the main areas where yellow lampmussels have been found in greater numbers[47].

Table 3.3.1-1: Yellow Lampmussel Sites and Numbers in Holyoke Impoundment

Site No.	Name	No. of Yellow Lampmussels detected in 2009	Approximate distance upstream of Holyoke Dam (mi)
2	Bachelor Brook Area	56	4.6
3	Mt. Tom Powerplant Area	63	6.0
4	Mitch's Island	66	7.1
5	Mitch's Island	87	7.6
6	Mitch's Marina	159	8.0
7	Mitch's Marina	52	8.3
8	Fort River	15	10.0
9	Elwell Island	5	11.8
10	Mill River	1	14.3
Total		504	

At Sites 11-13 (Site 11- Above Hadley Dike, Site 12- Opposite Bashin Beach, Site 13- Water Trail (Utility line to Nourse Farm) no yellow lampmussel were detected. Based on the 2009 mapping, most yellow lampmussels were found upstream of Holyoke Dam between Bachelor Brook and Mill River. In addition to documenting the location and numbers, data were collected on the range of depths, substrate, and flow rate (generally characterized by the resistance such as light, moderate, strong).

Data from 2009 and the August 2013 mussel studies, combined with a survey proposed by FirstLight in 2013 from Cabot Station downstream to Route 116 Bridge in Sunderland (Study No. 3.3.16) will provide information on the distribution and habitat of common and federally/state-listed mussel species in the Connecticut River in the instream flow study area.

<u>Project Nexus (18 CFR § 5.11(d)(4))</u>

Per the FERC license, FirstLight is required to release a continuous minimum flow of 1,433 cfs or inflow, whichever is less, below the Turners Falls Project year-round. FirstLight typically maintains the minimum flow requirement through discharges at Cabot Station and/or Station No. 1.

Per the FERC license, a continuous minimum flow of 200 cfs is maintained in the Connecticut River bypass reach starting on May 1 by releasing flow through a bascule gate[48]. This flow increases to 400 cfs when fish passage begins. 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. A 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. There is no bypass reach minimum flow once the river

[47] FirstLight is in the process of securing the flood insurance studies in this lower reach thus the FIS transects are not shown on Figure 3.3.1-3. FEMA has provided FirstLight with transect data from Turners Falls Dam to approximately the Route 116 Bridge.
[48] The bascule gate used to pass the minimum flow is located at the Turners Falls Dam and is the one closest to the gatehouse.

temperature drops below 7°C. The 120 cfs flow release was determined in 1993 in consultation with MADFW, NMFS, and USFWS to ensure that an adequate zone of passage exists in the reach during the months when sturgeon may be present and require volitional movement.

Approximately 87% of the inflow to the Turners Falls Impoundment is controlled by discharges from the Vernon Hydroelectric Project. The majority of the remaining 13% percent of inflow to the Turners Falls Impoundment is from the Ashuelot and Millers Rivers. The Vernon Hydroelectric Project has a hydraulic capacity of 17,130 cfs, while the hydraulic capacity of the Turners Falls Project (Cabot and Station No. 1 combined) is approximately 15,938 cfs. When flows are within the hydraulic capacity of the Vernon Hydroelectric Project, inflows to the Turners Falls Impoundment reflect peaking discharges.

FirstLight operates the Turners Falls Project as a peaking facility when flows are in the hydraulic range of the Turners Falls Project and as a run-of-river facility when flows exceed the hydraulic capacity of the Turners Falls Project (15,938 cfs). The Northfield Mountain Project operates as a peaking project.

Project operations have the potential to influence aquatic habitat in the bypass reach and below Cabot Station. Based on water level monitoring studies conducted in 2012, it appears that hydraulic effects of peaking operations may extend downstream to Rainbow Beach, approximately 25 miles below Cabot Station; however, as shown in Attachment A, the WSEL fluctuations attenuate at Rainbow Beach.

The Connecticut River immediately below Cabot Station has been identified as a major spawning area for the Endangered Species Act (ESA)-listed shortnose sturgeon. Other diadromous species such as American shad adults and juveniles, blueback herring and sea lamprey seasonally utilize habitat in this vicinity for spawning and rearing. American eels also utilize the habitat in this reach.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Background

The scope of this study is to quantify the effects of Project flows on aquatic habitat suitability in the Connecticut River for the aquatic community and its managed fish resources, including diadromous and resident fish species, and aquatic invertebrates. These data will then be used in conjunction with hydrologic, operational and other models to evaluate the costs and benefits of potentially providing alternate habitat-based flows to the Connecticut River in the study area.

Task 1: Consult with Agencies and Interested Stakeholders to Determine Study Area, Study Reaches, and Habitat Suitability Index Curves

Study Area

The Connecticut River segment between the Turners Falls Dam (drainage area ~7,163 mi^2) and the Route 116 Sunderland Bridge (Figure 3.3.1-1) was identified by the applicable state and federal fishery agencies (agencies) as the study area for purposes of the habitat based study using PHABSIM and 2-D modeling. Flow in this reach is cumulatively influenced by discharges from upstream tributaries, hydroelectric projects in the upper Connecticut River, Fall River (to the bypass reach), the Turners Falls Project and the Northfield Mountain Project. Additional discharges to the study area immediately below Cabot Station include the Deerfield River, which contributes approximately 665 mi^2 of additional drainage area. The Deerfield River includes several FERC-licensed hydroelectric projects operating as peaking facilities and two seasonal regulated storage reservoirs- Somerset and Harriman Reservoirs in Vermont.

The river downstream of Route 116 Bridge is backwatered by the upstream end of the Holyoke Dam impoundment (Study Reach 5 – see detailed description of study reaches below). The hydraulics (depth, velocity, shear stress) in Reach 5 is cumulatively influenced by Holyoke Dam operations (currently a 1.2 foot fluctuation) as well as the upstream influences as described above. As a result, FirstLight will evaluate state and federally listed mussels in this reach as described in more detail later.

An IFIM study is proposed to develop an understanding of key habitat suitability-flow relationships in the study areas. This will be quantified by using a PHABSIM model or the equivalent. The model(s) will be used to simulate habitat suitability at various flow increments representing selected anadromous and resident fish species, host fish species, macroinvertebrates and state and federally listed mussels that are documented. One-dimensional (transect-based) and/or two dimensional (finite elements-based) hydraulic models are required to simulate river channel hydraulics in various areas of interest.

Consistent with IFIM protocol, a study team comprised of licensee representatives and qualified technical experts will be formed for the purpose of making technical decisions regarding input parameters and review of study output. Specifically, that study team will collaboratively designate:

1. specific spatial and temporal habitat management goals,
2. boundaries of the study area and reaches,
3. locations of specific representative or critical study sites, and study site transects,
4. Habitat Suitability Index (HSI) criteria for applicable species and lifestages[49], and
5. calibration flows and range of flows to be assessed.

Study Reaches and Transect Selection (1-D and 2-D Modeling)

The proposed study methodology involves a phased approach beginning with review of recently-mapped mesohabitat distribution throughout the study area. The mapping and characterization of aquatic mesohabitat provides essential information regarding the extent, location, and composition of aquatic habitats that may be affected by Project operation, and provides a framework for selecting strategic study sites and transects.

Study reach boundaries are typically placed at significant breaks in geomorphic, hydrologic or habitat use in the study area (Bovee et al., 1998). The study team will consult to define study reaches and select applicable study sites within each reach, as well as cell boundaries and transects in areas of one-dimensional (1-D) modeling within each study site. A site visit has been scheduled for September 2013 to select transect locations and review 2-D options in the study area from the Turners Falls Dam downstream to the Deerfield River confluence.

Study sites may represent typical and/or unique but critical habitats within each reach. For 1-D model applications, the study team will select upstream and downstream cell boundaries within each study site based on localized observed shifts in stream width, cover, substrate, and hydraulics. The area between a pair of cell boundaries is considered to be relatively homogenous and is described by a transect located within the cell. Study team participants will locate cell boundaries and have input to transect placement within cell boundary pairs.

Based on discussions with the study team, due to complex flow patterns near the islands above the Cabot Station tailrace, a 2-D model is proposed from the upstream end of the Rawson Island to just below the

[49] As noted in USFWS' July 15, 2013 comments on the Updated PSP further modifications to the HSI curves are needed and FirstLight proposes to consult with stakeholders to finalize the HSI curves.

Deerfield River confluence (specifically at the USGS Gage at Montague). The study team, with the input of a hydraulic modeler, will also evaluate the need and feasibility for a 2-D model in Reach 1 immediately below the Turners Falls Dam downstream to the sharp bend in the bypass reach, as well as the downstream-most segment of Reach 2 around the Rawson Island complex during the September 2013 site visit.

Project operations and configuration affect flow and habitat in distinct ways. For this reason, five study reaches are recommended for modeling purposes (see an overview of locations in Figure 3.3.1-1 and a close-up of the bypass reach area in Figure 3.3.1-4). The following study reaches are proposed:

- **Reach 1. Upper Bypass Reach**. This reach is approximately one mile long extending from the Turners Falls Dam downstream to the confluence with the Station No. 1 tailrace. Habitat and flow in this reach are influenced by discharges from the Turners Falls Dam, attraction and fishway flows for the Spillway fish ladder and the Fall River (see Figure 3.3.1-4 for location). Stream channel structure and geomorphology are controlled primarily by bedrock. From the Turners Falls Dam to below the Fall River confluence approximately 0.25 miles downstream of the dam, the bypass channel is significantly wider than other reaches, dominated by scoured ledge substrate, and a poorly defined thalweg, before narrowing upstream from the Station No.1 tailrace. Mesohabitat in this reach includes pool, run and riffle with bedrock overlaid with rubble and cobble substrates. The study team will conduct a site visit at a safe and low flow, to evaluate potential modeling needs in the pool and ledge complex below the dam. 2-D model may be required in this reach, depending on the outcome of the site visit.

- **Reach 2. Lower Bypass Reach**. This reach is approximately two miles long extending from the Station No. 1 tailrace downstream, terminating at an island complex and a geological feature including a natural ledge drop known as "Rock Dam". Flow is influenced by both the net discharge from Reach 1, as well as Station No. 1, when generating. Stream channel structure is controlled primarily by bedrock. Reach 2 channel morphology is relatively well defined, and includes pool, run and riffle mesohabitats with bedrock overlaid with rubble and cobble substrates. The need to employ a 2-D model in the lower portion of this reach (where flow bifurcates around Rawson Island) will be evaluated in the field.

- **Reach 3. Tailrace Reach**. The tailrace reach extends from below the Rock Dam/Rawson Island complex downstream approximately 1.75 miles to the USGS Gage No. 01170500 at Montague, which includes the confluence with the Deerfield River. Habitat in this reach is influenced by flows from Reaches 1 and 2 as well as generation at Cabot Station, including backwatering around the island complex upstream to the toe of Rock Dam. Stream channel structure is comprised of alluvial deposits, including a series of island and split channel complexes both upstream, across, and downstream from the Cabot Station powerhouse. Hydraulic effects are complex, and include backwatering from Cabot Station upstream to Rock Dam as well as flow between islands. Habitat is primarily riffle and run; substrate is dominated by gravel bars and cobble, and includes ledge outcrops at the General Pierce Bridge area.

Two additional reaches have been identified for future modeling, but will not be initially modeled in 2013, pending investigations pertaining to freshwater mussel habitat. These reaches are:

- **Reach 4. Downstream Reach**. This reach is approximately nine miles long and extends from the Montague gage to the Route 116 in Sunderland, which is where backwater influence of the Holyoke Project impoundment generally is detected. Flow is primarily influenced by outflow from Reaches 1-3 and the Deerfield River. This section of river is alluvial and low gradient, with well defined channel and embankments, and repeating patterns of pool and run habitat. Substrate varies but is dominated by cobble, gravel and fines. This reach will be modeled using a 1-D PHABSIM model.

- **Reach 5.** This section of the river extends from the Route 116 Bridge downstream for approximately 22 miles to a natural hydraulic control located in the vicinity of Dinosaur Footprints Reservation. It is a low gradient, alluvial reach with limited mesohabitat variability and in many cases very gradual or subtle transitions from one mesohabitat type to the next contiguous type. Over 75% of the mesohabitat in this reach is comprised of run and most of the remainder is pool. Hydraulics in this reach are influenced by Holyoke Dam operations (1.2 foot fluctuation) and upstream hydropower projects. As shown in Attachment A, a water level monitor at Rainbow Beach showed WSEL fluctuations on the order of 1 foot in this area when flows were in the range of the Turners Falls Project hydraulic capacity. The hydraulic modeling approach in this reach will rely on the HEC-RAS model that is being developed as part of Study Plan 3.2.2 along with Delphi-developed HSI criteria for any state or federally listed mussels found there. Because hydraulics (depth, velocity) in Reach 5 are influenced by both Holyoke and Turners Falls Project operations, a different modeling approach is suggested as described in more detail below.

Transect selection and field work for Reaches 4 and 5 is proposed to occur in 2014 once the location and extent of freshwater mussel populations and American shad spawning has been collected and evaluated. TU's July 15, 2013 comment letter notes the following: "As the locations of shad spawning areas are significant, transects in the IFIM study should be located at each spawning location in reaches 3, 4, and 5. If there are additional spawning locations identified after the shad spawning survey is completed, a transect should be placed at each location". FirstLight is proposing to place transects in Reach 3 and 4 in representative habitat. Each transect depicts homogenous habitat within a longitudinal cell extending a distance upstream and downstream of the actual transect site defined by the study team in the field. Shad spawning habitat will be included in representative cell locations and may be selected using available information pertaining to shad spawning to inform cell boundary loci; however, FirstLight is not proposing to place a transect at every shad spawning locus.

Habitat Suitability Index Criteria

FirstLight anticipates the use of habitat suitability index curves (HSI) curves adopted primarily from those previously used in support of recent PHABSIM models conducted at study sites with similar geomorphic and ecoregion characteristics. FirstLight has begun agency consultation to select applicable HSI curves. Although most have been resolved, several categories are continuing to be researched and modified as necessary and approved by the study team at this time. Based on consultation with agencies and stakeholders accomplished to date, FirstLight provisionally proposes to employ the HSI criteria listed in Table 3.3.1-2. Please note that freshwater mussel HSI are described separately later in this section.

Attachment B includes a set of proposed HSI curves and supporting references. The following potential guilds have been proposed for inclusion, to capture habitat requirements for species for which HSI curves are not otherwise available (for example, burbot and Eastern silvery minnow):

- Shallow-slow
- Shallow-fast
- Deep-slow
- Deep-fast

FirstLight will continue to consult with the study team to further classify fish species into applicable guilds, and assign depth and velocity criteria to each guild, prior to developing the PHABSIM model.

The documented location of shad spawning in the Connecticut River between Holyoke Dam and Turners Falls Dam was identified in previous studies by Layzer (1974) and Kuzmeskus (1977). The documented spawning locations from Cabot Station downstream to the Route 116 Bridge are shown in Figure 3.3.1-5.

Freshwater mussels

Freshwater mussel habitat suitability will potentially be assessed in all study reaches: in Reaches 1-4 a host fish approach will be employed to evaluate non-listed mussels species. In Reaches 4-5, Category I mussel habitat suitability criteria for state or federally-listed freshwater mussels will be developed through a combination of literature review and by convening a panel of credentialed mussel biology experts who will provide input to developing specific HSI criteria. Target mussel species' preferred habitat and their host species (Nedeau, 2008) are shown in Table 3.3.1-3. The specific method for developing state and federally listed mussel HSI criteria is explained in Study No. 3.3.16, Task 3.

For non-listed species, FirstLight will evaluate habitat suitability based on established suitability criteria for co-evolved host species. Host fish species associated with eastern elliptio, eastern floater, and the triangle floater (non-listed species) are generally habitat generalists which are poor indicators of fluvial habitat suitability, with the exception of white sucker. As suggested by USFWS, the white sucker will be used as a surrogate for these three mussel species. For the alewife floater, FirstLight is proposing to utilize the host species American shad juvenile and adult criteria for analyzing habitat suitability.

Table 3.3.1-2: Target Species and Life Stages Presently Proposed for the IFIM Study Reaches.

Study Reach	**Species**	**Lifestage/criteria**
Reach 1 and 2	American shad	zone of passage
	American shad	spawning and incubation
	blueback herring	zone of passage
	blueback herring	(use American shad spawning HSI as a surrogate)
	white sucker	zone of passage
	white sucker	spawning, fry, juvenile, adult
	fallfish	spawning, fry, juvenile, adult
	walleye	spawning, fry, juvenile, adult
	shortnose sturgeon	zone of passage
	shortnose sturgeon	spawning, non-mobile ELS, fry
	sea lamprey	spawning, or adopt shallow-fast guild
	tessellated darter	juvenile and adult, or adopt shallow-slow guild
	dace	juvenile and adult, or adopt shallow-fast guild
	freshwater mussels	host fish (*deep slow and shallow slow guild*)**
	macroinvertebrates	larvae
Reach 3	American shad	spawning and incubation, juvenile, adult
	shortnose sturgeon	spawning, non-mobile ELS, fry, juvenile, adult
	sea lamprey	spawning, or adopt shallow-fast guild
	walleye	spawning, fry, juvenile, adult
	tessellated darter	juvenile and adult, or adopt shallow-slow guild
	dace	juvenile and adult, or adopt shallow-fast guild
	white sucker	spawning, fry, juvenile, adult
	fallfish	spawning, fry, juvenile, adult
	freshwater mussels	host fish (*deep slow and shallow slow guild*)**
	macroinvertebrates	larvae
*Reach 4**	*American shad*	*spawning and incubation, juvenile, adult*
	sea lamprey	*spawning and incubation*
	white sucker	*spawning, fry, juvenile, adult*
	fallfish	*spawning, fry, juvenile, adult*
	walleye	*juvenile, adult*
	tessellated darter	*juvenile and adult, or adopt shallow-slow guild*
	dace	*juvenile and adult, or adopt shallow-fast guild*
	freshwater mussels	*host fish (deep slow and shallow slow guild), and mussel HSI criteria, if listed mussels are detected in Reach 4***
	macroinvertebrates	*larvae*
	shortnose sturgeon	*Young of year nursery, juvenile foraging and overwintering, adult foraging and overwintering*[50]
*Reach 5**	*freshwater mussels*	*mussel HSI criteria***

[50] This lifestage was modified as requested by the NMFS per their July 15, 2013 comments filed on the Updated PSP.

*Notes: * Reaches 4 and 5 will be studied subsequent to further studies and agency consultation.*

Sea lamprey HSI curves may be updated contingent on the results of the Study No. 3.3.15.

*** final selection of host species and/or HSI criteria to be determined in ongoing consultation*

Table 3.3.1-3: Mussel Species Potentially Found in the Study Area and their Preferred Habitat and Host Fish.

Mussel Species	Preferred Habitat	Host Fish
Yellow Lampmussel*	It has been found in shallow water and areas more than 30 feet deep, usually in slow to moderate flow conditions. Within its core range in Massachusetts, it exhibited a distinct preference for sand and fine gravel substrates, and it was proportionately more abundant in shallow sandbars than it was in nearby areas that were deeper and had a rocky or muddy substrate.	White perch; yellow perch; possibly striped bass; potential species include banded killifish, chain pickerel, white sucker, smallmouth bass, largemouth bass
Eastern Elliptio	Habitat generalist. The species has no clear preference for substrate: it is found in clay, mud, sand, gravel, and cobble bottoms. Like most species, it is less common in the areas of rivers where substrate is largely boulder and bedrock. May thrive in areas where habitat has been greatly modified or where pollution is moderate to severe, suggesting that the species is tolerant to many of the stressors that limit the distribution and abundance of other species.	White perch; yellow perch; American eel; alewife; blueback herring; threespine stickleback; banded killifish; **white sucker**; pumpkinseed; redbreast sunfish; black crappie; largemouth bass; smallmouth bass; brook trout; lake trout; mottled sculpin
Alewife Floater	Exists in small streams and large rivers, without clear preference for substrate, depth or flow conditions. Its habitat use and population density seems to be more strongly tied to where its host fish are likely to spawn or congregate.	**American shad**; alewife; blueback herring; possibly striped bass
Eastern Floater	The eastern floater is found in a wide variety of habitats. Appears to prefer deeper areas and silt and mud substrates, indicative of lower velocity areas.	Generalist: **white sucker**; carp; threespine stickleback; pumpkinseed; bluegill
Eastern Pondmussel*	The eastern pondmussel inhabits a wide variety of habitats in the southern part of the watershed. It exhibits no distinct preference for substrate, depth or flow conditions.	Unknown: anadromous or coastal
Triangle Floater	The triangle floater is most common in flowing water, where is occupies a wide range of substrate and flow conditions. Preferred habitats include low-gradient river reaches with sand and gravel substrates and with low to moderate water velocities.	Common shiner; blacknose dace; longnose dace; pumpkinseed; fallfish; slimy sculpin; white perch; **white sucker**; largemouth bass

*Notes: * indicates MA state-listed species. Source: Nedeau, 2008. Host species in **bold** indicates the surrogate proposed for each mussel species.*

Task 2: Method for Assessing State and Federally Listed Mussels

Task 2a: Screening Level Mussel Assessment

FirstLight proposes a sequential approach relative to assessing potential impacts to state-listed mussels. In general the approach includes using the HEC-RAS hydraulic model to simulate the range of operating conditions at Holyoke Dam (WSEL at the dam) and the Turners Falls Project (up to its hydraulic capacity) to determine how operations impact depth, velocity, shear stress and Froude number at model transects near documented state or federally listed mussel beds. Using the binary[51] HSI criteria developed in Study No. 3.3.16 for any state-listed species that are discovered in study reach 4 or 5, determine if any binary HSI thresholds[52] are not met under a range of modeled operating conditions (Table 3.3.1-4) anywhere in study reach 4 or 5. If threshold levels are not exceeded in any transects, then no further assessment of documented state and federally listed mussel beds is proposed. If threshold levels are exceeded, then a more detailed assessment is proposed as described in Task 2b.

Table 3.3.1-4: Proposed model operating conditions.

Scenario No.	Holyoke Dam Impoundment Elevation	Deerfield River Flow	Turners Falls Hydroelectric Project Flow	Total Flow
1	Min- 99.47 ft NGVD	Station No. 2 Min Flow 200 cfs	Station No 1 Min Flow 1,433 cfs	1,633 cfs
2	Max- 100.67 ft, NGVD	Station No. 2 Min Flow 200 cfs	Station No. 1 Min Flow 1,433 cfs	1,633 cfs
3	Min- 99.47 ft NGVD	Median Annual Flow Deerfield River at West Deerfield USGS Gage 1,010 cfs	Half Cabot Station Hydraulic Capacity 6,864 cfs	7,874 cfs
4	Max- 100.67 ft, NGVD	Median Annual Flow Deerfield River at West Deerfield USGS Gage 1,010 cfs	Half Cabot Station Hydraulic Capacity 6,864 cfs	7,874 cfs
5	Min- 99.47 ft NGVD	Station No. 2 Max Hydraulic Capacity 1,450 cfs	Cabot Station Hydraulic Capacity 13,728 cfs	15,178 cfs
6	Max- 100.67 ft, NGVD	Station No. 2 Max Hydraulic Capacity 1,450 cfs	Cabot Station Hydraulic Capacity 13,728 cfs	15,178 cfs

Task 2b: Detailed One-Dimensional HEC-RAS Modeling

As described above, part of Study No. 3.3.16 will involve developing binary habitat suitability criteria for any state or federally-listed mussel species discovered in Reach 4 or 5. The criteria may include depth, velocity, shear stress, relative shear stress, Froude number or other hydraulic metrics. These criteria will be combined with the hydraulic model results from Task 2a to conduct a persistent habitat analysis similar to that conducted in Maloney et al. (2012), but using one-dimensional model outputs. The analysis will consist of the following steps:

1) Transect data will be collected (described in detail in Task 3).

2) The model will be georeferenced and have an associated river length associated with each transect;

[51] The HSI developed in Study No 3.3.16 will be binary in nature, indicating a single "suitable" range for each criteria developed.

[52] In this case threshold means if operating conditions result in exceeding a minimum depth, minimum velocity, maximum velocity, maximum shear stress or maximum Froude number. These metrics may change depending on the conclusions of Study No. 3.3.16.

3) For each transect at each flow scenario, the model results (which may include depth, velocity, shear stress, Froude number or other hydraulic metrics) will be output on a subdivided basis, such that each transect is broken into 20 equally-spaced lateral sub-sections (i.e. cells).

4) The cells will be compared to the mussel binary HSI criteria and each cell will be designated as "suitable" if it meets all binary HSI, or "unsuitable" if it does not meet all binary HSI.

5) The results for each cell will be compared across all model scenarios. If a cell is deemed "suitable" habitat for all model runs, then it will be identified as a "persistent potential habitat" cell. Cells that are not "suitable" for all model runs will be identified as "unsuitable habitat" cells.

6) The effective area for each cell that is identified as "persistent potential habitat" will be calculated and summed along the entire reach. A cell's effective area will be calculated by multiplying the cell's transect river length from step 1 by the cell's subdivided width. This sum will represent the total persistent potential habitat for the given set of flow scenarios (Table 3.3.1-5).

7) In consultation with relicensing stakeholders, additional "scenario sets" consisting of other model runs (e.g., different minimum or maximum flow pairs, or Holyoke pond elevations) may be developed and modeled, if FirstLight deems this step necessary after the completion of step 6.

Task 3: Field Data Collection

The second phase will quantify habitat-discharge relationships for selected species and lifestages in the study area, using standard PHABSIM data collection and flow modeling procedures (Bovee, 1982; Bovee *et al*., 1998). The modeling approach dictates what field data collection is necessary as explained below.

Data Collection in Reaches 1, 2, and 4 (1-D modeling)

A 1-D model approach using PHABSIM is suitable for Reaches 1[53], 2, and 4. A 1-D modeling approach will be based on hydraulic data developed from cross-sectional depth, velocity, and substrate measurements following Milhouse et al. (1989), using PHABSIM for Windows (V 1.5.1), developed by the USFWS and distributed by the USGS Fort Collins (CO) Science Center.

The location of each transect will be field blazed with flagging or other appropriate means. Each study site and cell boundary will be mapped sufficiently to quantify the area represented by each transect. The transect headpin and tailpins will be located at or above the top-of-bank elevation, and secured by steel rebar or other similar means. Measuring tapes accurate to 0.1 ft will be secured at each transect to enable repeat field measurements to occur at specific stream loci[54]. Stream bed and water elevations tied to a known datum will be surveyed to the nearest 0.1 ft using standard optical surveying instrumentation and methods.

Depth, velocity, and substrate data will be gathered at intervals (verticals) along each transect. Each vertical will be located to the nearest 0.1 ft wherever an observed shift in depth or substrate/cover occurs. Between 20 and 99 verticals per transect will be established as necessary on each transect. Verticals will be positioned so that no more than 10% of the discharge passes between any pair, to enhance hydraulic model calibration. A staff gage will be located in each study site, and monitored at the beginning and end

[53] A 2-D model may be required for a portion of the uppermost section of the bypass reach if specific habitat targets are identified in this locale and modeling is deemed feasible.

[54] Supplemental transects may be located as needed to record water surface and bed elevation data at hydraulic controls to establish backwatering parameters necessary for hydraulic modeling.

of each set of hydraulic measurements to verify stable flow during measurements. If flow is found to be insufficiently stable, the related data will be discarded and re-measured once stable flow is established.

Mean column velocity will be measured to the nearest 0.1 ft/second with either a calibrated electronic velocity meter mounted on a top-setting wading rod, or alternatively an Acoustic-Doppler Current Profiler (ADCP) transducer. The following protocol will be used when an electronic velocity meter is used: in water less than 2.5 ft depth, velocity measurements will be made at 0.6 of total depth (measured from the water surface); at greater depths, paired measurements will be made at 0.2 and 0.8 of total depth and averaged. At transects portraying mussel habitat (determined in consultation with MADFW), bottom velocity measurements will also be collected, or simulated using the IFG4 program in PHABSIM which facilitates modeling “nose” velocities (*i.e*. velocities occurring at the depth at which a species/lifestage is known to occupy).

Each calibration flow will be provided by scheduled releases from the Project via unit operation or in the case of the bypass reach through gate or fishway flow settings. Turbine and gate rating curves, USGS gages, and study-site field gaging will be collectively used to estimate each calibration flow release. Flow input from Fall River at the time of data collection will be accounted for by manually gaging. These data are added to the real-time discharge from the dam to define the net calibration flow passing through the study sites. Manual gaging will be accomplished using standard stream flow measurement techniques in which cellular depth and velocity measurements are collected across a transect and summing the measurements to calculate a flow in cfs.

The 1-D hydraulic model will be developed from measurements gathered at a minimum of three calibration flows (low, intermediate, high) to facilitate extrapolation of hydraulic data across the range of interest (see table below). To accomplish calibration, a full set of depth, velocity and water surface elevation (WSEL) data will be gathered at each transect at the intermediate flow, and WSEL will be measured at each transect for the low and high flows to calibrate the hydraulic models. At transects with complex hydraulics such as riffles, and/or sites with unusual backwatering or eddy effects, supplemental velocity data may also be gathered at the low calibration flow. This will be determined in the field on a case-by-case basis.

For the 1-D model, each calibration flow should ideally be broadly separated to provide a suitable stage-discharge curve for the hydraulic model. The general rule of thumb is the hydraulic model, and hence depths and velocities, can be extrapolated from 40-250% of any given calibration (measured) flow. Thus, the following calibration flows and associated flow ranges can be evaluated in the 1-D and 2-D hydraulic models. The calibration flow targets are listed below.

Reach	Model type	Approximate calibration flow (CFS)[55]	Approximate Extrapolated flow range (CFS)	WSEL	Velocity
1 and 2	1-D	120	50-300 cfs	X	*
1 and 2	1-D	700	280-1,750	X	X
1 and 2	1-D	4,000	1,600-10,000	X	
1 and 2	2-D**	120-4000[56]	50-10,000 cfs	120 cfs-5000	X[57]

[55] Reach 5 will be determined at a later date.

Reach	Model type	Approximate calibration flow (CFS)[55]	Approximate Extrapolated flow range (CFS)	WSEL	Velocity
				cfs	
3	2-D	2,500-9,000 cfs	140[58]-22,500 cfs	1,430 cfs-22,500 cfs[59]	X[60]
4	1-D	2,000 cfs	800 – 5,000 cfs	X	
4	1-D	6,000 cfs	2,400 – 15,000 cfs	X	X
4	1-D	15,000 cfs	6,000 – 37,500 cfs	X	

**supplemental velocity sets may be required at some complex transects as determined by hydraulic modeler*

***if 2-D modeling option is required in portions of these reaches, pending site visit and consultation with hydraulic modeler*

Data Collection in Reach 3 (2-D Modeling)

A two dimensional (2-D) approach will best represent hydraulics in Reach 3 due to the complex channel characteristics and hydraulics. A 2-D model is also being considered for the upstream portion of Reach 1 and the downstream portion of Reach 2. A final decision on the application of 2-D modeling will be based on a study site visit and consultation with a hydraulic modeler.

For the 2-D model, two calibration flows will be employed; the exact flows required are not critical but should represent hydraulic conditions including both “typical” generating from Cabot Station and an intermediate discharge through the study reach. The two calibration flows will be collected under approximately steady flow conditions, as safety and hydrologic conditions allow. The calibration flow data allows the modeler to evaluate the flow directionality and magnitude under different flow inputs both from the bypass reach as well as from station discharge. Additionally, at least three water level loggers will be deployed within the study reach to assist with model calibration. The specific locations will be chosen following the study site visit, but will in general include one logger in the “upper” study reach upstream of backwater effects from Cabot Station operations, one logger in the vicinity of Cabot station and a third logger near the downstream boundary of the study reach. The need for any additional calibration flow data will be evaluated on a case-by-case basis. A two dimensional substrate map will be developed from recently collected information and supplemented with additional field work. Substrate will be categorized based on substrate size codes specified within the HSI substrate curves in Attachment A.

[56] The calibration flow(s) chosen for this reach will largely depend on the ability (and safety) of the field crew to collect data in this reach. At various flows there may be areas that are too shallow or fast to safely boat but still too deep or fast to wade. As such, spatially incomplete calibration sets may be collected for portions of this reach.
[57] At least one velocity dataset across the reach will be collected, as field conditions allow.
[58] The model will only be calibrated as low as 140 cfs in the upper modeling reach. The model will be calibrated for as low as 1,430 cfs at and downstream of Cabot Station.
[59] A water level logger will also be located near the upper extent of the model reach. This will capture water surface elevations under bypass reach flows as low as 140 cfs. We expect this to be sufficient for calibrating the upper portion of the study reach.
[60] At least one velocity dataset across the reach will be collected, as field conditions allow. The actual flow chosen will depend on the July site visit results and safety/boatability in the field. For Reach 3, calibration flows may be provided from Turners Falls Dam, or through a combination of Turners Falls Dam and Cabot Station to evaluate the backwater influence.

The 2-D model will be developed using a combination of terrain (LIDAR and/or 10m DEM, depending on availability) and bathymetric data. This will include a WSEL survey, and flow gaging at the inlet and/or outlet of the study site boundaries. To the extent possible, bathymetric data will be provisionally assembled from existing sources including past modeling, surveys, bridges, Project related information, and fishing/recreation maps. It is likely that additional bathymetric data will need to be collected to supplement the existing data coverage to create a fine scale mesh. These will be obtained through a combination of depth sounding and RTK-GPS (Real Time Kinematic), as required. In addition, it is expected that a high-level of bathymetric mapping will be obtained in the vicinity of the Cabot tailrace and existing fishway entrance as part of a computation fluid dynamic (CFD) model being developed (see Study No. 3.3.8 *Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays*).

Data Collection in Reach 5

If the screening-level analysis described above indicates that state and federally listed mussels are potentially impacted by Turners Falls Project operations (i.e., the study proceeds to task 2b), then FirstLight will develop a more detailed HEC-RAS hydraulic model to assess state and federally listed mussels. This will involve collecting supplemental transect data. Based on the 2009 mussel data, 96% of the yellow lampmussels detected were located in Sites 2-7. The distance between Site 2 and 7 is approximately 3.7 miles. Therefore, FirstLight is proposing to focus its efforts in this approximate 3.7 mile reach. One transect will be placed through Sites 2-7 (total of six sites and transects) and the following data will be collected across each transect: depth, column velocity, and substrate. Additional transects will be collected upstream and downstream of each mussel survey site (one upstream, one downstream) to understand the hydraulic conditions between each site. Data will be collected using a boat-mounted RiverSurveyor M9 ADCP linked to a GPS system. For modeling purposes, only depth and substrate are necessary. Velocity will be collected as a supplemental dataset while the field crew is collecting data, but it will not be used directly in any habitat calculations or as model input. The velocity data may assist in model calibration. Data collection will occur when river flows are less than the hydraulic capacity of the Turners Falls Project, but since velocity is only a supplemental dataset no specific flow or water level will be sought.

If the 2013 mussel studies in Reaches 4 and 5 yield new state or federally listed species, then FirstLight will consult further with MADFW to determine if modifications to the approach above are needed.

Task 4: Hydraulic Modeling (Reaches 1-4)

Model boundary conditions (input values for generation at Cabot and Station No. 1, river discharge, spill at Turners Falls Dam, and tributary inflows) will be obtained from observed flow and release records. Modeling scenarios will be developed and run in “steady state” mode to produce data required to support the PHABSIM analyses including water profiles, wetted area, depth and velocity at flow increments of interest.

1-D hydraulic modeling will be accomplished by calibration (correlating each surveyed WSEL set with discharge to develop a stage-discharge relationship for each transect). PHABSIM uses STGQ, MANSQ and WSP models to predict water surface elevations at various calibration flows. It then uses the VELSIM model to predict cellular water velocities based on the calibration dataset(s). The model is calibrated by comparing simulated hydraulics to empirical measurements taken at the calibration flows. Coefficients such as relative stream channel roughness (*commonly referred to as Mannings n*) are then iteratively adjusted as needed to optimize model accuracy across the full flow range. Once this relationship is established, the model then calculates additional WSELs at other flow increments, and adjusts velocities obtained at calibration flows to other flow increments of interest for which defined water stages have been calculated.

2-D hydraulic modeling, while similar in many ways to 1-D modeling, requires an initial phase of developing and testing of the model grid-space and arrangement. The process is iterative, with a goal of finding the best balance of model stability, accuracy, and performance. This will occur at a single test condition that represents a fairly common flow, including representative hydraulics, and has sufficient supporting input data (*e.g.*, most observations).

Following development and testing of the model grid, the model will then be calibrated and verified. The most common approach for calibration is to provide a discharge value as the upstream boundary condition while the downstream boundary relies on the measured WSEL. Measured WSELs at the survey transects will be used to directly calibrate to a specific steady flow analysis scenario. Calibration is achieved by adjusting the resistance terms in the model to provide predicted WSELs that best match measured WSELs, for a given discharge. Model verification will be conducted by running the calibrated model for other measured flow conditions and comparing the model-predicted results to the independent measured values.

Task 5: Hydraulic Modeling (Reach 5)

This task will consist of conducting the hydraulic modeling as described above. Assuming detailed modeling is necessary in this reach (see Task 2a), a HEC-RAS model will be built using newly-collected transect data from Task 3. The model will be run for the flow scenarios described in Table 3.3.1-4. Additional flows may be modeled if the results indicate the proposed scenarios do not provide enough resolution for the habitat analysis.

Task 6a: Habitat Modeling (Reaches 1-4)

Once the hydraulic model is calibrated, habitat suitability at each flow increment of interest will be quantified by combining the HSI and hydraulic model data using the HABTAE and supporting programs within PHABSIM. These output units of Weighted Usable Area (WUA) for each transect at each flow increment, for each species and lifestage. WUA is an abstract habitat suitability index generated from units of square feet of optimal habitat available per 1,000 feet of represented stream length. The habitat suitability-flow curves across the flow range for all transects in a given study site are then weighted and summed at the study reach level, according to actual linear stream length that each site represents, as mapped in the field.

Task 6b: Persistent Potential Habitat Modeling (Reach 4 (if necessary) and 5, mussels only)

Persistent habitat modeling will be conducted following the steps described in Task 2 for state listed mussels in Reaches 4 and 5. The results will be described in terms of a total persistent habitat within each study reach. Plots showing which cells are persistent potential habitat within each transect will be produced. Because the cell size for each transect will vary depending on the channel width, the cells will likely not line up evenly between transects. FirstLight, however, does understand the merit in spatially presenting the dual-flow outputs (e.g., overhead maps). To date, however, we have not seen any currently available technology that will spatially present dual-flow or persistent habitat results from a one-dimensional model. FirstLight will research any available or possible methods for doing this and will utilize any methods requiring a reasonable amount of effort, but we are not committing to produce such outputs at this time.

Task 7: Habitat Time Series (Reaches 3 and 4)

The WUA information (habitat versus flow) will be merged with HEC-ResSim model results (see Study No. 3.8.1, *Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation*) for Reaches 3 and 4. Specifically, FirstLight will use the hourly discharge hydrograph(s) below Cabot Station from the HEC-ResSim model. The discharge hydrograph from the model will be merged with the Weighted Usable Area versus flow curves from the IFIM study to yield habitat time series (Figure 3.3.1-6). All habitat time series analysis will rely on flow data from the baseline model, which will be used as a basis of comparison. Habitat time series will be developed from any alternative modes of operation using the HEC-ResSim discharge data, which again will be compared to the baseline model habitat time series. The alternative operation scenarios will be developed in consultation with the relicensing stakeholders after the initial study results have been completed.

Task 8: Persistent Habitat Analysis and Mapping (Reach 3) and Dual Flow Analysis (Reach 4)

The objective of Task 8 is to evaluate the relationship between short-term hydrologic variability (i.e., peaking flows) and immobile aquatic species' habitat. "*Immobile aquatic species*" are those species and/or life stages that are considered unable to volitionally relocate to suitable locations in response to a typical peaking cycle, or are weak swimmers that may need to expend significant bioenergetics or risk of predation to do so (*e.g*., aquatic macroinvertebrates, mussels, incubating eggs, early fry, weak swimmers, *etc*.). A persistent habitat analysis will be conducted for study reaches modeled with a two-dimensional model. A dual flow analysis will be conducted for Reach 4 (modeled with a one-dimensional model).

A persistent habitat analysis consists of first identifying "quality" habitat areas (*i.e*., a model node's combined habitat suitability ≥ 0.5) at each modeled base flow, and then finding overlapping areas of quality habitat that persist at various low and high flow pairs (e.g., 1,000 cfs and 5,000 cfs). "Persistent" habitat is then calculated for various flow pairs on a node-by-node basis, where a node is marked as persistent habitat for that flow pair if the high and low flows (as well as any flows in between) are considered quality habitat. The analysis results can be mapped to visualize what areas provide consistently good habitat throughout the target flow range. The results from this task will include a low/high flow habitat matrix for each target species/life stage (Table 3.3.1-4) and a series of maps depicting persistent habitat for a variety of flow ranges covering expected operation flows (Figure 3.3.1-7).

A "dual flow" analysis is similar to persistent flow analysis but is the term applied to the 1-D model. It calculates the quantity of habitat present over paired base flow and peak flows across a range of scenarios, such as those that may be expected during a minimum flow/peaking flow hydroelectric operation. Dual flow results will be presented on a transect-by-transect basis. Deliverables will include dual flow habitat tables (similar to persistent habitat tables) for each study transect. Composite dual flow results may also be presented, based on the total dual flow habitat available at each transect. Because the cell size for each transect will vary depending on the channel width, the cells will likely not line up evenly between transects. FirstLight, however, does understand the merit in spatially presenting the dual-flow outputs (e.g., overhead maps). To date, however, we have not seen any currently available technology that will spatially present dual-flow or persistent habitat results from a one-dimensional model. FirstLight will research any available or possible methods for doing this and will utilize any methods requiring a reasonable amount of effort, but we are not committing to produce such outputs at this time.

Task 9: Study Report

A draft report will be prepared for study team review and comment, documenting methods and results. The report will quantify flow/WUA relationships for applicable species and lifestages in each study reach.

WUA and supporting hydraulic data will be presented in graphic and tabular form, along with an analysis of trends in the data, and documentation of study team consultation. Spatial plan views of habitat suitability for a subset of species/life stages and flows will be displayed graphically. These will be identified in consultation with stakeholders to narrow the number of maps to be developed. Additional graphics will potentially be developed as required during a study data review workshop that First Light will host. Appendices will also include cross-sectional survey data and reference photographs of study sites. The report will be finalized following receipt of input from the study team. Raw field data and model output data will be made available in digital format upon request.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The estimated cost for the study outlined in this plan is approximately $225,000-$300,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight is proposing to commence this study in advance of the FERC Study Plan Determination. In developing this study plan, meetings were held with the state and federal resource agencies including NOAA, USFWS, MADFW, and MADEP to help jump-start the study planning.

However, to ensure all interested parties have input on the study plan, a draft of this study plan was provided to all parties on the mailing list and a meeting was held to solicit and address issues on the plan on April 16, 2013 at the Northfield Mountain Visitor Center (99 Millers Falls Road, NorthFGS, MA). A subsequent draft was provided to the working group on May 30, 2013. A site visit is scheduled with interested parties for September 2013 in order to select study sites and cell boundaries. Additional stakeholder consultation will occur as this and other relicensing studies progress.

The accelerated schedule for this study is listed below.

TASK	COMPLETION DATE
Select study sites and cell boundaries	September, 2013
Collect hydraulic and bed profile data	Sept.-Oct., 2013
Complete modeling (Reaches 1-3)	2013
Issue draft report (Reaches 1-3)	2013
Consult with stakeholders to scope remaining work and refine mapping deliverables	December, 2013
Issue interim final report (Reaches 1-3)	March 1, 2014
Complete work on Reach 4 and 5, as necessary	2014, in accordance with ILP

Literature Cited

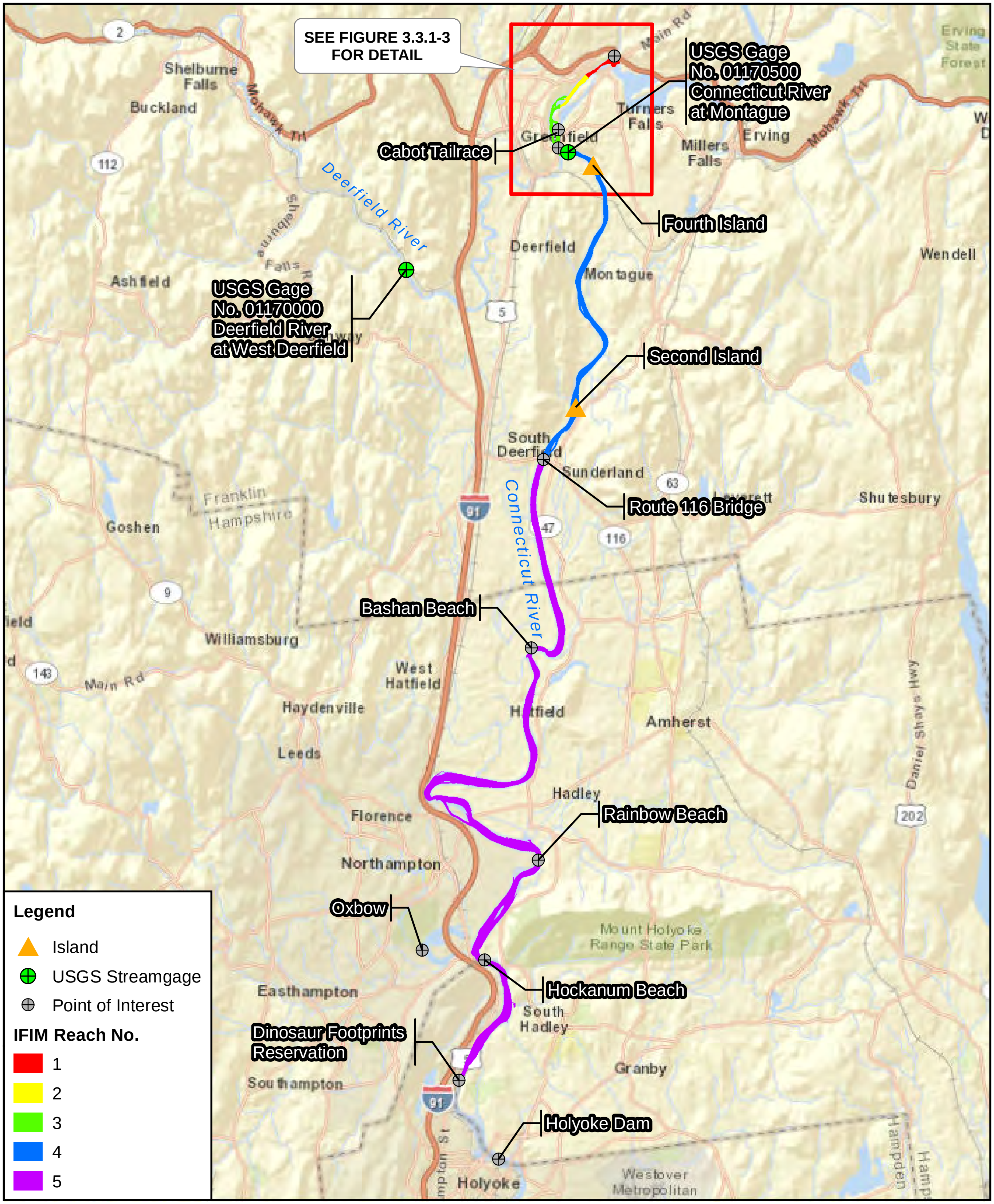
Bovee, K.D. (1982). *A guide to stream habitat analysis using the instream flow incremental methodology*. (Office of Biol. Service FWS/OBS-82-26). Washington, DC.: USFWS, U.S. Dept. of Interior.

Bovee, K.D., Lamb, B.L., Bartholow, J.M., Stalnaker, C.B., Taylor, J. & Henriksen, J. (1998). S*tream habitat analysis using the instream flow incremental methodology*. (Biological Resources Division Information and Technology Report USGS/BRD-1998-0004/ viii). U.S. Geological Survey, Maloney, K.O., Lellis, W.A., Bennett, R.M., Waddle, T.J. (2012). *Habitat persistence for sedentary organisms in managed rivers: the case for the federally endangered dwarf wedgemussel (Alasmidona heterodon) in the Delaware River*. Freshwater Biology (57) pp 1315-1327.

Milhouse, R. T., Updike, M. A, & Schneider, D. M.. (1989). *Physical habitat simulation system reference manual: version 2, Instream flow information paper 26* (Biological Report 89(16)). Washington, D.C.: U.S. Fish and Wildlife Service.

Table 3.3.1-5: Example of a typical persistent habitat or dual flow habitat matrix

	Generation Flow (cfs)													
Minimum Flow (cfs)	2,000	3,500	5,000	7,500	10,000	15,000	20,000	30,000	40,000	50,000	60,000	70,000	80,000	86,000
2,000	**144,797**	144,797	144,797	144,797	144,797	141,917	123,412	51,975	22,024	9,953	2,244	2,244	2,244	2,244
3,500		**185,653**	185,653	185,653	185,653	182,772	164,268	90,944	60,993	50,809	36,878	12,923	8,355	5,797
5,000			**205,330**	205,330	205,330	202,449	183,944	110,621	80,670	67,350	49,507	23,477	18,908	16,351
7,500				**282,747**	282,747	279,867	261,362	188,038	154,263	129,637	107,840	78,039	65,696	59,689
10,000					**577,085**	574,204	555,699	482,376	441,548	395,558	358,637	286,794	237,594	218,426
15,000						**1,465,467**	1,446,962	1,371,294	1,304,578	1,214,177	1,127,012	1,011,489	835,362	775,405
20,000							**2,022,046**	1,941,371	1,864,518	1,724,558	1,577,015	1,399,627	1,138,275	1,060,982
30,000								**2,649,183**	2,560,652	2,374,400	2,144,559	1,901,348	1,562,157	1,444,265
40,000									**2,973,742**	2,774,018	2,528,802	2,245,387	1,867,061	1,717,777
50,000										**3,030,923**	2,777,884	2,481,909	2,097,652	1,936,262
60,000											**2,949,583**	2,650,148	2,255,762	2,094,373
70,000												**2,822,902**	2,417,072	2,252,212
80,000													**2,521,060**	2,352,468
86,000														**2,428,418**



FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN
IFIM STUDY

Figure 3.3.1-1:
Proposed Instream Flow Study Reaches

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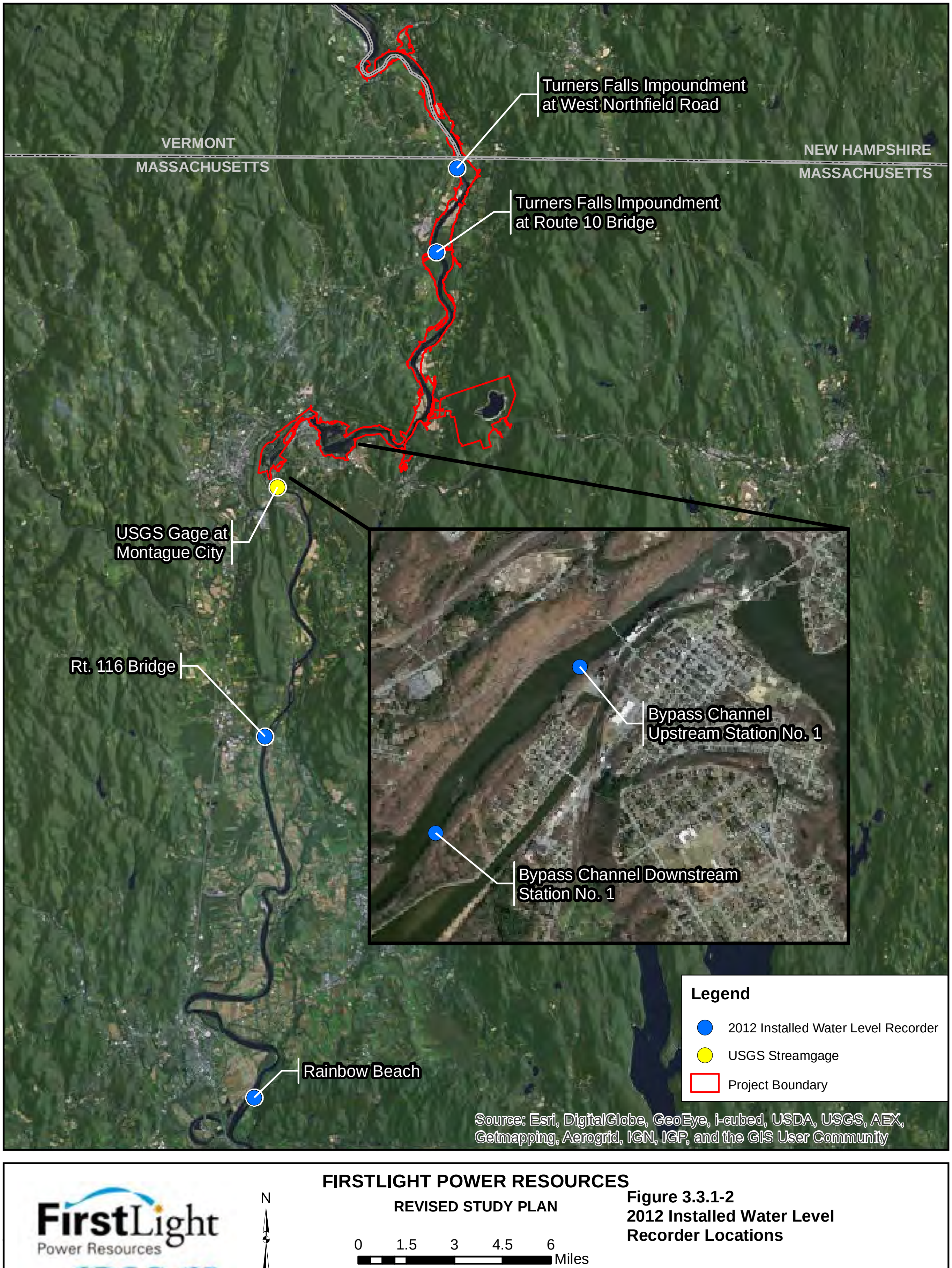

FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

Figure 3.3.1-2
2012 Installed Water Level Recorder Locations

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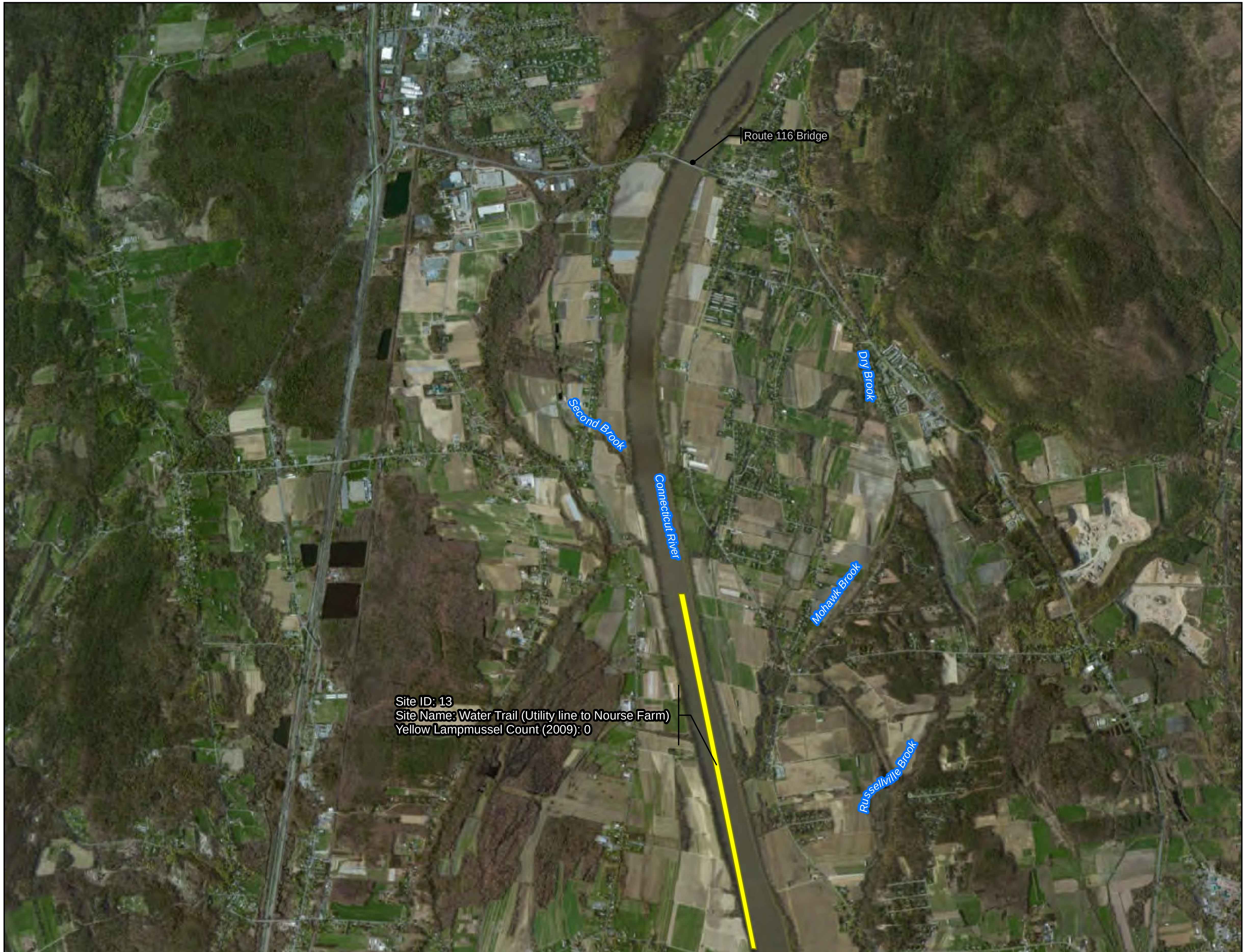

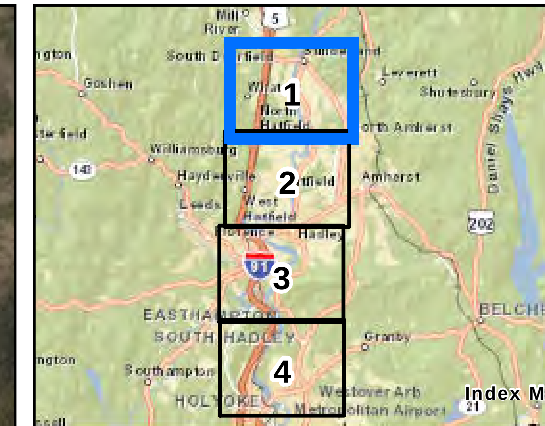

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.3.1-3
Historic Mussel Survey Areas
Downstream of Route 116 Bridge
Page 1 of 4

Legend

- TNC/USACE Cross Sections
- Holyoke Mussel Survey Area

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

0 0.25 0.5 1 Miles
1 inch = 0.5 miles

FirstLight Power Resources
GDF SUEZ

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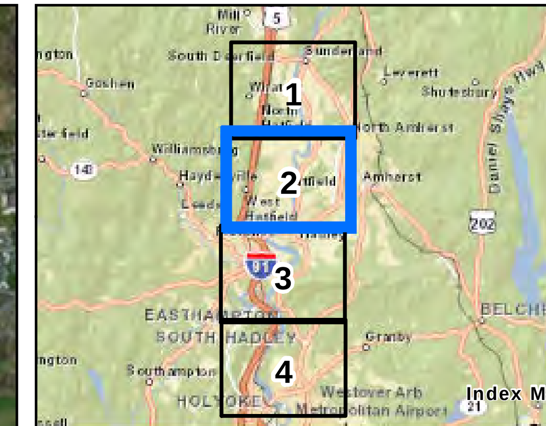

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.3.1-3
Historic Mussel Survey Areas
Downstream of Route 116 Bridge
Page 2 of 4

Legend

- TNC/USACE Cross Sections
- Holyoke Mussel Survey Area

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

0 0.25 0.5 1 Miles

1 inch = 0.5 miles

FirstLight Power Resources
GDF SUEZ

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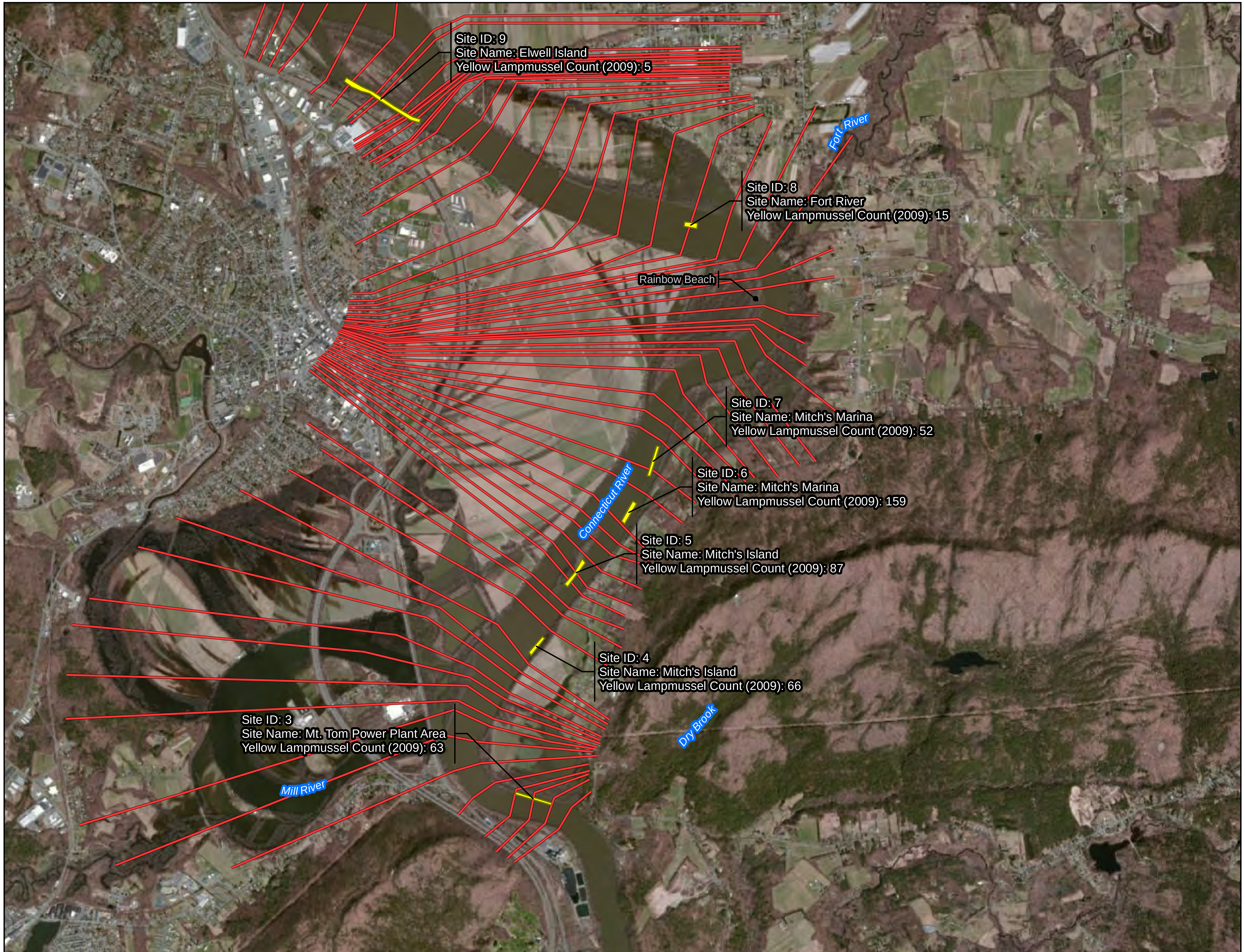

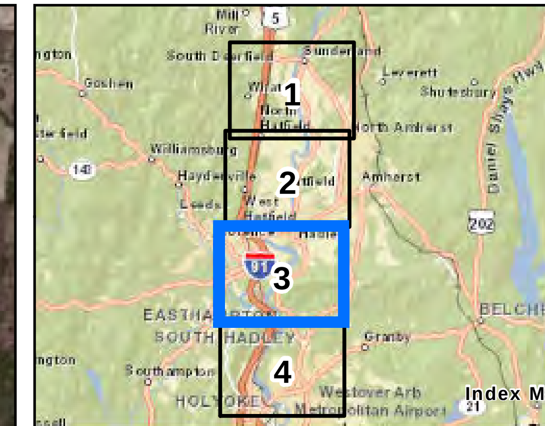

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.3.1-3
Historic Mussel Survey Areas
Downstream of Route 116 Bridge
Page 3 of 4

Legend

- TNC/USACE Cross Sections
- Holyoke Mussel Survey Area

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

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1 inch = 0.5 miles

FirstLight Power Resources
GDF SUEZ

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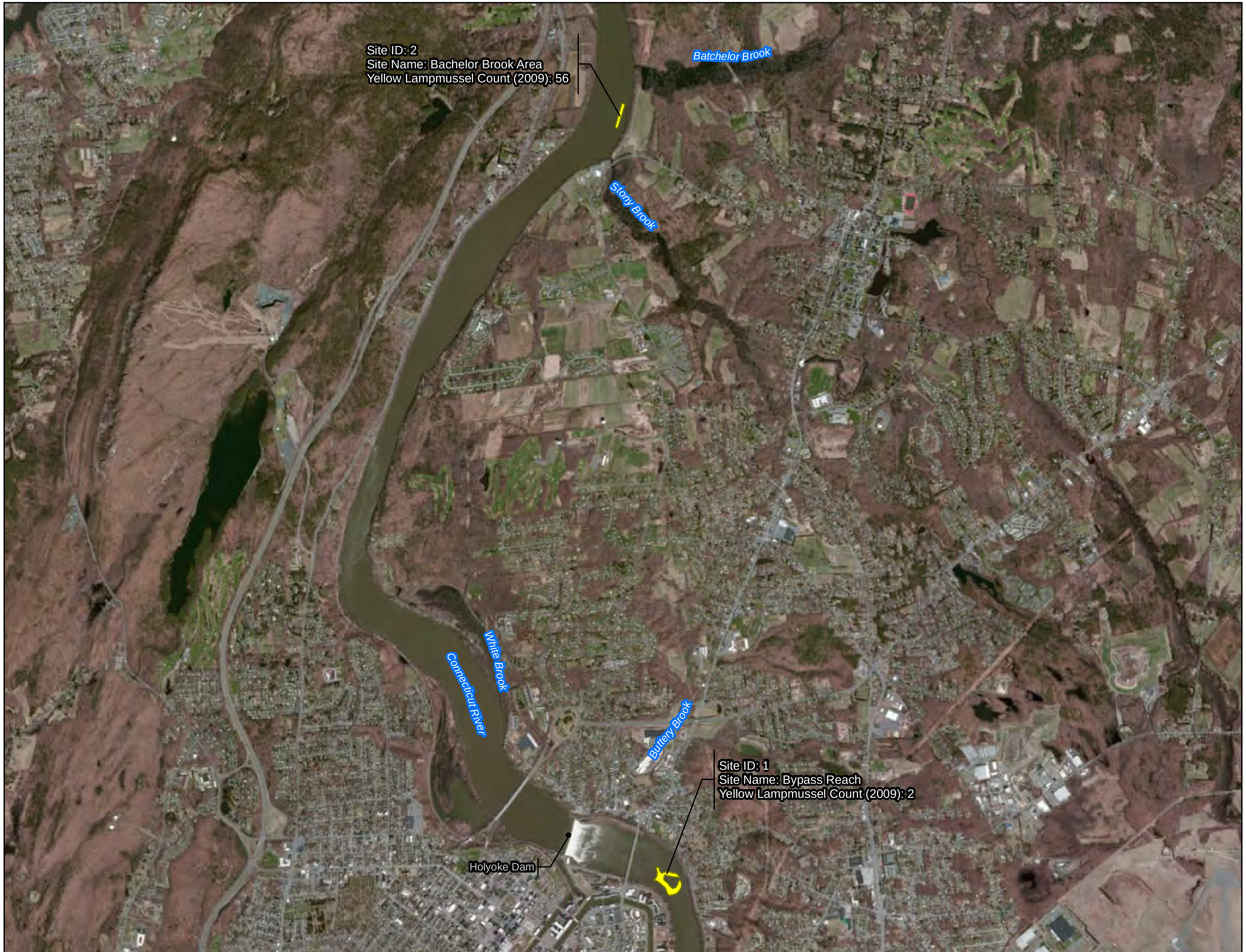

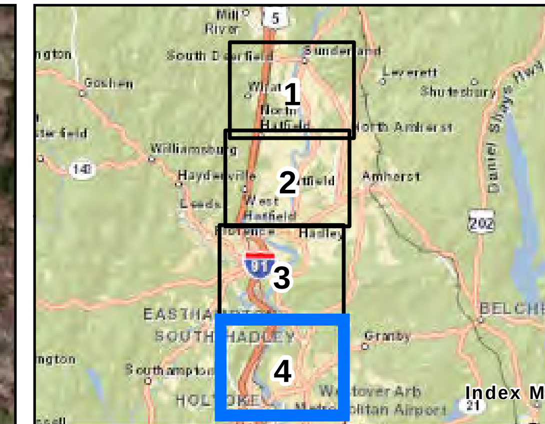

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.3.1-3
Historic Mussel Survey Areas
Downstream of Route 116 Bridge
Page 4 of 4

Legend

- TNC/USACE Cross Sections
- Holyoke Mussel Survey Area

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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

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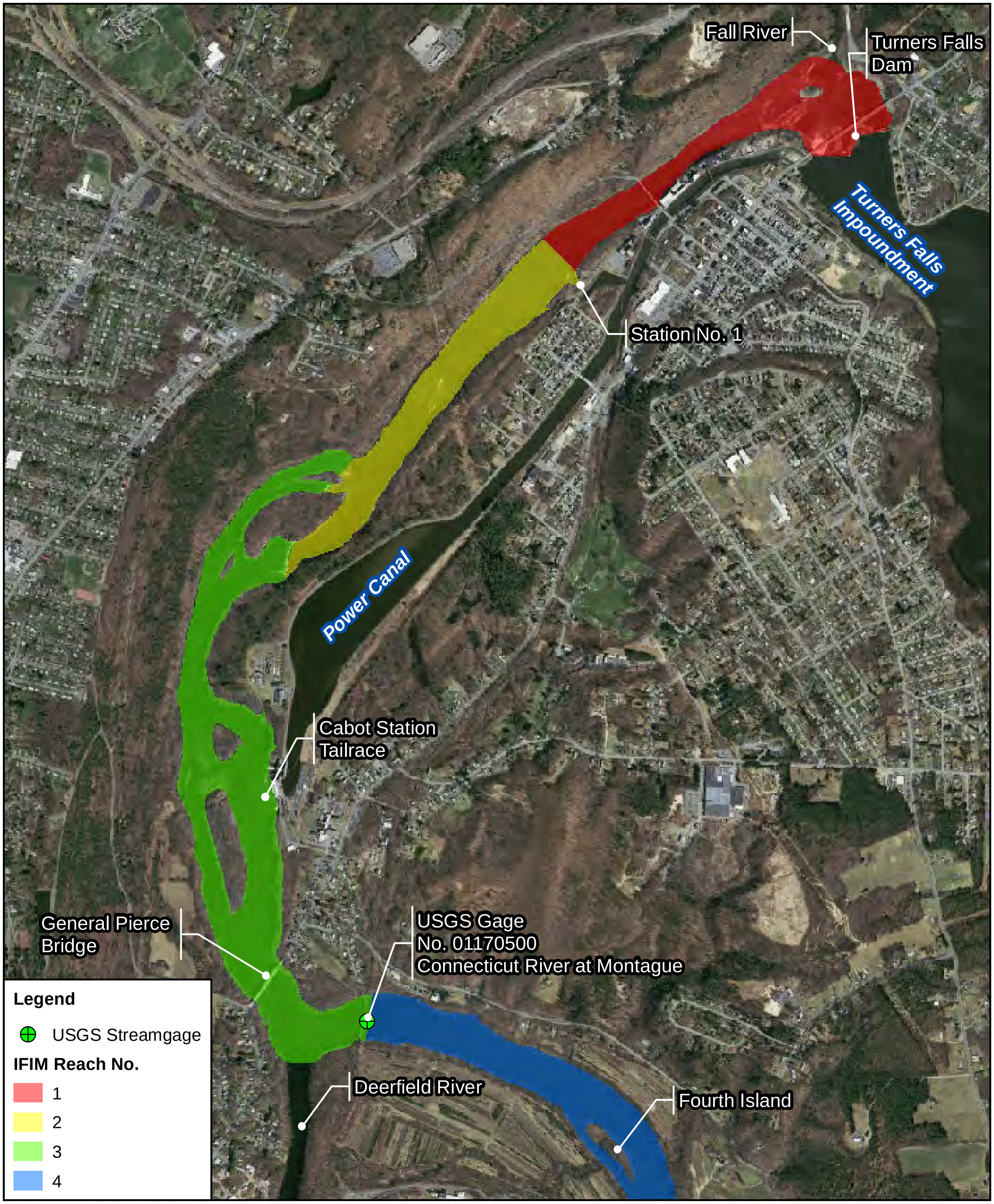

FirstLight Power Resources
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FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN
IFIM STUDY

0 0.25 0.5 1 Miles

Figure 3.3.1-4:
Proposed Instream Flow Study Reaches - Bypass Reach Inset

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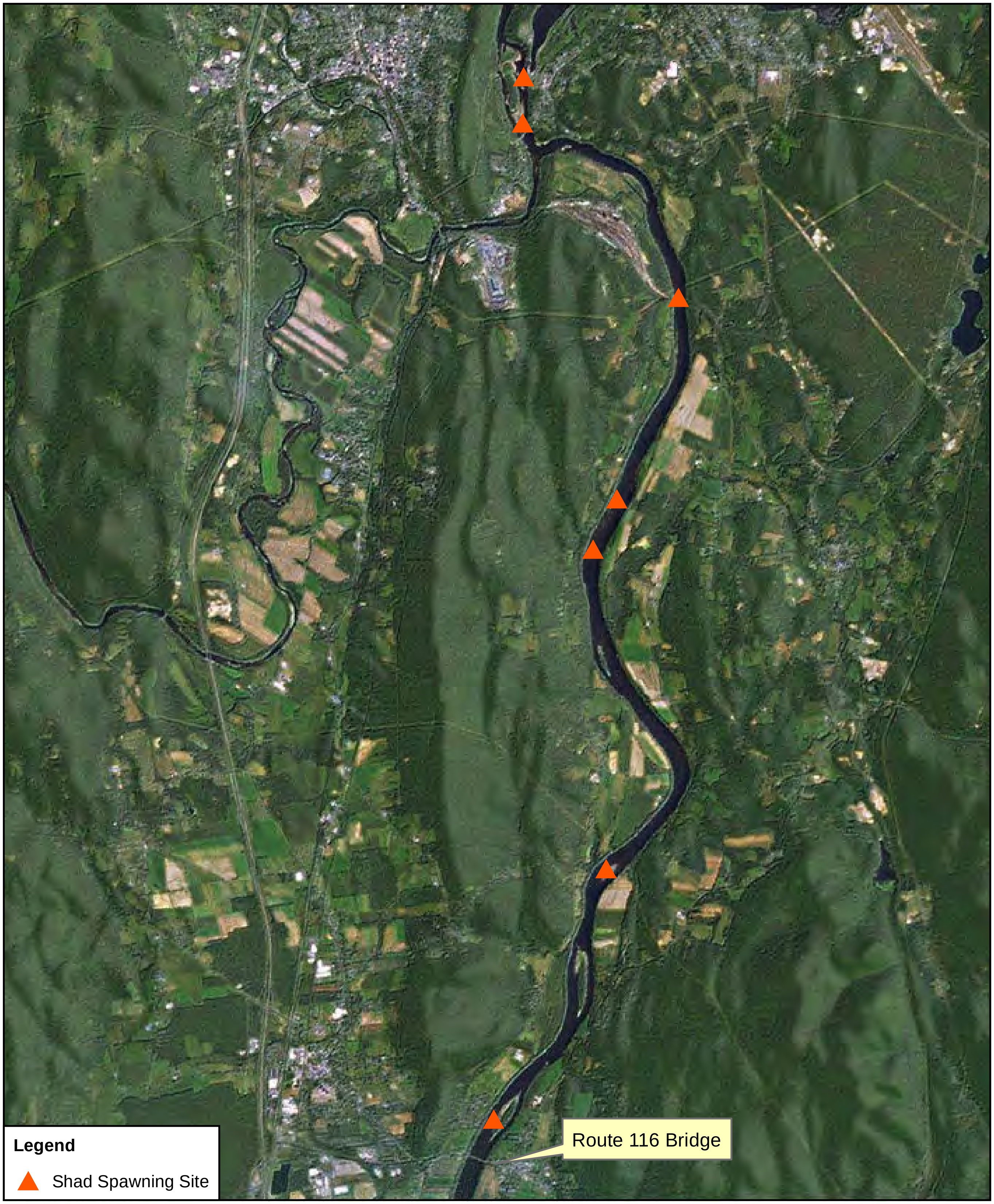

FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN
IFIM STUDY

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Figure 3.3.1-5
American Shad Spawning Sites
Layzer (1972) & Kuzmeskus (1975)

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Figure 3.3.1-6: Habitat Time Series Schematic

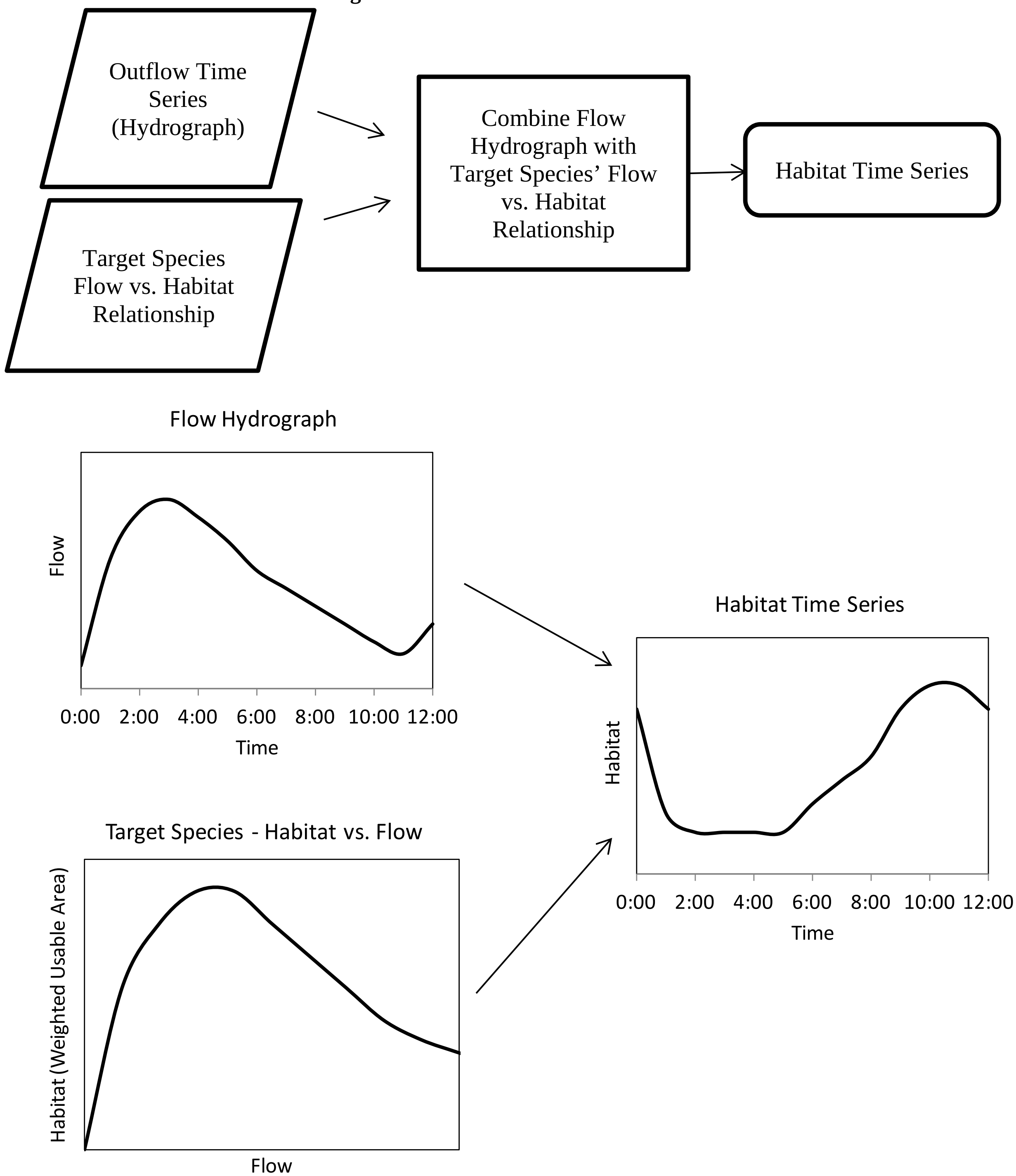
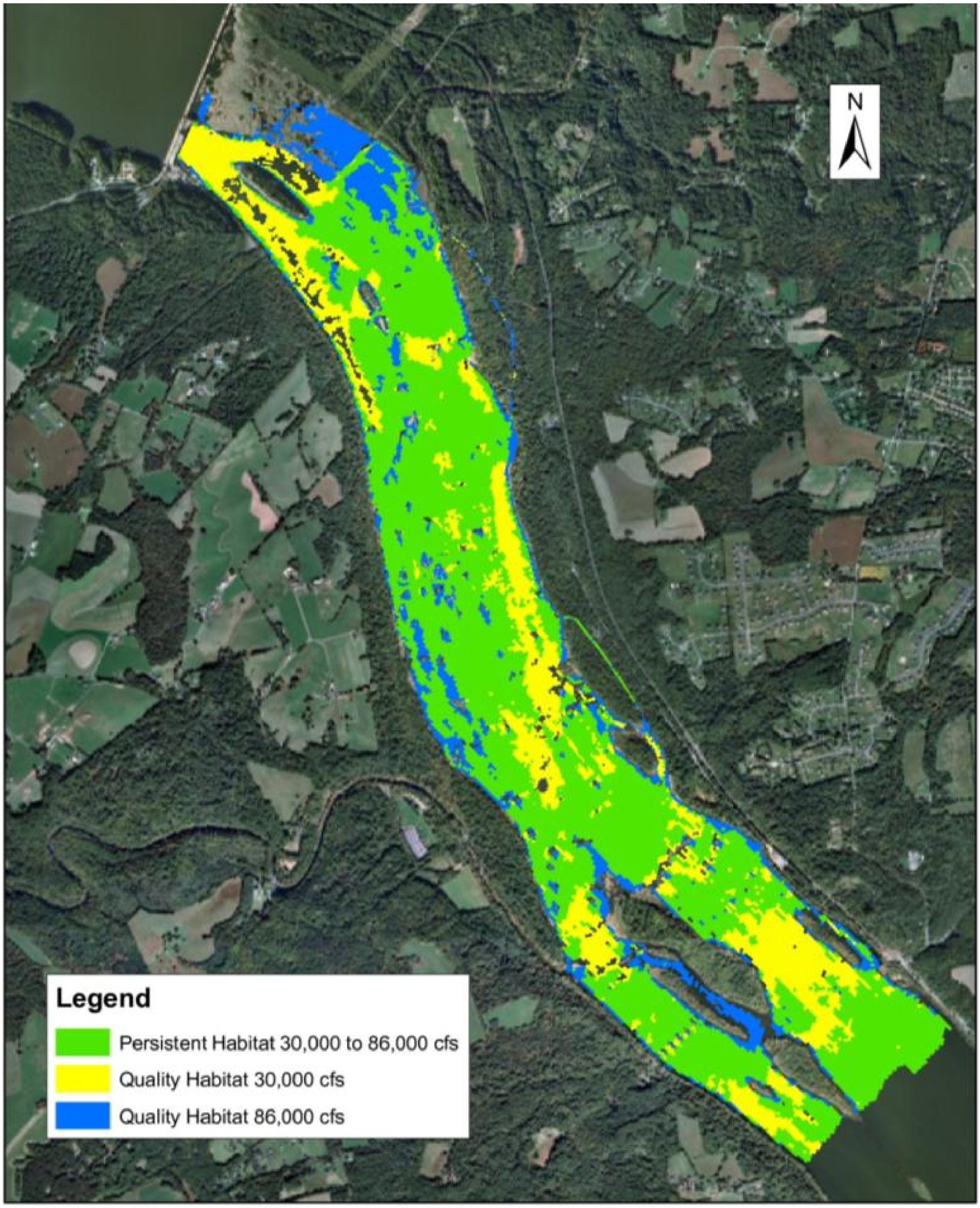
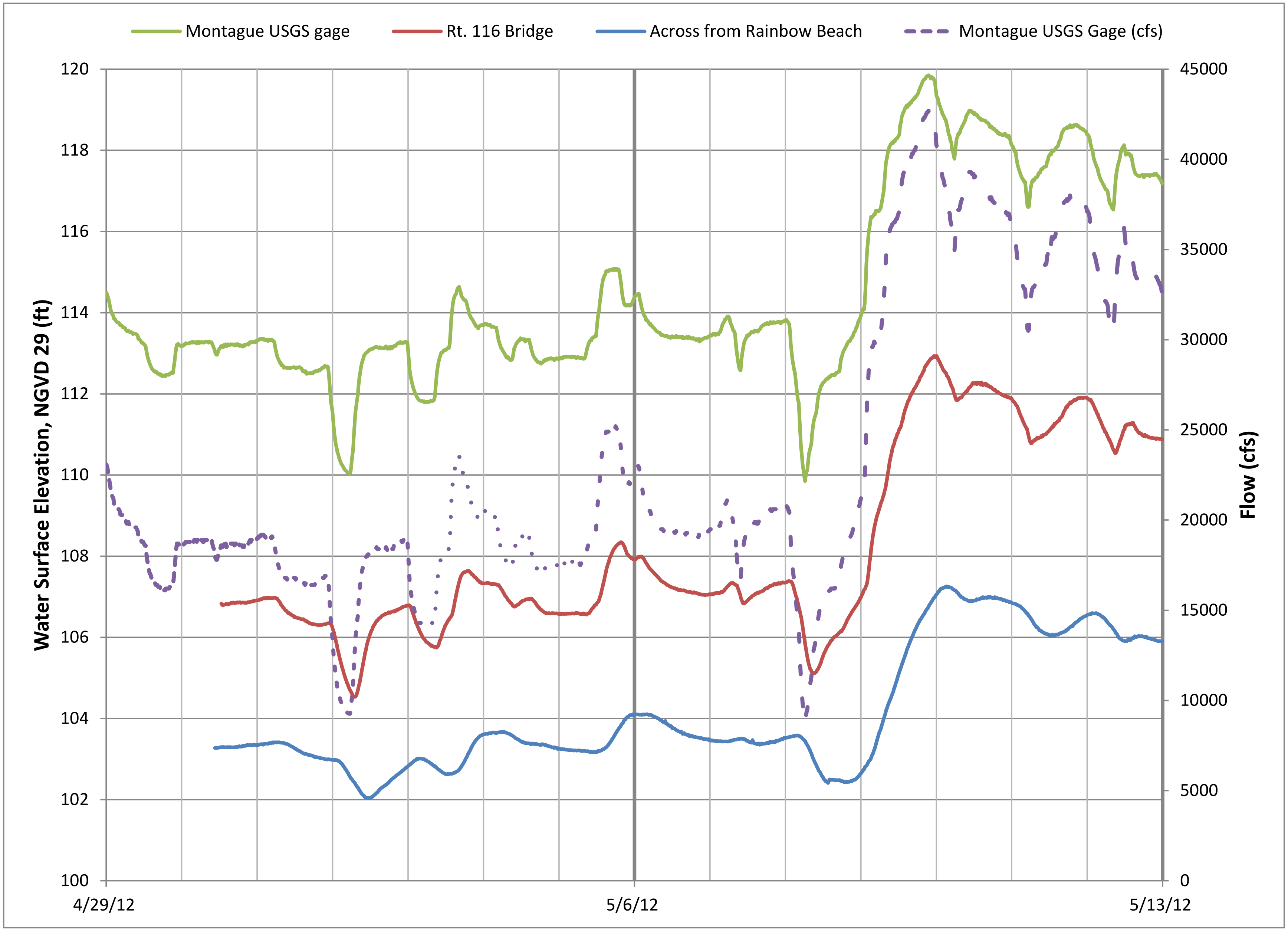


Figure 3.3.1-7: Example Persistent Habitat Map



ATTACHMENT A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Rt. 116 Bridge
Across from Rainbow Beach
Montague USGS Gage (cfs)
Water Surface Elevation, NGVD 29 (ft)
Flow (cfs)
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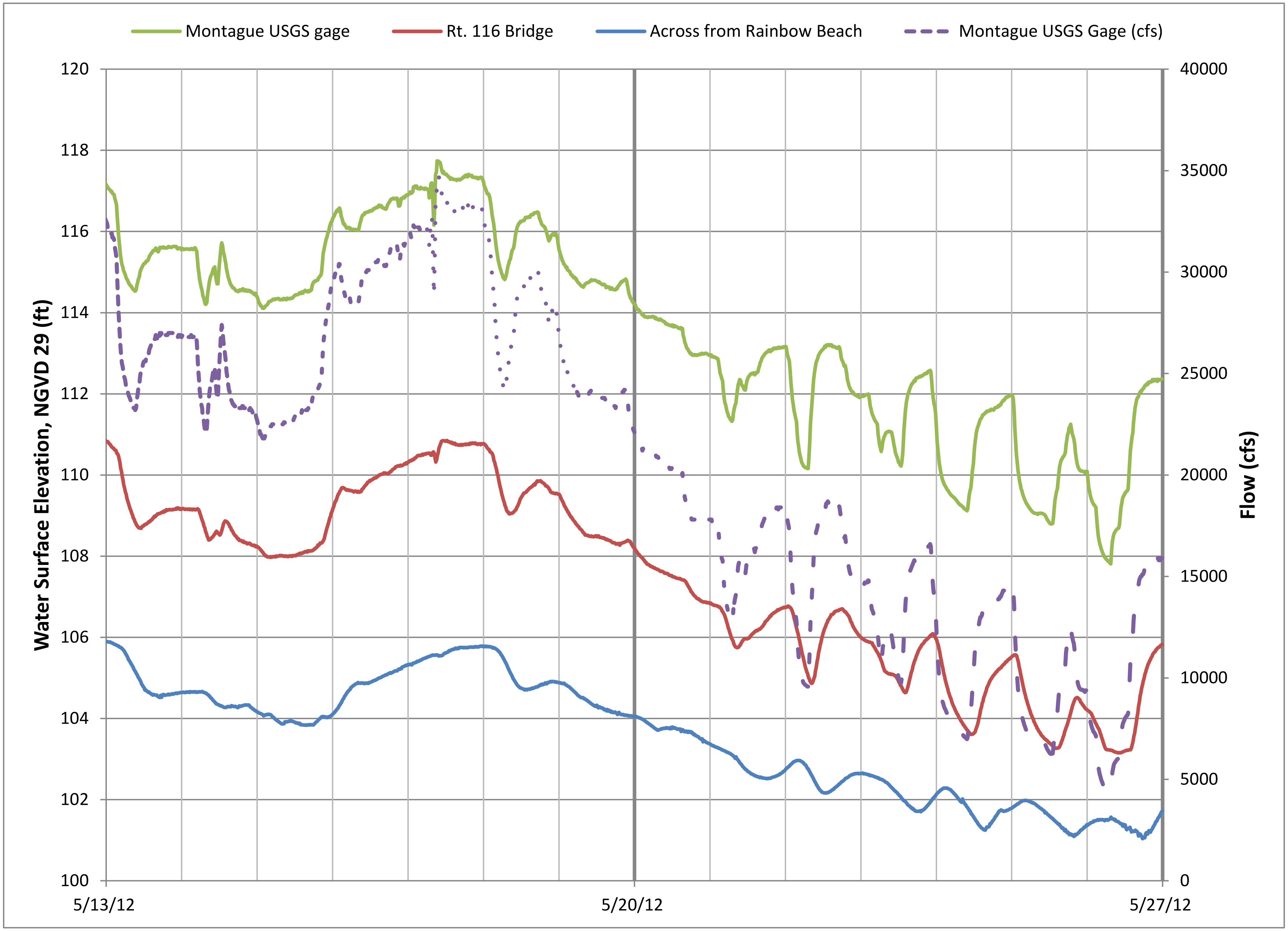
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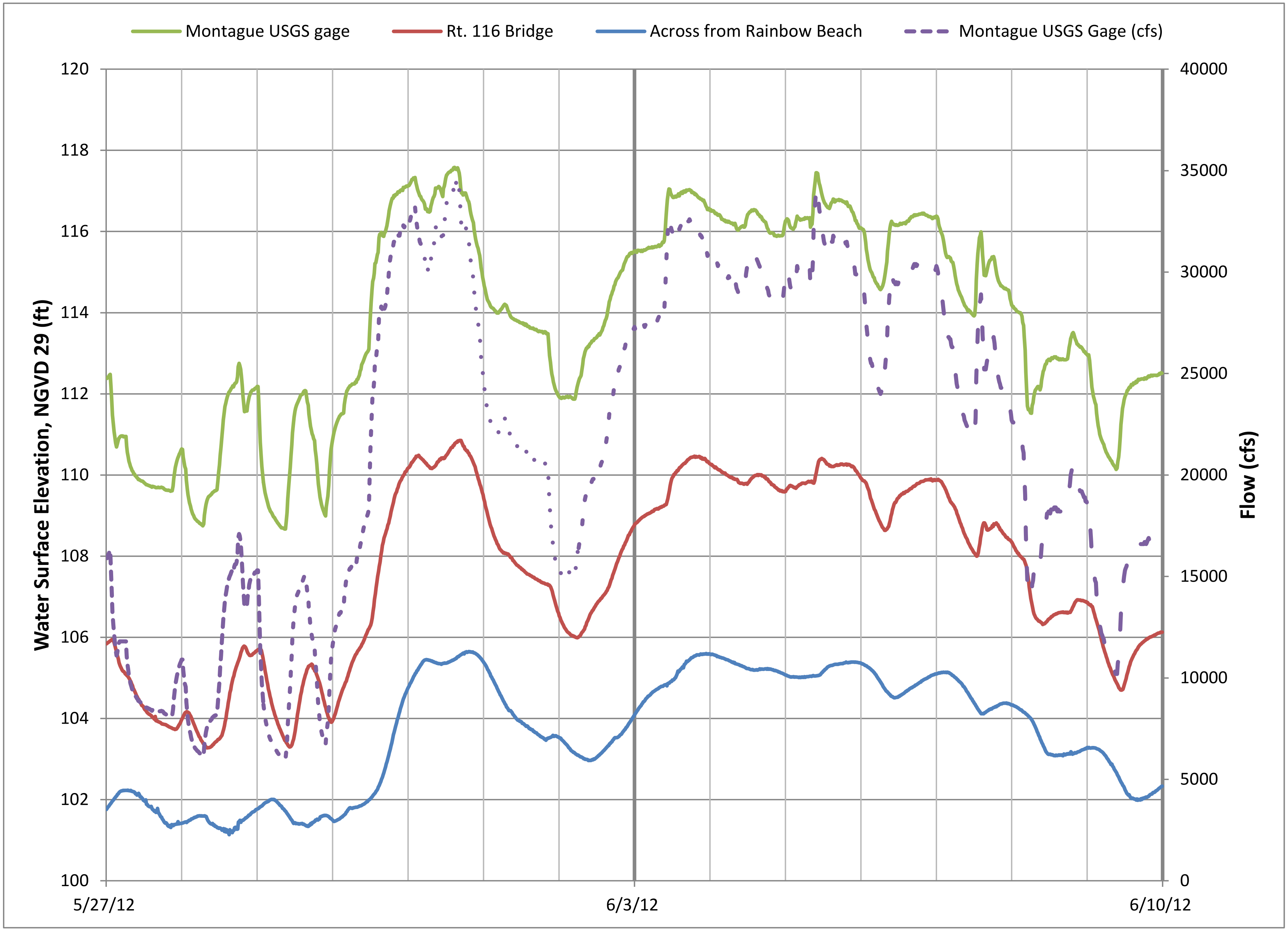
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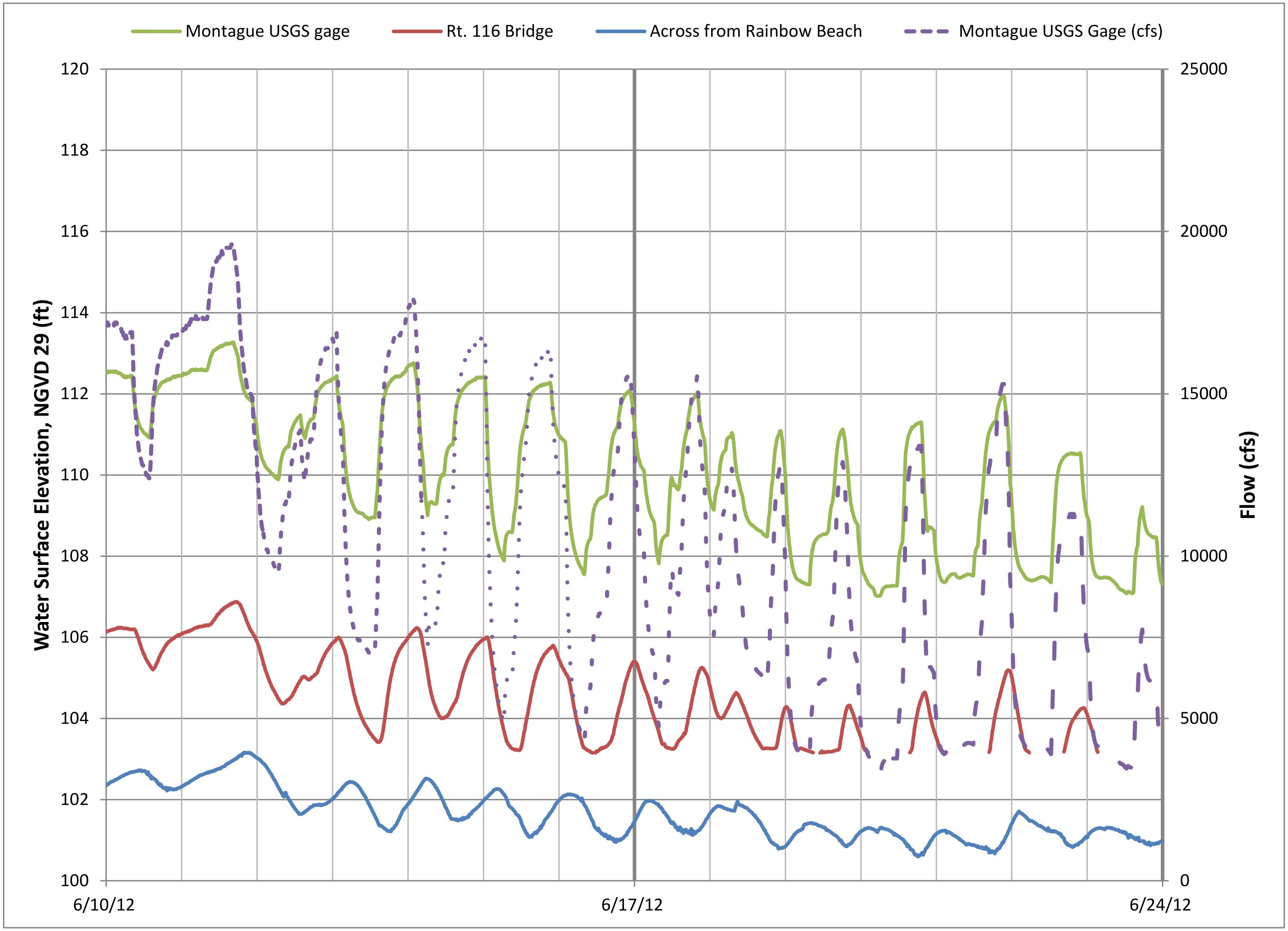
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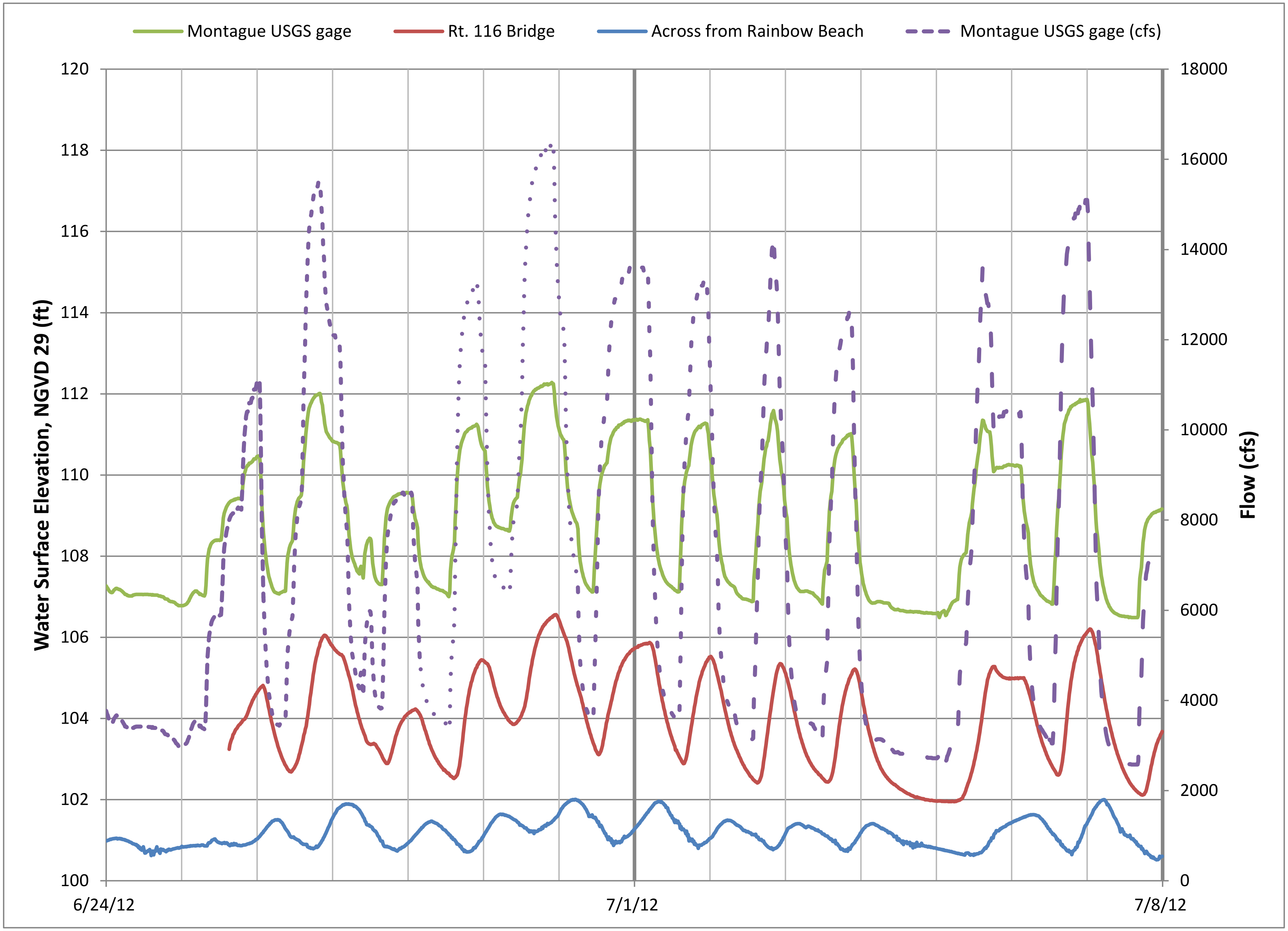
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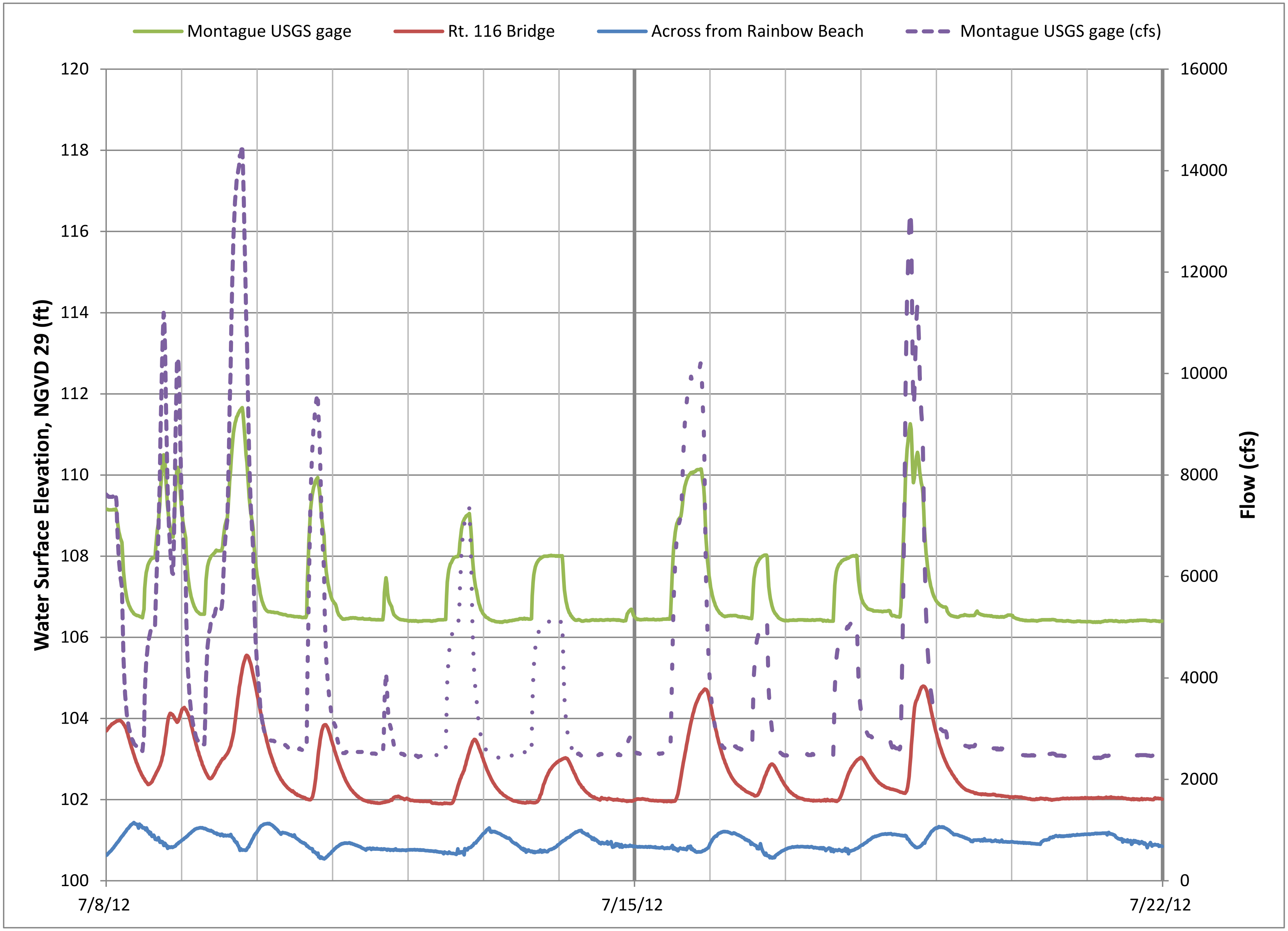
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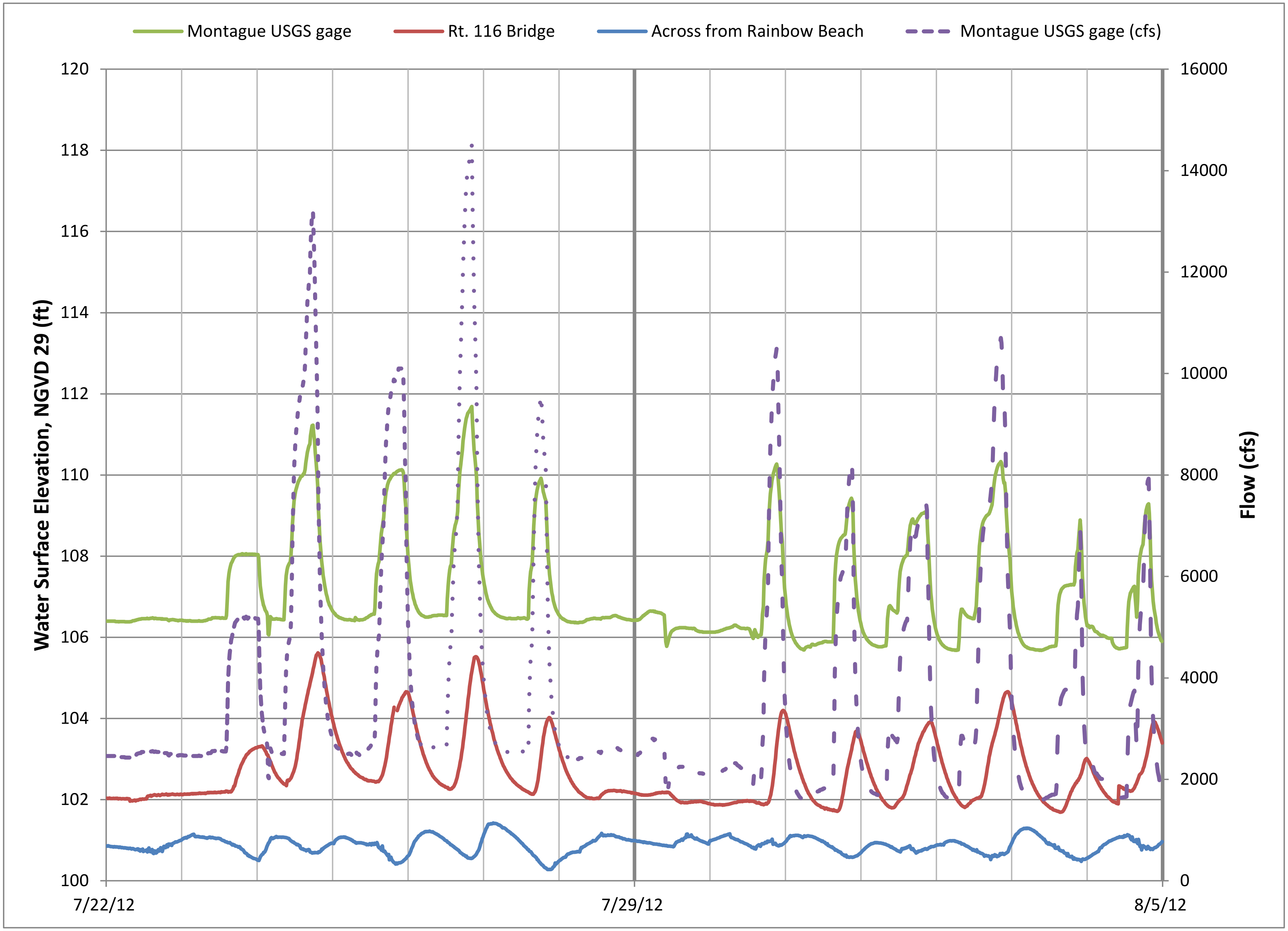
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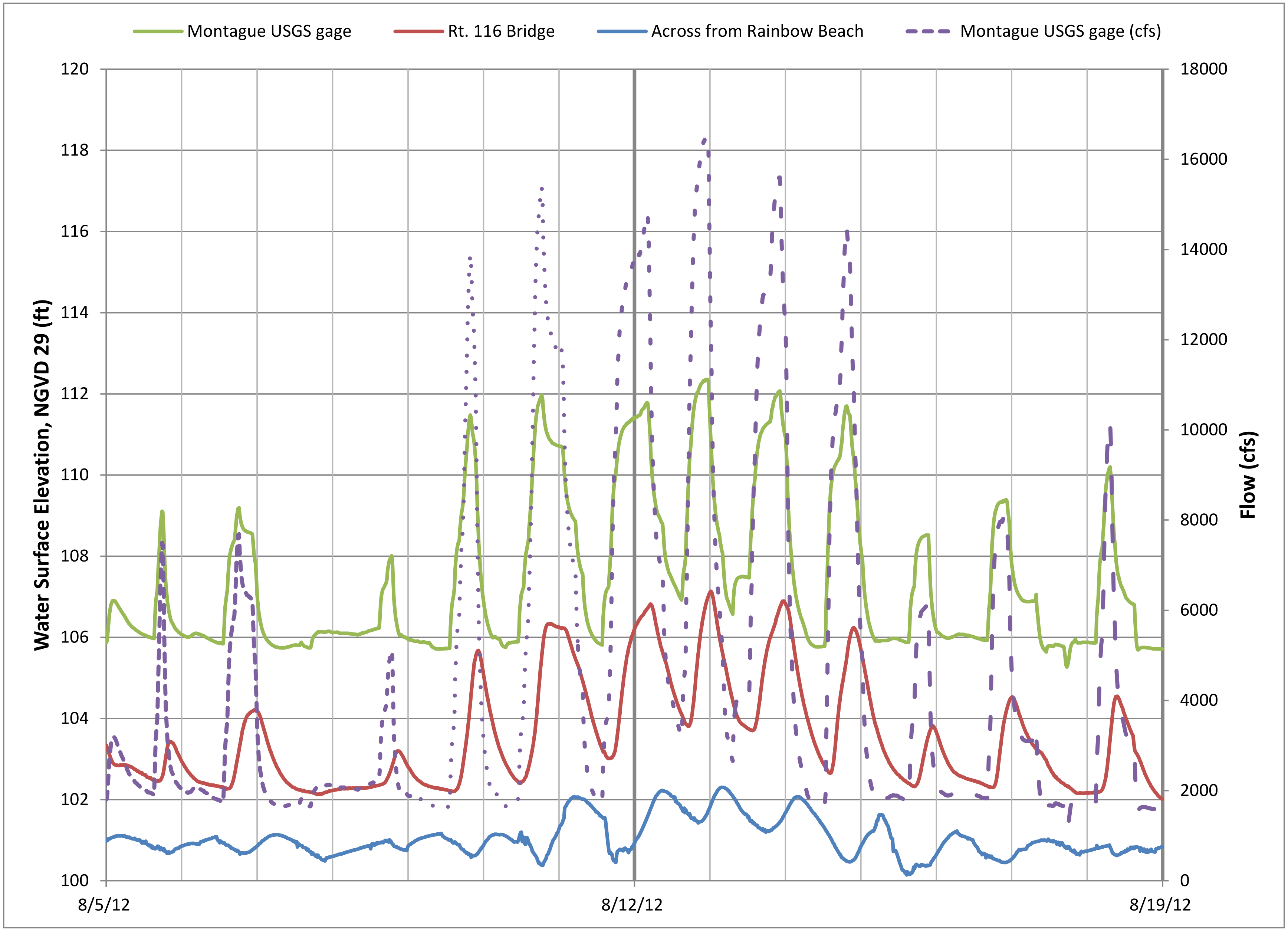
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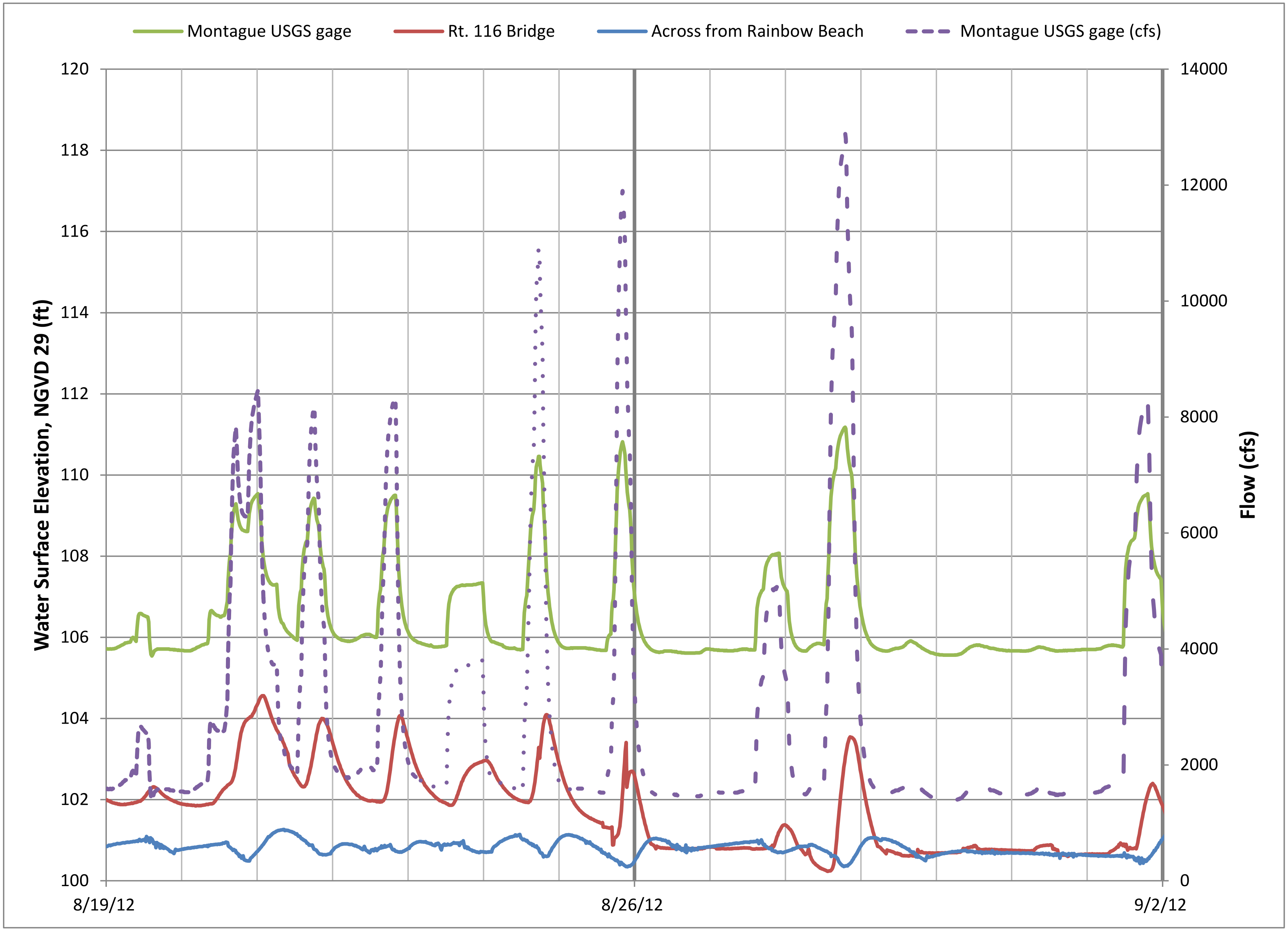
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Across from Rainbow Beach
Montague USGS gage (cfs)
Water Surface Elevation, NGVD 29 (ft)
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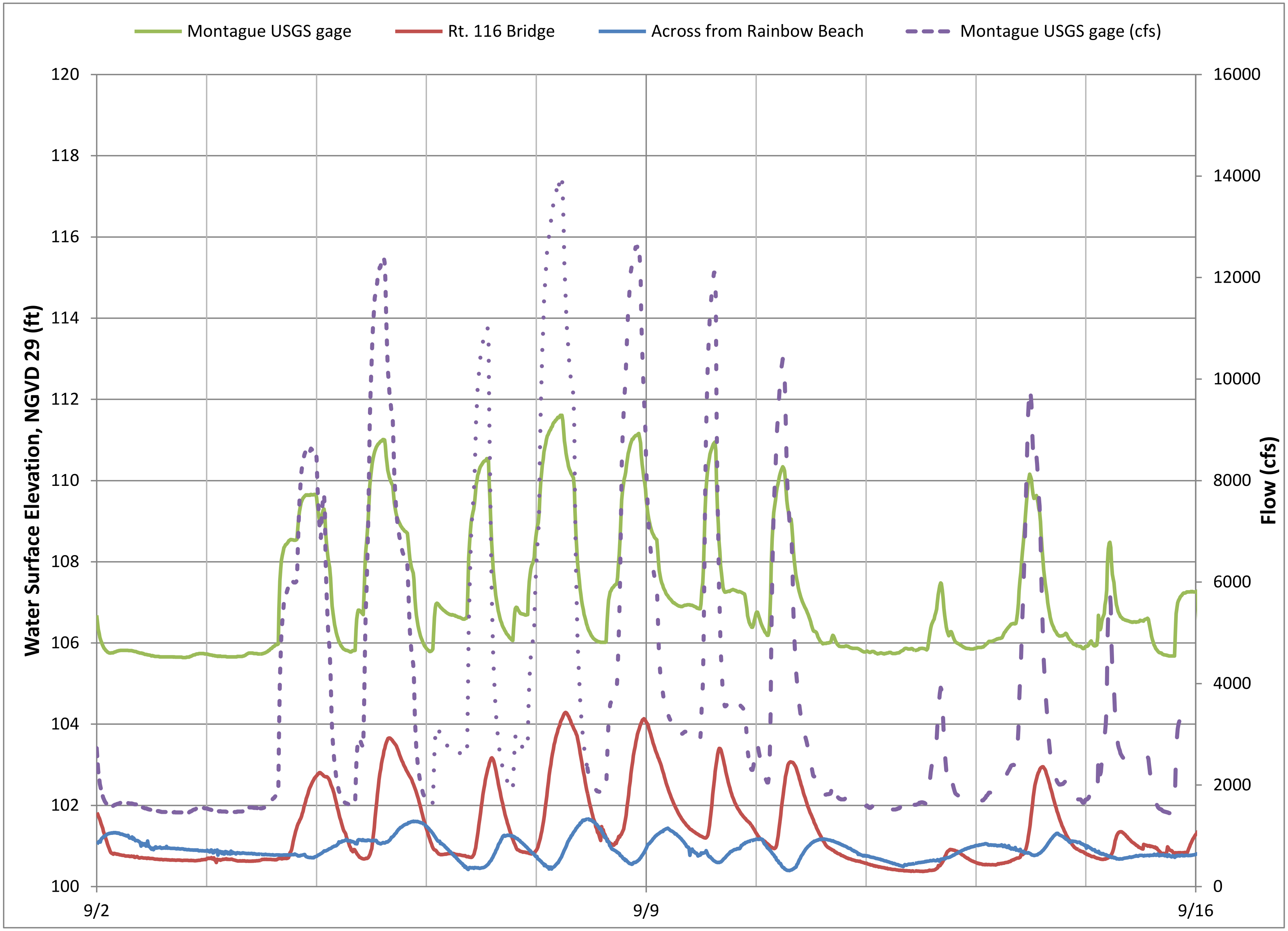
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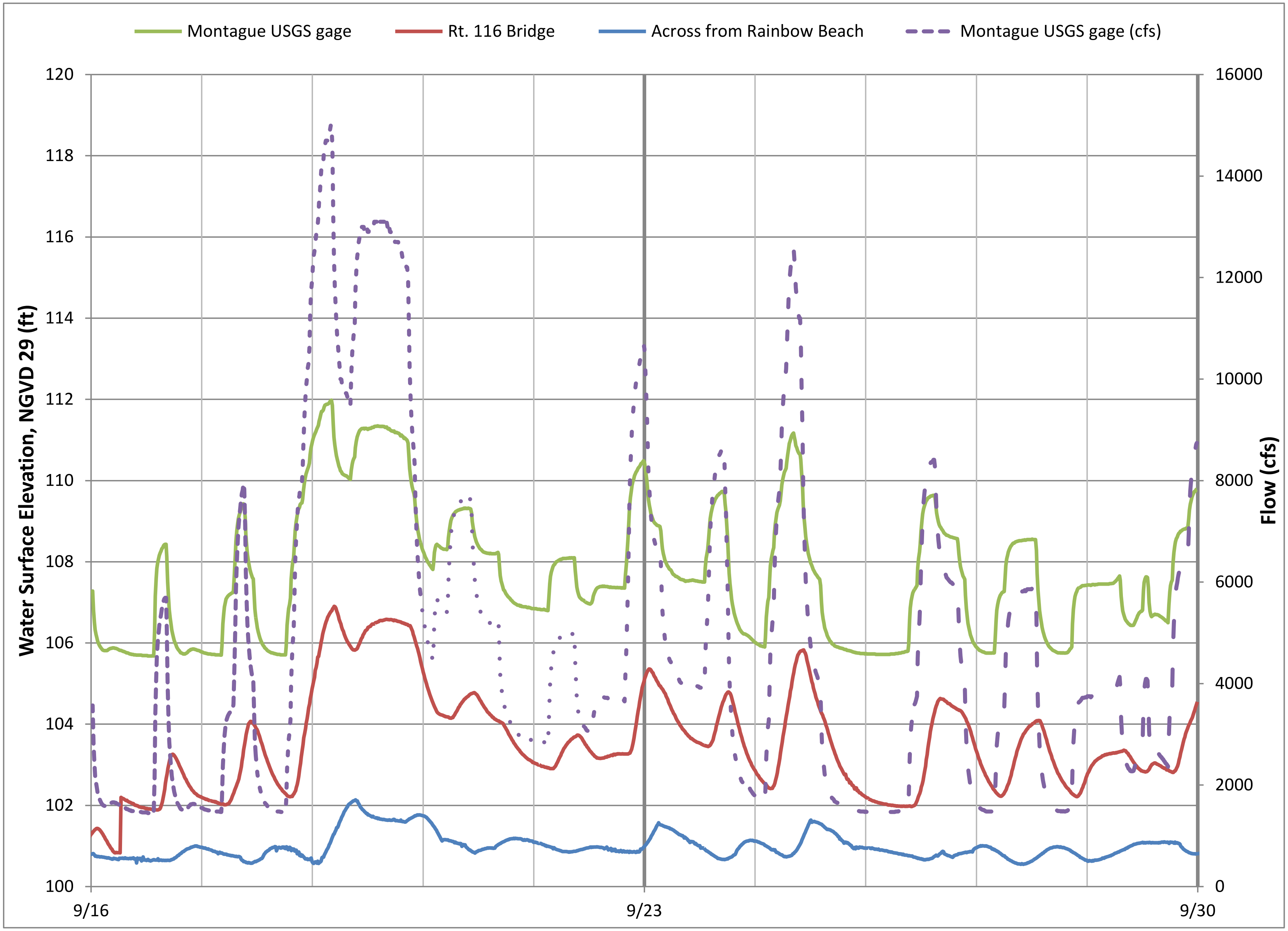
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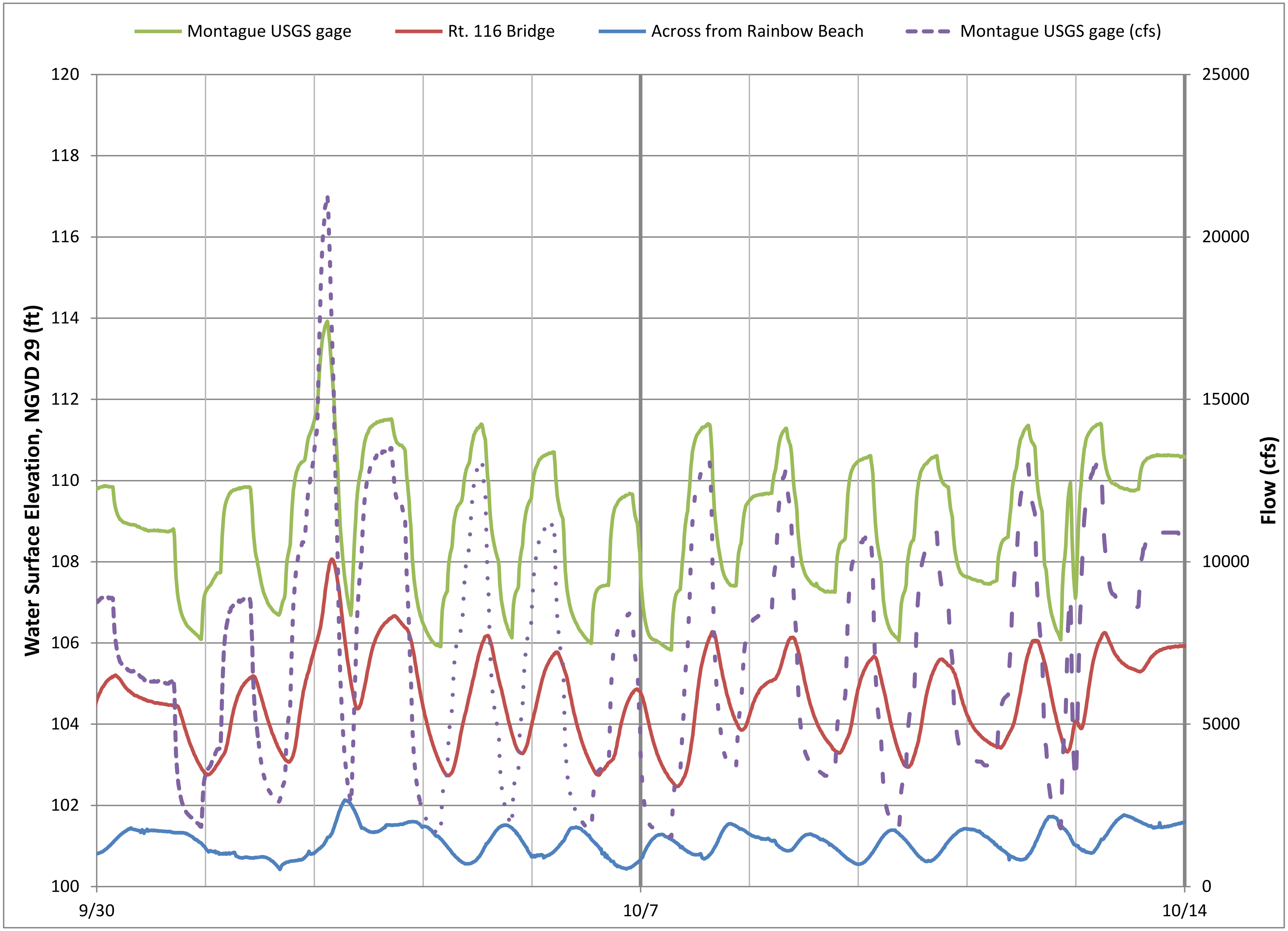
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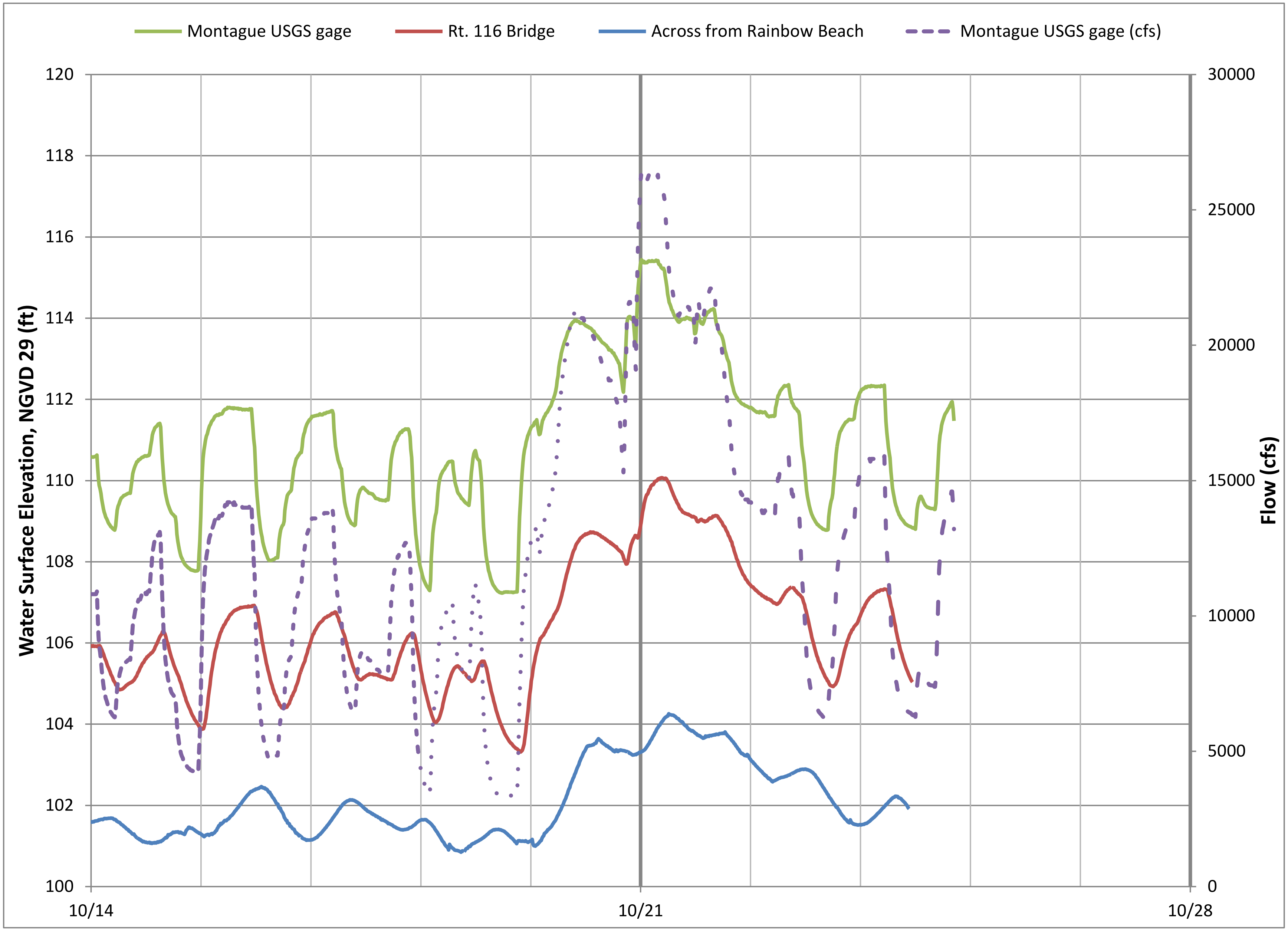
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ATTACHMENT B: PROPOSED HABITAT SUITABILITY INDEX CURVES

Habitat Suitability Criteria references for the Turners Falls Instream Flow Study.

Species	**Lifestage**	**HSC source reference**
American shad	Spawning	Hightower et al., 2012
	Juvenile	Stier and Crance, 1985
	Adult	Stier and Crance, 1985
Shortnose sturgeon*	Spawning	Kieffer and Kynard, 2012 and Kynard, et al., 2012
	Egg/non-mobile larvae	
	Fry	
	Juvenile	
	Adult	
Fallfish	Spawning	Gomez and Sullivan, 2007
	Fry	Gomez and Sullivan, 2007
	Juvenile	Gomez and Sullivan, 2007
	Adult	Gomez and Sullivan, 2007
Longnose dace	Juvenile	Gomez and Sullivan, 2000
	Adult	Gomez and Sullivan, 2000
White sucker	Spawning	Gomez and Sullivan, 2007
	Fry	Twomey, et al., 1984
	Juvenile/Adult	Twomey, et al., 1984
Walleye	Spawning	McMahon, et al., 1984 and Bozek et al., 2011
	Fry	McMahon, et al., 1984
	Juvenile	McMahon, et al., 1984
	Adult	McMahon, et al., 1984
Tessellated darter	Juvenile/Adult	PPL Bell Bend, 2012
Sea lamprey	Spawning	Kynard and Horgan, 2013
Macroinvertebrates	-	Gomez and Sullivan, 2000

* Habitat suitability data for shortnose sturgeon provided via personal communication on May 7 and May 13, 2013 from Jessica Pruden, Northeast Region Shortnose Sturgeon Recovery Coordinator, NOAA Fisheries, Gloucester, MA. Data values are based on Kieffer & Kynard, 2012 and Kynard et al., 2012.

Habitat Suitability Criteria References

Bozek, M.A., T. J. Haxton, and J. K. Raabe. 2011. Walleye and sauger habitat. Pp 133-197, *in* Biology, management, and culture of walleye and sauger, B. A. Barton, editor. 570 pages, American Fisheries Society, June 2011 ISBN: 978-1-934874-22-6.

Exelon. 2012. Instream flow habitat assessment below Conowingo Dam, Conowingo Hydroelectric Project, FERC Project No. 405. Prepared by Gomez and Sullivan Engineers and Normandeau Associates.

Gomez and Sullivan Engineers. 2000. Lamoille River Hydroelectric Project, FERC Project No. 2205. Instream flow and habitat study report. Prepared for Central Vermont Public Service Corp.

Gomez and Sullivan Engineers. 2007. Glendale Hydroelectric Project, FERC Project No. 2801. Final Report Bypass reach aquatic habitat and instream flow study.

Hightower, J.E., J. E. Harris, J. K. Raabe, P. Brownell, C. A. Drew. 2012 . A bayesian spawning habitat suitability model for American shad in southeastern United States rivers. Jour. of Fish and Wildl. Mngmnt. 3:2 p 184-198

Kynard B. & M. Horgan. 2013. Habitat suitability index for sea lamprey redds. Unpublished manuscript. 5 pp.

Kieffer, M. and B. Kynard. 2012. Spawning and non-spawning migrations, spawning, and effects of river regulation on spawning success of Connecticut River shortnose sturgeon. Chapter 3 in Life history and behavior of Connecticut River shortnose sturgeon and other sturgeons. B. Kynard, P. Bronzi, and H. Rosenthal Editors. World Sturgeon Conservation Society: Special Publication #4. Norderstedt, Germany.

Kynard, B., D. Pugh, T. Parker and M. Kieffer, 2012. Spawning of Connecticut River Shortnose Sturgeon in an Artificial Stream: Adult Behavior and Early Life History. Chapter 6 in Life history and behavior of Connecticut River shortnose sturgeon and other sturgeons. B. Kynard, P. Bronzi, and H. Rosenthal Editors. World Sturgeon Conservation Society: Special Publication #4. Norderstedt, Germany.

McMahon, T.E., J.W. Terrell, & P.C. Nelson. 1984. Habitat suitability information: Walleye. U.S. Fish and Wildl. Serv. FWS/OBS-82/10.56. 43 pp.

PPL Bell Bend, LLC. 2012. Bell Bend Nuclear Power Plant. IFIM and aquatic impact studies.

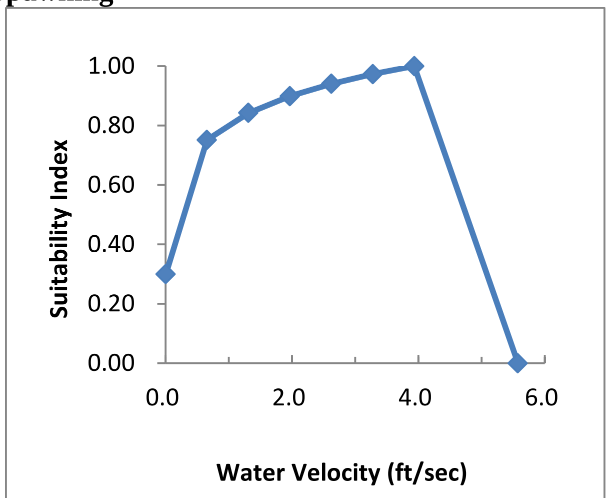
Stier, D.J., & Crance, J.H. 1985. Habitat suitability index models and instream flow suitability curves: American shad. United States Fish and Wildlife Service Biological Report 82(10.88).

Twomey, K.A, Williamson, K.L., & Nelson, P.C. 1984. Habitat suitability information: white sucker. U.S. Fish and Wildlife Service. Biol. Rep. FWS/OBS-82/10.64.

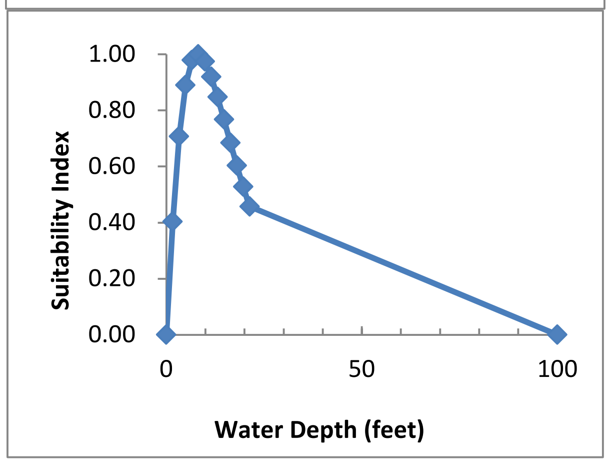
Species: American Shad
Lifestage: Spawning

Velocity

Velocity	SI Value
0.0	0.30
0.7	0.75
1.3	0.84
2.0	0.90
2.6	0.94
3.3	0.97
3.9	1.00
5.6	0.00

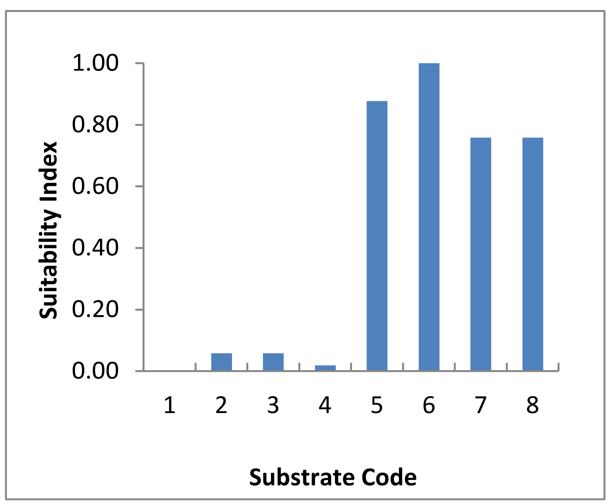


Depth (ft)	SI Value
0.0	0.00
1.6	0.40
3.3	0.71
4.9	0.89
6.6	0.98
8.2	1.00
9.8	0.97
11.5	0.92
13.1	0.85
14.8	0.77
16.4	0.68
18.0	0.60
19.7	0.53
21.3	0.46
100.0	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.06	Mud/soft clay
3	0.06	Silt
4	0.02	Sand
5	0.88	Gravel
6	1.00	Cobble/rubble
7	0.76	Boulder
8	0.76	Bedrock

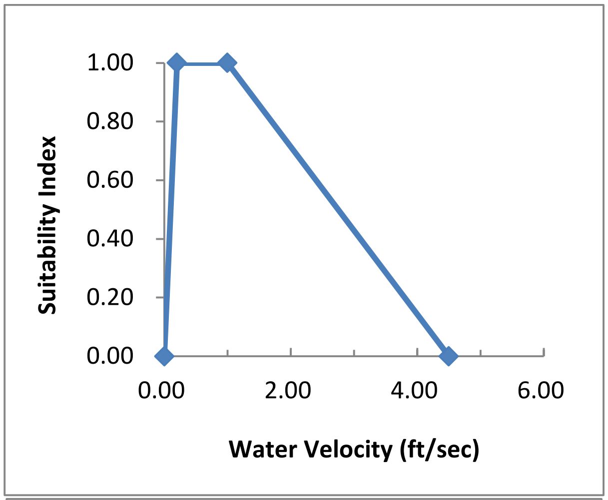


Source: Hightower et al, 2012

Species: American Shad
Lifestage: Juvenile

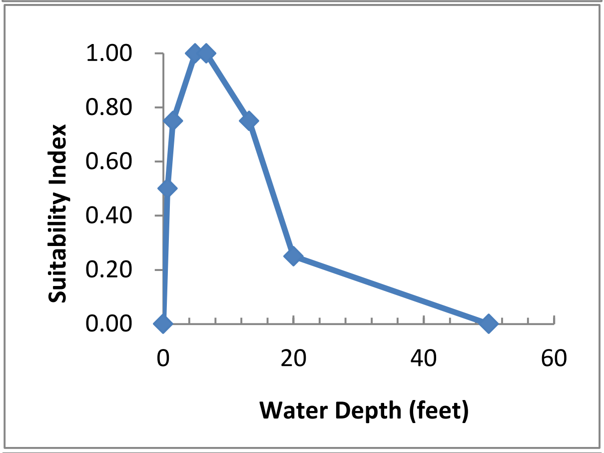
Velocity

Velocity	SI Value
0.00	0.00
0.20	1.00
1.00	1.00
4.50	0.00



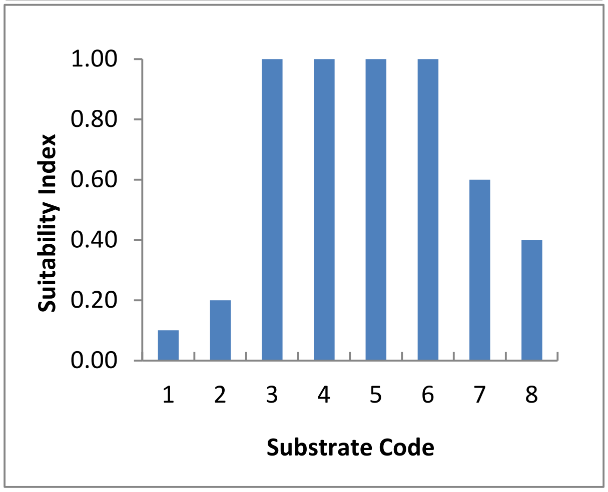
Depth

Depth	SI Value
0.00	0.00
0.66	0.50
1.50	0.75
4.90	1.00
6.60	1.00
13.20	0.75
20.00	0.25
50.00	0.00



Substrate

Substrate	SI Value	Type
1	0.10	Detritus/Organic
2	0.20	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	0.60	Boulder
8	0.40	Bedrock

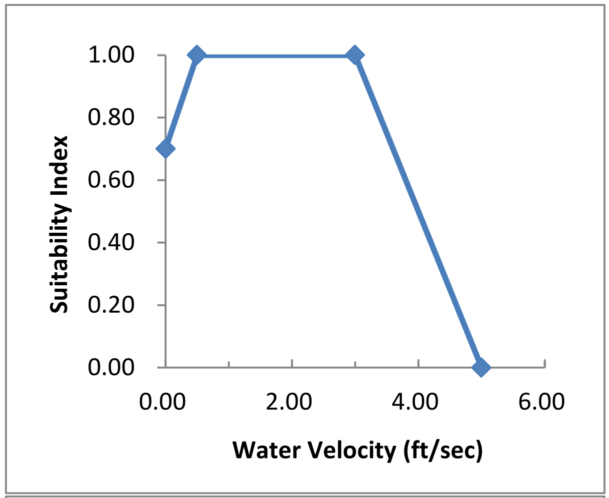


Source: Conowingo IFIM
Stier & Crance, 1985
Depth from Ross et al., 1993

Species: American Shad
Lifestage: Adult

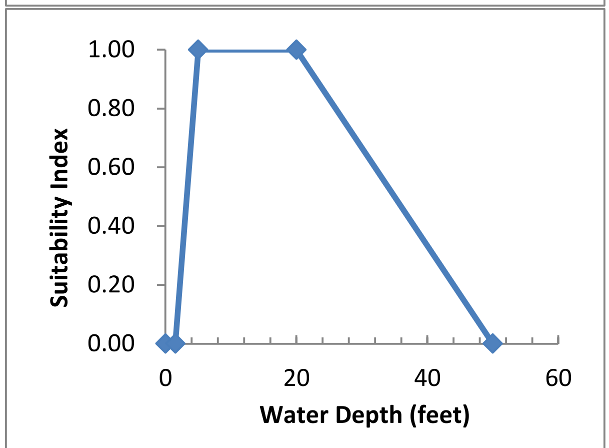
Velocity

Velocity	SI Value
0.00	0.70
0.50	1.00
3.00	1.00
5.00	0.00



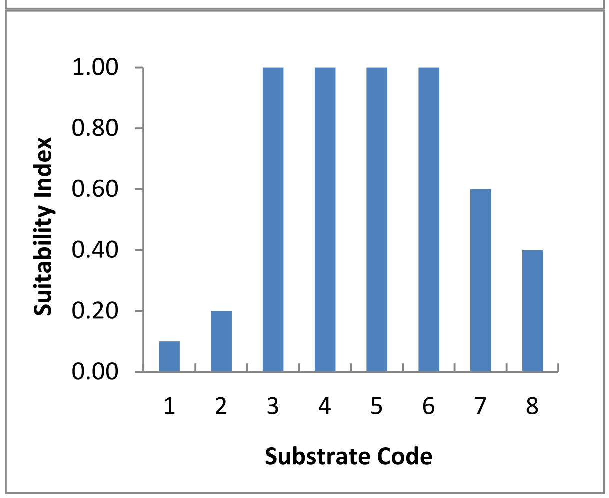
Depth

Depth	SI Value
0.00	0.00
1.50	0.00
5.00	1.00
20.00	1.00
50.00	0.00



Substrate

Substrate	SI Value	Type
1	0.10	Detritus/Organic
2	0.20	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	0.60	Boulder
8	0.40	Bedrock

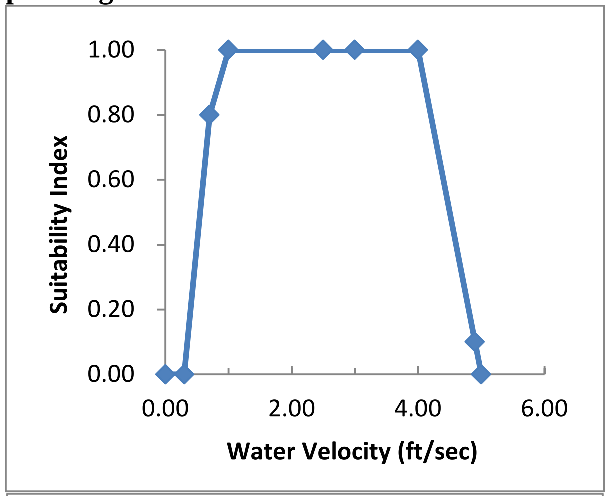


Source: Conowingo IFIM
Stier & Crance, 1985

Species: Shortnose Sturgeon
Lifestage: Spawning

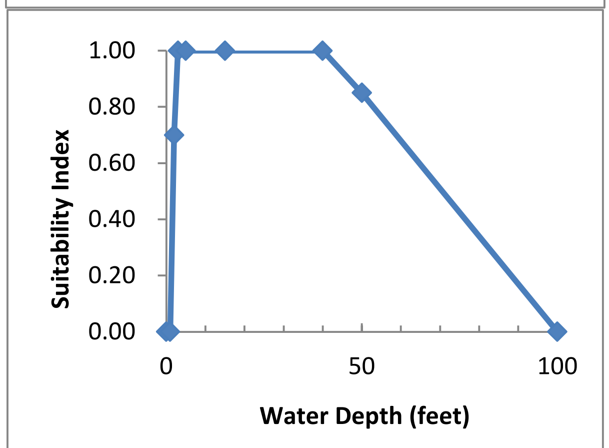
Velocity

Velocity	SI Value
0.00	0.00
0.30	0.00
0.70	0.80
1.00	1.00
2.50	1.00
3.00	1.00
4.00	1.00
4.90	0.10
5.00	0.00



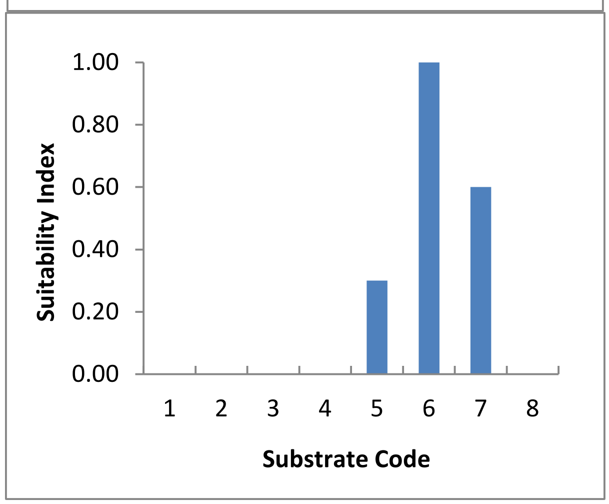
Depth

Depth	SI Value
0.00	0.00
1.00	0.00
2.00	0.70
3.00	1.00
5.00	1.00
15.00	1.00
40.00	1.00
50.00	0.85
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.00	Sand
5	0.30	Gravel
6	1.00	Cobble/rubble
7	0.60	Boulder
8	0.00	Bedrock

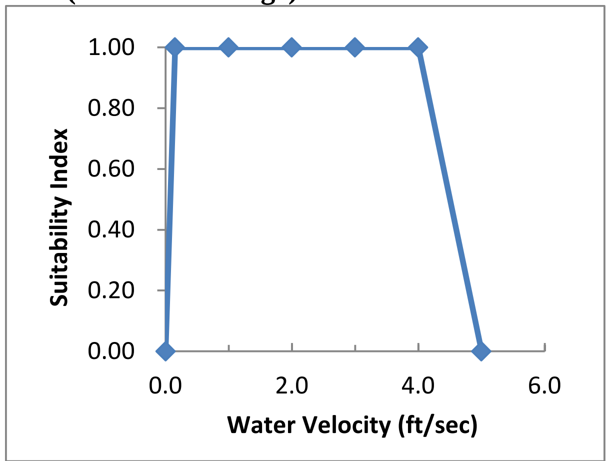


Source: Adapted from Conowingo IFIM by NOAA.

Species: Shortnose Sturgeon
Lifestage: Egg/ Embryo/larvae (non-mobile stage)

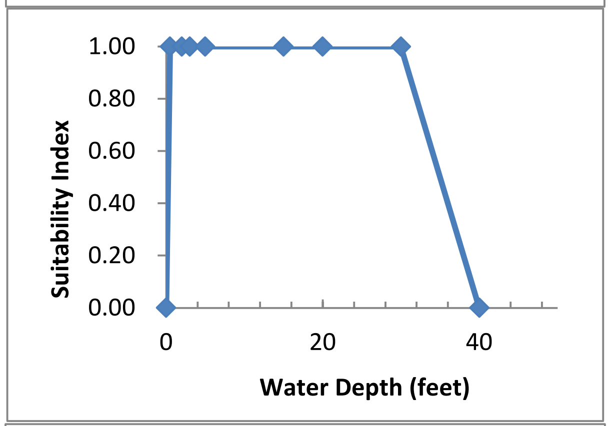
Velocity

Velocity	SI Value
0.00	0.00
0.15	1.00
1.00	1.00
2.00	1.00
3.00	1.00
4.00	1.00
5.00	0.00



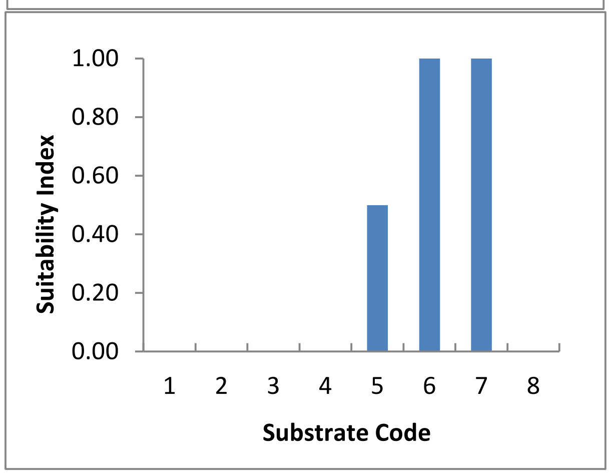
Depth

Depth	SI Value
0.00	0.00
0.50	1.00
2.00	1.00
3.00	1.00
5.00	1.00
15.00	1.00
20.00	1.00
30.00	1.00
40.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.00	Sand
5	0.50	Gravel
6	1.00	Cobble/rubble
7	1.00	Boulder
8	0.00	Bedrock

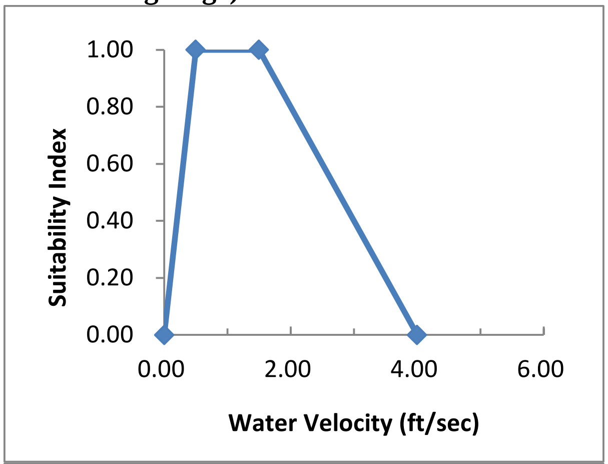


Source: NOAA, 2013.

Species: Shortnose Sturgeon
Lifestage: Fry (post drift/ exogenous feeding stage) 16-57mm

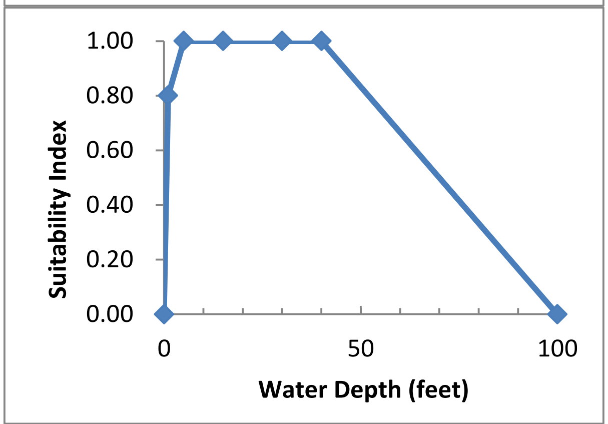
Velocity

Velocity	SI Value
0.00	0.00
0.50	1.00
1.50	1.00
4.00	0.00



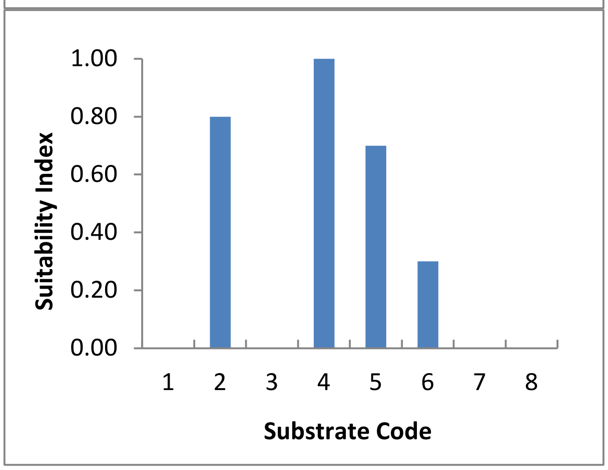
Depth

Depth	SI Value
0.00	0.00
1.00	0.80
5.00	1.00
15.00	1.00
30.00	1.00
40.00	1.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.80	Mud/soft clay
3	0.00	Silt
4	1.00	Sand
5	0.70	Gravel
6	0.30	Cobble/rubble
7	0.00	Boulder
8	0.00	Bedrock

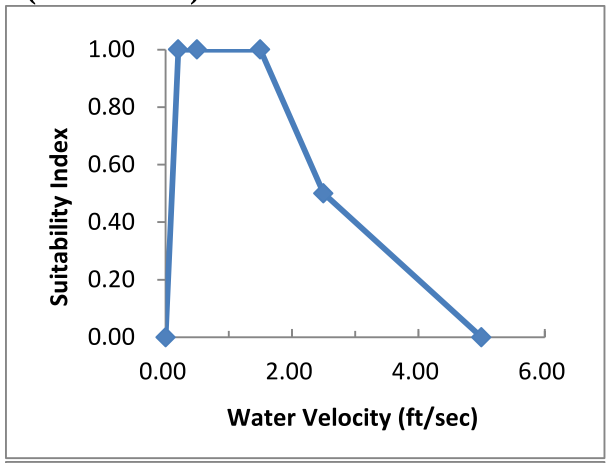


Source: Adapted from Conowingo IFIM by NOAA.

Species: Shortnose Sturgeon
Lifestage: Juveniles (60 - 650 mm)

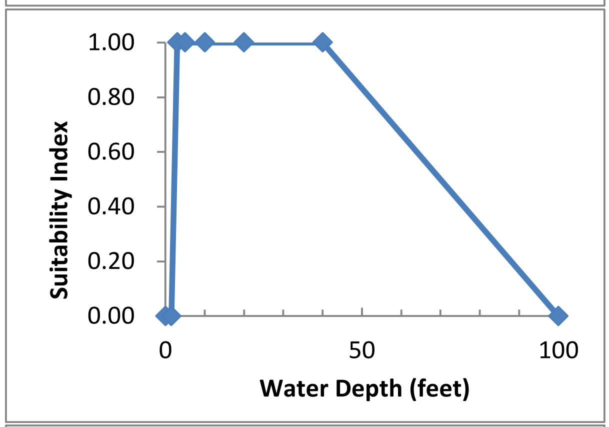
Velocity

Velocity	SI Value
0.00	0.00
0.20	1.00
0.50	1.00
1.50	1.00
2.50	0.50
5.00	0.00



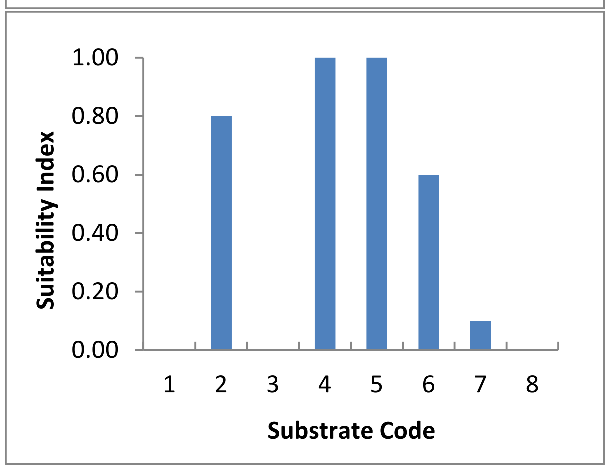
Depth

Depth	SI Value
0.00	0.00
1.50	0.00
3.00	1.00
5.00	1.00
10.00	1.00
20.00	1.00
40.00	1.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.80	Mud/soft clay
3	0.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	0.60	Cobble/rubble
7	0.10	Boulder
8	0.00	Bedrock

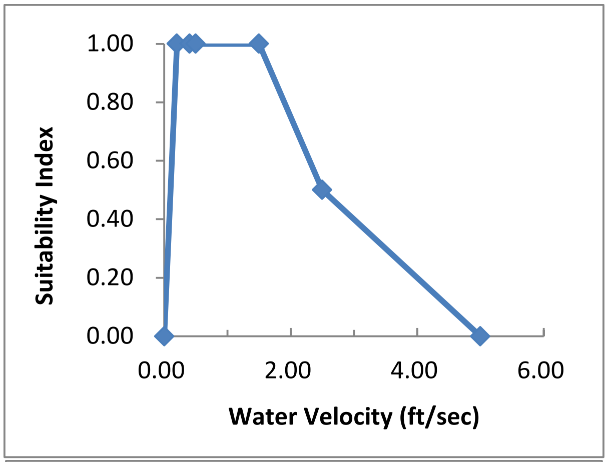


Source: Adapted from Conowingo IFIM by NOAA.

Species: Shortnose Sturgeon
Lifestage: Adults

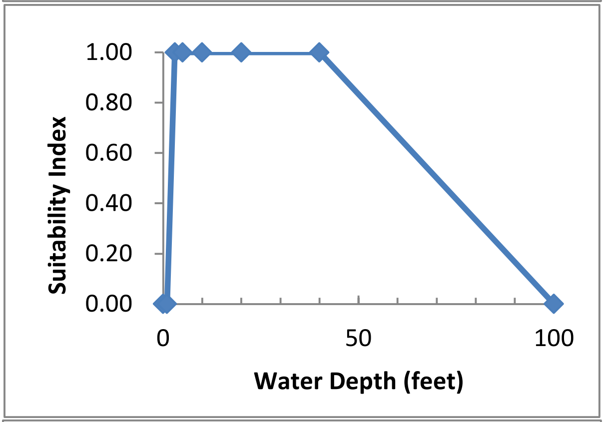
Velocity

Velocity	SI Value
0.00	0.00
0.20	1.00
0.40	1.00
0.50	1.00
1.50	1.00
2.50	0.50
5.00	0.00



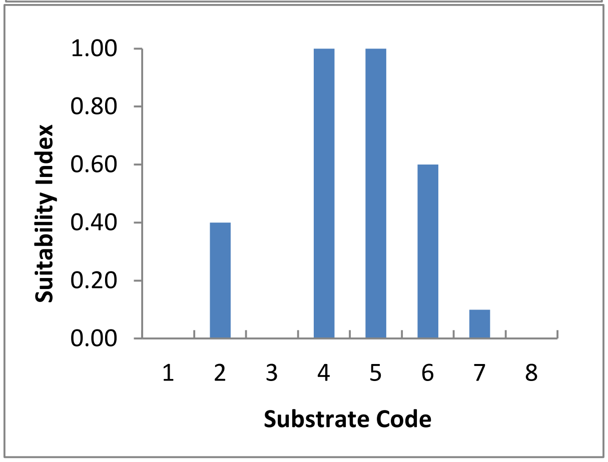
Depth

Depth	SI Value
0.00	0.00
1.00	0.00
3.00	1.00
5.00	1.00
10.00	1.00
20.00	1.00
40.00	1.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.40	Mud/soft clay
3	0.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	0.60	Cobble/rubble
7	0.10	Boulder
8	0.00	Bedrock

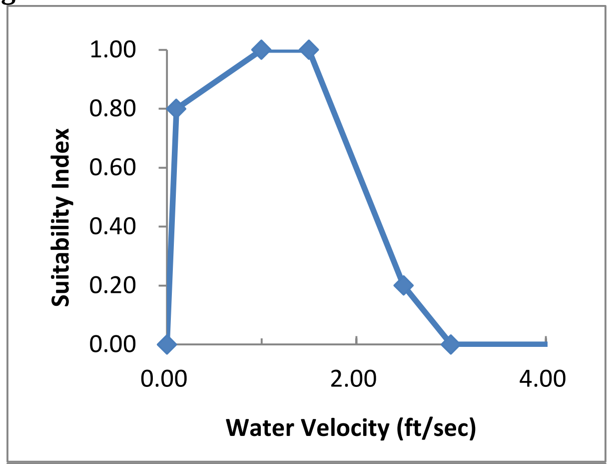


Source: Adapted from Conowingo IFIM by NOAA.

Species: Fallfish
Lifestage: Spawning and Incubation

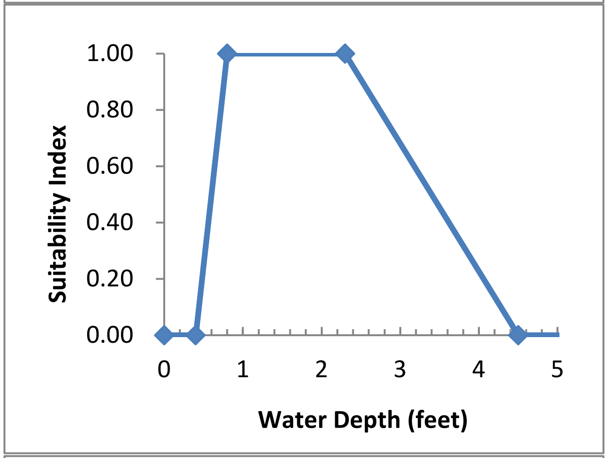
Velocity

Velocity	SI Value
0.00	0.00
0.10	0.80
1.00	1.00
1.50	1.00
2.50	0.20
3.00	0.00
100.00	0.00



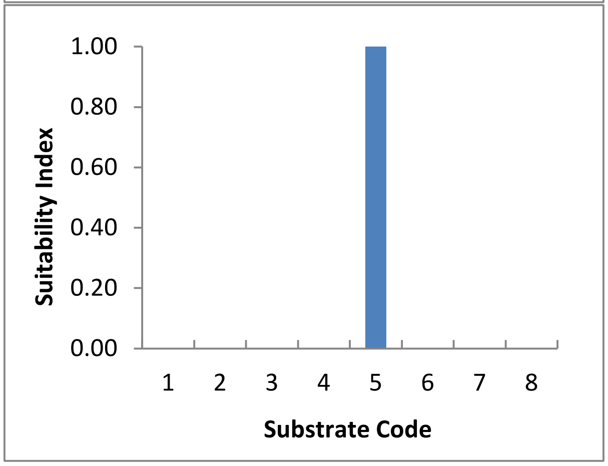
Depth

Depth	SI Value
0.00	0.00
0.40	0.00
0.80	1.00
2.30	1.00
4.50	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.00	Sand
5	1.00	Gravel
6	0.00	Cobble/rubble
7	0.00	Boulder
8	0.00	Bedrock

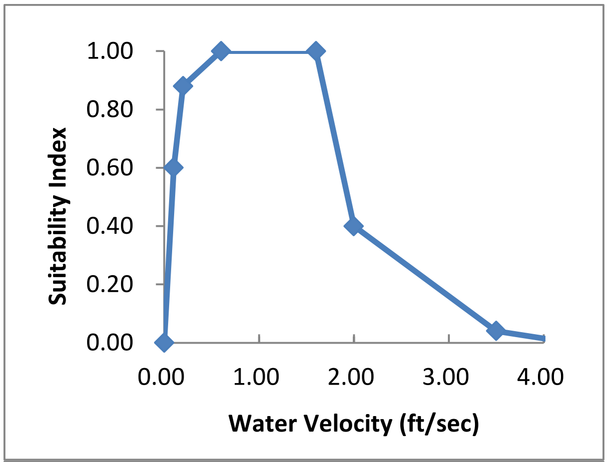


Source: Glendale Hydro Project IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: Fallfish
Lifestage: Juvenile

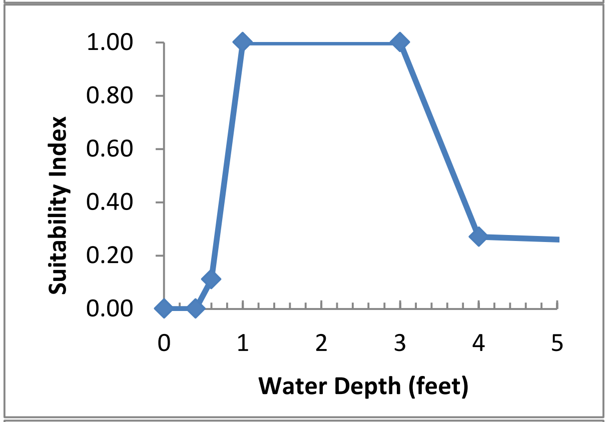
Velocity

Velocity	SI Value
0.00	0.00
0.10	0.60
0.20	0.88
0.60	1.00
1.60	1.00
2.00	0.40
3.50	0.04
4.30	0.00
100.00	0.00



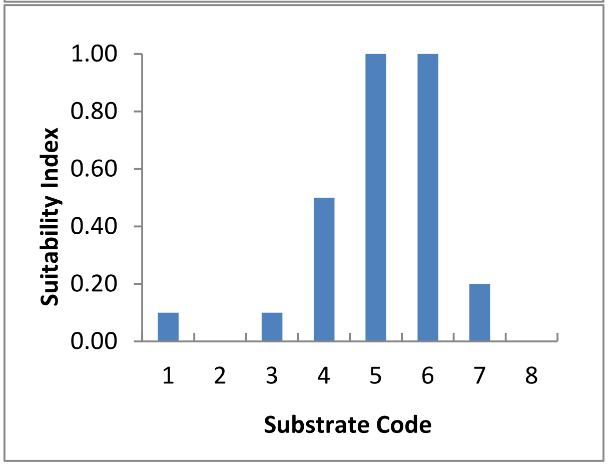
Depth

Depth	SI Value
0.00	0.00
0.40	0.00
0.60	0.11
1.00	1.00
3.00	1.00
4.00	0.27
7.00	0.24
8.00	0.07
100.00	0.07



Substrate

Substrate	SI Value	Type
1	0.10	Detritus/Organic
2	0.00	Mud/soft clay
3	0.10	Silt
4	0.50	Sand
5	1.00	Gravel
6	1.00	Cobble/rubble
7	0.20	Boulder
8	0.00	Bedrock

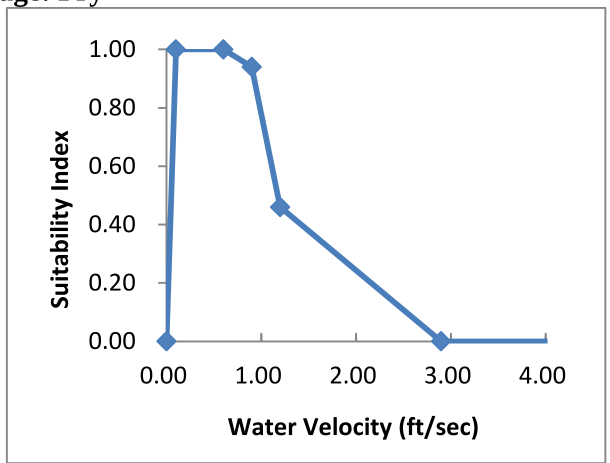


Source: Glendale Hydro Project IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: Fallfish
Lifestage: Fry

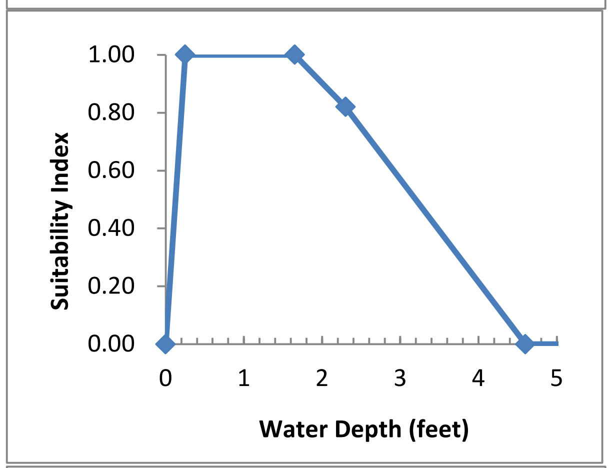
Velocity

Velocity	SI Value
0.00	0.00
0.10	1.00
0.60	1.00
0.90	0.94
1.20	0.46
2.90	0.00
100.00	0.00



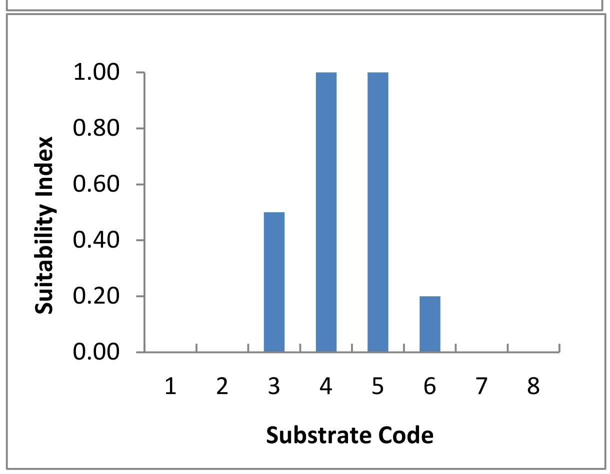
Depth

Depth	SI Value
0.00	0.00
0.25	1.00
1.65	1.00
2.30	0.82
4.60	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.50	Silt
4	1.00	Sand
5	1.00	Gravel
6	0.20	Cobble/rubble
7	0.00	Boulder
8	0.00	Bedrock



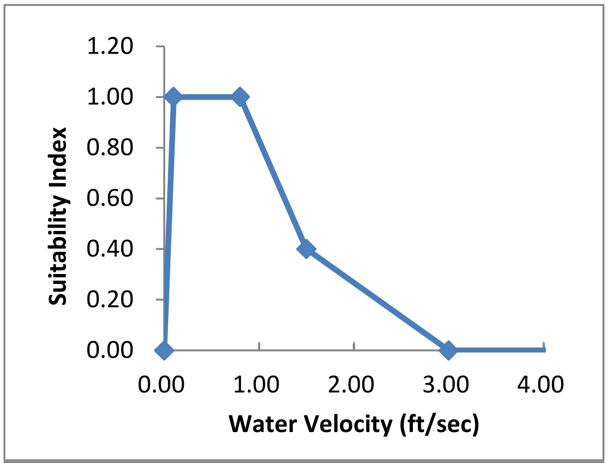
Source: Glendale Hydro Project IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: Fallfish

Lifestage: Adult

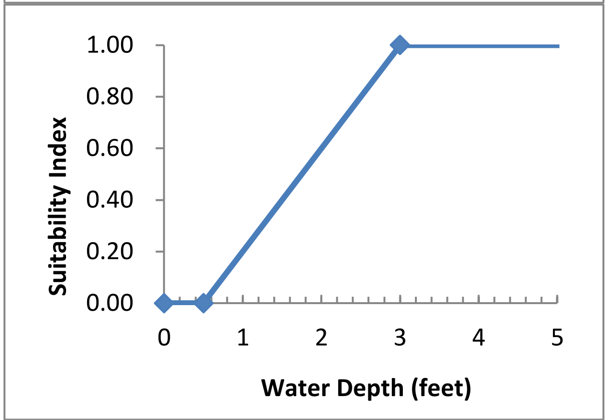
Velocity

Velocity	SI Value
0.00	0.00
0.10	1.00
0.80	1.00
1.50	0.40
3.00	0.00
100.00	0.00



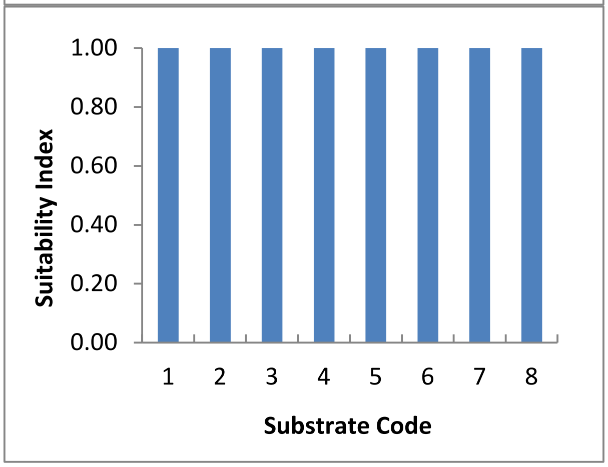
Depth

Depth	SI Value
0.00	0.00
0.50	0.00
3.00	1.00
100.00	1.00



Substrate

Substrate	SI Value	Type
1	1.00	Detritus/Organic
2	1.00	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble/rubble
7	1.00	Boulder
8	1.00	Bedrock



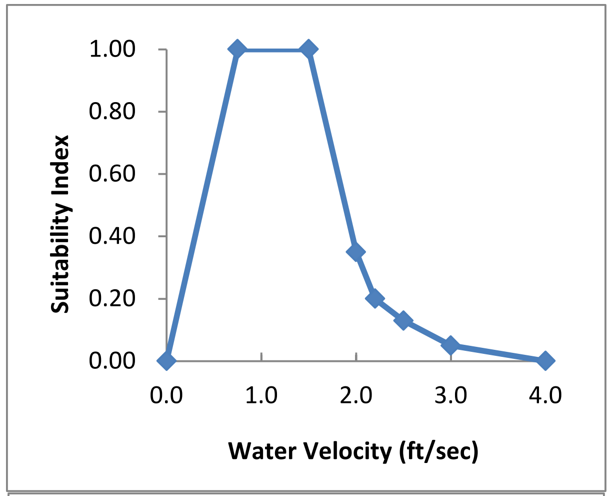
Source: Glendale Hydro Project IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: Longnose dace

Lifestage: Juvenile

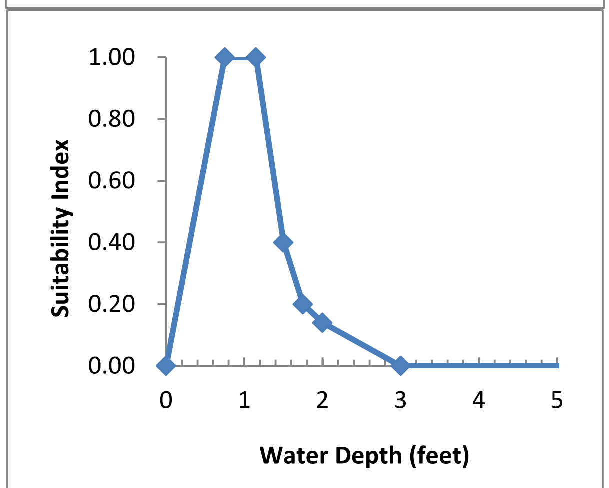
Velocity

Velocity	SI Value
0.00	0.00
0.75	1.00
1.50	1.00
2.00	0.35
2.20	0.20
2.50	0.13
3.00	0.05
4.00	0.00
100.00	0.00



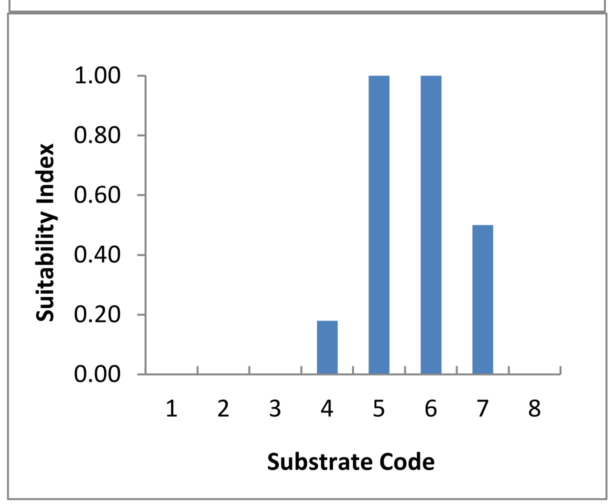
Depth

Depth	SI Value
0.00	0.00
0.75	1.00
1.15	1.00
1.50	0.40
1.75	0.20
2.00	0.14
3.00	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.18	Sand
5	1.00	Gravel
6	1.00	Cobble/rubble
7	0.50	Boulder
8	0.00	Bedrock



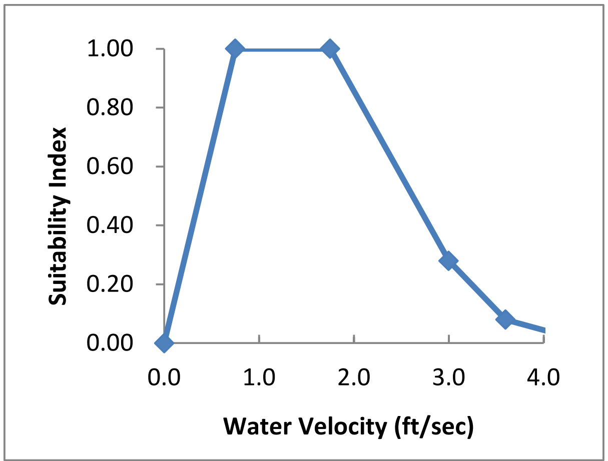
Source: Lamoille River IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: Longnose dace

Lifestage: Adult

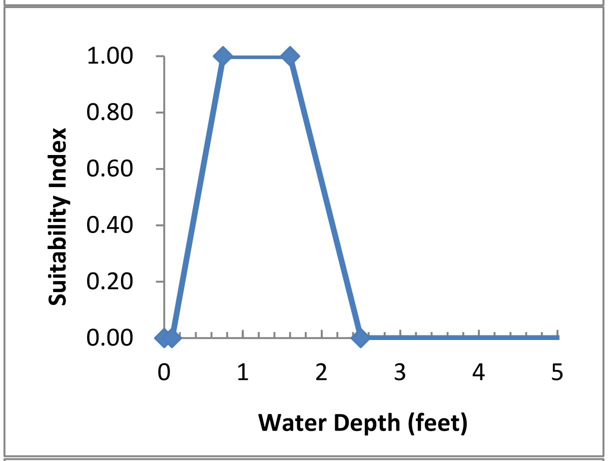
Velocity

Velocity	SI Value
0.00	0.00
0.75	1.00
1.75	1.00
3.00	0.28
3.60	0.08
4.50	0.00
100.00	0.00



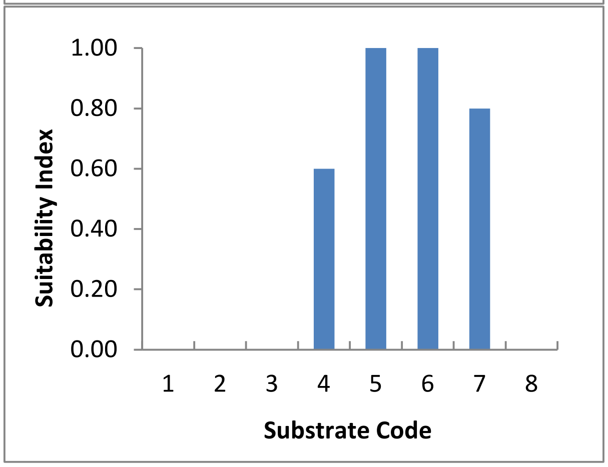
Depth

Depth	SI Value
0.00	0.00
0.10	0.00
0.75	1.00
1.60	1.00
2.50	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.60	Sand
5	1.00	Gravel
6	1.00	Cobble/rubble
7	0.80	Boulder
8	0.00	Bedrock



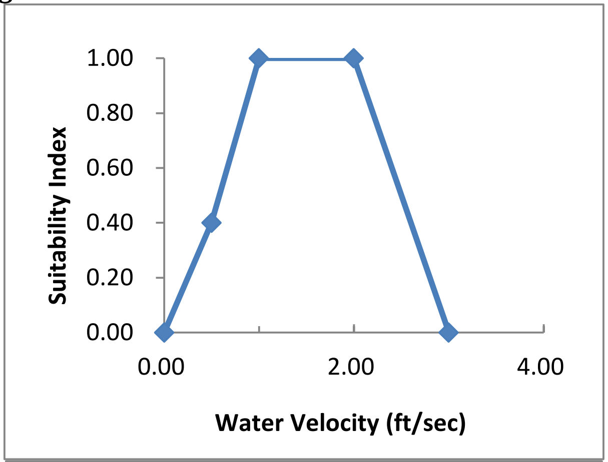
Source: Lamoille River IFIM
Consolidated Substrate Codes
Removed embeddedness and cover from substrate

Species: White Sucker

Lifestage: Spawning and Incubation

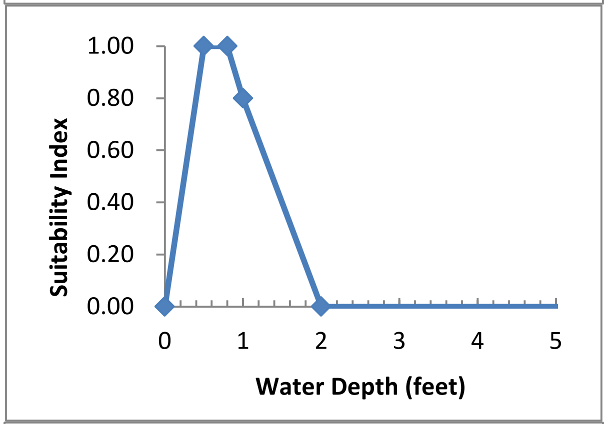
Velocity

Velocity	SI Value
0.00	0.00
0.50	0.40
1.00	1.00
2.00	1.00
3.00	0.00
100.00	0.00



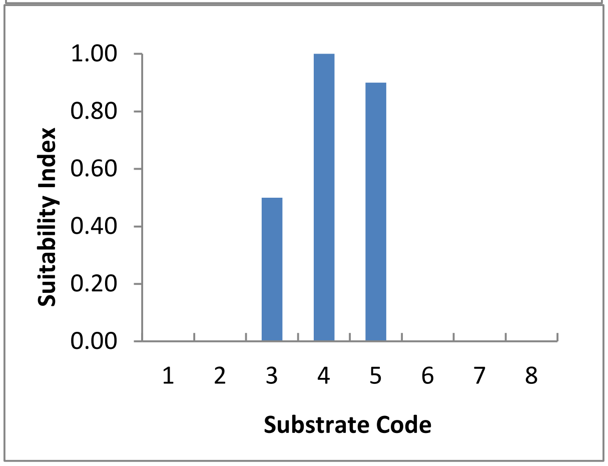
Depth

Depth	SI Value
0.00	0.00
0.50	1.00
0.80	1.00
1.00	0.80
2.00	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.50	Silt
4	1.00	Sand
5	0.90	Gravel
6	0.00	Cobble
7	0.00	Boulder
8	0.00	Bedrock



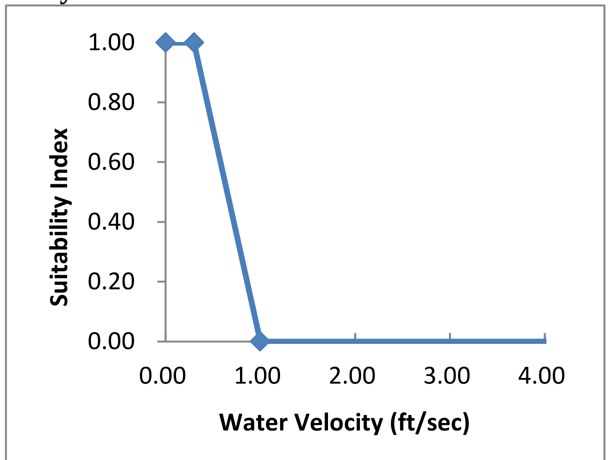
Source: Glendale Hydro IFIM

Species: White Sucker

Lifestage: Fry

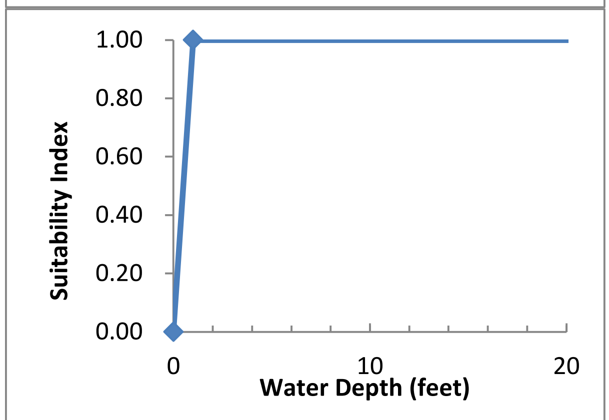
Velocity

Velocity	SI Value
0.00	1.00
0.30	1.00
1.00	0.00
100.00	0.00



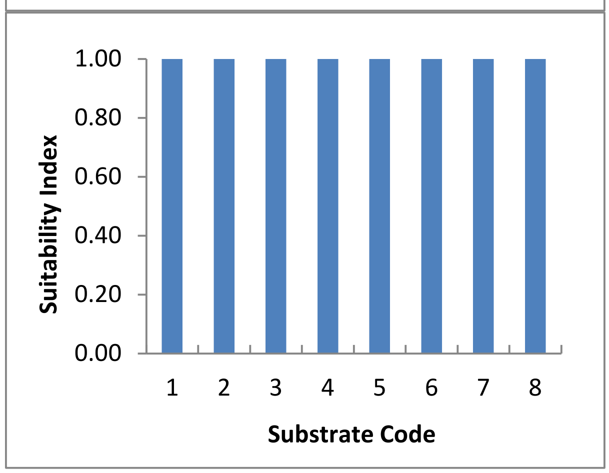
Depth

Depth	SI Value
0.00	0.00
1.00	1.00
100.00	1.00



Substrate

Substrate	SI Value	Type
1	1.00	Detritus/Organic
2	1.00	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	1.00	Boulder
8	1.00	Bedrock



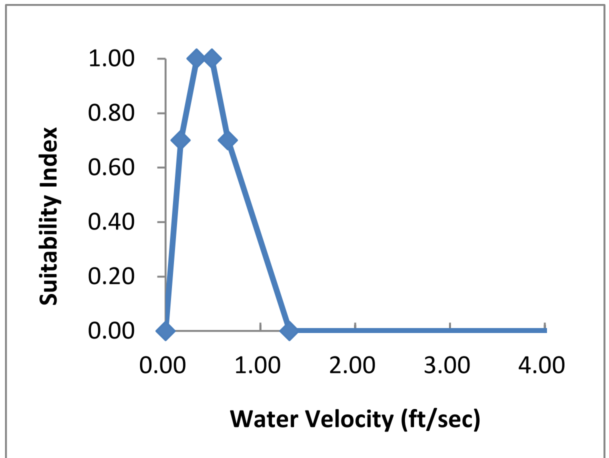
Source: Twomey et al., 1984

Species: White Sucker

Lifestage: Adult/Juvenile

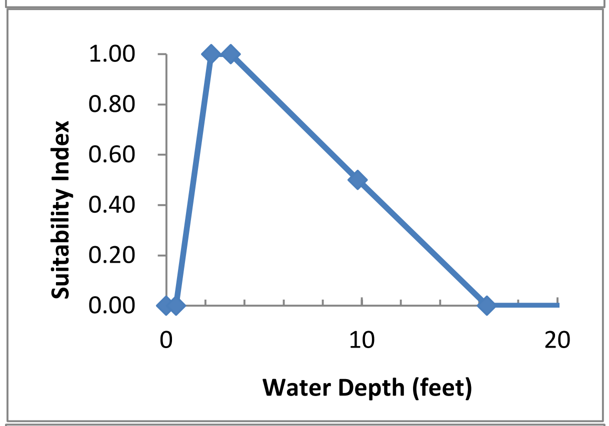
Velocity

Velocity	SI Value
0.00	0.00
0.16	0.70
0.33	1.00
0.49	1.00
0.66	0.70
1.31	0.00
100.00	0.00



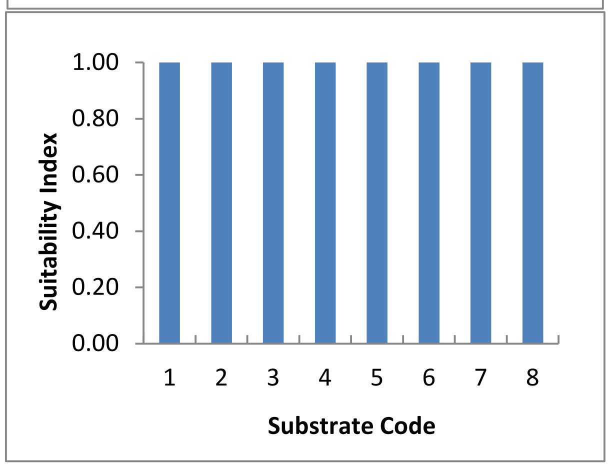
Depth

Depth	SI Value
0.00	0.00
0.50	0.00
2.30	1.00
3.30	1.00
9.80	0.50
16.40	0.00
100.00	0.00



Substrate

Substrate	SI Value	Type
1	1.00	Detritus/Organic
2	1.00	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	1.00	Cobble
7	1.00	Boulder
8	1.00	Bedrock



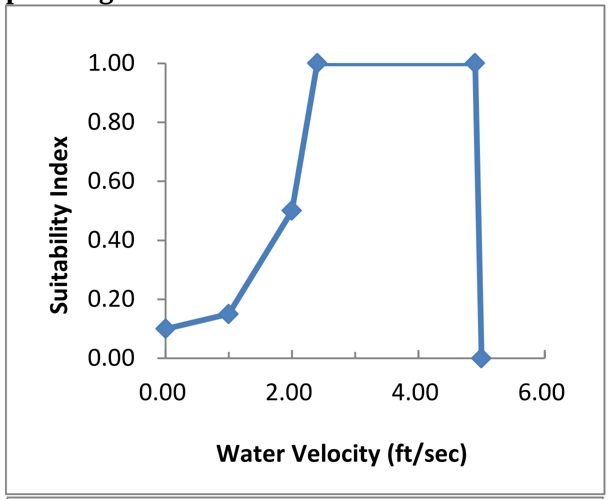
Source: Twomey et al., 1984

Species: Walleye

Lifestage: Spawning

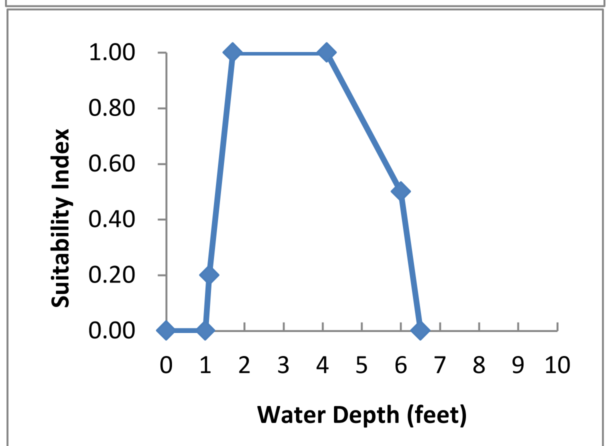
Velocity

Velocity	SI Value
0.00	0.10
1.00	0.15
2.00	0.50
2.40	1.00
4.90	1.00
5.00	0.00



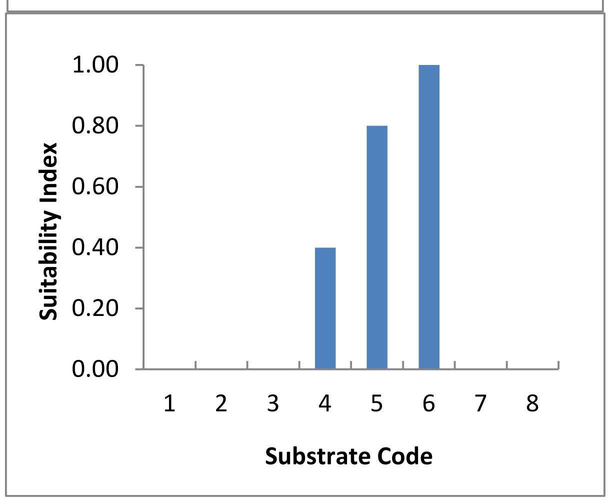
Depth

Depth	SI Value
0.00	0.00
1.00	0.00
1.10	0.20
1.70	1.00
4.10	1.00
6.00	0.50
6.50	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.40	Sand
5	0.80	Gravel
6	1.00	Cobble/rubble
7	0.00	Boulder
8	0.00	Bedrock



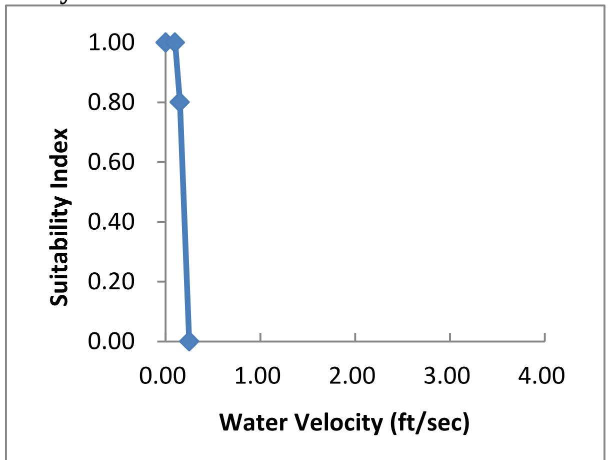
Source: McMahon, et al., 1984. Modified to include velocity and depth data from Bozek, et al., 2011.

Species: Walleye

Lifestage: Fry

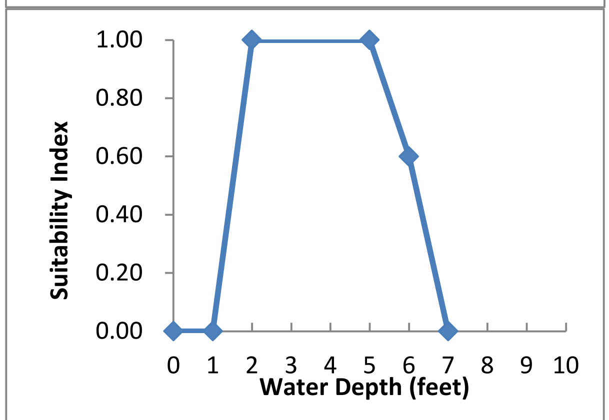
Velocity

Velocity	SI Value
0.00	1.00
0.10	1.00
0.15	0.80
0.25	0.00
2.00	0.00



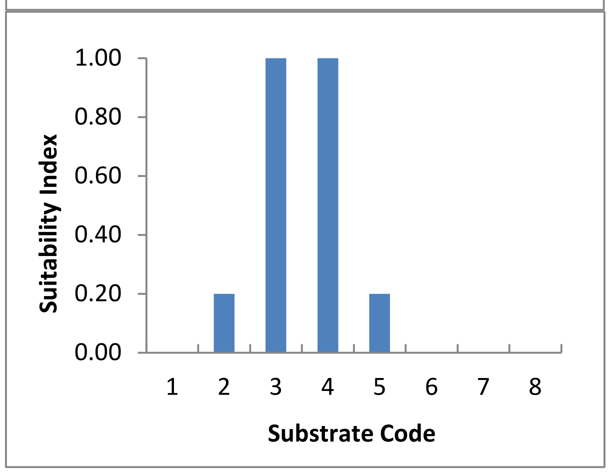
Depth

Depth	SI Value
0.00	0.00
1.00	0.00
2.00	1.00
5.00	1.00
6.00	0.60
7.00	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.20	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	0.20	Gravel
6	0.00	Cobble
7	0.00	Boulder
8	0.00	Bedrock



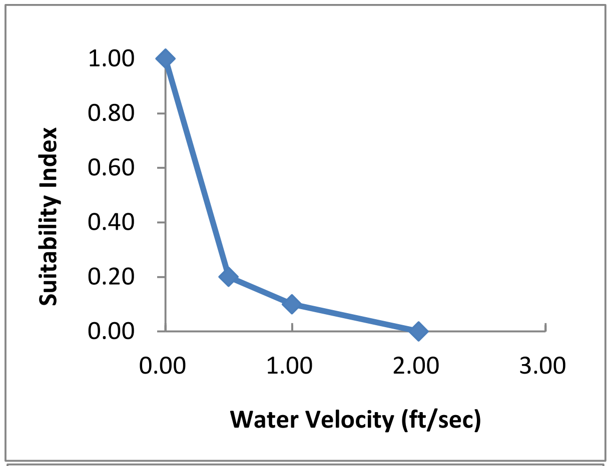
Source: McMahon, et al., 1984.

Species: Walleye

Lifestage: Juvenile

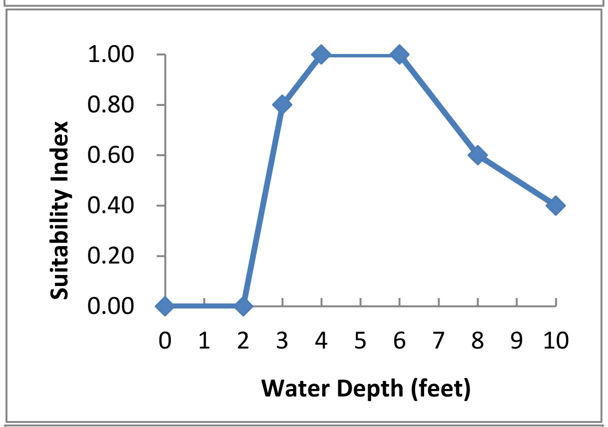
Velocity

Velocity	SI Value
0.00	1.00
0.50	0.20
1.00	0.10
2.00	0.00



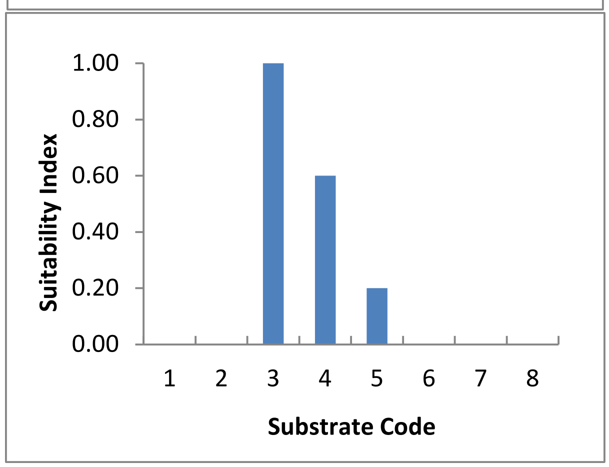
Depth

Depth	SI Value
0.00	0.00
2.00	0.00
3.00	0.80
4.00	1.00
6.00	1.00
8.00	0.60
10.00	0.40
50.00	0.40



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	1.00	Silt
4	0.60	Sand
5	0.20	Gravel
6	0.00	Cobble
7	0.00	Boulder
8	0.00	Bedrock



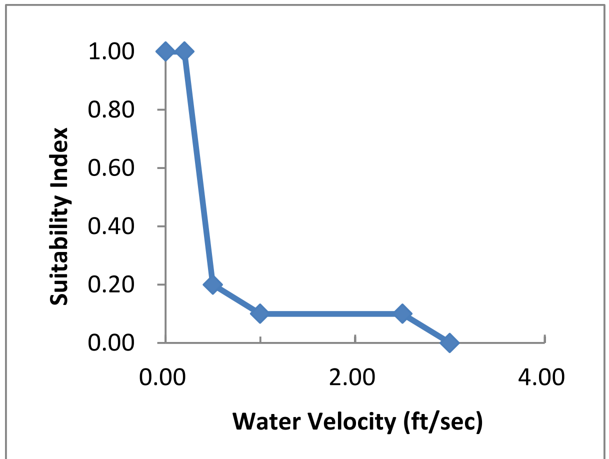
Source: McMahon, et al., 1984.

Species: Walleye

Lifestage: Adult

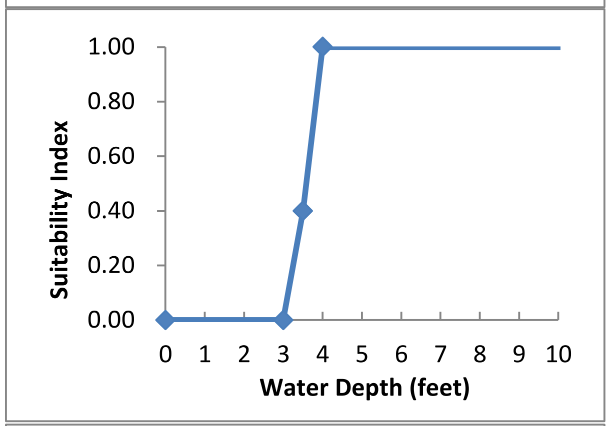
Velocity

Velocity	SI Value
0.00	1.00
0.20	1.00
0.50	0.20
1.00	0.10
2.50	0.10
3.00	0.00



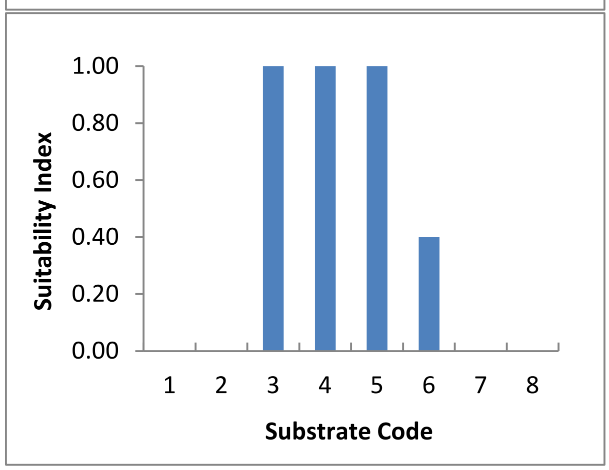
Depth

Depth	SI Value
0.00	0.00
3.00	0.00
3.50	0.40
4.00	1.00
50.00	1.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	1.00	Silt
4	1.00	Sand
5	1.00	Gravel
6	0.40	Cobble
7	0.00	Boulder
8	0.00	Bedrock



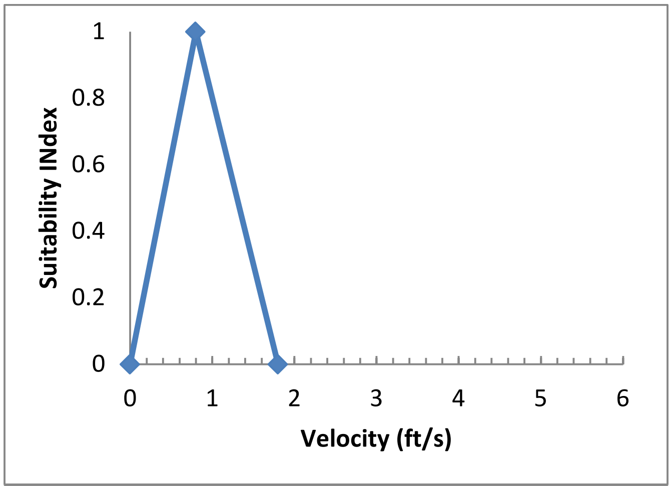
Source: McMahon, et al., 1984.

Species: Tessellated Darter

Lifestage: Adult and Juvenile

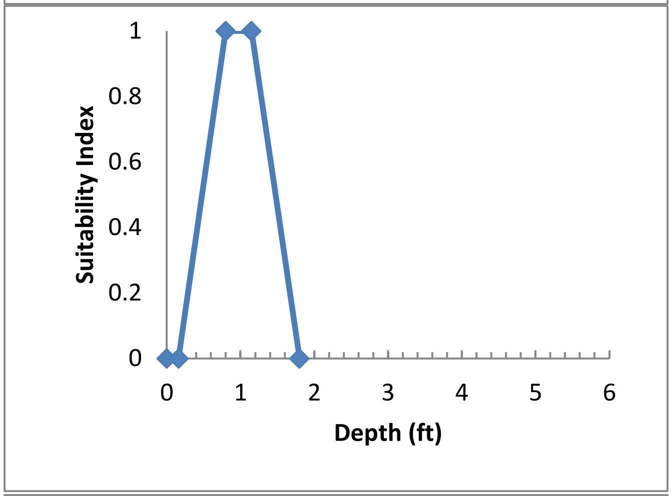
Velocity

Velocity	SI Value
0	0
0.8	1
1.8	0



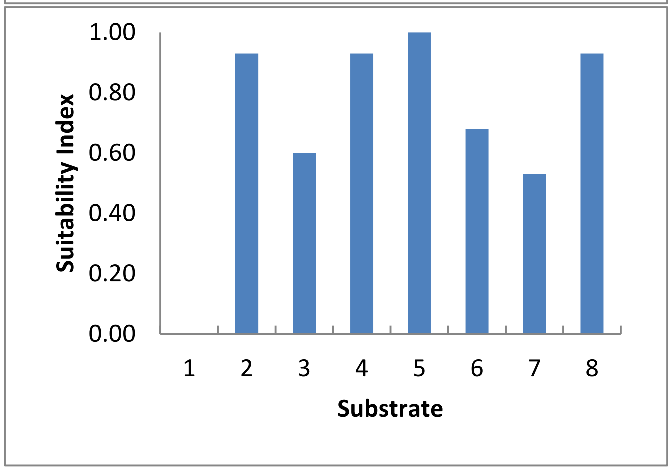
Water Depth

Depth	SI Value
0	0
0.16	0
0.8	1
1.15	1
1.8	0



Substrate

Code	SI Value	Type
1	0.00	Detritus/Organic
2	0.93	Mud/soft clay
3	0.60	Silt
4	0.93	Sand
5	1.00	Gravel
6	0.68	Cobble
7	0.53	Boulder
8	0.93	Bedrock



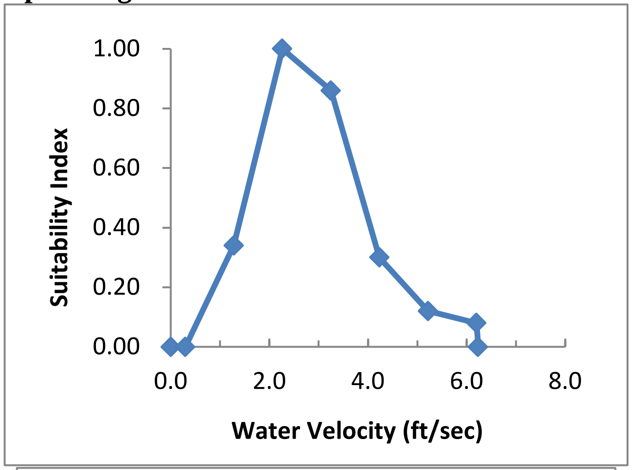
Source: PPL Bell Bend, 2012

Species: Sea lamprey

Lifestage: Spawning

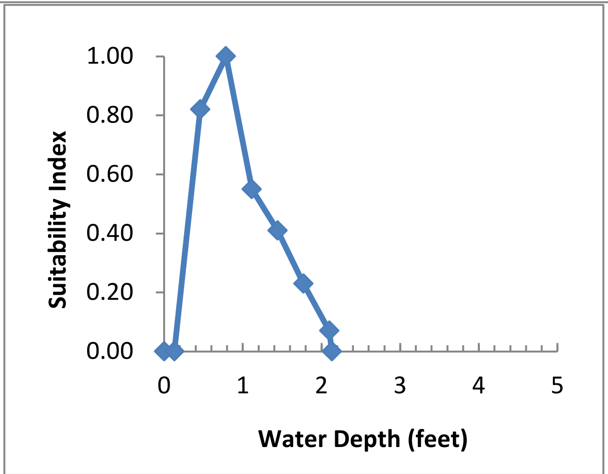
Velocity

Velocity	SI Value
0.00	0.00
0.30	0.00
1.28	0.34
2.26	1.00
3.25	0.86
4.23	0.30
5.22	0.12
6.20	0.08
6.23	0.00



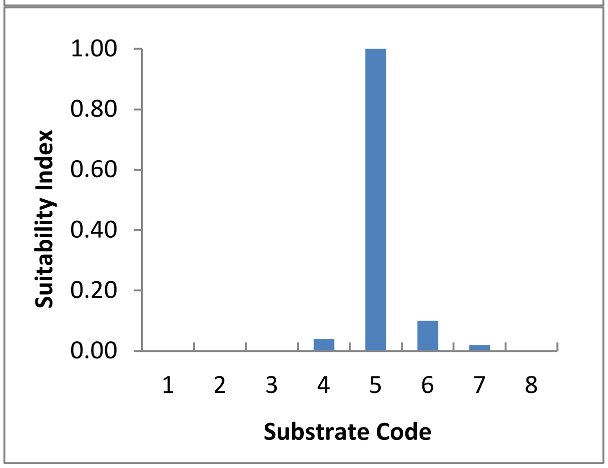
Depth

Depth	SI Value
0.00	0.00
0.13	0.00
0.46	0.82
0.79	1.00
1.12	0.55
1.44	0.41
1.77	0.23
2.10	0.07
2.13	0.00



Substrate

Substrate	SI Value	Type
1	0.00	Detritus/Organic
2	0.00	Mud/soft clay
3	0.00	Silt
4	0.04	Sand
5	1.00	Gravel
6	0.10	Cobble/rubble
7	0.02	Boulder
8	0.00	Bedrock

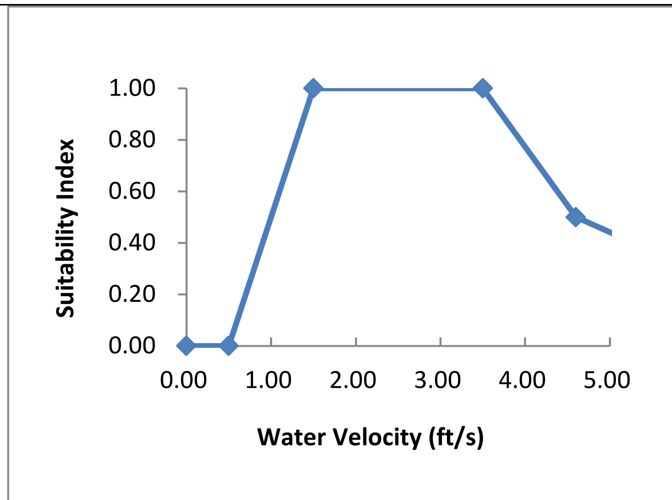


Source: Habitat Suitability Index for Sea Lamprey redds
Kynar & Horgan, 2013
BK-Riverfish, LLC
Consolidated Substrate Codes, converted from metric

Species: Macroinvertebrates

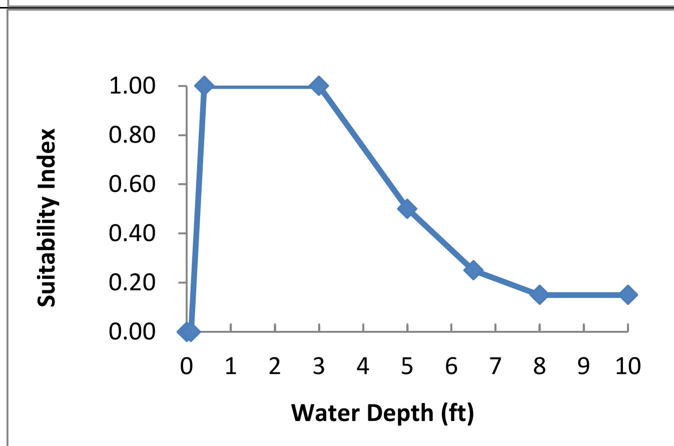
Velocity

Velocity	SI Value
0.00	0.00
0.50	0.00
1.50	1.00
3.50	1.00
4.60	0.50
8.00	0.00



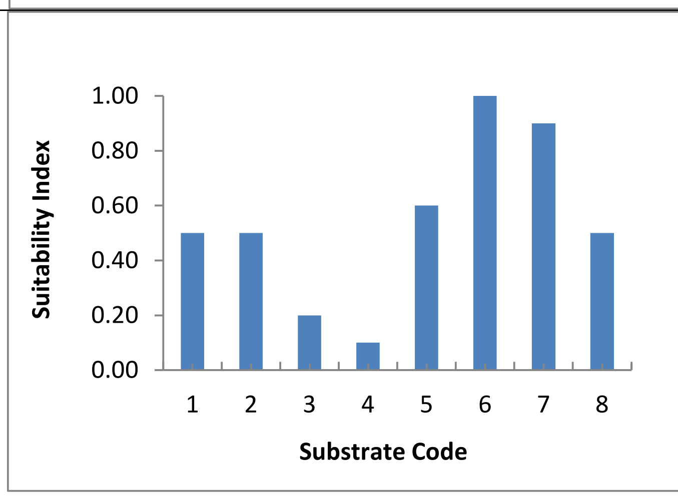
Depth

Depth	SI Value
0.00	0.00
0.10	0.00
0.40	1.00
3.00	1.00
5.00	0.50
6.50	0.25
8.00	0.15
10.00	0.15
100.00	0.00



Substrate

Code	SI Value	Type
1	0.50	Detritus/Organic
2	0.50	Mud/soft clay
3	0.20	Silt
4	0.10	Sand
5	0.60	Gravel
6	1.00	Cobble/rubble
7	0.90	Boulder
8	0.50	Bedrock



Source: Lamoille River IFIM

3.3.2 Evaluate Upstream and Downstream Passage of Adult American Shad

General Description of Proposed Study

An evaluation of upstream and downstream passage of adult American shad has been requested by FERC, USFWS, NOAA, MDFW, NHDES, NHFG, VTDEC, CRWC, TU and the Town of Gill. A telemetry study with both radio and Passive Integrated Transponder (PIT) tag types will be conducted to assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the Turners Falls Project and Northfield Mountain Project during both upstream and downstream migration. Additionally, video recording techniques will be used to evaluate passage efficiency at the Spillway fishway. FirstLight has spent considerable effort in the past studying adult shad passage at the Cabot and Gatehouse ladders (*see* Appendix E). As an initial phase of this study, FirstLight proposes to evaluate this information relative to the objectives of this study to determine if additional field data collection and analysis in these two specific locations is warranted.

A potential alternative to the current configuration of fishways at the project would be to minimize attraction to the Cabot ladder and operate a single fish lift facility at the dam. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. The effect of different levels of dam releases that would induce fish to move past the Cabot Station into the bypass reach and up to the dam will be evaluated during Year 1. If results of the Year 1 study indicate a potential to attract shad to the spillway ladder under flow releases that satisfy flow requirements from Study No. 3.3.1 and project operations then a high frequency ultrasound array will be tested at the Cabot Station tailrace in Year 2 that may further reduce shad attraction to the tailrace and guide shad into the bypass reach. Study No. 3.3.19 *Evaluate the use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace* proposes to evaluate the use of an ultrasound array to guide fish past the Cabot Station tailrace.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to identify the effects of the Turners Falls and Northfield Mountain Projects on adult shad migration. The study objectives are to:

- Describe the effectiveness of the Cabot fish ladder;
- Evaluate attraction, entrance efficiency and internal efficiency of the gatehouse ladder;
- Identify migration delays resulting from continued operation of the Turners Falls Project;
- Determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels;
- [61]Evaluate attraction, entrance efficiency and internal efficiency of the spillway ladder for shad reaching the dam spillway, under a range of spill conditions;
- Evaluate migration through the Turners Falls Impoundment;

[61] This may be achieved with existing information; FirstLight is awaiting data from the USGS Conte Laboratory.

- Identify impacts of Northfield Mountain, Cabot Station and Station No. 1 operations on upstream and downstream adult shad migration, including delays, entrainment, behavioral changes and migration direction shifts.

- Determine downstream passage route selection, timing/delay, and survival at Turners Falls Dam; and

- Determine passage rates and routes taken by shad migrating downstream through the canal, and evaluate Cabot Station fish bypass effectiveness.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

In 1992, the Connecticut River Atlantic Salmon Commission (CRASC) developed a draft document titled: *A Management Plan for American Shad in the Connecticut River Basin*.

Management objectives in the plan include the following:

- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.

- Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

- Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, aims to maximize the number of juvenile recruits emigrating from freshwater stock complexes via the following objectives::

- American shad must be able to locate and enter the passage facility with little effort and without stress.

- Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.

- Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

- To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

Based on the CRASC plan, USFWS seeks the accomplishment of several resource goals and objectives through the relicensing process for the Turners Falls Project and Northfield Mountain Project. Specific to American shad movement and migration, the agency's goal is to minimize current and potential negative project operation effects, such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement that could hinder management goals and objectives.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Shad Migration through Turners Falls Impoundment

Adult shad movements within the Turners Falls Impoundment were monitored during 1973-1975, primarily in the vicinity of the Northfield Mountain facility and the Vernon Dam tailrace (Layzer, 1975; 1977); these studies identified patterns of movement throughout the impoundment and determined that fish were often located in deeper areas. The location with the most shad detections was a deep area below the Northfield Mountain tailrace (Layzer, 1977). A deep, turbulent area known as the Narrows near French King Rock was identified as a location where delay occurred (Layzer, 1975).

Passage through the Turners Falls Complex

Many previous studies have been conducted on shad migration and/or passage within the Turners Falls Complex; for a list of publications and reports, see Appendix E. Adult shad movements have also been studied in the Turners Falls power canal starting in the mid-1980's (BioSonics, 1985; ERC, 1987); the approach to the Gatehouse fishway was identified as an obstacle to shad passage.

More recently, researchers at the Conte Lab have expended considerable effort monitoring passage at Turners Falls Project, with PIT, telemetry, or a combination of those methods having been employed from 1999 through 2012. PIT tagging studies, sometimes in combination with telemetry, were conducted during the past several years. These studies primarily evaluated shad passage performance through the Turners Fall complex. Areas of evaluation included Cabot fishway, Spillway fishway, Gatehouse gallery and fishway, the power canal, and the river from Holyoke to Turners Falls (Sullivan et al., 2002; CAFRC, 2003).

Further PIT tag assessment of the Cabot fishway (Sullivan, 2004) determined that 57% of shad that enter the fishway did not ascend past the lower third of the fishway, and problems were identified within the ladder (Haro & Castro-Santos, 2005). In general, the numbers of tagged fish passing through the Spillway fishway were too low for rigorous evaluation (Haro & Castro-Santos, 2005).

Some of the more recent studies have evaluated adult shad passage into the Gatehouse fishway following modifications intended to improve passage, using PIT and radio telemetry (Haro & Castro-Santos, 2009; Haro & Castro-Santos, 2010). Passage through the Gatehouse improved after modifications, but the studies were unable to discern the ultimate cause of improved passage because multiple modifications were made. This study also found that fish which were transported from Holyoke exhibited improved passage relative to those which ascended the Cabot fishway, possibly indicating that stress and delay due to passage through the Holyoke impoundment, and/or the Cabot fishway could result in reduced passage at the Gatehouse.

Whole-River Telemetry Studies

In addition, shad telemetry studies from the mouth of the Connecticut River to Vernon Dam and beyond were performed in 2011 and 2012. These data should help assess delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies. The studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam. Similar patterns were noted in 2012 (T. Castro-Santos, personal communication). Similarly, concerns relative to delay of downstream passage of spent shad remain, with existing unpublished USGS telemetry data sets suggesting that delays occur within the Turners Falls power canal.

The Need for Additional Information

Due to the relatively large amount of data gathered by previous studies, it is possible that some objectives of this study including but not limited to Cabot ladder and Gatehouse entrance efficiency, may already be partially satisfied, or that this study could be designed to address questions raised by results of those studies; however, the data require further analysis prior to reaching conclusions regarding their relevance to this study.

Project Nexus (18 CFR § 5.11(d)(4))

Project operations may affect passage route selection, entry into fishways, and create delays to upstream and downstream migration. The project's upstream and downstream passage facilities should be designed and operated to provide effective upstream and downstream fish passage.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The proposed study will employ telemetry and video monitoring techniques to evaluate shad migration through the Turners Falls and Northfield Mountain Projects and will build and expand on the information collected by the Conte Lab and FirstLight in previous studies. FirstLight has consulted with TransCanada to coordinate the study effort by using compatible telemetry equipment such that test fish from either study effort may be monitored. This collaboration will ensure that the studies take full advantage of the test fish that will be in the system. Due to the iterative process of collating and reviewing existing information to inform FirstLight and stakeholders in determining specific details for field studies, the Study Schedule section below identifies an estimated timeline for data review and consultation with the stakeholders.

Task 1: Review Existing Information

Substantial data have already been collected at the Turners Falls Project from multiple years of passage assessments conducted for FirstLight by Conte Lab researchers. These data may be useful to determine whether further study of those areas is required or determine whether objectives have already been met with recent existing data. Data were also collected during the 2011 and 2012 full river study and have not yet been analyzed. The study addresses migration and passage questions at the Turners Falls and Northfield Mountain Projects and the resulting data will be analyzed in 2013.

Task 2: Study Design and Methods

The study will monitor shad migration within the study area using a combination of active and passive radio telemetry techniques and video surveillance. These techniques are widely accepted as the best methods by which to assess fish migration and passage and have been used extensively at the Turners Falls Project in the past. The study design and methods presented herein generally follow those requested by the resource agencies.

Adult shad will be collected at Holyoke Dam and Cabot Ladder, half will be tagged with radio and PIT tags (double tagged) the other half will be PIT tagged. Radio-tagged fish will be tracked throughout the study area during both upstream and downstream migration with fixed antennae and mobile tracking (twice weekly, by boat, car and/or on foot). The use of PIT tags in addition to radio telemetry tags will provide an inexpensive safeguard in the event of radio tag loss, and will also allow for precise tracking within the fishways.

Sample Size

An adequate sample size will be essential to meet the objectives of the study. As such, a combination of factors were considered when determining an adequate sample including; tag performance, handling and transport affects, fish condition, tag expulsion and the percent of fish that pass Holyoke but do not migrate to Turners Falls (estimated to be 40% based on the whole River study conducted in 2011 and 2012). These factors tend to increase the number of test fish required but must be weighted against the functional limitations of effectively monitoring large numbers of fish within any one detection zone due to interference between tags. Based on these factors a total number of 340 shad will be doubled tagged and released within the study area, however result of Task 1 may further refine our sample numbers.. USFWS recommended a more extended release period however shad tagged earlier in the season tend to migrate further upstream (Ted Santos-Castro USGS, per. comm.) thus we propose to tag shad early to mid migration season to ensure a robust sample size in the Project area.

Each week, for five weeks, 96 shad (total: 480 shad) will be collected at the Holyoke Dam, half will be double tagged (240) and half will be PIT tagged and all will be released at Holyoke. The exact timing of the tagging effort will depend on the timing of the shad migration but is anticipated to begin the week of April 21, 2014 extending through the week of May 19, 2014.

A second group of 200 fish will be collected in early May, 2014 at Holyoke (100 fish) and Cabot Ladder (100 fish). One hundred of these fish will be double tagged and 100 will be PIT tagged only; transported upstream and released in the vicinity of the Gatehouse exit over a three week period (~66 fish each week) beginning the week of May 5, 2014 through the week of May 19, 2014. This test group will be used to assess the rate of movement through the Turners Falls impoundment and NMPS intake area as well as to ensure that a sufficient number of post spawned adults are available for the downstream passage assessment.

Further the USFWS recommended an additional group of 50 double tagged and 50 PIT tagged fish to be released at the Cabot Station Forebay. However, extensive effort to improve the Turners Falls fishways, especially the Gatehouse and/or Cabot fishways, has been underway since 1999. During this time, FirstLight and the Conte Anadromous Fish Research Center (CAFRC) have entered into annual technical service agreements to evaluate the fishways and develop recommendations. CAFRC conducted telemetry studies while FirstLight monitored overall fish passage and Project operating conditions.

The effort led to the installation of a new entrance from Cabot canal into the gatehouse fishway in 2007. Prior to installation of the new entrance, a false entrance was deployed in the canal and evaluated by CAFRC during 2004 and 2005. A total of 388 PIT-tagged shad were released in the canal during those evaluations; 117 of these fish were also radiotagged. The results indicated that substantial numbers of shad entered the prototype structure, thus FirstLight built the new entrance.

CAFRC and FirstLight then evaluated the performance of the new entrance annually from 2008 through 2012. A total of 1,177 PIT-tagged shad were released during the CAFRC studies, 493 of which were also radiotagged. This effort lead to structural changes at the new entrance and operational changes which have resulted in improved passage through the gatehouse fishway. FirstLight then engaged Alden Research Laboratory to develop a three-dimensional CFD model of the upper canal and gatehouse fishway. Analysis of the model results led to recommendations for structural modification of the original entrance; FirstLight has not yet discussed the results of the model with the stakeholders, but it believes implementation of the recommendations would substantially improve shad passage through the original entrance. The model results also suggested changes in the way headgates are deployed at the gatehouse, which FirstLight implemented prior to the 2013 migration season and may have played a role in improved shad passage observed during 2013.

Evaluation of shad passage through the gatehouse fishway, including the release of 1,565 tagged fish in the canal, has led to improved passage at gatehouse ladder, and prospects for further improvement are good with information already in hand. It is FirstLight's position that the information in hand is more than adequate to describe the movement of shad in the canal and through the gatehouse fishway under a wide range of operating conditions, thus it is proposing to analyze the existing data in more detail, but not to conduct additional field evaluation of shad passage through gatehouse fishway.

Monitoring Locations

Prior to the release of test fish, stationary monitoring stations (radio and PIT) will be established to address the issues identified among the project areas, and will provide an appropriate level of resolution to fulfill the objectives of the study. A preliminary list and map of proposed stationary receiver locations have been developed but may be further refined based on results of Task 1 (Table 3.3.2-1 and Figure 3.3.2-1 through Figure 3.3.2-4). Further, refinement may occur in the field if additional antennas and/or receivers are needed to provide adequate coverage. Range testing of each monitoring station will be conducted during study set-up and will provide the basis for a tag detection power analysis of those test fish detected at any one monitoring station and determine any overlap of detection zones. This information will be essential when analyzing the telemetry data.

The USFWS and other stakeholders have made recommendations about the location and configuration of the monitoring locations, most of which have been incorporated into this study plan. However, FirstLight has some modifications of recommended telemetry locations:

- USFWS has requested active radio telemetry monitoring stations at the entrance and exits to the three fish ladders (Cabot, Spillway and Gatehouse ladders). However, these locations will be monitored using PIT receivers and will provide a record of fish entering and exiting the fishways. Further, nearby active radio telemetry monitoring stations will provide a record of those fish that exhibit delay in the vicinity of the ladders.

- The USFWS has requested a monitoring station in the vicinity of the Conte fish passage building with detection extending across the entire width of the power canal. This monitoring location is redundant due to its close proximity (~1000ft) to the Cabot Forebay monitoring station, which will provide canal wide monitoring just downstream.

- USFWS has commented that the Station 1 Tailrace monitoring zone proposed by FirstLight is too wide, and recommends two monitoring arrays; one to detect fish attracted to the Station 1 discharge, and one to document fish that continue upstream toward the dam. These goals can be accomplished using a single receiver through the use of a tag detection power analysis in which those test fish attracted by the Station discharge and thus in close proximity of the monitoring antenna array will transmit at a distinctly higher power and presumably for an extended duration when compared to those that continue upstream allowing for the differentiation between the two behaviors.

- TU has recommended a monitoring station in the upper reservoir of NMPS to investigate entrainment. FirstLight will monitor the NMPS intake, should a fish be detected at the intake and not detected again by other monitoring stations (either up- or downstream) than the fish will be classified as entrained thus an additional monitoring station in the upper reservoir is not needed.

- TU has recommended monitoring stations further upstream than was proposed, in the vicinity of Stebbins Island. However, The TransCanada study team will be conducting their evaluation concurrently and will have monitoring stations located at the Northfield Mount Herman Boat

Launch and below the Vernon Dam. FirstLight will consult with the TransCanada Study Team and will coordinate tag and receiver configurations such that both studies may take advantage of all of the monitoring locations upstream of the Turners Falls Dam and thus the recommended monitoring locations would be redundant and unnecessary.

- TU commented that the study design does not provide a means by which to determine the downstream passage route at Cabot Station (i.e. entrainment vs. passage via the downstream bypass). The study design presented herein monitors the Cabot Station forebay and tailrace as well as the entrance to the downstream fish bypass with a combination of active radio telemetry and PIT methods and will provide the data necessary to determine the route of passage.

Manual tracking will also occur at least once per week to determine the locations of the tagged shad. The tracking crew will cover the entire study area until the entire project area from Holyoke to Mount Herman School is checked or until all radio-tagged fish have been located.

A series of test flows will be released in the Turners Falls bypass reach during this study. Flows between 2,500 and 6,300 cfs will be evaluated during late April to early June as they have been identified as the range of flows needed for successful spawning for ESA-listed shortnose sturgeon which occurs at the same time as upstream shad passage. Flows of 2,500 cfs, 4,400 cfs and 6,300 cfs will each be tested for at least 3 days during this time. In addition, from early June to early July (after the sturgeon spawning period) flows of 1,000 cfs and 1,500 cfs will also be tested for at least 3 days. These flow ranges may be further refined based on results of the instream flow study in the bypass reach (Study No. 3.3.1).

Tagging and Equipment

Adult shad will be collected at the Holyoke Dam and Cabot Ladder, tagged and released as described above (see section: Sample Size). Radio tags will be implanted through the esophagus and into the stomach; PIT tags will be implanted within the peritoneal cavity through a small incision on the ventral side of the fish.

The study will employ a combination of Lotek SRX receivers and Orion DSP based receivers manufactured by Sigma Eight Inc. Radio transmitters will transmit on several frequencies and are anticipated to range between 2 and 4 frequencies within the 150 to 151 megahertz band and will be uniquely coded to allow for individual fish identification. Transmitters will be supplied by Sigma Eight Inc. (model TX-Px-I-450) and will allow for in-field coding should ambient radio noise preclude the use of any particular frequency and code combination. The transmitters will employ a motion sensor and be configured such that the 2 second burst interval shifts randomly to minimize repeated collision of tags on the same frequency. The tag parameters include:

- Width - 12mm
- Length - 40mm
- Mass - 8g
- Apparent mass in water - 3.5g
- Estimated tag life - 360 days with a 2 second burst interval

The PIT receivers and tags will be half-duplex and supplied by Oregon RFID. The tags will be 32mm in length and read only with a 64 bit unique ID (ISO 11784/11785 compatible).

Video Monitoring

Video monitoring will be used for specific study areas such as the Spillway fishway. Use of video monitoring of the Spillway fishway will provide data on fishway efficiency; shad attempting to pass would be monitored versus only those shad that have been tagged. FirstLight proposes to conduct video monitoring using the Delta Vision commercial series of underwater video camera and lighting manufactured by Ocean Systems Inc. This system was recommended by A. Haro (Conte Lab) and has proven effective at other facilities. Video data will be recorded on a dedicated digital video recorder (DVR). Video monitoring will not occur at the Cabot ladder since this facility has been studied numerous times over many years.

Task 3: Evaluation of Mortality

The telemetry study will employ motion sensor telemetry tags that will give researchers an indication of passage induced mortality. The tags will be configured such that the 2 second burst rate will switch to a 10 second burst rate upon triggering. Mortality will be assessed at locations where tagged fish are subjected to entrainment or passage via spillage and will include downstream quiescent areas where dead fish are likely to settle including the Hatfield S-Turn and deep pool areas. If mortality estimates cannot be assessed using motion sensor tags in Year 1 then FirstLight will consider a Hi-Z tag study to determine mortality at Cabot and Station No. 1 in Year 2.

Task 4: Reporting

An initial report summarizing existing data evaluated in Task 1 will be prepared. Following the completion of Tasks 2-3, a report will be prepared including a summary of the results of the collected telemetry data along with analyses of American shad migration and behavior throughout the study area in the Connecticut River. The report will include:

- graphical portrayals of movement identifying passage routes;
- depictions of the rate of movement from the release sites up to and through any passage facilities in tabular form;
- an analysis of telemetry data in relationship to environmental and operational conditions; and
- a summary of mortality by passage route in tabular form.

The CFD modeling results (Study No. 3.3.8) will be coupled with the telemetry results, passage counts and environmental variables (water temperature, river flow) to understand which conditions are preferable for guiding migrating fish to the entrances.

Flow and project operational parameters shown in Table 3.3.2-2 will be utilized in the data analyses. All data used to develop the report will be included in an appendix. In addition data will be shared with Stakeholders in digital form.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The analysis of existing data and data from the requested study will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at Holyoke to release at upstream locations. We are not aware of any other study technique that would provide project specific fish behavior and migration information to adequately assess existing project operations and provide insight into possible operational and/or structural measures needed to address impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to range from $500,000 to $600,000 based on past Turners Falls Project studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the Spillway fishway would add a modest cost to this study.

Study Schedule (18 CFR § 5.11(b)(2) and (c)

Adult American shad migrate into the lower Connecticut River during late March or early April. Fish lift operation at the Holyoke Project, located downstream, typically begins on April 15, with shad reaching Cabot Station in late April or early to mid- May. As such, the telemetry based monitoring system will be deployed, calibrated and tested in late March and early April 2014, prior to the arrival of adult shad in the study area. Test fish will be collected at the Holyoke Project and released at Holyoke and above Turners Falls Dam. Prior work conducted in the Connecticut River has shown that early migrating shad have the strongest migratory drive, traveling the farthest upstream (T. Castro-Santos, USGS Conte Lab, personal communication). These early migrants will be targeted for use in the study to maximize the potential for test fish to reach and interact with the Turners Falls and Northfield Projects. American shad migrate up river when water temperatures are generally between 12 and 20°C; spawning occurs from 14 to 23°C when river flow is generally declining from the spring peak. Spent outmigrants travel downstream shortly after spawning. The exact timing of the out-migration will be dependent on many factors, most notably water temperature. The study field work is anticipated to conclude by early July 2014. Depending on the results of the 2014 study results, a second year of field work may be conducted.

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Table 3.3.2-1: Proposed locations and types of monitoring and telemetry equipment proposed for the upstream and downstream passage of adult shad study.

Location	RM	Receiver Station
Red Cliffe Canoe Club (upstream of Holyoke Dam)*	86.5	A Lotek SRX receiver with yagi antenna will monitor the full width of the River
Sunderland Route 116 Bridge	111	A Lotek SRX receiver with yagi antenna will monitor the full width of the River
Montague Wastewater	119.5	A Lotek SRX receiver with yagi antenna will monitor the full width of the River
Deerfield River Confluence	119.5	An Orion or Lotek SRX receiver with yagi antenna will monitor the full width of the Deerfield River upstream of its confluence
Cabot Station Tailrace	120	Two radio receivers will monitor the tailrace area; 1) Lotek SRX with yagi antenna–to monitor the full river width (far field) 2) Lotek or Orion with yagi antenna– to monitor attraction to the Cabot Station tailwater (near field)
Cabot Station Forebay	120	Two radio receivers and one PIT receiver will monitor the Forebay area; 1) Lotek or Orion with yagi antenna will monitor the full width of the canal immediately upstream of the Cabot station 2) Orion with dipole antenna and PIT receiver will monitor the entrance to the Cabot downstream bypass.
Cabot fish Ladder	120	Two pit tag receivers will monitor the entrance (1) and exit(1) to the ladder
Rawson Island	120.5	The North and South channel will be monitored independently using either one Orion or Lotek SRX

Location	**RM**	**Receiver Station**
		receiver employing antenna switching or with two receivers
Station 1 Forebay	121	A Lotek SRX or Orion with yagi antenna will monitor the full width of the intake canal
Station 1 Tailrace	121	A Lotek SRX or Orion 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
Turners Falls Spillway Ladder	122	Five PIT tag receivers will monitor the ladder; 1) Entrance 2) Between the ladder entrance and first turn pool 3) At the turn pool exit 4) Downstream of the counting window 5) Exit
Below Turners Falls Dam	122	Two Orion or Lotek SRX receivers with yagi antennas 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
Gatehouse Ladder	122	Four PIT receivers will monitor the Gatehouse Ladder; 1) Entrance 2) First vertical slot 3) Viewing window 4) Last vertical slot
Upstream End of the Canal	122	A Lotek or 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

Location	**RM**	**Receiver Station**
Turners Falls Impoundment	122	A Lotek with a yagi antenna will monitor the full width of the impoundment
NMPS Gill Bank	126.5	A Lotek with a yagi antenna will monitor the full width of the impoundment
NMPS Intake	127	A Lotek or Orion with a yagi, dipole antenna and bottom droppers will monitor the intake area
Shearer Farms**	127.5	A Lotek with a yagi antenna will monitor the full width of the impoundment

Notes: See Figure 3.3.2-2 through 3.3.2-4 for specific locations.

** Holyoke Dam is located at River Mile 86.0.*

*** Other upstream locations will be monitored by the TransCanada Study Team and includes:*

The Northfield Mount Herman Boat Launch, and

Downstream of the Vernon Dam

Table 3.3.2-2: Proposed flow and Project operational parameters which will be compiled for the adult American shad movement study.

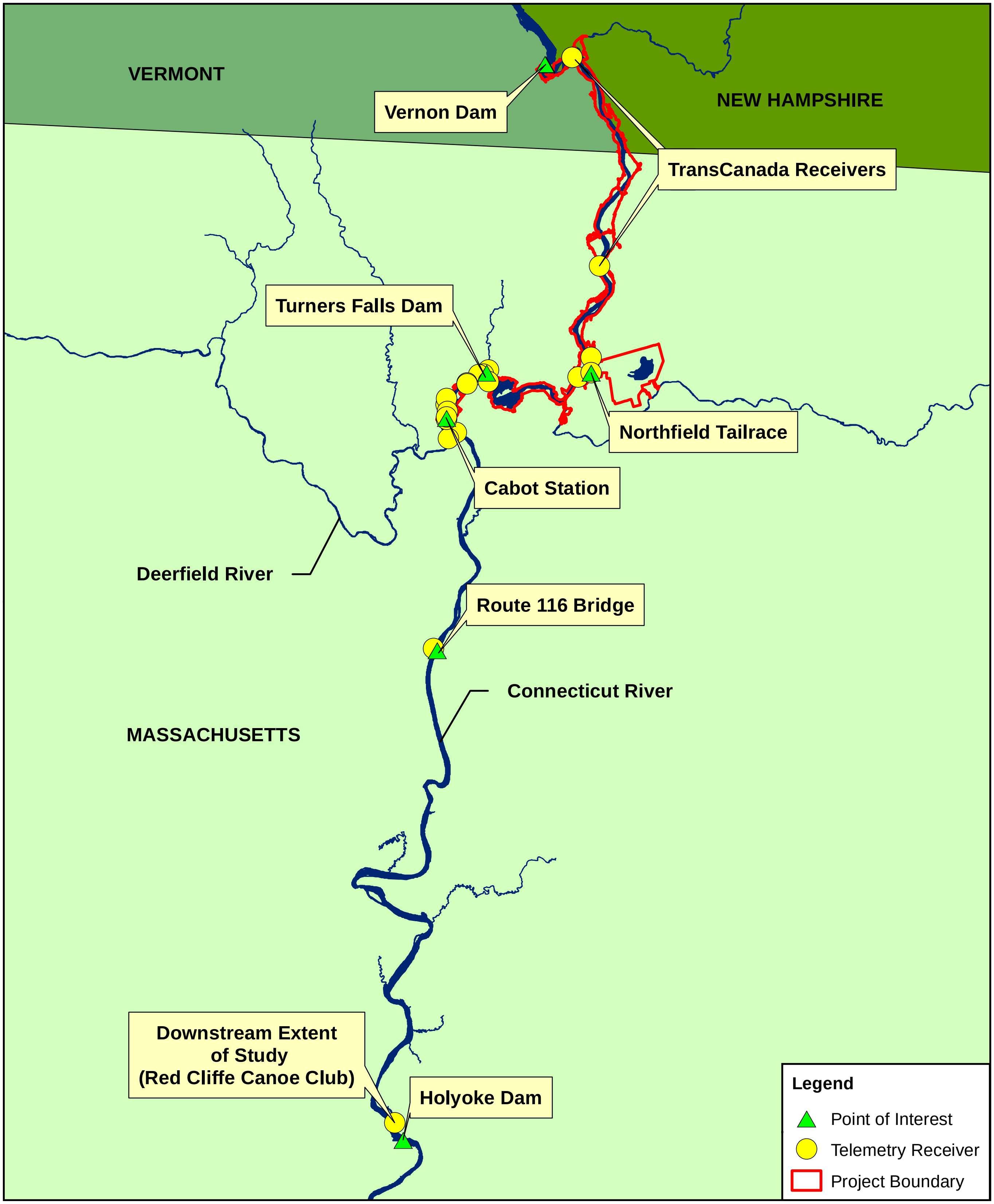
Parameter	Units
Water Surface Elevation	
Vernon Tailwater	Feet, above mean sea level
Northfield Mountain Tailrace	Feet, above mean sea level
Turners Falls Impoundment @ Boat Barrier	Feet, above mean sea level
Turners Falls Dam	Feet, above mean sea level
Discharge	
Vernon Dam	cfs
Ashuelot River	cfs
Millers River	cfs
Connecticut River Natural Routed Flow	cfs
Bypass Reach Flow	cfs
Deerfield River at West DeerFGS, MA	cfs
Fishway Discharge	
Cabot Ladder	cfs
Spillway Ladder	cfs
Gatehouse Ladder	cfs
Downstream Fish Passage Sluiceway	cfs
Station Generation	
Northfield Mountain	MW
Station No. 1	MW
Cabot Station	MW

Notes:

Data interval will be on at least a 15-minute time step, pending data availability.

All MW data will be converted to approximate flow through a ratio of design flow (cfs) to design capacity (kW)

Connecticut River Natural Routed Flow is a calculation summing discharges from Vernon Station, Ashuelot River and Millers River



FIRSTLIGHT POWER RESOURCES

Revised Study Plan

N

0 2.5 5 10 Miles

Figure 3.3.2-1: Overview of American Shad Radio Telemetry Locations

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FirstLight Power Resources GDF SUEZ

FIRSTLIGHT POWER RESOURCES

Revised Study Plan

N

0 600 1,200 2,400 Feet

Figure 3.3.2-2: American Shad Radio Telemetry Locations near Cabot Station

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FirstLight Power Resources GDF SUEZ

FIRSTLIGHT POWER RESOURCES

Revised Study Plan

Figure 3.3.2-3: Proposed American Shad Radio Telemetry Locations near Turners Falls Dam

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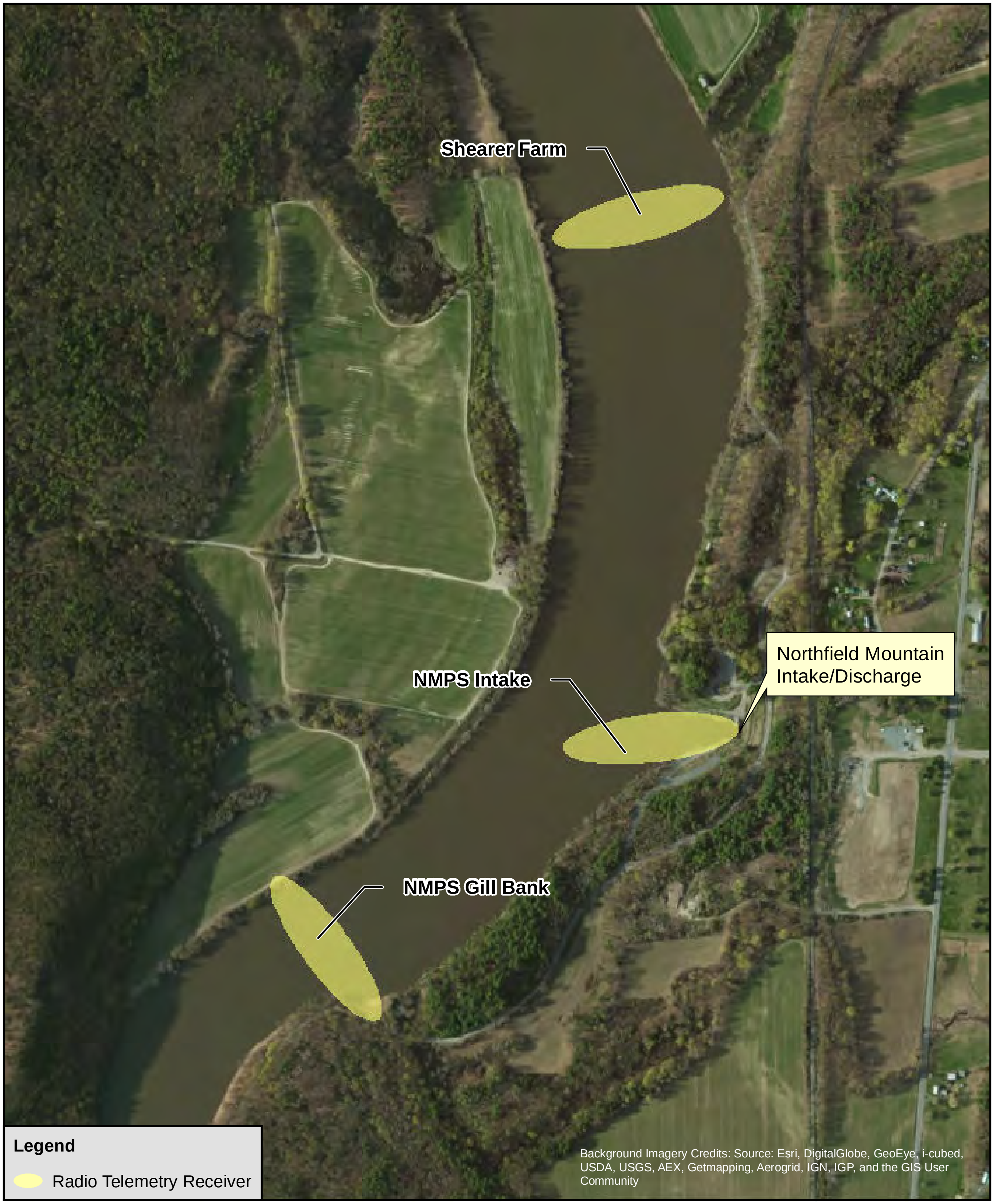

FirstLight Power Resources
GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES

Revised Study Plan

0 375 750 1,500 Feet

Figure 3.3.2-4: Proposed American Shad Radio Telemetry Locations near Northfield Mt. Intake

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3.3.3 Evaluate Downstream Passage of Juvenile American Shad

General Description of Proposed Study

An evaluation of downstream passage of juvenile American shad has been requested by USFWS, NOAA, MDFW, NHFG, VTDEC, CRWC, TU and the Town of Gill. A field study of juvenile American shad outmigration through the Turners Falls Impoundment and power canal and over Turners Falls Dam, will be conducted to assess outmigration success.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to determine if project operations affect juvenile American shad outmigration success.

Study objectives are to obtain information to:

- Assess the effects of the Projects on the timing, orientation, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that pass downstream through the power canal versus over the dam under varied operational conditions, including a range of spill conditions;
- Determine the rate of downstream movement within the impoundment, over the dam and through the bypass reach, or through the power canal;
- Determine survival rates for juveniles spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
- Determine downstream passage timing, route selection, and rate of movement of juvenile shad through the power canal to Station No. 1, Cabot Station and the Cabot Station bypass;
- Determine the rate of entrainment at the Northfield Mountain Project;
- Determine the survival rate for juvenile shad entrained into Station No.1; and
- Determine the survival rates for juvenile shad entrained at Cabot Station.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

In 1992, the CRASC developed a draft document titled: *A Management Plan for American Shad in the Connecticut River Basin*.

Management Objectives in the plan include the following:

- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
- Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

- Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, aims to maximize the number of juvenile recruits emigrating from freshwater stock complexes.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

American shad have had access to spawning and rearing habitat upstream of Turners Falls Dam since passage was provided via fishways in 1980. Effective downstream passage and successful spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River. American shad broadcast spawn with the highest spawning activity occurring in runs and lowest activity in pools and riffle/pools (Ross et al., 1993). Field research by Ross et al. (1993) in the Delaware River further noted that a combination of physical characteristics that seems to be avoided by spawning adults is slow current and greater depth. American shad year-class strength has been shown to depend on parent stock size and environmental conditions during the larval life stages (Creeco & Savoy, 1984). Rate of movement in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski et al., 2003). During the peak of the migration, juvenile shad captured by O'Leary and Kynard (1986) averaged 97 – 100 mm in total length.

Juvenile shad abundance has been shown to be negatively correlated with Connecticut River flow in June (Crecco & Savoy, 1984). Juvenile shad are abundant in many river locations throughout the summer, where they provide a forage base for predatory fish. Although some fish may move downstream through the Project from August to November (O'Donnell and Letcher, 2008), the peak seaward migration out of the Connecticut River occurs in September through October.

Much daily movement occurs in evening and night hours until about 2300 h. 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.

Downstream juvenile clupeid passage studies were conducted at Turners Falls in the fall of 1991 and 1992 (Harza & RMC, 1992; 1993) to determine the percentage of juvenile shad and herring that passed downstream via the bypass log sluice and the Cabot Station turbines. An estimated 54% (average bypass rate, weighted by estimated number bypassed) of the juvenile American shad approaching Cabot Station were bypassed via the log sluice prior to installation of a special weir in the mouth of the bypass in 1992. The weir design was developed to narrow and deepen the entrance to the bypass and reduce the rate of flow acceleration approaching it. Following installation of the weir an estimated 87% of juvenile shad passed through the log sluice in 1992. A follow-up study during fall 1993 determined that 94.4% of juvenile clupeids passed downstream via the log sluice after it was equipped with artificial above-water lighting (RMC, 1994).

Project Nexus (18 CFR § 5.11(d)(4))

Project operations may affect passage route selection, entry into bypass, and rate of downstream migration. The Project's downstream passage facilities need to be designed and operated to provide effective downstream fish passage.

Adult American shad passed upstream of Turners Falls Dam utilize upstream spawning habitat. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require downstream passage to complete their lifecycle and promote recruitment to the basin.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The impact to juvenile shad outmigrants by project operations will be studied using a combination of approaches including hydroacoustics, radio telemetry, and the use of HI-Z Turb'N tags. The study objectives will be met by a tasked approach and the study will be conducted in 2014.

Task 1: Evaluation of Timing, Duration and Magnitude of Migration

The timing, duration, and magnitude of juvenile shad migration at the Turners Falls Project will be evaluated over a range of available river flow (high and low river flow) and operational conditions (reduced pumpback and 3 to 4 unit pumpback at Northfield). Hydroacoustics will be deployed in the forebay area at Cabot Station, at the Gatehouse and the Northfield Mountain Project intake (August through October). An array of split beam transducers will be deployed to provide sufficient coverage of the targeted areas. The exact location, orientation and number of transducers will be determined during reconnaissance and test deployment prior to the commencement of the survey to optimize spatial coverage. To the extent possible, transducers will be mounted in areas of limited turbulence and ambient noise and away from eddies or other hydraulics where fish "milling" would occur. Ideally transducers (333 to 430 kHz) would be mounted as close to the target area as possible.

Data will be recorded and archived continuously; however at the Northfield Mountain intake only data recorded during 1 hour before and during pumpback mode will be analyzed. Depending on the configuration of the system and the target area, fish moving in the direction of the target area, fish size, or other sampled parameters can potentially be used to identify acoustic targets corresponding to shad. Acoustic targets can be filtered by size and supporting data used to apportion the number of fish by size class. Current plans are to have the hydroacoustic expert on site August 13, 2013. It is assumed that numbers of juvenile fish will be estimated based on echo-integration.

Data will be recorded on site. Transducers will be inspected and serviced by a qualified technician on a weekly basis, and data will be remotely downloaded and reviewed at least once per week during sampling to qualitatively view trends, and to ensure the system is functioning properly. During analysis, echo data will be analyzed using standard analytical tools such as Echoview ® software, and related to concurrent station operation, water temperature, climatic conditions and Connecticut River flow. Data will be displayed in both tabular and graphic form, and include hourly daily, monthly and full season estimates. To the extent possible data output will also show patterns of spatial distribution of targets in the intake area. The exact number and position of the hydroacoustic transducers will be determined in the field but it is anticipated that a surface transducer with a downward orientation would be deployed. Data from the hydroacoustics will provide information on the timing, frequency and magnitude of the migration, as well as estimates of juvenile shad entering and exiting in the Canal and estimates of the numbers entrained at the Northfield Mountain Project. The downstream bypass will be sampled concurrently. Concurrent bypass sampling will be conducted over several discrete evenings (12 to 18) to ground truth the hydroacoustic data and compare the percent of juvenile shad passing via the Cabot sampler and Cabot Station.

Task 2: Evaluate Route of Passage

Radio telemetry methods will be used to assess routes of downstream passage and occurrences of delay, if feasible. Juvenile shad are fragile and can be difficult to reliably test using methods requiring handling and tagging. However, prior telemetry studies conducted with juvenile shad have had success, particularly when large sized (~120mm) hatchery juvenile test fish were used. FirstLight plans to work with the USFWS to hatchery raise juvenile shad to this larger size for use during the tagging studies. The North Attleboro National Fish Hatchery has retained larval and juvenile shad to determine growth rates during the fall of 2013 to ensure suitable sized juvenile shad are available for the fall of 2014 tagging (Ken Sprankle, USFWS, per. comm.).FirstLight will consult with the Stakeholders about specifics on transport and holding facilities for these fish prior to study implementation.

The routes of passage will be monitored via a radio telemetry monitoring array such that each route of passage (i.e., past NorthFGS, over the dam, Station No. 1, Cabot Station, the fish bypass and through the canal) is monitored. Receivers will be set up above and below Northfield Mountain and the Turners Falls Dam to determine route of passage, delay and spillage survival (Table 3.3.3-1). Study fish will be radio tagged and released about 2 miles upstream of Northfield and at least 1 mile upstream of the Turners Falls Dam. It is proposed that groups of fish tagged with external radio transmitters (5 mm wide X 3 mm high X 14 mm long with a weight less than 0.5 g, 8 day battery life) will be released. Proposed sample sizes for this study is a total of 144 fish that will be released on six days during the migration period above Northfield and 80 fish that will be released over 4 days above the Gatehouse. FirstLight and TransCanada will consult before purchasing tags to ensure all radio telemetry receivers at the Projects can detect them.

Task 3: Turbine and Dam Passage Survival

HI-Z Turb'N tags will be used to empirically determine rates of survival for fish entrained at Station No. 1, Cabot Station and passing over the dam. As currently envisioned, a minimum of 150 tagged shad Hi-Z and radio tags) will be released into turbines for testing and an additional 150 will be released into the tailrace as controls. This sample size should result in a survival estimate that is $\pm$ 10% 90% of the time (α=0.10). An additional 125 fish will be released above the dam to determine spill mortality (25 fish per 4 bascule gates and 1 tainter gate.

The tagged fish will be proportionally allocated by the number of different turbine types at Station No. 1 and Cabot Station. All six turbines at Cabot Station are similar type and hydraulic capacity so testing will be conducted at one turbine at Cabot Station as a representative unit. Data for that unit will be extrapolated to calculate a total station survival rate. Station No. 1 has five Francis style turbines. Four of the five turbines are similar in speed, hydraulic capacity (490 to 560 cfs) and have double runners and one is smaller (140 cfs) with a single runner. Testing will be conducted at two turbines at Station No. 1 (at one to represent the four larger units and at the smaller capacity unit). Like Cabot, the data for the representative unit will be extrapolated to calculate a total survival rate for all four units and combined with the data for the smaller unit for a total station survival rate. Tests will be conducted by injecting tagged fish into the selected turbines at Cabot and No. 1 Stations at or near best efficiency conditions for each test unit. Fish will be recovered from the tailrace, examined for injuries and held for 48 hours to determine latent mortality.

Task 4: Reporting

The hydroacoustic, radio telemetry and HI-Z Turb'N tag data will be analyzed relative to passage route(s) timing, frequency, magnitude and survival. Telemetry data from each fish will be portrayed graphically including movement and timing through the project area with passage route selection identified. Movements will be analyzed relative to environmental and operational parameters. For the entrainment task, survival through each turbine and spill gate tested will be calculated based on the number of tagged fish injected into a turbine or gate that are alive immediately after testing and 48 hours later. Results will be adjusted for control fish survival. All injuries will be reported. Total through-project survival will be calculated based on results of the survival study, other related studies as well as operations.

This information will be compiled into a report and will include the methods used, results, a discussion and conclusions. Data use to develop the report will be made available to stakeholders in digital form.

Table 3.3.3.-1: Location and types of telemetry receivers proposed for the juvenile shad emigration study.

Location	RM	Receiver Station
Montague Wastewater	119.5	A Lotek SRX receiver with yagi antenna will monitor the full width of the River
Cabot Station Tailrace	120	Lotek SRX with yagi antenna–to monitor the full river width
Cabot Station Forebay	120	Two radio receivers will monitor the Forebay area: 1) Lotek or Orion with yagi antenna will monitor the full width of the canal immediately upstream of the Cabot station 2) Orion with dipole antenna will monitor the entrance to the Cabot downstream bypass
Station 1 Forebay	121	A Lotek SRX or Orion with yagi antenna will monitor the full width of the intake canal
Station 1 Tailrace	121	A Lotek SRX or Orion 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 Orion or Lotek SRX receivers with yagi antennas 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 End of the Canal	122	A Lotek or 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
Turners Falls Impoundment	122	A Lotek with a yagi antenna will monitor the full width of the impoundment
NMPS Gill Bank	126.5	A Lotek with a yagi antenna will monitor the full width of the impoundment
NMPS Intake	127	A Lotek or Orion with a yagi antenna will monitor the intake area
Shearer Farms	127.5	A Lotek with a yagi antenna will monitor the full width of the impoundment

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort will adequately address the study objectives. The estimated cost for the study is expected to be between $400,000 and $500,000, with much of the costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and HI-Z Turb'N tags, and related fieldwork labor).

Study Schedule (18 CFR § 5.11(b)(2) and (c))

The peak out-migration of juvenile American shad typically occurs in September and October as water temperature cools. However, recent work conducted by O'Donnell and Letcher (2008) in the Connecticut River suggests that the emigration starts as early as the middle of August. As such, the hydroacoustic monitoring equipment will be deployed, calibrated, and tested in the first half of August becoming operational no later than August 15th. Study tasks will be conducted during the out-migration season, August 15 through the end of October, 2014.

Downstream American eel study (Study No. 3.3.5) will require hydroacoustic monitoring during roughly the same period because of overlap in the emigration periods of adult eel and juvenile shad. As such, these studies will be conducted concurrently, within the same study year, to take advantage of cost saving related to monitoring equipment rental, deployment, calibration, data management and analysis.

Because the study effort will be ongoing when the Initial Study Report is due to Stakeholders in September 2014, FirstLight proposes to provide Stakeholders with a study report supplement to summary downstream juvenile shad monitoring results in February 2015, followed by a meeting to discuss any potential additional information needs. The outcome of that discussion will determine if further study planning efforts are necessary for 2015.

Literature Cited

Atlantic States Marine Fisheries Commission. (2010). *Amendment #3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management)*. Washington, D.C: Author.

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O'Donnell, M. & Letcher, B. H. (2008). Size and age distributions of juvenile Connecticut River American shad above Hadley Falls: influence on outmigration representation and timing. *River Research Applications , 24*, 929-940.

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RMC Environmental Services, Inc. [RMC]. (1994). *Emigration of juvenile clupeids and their responses to light conditions at the Cabot Station, Fall 1993*. Prepared for Northeast Utilities Service Company, Berlin, CT.

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Zydlewski, J., McCormick, S. D., & Kunkel, J. G. (2003). Late migration and seawater entry is physiological disadvantageous for American shad juveniles. *Journal of Fish Biology, 63*, 1521-1537.

3.3.4 Evaluate Upstream Passage of American Eel at the Turners Falls Project

General Description of Proposed Study

An evaluation of upstream American eel passage has been requested by USFWS, NHFG, MDFW, NHDES, VTDEC, CRWC, and TU. FirstLight proposes to complete a study to assess upstream American eel passage at the Turners Falls Project through trapping and visual observation of eel concentration areas. FirstLight anticipates conducting visual surveys for eel concentration areas in 2014 and using this information to inform trap placement in 2015.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to identify and assess potential locations for upstream American eel passage at the Turners Falls Project.

This study has two objectives:

- Identify concentrations of eels staging in pools or attempting to ascend wetted structures; and
- Assess whether eels can be passed in substantial numbers and whether sites are viable for permanent passage structures.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The goals of the Atlantic States Marine Fisheries Commission (ASMFC) management plan for American eel (2000) include: (1) protect and enhance American eel abundance in all watersheds where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel (letter from NOAA Fisheries, Comments on FirstLight Power Resources Notice of Intent to File License Application, February 27, 2013). Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process (letter from NOAA Fisheries, Comments on FirstLight Power Resources Notice of Intent to File License Application, February 27, 2013).

In addition, the CRASC developed a Management Plan for American eel in the Connecticut River Basin in 2005. The goal of the plan is "*to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem.*" Management objectives in the plan include the following:

- Protect and enhance eel populations where they currently exist;
- Where practical, restore populations to waters where they had historical abundance;
- Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin, and;
- Comply with all requirements of the Fishery Management Plan of the ASMFC.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

While eels have been known to ascend the Turners Falls fishways, efficiency is unknown and they are typically operated only during the American shad passage season. Eels are currently able to pass the Turners Falls Dam complex (as evidenced by documented presence of eels upstream), but the total number of eels attempting to pass Turners Falls and the proportion successfully passing the Turners Falls Project are unknown (letter from NOAA Fisheries, Comments on FirstLight Power Resources Notice of Intent to File License Application, February 27, 2013).

The Holyoke Project has operated upstream eel passage facilities since 2004. In 2012, these facilities passed over 40,000 juvenile eels (letter from NOAA Fisheries, Comments on FirstLight Power Resources Notice of Intent to File License Application, February 27, 2013). There is eel rearing habitat in the 35-mile reach between the Holyoke and Turners Falls Dams; however, it is likely that some eels will attempt to continue upstream to access habitat above the Turners Falls Dam.

Project Nexus (18 CFR § 5.11(d)(4))

The Turners Falls Project may directly impact upstream American eel as Project structures create impediments to migration.

The investigation area includes the following features of the Turners Falls Project:

- Cabot Station discharge area.
- Station No. 1 discharge area.
- Various canal discharge areas.
- Turners Falls Dam.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The study will be performed in accordance with the following methodologies.

Task 1: Systematic Surveys

Systematic surveys of eel presence and relative abundance will be conducted 10-12 times during the 2014 eel upstream migratory season. The first survey will be initiated within one week of eels being observed downstream of the project area at the Holyoke eel pass, with subsequent surveys occurring at night after precipitation events throughout the 2014 migration season. Each survey will consist of visual inspection on foot or by boat in areas where eels are likely to concentrate as they attempt to climb structures wetted by spill or leakage flow in the Turners Falls Dam complex area. The survey crew will use a red light if the water is not turbid and a white light when the water is deeper and more turbid to observe the eel; each site will be surveyed for at least 30 minutes. These locations, shown in Figures 3.3.4-1 and 3.3.4-2, include:

- Cabot Station spillway (emergency water control gates).
- Cabot fishway (dewatered state, will provide some attraction water).
- Cabot log sluice.
- USGS Conte Lab flume outfall.
- Station No. 1 outfall.
- Small turbine and process water outfalls from the Cabot Canal.
- Spillway fishway attraction water stilling basin.
- Leakage points along the downstream face of Turners Falls Dam (as site safety conditions allow).

Recorded data will include location, observation of eels (presence, absence) and estimated numbers, approximate sizes, behaviors, and time/date of observation, recent weather, and current discharge.

<u>Task 2: Trap Collections</u>

Areas identified in Task 1 as having eels present in sufficient numbers will be targeted as potential areas for permanent eel trap/passes and will be initially assessed using temporary/portable traps in 2015. At a minimum (regardless of survey results), temporary traps will be installed at the following locations in 2015:

- Cabot fishway attraction flow stilling basin (during dewatered fishway period),
- Station No. 1 discharge, and
- Spillway fishway attraction flow stilling basin (during watered and dewatered fishway period).

The temporary trap/passes will be designed and built for each location, and operated throughout the eel upstream migratory season, beginning within one week of eels being recorded at the Holyoke eel pass and continuing through October. Ramp-type traps, supplementary attraction flow will be provided. Traps will operate daily (24 hours per day) and will be checked every two to three days or after rain events to quantify the catch. Recorded data will include location, trapping interval, numbers of eels trapped, relative eel sizes, and hydraulic and environmental conditions during the trapping period.

The temporary trap/pass will be constructed of ¾-in marine plywood and will typically be 60 in long and 24-in wide with 72-in-long and 5-in-wide sides with a plywood cover to prevent avian predation. A PVC spray bar will provide water for the ramp and attraction water will be provided by a siphon hose or pump hose with a minimum of 0.2 cfs attraction flow (Figure 3.3.4-1). Ramps will be less than a 35-degree angle and will be rigidly mounted to minimize movement and will be wetted with about 0.3 liters per second flow. A hopper large enough to prevent crowding will be deployed and at least 2 different sized Milieu-type substrates will be used side by side to pass eel of varying size.

Eels collected from trap/pass collections will be transported to and released in the Turners Falls Impoundment.

<u>Task 3: Data Analysis</u>

All field data will be compiled, entered into a database, assured for quality, and archived. Tabular and graphic summaries of eel abundance by location will be developed.

<u>Task 4: Reporting</u>

A report will be prepared describing monitoring methods and results. Length and weight data will be collected for all eels collected in the eel traps along with water temperature, river flow and operational parameters.

<u>Level of Effort and Cost (18 CFR § 5.11(d)(6))</u>

The level of effort for Task 1 of the American eel study (Systematic Surveys) will include at least 10 to 12 evening surveying events. Cost of this effort including equipment is estimated to be $25,000 to $35,000. The 2015 effort to place temporary ramps at identified concentration areas and checking collection boxes on a routine basis (Task 2) will cost between $25,000 and $35,000. The total cost for this study ranges from $50,000 to $70,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Systematic surveys and trapping to evaluate eel presence and abundance will be conducted 10-12 times throughout the eel upstream migratory season (approximately May 1 to October 15, dependent on river temperatures and observations at the downstream eel pass) in 2014. Results will inform locations for installing temporary trap/passes during the same period during 2015.

Because the study effort will be ongoing when the Initial Study Report is due to Stakeholders in September 2014, FirstLight proposes to provide Stakeholders with a report supplement in December 2014 for the eel survey and December, 2015 for the trap collection study.

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Harza Engineering Company (Harza), BioSonics, Inc. (BioSonics), and Environmental Research and Consulting (ERC). (1991). *Northfield Mountain Pumped Storage Project 1990 Field Sampling Program*. Report to Northeast Utilities Service Company.

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Schmidt, R.E., O'Reilly, C.M., & Miller, D. (2009). Observations of American eels using an upland passage facility and effects of passage on the population structure. *North American Journal of Fisheries Management 29(3)*, 715-720.

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FirstLight Power Resources GDF SUEZ

FIRSTLIGHT POWER RESOURCES

Revised Study Plan

Figure 3.3.4-1: Approximate Locations of Systematic Eel Surveys near Turners Falls Dam.

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FIRSTLIGHT POWER RESOURCES

Revised Study Plan

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Figure 3.3.4-2: Approximate Locations of Systematic Eel Surveys near Cabot Station

3.3.5 Evaluate Downstream Passage of American Eel

General Description of Proposed Studies

The USFWS, NHFG, MDFW, NOAA, VTDEC, TU, and CRWC have requested two specific studies regarding downstream passage of adult American eel. The first study request was for a timing evaluation of downstream migratory movements of American eel on the mainstem Connecticut River. The second study request was for an assessment of downstream American eel passage at the Turners Falls Project and Northfield Mountain Projects. The study proposed herein will use radiotelemetry and hydroacoustic methods to investigate the timing of silver phase eel outmigration in the Connecticut River in the Project area and routes of passage through the Projects. Additionally, HI-Z Turb'N tags will be used to empirically determine rates of survival for eels entrained at Station No. 1 and Cabot Station and to determine spill survival over the dam.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goals of these studies are to:

1. Better understand migration timing of adult, silver-phase American eel as it relates to environmental factors and operations of the Turners Falls Project and Northfield Mountain Project.

2. Collect information to determine the impact of the Turners Falls Project and Northfield Mountain Project on the outmigration of silver eel in the Connecticut River.

Specific objectives of these studies are to:

1. Characterize the general migratory timing and presence of adult, silver-phase American eel migrating past the Turners Falls Project and Northfield Mountain Project relative to environmental factors and operations.

2. Quantify movement rates and proportion of eel passing downstream via various passage routes at the Turners Falls and Northfield Mountain Projects. For the Northfield Mountain Project, the study will evaluate the proportion of eel entrained into the intake. For the Turners Falls Project, the study will evaluate the proportion of eel passing via the available routes of passage.

3. Evaluate survival of adult silver eel passed at the available routes of passage at the Turners Falls complex.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

Based on management plans developed by the ASMFC and the CRASC, the resource management goals identified by the commenting agencies are to:

- Ensure PME measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific goals with respect to downstream passage of American eel are to:

- Minimize current and potential negative project operation effects that could hinder management goals and objectives.
- Minimize project-related sources of downstream passage injury, stress, and mortality in order to maximize the number of silver eel migrating to the spawning grounds.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

According to the commenting agencies, data on the timing of downstream migratory movements and rates of American eel in the mainstem Connecticut River are sparse and relatively incomplete. Preliminary data on the presence of "eel-sized" acoustic targets have been collected (Haro et al., 1999) within the Cabot Station forebay, supported by video monitoring at the Cabot Station downstream fish bypass. This was a short-term study, with acoustic monitoring performed between 17 September and 5 October and video monitoring conducted between 18 September and 22 October. Some daily monitoring of the downstream fish bypass at the Holyoke Dam (canal louver array) was performed in 2004 and 2005 (Kleinschmidt Associates, 2005; 2006; Normandeau Associates, 2007); these studies also were of relatively short duration (spanning from October 5 to November 10 in 2004 and September 9 to November 11 in 2005) and the sampler was only operated at night

As discussed in the PAD, 2-D and 3-D telemetry studies were conducted at Cabot Station in 1996, 1997, 2002 and 2003. Results of those studies indicate that a significant proportion of eel entering the Cabot forebay become entrained through the Station turbines (90% in 2002, 100% in 2003; Brown, 2005; Brown et al., 2009). The PAD notes that the study done in 2003 determined that 15 of the 29 test eel were detected at the Hadley Falls Station. However, that study was not designed to assess turbine mortality. The approach velocity at the Cabot Station racks is approximately 2.0 feet per second at maximum hydraulic capacity. At Station No. 1, the racks have 2.6-inch clear spacing and an approach velocity of 1.2 feet per second. The intake at the Northfield Mountain Project has 48-foot-deep trash racks with six-inch clear spacing over the intake and an approach velocity of 3.5 feet per second at full pumping capacity (15,000 cfs).

To date, no directed studies of eel mortality at Cabot Station or eel entrainment or mortality at either Station No. 1 or the Northfield Mountain facility have been conducted.

Existing research and literature on the American eel relevant to these proceedings includes the following:

Brown, L.S. (2005). Characterizing the downstream passage behavior of silver phase American eel at a small hydroelectric facility. M.Sc. Thesis, Department of Natural Resource Conservation, University of Massachusetts. Amherst, Massachusetts: University of Massachusetts.

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Electric Power Research Institute (EPRI). (2001). Review and documentation of research and technologies on passage and protection of downstream migrating catadromous eel at hydroelectric facilities. EPRI Technical Report No. 1000730, Palo Alto, California 270 pp.

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Haro, A., D. Degan, J. Horne, B. Kulik, and J. Boubée. (1999). An investigation of the feasibility of employing hydroacoustic monitoring as a means to detect the presence and movement of large, adult eel (Genus *Anguilla*). S. O. Conte Anadromous Fish Research Center Internal Report No. 99-01. Turners Falls, Massachusetts. 36 pp.

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Normandeau Associates, Inc. (2007). *American eel emigration approach and downstream passage routes at the Holyoke Project, 2006*. Submitted to the City of Holyoke, Holyoke Gas and Electric Department. Final report. Westmoreland, New Hampshire: Normandeau Associates, Inc.,

Project Nexus (18 CFR § 5.11(d)(4))

Project operations may directly or indirectly affect eel outmigration in the fall through entrainment, rate of movement, injury, or mortality. Baseline information related to the timing and passage of outmigrating eel will allow stakeholders to assess project-related effects on eel migratory success and survival.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Information will be collected to assess potential impacts to adult eel outmigrants by project operations by a combination of approaches including hydroacoustic and radio telemetry, and the use of HI-Z Turb’N tags. The study objectives will be met by a tasked approach and are anticipated to occur in 2014.

Task 1: Evaluate Timing of Downstream Migratory Movements

The timing, duration, and magnitude of adult eel migration at the Turners Fall Project will be evaluated over a range of existing and operational conditions. Hydroacoustics will be deployed in the forebay area at Cabot Station, at the Gatehouse and the Northfield Mountain Project intake (August through October). An array of split beam transducers will be deployed to provide sufficient coverage of the cross-sectional targeted areas. The exact location and number of transducers, and orientation will be determined prior to the commencement of the survey during reconnaissance and test deployment, but will be established to optimize spatial coverage. To the extent possible, transducers will be mounted in areas of limited turbulence and ambient noise and away from eddies or other hydraulics where fish “milling” would occur. Ideally transducers would be mounted as close to the target area as possible.

Data will be recorded and archived continuously; however at the Northfield Mountain intake, only data recorded during 1 hour before and during pumpback mode will be analyzed. Depending on the configuration of the system and the target area, fish moving in the direction of the target area, fish size, or other sampled parameters can potentially be used to identify acoustic targets corresponding to adult eels. Acoustic targets can be filtered by size and supporting data used to apportion the number of fish by size class. Current plans are to have the hydroacoustic expert on site on August 13, 2013.

Data will be recorded by an onsite data logger. Transducers will be inspected and serviced by a qualified technician on a weekly basis, and data will be remotely downloaded and reviewed at least once per week during sampling to qualitatively view trends, and to ensure the system is functioning properly. During analysis, echo data will be analyzed using standard analytical tools such as Echoview ® software, and temporally related to concurrent station operation, water temperature, climatic conditions and Connecticut River flow. Data will be displayed in both tabular and graphic form, and include hourly daily, monthly and full season estimates. To the extent possible data output will also show patterns of spatial distribution of targets in the intake area. Data from the hydroacoustics will provide information on the timing, frequency and magnitude of the migration, as well as estimates of adult eel entering to and existing in the Canal and estimates of the numbers entrained at the Northfield Mountain Project. Eel outmigration through the downstream bypass will be sampled concurrently. Concurrent bypass sampling will be conducted over several discreet events (12 to 18) to ground truth the hydroacoustic data and compare the percent of eels passing via the Cabot sampler and Cabot Station. One year of hydroacoustic sampling is being proposed. If the 2014 season is a typical flow/weather season, then that would conclude this effort. If the 2014 season is not typical, a second season would be considered based upon discussions with the resource agencies.

Task 2: Assessment of Downstream Passage of American Eel

FirstLight will assess downstream passage and entrainment survival of adult American eel through use of radio-telemetry techniques.

FirstLight will use radio telemetry techniques to monitor adult downstream eel passage at the Turners Falls Project and Northfield Mountain Project. For the Northfield Mountain Project, the study will evaluate the proportion of tagged eel entrained into the intake. For the Turners Falls Project, the study will evaluate the proportion of eel passing via spillways, gates, turbines, and the existing fish bypass at Cabot Station and/or Station No. 1. The route of passage study will be designed with the use of motion sensor telemetry tags that will give researchers an indication of passage-induced mortality.[62] This phase of the study will involve systematic releases of radio-tagged silver phase eels at strategic points above areas of interest to assess general routes of passage (i.e., via spill, fish passageways, or turbines).

Radio transmitters will transmit on several frequencies and are anticipated to range between 2 and 4 frequencies within the 150 to 151 megahertz band and will be uniquely coded to allow for individual fish identification. Transmitters will be supplied by Sigma Eight Inc. and will allow for in-field coding should ambient radio noise preclude the use of any particular frequency and code combination. The transmitters will employ a motion sensor and be configured such that the 2 second burst interval shifts randomly to minimize repeated collision of tags on the same frequency. FirstLight and TransCanada will consult before purchasing tags to ensure all radio telemetry receivers at the Projects can detect them

Emigrating silver phase eels will be collected at the Cabot bypass sampler or the Holyoke Canal bypass sampler. Eels selected for tagging will meet morphometric (e.g., eye diameter relative to body size - Pankhurst Index of approximately 6.5 or greater) criteria to ensure they are migrant silver phased eels. Collections will be made within the migratory season (late August to mid-October), and eels will be tagged and released within 21 days of collection.[63] In addition, project operation (flows, levels, gate

[62]For example, if an eel goes into an immobile state for a period of 36 hours, the tag's code will be programmed to switch signal transmission patterns (e.g., to a different code or different burst rate).
[63] The timing of collection, tagging, and release will be entirely dependent on migratory patterns and weather/river conditions. All tagged eel will be released at night during inclement weather or with inclement weather pending to increase the likelihood that eel will move soon after release. Though FirstLight will target a seven-day hold period, riverine conditions may not be adequate for release, and therefore hold times may last longer than seven days.

openings, number of units operating and operation level) and environmental conditions (river flow, water temperature, air temperature, and moon phase and precipitation amounts) will be recorded throughout the duration of the studies.

Task 2a: Northfield Mountain Route Selection Study

Groups of eels will be tagged and released approximately 5 km upstream of the Northfield Mountain tailrace. Tagged eels (n = 72) will be released on 8 nights (4 nights at 3 unit operation and 4 nights at 4 unit operation) with three releases per night (at dusk, two hours later and two hours after that) and 3 tagged fish per release. The proposed telemetry receiver locations and equipment are listed on Table 3.3.5-1. An adaptive release strategy will be used to target eels passing Northfield when pumps are running.

Task 2b: Turners Falls Dam Route Selection Study

Groups of eels will be tagged and released approximately 3 km upstream of the Turners Falls Dam. Groups of eels will be released over various spill conditions including no spill and will be determined based on results of the instream flow study (Study No. 3.3.1). A total of 30 tagged eels will be released at dusk on the day prior to target flow conditions in small multiple batches. The proposed telemetry receiver locations and equipment are listed on Table 3.3.5-1. An additional 30 eels will be released in the canal.

Table 3.3.5.-1: Location and types of telemetry receivers proposed for the silver eel emigration study.

Location	**RM**	**Receiver Station**
Montague Wastewater	119.5	A Lotek SRX receiver with yagi antenna will monitor the full width of the River
Cabot Station Tailrace	120	Lotek SRX with yagi antenna–to monitor the full river width
Cabot Station Forebay	120	Two radio receivers will monitor the Forebay area; 1) Lotek or Orion with yagi antenna will monitor the full width of the canal immediately upstream of the Cabot station 2) Orion with dipole antenna will monitor the entrance to the Cabot downstream bypass.
Station 1 Forebay	121	A Lotek SRX or Orion with yagi antenna will monitor the full width of the intake canal
Station 1 Tailrace	121	A Lotek SRX or Orion 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 Orion or Lotek SRX receivers with yagi antennas will

Migratory movements of silver eel have been noted after hold periods longer than seven days during several recent radio-telemetry studies at hydroelectric facilities in the northeast [(see FERC projects P-2364 (Abenaki), P-2365 (Anson), P-2325 (Weston)].

		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 End of the Canal	122	A Lotek or 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
Turners Falls Impoundment	122	A Lotek with a yagi antenna will monitor the full width of the impoundment
NMPS Gill Bank	126.5	A Lotek with a yagi antenna will monitor the full width of the impoundment
NMPS Intake	127	A Lotek or Orion with a yagi antenna will monitor the intake area
Shearer Farms	127.5	A Lotek with a yagi antenna will monitor the full width of the impoundment

Task 2c: Mobile Tracking

Mobile tracking (i.e., via boat, vehicle, or by foot) in river reaches between release sites and 5 km downstream of Cabot Station will be performed on a weekly basis during and after releases to confirm routes and fates of passed fish, or fish lost to follow-up. Tracking will occur until the tagged eels leave the study area or water temperatures at $5^{o}C$ Movement rates (time between release and passage) of eels passing the projects by various routes will also be quantified.

Tag pulse will likely be programmed at 2 second intervals with a battery life of at least 50 days. Prior to release of tagged eel, FirstLight will perform testing and range verification to minimize overlap of detection fields while maximizing detection range. As needed, beacon transmitters will be employed at strategic locations to provide a repeated data stamp during the study to verify receiver functionality.

Task 3: Data Management and Analysis

Data from hydroacoustic timing studies (Task 1) will be collected in the field and transferred to an electronic format. All data entry will be assured for quality. These data will be processed with Myriax Echoview or similar software. The data will be reduced by applying an intensity threshold that is representative of the target size and analyzed with an α, β-tracking algorithm, which identifies the series of echoes that were returned by an individual fish over successive pings. The tracking results will be reviewed on the echogram and exported as a database containing time, target strength, and 3-D positional information for each fish detected. An expansion factor will be calculated for each individual eel as a function of its effective beam width at the range it was observed. This effective beam width depends on the acoustic beam pattern and the size of the target. The expansion factor compensates for this differential detection probability.

Data from the adult eel telemetry study (Task 2) will be collected regularly from the field during the study periods (i.e., at 2 to 3 day intervals). Data will be archived and entered into an MS Access or MS Excel database for sorting and post-processing. All data entry will be reviewed for quality assurance. To the extent possible, routes of passage will be determined. Route determinations will be based on the sequence of individual eel detections at the antenna arrays. Additionally, route-specific survival will be determined by analysis of the sensor tag data, which will indicate whether an eel has resumed typical migratory behavior after passing downstream or has not survived passage.

Task 4: Turbine and Dam Passage Survival

HI-Z Turb'N tags will be used to empirically determine rates of survival for eels entrained at Station No. 1 and Cabot Station and spill survival over the dam. As currently envisioned, a total of 150 tagged (Hi-Z and radio tagged) eels will be released into turbines. The tagged eels will be proportionally allocated by the number of different turbine types at Station No. 1 and Cabot Station. All six turbines at Cabot Station are similar type and hydraulic capacity so testing will be conducted at one turbine at Cabot Station as a representative unit. Data for that unit will be extrapolated to calculate a total station survival rate. Station No. 1 has five Francis style turbines. Four of the five turbines are similar in speed, hydraulic capacity (490 to 560 cfs) and one is smaller (140 cfs). Testing will be conducted at two turbines at Station No. 1 (at one to represent the four larger units and at the smaller capacity unit). Like Cabot, the data for the representative unit will be extrapolated to calculate a total survival rate for all four units and combined with the data for the smaller unit for a total station survival rate. Tests will be conducted by injecting tagged eel into the selected turbines at Cabot and No. 1 Stations at or near best efficiency hydraulic capacity conditions for each test unit. Fish will be recovered from the tailrace, examined for injuries and held for 48 hours to determine latent mortality. An additional 125 fish will be released above the dam to determine mortality due to passage at the bascule and tainter gates.

Task 5: Reporting

The hydroacoustic, radio telemetry and HI-Z Turb'N tag data will be analyzed relative to passage route(s) timing, frequency, magnitude and survival. Telemetry data from each fish will be portrayed graphically including movement and timing through the project area with passage route selection identified. Movements will be analyzed relative to environmental and operational parameters. For the entrainment task, survival through each turbine or spill gate tested will be calculated based on the number of tagged fish injected into a turbine or gate that are alive. All injuries will be reported. Total through-project survival will be calculated based on study results of the survival study, other related studies as well as operations data. This information will be compiled into a report and will include the methods used, results, a discussion and conclusions. It will include release numbers, locations and dates, fish length, weight, and morphometric criteria, river temperature at NMPS, canal, bypass and below Cabot Station,

Data use to develop the report will be made available to stakeholders upon request in digital form.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Projects on downstream passage and timing of adult eel in the investigation area. The estimated cost for this study is approximately between $400,000 and $500,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Because the study effort will be ongoing when the Initial Study Report is due to Stakeholders in September 2014, FirstLight proposes to provide Stakeholders with a study report supplement to summarize downstream adult eel monitoring results in February 2015, followed by a meeting to discuss any potential additional information needs. The outcome of that discussion will determine if further study planning efforts are necessary for 2015. An additional year of the study may be necessary if unfavorable environmental conditions occur, equipment malfunctions, not able to secure sufficient test fish, and inadequate replicates of various locations and / or operating scenarios.

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*

General Description of Proposed Study

The following stakeholders requested studies to investigate the impact of project operations on shad spawning, spawning habitat and egg deposition within the project boundary: USFWS, MADFW, NHFGD, NHDES, CTRWC, NOAA, the Town of Gill, TU, and VTDEC. Section 4.4.5 of the PAD identifies several migratory species of fish that seasonally occur in the aquatic habitat within the Project boundary. One such species, the American shad (shad), migrate into the Connecticut River to spawn, reaching Project waters in late April or early to mid- May. Much of the river downstream of Cabot Station is suitable for shad spawning, and the reach of the Connecticut River including the Deerfield River confluence is thought to be particularly productive spawning habitat. The study described herein will gather data to determine the effects of operational changes and subsequent flow/water level fluctuations on spawning shad in the project area.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

Determine if project operations (under the permitted and proposed operational ranges) affect shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches that extends from the base of Vernon Dam to the Route 116 Bridge in Sunderland.

Specifically, the shad spawning study will:

- Determine areas utilized by shad for spawning by conducting night-time visual and aural observation of spawning activity;
- Identify and define those areas geospatially, and obtain data on physical habitat conditions affected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
- Collect information in order to assess project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
- Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity; and
- Verify spawning activity as measured by night-time spawning/splash surveys in areas of spawning activity, and downstream of these areas, to gather data to determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The CRASC was established by Congress in 1983 (and reauthorized in 2002 for another 20 years) through the Connecticut River Atlantic Salmon Compact (Public Law 98-138).

CRASC developed *A Management Plan for American Shad in the Connecticut River Basin* in 1992. Management Objectives in the plan include the following:

- Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
- Achieve annual passage of 40% to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, aims to maximize the number of juvenile recruits emigrating from freshwater stock complexes through the following objectives:

- To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
- Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.
- Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
- When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations, to enhance river habitat.

The resource agencies' goals related to aquatic natural resources include:

- Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
- Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.
- Conserve, enhance, and restore natural communities, habitats, and species and the ecological processes that sustain them.
- Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.
- Ensure that PME measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
- Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Turners Falls Project.

The resource agencies' goal specific to American shad is:

- Minimize current and potential negative project operation effects on American shad spawning and recruitment.

The agency requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and PME measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R.794), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time. The number of shad lifted at Holyoke reached 721,764 in 1992 and the overall Connecticut River shad population exceeded 1.6 million shad in that year (CRASC 1992). In most years, however, the shad population has not reached CRASC management plan objectives. Likewise the number of shad passing Turners Falls Dam has not met the CRASC objective.

In preparation of the PAD, fisheries data were compiled on the shad resources in the Connecticut River; the data can be found in section 4.4.5 of the PAD. American shad seasonally migrate into the Connecticut River in the spring, late March or April, to spawn; typically reaching Project waters by late April to mid-May when river flow is generally declining from the spring peak. Shad passage has been monitored at the Holyoke Dam (Figure 4.4.5-1 of the PAD) and these counts provide a comprehensive record of the number of shad that have access to Project waters. Population number and passage numbers past Holyoke have declined from the 1992 peak described above, with average Holyoke passage numbers over the last ten years of 211,850. However, shad numbers have been on the rise since 2005 with over 490,000 shad passing Holyoke Dam in 2012.

American shad typically spawn in water ranging from 3 to 18 ft in depth, in run or glide habitat (FirstLight, 2012). Shad typically spawn at night, with males reaching spawning areas prior to females (Greene et al., 2009). Daytime spawning has been documented on overcast days or in turbid water when light intensity is somewhat diminished (Greene et al., 2009). Females are broadcast spawners, preferring to release their eggs in the water column over coarse substrates including cobble, gravel and sand (Greene et al., 2009 and FirstLight, 2012). American shad are highly fecund and spawn repeatedly as they move up river (Greene et al., 2009). The act of spawning can be conspicuous and vigorous, with spawning individuals breaking the surface.

Most (~77%) of the 30 mile reach below Cabot Station consists of *run* mesohabitat type with coarse substrates; presence of glide habitat areas are negligible (FirstLight, 2012a). Though habitat suitable for shad spawning is abundant in the 30 mile reach downstream of Cabot Station, the area of the Connecticut River, in the vicinity of the Deerfield River confluence, is thought to be particularly productive. The location of American shad spawning in the Connecticut River between Holyoke Dam and Turners Falls Dam was identified in previous studies by Layzer (1974) and Kuzmeskus (1977). The documented spawning locations from Cabot Station downstream to the Route 116 Bridge are shown in Figure 3.3.1-4. The upstream extent of this range is in close proximity to Cabot Station and experiences flow changes resulting from Station operation.

In 2012, FirstLight conducted studies in the late spring and summer to examine habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD).

Project Nexus (18 CFR § 5.11(d)(4))

For the purposes of this study plan the Study Area includes the Connecticut River: downstream from Cabot Station to the upper extent of the Holyoke impoundment (specifically, the Route 116 Bridge in Sunderland); in the bypass reach between Turners Falls Dam and Cabot Station, and in the Turners Falls impoundment.

Shad spawning is likely influenced by river flow, among other environmental factors such as water temperature. Flow fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While several shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. There are no known studies of the relationship between spawning behavior, habitat use, and egg deposition and Turners Falls and Northfield Project operations Continued Project operation and maintenance activities could, through the manipulation of flow, affect American shad that utilize the project area for spawning. The Agencies are concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets. This study will provide information regarding the availability and location of shad spawning habitat and the effect on spawning activity of flow changes caused by Project operation.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

FirstLight will investigate shad spawning within the study area to determine how operations at Cabot Station and Northfield may affect shad spawning behavior. The investigation will include a review of existing information relative to shad spawning in the Connecticut River and a visual and aural survey of the study area to locate spawning areas and evaluate the effect of Project operations on spawning.

The field studies will examine known spawning areas downstream of the Turners Falls Project (to the Route 116 Bridge), although, pending NMFS review, the plankton-net sampling described below may be restricted to areas where the sampling will not affect shortnose sturgeon eggs and larvae. No previous studies have attempted to locate spawning areas upstream of Turners Falls Dam. Additionally, the field effort will include surveying the impoundment (up to the Vernon Dam) for evidence of shad spawning.

Field study locations will be determined by review of existing information, results of the IFIM study (Study No. 3.3.1) and hydraulic modeling; therefore, FirstLight will consult with Stakeholders to review results of Task 1, as outlined under the Study Schedule section below.

Task 1: Development of a Detailed Study Design

As a first step, historic data pertaining to Cabot Station discharge and flow data will be collected to provide the basis for determining typical flow regimes during the study period. Operational data from the previous ten years of generation will be reviewed to determine how the station has historically operated during the shad spawning season. Historical data from the USGS gage located on the Connecticut River in the City of Montague (USGS 01170500) and the Deerfield River (USGS 01170000) near the town of West DeerFGS, Massachusetts will be reviewed in conjunction with station operation data. It is important to determine the magnitude of flow and corresponding water level fluctuation in the Connecticut River below Cabot Station when flows exceed the hydraulic capacity of the Turners Falls Project. Similarly, it will be important to determine the same when flows are within the hydraulic capacity of the Turners Falls Project. The frequency of changes and rate of flow changes will also be reviewed.

FirstLight is developing a hydraulic model of the Connecticut River from the Turners Falls Dam to the Holyoke Dam- see Study No. 3.2.2 *Hydraulic Studies of Turners Falls Impoundment, Bypass Reach, and below Cabot Station*. The hydraulic model developed for the reach between Turners Falls Dam and Holyoke Dam will be used to further inform this study. More specifically, the hydraulic model will simulate water elevations in this reach under the historic flow ranges during the spawning season. Flow data will be obtained from the Montague USGS gage. The model will be run in an unsteady mode to simulate the peaking operations of the Turners Falls Project during the spawning season. The intent of the modeling is to understand the relationship between the magnitudes of water level fluctuations due to peaking operations. The hydraulic model and previous water level data collected at Route 116 Bridge and at Rainbow Beach may also place bounds on the geographic extent of the study. For example, peaking operations may have a greater impact on the magnitude of water level fluctuations closer to Cabot Station than further downstream. Based on the water level monitoring conducted at the USGS gage in Montague, Route 116 Bridge and at Rainbow Beach, the magnitude of water level fluctuation decreases and attenuates further downstream. The results of the hydraulic model will also provide an indication of areas that potentially become dewatered under certain operational scenarios.

Further, counts of shad passed at the Holyoke Dam and Turners Falls will be tracked to pinpoint the most effective timing of field surveys. Concurrent adult shad telemetry studies may also provide insight as to the location of spawning shad.

Task 2: Examination of Known Spawning Areas Downstream of Turners Falls Dam

Field surveys will be conducted in two phases at night primarily by boat or from shore during periods of anticipated spawning; timing and flow regimes will be based on information collected in Task 1; Phase 1 will identify locations where shad are actively spawning, and information will be collected to evaluate project effects in Phase 2. In the study area, spawning typically occurs between early May to mid-June, when water temperatures reach 13-18ºC (Collette and Klein-MacPhee, 2002). Field surveys of spawning activity will commence during this period (approximately early May) or after a minimum of 10,000 shad have passed the Holyoke Project. The level of effort will be dependent on the density of spawning shad within the study area, with initial surveys to be conducted twice weekly and will be increased to three times per week during peak spawning..

Surveys conducted below Turners Falls Dam will investigate all the historical spawning locations downstream to the Route 116 Bridge (Layzer, 1974; Kuzmeskus, 1977). However since this work was conducted over 35 years ago, it is probable that spawning sites have changed so we will also survey the area, down to the Route 116 Bridge, for radio tagged fish that may be spawning as well as previously undocumented spawning sites.

Phase 1 of the surveys will employ methods described by Ross et al. (1993). Adult spawning shad will be observed and quantified by counting spawning splashes over 15-minute intervals between sunset and 01:00 hours. Once splashes have been observed for a 15-minute interval, the survey crew will progress to the next known spawning area for observations. The amount of time spent at each spawning area will be subjectively determined by the field survey crew, but will be such that all of the known spawning areas are observed between sunset and 01:00 hrs. Sampling will be conducted to ensure the results are not bias by visiting the same site at the same time of day every time.

Spot lights will be used to verify that such splashes were made by spawning American shad. The species and number of fish observed and their behavior will be recorded. We assume that, though every splash may not represent actual spawning and every spawning may not be accompanied by a splash, the level of surface activity is strongly correlated with actual spawning (Ross et al., 1993). Other parameters to be measured during observed spawning events include; spawn timing and location (GPS); water temperature, dissolved oxygen (DO), pH, conductivity, turbidity, depth and surface velocity; and predominant substrate type. All data will be recorded on a dedicated data sheet. The data sheet will include aerial reference images and/or maps of the study area to document the relative position of observed spawning shad and provide the information necessary to estimate the total area used for spawning as well as an index of spawning activity. The data collected in the field will be correlated to Cabot Station discharge and river flow as a function of time.

In Phase 2, the impacts of flow fluctuation on spawning shad will be investigated during the peak spawning period at locations identified in Phase 1 These areas will be targeted for observations during periods of discharge fluctuation at Cabot Station. Prior to , during, and after flow changes, data (including splash observations, water quality parameters, depth, surface velocity, predominant substrate type, and location) will be collected to provide a baseline of shad spawning rate. FirstLight will then manipulate discharge at Cabot Station to investigate impacts to spawning. Shad spawning rate will be investigated over a range of expected seasonal flow fluctuations based on historic discharge data at Cabot Station. Several discharge manipulations will be investigated but will begin with the most extreme fluctuations scenarios. Baseline spawning rate and behavior will be compared to those observed during periods of flow manipulation to investigate potential impacts to spawning. In addition, based on the results of Phase 1 of the spawning survey, ichthyoplankton nets will be deployed downstream of spawning areas during operational changes to determine if shad eggs are present and viable. A 1-meter -long ichthyoplankton net 500 micron mesh or smaller will be towed for 10 minutes, the net will be retrieved and the contents preserved for subsequent analysis and identification of shad eggs. Identification of shad eggs will be in accordance with existing literature and will rely on methods of Ross and Bennet (1993) for distinction from white sucker eggs.

Task 3: Identification of Spawning Areas Upstream of Turners Falls Dam

Less is known about spawning locations upstream of the Turners Falls Dam; and the study described herein should provide insight on spawning locations upstream within the study area (to the Vernon Dam). As such, upstream surveys will target areas of suitable aquatic habitat for shad spawning based on HSI curves. The methodology for these surveys will focus on identifying spawning areas via splash surveys consistent with Phase 1 of Task 1. Sampling will begin after 2,500 shad pass the Gatehouse ladder.

Task 4: Examination of Identified Spawning Areas Upstream of Turners Falls Dam

Further investigation of spawning areas identified upstream of the Turners Falls Dam (to the Vernon Dam) in Task 3 will be performed with methodology consistent to that utilized for Phase 2 of Task 2. As discussed above, a review of the previous ten years of Project operational data will allow for the determination of appropriate operating scenarios for which sampling will occur.

Task 5: Data Analysis and Reporting

Information collected during this study will be compiled and presented in a report, which will include a map of the study area depicting the locations of observed spawning shad; materials and methods; results; a discussion of observed spawning behaviors; and, if applicable, impacts due to operational changes.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort will adequately assess the potential effects of continued Projects operations on spawning shad and their habitat within the study area. One year of the study is anticipated to cost between $70,000 and $90,000. Should a second year of study be required, year two cost is anticipated to be between $50,000 and $60,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Due to the iterative nature of the study tasks that need to occur prior to field investigations, FirstLight proposes to utilize an ongoing consultation process with Stakeholders. This will provide Stakeholders with an opportunity to review results of Task 1 and to provide input on specific known and likely spawning locations to be visited in the field. The following study and consultation steps/estimated timeframes will be the following:

- FirstLight to conduct Task 1 – October 2013 through December 2013 (it is anticipated that results of hydraulic modeling and IFIM study will be compiled in the fall 2013 timeframe sufficient to be considered under this task to identify operating regimes under which field studies will be conducted)
- Distribute results of Task 1 and proposed locations for field investigation of known and anticipated spawning locations – January 2014
- Hold meeting with Stakeholders to review desktop analysis and reach consensus on field study locations – February – March 2014

Conduct field studies of spawning locations during the 2014 spawning season, May through June. The exact timing of the field survey will depend on a variety of seasonal and site specific factors but water temperature is the primary factor that triggers spawning. Other factors include photoperiod, water flow and velocity, and turbidity. The timing of the survey will be further refined using information obtained from shad passage data collected downstream at the Holyoke Project fish lift and Turners Falls Project fish ladders. Further, information collected during concurrent shad migration investigations may also provide insight to the locations and timing of spawning.

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3.3.7 Fish Entrainment and Turbine Passage Mortality Study

General Description of Proposed Study

The following stakeholders requested a field study to assess fish entrainment from the Connecticut River at the Northfield Mountain Project: USFWS, NMFS, NHFG, MDFW, CRWS, TU, and Town of Gill, MA. The requested objective is to quantify the number of resident and migratory fishes entrained on an annual basis as a means to evaluate potential impacts to riverine fish populations in the Turners Falls Impoundment and transient diadromous fish populations passing though the study area. The FERC has requested a literature-based assessment of fish impingement, entrainment and survival at the Northfield Mountain and Turners Falls Projects.

Entrainment field studies of the type requested by the agencies, by themselves, provide only an estimate of annual turbine fish passage and survival, but are not sufficient to determine population-level impacts on riverine resident fish populations (FERC, 1995). In recent years, desktop entrainment analyses have been found to be adequate by the FERC for characterizing annual fish entrainment loss at hydroelectric projects. Therefore, FirstLight proposes to conduct a *desktop* fish entrainment and turbine mortality assessment of the Northfield Mountain Project. For the purposes of this desktop entrainment mortality assessment, the study area includes the Turners Falls Impoundment and the Northfield Mountain Project.

The proposed study described herein will assess the potential entrainment and turbine mortality risk of both resident and diadromous fish species within the study area. This assessment will be supplemented by radio telemetry, hydroacoustics and turbine tag studies of American shad and American eel proposed under other study plans (see Study Nos. 3.3.2, 3.3.5, and 3.3.6), which will provide information necessary to evaluate the impacts of entrainment and turbine mortality as a result of continued Project operation.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to assess fish impingement, turbine entrainment, and turbine passage survival at the two Projects.

The specific objectives of this proposed study include:

- Estimate the potential risk of entrainment, impingement, and turbine mortality loss to resident fish species at the Northfield Mountain Project and Turners Falls Project by developing a qualitative scale of entrainment risk for resident and migratory fish species.
- Conduct a quantitative assessment of the potential impact of entrainment and turbine mortality of American shad and American eel.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The Connecticut River is home to riverine species of fish and also serves as a migratory corridor and spawning and rearing habitat for diadromous species such as Atlantic salmon and American shad. In 1967, Federal (USFWS and NMFS) and state (VT, NH, MA, CT) agencies formed a cooperative program called the Connecticut River Anadromous Fish Restoration Program (Restoration Program). The goal of the Restoration Program is to restore anadromous fish to the Connecticut River. In 1983, Federal legislation passed and gave jurisdiction over the Restoration Program to the CRASC, which also continues to work toward American shad restoration in the Connecticut River under the jurisdiction of the Restoration Plan. Agency study requests indicate that investigating the potential impacts of continued Project operation on fisheries resources in the study area will provide the necessary baseline information to evaluate the need for mitigation measures.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

In preparation of the PAD, existing information was compiled regarding the physical characteristics of the Northfield Mountain Project and Turners Falls Project to be evaluated. Factors that affect the potential for entrainment at a hydroelectric project include the size and depth of the intakes, the hydraulic capacity and configuration of the turbines, the velocity of water as it enters the intake relative to fish swim speeds, the location of the intake relative to fish habitat, and the characteristics of fish species present in the study area. Further, the PAD identified those fish species that are likely to occur in the study area and, therefore, may be potentially susceptible to entrainment and turbine mortality. The fish assemblage within the study area is comprised of both riverine and diadromous species. For more information regarding the local and transient fish assemblage please see section 4.4.5 of the PAD.

Prior entrainment studies conducted at the Northfield Mountain Project include an entrainment study targeting juvenile American shad in 1992 (LMS, 1993), a strobe light exclusion efficiency study (Cook, et al., 1994) and a guide net exclusion efficiency study (NUSCO, 1999). These studies were conducted to evaluate and mitigate the impacts of the Project operation on anadromous fish species in the Connecticut River. Methods included radio telemetry, entrainment netting, and mark/recapture to investigate the probability of entrainment, and did not investigate turbine mortality.

Downstream juvenile clupeid passage studies at Turners Falls were conducted in the fall of 1991, 1992, and 1993 (Harza & RMC 1992; 1993; RMC 1994) which included the objectives of determining the percentage of juvenile shad and herring that pass via the bypass log sluice or that were entrained in the Cabot Station turbines.

Project Nexus (18 CFR § 5.11(d)(4))

Continued Project operation could potentially affect riverine and migratory fish species that utilize the aquatic habitat within Project area. This information will provide insight on the effects of continued Project operations to the fisheries resources in the Project area.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The proposed study methodology involves both a qualitative and quantitative approach to characterizing and estimating fish entrainment for the Northfield Mountain Project and Turners Falls Project. Entrainment magnitude and turbine mortality will both be evaluated. A qualitative approach will utilize a desktop entrainment analysis of resident fish species entrainment, whereas a quantitative approach will be specific to adult and juvenile American shad and adult American eel.

Task 1: Qualitative Assessment of Entrainment and Impingement

Resident fish species dwelling in, or migrating through the Turners Falls Project area may potentially be subject to entrainment at Cabot, Station Number 1, or the Northfield Mountain Project (during pumpback). A qualitative scale of entrainment potential ranging from “Low” to “High” will be developed for each resident fish species documented as existing in the Turners Falls Impoundment during the baseline fish assemblage assessment (Study No. 3.3.11). This approach provides reasonable seasonal and annual entrainment risk estimates for fishes of three size groups, small (<8”), medium (8-15”) and large (>15”). River resident species composition and length frequency distribution will be derived from the site-specific fish abundance survey data collected in the Turners Falls Impoundment as part of Study No. 3.3.11.

The probability of entrainment will be assessed through an examination of the biological, habitat, and engineering/operational characteristics of the Northfield Mountain Project and Turners Falls Project relative to life history and behavioral traits of key species. These factors, and reviews of past entrainment reports (FERC, 1995, EPRI, 1997), suggest that resident species entrainment rates are generally influenced by these variables:

- **Intake proximity to shoreline:** Near-shore intakes typically entrain fishes at higher rates than offshore intakes, as fish tend to concentrate in littoral areas, and/or follow shorelines or orient to physical structure associated with shorelines.

- **Intake location in littoral zone:** The littoral zone is the most productive region of a reservoir and most fish rear in the shallower littoral areas.

- **Abundant littoral zone species:** Fishes such as centrarchids that spawn, rear, and spend most of their lives in shallow near-shore waters tend to be among the most abundant species in a fish assemblage.

- **Abundant resident clupeids:** Entrainment rates trend highest at projects with clupeids such as gizzard shad and threadfin shad.

- **Presence of obligatory migrants:** Resident fishes are usually entrained relative to their use of near-intake habitat. Migrants into or out of freshwater systems must locate a passage or exit route such as turbine intakes or draft tubes. Such structures provide the flow cues used by migrating fish and may attract such fish if no other flow outlets are present.

- **Shallow intake depth:** Fish are usually more abundant in shallower portions of a reservoir throughout most of the year.

- **Large hydraulic capacity:** More water passed through intakes relative to project inflow or impoundment volume will potentially present a higher entrainment risk.

- **High approach velocity:** Approach velocities may positively correlate with entrainment risk. Resident species may become involuntarily entrained if intake velocities exceed their volitional escape swimming speed.

FirstLight will develop a summary of the life history traits and habitat requirements of key resident species as they relate to these factors affecting entrainment at the Northfield Mountain Project and Turners Falls Project from standard literature sources. Habitat use, swimming performance, behavior, and life stages, for example, are factors affecting entrainment potential. This process will index species and lifestage of resident fish across a range from most to least prone to involuntary entrainment. The potential for involuntary entrainment of the most susceptible species will be assessed by comparing swim speed thresholds to intake velocity.

Impingement is defined as the involuntary contact and entrapment of fish on the surface of an intake trashracks. Impingement on an intake trashrack may result in injury or death for fish. After determining which fish species have the potential to be present in the area of the intake structures an analysis will be performed to estimate the body length and width of fish that would be physically excluded by the bar rack spacing at each intake structure, and, thus, at risk for potential impingement. The potential for involuntary impingement of these species will then be assessed by comparing swim speed thresholds to intake velocity.

Task 2: Quantification of Shad and Eel Entrainment

FirstLight proposes to quantify entrainment rates of American shad and American eel at Cabot Station, Station No. 1 and Northfield Mountain. Entrainment rates (*i.e.* the percentage of fish entrained through a given structure) at Cabot and Station Number 1 will be derived from data collected during proposed tagging and hydroacoustic studies (Study Nos. 3.3.2, 3.3.3, and 3.3.5). Annual entrainment of juvenile American shad and American eel at Northfield Mountain will be estimated through hydroacoustic monitoring of the pumpback intake area during the period August through October when Young of Year (YOY) American shad may be in the vicinity of the Northfield Mountain intake. An array of split beam transducers will be deployed to provide sufficient coverage of the intake cross-sectional area. The exact location and number of transducers, and orientation will be determined prior to the commencement of data collection during reconnaissance and test deployment, but will be established to optimize spatial coverage. To the extent possible, transducers will be mounted in areas of limited turbulence and ambient noise and away from eddies or other hydraulics where fish "milling" would occur. Ideally, transducers would be mounted as close to the trashracks as possible. A frequency in the 333 to 430 kHz frequency range will be used to minimize avoidance behavior of shad known to occur at some frequencies.

Data will be recorded and archived continuously; however, only data recorded during pumpback mode will be analyzed. Depending on the configuration of the system and the intake, fish moving in the direction of the intake, fish size, or other sampled parameters can potentially be used to identify acoustic targets corresponding to shad. Acoustic targets can be filtered by size and supporting data used to apportion the number of entrained fish by size class. Echo characteristics that separate juvenile shad and adult eels from other species will be ground-truthed by concurrent sampling to be conducted over several discreet events (12 to 18) at the Cabot Station and Cabot bypass.

Data will be recorded by an on site data logger. Transducers will be inspected and serviced by a qualified technician on a weekly basis, and data will be remotely downloaded and reviewed at least once per week during sampling to qualitatively view trends, and to ensure the system is functioning properly. During analysis, echo data will be analyzed using standard analytical tools such as Echoview ® software, and temporally related to concurrent station operation, water temperature, climatic conditions and Connecticut River flow. Data will be displayed in both tabular and graphic form, and include hourly daily, monthly and full season estimates. To the extent possible data output will also show patterns of spatial distribution of targets in the intake area.

Task 3: Estimation of Turbine Mortality Rates

Turbine mortality may occur due to collision of individual fish with blades, wicket gates, or vanes, shear forces, and/or pressure changes. Turbine mortality will be assessed in several different ways.

For the Turners Falls Project, turbine mortality rates for resident fish species will be estimated from literature values. Turbine passage survival studies have been independently performed at numerous hydroelectric projects throughout the country (Franke et al., 1997) for a wide range of salmonid, alosid, anguillid, centrarchid, percid, catostomid, cyprinid, and other freshwater fish species. Most studies have been conducted across a range of sizes of both propeller/Kaplan, as well as Francis turbine designs, using a variety of mark-and-recapture techniques. As a result, trends in quantitative turbine mortality estimates can be used to derive mortality and strike probability equations based on the design characteristics of Project turbines and the relative sizes of subject fish. Study data will be reviewed to identify a subset of applicable source studies. Suitable source studies will be selected for transfer of turbine mortality data for each Project turbine. Data will be selected from source studies involving turbines of similar design and engineering parameters, and similar or identical fish species and size classes. Applicable turbine survival data will be obtained from the literature, and associated field data from the studies listed above will be used to estimate fish turbine passage mortality. The following turbine characteristics will be used as criteria in this analysis:

- Turbine design type
- Operating head
- Runner speed
- Turbine diameter
- Blade number and spacing
- Peripheral runner velocity

Mortality of American shad and American eel will be evaluated based on site-specific data generated by Study Nos. 3.3.2, 3.3.3, and 3.3.5, and supplemented by applicable literature data. Entrainment loss will be estimated by multiplying fish entrainment rate estimates by turbine mortality rates for both species (and multiple life-stages, where applicable).

For the Northfield Mountain Project, FirstLight proposes to conservatively assume that all fish entrained during pumpback experience 100% mortality. Fish mortality occurring during pumpback at the Northfield Mountain Project can theoretically be estimated based on blade strike probability literature. This would estimate “once through” mortality. but some surviving fish may be subjected to multiple passes through the Project. If surviving fish recruited to the reservoir are re-entrained, additional incremental mortality would potentially occur. Insufficient information exists to quantify residency time of fish in the upper reservoir or predict the percentage of surviving fish recruited to the reservoir re-entrained during subsequent generation, and/or pumped back again. Therefore, entrainment/mortality during pumping will be evaluated in the context of operating hours in each mode.

Task 4: Reporting

Results will be presented in a summary report, and will be discussed in regards to overall effects to fish populations based upon fish assemblage structure results from Study No. 3.3.11 along with fish passage count data. Per stakeholders’ request, the report will include a tabular summary of pumping (number of units per hour) by month for April through November to assist in the data analysis.

A tentative table of contents for this study will include:

- Introduction
- Methodology
- Description of Project Features
- Fisheries Community
- Susceptibility to Entrainment and Impingement
- Quantitative Results for American shad and American eel
- Effects of Entrainment and Impingement on Fish Populations
- Conclusions

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort will adequately assess the rate of entrainment and turbine mortality at the Northfield Mountain Project and Turners Falls Project. The proposed approach is consistent with methods accepted by FERC at other hydroelectric projects, such as the Muddy Run Pumped Storage Project (P-2355), Conowingo Project (P-405), Niagara Power Project (P-2216), and the St. Lawrence-FDR Power Project (P-2000); the study will provide information necessary to assess potential impacts of continued project operation on fisheries resources within the study area. The estimated cost for this one-year study effort will be approximately $50,000 to $70,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on June 4, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. Because a portion of this study draws upon data from radio telemetry, hydroacoustics and baseline fish assemblage studies, this assessment will be completed upon analyses of the field-based studies.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

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3.3.8 Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays

General Description of Proposed Study

The USFWS, NHFG, MDFW, NOAA, CRWC, and TU requested a study utilizing Computational Fluid Dynamics (CFD) Modeling in the vicinity of the fishway entrances and the powerhouse forebays to evaluate flow field conditions. The Turners Falls Project consists of two hydroelectric facilities, Station No. 1 and Cabot Station, which utilize flow from the power canal to generate power. Upstream fish passage at the Project consists of three passage structures: the “Spillway ladder” (located at the Turners Falls spillway), the “Gatehouse ladder” (located at the Turners Falls Dam gatehouse), and the “Cabot ladder” (located at Cabot Station). These fish ladders provide an opportunity for upstream passage to migratory and resident fish. Downstream passage routes at the Turners Falls Project include over the dam, through the powerhouses, or through the downstream fish passage sluice adjacent to Cabot Station. CFD modeling in the vicinity of the fishway entrances and powerhouse forebays is proposed to evaluate flow field conditions.

As part of this study, bathymetry surveys will be conducted at the Spillway and Cabot fishway entrances and in front of the two powerhouse intakes (Figure 3.3.8-1). The depth and velocity data collected from these surveys will be used to develop six three-dimensional CFD models as follows:

1) the power canal in front of the Station No. 1 powerhouse;

2) the Station No. 1 intake racks[64];

3) the power canal in front of the Cabot Station powerhouse;

4) the Cabot Station intake racks;

5) the Cabot fishway entrance; and

6) the Spillway fishway entrance[65]

Once the models are developed, production runs will be conducted to analyze the hydraulic characteristics (depth, velocity) found in these areas. Proposed production runs are outlined later in this study plan.

The CFD modeling of the fishway entrances will be coupled with the telemetry results (Study No. 3.3.2, Study No 3.3.3, Study No 3.3.5, Study No 3.3.19), passage counts and environmental variables (water temperature, river flow) to understand which conditions are preferable for guiding migrating fish to the entrances. This assessment will be completed as part of the respective telemetry studies, and not as part of this study. We anticipate that the “coupling” assessments will be undertaken as part of a year-two (2015) study, since both the telemetry and CFD studies must first be completed.

64 For computational reasons, the Station No. 1 and Cabot Station intake rack models will be representative portions of the rack, rather than the entire intake rack.
65 The spillway ladder becomes inundated by flow from bascule gate no. 1 if there is any substantial spill over the dam. At such flows, the CFD model may have difficulty identifying some hydraulic influences.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The study goal is to obtain information to determine the flow field conditions that exist in and around the fishway entrances, and upstream of the Cabot Station and Station No. 1 intakes. While MADFW and CRWC suggested that CFD modeling in the Station No. 1 tailrace may determine potential impacts to upmigrating fish through the bypass reach, FirstLight is not proposing CFD modeling at that location. FirstLight believes that the hydraulic modeling that is proposed as part of Study No. 3.3.1 for that reach will asses this objective. Additionally, FirstLight is not proposing CFD modeling at the Gatehouse ladder as such modeling was recently completed (Alden, February 2012). The Alden report summarizing CFD modeling at the Gatehouse ladder can be found in Appendix F.

The study objectives are to:;

1) Characterize the hydraulics of current (existing) conditions and any changes to:
    a. Fishway attraction flows;
    b. Turbine operations; and
    c. log sluice gates
2) Develop a series of velocity maps at select discharges showing approach velocities and flow fields that may create a response in fish;
3) Characterize the flow field in front of the Cabot Station and Station No. 1 intakes using velocity maps and cross-sectional plots;
4) Assess whether fish are directed to the surface bypass weir near Cabot Station;
5) Characterize the near-rack "sweeping" velocities at the Cabot Station and Station No. 1 intakes.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

This study was requested by NHFGD, MDFW, NOAA NMFS, USFWS, CRWC, and TU. As outlined in their study request letters, the management goals of this study are:

"…to obtain information that will help assist in designing effective upstream fishways for upstream migrating trust species and to *reduce impingement, entrainment and delay for downstream migrating fish. CFD models are a relatively cost effective way to analyze existing and future conditions. As such, changes in the amount of attraction water, changes in which turbines are operating and which spillway gates are releasing water can all be examined. This study's results are intended to be analyzed in coordination with the data generated from the telemetry study. The combined analysis from these two data sources can help assess which flow conditions are most advantageous for migrating trust species to enter the fishway under current and proposed conditions.*

As for downstream migration of adult and juvenile shad, and adult eel, the results from the models will reveal flow magnitude and direction in front of each powerhouse. Given the limited information that currently exist on survival through Cabot and Station 1, the agency management goal is to direct as many downstream migrating fish as possible towards the uniform acceleration weir and downstream *bypass. With respect to upstream passage, it is the goals of the agencies to maximize the number of fish that find and enter the fishway entrances.*

Agency study requests are intended to facilitate the collection of information necessary to conduct effective analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 et seq.), and the Federal Power Act (16 U.S.C. §791a, et seq.).”

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

As noted above, a CFD model of the Gatehouse fish ladder at the Turners Falls Dam is completed and can be found in Appendix F. Methodology defined and data collected during this effort will act as supplemental information for FirstLight’s CFD modeling conducted as part of this study. FirstLight believes this recently completed model will be adequate for the required analysis and, as such, is not proposing to develop a new model for the Gatehouse fish ladder. However, additional model runs may be considered using the existing model, if necessary.

Existing GIS elevation data (i.e. contours, DEM, TIN) and Project drawings, combined with field collected data, will be used for the model input. In order to obtain the level of detail required of a three-dimensional model, a bathymetry survey of the study area will be conducted. Field data collected during this effort will include: river bed elevation, water surface elevation, water depth, and velocity (where field conditions allow). The model will be validated with field data prior to executing production runs.

Project Nexus (18 CFR § 5.11(d)(4))

The Turners Falls Project consists of two hydroelectric stations (Station No. 1 and Cabot Station), a power canal, bypass channel, dam and impoundment. In order to provide upstream fish passage through the bypass channel and power canal fish ladders were constructed at the Turners Falls Spillway, the Gatehouse at Turners Falls Dam, and at Cabot Station. An existing log sluice/bypass adjacent to Cabot Station was modified to provide downstream fish passage. Existing information indicates that substantial numbers of downmigrating fish (other than eels) use the log sluice/bypass. To identify hydraulic influences related to Project operations and/or naturally occurring hydraulic conditions, CFD modeling will be employed to evaluate potential fish passage barriers in the study area. Though the CFD results will provide insight to the hydraulic influences in the study areas, it is important to remember that other non-hydraulic factors can also factor into whether and how fish use a passage structure. This study will focus only on the hydraulic influences at the Spillway and Cabot Station fish ladders as related to fish passage effectiveness, as well as the Cabot and Station No. 1 influences relative to downstream fish passage effectiveness. The Gatehouse fish ladder will not be included in this study due to the fact that a CFD model was previously developed in 2011-2012.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

CFD models will be developed and various production runs will be conducted to gain a better understanding of hydraulic conditions at the Cabot Station and Turners Falls Spillway fish ladders as well as the Station No. 1 and Cabot Station forebays. Prior to development of the models, bathymetric surveys will be conducted at the entrances of the fish ladders and the powerhouse forebays to collect the necessary model input data. In order to effectively meet the requirements of this study, four key tasks have been identified. These tasks include: 1) bathymetric survey of the study area; 2) compile model input datasets in CAD; 3) construct, calibrate, and validate the three-dimensional model; and 4) execute model production runs. These tasks are described in more detail below.

Task 1: Bathymetric Survey of the Study Areas

Water surface elevations and water depths will be collected to create bathymetric map of the study area. Data will be collected throughout the study reach, including at the fish ladder entrances and in the forebays, along a number of evenly spaced transects and longitudinal profiles. Figure 3.3.8-1 shows the proposed modeling and data collection locations. Water column velocities/profiles will also be collected during this task.

Task 2: Compile Model Input Datasets in CAD

Utilizing existing ArcGIS elevation data and the bathymetry data collected in Task 1, three-dimensional surfaces of the study area river bed will be constructed in AutoCAD Civil 3D. Project drawings will then be used to develop three-dimensional representations of the fish ladders and pertinent Project facilities. Once completed, the three dimensional surfaces and Project facilities models will be compiled into one CAD file (per area) to depict a full physical representation of that area. The composite CAD files will then be used to create the input files for the CFD models.

Task 3: Construct Three-Dimensional Model

The input CAD files developed in Task 2 will be used to build six three-dimensional FLOW3D hydraulic models. Once built, various test scenarios will be run utilizing the field data collected in Task 1 to validate the model results. The model will be validated using field collected water surface elevations and water column velocity data.

Task 4: Conduct Model Production Runs

Once the models have been satisfactorily calibrated and validated, production runs utilizing various input parameters will be developed and executed. The results of these model runs will provide a better understanding of the hydraulics at various flows and river conditions. FirstLight has developed a list of potential production runs for each of the four models, which are described below and include what variables will be adjusted between runs (adjustment variables). Note that while tailwater levels are not directly addressed in the proposed run matrices, the water levels will vary as a function of flow for the non-power canal models. These run descriptions and proposed grid sizes should be considered preliminary and may be adjusted depending on stakeholder input and feedback.

Model 1 will cover the power canal in front of the Station No. 1 intake. Model 2 will cover the Station No. 1 intake rack, and will be run for similar flow conditions as model 1. Since the power canal's water surface elevation is constant, the primary adjustment variables for model 1 will be the total power canal flow and the flow passing through Station No. 1. Table 3.3.8-1 outlines FirstLight's proposed flow scenarios for models 1 and 2, which includes a total of three runs. The proposed grid size for model 1 is approximately 4 ft (X axis) by 4 ft (Y axis) by 2 ft (Z axis), provided there are no computational limitations that require a larger grid size. The proposed grid size for model 2 is approximately 0.025 ft (X axis) by 0.025 ft (Y axis) by 0.05 ft (Z axis), provided there are no computational limitations that require a larger grid size. Model 2 will only cover an approximately 4 ft wide portion of the Station No. 1 intake rack (to full depth), due to anticipated computational limitations. The model 2 scenarios will also include different flow approach angles (in addition to normal), which will be developed based on the results from Model 1.

Table 3.3.8-1: Proposed flow scenarios for CFD model 1 and CFD model 2.

Scenario Number	Models Run	Station No. 1 Flow (cfs)	Canal Pass-Through Flow[66] (cfs)	Total Power Canal Flow (cfs)
1-1, 2-1	1 and 2	1,433 (current min flow)	200	1,433 (
1-2, 2-2	1 and 2	2,210 (Station No. 1 capacity)	200	2,210
1-3	1	2,210	13,928 (Cabot capacity of 13,728 cfs plus 200 cfs for log sluice)	16,138

Model 3 will cover the power canal in front of the Cabot Station intake. Model 4 will cover the Cabot Station intake track, and will be run for similar flow conditions as model 3. The primary adjustment variables for model 3 will be the flow passing through Cabot Station. The flow passing through the log sluice is approximated at 200 cfs for each run. Table 3.3.8-2 outlines FirstLight's proposed flow scenarios for models 3 and 4, which includes a total of three runs. The proposed grid size for model 3 is approximately 4 ft (X axis) by 4 ft (Y axis) by 2 ft (Z axis), provided there are no computational limitations that require a larger grid size. The proposed grid size for model 4 is approximately 0.025 ft (X axis) by 0.025 ft (Y axis) by 0.05 ft (Z axis), provided there are no computational limitations that require a larger grid size. The Model 3 grid will likely need to be further refined (perhaps down to a 1 ft by 1 ft by 1 ft mesh) in the vicinity of the fishway entrance. Model 4 will only cover an approximately 4 ft wide portion of the Cabot Station intake rack (to the depth of the upper intake rack), due to anticipated computational limitations. The model 4 scenarios will also include different flow approach angles (in addition to normal), which will be developed based on the results from Model 3.

Table 3.3.8-2: Proposed flow scenarios for CFD model 3 and CFD model 4.

Scenario Number	Models Run	Cabot Flow (cfs)	Log Sluice Flow (cfs)	Total Power Canal Flow (cfs)
3-1, 4-1	3 and 4	1,700	200	1,900
3-2, 4-2	3 and 4	7,500	200	7,700
3-3, 4-3	3 and 4	13,728 (Cabot capacity)	200	13,928

Model 5 will cover the Cabot fishway entrance area. Adjustment variables will include the bypass reach flow and Cabot Station flow. Table 3.3.8-3 outlines FirstLight's proposed flow scenarios for model 5, which includes a total of five runs. The runs represent total flow values for several April flow exceedance percentiles (75%, 50% exceedance), plus other meaningful operational scenarios. The proposed grid size for model 5 is approximately 4 ft (X axis) by 4 ft (Y axis) by 2 ft (Z axis), provided there are no computational limitations that require a larger grid size. The grid will likely need to be further refined (perhaps down to a 1 ft by 1 ft by 1 ft mesh) in the vicinity of the fishway entrance.

Table 3.3.8-3: Proposed flow scenarios for CFD model 5.

Scenario Number	Cabot Flow (cfs)	Bypass Reach Flow (cfs)	Cabot Fishway Flow (cfs)	Total Flow (cfs)
5-1	1,700	400	368	2,468
5-2	7,500	400	368	8,268
5-3	13,728	400	368	14,496
5-4	13,728	6,501	368	20,597 (April 75% exc.)
5-5	13,728	16,240	368	30,336 (April 50% exc.)

[66] Represents the flow passing through the power canal toward Cabot Station and the log sluice (~200 cfs).

Model 6 will cover the Spillway fishway entrance area. FirstLight anticipates modeling the spillway fishway and attraction flow, as well as flow from each of the bascule gates as separate inflow boundary conditions. Spill from the three tainter gates will be reflected in the model's downstream tailwater elevation, but not explicitly modeled. Table 3.3.8-4 outlines FirstLight's proposed flow scenarios for model 6, which includes a total of four runs. The runs represent total flow values for several April flow exceedance percentiles (75%, 50%, 25% exceedance), as well as the typical bypass reach minimum flow during passage season (400 cfs). The flow distributions below were developed assuming an impoundment elevation of approximately 180 ft, which is a reasonable elevation at which station operators may maintain the pond during higher flow periods. At an impoundment elevation of 180 ft., the bascule gate flow can be approximated at about 7,500 cfs per gate when fully open. The proposed grid size for model 3 is approximately 4 ft (X axis) by 4 ft (Y axis) by 2 ft (Z axis), provided there no computational limitations that require a larger grid size. The grid size will likely need to be further refined (perhaps down to a 1 ft by 1 ft by 1 ft mesh) in the vicinity of the fishway entrance.

Table 3.3.8-4: Proposed flow scenarios for CFD model 6.

Scenario Number	Power Canal Flow[67] (cfs)	Spillway Ladder Flow (cfs)	Bascule Gate No. 1 Flow (cfs)	Other Bascule Gate Spill[68] (cfs)	Tainter Gate Spill[69] (cfs)	Total Turners Falls Flow (cfs)
6-1	7,282	318	400	0	0	8,000
6-2	15,938	318	4,341	0	0	20,597
6-3	15,938	318	7,500	6,580	0	30,336
6-4	15,938	318	7,500	12,460	10,000	46,216

Task 5: Report

A report will be developed summarizing the study findings. The report will address each of the five objectives defined for this study. The report will include maps, cross-sections and other visualizations of the model results that are relevant to the study objectives.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort defined above is adequate to conduct CFD modeling in the study area. Due to the location of the powerhouses and fish ladders along the power canal/bypass channel,

[67] The power canal is not included in CFD model 6, but is included in this table to show the flow distribution.
[68] The bascule gates are typically operated in a set order of no. 1, no. 2, no. 4 and no.3, with gate no. 1 being opened first and closed last, and gate no. 3 being opened last and closed first. The bascule gates can be throttled as desired.
[69] The tainter gates are typically opened to maintain some flexibility in the bascule gates' available capacity. Since the bascule gates do not require manual operation like the tainter gates, station personnel generally prefer to not max out the bascule gate capacity. The tainter gates can be throttled as necessary, but the adjustments cannot be done remotely like it can for the bascule gates.

four separate bathymetry surveys will need to be conducted and four separate CFD models will need to be developed (Spillway ladder entrance, Station No. 1 forebay, and Cabot ladder/forebay). As such, the total cost to conduct this study is approximately $250,000 to $350,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight proposes to conduct this study during the 2014 study year. The bathymetric survey, and any other pertinent field efforts, will be completed during the spring or early summer of 2014 contingent on safe river conditions. Assuming field efforts are completed by early June, data post processing and CAD model development will be completed by late August. Once all model input data has been created, CFD model testing and production runs will occur throughout the fall 2014. All modeling efforts are intended to be complete by the end of the 2014 study year. Additional analysis associated with coupling the CFD results with telemetry data will be undertaken as part of the respective telemetry studies during the 2015 study season.

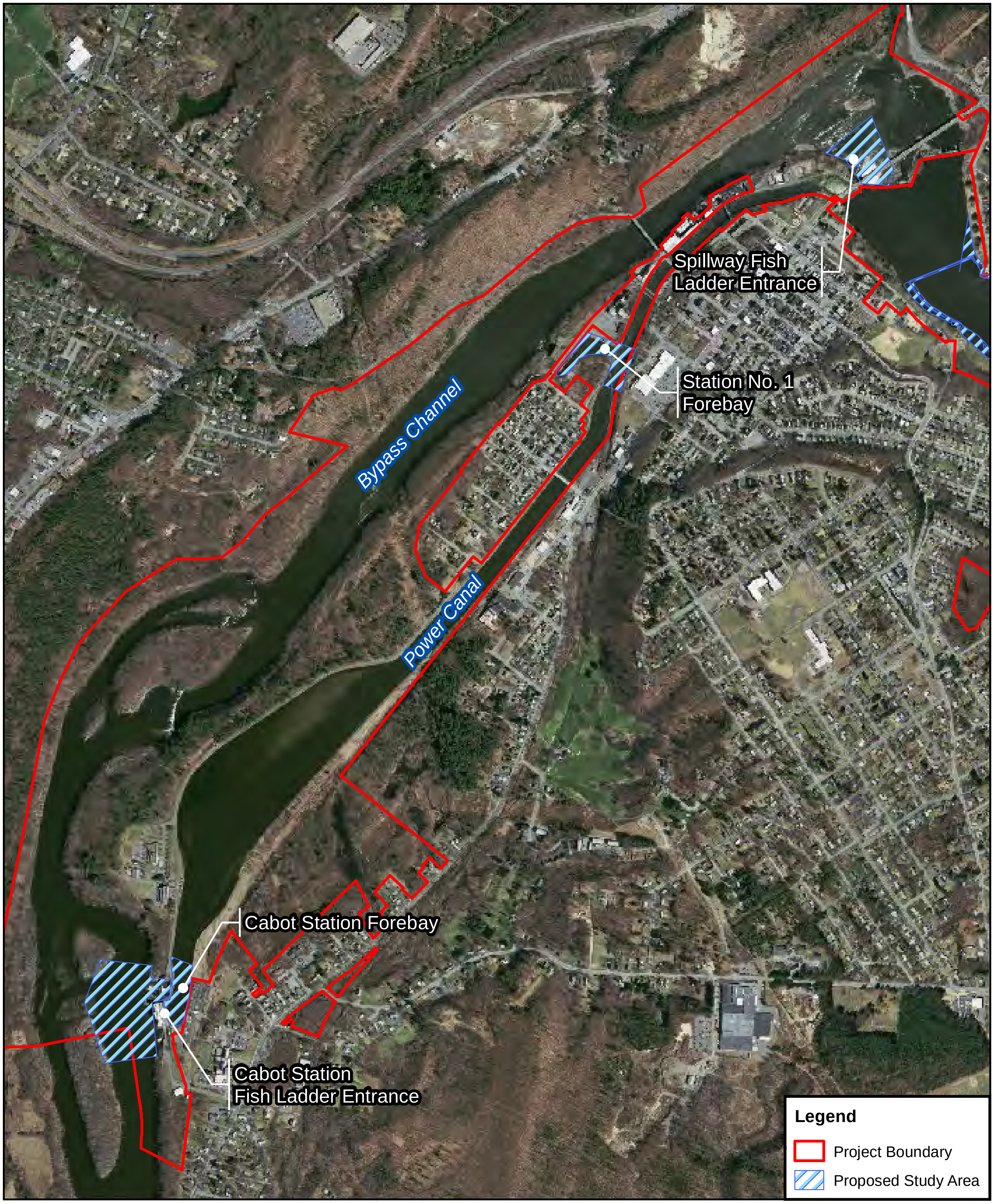

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Figure 3.3.8-1: CFD Modeling Locations in the Vicinity of the Turners Falls Power Canal and Bypass Channel

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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.

General Description of Proposed Study

The USFWS, NHFG, MDFW, CRWC, TU, LCCLC, and the Town of Gill requested similar studies utilizing CFD modeling in the vicinity of the Northfield Mountain Project intake/tailrace channel and in the Connecticut River upstream and downstream of the intake/tailrace to evaluate flow field conditions. The Northfield Mountain Project discharges water from its upper reservoir into the Connecticut River when generating and withdraws water from the Connecticut River to the upper reservoir when pumping. Pumping and generating associated with Project operations utilize the same infrastructure, at the same location (Figure 3.3.9-1). To better understand potential Project operations impacts, River2D software will be used to conduct two-dimensional hydraulic modeling of the Northfield tailrace and a 10-kilometer portion (5 km upstream, 5 km downstream) of the Turners Falls impoundment surrounding the Northfield tailrace. In the immediate vicinity of the tailrace, field-collected data will be used to assess the flow field conditions under pumping and generating conditions.

In 2007, Woodlot Alternatives developed a two-dimensional model of the Turners Falls Impoundment from Vernon Dam to Turners Falls Dam, including the majority of the proposed study reach. The 2007 Woodlot model was developed using 2006 bathymetry data collected by HydroTerra. A modified version of this model will be used to satisfy the objectives of this study. In order to modify the existing model, new supplemental bathymetry data will be collected in the vicinity of the Northfield tailrace and input into the model. FirstLight will collect the new supplemental bathymetry data as part of this study.

Once the model is updated, various model production runs will be conducted to analyze the hydraulic characteristics (depth, velocity) found in the study area over a range of conditions.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to model flow characteristics upstream and downstream of the Northfield Mountain Project tailrace under existing Northfield Mountain Project operations (pumping/generating), at several representative river flow levels, under proposed operational changes such as those discussed in Section 3.4.4 of the PAD, and under alternative Northfield Mountain Project operations representing potential conditions under a new license. The alternative Northfield Mountain Project operations scenarios will be developed in consultation with the relicensing stakeholders after the initial study results are complete.

The specific study objectives are to:

1) Assess velocities and flow fields at, and in proximity to, the Northfield Mountain Project intake/discharge structure, when pumping or generating, and their potential to interfere with fish migration;
2) Assess the potential for velocity barriers in the mainstem river to develop from pumping and generation flows at the Northfield Mountain Project, alone or in combination with generation flows from the upstream Vernon Project and downstream Turners Falls Project;
3) Characterize water column velocity profiles in the immediate vicinity of the Northfield tailrace (i.e., inside the boat barrier);
4) Assess the potential for Northfield Mountain Project operations to create undesirable attraction flows to the intake/discharge area that may result in entrainment or delay of migratory fish; and

5) Assess potential migratory fish impacts due to flow reversals under:
    a) pumping conditions, such that the river flows from the Turners Falls Dam toward the Northfield tailrace; and
    b) generating conditions, such that the river flows from the Northfield tailrace toward Vernon Dam

In addition to the objectives outlined above, CRWC requested that this study also include an assessment of pumping and generation impacts on bank erosion and paddling. These issues are addressed in other study plans and thus, are not included as a study objective.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

This study was requested by MDFW, USFWS, NHFGD, Town of Gill, LCCLC, CRWC, and TU. The Town of Gill, LCCLC, CRWC, and TU are not resource agencies.

The MDFW, USFWS, and NHFGD all state that the goal of this study is to determine the potential impacts (both project-specific and cumulative) of the Northfield Mountain Project operations (pumping and generating) on the zone of passage for migratory fish near the Northfield Mountain turbine discharge/pump intake, on natural flow regimes in the area of the Connecticut River immediately upstream and downstream of the project, on the potential for entrainment during pumping operations, on the potential for pumping cycles to confuse migratory fish attempting to pass the project, and on bank erosion on both sides of the river in the vicinity of the tailrace.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Project operations data including pumping, generation, water surface elevation, and other pertinent information are currently collected and maintained by FirstLight.

In 2007 a two-dimensional flow model for the Turners Falls Impoundment, including the majority of the study area, was developed by Woodlot Alternatives. Although not originally developed to meet the scope of this proposed study, the data used to develop the original model, combined with updated data where needed, can be utilized to satisfy the goals and objectives previously discussed. As part of the 2007 modeling work, a bathymetric survey of the Turners Falls Impoundment, including the study area, was conducted in 2006 by HydroTerra. The bathymetry data collected as part of that survey, combined with proposed newly collected data in the vicinity of the Northfield tailrace, will be used to update the existing two-dimensional model where required. Additionally, FirstLight's 2010 *Consent Order and Restoration Plan for Removal of Silt/Sediment* filing with FERC includes several bathymetric maps and a plan map of bed elevations in the final appendix of the restoration plan.

Due to the extensive amount of existing information in the study area, FirstLight is not proposing to develop an entirely new two-dimensional model or bathymetric survey. FirstLight instead proposes to review and update the existing model with supplemental field data collection.

Project Nexus (18 CFR § 5.11(d)(4))

The Northfield Mountain Project discharges water during generation and withdraws water during pumping from a channel adjacent to the mainstem of the Connecticut River. Pumping and generating associated with Northfield Mountain Project operations utilize the same infrastructure, at the same location. Existing Northfield Mountain Project operations affect instream flows in this area. Potential impacts of Northfield Mountain Project operations may include: passage of migratory fish near the pump/discharge area, entrainment during pumping operations, and creation of flow reversals in the Connecticut River during pumping cycles which may confuse migratory fish attempting to pass the Northfield Mountain Project.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The 2007 Woodlot Alternatives two-dimensional model will be updated and various production runs will be conducted to gain a better understanding of the potential impacts of Northfield Mountain Project operations within the study area. For the purpose of this effort, the study reach will include the Northfield Mountain Project intake/discharge channel and the Connecticut River 5 km upstream and downstream of the tailrace channel (Figure 3.3.9-1). In order to effectively meet the requirements of this study, five tasks have been identified, including: 1) review existing data and identify data gaps; 2) conduct a bathymetric survey of areas identified in Task 1, post process field data collected, and post process model input data; 3) develop and graph field-collected water column velocities; 4) build and calibrate the two-dimensional model; and 5) conduct steady-state model runs using River2D software. These tasks are described in more detail below.

Task 1: Review Existing Data and Identify Data Gaps

Input bathymetric data used to create the original 2007 model will be reviewed for accuracy and completeness. All data gaps will be identified to ensure the entire study reach, including the intake/discharge channel, are accurately represented in the final model. Areas found to be lacking adequate bathymetric coverage will be supplemented with newly collected bathymetry data. Based on review of the existing data, FirstLight anticipates collecting supplemental data in the area of the Northfield tailrace at a minimum. During the data collection, some "spot checks" of the 2006 bathymetry will occur to assess the appropriateness of using the 2006 bathymetry. If FirstLight determines there are substantial changes in bed elevations since 2006, then a full new bathymetry set throughout the study reach will be collected.

Task 2: Bathymetric Survey Update & Post Processing

As part of this study, new bathymetry data in the vicinity of the Northfield tailrace will be collected. Water surface elevations, water depths, and water column velocities will be collected along several evenly spaced transects and longitudinal profiles. We anticipate using a boat-mounted RTK-GPS linked to a Sontek RiverSurveyor M9 (a type of ADCP) to collect the data. Data will only be collected under safe boating conditions. In particular, it will be unsafe to boat inside of the tailrace boat barrier under any Northfield Mountain Project operations, and may be deemed unsafe even further from the boat barrier depending on in-field conditions. Thus for safety reasons, the majority of our field data, will be collected when the Northfield Mountain Project is not operating. Water velocity profile data near the tailrace structure will be collected as part of task 3.

During the field survey, FirstLight will temporarily deploy four water level loggers throughout the study reach, as field conditions allow. The logger locations are included in Figure 3.3.9-1. The purpose of the water level loggers is to assist in model calibration. The water level loggers will be surveyed to the NGVD vertical datum. FirstLight anticipates using non-vented pressure transducers (similar to the Onset HOBO U20 water level data loggers) attached to an anchor with a marking buoy. If suitable operating conditions are observed (e.g., a full pumping or full generation cycle), the water level data may be used to verify transient model results.

Task 3: Develop and Graph Water Column Velocity Profiles

This task will involve collecting, compiling and graphing field-collected water column velocity data inside of the Northfield Mountain Project tailrace's boat barrier under various operating conditions. Cross-sectional plots and three-dimensional GIS maps will be created to present the near-intake water column velocity profile. Field-collected data will be used for this task, rather than modeled data, because the two-dimensional model is depth averaged and therefore does not evaluate the water column velocity profile. The near-tailrace profile data will be collected along three transects stationed inside of the tailrace boat barrier (Figure 3.3.9-2) using the RiverSurveyor M9 linked to an RTK-GPS.

The transects will be marked using driven stakes or rock pins to maintain the exact position across multiple data collection periods. A metal cable will be strung across the transect pins to guide a floating apparatus that will hold the RiverSurveyor and RTK-GPS setup. The setup will then be manually pulled across each of the three transects for a given operating scenario. This will ensure the data are collected along identical paths for each event. FirstLight proposes to collect near-intake velocity data under four operating scenarios including: four units pumping, two units pumping, two units generating and four units generating. While other factors such as pond levels and mainstem river flows may have some influence on near-intake velocity profiles, FirstLight believes these influences will be relatively small compared to Northfield Mountain Project operations. Thus, while an attempt will be made to conduct the field work in a short and consecutive time period (perhaps two days) to minimize variations in field conditions (pond level, river flow, etc.), FirstLight will only collect one velocity set per flow condition. The field data collection will occur when river flows are less than approximately 15,000 cfs, since FirstLight will have reasonable control of the impoundment conditions under such a flow.

Task 4: Build and Calibrate 2D Model

The original model input files and the additional field collected data will be merged into one dataset to build a functional two-dimensional model using River2D software. River2D is a depth-averaged two-dimensional (lateral-longitudinal) finite element hydraulic and habitat model. It requires input data for a set of spatially-distributed points or "nodes" throughout the study reach. It then creates a linearly-interpolated triangulated mesh from the set of nodes, with each triangle referred to as an "element." River2D solves for mass conservation and momentum balance in two (x,y) dimensions using the St. Venant flow equations. Input data includes a digital bathymetric (riverbed topography) map, a stage-discharge relationship or boundary elevation at the downstream end of the study reach, and bed roughnesses throughout the study reach. Observed water surface elevation and water column velocity data are used for calibration purposes, but are not direct model inputs.

Though USFWS expressed concern with using River2D because River2D cannot model vertical walls, we are not aware of any vertical walls in the tailrace aside from the outflow structure itself. Since the outflow structure will be included as a model boundary, we do not anticipate having any model issues or instabilities. If model applicability/stability does become an issue, we will discuss with stakeholders the possibility of using a different two-dimensional model such as SMS, CCHE2D or other suitable models.

The model will be built to ensure an accurate representation of the river bed's physical features. Steps in building the model will include importing the bed elevation or "node" data, and then building a finite-element computational mesh consisting of linear triangular elements. An initial uniform gridded base mesh will be generated on an approximate 50-75 ft spacing, though the actual base mesh density will depend on how rapidly bed features change and on computational limitations. The model will extend approximately five kilometers upstream and downstream from the Northfield tailrace, for a total model length of approximately 10 river kilometers. The mesh will then be modified with the primary objective of accurately representing the river bed structure within the model. This will be done by visually assessing the raw bathymetry data, aerial photos and using local knowledge of the river to identify areas of potentially complex flow. In particular, the mesh around the Northfield tailrace will be denser, in the range of approximately 5-10 ft. At each node, bed elevation and roughness height will be specified.

As shown in Figure 3.3.9-3, the model boundary will begin just downstream from the end of the Northfield Mountain Project intake/discharge structure, which is approximately 110 ft from shore relative to the visible portion of the outlet works. The model boundary's exact location will be determined based on the data collected during Task 3, which will show where three-dimensional flow effects are negligible. This will minimize the influence of the flow structure typically being submerged by 6 ft to 15 ft of water (Figure 3.3.9-4). We expect to model Northfield generation by defining the outlet works as an inflow condition boundary that is spread evenly across the inflow boundary. We expect to model Northfield pumping by defining the outlet works as an outflow condition boundary area. The outflow condition will be defined as a stage-discharge relationship where the discharge is set to a constant outflow value that is nearly constant over the expected pond elevation range (e.g., outflow is 8,999.99 cfs at pond elevation 176 ft and is 9,000.01 cfs at pond elevation 185 ft). This model will not produce results for anywhere inside of the intake/discharge structure or for the area closer to shore behind the intake/discharge structure. Because of these modeling approximations, we anticipate that the model results in the immediate vicinity of the tailrace may have some discrepancies with the field-collected data.

Once built, the model will be calibrated to existing water surface elevation data. Calibration will be an iterative process that will primarily consist of adjusting the nodes' "roughness coefficient" within the model to better fit observed water surface elevations and water velocities. For example, if model-predicted water surfaces are higher than observed data show, then surface roughness may be lowered. If model-predicted water surfaces are lower than observed data show, then surface roughness may be raised. Surface roughness, given the units of length, must be kept within reasonable limits given the bed makeup, and is typically not larger than 1-3 times the maximum particle size (D100) within that area, unless there is a large amount of in-stream debris or other atypical features. Calibration may also involve adjustments to the finite element mesh to increase node density in complex flow areas not identified in the initial mesh construction. Successful calibration will yield results within ±0.15 ft of field-measured water surface elevations, and show a reasonable match with field-collected velocity profiles.

Task 5: Conduct and Analyze Transient Production Runs

Once the model has been calibrated, production runs representing various operating scenarios will be run. The runs will reflect unsteady-state (i.e. transient) hydraulic conditions, and are described in Table 3.3.9-1. The runs will assess river hydraulics by iterating three variables: a) Turners Falls impoundment elevation; b) main stem river flow (based on the 25% and 75% exceedance flow at Turners Falls Dam); c) Northfield Mountain Project flow (4 pumps, 2 pumps, 4 generators, 2 generators. The model run results will include two-dimensional maps of water depths and velocities. We also expect to produce time-lapse animations of the outputs (water depths, water surface elevations, depth-averaged water velocities) that will be provided to stakeholders, by request, in an electronic format. The animations will help identify spatial and temporal hydraulic influences due to Northfield Mountain Project operations. These outputs can be used to provide a better understanding of potential fish passage barriers resulting from Northfield Mountain Project operations at various flows, river conditions, and other hydraulic influences.

Task 6: Report

A report will be developed summarizing the findings of the study. The report will include presentations of the model results. The results will be presented in a variety of forms, including:

1) Colored maps of water velocity, depth, and water surface elevation under each modeled scenario;

2) Vector maps showing the magnitude and direction of water velocities;

The report will also include analysis of the model results as described in the study objectives. Maps and figures from Task 3 will also be included in the report.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort defined above is adequate to conduct River2D modeling in the study area. The results of the River2D model production runs will provide the data necessary to satisfy the goals and objectives previously outlined. The estimated cost for this study is approximately $50,000 to $85,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight will conduct this study during the 2014 study year. Existing data will be reviewed for accuracy and completeness and data gaps will be identified during the late winter, early spring of 2014. All field efforts required to update the existing bathymetry and model input data will be conducted in the spring or early summer provided there is an adequate amount of flow present in the study reach. Assuming field efforts are completed by early June, data post processing will be completed by mid August. Once all model input data has been created, the two-dimensional model will be calibrated and production runs will be conducted throughout the fall 2014. All modeling efforts, with the exception of the potential new Northfield Mountain Project operating scenarios, will be completed by the end of the 2014 study year. The new Northfield Mountain Project operating scenarios will be developed in consultation with stakeholders after the initial study results have been presented, and will be completed as part of the 2015 study year.

Table 3.3.9-1: Proposed two-dimensional modeling scenarios.

Scenario No.	Vernon Project Flow (cfs)	Northfield Mountain Project Generation Flow (cfs)	Northfield Mountain Project Pumping Flow (cfs)	Turners Falls Impoundment Starting Elevation (ft)	Turners Falls Dam Flow (cfs)
1	4,853	10,000	0	176.0	4,853 (75% exc)
2	4,853	10,000	0	185.0	4,853 (75% exc)
3	4,853	20,000	0	176.0	4,853 (75% exc)
4	4,853	20,000	0	185.0	4,853 (75% exc)
5	4,853	0	7,600	176.0	4,853 (75% exc)
6	4,853	0	7,600	185.0	4,853 (75% exc)
7	4,853	0	15,200	176.0	4,853 (75% exc)
8	4,853	0	15,200	185.0	4,853 (75% exc)
9	15,575	10,000	0	176.0	15,575 (25% exc)
10	15,575	10,000	0	185.0	15,575 (25% exc)
11	15,575	20,000	0	176.0	15,575 (25% exc)
12	15,575	20,000	0	185.0	15,575 (25% exc)
13	15,575	0	7,600	176.0	15,575 (25% exc)
14	15,575	0	7,600	185.0	15,575 (25% exc)
15	15,575	0	15,200	176.0	15,575 (25% exc)
16	15,575	0	15,200	185.0	15,575 (25% exc)

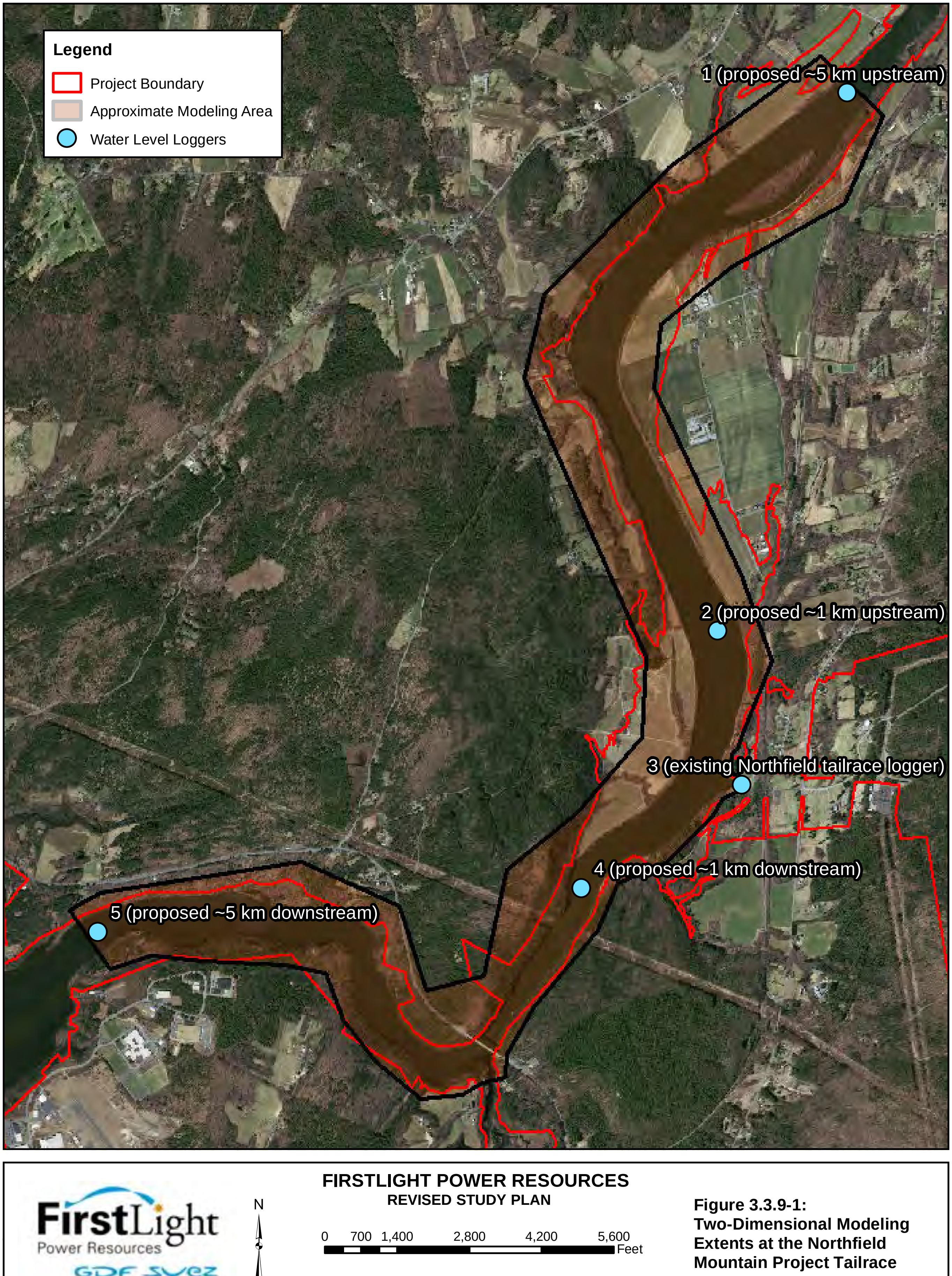

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Figure 3.3.9-1: Two-Dimensional Modeling Extents at the Northfield Mountain Project Tailrace

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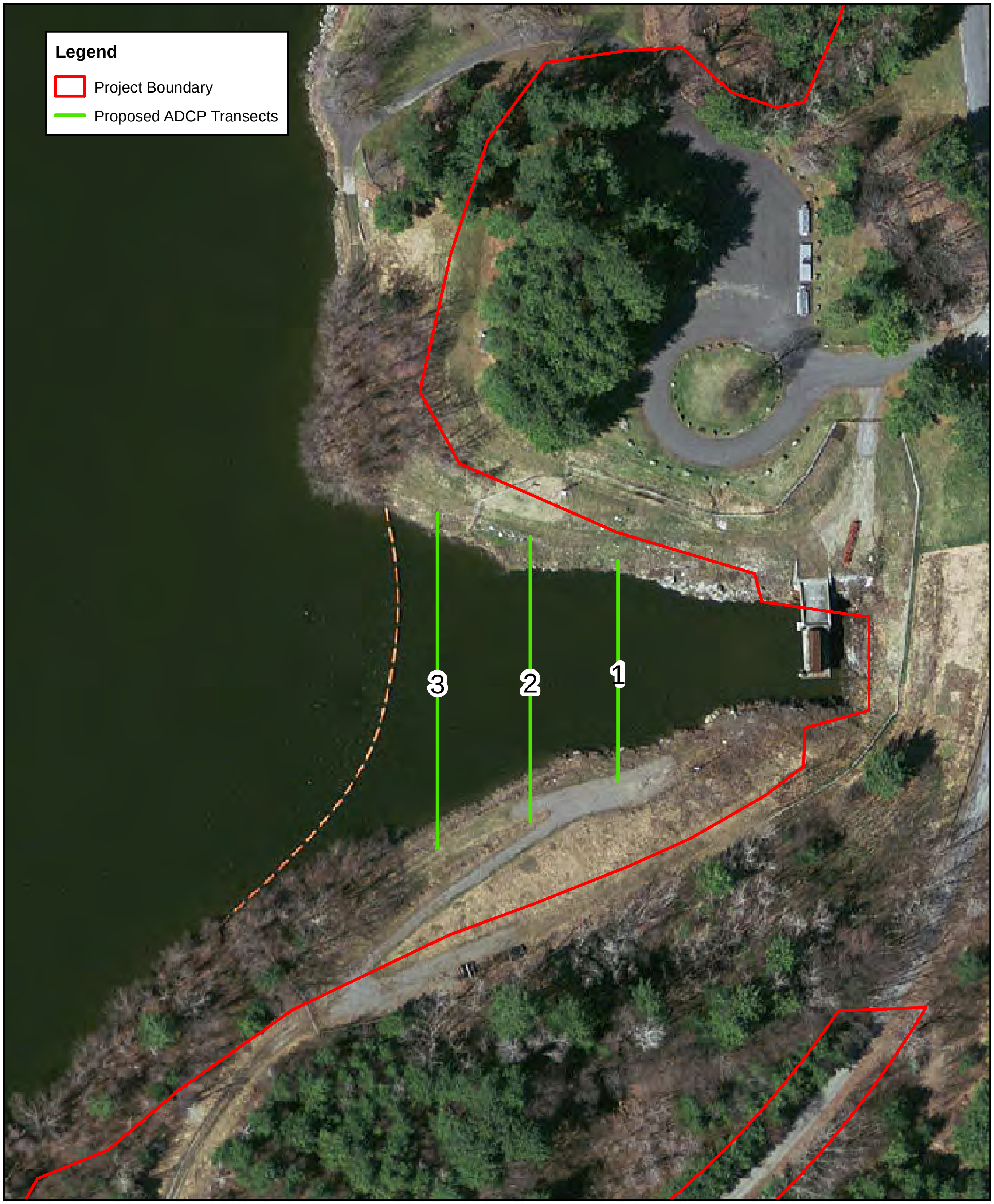

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Figure 3.3.9-2:
Near-Tailrace Proposed ADCP Velocity Profile Transects

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Figure 3.3.9-3: Northfield Tailrace Proposed Model Boundary Extent

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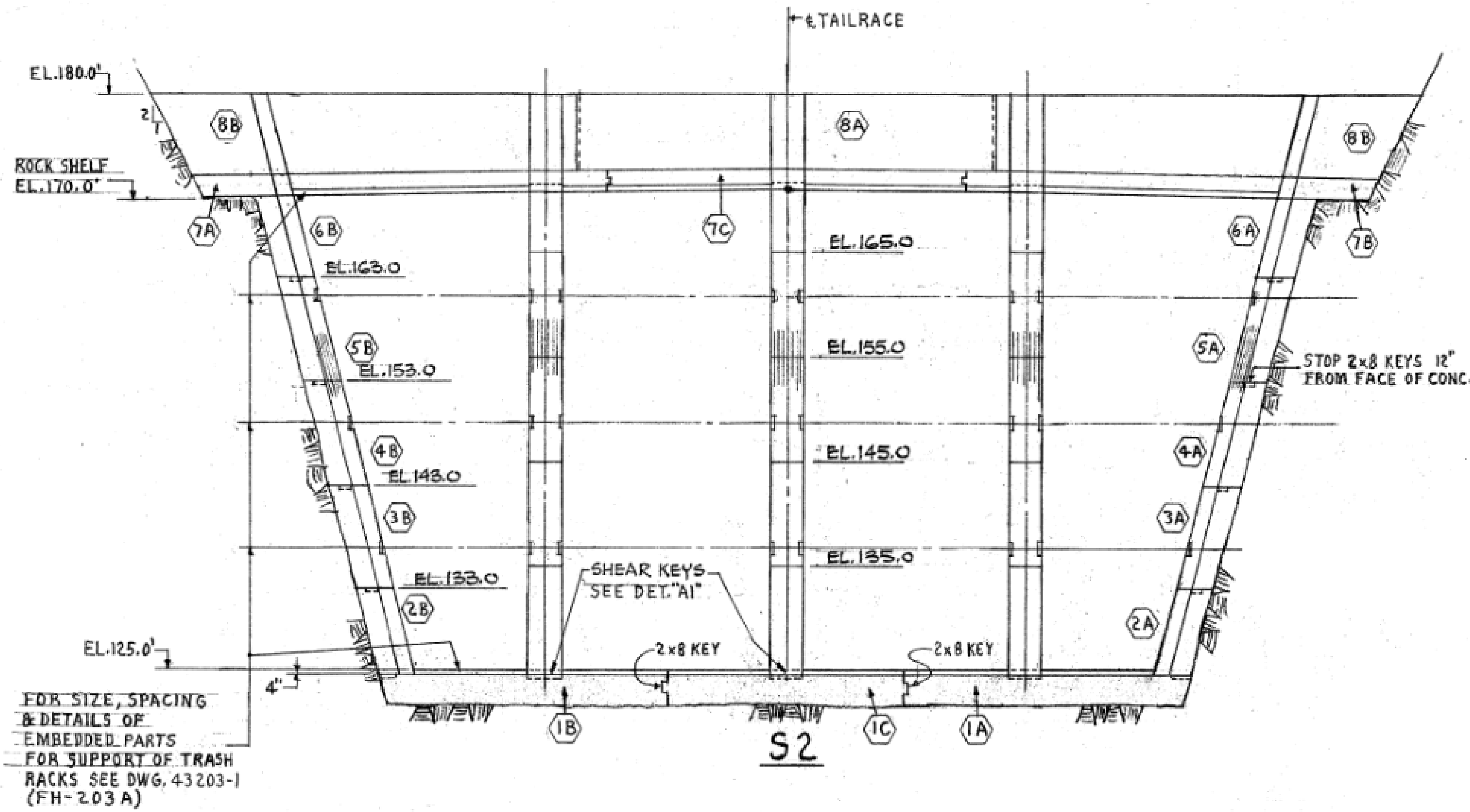
Figure 3.3.9-4: Cross-section of the Northfield intake/discharge structure. Note rock shelf elevation relative to typical pond elevation (El. 180.0 ft).



3.3.10 Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River

General Description of Proposed Study

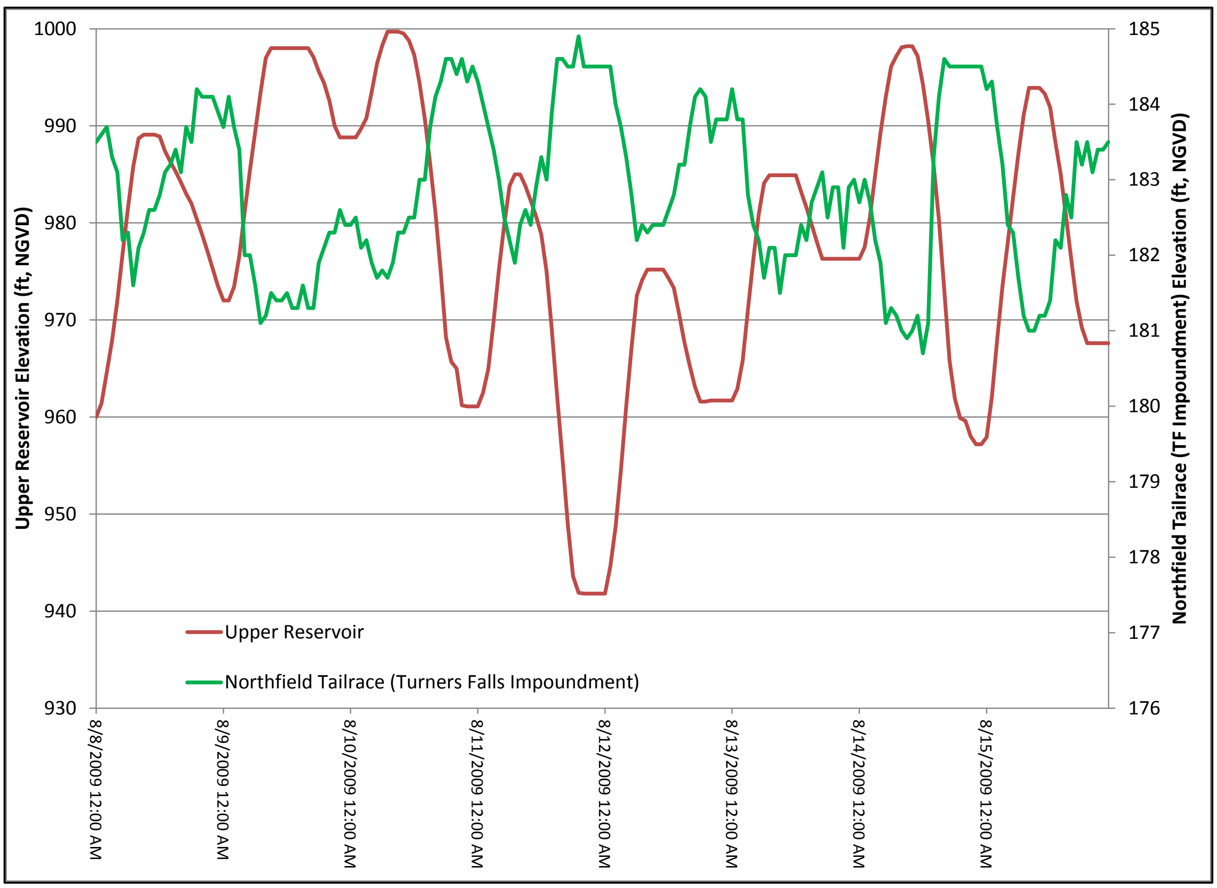
MADFW requested a study investigating the impacts of Northfield Mountain Project operations on the emergence of riverine odonates, with an emphasis on state-listed species. MADFW requested that these studies be conducted in the Upper Reservoir, the Turners Falls Impoundment, and a 13-mile reach from the Turners Falls Dam to the Route 116 Bridge in Sunderland. FirstLight proposes to conduct the studies described in this section for the Turners Falls Impoundment and the reach below the Turners Falls Dam, but does not propose to conduct studies in the Upper Reservoir.

In its PSP, FirstLight proposed to exclude the Upper Reservoir from the odonate study. On June 27, 2013 a conference call was held between FirstLight, MA Natural Heritage and Endangered Species Program (NHESP) and FERC to discuss, among many issues, the odonate study. As stated in that call and reiterated in this RSP, FirstLight is not proposing to conduct an odonate study in the Upper Reservoir for the following reasons:

- Below is an overhead picture of the manmade Upper Reservoir as well as photographs of the inboard shoreline. As the photograph shows the majority of the Upper Reservoir shoreline is comprised of rock. The near-complete lack of shallow vegetated littoral zone and rocky substrate, coupled with the daily water surface elevation fluctuations would likely preclude state-listed odonates.

- NHESP stated in its June 24, 2013 comments that "appropriate substrates for odonates vary by species, but may include sand, silt, rocks, trees, coarse woody debris, undercut banks, tree/plant roots, and anthropogenic structures." The Upper Reservoir differs markedly from the Turners Falls Impoundment in that it offers few to none of these substrates other than large expanses of rock, as depicted in the photographs above.

- There are other reasons why the Upper Reservoir is not a likely location for odonates to exist. The Upper Reservoir elevation can fluctuate 10-40 feet a day (sometimes more), pending power demand. The NHESP asserts in their comment letter on the Updated PSP the following "Additionally, the TFD Impoundment exhibits water level fluctuations similar to the Upper Reservoir, suggesting that the Proponent's assertion (e.g. that water level fluctuations in the Upper Reservoir preclude presence) is not supported". In fact, the water levels of the Upper Reservoir fluctuate dramatically more than the Turners Falls Impoundment., Per the FERC license the Upper Reservoir can fluctuate between elevations 1000.5 and 938.0 feet, NGVD (62.5 foot fluctuation) while the Turners Falls Impoundment can fluctuate between elevations 185 and 176 feet, NGVD (9 foot fluctuation). Reference is made to the elevation duration curves of the Upper Reservoir and Turners Falls Impoundment provided in the PAD demonstrating the considerably wider range of fluctuation in the Upper Reservoir as compared to the Turners Falls Impoundment. To provide a sense of the fluctuations in the Upper Reservoir and Northfield Tailrace (Turners Falls Impoundment), below is an hourly plot of the reservoir elevations for one week in August 2009. The magnitude of the Upper Reservoir fluctuation (58 feet in this example) is much greater than the Turners Falls Impoundment (approximately 4 feet). Note that fluctuations in water level in the Upper Reservoir and the Turners Falls Impoundment are mapped on different scales on the chart.



- The Upper Reservoir is not within NHESP's Priority Habitat[70] area. Priority habitats have been delineated by NHESP and are used for screening projects and activities that may impact state-listed rare species and their habitats as set forth in 321 CMR 10.18. The Upper Reservoir is also not mapped as "Estimated Habitat" of Rare Wetlands Wildlife under the regulations implementing the Massachusetts Wetlands Protection Act, as set forth in 310 CMR 10.59. In contrast much of the Turners Falls Impoundment and area rivers have been designated as Estimated or Priority Habitat.

- In light of the unsuitability of the Upper Reservoir to support state listed odonate species, FirstLight believes the effort to assess their presence is likely to be disproportionate to the expected benefit. Note that First Light is proposing to conduct a variety of odonate studies in various parts of the Turners Falls Impoundment and below the Turners Falls Dam as set forth later in this section.

The proposed study will include synthesis of existing data, field surveys, and the use of a hydraulic model (see Section 3.2.2) to assess potential effects of water level fluctuations on factors related to odonate emergence/eclosure behavior.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

This study has two objectives:

- Synthesis of existing data, supplemented with field surveys, to characterize the assemblage structure and emergence/eclosure behavior of odonates in the project area.
- Determine if project operations affect the emergence and eclosure success of state-listed odonates, and the potential implications for the odonate assemblage in affected areas, particularly state-listed species.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The Massachusetts Natural Heritage & Endangered Species Program (NHESP), part of the MADFW, is charged with ensuring the conservation and protection of species listed under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) as Endangered, Threatened, or of Special Concern. The resource management goals identified by the NHESP/MADFW are to:

- Ensure that PME measures are commensurate with Project effects and meet MESA requirements for the Project.
- Conserve, protect, and enhance the habitats for state-listed species that will be affected by Project operations.

[70] Per 321 CMR 10:02 (Definitions and Abbreviations) of the MA Endangered Species Act: "Priority habitat means the geographic extent of Habitat for State-listed Species as delineated by the Division pursuant to 321 CMR 10.12. Priority Habitats are delineated based on records of State-listed Species observed within the 25 years prior to delineation and contain in the Division's NHESP database".

The MADFW study request is intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, PME measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Clean Water Act (33 U.S.C. §1251 *et seq*.), the MESA, and the Massachusetts Wetlands Protection Act (WPA).

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

State-listed Odonate Species Composition: The status of state-listed odonate species is well documented for the Turners Falls Impoundment due to several studies conducted 2001–2010 (Morrison et al., 2001; 2004; 2006; Mclain et al., 2004; 2006; Martin, 2007; 2010). Six state-listed species have been observed within reaches above the dam—Cobra Clubtail (*Gomphus vastus*), Stygian Shadowdragon (*Neurocordulia yamaskanensis*), Spine-crowned Clubtail (*G. abbreviatus*), Skillet Clubtail (*G. ventricosus*), Riverine Clubtail (*S. amnicola*), and Midland Clubtail (*G. fraternus*) (McLain et al., 2006). Cobra Clubtail and Stygian Clubtail are the most abundant state-listed species encountered in this area. In contrast to the Turners Falls Impoundment, survey effort below the dam has been far less intensive; this region of the Connecticut River represents an information gap with regard to rare odonate species composition and abundance.

Based on odonate studies conducted in the Turners Falls Impoundment, as well as both published and unpublished research on the life history and ecology of these species, we have a basic understanding of emergence and eclosure, including when emergence occurs, how high above the water eclosure takes place, how long the process takes, what substrates are typically used, and how these factors differ by species or family groups. To some extent, a thorough review of existing information will provide adequate biological information for an impact assessment using the hydraulic model (see Study No. 3.2.2 *Hydraulic Study of the Turners Falls Impoundment, Bypass Reach and below Cabot Station*), but field observations are planned to fill critical knowledge gaps by conducting surveys in both the Turners Falls Impoundment and downstream from the Turners Falls Dam. For example, because much of the odonate research in the Turners Falls Impoundment was initiated due to riverbank stabilization efforts, some habitat types (e.g., the lentic environment near Barton's Cove) have not been well surveyed for odonates, and the emergence/eclosure behavior of odonates in these different habitat types is not well understood.

Impact of Water Level Fluctuations: The extent to which water level fluctuations disrupt odonate emergence and eclosure is not well understood. The concern is whether emergent larvae ascend a great enough vertical distance, and quickly enough, to avoid being inundated after eclosure begins. This will depend on a variety of factors, such as the propensity of a species to travel far or climb high, the timing of emergence compared to the timing of water level fluctuations at that particular site, bank slope, and substrate. Related research in the Connecticut River by Martin (2010) and others (McLain et al., 2004, 2006; Morrison et al., 2001) has investigated the factors that influence the distance nymphs travel before eclosure; air temperature, substrate, and water velocity were among factors identified. Studies have found that coarse substrate on the riverbank, especially riprap, discouraged travel of some odonate nymphs. The furthest nymphs were recorded traveling during these studies on any substrate is about 40 feet (Martin, 2010), but many eclose after traveling just a few feet.

The effect of water level fluctuations on aquatic habitat parameters in the Turners Falls Impoundment and downstream from the Turners Falls Dam is not well documented. A separate study plan is proposed to produce a hydraulic model of these areas (see Study No. 3.2.2 *Hydraulic Study of the Turners Falls Impoundment, Bypass Reach and below Cabot Station*).

Project Nexus (18 CFR § 5.11(d)(4))

The timing, rate, and magnitude of releases from the Projects may have adverse effects on state-listed riverine odonate tenerals (newly emerged) although the degree of these effects is unknown. In order to fill this information gap, an empirical study is proposed to provide information on the relationship between Project operation and the effects of water level changes on emerging odonate tenerals. Results will be used by the MADFW to determine appropriate recommendations to protect and/or enhance state-listed odonates and their habitats.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Review of Existing Information

Existing information on the species composition of odonates in the proposed study reaches of the Connecticut River will be gathered from a variety of sources (see Literature Cited in this section). The life history and ecology of these species and species groups will be summarized, and significant data gaps related to habitat preference and emergence/eclosure behavior will be identified.

Task 2: Finalize Study Plan and Attain Collection Permit

Because the study is focusing on state-listed odonate species, FirstLight will work with NHESP to finalize the study plan and attain the necessary permit to handle/collect state-listed odonates. FirstLight will comply with the conditions and reporting requirements of the collection permit.

Task 3: Qualitative Surveys for Larvae and Exuviae to Determine Species Presence

Odonate larvae and exuviae will be surveyed between the Turners Falls Dam and the Route 116 Bridge in Sunderland, and in the Turners Falls Impoundment near Barton's Cove, to establish a qualitative baseline for the odonate assemblage in these areas (Figure 3.3.10-1). Aside from the Barton's Cove area, surveys above the Turners Falls Dam are not necessary due to the intensive survey effort in this area from 2001 to 2010. The survey will be conducted just prior to spring emergence (mid May to early June) to maximize detection of species, under conditions of average to below-average river flows. By focusing on larval (aquatic) life stages, this qualitative survey will effectively capture species that might emerge later in the spring or summer, eliminating the need to time the surveys for specific emergence periods. The qualitative survey will, however, also collect exuviae or tenerals to document early-emerging species.

Study Areas

1. Representative shoreline habitats in Barton's Cove, totaling approximately 200 meters, will be surveyed, with emphasis on habitat conditions preferred by target state-listed species that have not already been documented in the area (i.e., *Gomphus fraternus* and *Gomphus ventricosus*).

2. Representative shoreline habitats in Reach 3 (as defined in Study No. 3.3.1) totaling approximately 200 meters, will be surveyed, with emphasis on habitat conditions preferred by target state-listed species that have not already been documented in the area (i.e., *Gomphus fraternus* and *Gomphus ventricosus*)

3. Representative habitats within two (2) reaches in the area between the Railroad Bridge and Third Island (Montague/Deerfield), totaling approximately 400 meters, will be surveyed, with emphasis on habitat conditions preferred by target state-listed species that have not already been documented in the area (i.e., *Gomphus abbreviatus*, *Gomphus fraternus*, *Gomphus vastus*,

Gomphus ventricosus, *Neurocordulia yamaskanensis*, *Stylurus amnicola*, and *Enallagma carunculatum*)

Collection methods for larvae will include aquatic D-nets or other nets appropriate for conditions at each site. Tenerals or exuviae will also be collected on the riverbank if emergence has started. Collections will be made while wading or snorkeling in shallow water, SCUBA diving in deep water, or while walking along the riverbank. The amount of time spent at each location (i.e., survey effort) will vary depending on how quickly target species are found, but generally, eight (8) person-hours of collection per site or a total of 32 person-hours, will be expended for these qualitative surveys. At each site, aquatic, riparian, and upland habitats will be photographed and the following parameters will be recorded:

Aquatic Parameters: water depth, water velocity, dominant substrate types, species composition and coverage of aquatic plants, presence and coverage of fine and coarse organic material;

Riparian Parameters: bank slope, bank height, bank stability, dominant substrate types, plant species composition and cover, tree canopy height, tree canopy density;

Upland Parameters: land use/land cover, dominant vegetation.

For any tenerals or exuviae collected (if emergence has started), the following information will also be collected: elevation above the water surface, vertical and lateral distance from the water's edge, and substrate.

Task 4: Quantitative Surveys of Emergence/Eclosure Behavior

Quantitative surveys to determine the emergence/eclosure of odonate species will be conducted at four study reaches. Through consultation with NHESP, two study reaches will be selected from the Turners Falls Impoundment and two will be selected from downstream of the Turners Falls Dam. The specific reaches will be selected to represent a range of aquatic and riverbank habitat conditions and hydraulic characteristics. The two reaches selected in the impoundment will have different habitat than the sites associated with riverbank stabilization that were monitored from 2001 to 2010.

A minimum of six transects will be established within each study reach, for a total minimum of 24 transects. More may be added depending on habitat variability within each reach, habitat preference of target species, and variability in the density and species composition of exuviae among transects (e.g., low density and high variability may require additional transects). The Task 3 results will help inform this decision, and the plan may evolve further depending on preliminary Task 4 results. Transects will be monumented with PVC pipe or rebar along their length. Each transect will be perpendicular to the river, 2 m wide, and will extend upslope approximately 12 m (i.e., the greatest distance recorded in earlier studies of odonate emergence in this area). The following habitat data will be collected at each transect: GPS location of both ends, slope, elevation of the upslope and water ends, elevation of the mean high water mark, types and percent cover of each substrate type, substrate embeddedness, species composition and percent cover of aquatic and upland plants, and anything else noteworthy about conditions at each transect. All transects will be photo-documented. In addition to these transect-specific data, aquatic, riparian, and upland habitat will be characterized for each of the four reaches, as described under Task 3.

Surveys for emerging larvae, exuviae, and tenerals will be conducted at each transect every two weeks from mid-May through late August, and will be timed to coincide with weather (warm air temperatures, dry and sunny days) and flow conditions (average to below-average flows, based on USGS streamflow data at the Montague City gage (01170500)) that are conducive to emergence, and during times that are generally considered peak emergence periods for target species that occur in these areas. Surveys will be conducted on weekday mornings when recreational use of the river is low. If possible, surveys will be coordinated with upstream hydropower operations to occur during a period of stable water levels to increase likelihood of collecting data on species that emerge very near the water line and might otherwise be washed away by daily flow fluctuations, and for similar reasons, will not be conducted within two days of heavy rainfall that might dislodge and wash away exuviae. The time of day, weather, water level, and a qualitative assessment of boat traffic will be recorded at the time of each survey. For each exuvia and teneral found, the emergence distance from the water, elevation above the water surface, vertical and lateral distance from the water's edge, and the structure/substrate it was found upon will be recorded. All exuviae will be collected in individual vials, labeled with site information and date, and preserved for later species identification.

Emergence and Eclosure Time

Emerging larvae will be watched/tracked as they progress upslope, and the time it takes for them to stop, eclose, and take flight will be recorded. There is little guidance in the literature on how to implement such a study in a way that provides robust and representative data, adequately addresses for potential confounding factors, and reduces observer bias. This is a time-intensive observation process that relies on seeing larvae as they exit the water, and it might be challenging to get a large number of observations for a range of species (especially rare species). As such, FL is providing general details on such a study, but may modify specific details of the study (in consultation with NHESP) depending on how well it works, environmental conditions at the study sites, larval densities, etc. Generally:

Observations will be made concurrently with the exuviae surveys (mid-May to late August), as described above. Biologists will look for larvae exiting the water. It may be possible to mark each larva with a dab of paint to be able to track each individual (we will experiment with this concept), or simply have the biologist focus on a single individual as it crawls upslope and comes to rest to begin the eclosure process. The biologist will use a stopwatch to record the time it takes for the larvae to come to rest after leaving the water, the time it takes for the eclosure process to complete, and finally, the time it takes for the wings of the teneral to dry and for the adult odonate to take flight. For each exuvia, the emergence distance from the water, elevation above the water surface, vertical and lateral distance from the water's edge, and the structure/substrate it was found upon will be recorded. All exuviae will be collected in individual vials, labeled with site information and date, and preserved for later species identification.

Analysis

Water level data will be used to identify the zones along each transect that have low, moderate, to high inundation frequency. The abundance, density, and species composition of emerged odonates will be compared along a gradient of inundation frequency (taken from water level data). In addition, the influence of water level, habitat characteristics (substrate, vegetation cover, elevation), and weather conditions on emergence distance will be determined using correlation and regression analyses.

<u>Task 5: Water Fluctuation Impact Assessment</u>

A hydraulic model, which will be developed for the whole study area independent of the odonate study, will be used to determine if water level fluctuations affect the emergence and eclosure success of state-listed odonates. The field data gathered during Task 4, particularly the timing (e.g., when species emerge), distance travelled (both horizontal and vertical), and duration (i.e., speed) of travel and eclosure for species and/or species groups will be used in concert with the hydraulic model to determine which species are most vulnerable to fluctuating water levels, and under what conditions they are most susceptible.

Task 6: Report

A report will be prepared describing the survey and modeling methods and results. A tentative table of contents follows:

- Introduction
- Study Area
- Methods
    - Larval Surveys
    - Exuvia Surveys
    - Water Level Impact Assessment
- Results
    - Larval Surveys
    - Exuvia Surveys
    - Water Level Impact Assessment
- Discussion
- Conclusions
- Literature Cited

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The methods and analyses proposed are consistent with other studies of this nature, and build upon knowledge gained from other studies to focus specifically on the effects of water level fluctuations. The estimated cost for this study may range from $45,000 - $70,000 (not including the hydraulic modeling completed as a separate study). Task 3, which can be considered a first phase of fieldwork that would inform the quantitative surveys, would cost approximately $10,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Field work for this study is proposed to occur in 2014. A final study plan for the quantitative survey and hydraulic/habitat analysis would be developed in cooperation with NHESP.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Literature Cited

Martin, K. (2006). Impact of bank stabilization technique, boat wake, water level rise, and predation on the mortality rate, and eclosure success of odonate nymphs in Gill, MA: Results of the 2006 field season. Unpublished report (MA Natural Heritage and Endangered Species Program, New England Environmental, Inc.)

Martin, K. (2007). Impact of bank stabilization technique, boat wake, water level rise, and predation on the mortality rate, and eclosure success of odonate nymphs in Gill, MA: Results of the 2007 field season. Unpublished report (New England Environmental, Inc.)

Martin, K. (2008). Impact of bank stabilization technique, boat wake, water level rise, and predation on the mortality rate, and eclosure success of odonate nymphs in Gill, MA: Results of the 2008 field season. Unpublished report (New England Environmental, Inc.)

Martin, K. (2010). The transition zone: impact of riverbanks on emergent dragonfly nymphs. Implications for riverbank restoration and management. Ph.D. Dissertation, Antioch College.

McLain, D. (2008). Dragonfly population dynamics and bank stabilization in the Turners Falls Pool of the Connecticut River: Results of the 2008 field season. Unpublished report to New England Environmental, Inc., and Energy Capital Partners.

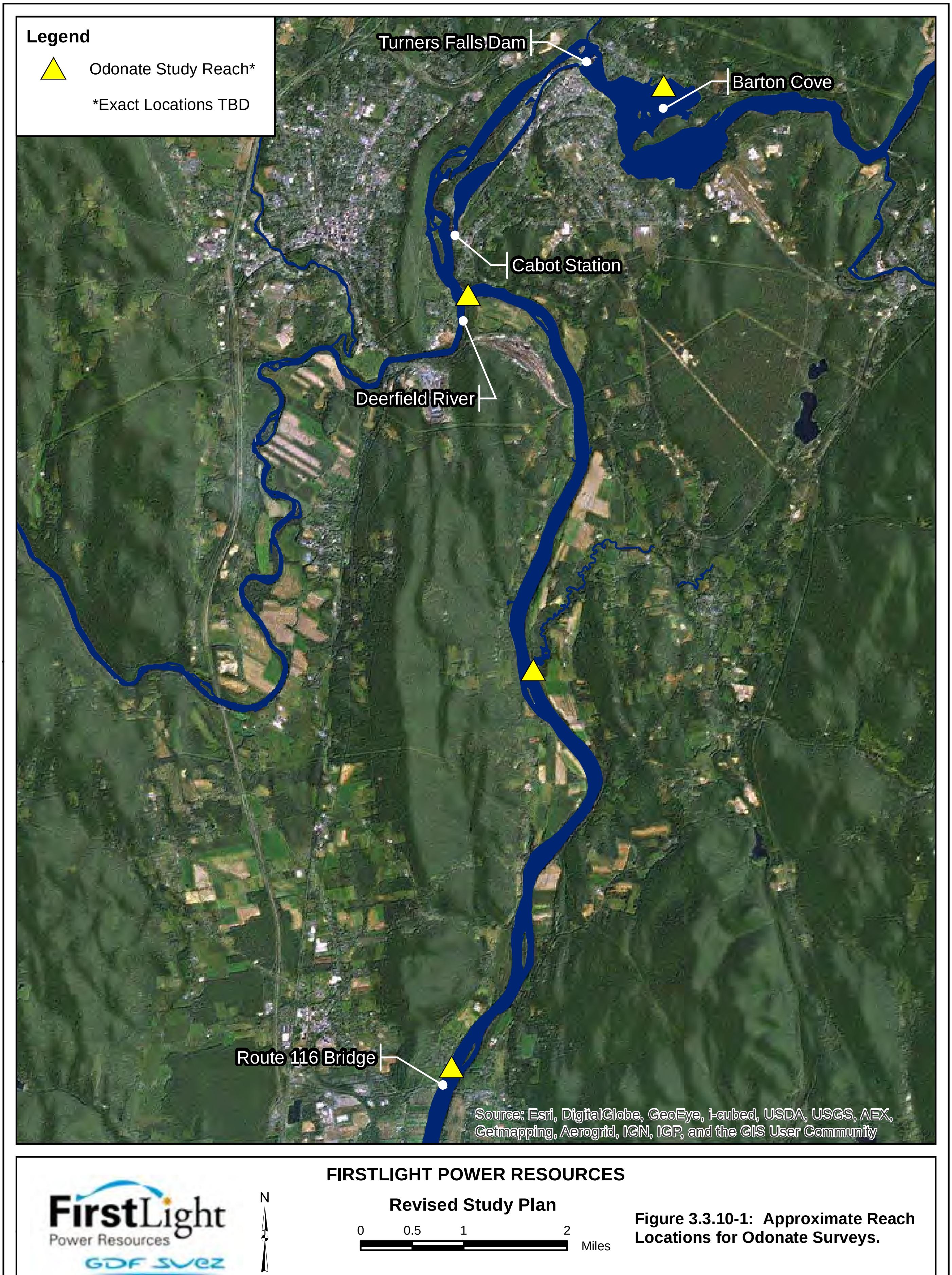
McLain, D., Morrison, F., and Sanders, L. (2004). Dragonfly population dynamics, effects of bank stabilization, and ecology of nymphs in the Turners Falls Pool of the Connecticut River, 2004 field season. Unpublished report to The Massachusetts Environmental Trust, Franklin Land Trust, and Northeast Generation Services.

McLain, D., Morrison, F., and Sanders, L. (2006). Bank stabilization and dragonfly emergence, population dynamics, and larval ecology in the Turners Falls Pool of the Connecticut River, 2005 field season. Unpublished report to Northeast Generation Service, The Massachusetts Environmental Trust Fund, and the Franklin Land Trust.

Morrison, F., Mclain, D., and Sanders, L. (2001). A survey of dragonfly species at the Urgiel-Upstream Site. Prepared for New England Environmental.

Morrison, F., Mclain, D., and Sanders, L. (2004). A Survey of Dragonfly Species Two Years after Bank Stabilization at the “Urgiel – Upstream” Site, Gill, Massachusetts. Unpublished report to New England Environmental.

Morrison, F., Mclain, D., and Sanders, L. (2006). A survey of dragonfly emergence patterns based on exuvia counts and the results of river bottom transects at selected sites in the Turners Falls Pool of the Connecticut River, 2006 field season. Unpublished report to New England Environmental, Inc., Energy Capital Partners, The Massachusetts Environmental Trust, and Franklin Land Trust.



FIRSTLIGHT POWER RESOURCES

Revised Study Plan

Figure 3.3.10-1: Approximate Reach Locations for Odonate Surveys.

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3.3.11 Fish Assemblage Assessment

General Description of Proposed Study

In the study request letter from the FERC, a baseline fisheries population study was requested. The request included sampling within the Turners Falls Impoundment, tailwater areas, the bypassed reach, and downstream riverine corridors via electrofishing surveys. The FERC also requested targeted eel sampling of upstream and downstream migrating American eel. Targeted eel sampling will be conducted as part of Study No. 3.3.4 – *Evaluate Upstream Passage of American Eel at the Turners Falls Project* and silver-phase eel abundance and migration will be evaluated in Study No. 3.3.5– *Evaluate Downstream Passage of Eel*; thus, additional targeted eel sampling is not being proposed for this study.

In their study request letters, USFWS, MADFW, NHFGD, CRWC, Town of Gill, TNC, TU, VANR each requested a fish assemblage assessment to determine the occurrence, distribution, and relative abundance of fish species within the project areas and to compare study results to historical records. They requested a comprehensive assessment of fish assemblages, employing multiple gear types to randomly sample a variety of habitats throughout the study area during spring, summer, and fall as part of a robust sampling design. The proposed study will include multiple sampling methods within a statistically rigorous and comprehensive stratified-random design similar to what has been used successfully on large rivers a high degree of spatial heterogeneity.

MADFW further requested that the study include state-listed fish species as well as host fish species of the dwarf wedgemussel (*Alasmidonta heterodon*), federally- and state-listed as “Endangered”; the yellow lampmussel (*Lampsilis cariosa)* state-listed as “Endangered”; and the Eastern pondmussel (*Ligumia nasuta*), state-listed as “Special Concern.” MADFW requested that the study should assess the occurrence and abundance of mussel larvae on resident host fish. FirstLight is not proposing to evaluate mussel larvae on host fish because the relationships are already well understood (Table 3.3.11-1); the level of effort proposed will provide data on the distribution and relative abundance of state-listed fish species and host fish species.

The PAD for the Turners Falls Project and Northfield Mountain Projects identifies 22 species of fish that occur in the aquatic habitat within the Project boundary. The study described herein will document fish species occurrence, distribution and relative abundance within the Turners Falls Project and Northfield Mountain Project areas. FirstLight believes that the level of effort will provide baseline fish assemblage data and that the overall sampling design will provide useful data that can be used to inform other proposed studies.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to provide baseline information pertaining to the fish assemblage structure within the study area. Specific objectives include to:

- Document species occurrence, distribution, and relative abundance of resident and diadromous fish within the project area along spatial and temporal gradients.
- Describe the distribution of resident and diadromous fish species within reaches of the river and in relationship to habitat.
- Compare historical records of fish species occurrence in the project area to results of this study.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The MADFW, NHFGD and the VTFWD each have, as a mission, the protection and conservation of fish and their habitats. Riverine fish species are an important component of the river's ecology and are the basis for the sport fishery. Furthermore, several of the states' Species of Greatest Conservation Need (SGCN) have been documented in the project area.

The conservation and protection of species state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) is an important objective of the Natural Heritage & Endangered Species Program of the MADFW. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), as well as the rare wildlife species provisions of the Massachusetts Wetlands Protection Act (WPA) (310 CMR 10.59). The Division seeks to accomplish the resource goals and regulatory requirements of the MESA in order to:

- Ensure that PME measures are commensurate with Turners Falls Project and Northfield Mountain Project affects and meet MESA requirements for the Turners Falls Projects and Northfield Mountain Project.
- Conserve, protect, and enhance the habitats for state-listed species that will be affected by Turners Falls Project and Northfield Mountain Project operations.

The agencies requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, PME measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Clean Water Act (33 U.S.C. §1251 *et seq*.), the MESA, and the WPA. Specific to state-listed fish and mussel species, the Divisions goals are to:

- Protect, enhance, or restore diverse high quality aquatic habitats in the Connecticut River watershed and mitigate for the loss or degradation of these habitats.
- Minimize current and potentially negative effects of Turners Falls Project and Northfield Mountain Project operations on state-listed species and their habitats.

Determining species occurrence, distribution, and abundance of fish species will better clarify what species occur in the project area both spatially and temporally relative to habitats which may be affected by operation of the Turners Falls Project and Northfield Mountain Project. This information will better inform results from other study requests that will be examining the effects of operations of the Turners Falls Project and Northfield Mountain Project on various aquatic habitats, water quality, and other related concerns such as entrainment concerns at the Northfield Mountain Project. This information will be used to make recommendations and provide full consideration for all species, including those that might not otherwise be known to occur in the project area and impacts that may affect their population status through direct or indirect effects of the Turners Falls Project and Northfield Mountain Project.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

A study of resident fish species in the Turners Falls Impoundment was conducted by the Commonwealth of Massachusetts from 1971 to 1975. Eight stations in the impoundment were sampled every other week from April through October with electrofishing equipment (MDF&G, 1978). Because many changes have occurred throughout the watershed during the last four decades, these data may not be an accurate representation of the current fish assemblage.

In 2008 the impoundment was surveyed via electrofishing; this survey, conducted by Midwest Biodiversity Institute (MBI), was part of a larger USEPA effort to sample the entire Connecticut River from its headwaters at Lake Francis to the freshwater extent of the tidal estuary (Yoder et al., 2009). The 2008 survey did not have the same goals and objectives as this study; thus, data collected is not sufficient to assess the abundance, occurrence, or distribution of fish within the study area or in relation to project operations. Neither study employed the use of alternative gear types; while electrofishing is considered to an effective method for capturing fish in littoral areas of flowing water, capture probabilities are typically lower for small fish or those lacking swim bladders. It is also not effective at capturing fish from deep water unless modified. A total of 22 fish species was identified in the project area based on historical data, but several species reported to occur within the project area were not documented, including Northern pike, burbot, Eastern silvery minnow, and channel catfish.

As referenced in the PAD, Section 4.4, two state-listed fish species are known to occur in the Connecticut River, including the Eastern silvery minnow (*Hybognathus regius*) and burbot (*Lota lota*), both of which are state-listed as “Special Concern.” Currently, there are only two known populations of the Eastern silvery minnow in Massachusetts, both located in the Connecticut River. Burbot are also rare in Massachusetts, with only a few individuals having been collected in the Connecticut River watershed.

The tessellated darter is one of only three fish species in the Upper Connecticut River that serve as hosts for the glochidia of dwarf wedgemussel, the others being the slimy sculpin (*Cottus cognatus*) and the Atlantic salmon (*Salmo salar*) (Nedeau, 2008). Tessellated darters are a relatively sedentary benthic insectivorous fish with small home ranges and short, fast bursts of speed.

Based on data collected by Yoder (2009), sampling at 4-5 transects distributed throughout the Turners Falls Impoundment was sufficient to capture most but not all species detectable by electrofishing the shoreline of the impoundment (Figure 3.3.11-1).

Project Nexus (18 CFR § 5.11(d)(4))

Operation of the Turners Falls Project and Northfield Mountain Project has the potential to directly affect fish populations, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater spawning areas, which could limit the productivity of certain fish species through direct impacts to their spawning success, ultimately resulting in alterations to fish assemblage structure. An understanding of the current fish assemblage is needed in order to examine potential effects. Determining species distribution and abundance will clarify what species occur in the Turners Falls Project and Northfield Mountain Project areas, spatially and temporally, relative to habitats that may be affected.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

The study area includes the Connecticut River from Vernon Dam to the Route 116 Bridge in Sunderland, although the geographic scope of this study is being reviewed by NMFS as the potential impact on shortnose sturgeon due to fish sampling may result in modifying the geographic area. The study will employ a stratified-random sampling design. The study area will be divided into strata based on mesohabitat type. Proposed sampling methods include daytime boat electrofishing, nighttime boat electrofishing, gill nets, and seine nets. Sampling will be performed during the early summer (June) and again in the fall (September).

The stratified random sampling design will randomly assign sampling stations within particular mesohabitat types in proportion to their linear habitat distance. Thus for mesohabitat types having a larger proportion of linear mesohabitat, more random sites will be assigned. A stratified random sample will capture key population characteristics that are proportional to the overall Connecticut River fish assemblage. Furthermore, stratified random sampling performs as well or better than simple random sampling and results in substantial improvement in precision when variation within strata (mesohabitat type) is less than variation among strata (Hansen, Beard and Hayes 2007). In stratified random sampling, an estimate for the whole population is obtained by weighting estimates from each stratum by the fraction of the whole population contained in each stratum. It is important to note that stratified random sampling requires that the entire sampling frame be divided into strata before sampling begins (Hanson, Beard and Hayes 2007). Multiple methods of fish capture will be used in each stratum. Selected locations within each station will be sampled either by day and night-time boat electrofishing (shoreline and littoral habitat), gill nets (deeper, benthic areas), and seine net (wadeable shoreline and littoral habitat) during the early summer and again in the fall. The exact number of sampling locations will be dependent on the weighted stratification of the study area by mesohabitat but it is anticipated that at least 18 stations will be sampled during each sampling event.

Stakeholders requested an additional spring sampling. FirstLight is not proposing to sample during the spring for the following reasons: 1) Anadromous fish will be available for capture during the proposed early summer collection. 2) The fall collection will occur when young-of-the-year (age-0+) fish had grown to sizes such that they were readily susceptible to capture using various sampling gears. 3) All species of fish that are found within the study area should be readily captured during the early summer and fall sampling events that FirstLight proposes. 4) FirstLight is proposing to conduct a comprehensive survey of the nesting fish in the littoral zone during the spring which will provide information on the occurrence, distribution, and relative abundance of these fish species.

Task 1: Sampling Location Selection

During this assessment, a stratified-random sampling design will be utilized to provide unbiased and precise fish assemblage data. The proposed design incorporates general river morphology along with mesohabitat through the use of strata and sub-strata. To accomplish this, the underlying strata allow for delineation of the study area spatially, based on locations where changes in river morphology occur. For all areas downstream of Cabot Station to the Route 116 Bridge, mesohabitat sub-strata were derived from surveys performed during 2012. Alternatively, the bypass reach contains the greatest diversity of mesohabitats, but each mesohabitat segment is relatively small; thus, random stations will be selected from shoreline, deep water, and tailwater habitats such that a representative sample from multiple habitats will be collected. Sub-strata in the Turners Falls Impoundment will be derived from bathymetry data, because the impoundment contains areas with relatively deep water.

Due to inherent variability of flows, water levels, and likely fish movements within the study area, different sampling locations will be selected for each sampling event; this statistically valid practice will avoid bias. Prior to field sampling, stations to be sampled will be selected to ensure all mesohabitat types are adequately represented. Mesohabitat types include;

- **Riffle:** shallow, moderate velocity, turbulent, high gradient, moderate to large substrates (cobble/gravel)
- **Rapid:** shallow, moderate to high velocity, turbulent, chutes and eddies present, high gradient, large substrates or bedrock
- **Run:** moderately deep to deep, well defined non-turbulent laminar flow, low to moderate velocity, well defined thalweg, typically concave stream geometry, varying substrates, gentle slope

- **Glide:** moderately shallow, well defined non-turbulent laminar flow, low velocity, well defined thalweg, typically flat stream geometry, typically finer substrates, transitional from pool
- **Pool:** deep, low velocity, well defined hydraulic control at outlet
- **Backwater:** varying depth, minimal or no velocity, long backwatered reaches
- **Impounded:** varying depth, low velocity influenced by the presence of a dam
    - **Nearshore/Shallow**: less than 8ft in depth
    - **Mid-Channel**
    - **Deep water:** depths greater than 20ft

Alternative sampling locations will also be identified by mesohabitat in case a selected sampling station is inaccessible.

<u>Task 2: Fish Capture</u>

FirstLight anticipates using a variety of techniques to sample the various habitat types within the study area, including day and nighttime boat electrofishing, gill netting, and seining as described below. The type of gear utilized will be dictated by habitat type. In addition to biological data, supporting data will also be collected for each sample site including: location (GPS), sampling gear type, sampling effort, mesohabitat type, average depth, average velocity, river flow, water temperature, turbidity, predominant substrate, time of day, day of year, presence of cover, and proportion of vegetation cover. All data will be recorded on dedicated data sheets. Upon return from the FGS, data sheets will be review for quality assurance and archived.

The MADFW has recommended that sampling include the use of eel pots. Boat electrofishing is effective at collecting eel within the littoral habitat and will therefore be adequately represented within the sampled fish assemblage. The sampling effectiveness of collecting eel in the Connecticut River was demonstrated by Yoder (unpublished data 2009) whom found that the American eel was the most abundant species collected using boat electrofishing methods in the Connecticut River below the Holyoke Dam. The VANR has recommended the use of a benthic trawl; however, FirstLight proposes to use gill nets to sample deeper sections of the river.

Boat Electrofishing

Due to the presence of spawning and juvenile surgeon in the bypass reach during the spring, no electrofishing will be performed in this stratum from April 15 – June 30 as suggested by the NMFS.

Boat electrofishing will occur during the daytime and night. All electrofishing transects will be standardized by time (500 seconds fished) such that a catch per unit effort (CPUE) may be calculated. Boat electrofishing can effectively sample fish from most near-shore littoral habitats present within the Connecticut River (typically 10 feet deep or less).

Electrofishing will be accomplished with the use of a 16-ft jonboat rigged with a pulsed-DC Smith-Root GPP 5.0 electrofisher with the capacity to adjust the pulse rates between 30 - 120 pulses/second and vary voltage to accommodate ambient conductivity. The electrode array includes an array of cathodes suspended from the bow to a depth of approximately six feet to project the electric field into both the shoreline epibenthic zone, as well as the upper water column. The anode array is suspended from the bow on an adjustable boom. Both anodes and cathodes will be configured to optimize the electric field under ambient low conductivity conditions. A smaller vessel capable of negotiating riffles and shoals, similarly rigged with a 2.5 GPP unit may be deployed for sampling in the shallower riverine habitats. This smaller boat will consist of a 14 ft inflatable Sea-Eagle raft with retractable anodes and side-mounted cathodes.

Electrofishing will be conducted in a downstream manner, following standardized methods developed specifically for large river quantitative electrofishing surveys (MBI, 2002, Yoder and Kulik, 2003). The start point, end point, and boat track for each sampling station will be geo-referenced using a handheld Garmin GPS (or similar device) and transposed to corresponding USGS topographic mapping software program (Terrain Navigator).

All stunned fish will be collected with ¼-inch mesh dip nets and deposited into a live-well filled with aerated ambient river water. At the conclusion of each sample, all captured fish will be identified to species, classified as adult, juvenile or Young-of-Year (YOY), enumerated, weighed, measured for total length, and then released. If large numbers (n > 25) of small fish (YOY fish or cyprinids less than 100 mm) are captured, they will be grouped by size class, enumerated, and batch-weighed with length measurements only taken from one large and one small representative specimen within each group. Fish that are not able to be identified in the FGS, such as small cyprinids, will be brought back to the lab for identification.

Gill Netting

For sampling deeper habitat sub-strata (Depth 12-25 feet; Depth 25-40 feet; Depth > 40 feet), where electrofishing will not be effective, sampling will be conducted with experimental gill nets consistent with standardized methods for fish capture from rivers (Bonar, Hubert, & Willis, 2009). The nets will be 12-foot feet high by 100-foot in length and will be constructed of 4 to 5 panels of increasing mesh size (e.g., 1.5, 2, 2.5, 3, 3.5-inch stretched mesh) to accommodate collection of the various sized fish in the project waters.

The nets will be deployed to maximize capture area where water depths are greater than net height. Nets will be set in selected locations and allowed to fish for 4 hours prior to retrieval.

The exact locations of each net set will be recorded using a handheld Garmin Vista HCx GPS (or similar device) and the time of deployment and retrieval will also be recorded. Fish processing will occur as described above for electrofishing.

Seining

In shallow shoreline locations where boat access may not be feasible sampling will be performed via seining with a 100-ft long, 6-ft deep, 1/4-inch mesh bag seine net.

Seine samples will be collected by extending the net parallel to shore and then pulling the upstream end of the net into the water and in a downstream direction for a 180 degree sweep while the opposite end of the net is held in place (Bonar, Hubert, & Willis, 2009). The start point and end point for each sweep will be geo-referenced using a handheld Garmin Vista HCx GPS (or similar device) and transposed to corresponding USGS topographic mapping software program (Terrain Navigator). Total fish catch will be processed following each haul in the same manner as described above for electrofishing and gill netting.

Task 3: Data Analysis and Reporting

All data will be standardized by effort expended (seconds of electrofishing, net-hours, and number of seine hauls for electrofishing, gill netting, and seining respectively). Catch per unit effort (CPUE) and standard errors will be calculated for each species, station, and sampling technique. Data will also be separated into groups by size and a CPUE per size group will be calculated. Values of CPUE for each segment and gear type will be calculated as the sum of catch from all samples within a station divided by the sum effort expended within that station. The Shannon-Weiner index of diversity, which is a function of species richness and evenness, will also be calculated.

Information collected during this study will be compiled and presented in a final report. The report will include tabular data summarizing length, weight, and size class of fish captured, a map of the study area to depict the location of sample stations, and overall results including occurrence, distribution and relative abundance. Comparisons will be made with historical records. Results will be described in relation to studies described in study plans 3.3.14 – *Aquatic Habitat Mapping of the Turners Falls Impoundment* and 3.3.13 – *Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat*. Raw data will be provided to stakeholders in digital format upon request.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort will adequately address the objectives by documenting fish species occurrence, distribution and abundance within the project area along spatial and temporal gradients. FirstLight estimates the cost of this study to be $75,000 to $85,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

The study described herein is scheduled to be conducted in the early summer and fall of 2014, with Task 1 occurring prior to field studies. Because the study effort will be ongoing when the Initial Study Report is due to Stakeholders in September 2014, FirstLight proposes to provide Stakeholders with a study report supplement to summarize results in February 2015.

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Table 3.3.11-1: Freshwater mussel and glochicial host fish relationships.

Freshwater Mussel	Connecticut River Glochidial Host Fish
Dwarf Wedgemussel	Tessellated darter, slimy sculpin, juvenile and parr Atlantic salmon
Yellow Lampmussel	White perch, yellow perch; banded killifish, chain pickerel, white sucker, smallmouth bass, and largemouth bass
Eastern Pondmussel	Unknown; reported to parasitize centrarchids (sunfishes and bass) as well as banded killifish

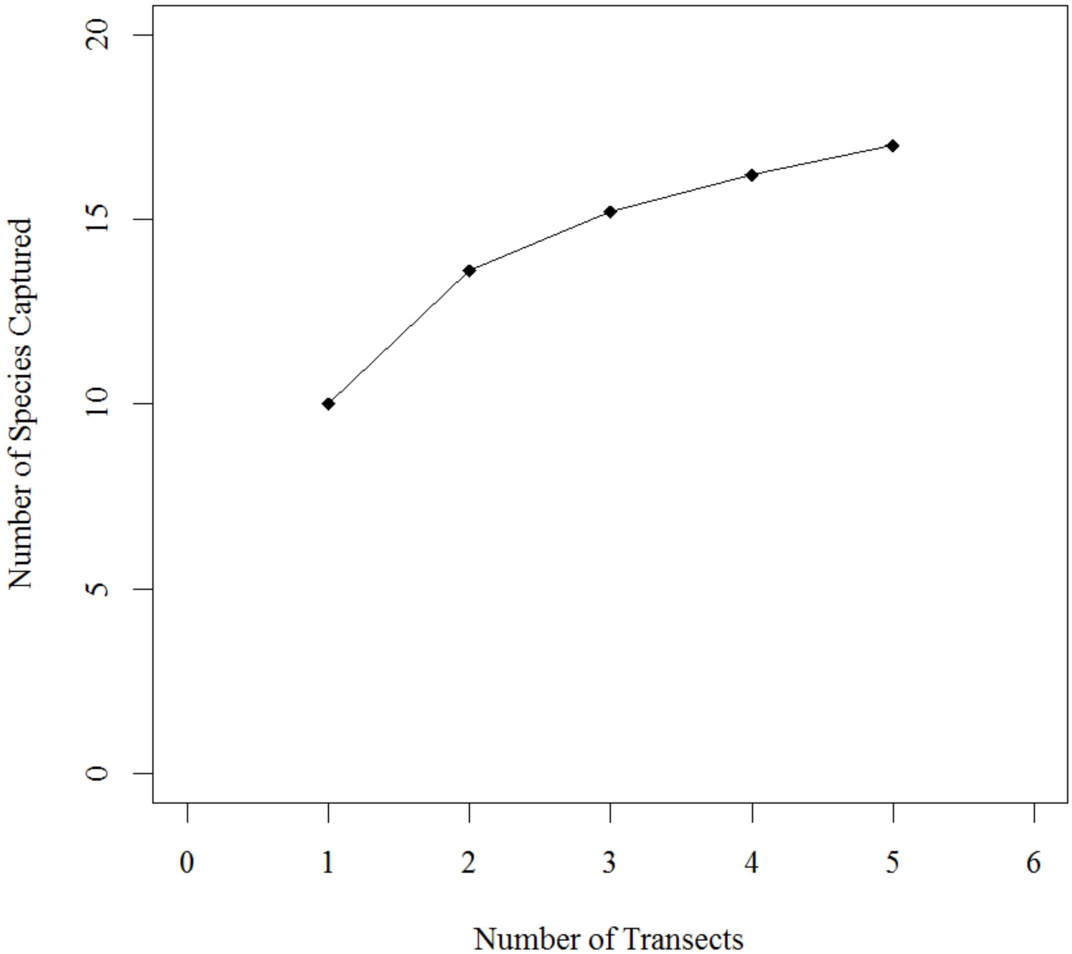

Figure 3.3.11-1: Species-accumulation curve derived from Yoder (2009) boat electrofishing data within the Turners Falls Impoundment

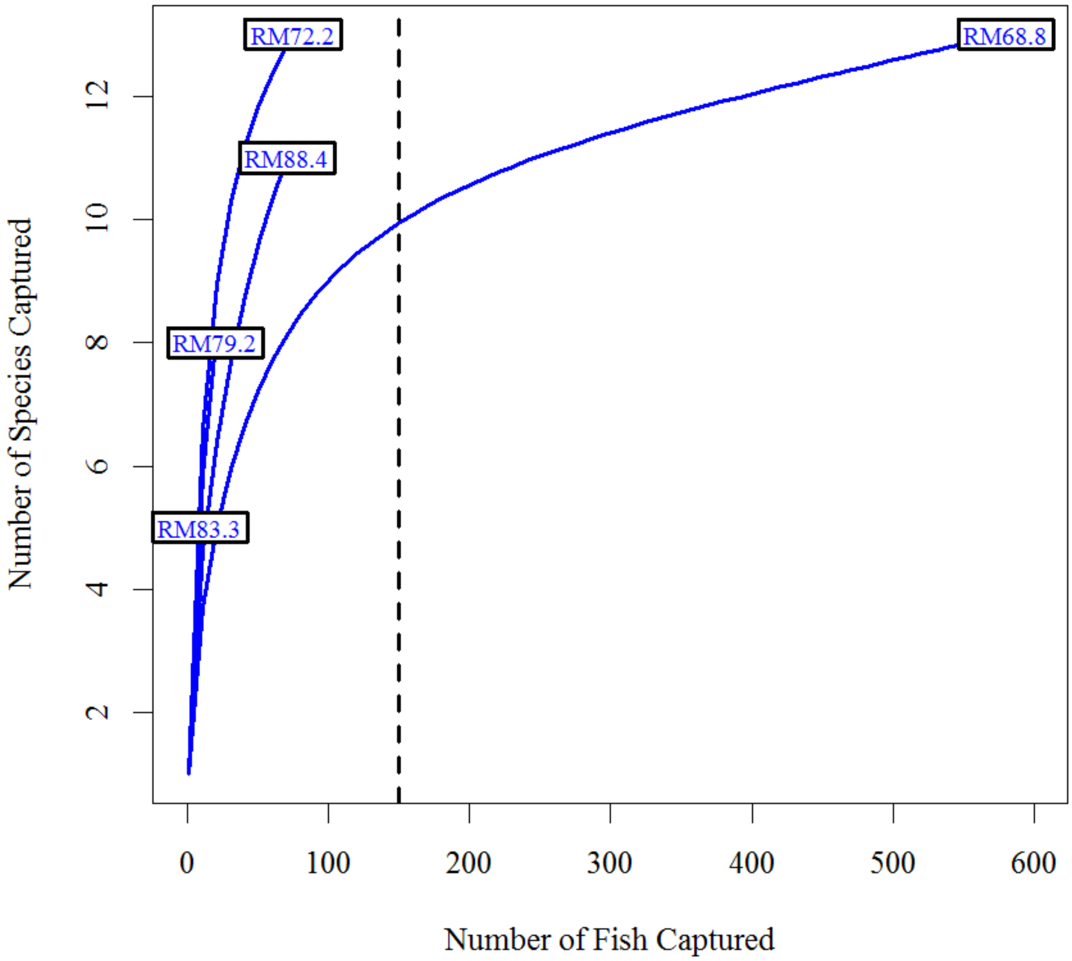

Figure 3.3.11-2: Rarefaction curves derived from each transect sampled by Yoder (2009). Labels indicate locations (River Mile) within the Turners Falls Impoundment where fish were sampled. The dashed vertical line indicates the proposed minimum sample size (n = 150 fish) per reach sampled.

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

General Description of Proposed Study

In their study request letters, the USFWS, NMFS, NHFGD, and CRWC each requested 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.

Based on discussions held at the Proposed Study Plan Meeting on May 21, 2013, FirstLight is proposing to conduct this study incrementally. First, existing data will be obtained and analyzed to understand the operation of the emergency spill gates and bypass flume; second, this analysis will be shared with the resource agencies and a meeting will be held to discuss the results and to determine if a field component of the study is necessary; if so, field measurements will be collected in accordance with the methods detailed in this plan, subject to modification based on agency consultation. The field assessment will involve collecting information on water velocity and sediment transport conditions during spillage events at Cabot Station to describe potential impacts on shortnose sturgeon and to inform potential mitigation.

The Study Schedule section below identifies an estimated time line of activities to incorporate a consultation process into this study.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to determine the frequency of spill events during the sturgeon spawning duration, and, if deemed necessary, determine appropriate protocols for operation of the emergency water control gates and bypass flume that will be sufficiently protective of shortnose spawning and rearing below Cabot Station from excessive water velocities and exposure to abrasive sediments dislodged and transported across spawning and rearing areas.

The objectives of the study are to:

1. Determine the frequency with which the emergency water control gates are operated to discharge large quantities of water.

2. Describe the operation of the bypass flume that results in bypass flume spill events.

3. Evaluate the impact of these events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat below Cabot Station.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The USFWS and NMFS seek to understand current emergency water control gate and bypass flume operations and associated impacts to determine potential operation protocols that avoid or minimize negative effects on shortnose sturgeon spawning and rearing.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

During monitoring of shortnose sturgeon spawning, researchers at the S.O. Conte Anadromous Fish Research Center [Conte Lab] have observed spillage at the emergency water control gate and the bypass flume that increased velocity over the rearing area downstream of Cabot Station and may have also resulted in a debris plume (Kieffer and Kynard, 2007; Kynard et al., 2012). The frequency of these events has not been studied, nor has the impact on shortnose sturgeon spawning and early life-history stages.

Ten gates are present at the Cabot spillway, two of which are used to provide attraction flow at the Cabot Fishway. The discharge capacity of these gates (8) is 12,000 cfs at the normal canal level of 173.5'. Eight Cabot spill gates will open automatically if the forebay water surface elevation exceeds a pre-set limit to prevent overtopping of the power canal walls – this is a protective measure in the event of a load rejection of Cabot Station. The gates will also open if changes in elevation indicate that a canal breach may have occurred. Operators open one or more gates when necessary to help remove debris from the trash boom.

The bypass flume is utilized as a downstream fish passage facility at Cabot Station and is generally open for fish passage from April through mid-November in accordance with a schedule provided by CRASC. The bypass flume (also referred to as the log sluice) can also be used to pass debris downstream.

Data are available from FirstLight from 2005-2013 regarding the timing and magnitude of gate openings for both structures; however, no data exist that relate operations to potential impacts on sturgeon spawning and rearing such as bottom velocities and sedimentation rates.

Project Nexus (18 CFR § 5.11(d)(4))

One of the two critical shortnose sturgeon spawning and rearing areas in the Connecticut River is located within the Cabot Station tailrace, within an area impacted by project discharges (Figure 3.3.12-1). Spillage events through the emergency water control gates and bypass flume (which is also used to pass migratory fish downstream) have been observed to create flow dynamics that may affect shortnose sturgeon spawning and rearing in this area. Results of this study will provide recommendations for operation of the emergency water control gates and the bypass flume that will avoid or minimize sedimentation and improve bottom velocities for shortnose sturgeon spawning and rearing.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

This study will use a phased approach to evaluate potential impacts of spillage from the emergency water control gates and the bypass flume at Cabot Station on shortnose sturgeon spawning and rearing. Existing operations data will first be analyzed to determine whether additional field studies will be performed; if additional field data are required, a variety of flow conditions will be evaluated in the field. Control locations upstream of Cabot Station will be used to provide a baseline for comparison with areas affected by the discharges. Flow scenarios and associated measurements will be performed separately for the emergency water control gate and the bypass flume, and will be evaluated during the summer after the sturgeon spawning season ends to avoid impacts by this study on sturgeon spawning.

Task 1: Preliminary Study: Analysis of Existing Data

Historic records of gate openings will be analyzed to evaluate the frequency, magnitude and causes of emergency and non-emergency spill events during the sturgeon spawning and rearing seasons. Time series data during April 15th through June 22nd from 2005-2012 will be plotted, examined, and synthesized for the emergency water control gates and the bypass flume. The results of these analyses will be presented to interested stakeholders before proceeding further with this study; a mutual agreement will be reached in consultation with interested stakeholders to determine whether additional study is necessary. Emergency protocols will also be described. If spillage events during the sturgeon spawning period are infrequent and/or of low intensity, then it may be determined that field study is not required and the study will be considered completed. Alternatively, if it is determined that additional field study is required, the study will continue to the tasks as outlined below.

Task 2: Scenario Development

Results from Task 1 will be used to select gate scenarios for further analysis. Routine operating and maintenance scenarios that involve spillage will be selected in consultation with stakeholders prior to any potential field work, and will include up to three flows through the emergency water control gates and the bypass flume. Each spillage scenario will also be evaluated under two bypass flow rates, and two generation flow rates for a total of up to 12 total scenarios for each of the spill locations.

Task 3: Field Verification of Conditions

Simulated events, with spillage rates identified during Task 2, will be evaluated in the field by measuring bottom velocity and capturing sediment. To evaluate the effects of spillage events in an unbiased manner, while also accounting for spatial variability, the spawning/rearing area will be stratified based on criteria developed in consultation with the agencies. At least four random locations will be selected from within each stratum.

Bottom velocities at the known sturgeon spawning/rearing area (*see* Kynard et al., 2012) will be quantified using a sample of ten random locations within the spawning area; at each location, average water velocity will be measured at 1.5 feet from the bottom for 60 seconds or until the velocity readings stabilize. Additionally, average velocities will be measured in the same manner at ten random locations within the same area and under the same river flow and operational conditions, except in the absence of spillage.

To quantify sediment transport, it is envisioned that five Helley-Smith style sediment samplers with 250 micron mesh will be placed at stratified random locations within the known spawning/rearing area (*see* Kynard et al., 2012); soak time will be determined in collaboration with interested stakeholders and the Conte Lab. Velocity measurements will be taken at the mouth of each net upon setting, spillage stabilization, and upon removal to aid in calculations of volume of water sampled. As a control, three nets of the same design will be placed in random locations on a shoal upstream of Cabot Station determined to be distant enough from spillway locations to be independent from spill effects; spill has been documented to induce temporary flow reversal during low discharge (Kieffer and Kynard, 2007). Samples will be strained of large-sized organic material, visually inspected, and categorized to evaluate general content and grain size, photographed, and delivered to a laboratory for subsequent analysis of dry weight.

Task 4: Data Analysis and Reporting

Descriptive statistics (mean, standard error) of measured variables will be calculated. Multiple linear regression and analysis of variance (ANOVA) will be used to determine whether conditions measured at the sturgeon spawning and rearing area are correlated with and differ significantly among spillage levels, and to determine whether and/or how covariates such as river flow or spillway operational status affect the results.

If spillage at Cabot Station is found to increase the amount of sediment flowing over the sturgeon spawning area, results from this study will be compared to the 2-D hydraulic model developed during the instream flow study in order to assess a range of potential mitigation measures, and as requested by MA

DEP, FirstLight will evaluate practical strategies to manage and minimize sediment release through the power canal if sediment transport is shown to be a problem downstream of Cabot.

A preliminary report containing results will be presented after the 2014 sampling data are collected and analyzed; if river flows are conducive for evaluating all proposed scenarios during 2014, then all field data collection will be performed during 2014 and the data analysis and a final report will be completed by late 2014. If river flows are not conducive for evaluating all proposed scenarios during 2014, then the remaining work will be performed in 2015.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of spillage at Cabot Station on sturgeon spawning and rearing habitat. The estimated cost for this study is approximately $5,000 if no field work is attempted, or $35,000 to $45,000 if field work is performed.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Existing data will be analyzed prior to any potential field work. Field work, if necessary, will be performed during 2014. The final report will be submitted during late 2014.

- FirstLight to conduct Task 1 Data Analysis – Winter 2013.
- Distribute summary report of results Task 1 and meet with stakeholder to determine need for field study – Spring 2014.
- If necessary, perform field investigation outside of the sturgeon spawning season - Summer 2014.

Literature Cited

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FIRSTLIGHT POWER RESOURCES

Revised Study Plan

Figure 3.3.12-1: Location of the Shortnose Sturgeon Spawning and Rearing Area Near Cabot Station, and a Control Area Upstream

Path: W:\gis\maps\revised_study_plan\Figure 3.3.12-1.mxd

3.3.13 Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat

General Description of Proposed Study

In their study request letters, the USFWS, NHFG, MDFW, VTDEC, Town of Gill and CRWC each requested a study of the impacts of the Turners Falls and Northfield Mountain Projects on littoral zone fish spawning and spawning habitats. FirstLight proposes a study to determine if project operations and water level fluctuations in the Turners Falls Impoundment negatively impact anadromous and resident species and to determine if negative impacts are occurring so that appropriate mitigation measures may be developed, if warranted, to protect and conserve the species utilizing project waters. Fish that may be potentially impacted includes sea lamprey, white sucker, fallfish, smallmouth bass, yellow perch, spottail shiners, bluegill, black crappie, chain pickerel, northern pike, sunfishes, and walleye. A study plan to assess sea lamprey spawning within the Turners Falls and Northfield Mountain project areas can be found in Study No. 3.3.15. This study will focus on the resident populations of black basses, perches, suckers, minnows and pike/pickerels in the Turners Falls Impoundment. Additional information relevant to this study will be obtained from other proposed studies, including the fish assemblage (Study No. 3.3.11), habitat mapping (Study No. 3.3.14), and tributary access (Study No. 3.3.17) studies.

It is anticipated that this study will occur during the spring and early summer of 2014 when the resident species typically spawn. Should river discharge or temperature during this period prove to be atypical (*e.g.*, outside of 25-75th percentile of average weekly flows/temp), then FirstLight will consider repeating the study in 2015 to ensure representative conditions occur during sampling to reduce bias in observations.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to collect information in order to determine if project operations negatively impact fish species so that appropriate mitigation measures may be developed, if warranted, to protect and conserve the species utilizing project waters.

Specific objective of this study are to:

- Assess timing and location of fish spawning in the littoral zone.
- Delineate, qualitatively describe (*e.g.* substrate composition, vegetation type and relative abundance), and map shallow water habitat types subject to inundation and exposure due to project operations.
- Evaluate potential impacts of impoundment fluctuation on nest abandonment, spawning fish displacement and egg dewatering.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals identified are to:

1. Maintain, restore, and recover populations of species of conservation and management concern to self-sustaining levels.

2. Maintain and restore the ecological composition, structure, and function of natural and modified ecosystems to ensure the long-term sustainability of populations of species of conservation and management concern.

3. Protect and conserve fish and their habitats.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Resident fish species, as well as anadromous species, identified in project waters are discussed in Sections 4.4.2-4.4.4 of the PAD. Under the FERC license, the Turners Falls Impoundment elevation may fluctuate between 176.0 ft msl and 185.0 ft msl, as measured at the Turners Falls Dam. Additionally, a bathymetric map of the Turners Falls Impoundment based in field data collection in July 2006 was developed by Hydroterra Environmental Services, LLC (see Figure 3.2.1-4 of the PAD) is available for reference.

Project Nexus (18 CFR § 5.11(d)(4))

Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, water level changes due to Project operations could create conditions where fish eggs are exposed to air, where spawning habitat is dewatered, and/or where fish abandon nests containing eggs.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Information and data obtained though the proposed the fish assemblage study (Study No. 3.3.11), aquatic habitat mapping study (Study No. 3.3.14), and tributary access (Study No. 3.3.17) study will likely be used to address some of the objectives of this study.

FirstLight anticipates that this study will be conducted in the spring and early summer of 2014.

Task 1: Literature Review

Prior to conducting the field investigation, a desktop literature review will be performed to determine when resident species known to occur in the Turners Falls Impoundment typically spawn. In addition to the timing of spawning, the literature review will also be helpful for identifying typical habitat-types used by resident species for spawning, as well as spawning behavior or habits to aid in subsequent field identification.

Task 2: Field Surveys

Once spawning periods have been identified, the field survey effort will be scheduled to maximize potential observations of different species spawning activities. FirstLight anticipates a minimum of two surveying events (one in early spring and one in early summer) to capture of the spawning periods of the resident species. The exact number of surveys will be determined upon completion of the desktop literature review of Task 1.

During the May 22, 2013, Proposed Study Plan meeting, the stakeholders agreed to focus the study on the zone of reservoir fluctuation (*i.e.*, 176 to 185 ft msl) and shallower areas (less than 1 foot deep) at low pond elevation, if practical in the field (see Figure 3.3.14-1). The study will extend up to Vernon Dam. Considering the impoundment elevation may fluctuate up to nine feet due to project operations, to the extent practical, attempts will be made to conduct this study of the littoral zone when conditions are close to the minimum water surface elevation of 176.0 ft msl and maximum water surface elevation of 185.0 ft msl to ensure areas impacted by project-related water level changes are readily observable. For the purpose of this investigation, the littoral zone is depicted in Figure 3.3.14-1. This will be a general guideline, as the observable characteristics of the littoral zone can vary with water clarity, water level, time of day, and the prevailing weather conditions. The areas typically wetted when the impoundment is at the maximum allowable water surface elevation (El. 185.0') will also be observed during the field survey(s). Additionally, tributaries identified in Section 3.3.17 as accessible during spawning seasons will be observed during the field surveys.

Assuming the water clarity is conducive for visual assessment, field sampling will be conducted by systematically traversing the littoral zone of the Turners Falls Impoundment via boat and/or foot (wading) to visually identify any fish nests, egg masses/deposits, and/or spawning habitat. Additional necessary equipment and data collection will include:

- a digital camera for photo-documentation of habitat types, egg deposits, and identified nests;
- an underwater Atlantis™ Panning Camera and/or view tubes to identify spawning nests/habitats in those instances where they cannot be easily identified from the surface;
- a handheld GPS unit to geo-reference the locations of identified habitats, egg deposits, and nests;
- a handheld water quality meter to measure water temperature;
- a Marsh-McBirney flow meter to measure velocity at identified spawning habitats, egg deposits, and nests;
- a secchi disk to estimate water clarity;
- a stadia rod and/or depth meter for recording depth of identified spawning habitats, egg deposits, and nests; and
- data sheets for recording water quality parameters, general observations, weather conditions, and other relevant descriptive information (e.g., sediment/grain sizes associated with nests, embeddedness, approximate diameter of identified nests, presence of fish at nests, presence of aquatic vegetation, nest abandonment, sedimentation of eggs, etc.).

These data will be recorded on standardized, waterproof field data sheets. Upon completion of the field survey, all data sheets will be reviewed for quality assurance. Data necessary to develop a map of the observed spawning habitat, egg deposits and fish nests relative to the areas subjected to dewatering due to project operations will be electronically transcribed. A report containing a discussion of the impacts of water level fluctuations on the resident species spawning and spawning habitat, including potential nest abandonment, spawning fish displacement and egg dewatering, in the Turners Falls Impoundment will be produced.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Northfield Mountain Project and Turners Falls Project on fish spawning and spawning habitat in the investigation area. The estimated cost for this one-year study is approximately $25,000-35,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight anticipates that this study will be conducted in the spring and early summer of 2014, after high spring flow conditions have subsided.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

3.3.14 Aquatic Habitat Mapping of Turners Falls Impoundment

General Description of Proposed Study

FERC requested aquatic habitat mapping of the Turners Falls Impoundment, which compliments requests by other stakeholders as described in Study No. 3.3.13 and Study No. 3.5.1. FirstLight proposes to conduct a habitat field survey to delineate aquatic littoral and demersal habitat in terms of substrate and cover in the Turners Falls Impoundment.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The purpose of the study is to map the distribution and abundance of aquatic habitat within the Turners Falls Project impoundment in the Connecticut River, evaluate the types of aquatic habitats that occur there, and identify any potential effects of operations of the Turners Falls Project and Northfield Mountain Project on this habitat. The habitat mapping and accompanying characterization of aquatic mesohabitat will provide essential information regarding the character and extent of aquatic habitat that may potentially be affected by Project operation. The quantified spatial data generated by this survey will help to provide a framework for upcoming data analysis efforts relative to operations and impoundment modeling.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The FERC must decide whether to issue a new license to FirstLight for the Turners Falls and Northfield Mountain projects in the Connecticut River. Any license issued shall be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses. Aquatic habitats in the Connecticut River support a sustainable riverine ecosystem that provides public opportunities, including a sport fishery. Ensuring that the effect of project operations pertaining to this resource is considered in a reasoned way is relevant to the Commission's public interest determination.

Several resource agencies have submitted applicable management goals in their study request letters. Resource management goals for this study are consistent with those identified in Study No. 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.*

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

No prior habitat mapping information is available to document the habitat resources of the Turners Falls Impoundment. Mapped locations of aquatic habitats in the Turners Falls impoundment is needed to evaluate the potential influences of the Turners Falls and Northfield Mountain Project on aquatic resources.

Project Nexus (18 CFR § 5.11(d)(4))

Water levels in the Turners Falls impoundment fluctuate due to operations of the Turners Falls Project and because the impoundment also serves as the lower reservoir for the pumped-storage operations of the Northfield Mountain Project. As a result, littoral aquatic habitat and aquatic species that utilize the habitat may be affected by water level fluctuations. This study will establish a baseline condition and the health of the aquatic habitat and aquatic species of the Connecticut River in the Turners Falls Impoundment under current operations.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

FirstLight proposes to map the distribution and abundance of littoral aquatic habitat within the Turners Falls Project impoundment in two phases. During the first phase, major aquatic habitat types will be delineated. During the second phase detailed microhabitat data on depth, sediment type and vegetation will be collected at representative transects. These data will then be used in conjunction with operational and other models to evaluate project effects on aquatic resources in the study area. During the May 22, 2013, Proposed Study Plan meeting, the stakeholders agreed to focus the study on the zone of reservoir fluctuation (*i.e.*, 176 to 185 ft msl) and shallower areas (1 foot deep) at low pond elevation, if practical in the field (see Figure 3.3.14-1). The study will extend up to Vernon Dam.

Task 1: Field Survey

Lentic aquatic habitat suitability is defined primarily by substrate, cover and depth. Each of these habitat parameters will be assigned specific attributes to be used for field delineation. These will generally include:

- **substrate:** substrates will be identified visually in shallower areas. In deeper water, substrate composition will be determined with an underwater camera, use of a ponar dredge, or through use of a sediment probe to generally classify substrates (*i.e*., as fines or loose rock or bedrock/boulder). Dominant substrates in each habitat type will be identified using the following standard particle classification scheme (based on Wolman, 1954):
    - **Silt/Clay** – any particle less than .062 mm across.
    - **Sand** – any particle .062 mm to 2.0 mm across.
    - **Gravel** – any particle 2.0 mm to 64 mm across.
    - **Cobble** – any particle 64 mm to 256 mm across.
    - **Boulder** – any particle 256 mm to 2048 mm across.
    - **Bedrock** – any particle greater than 2048 mm across.

  Where there are multiple substrate types, each substrate class will be assigned a relative percent dominance within individual habitats.

- **cover type:** object cover (*i.e.* boulder, woody debris, riprap, etc.), overhead cover (overhanging limbs, structures, etc.); vegetative cover (emergent, submerged)
- **cover density:** absent, low, moderate, high
- **depth (at normal pool):** surface to substrate (ft)

Task 1a: Delineation

Delineation of the 20-mile-long impoundment will be conducted by boat and will occur during summer during a period of relatively stable impoundment levels so that aquatic vegetation is established, and so that observations of depth relative to substrate and cover can be observed under consistent conditions, to the extent practical.

Habitat delineation will be conducted by a boat traveling through the littoral zone parallel to shore. The prevailing water elevation at the beginning of the survey will be documented by bench-marked survey. Staff gages will be established throughout the study area so that changes in water elevation during the survey can be accounted for. The field crew will methodically record habitat attributes and geo-reference with GPS each boundary where a pronounced change in substrate and/or depth occurs. We anticipate that cover will occur in patches rather than broad linear boundaries. Therefore, a centroid GPS waypoint will be collected at key cover nodes.

Additional relevant biological and geomorphic characteristics will also be collected where appropriate including readily observable aquatic fauna; channel geometry (including bank and shoreline slope); etc. The data will be recorded on data sheets, a dedicated field book, or via a pentop computer. Upon completion of the survey, all data will be rechecked for quality control and archived.

<u>Task 1b: Microhabitat</u>

Transect data will be gathered within representative littoral areas. The distribution and number of transects will be dictated by the variability detected during the delineation phase, but the goal would be to have one transect accounting for each major type of shoreline slope/littoral substrate/cover/depth condition documented during delineation. Each transect will extend from El. 185' to El. 176' and include the area to a water depth of approximately one foot deep under low impoundment elevation (176’). Verticals will be located along each transect to depict the following elevations:

- top of bank
- normal high water
- upper elevation of pool (if different than normal high water)
- normal pond elevation
- toe of bank
- Low pool elevation.

Additional verticals will be established at intervals wherever micro-changes in slope, substrate embeddedness, or cover are encountered. Elevations will be surveyed in project datum so that data can be integrated with other project operation data for analysis. The locations of all transects will be geo-referenced with GPS and transect headpins marked with blazing.

<u>Task 2: Analysis and Report</u>

Geospatial mesohabitat data will be transferred to a GIS format and used to develop both visual maps depicting distribution as well as tabular information quantifying the abundance and distribution of habitat features in the study area. A summary report will be developed that will include survey methods, GIS maps showing the mesohabitat spatial distribution in the impoundment, and a discussion of observations. The report will provide a narrative discussion of habitat use by aquatic fish and macroinvertebrates native to the study area. It is anticipated that data gathered during 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* will also be used to develop the habitat map and discussion for this summary report.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The estimated cost for the study outlined in this plan is approximately $30,000-$45,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

It is anticipated that the aquatic mesohabitat assessment and mapping survey will be conducted in July – August 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Literature Cited

Wolman, M.G., 1954. A method of sampling coarse river-bed material. Transactions of American Geophysical Union 35.

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN
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Figure 3.3.14-1
Littoral Zone Study Area

Page 1 of 23

Legend

- Littoral Zone Study Area
- Littoral Zone Study Area*

* Area to be examined in field to determine littoral extent.

N

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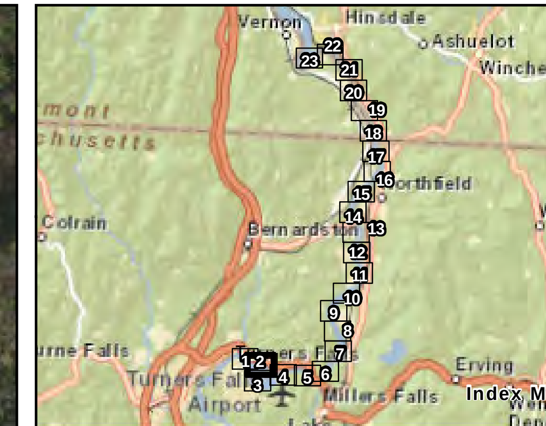

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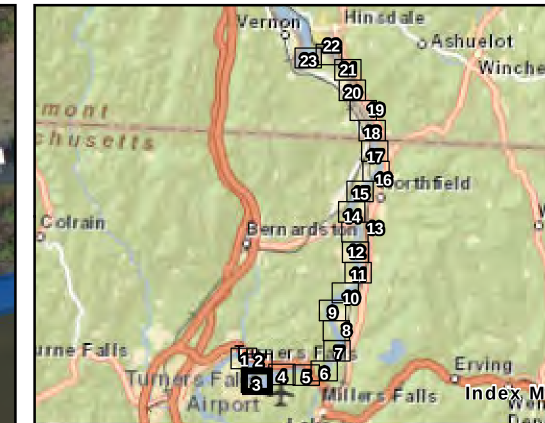

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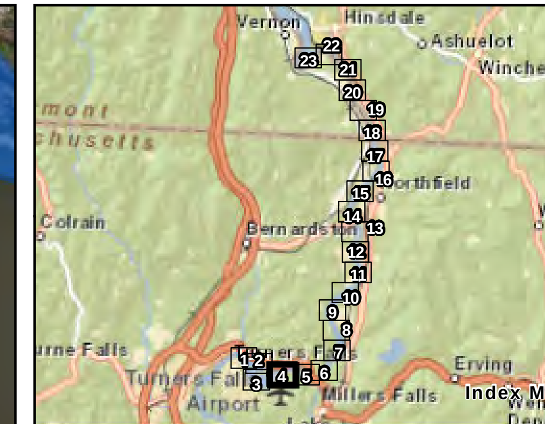

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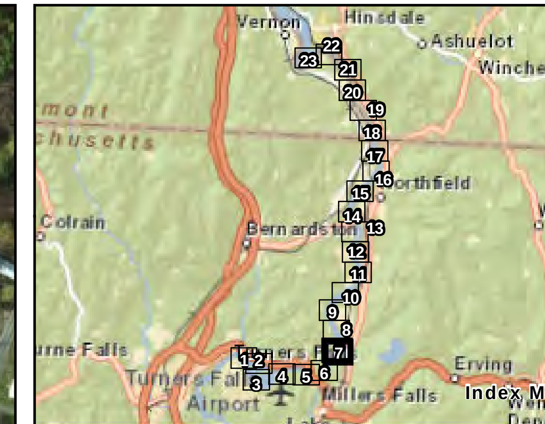

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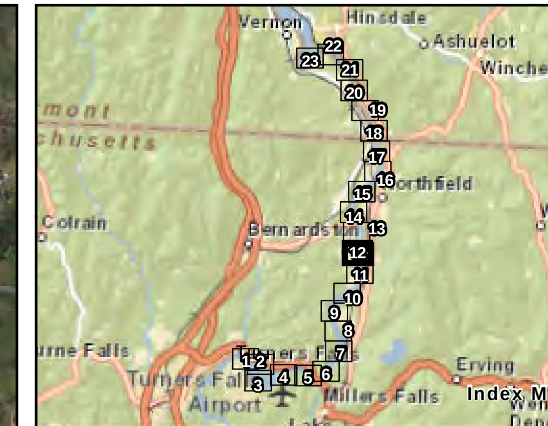

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Figure 3.3.14-1
Littoral Zone Study Area

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Littoral Zone Study Area
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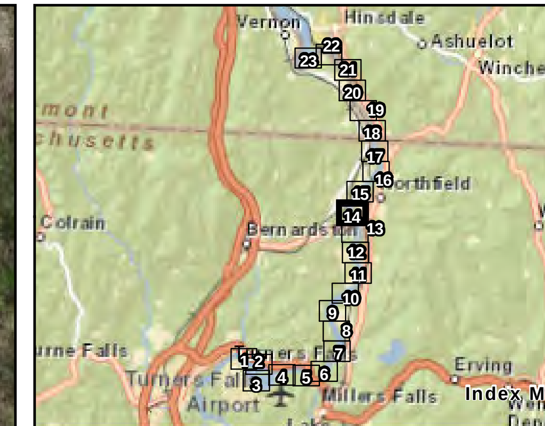

FIRSTLIGHT POWER RESOURCES
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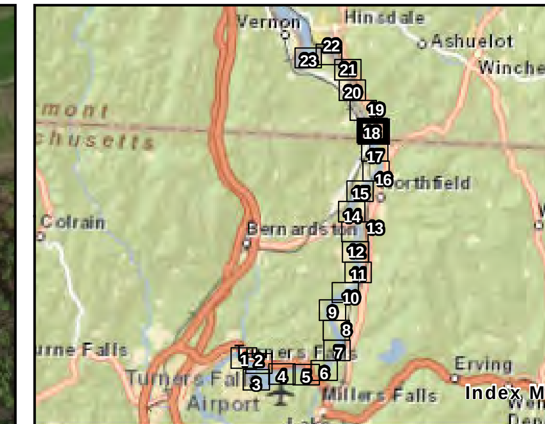

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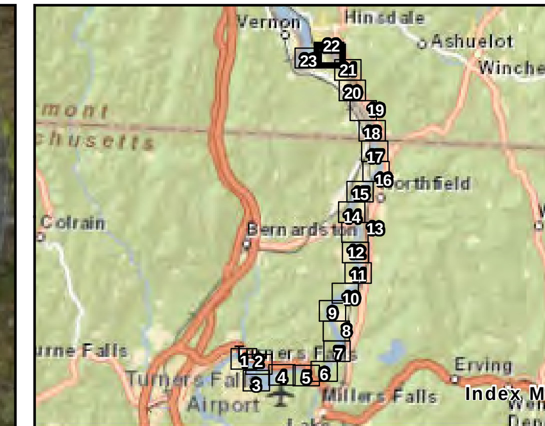

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3.3.15 Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Area

General Description of Proposed Study

NOAA requested an assessment of adult sea lamprey spawning within the areas of the Turners Falls and Northfield Mountain Projects. FirstLight will conduct a field study to assess adult sea lamprey spawning within those areas during the late spring or early summer of 2014.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to determine the impacts that operations of the Turners Falls Project and Northfield Mountain Project may have on sea lamprey spawning activity. Specific objectives of the study are to:

- Identify areas within the Project area where suitable spawning habitat may exist for adult sea lamprey.
- Conduct spawning surveys to confirm use of areas identified as containing suitable spawning habitat.
- Describe spawning mound characteristics, including location, size, substrate, water depth, and velocity.
- Collect the information to assess whether operations of the Turners Falls Project and Northfield Mountain Project are adversely affecting spawning areas (*i.e.,* if flow alterations are causing dewatering and scouring of lamprey spawning area).

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

Sea lamprey are a federal trust resource, and as such, NOAA Fisheries is charged with protecting the species and reducing threats to maintain its population. According to NOAA Fisheries, sea lamprey within the Connecticut River drainage are one of New Hampshire's and Vermont's Species of Greatest Conservation Need (SGCN). As outlined in Vermont's Wildlife Action Plan, research and monitoring needs for SGCN include monitoring and assessing populations and habitats for current conditions and future changes, and identifying and monitoring problems for species and their habitats.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Sea lamprey are an anadromous species known to spawn in the Connecticut River within the Turners Falls and Northfield Mountain Project Areas. They use mainstem and accessible tributary habitat consisting of gravel and cobble substrate in areas with flowing water in which they construct nests during spawning (NOAA, 2013). Sea lamprey pairs or groups (multiple fish may form an aggregate nest) can be observed building nests (or recently completed nests can be observed) in late-June (Hartel et al., 2002; NOAA, 2013). Lamprey spawning has been observed from the Sunderland Route 116 bridge upstream to Cabot Station in shallow water habitats where preferred substrate occurs and where water velocities are increased due to a riverine physical characteristics (*e.g.,* shifts in depth contours, channel meanders, or islands) (NOAA, 2013). According to NOAA, the Connecticut River Coordinator (K. Sprankle, USFWS) has observed sea lamprey spawning in the Connecticut River mainstem upstream of the Turners Falls Dam within close proximity of the Vernon Dam (suitable habitat adjacent to Stebbins Island, both sides of island) (NOAA, 2013). Sea lamprey are also known to utilize lower reaches of tributaries, such as the

Ashuelot River, Hinsdale, New Hampshire and mainstem gravel bar and shallow water habitats within the Turners Falls Impoundment (*e.g.*, Massachusetts State Line) (NOAA, 2013).

Many years of lamprey count data exist, the most recent being 2012, when 14,089 sea lamprey were passed upstream of Holyoke Dam, whereas 4,503 were passed at Turners Falls Dam. To date, no studies have been conducted that identify sea lamprey spawning habitat and/or activity or the effects of operations of the Turners Falls Project and the Northfield Mountain Project on spawning (NOAA, 2013).

FirstLight conducted studies in the late spring and summer of 2012 to examine habitat conditions downstream of Turners Falls Dam, including substrate composition. Habitat mapping indicated there is limited gravel-riffle spawning habitat in the mainstem downstream of Cabot Station or within the bypassed reach below Turners Falls Dam (FirstLight, 2012).

Project Nexus (18 CFR § 5.11(d)(4))

Operations of the Turners Falls and Northfield Mountain Projects have the potential to affect sea lamprey spawning activity, spawning habitat, and spawning success. If adult sea lamprey are actively spawning in the project area, it is important to assess whether Project operations are having any adverse effects (*i.e.*, dewatering and scouring) to these spawning activities, their nests, and spawning habitats.

The investigation area includes the following:

- Suitable gravel or cobble riffle habitat within the Connecticut River mainstem from Cabot Station downstream to Sunderland Bridge.
- Suitable gravel or cobble riffle habitat the Turners Falls bypassed reach (Connecticut River mainstem).
- Suitable gravel or cobble riffle habitat within the riverine portion of the upper Turners Falls Impoundment that is subjected to flow or elevational regulation resulting from project operations. Specifically, surveyors will focus in on the following three areas:
    a. The Connecticut River mainstem within close proximity of the Vernon Dam (habitat adjacent to Stebbins Island, both sides of island).
    b. Mainstem gravel bar and shallow water habitats within the Turners Falls Impoundment (*e.g.*, at or near the Massachusetts State Line and the railroad bridge gravel bar).
    c. Suitable spawning habitat in the vicinity of Rawson Island.

- Suitable gravel or cobble riffle habitat within tributary confluence areas that are or may be affected by the current operational protocols, including:
    a. The Deerfield River confluence with the Connecticut River.
    b. The Millers River confluence with the Connecticut River.
    c. The Ashuelot River confluence with the Connecticut River.
    d. The Fall River confluence with the Connecticut River.
    e. The Green River confluence with the Connecticut River
    f. The Sawmill River confluence with the Connecticut River

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Field Data Collection

Assessment of Sea Lamprey Spawning Activity and Habitat – If available, 40 sea lamprey will be collected and radio tagged at Holyoke. Twenty will be released upstream of the Rt. 116 bridge and 20 will be released upstream of the Turners Falls Gatehouse. The tagged lamprey will be tracked to their spawning locations. During the early portion of their run 20 lamprey will be tagged with 10 released at the Rt. 116 Bridge and 10 above the Gatehouse. During the mid-potion of their run an additional 20 lamprey will be tagged and again released at the 2 identified release locations. FirstLight will share radio frequencies with TransCanada so tagged fish that move from the Turners Falls Project in to the Vernon Project vicinity can be monitored by TransCanada.

Sea lamprey will be anesthetized, weighed and measured (total length) and girth and surgically implanted with a radio tag. Tagged lamprey will be allowed to recover in flow through water for 4 to 5 hours before release. They will be released mid-channel after sunset. Tags will not exceed 3 percent of the lamprey weight. Tags will be compatible with radio tags used for the adult shad study so will be able to be detected by the stationary receivers that will be deployed for the shad study. Once the tagged lamprey reach the spawning grounds in the Project affected areas, the area in the proximity of the tagged fish will be inspected via snorkeling or underwater camera to determine if the habitat is suitable spawning grounds (shallow rapid water, sandy or muddy bottom). Lamprey that move out of the project affected area will be followed until they become stationary. Project affected areas that are suitable for spawning will be GPS located, and characterized for substrate and depth and monitored every 3 to 4 days depending on how many spawning areas are found. Water quality (water temperature, DO, turbidly, pH, and conductivity), velocity, embeddedness and depth will be measured over a range of normal project operations. Once redds are built in the project affected areas and spawning occurs, the redds will be monitored every third day and a subsample will be capped and emerging larvae will be counted following methods by Fox et al. (2010). Efforts will be made not to disturb the redds.

Spawning grounds within the project affected areas will be observed from the time of lamprey arrival to the time of larval lamprey departure or until the water temperature exceeds 22 °C. All redds will be counted and a subsample of up to 25 will be monitored (water velocity, depth, water temperature, exposure and condition of the red) over range of operations Any changes to the habitat or redds will be recorded. Embeddedness, sediment composition, will also be monitored.

Task 2: Data Analysis

All radio telemetry data will be compiled, entered into a database, assured for quality, and archived. Tabular and graphic summaries of sea lamprey locations, abundance and a map of the spatial distribution of suitable habitat will be developed. Coordinates of spawning locations for tagged fish that spawn within the project affected areas will be identified graphically on maps. Congregation areas of radio tagged lamprey will be compiled and presented graphically on maps. Areas within the project affected area will be classified as 1) non-suitable habitat, 2) suitable spawning habitat-no observed spawning, 3) active spawning area, 4) active spawning area with larval sampling. These areas will be described as to substrate, range and average depth, range and average temperature, range and average water velocity and range and relative clarity over the spawning and rearing activities. Hourly project operations, turbine discharge, spill, river discharge, and water elevation will be correlated to changes observed and water level measurements taken at the redds.

Spawning success will be characterized by emergence of larvae from capped redds, if they emerge then spawning is successful. Emerging larvae will be counted and timing of emergence will be documented.

The effects of project operations on the spawning habitat and spawning success will be determined by a comparison of all collected data to project operations. The date and time of observed activities, water measurements and visual variations of structural spawning habitat and redd characteristics will be related to operational data. Effects will be classified by operational regime observed as, 1) no effect (no observable difference to habitat/red structure or lamprey activity), 2) moderate effect (observable difference to habitat/red structure and/or behavior noticed but normal spawning occurs), 3) large effect (observable structural differences to habitat/redds and observable decreased spawning activity, 4) severe effect (noticeable habitat/red degradation, dewatering, scour, and no successful spawning).

Task 3: Report

A report will be prepared describing monitoring methods and results. The report will also include an assessment of impacts due to Project operations. A map of spawning areas and individual redds that are monitored will be included.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Turners Falls Project and Northfield Mountain Project on sea lamprey spawning in the investigation area. The estimated cost for this one-year study is approximately $125,000 to 150,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

FirstLight anticipates that this study will be conducted in late May or June of 2014, depending on water temperature and river flow conditions, which corresponds with sea lamprey spawning timeframes in the Connecticut River.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Literature Cited

FirstLight Hydro Generating Company (FirstLight). (2012). *Aquatic Mesohabitat Assessment and Mapping*. NorthFGS, MA: Author.

Fox, M., J.C. Graham and S. Frank. 2010. Determining Adult Pacific Lamprey Abundance and Spawning Habitat in the lower Deschutes River sub-basin, Oregon. Department of Natural Resources Confederated Tribes of Warm Springs Reservation, OR.

Hartel, K.E., D.B. Halliwell, & A.E. Launer. 2002. Inland Fishes of Massachusetts. Massachusetts Audubon Society (Lincoln). 328 pp.

NOAA. 2013. Letter with Comments on FirstLight Power Resources Notice of Intent to File License Application dated February 27, 2013.

3.3.16 Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station

General Description of Proposed Study

MADFW requested a study investigating the potential effects of Project operations on state-listed freshwater mussels, or their habitat, downstream from the Turners Falls Dam. The 13-mile reach between the Route 116 Bridge in Sunderland and Cabot Station will be surveyed for state-listed mussels using semi-quantitative survey protocols; biologists will characterize populations of state-listed and co-occurring common mussel species, measure and describe key habitat parameters, and map habitat for any state-listed mussel species found in the study area.

Based on these results and existing information (described below) on the mussel assemblage in the 22-mile reach between Route 116 and the Dinosaur Footprints Reservation ("Reach 5" as described in the IFIM study plan), FirstLight will develop binary[71] HSI criteria for any state-listed species documented to occur in the 35-mile reach. HSI development will rely on data collected during this field survey, species-specific data from other studies in the Connecticut River and other rivers in the Northeast, and expert review. The HSI will be used in the IFIM study (Study No. 3.3.1) to assess potential effects of Project operations on state-listed mussel populations or their habitat.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

This study has two objectives:

- Delineate, through field surveys, populations of state-listed mussels and suitable habitat downstream from Cabot Station and characterize the distribution, abundance, demographics, and habitat use of these populations. Surveys will identify and map potential habitat for state-listed species based on habitat preference of each species.
- Develop binary HSI curves for all state-listed mussel species found to occur in the 35-mile reach downstream from Cabot Station, using species-specific data from the Connecticut River and other rivers in the Northeast, along with relevant publication and expert review. These HSI curves will be used in the IFIM to evaluate the potential effects of Project operations on state-listed mussel species.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The Massachusetts Natural Heritage & Endangered Species Program (NHESP), part of the MADFW, is charged with ensuring the conservation and protection of species listed under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) as Endangered, Threatened, or of Special Concern. The resource management goals identified by the NHESP/MADFW are to:

- Ensure that PME measures are commensurate with Project effects and meet MESA requirements.

[71] The curves will be "binary" in nature, meaning classified as "suitable" or "not suitable".

- Conserve, protect, and enhance the habitats for state-listed species that will be affected by Project operations.

The MADFW study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, PME measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Clean Water Act (33 U.S.C. §1251 *et seq*.), the MESA, and the WPA.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Species Composition: In 2011, a freshwater mussel survey was conducted in the Turners Falls Impoundment, bypass reach, and canal as a baseline study in anticipation of the FERC relicensing process. State-listed mussel species were not detected in any of these areas (Biodrawversity, 2012). Also in 2011, a freshwater mussel survey was conducted upstream and downstream of the Vernon Hydroelectric Project as part of the planning for TransCanada's FERC relicensing process, and no state-listed mussel species were found during that study (Biodrawversity & LBG, 2012).

As part of the requirements of the FERC license for the Holyoke Hydroelectric Project, freshwater mussel studies have been conducted at four-year intervals from Dry Brook (Sunderland) to the Holyoke Dam (this survey is scheduled to occur again in 2013). Details of the most recently published mussel survey findings in this reach are described in Study No. 3.3.1.

These studies, combined with surveys conducted for several riverbank stabilization or construction projects along this same reach, have resulted in a very good understanding of the distribution and habitat of common and state-listed mussel species in the Connecticut River from the Holyoke Dam to the Vernon Dam, minus a mostly unsurveyed 13-mile reach from the Route 116 Bridge in Sunderland to Cabot Station.

The yellow lampmussel (*Lampsilis cariosa*), listed as Endangered in Massachusetts, has been documented in the impoundment of the Holyoke Dam as far upstream as the Hadley Dike, with the highest concentrations from Elwell Island (Northampton) downstream to Brunelle's Marina (South Hadley). The eastern pondmussel (*Ligumia nasuta*) has been found at only one location in the lower Holyoke Dam impoundment, and it also occurs in several small tributaries. There is potential for either of these species to occur in the Connecticut River in the unsurveyed 13-mile reach downstream from Cabot Station. In addition, there is a historic record (~1978) of dwarf wedgemussel (*Alasmidonta heterodon*) in the Connecticut River at Sunderland, and it is possible that this species still persists in this reach. This is a federally endangered species, with the closest known populations in the Fort River (Amherst, MA), Mill River (HatFGS, MA), Ashuelot River (Swanzey, NH), and in the Connecticut River in the impoundment of the Bellows Falls Dam in New Hampshire and Vermont.

Impact of Flow Regime: Impacts of the current flow regime on mussels downstream from the Turners Falls Dam are not well understood. There are significant diurnal flow fluctuations downstream of the Turners Falls Dam and the Deerfield River. These changes in water elevations and flow dynamics have the potential to adversely affect state-listed mussels, their habitats, and their long-term viability in the Connecticut River. Species most vulnerable would be those that have an affinity for nearshore habitats, or other shallow areas that are most likely to become dewatered or shallow enough to make individuals vulnerable to heat stress or predators during periods of low flow. In addition, variation in flow velocity and bed shear stress across a range of flows may also affect mussel habitat, even in areas that remain watered even under low-flow conditions. Effects are expected to be most acute in areas of the river with channel morphometry, bank slope, and substrate conditions that are both conducive to mussel colonization and that experience the greatest degree of change from flow minima to flow maxima. The IFIM and hydraulic models studies proposed for this project, combined with the mussel surveys and habitat assessments that will be completed specifically during the mussel study, will help to identify both the species and locations where flow regime effects are more likely to occur, and will help provide an overall assessment of these effects.

Project Nexus (18 CFR § 5.11(d)(4))

The timing, rate, and magnitude of releases from the Turners Falls Project may have adverse effects on rare mussel populations although the degree of these effects is unknown. Baseline information is needed to evaluate the potential impacts of the Project on state-listed mussel species and their habitat.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Finalize study plan and attain collection permit

Because the study is focusing on state-listed mussel species, FirstLight will work with NHESP to finalize the study plan and attain the necessary permit to handle/collect state-listed mussels. FirstLight will comply with the conditions and reporting requirements of the collection permit.

Task 2: Mussel Survey and Habitat Assessment

Surveyors will systematically search the open water riverine habitats from Cabot Station to the Route 116 Bridge in Sunderland, employing the following protocol:

- A comprehensive habitat assessment will be completed over the reach from Cabot Station to the Route 116 Bridge using NHESPs *Endangered Species Habitat Assessment Guidelines: Freshwater Mussels (version May 2013)*. Results of this assessment will be provided to NHESP in advance of actual mussel surveys to reach concurrence on where suitable habitat exists and the most effective survey technique(s).
- Habitats suitable for state-listed mussels, as identified in the habitat assessment and with concurrence from NHESP, will be surveyed using semi-quantitative (i.e., timed qualitative) surveys. The duration of these surveys will depend on the spatial extent and quality of the habitat and the presence of state-listed mussels.
- The mussel survey will be conducted when appropriate water clarity and water depth conditions are present, between August and late September. Surveys will be conducted using SCUBA in depths over three feet, and by snorkeling in shallower waters.
- The Catch per Unit Effort (CPUE) method will be used to qualitatively assess mussel species abundance. Specifically, the number of individuals of each species encountered within a defined amount of time will be tallied, and the CPUE values will be calculated and compared.
- Standard morphometric data (e.g., species, size, shell injury/erosion etc.) and site data (i.e., location, extent, elevation) will be collected. All state-listed mussel species encountered, and the first 50 individuals of common species, will be measured (in mm) to enable assessment of size distribution and recruitment.
- For each individual state-listed mussel that is encountered, the following data will be recorded: precise location (using GPS and field notes), water depth, substrate, presence/abundance of aquatic plants, presence/abundance of woody debris, and flow velocity (recorded as "nose velocity", within 10 cm of the river bottom at each mussel's location).
- Representative digital photographs of each state-listed species will be taken at each site to document and confirm the identity. Photos showing the lateral view and/or in situ siphoning will be included.
- Representative samples of spent shells (if encountered) will be collected for each state-listed species; these will be sent to the Division for documentation.

- All mussels removed from the substrate will be replaced to the same area and carefully re-bedded into the sediment in their original orientation; anteriorly into the substrate, posterior end up.
- This habitat assessment and survey will provide habitat descriptions and maps to adequately describe the relative amount, distribution, and quality of suitable habitat for the state-listed freshwater mussels in areas influenced by the Turners Falls Project.

Task 3: Develop Binary HSI Criteria for State-Listed Mussel Species Documented in the Project Area

FirstLight will develop quantitative binary HSI criteria for all state-listed mussel species documented in the 35-mile reach between Cabot Station and Dinosaur Footprints Reservation. Binary HSIs have not yet been developed or vetted for any of the state-listed mussel species in Massachusetts, yet there is ample information on these mussel species from studies conducted in the Connecticut River, other rivers and lakes throughout the range of each species, and from the research and experiences of mussel experts throughout the Northeast. Therefore, FirstLight will facilitate the development of binary HSIs using the following approach:

1. Gather, review, and synthesize all available information on the distribution and habitat preference of all state-listed or federally listed mussel species documented to occur in the 35-mile project area. Information will come primarily from journal articles, government and consultant reports ("gray literature"), case studies contributed from the region's most experienced malacologists, and any field data collected specifically under Task 3.

2. Based on available information, develop binary HSI criteria for key parameters (e.g., water depth, flow velocity, substrate, shear stress, relative shear stress, Froude number) for each species, along with a written rationale for the criteria.

3. A panel of experts will review the binary HSI criteria, and, if needed, fine-tune the criteria based on expert opinion.

4. Finalize binary HSI criteria for each species and present to stakeholders for final review.

Task 4: Effects of Flow Regime on State-listed Mussels

The specific methods for evaluating the effects of the flow regime on state listed mussels are contained in Study No. 3.3.1.

Task 5: Report

A report will be prepared describing the survey, binary HSI criteria development, and analysis results. A tentative table of contents follows:

- Introduction
- Study Area
- Methods
    - Mussel Surveys
    - Habitat Assessment
    - Hydraulic Model and IFIM
- Results
    - Habitat Assessment
    - Mussel Surveys
    - Effects of Flow Regime

- Discussion
- Conclusions

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The estimated cost for this study will depend, in part, on whether state-listed mussel species are found and the amount of mussel/habitat data that must be collected where state-listed mussels are found. Overall costs may range $20,000 - $30,000 (not including the hydraulic model and IFIM completed as a separate study).

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Field work for the habitat assessment and mussel survey is planned to occur in 2013, if possible, in advance of the instream flow study proposed in Study No. 3.3.1. Completing the survey early in 2013 will help to inform the development of the HIS criteria and the planning for the instream flow study. The remainder of any necessary work will occur in 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Literature Cited

Biodrawversity, (2012). *Freshwater Mussel Survey in the Connecticut River for the Turners Falls and Northfield Mountain Hydroelectric Projects*. Amherst, MA: Author.

Biodrawversity and The Louis Berger Group, Inc. (LBG). (2012). *Freshwater mussel survey in the Connecticut River for the Vernon, Bellows Falls, and Wilder Hydroelectric Projects*. Prepared for TransCanada Hydro Northeast Inc.

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

General Description of Proposed Study

The NHFGD, Town of Gill, MADFW, CRWC, VTDEC, TU and USFWS requested a study to determine if water level fluctuations due to Project operations result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below the dams. Additionally, the stakeholders requested an assessment of the impacts of water level fluctuations due to Project operations on water levels, available fish habitat and water quality in the tributaries and backwaters of the impoundment and riverine reaches below the dams. It is anticipated that this study will provide data that may be used to determine the adequacy of existing downstream minimum flow requirements.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goals of this study are to determine if water level fluctuations from the Turners Falls and Northfield Mountain Projects result in reductions of available aquatic habitat due to movement barriers and/or habitat alterations. Results from this study will be useful for developing mitigation measures and to determine the adequacy of existing downstream minimum flow requirements. Specific objectives of the study are to:

1. Identify potential barriers or constrictions of fish access to tributaries and backwater areas resulting from Project-related water level fluctuations.

2. Measure changes to available habitat, and water quality in backwater areas and tributaries resulting from Project-related water level fluctuations.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals identified by the commenting agencies are:

- Protect, enhance, or restore diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
- Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Major tributaries to the Turners Fall Impoundment 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. Smaller named streams entering the Turners Falls Impoundment, 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. For the downstream reach from the base of the dam to the Route 116 Bridge, major tributaries potentially impacted by Project operations include the Fall River, Deerfield River, Sawmill River, and Gunn Brook.

Limited information related to the potential impacts of the Turners Falls Project and Northfield Mountain Project operations on tributary/backwater access and habitats is available; therefore, the study is being completed to establish baseline conditions and assess the potential effects of existing or proposed operations.

Project Nexus (18 CFR § 5.11(d)(4))

Operation of the Turners Falls Project and Northfield Mountain Project may directly impact tributary/backwater and aquatic habitat access through the use of water for hydropower generation.

The investigation area includes the following tributaries entering the Turners Falls Impoundment, from upstream to downstream (Figure 3.3.17-1)[72] as well as significant backwatered areas within the Turners Falls impoundment:

- Ashuelot River
- 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
- Fourmile Brook
- Millers River
- Backwater habitat encountered during survey work.

Investigation areas downstream of Turners Falls Dam will include the Fall River, Deerfield River, Sawmill River, and Gunn Brook (*see* Figure 3.3.17-2).

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Common tools to evaluate water level impacts may be used including: bathymetric mapping; habitat measurements (*e.g.*, substrate, depth and velocity), and water quality information (*e.g.*, dissolved oxygen, temperature, turbidity, and pH). Other methods (river bed surveys, visual inspections, GIS/GPS mapping, and hydraulic/habitat modeling) will also be utilized. The study area for tributary and backwater sampling will include tributaries along with other significant backwater habitat encountered during the surveys. All field work described below would be performed once during the spring, summer, and fall of the first study year.

[72] Assumes all of these tributaries are locatable.

Task 1: Field Data Collection

For the purpose of this study, low water level conditions will be considered as 176.0 feet msl (or as close as is practical at the time of the study) in the Turners Falls Impoundment, and at a gage height of ≤ 8 feet at Montague for river reaches below the Turners Falls Dam. For Fall River, low water conditions will be defined as flows of 400 cfs or less in the bypass reach.

Tributaries – Surveyors will locate individual tributary confluence areas within the Turners Falls Impoundment and the downstream reach to the Route 116 Bridge by boat or vehicle/foot during full-pond conditions or high water level conditions downstream. At each tributary site, surveyors will perform the following:

- Photo document the tributary confluence area.
- Delineate the perimeter of the inundated tributary confluence area with a sub-meter accuracy GPS. Aerial imagery may also be used to delineate tributary confluence areas.
- Perform bathymetric measurements of the confluence area of individual tributaries, including thalweg.
- Collect spot measurements of water temperature, dissolved oxygen, turbidity, and pH at one location within the inundated tributary confluence area. For comparison, measurements will also be taken at one location in the Connecticut River near the confluence area and in a free-flowing riverine reach immediately above the elevation affected by water level fluctuations.

Surveyors will then revisit tributary confluence areas during lower water level conditions (*i.e.*, low pond and low discharge in the Connecticut River) to determine if stream intermittency or constrictions occur as a result of Project operations that would restrict fish movements into free-flowing riverine reaches. At each tributary site, surveyors will perform the following:

1) Photo document the tributary confluence area and any stream channel features (*e.g.*, barriers) that may restrict fish movements. Assessment and identification of these constriction points will be based on the best professional judgment of the biological staff employed to do the work. Generally, stream features with water depths less than 1 foot in the thalweg area will be considered as potential constrictions to fish movements.[73]
2) Delineate the perimeter of the dewatered tributary confluence areas with a sub-meter accuracy GPS. Aerial imagery may also be used to delineate tributary confluence areas. Critical transects will also be GPS-located for future reference.
3) Characterize and map exposed aquatic habitats in the tributary confluence area.
4) If barriers to fish movement are observed:
    - Record and photo document their location.
    - Perform a longitudinal bathymetric/topographic thalweg[74] survey of the dewatered confluence area, with stream bed elevations relative to low water level elevation.
    - Perform a cross-sectional profile of stream channel features that may restrict fish movements.

[73] Given that these small tributaries are likely only used by resident riverine fish and perhaps sea lamprey, water depths greater than 1 foot will be considered adequate for upstream of downstream movements of fish.
[74] Point of lowest elevation.

- Collect water depth, velocity, and substrate data at longitudinal and cross-section survey points.

5) Collect spot measurements of water temperature, dissolved oxygen, turbidity, and pH within the riverine portion of the tributary. For comparison, measurements will be taken in three areas (within the Connecticut River near the mouth of the tributary confluence, within the affected portion of the tributary, and upstream of the influence of the normal water level fluctuations.
6) Photo document and delineate areas subject to fish stranding (*e.g.*, standing pools without or with little outflowing water to allow for volitional fish movements to deeper waters).

Backwater Areas – For purposes of this study we have defined backwater habitat as areas with a notable increase in water surface elevation caused by a constriction or obstruction in flow, or off-channel habitats created as a result of floodplain (or other habitat features, *e.g.*, oxbow) development. Backwater habitats are characterized by slow currents, shallow water, and silty or vegetated substrates. To assess the effects of Project operations, surveyors will locate backwater areas during relatively high water levels. Surveyors will collect/perform the following at each backwater site at these conditions:

1) Photo document and GPS the location of individual backwaters.
2) As possible, delineate the perimeter of backwatered areas with a sub-meter accuracy GPS. Aerial imagery may also be used to delineate backwater habitat.
3) Collect spot measurements of water temperature, dissolved oxygen, turbidity, and pH within the backwater. For comparison, measurements will also be taken in the impoundment near the backwater area.

Surveyors will then revisit backwatered areas during low water level conditions to assess connectivity and habitat conditions. The following information will be collected:

1) Photo documentation of backwaters at low water level conditions.
2) Photo documentation and GPS mapping of areas subject to fish stranding (*e.g.*, standing pools without or with little outflowing water to allow for volitional fish movements to deeper waters).
3) If barriers to fish movement are observed:
    - Record and photo document their location,
    - Perform longitudinal bathymetric/topographic thalweg survey of backwater area, with bed elevations relative to low water level elevation.
    - Collect water depth, velocity, and substrate data at longitudinal and cross-section survey points.
4) Collect spot measurements of water temperature, dissolved oxygen, turbidity, and pH within the backwater. For comparison, measurements will also be taken in the Connecticut River near the backwater area.

<u>Task 2: Evaluation of Fluctuation Range</u>

If it is determined that the existing flow fluctuation range creates barriers to fish movements in tributaries and/or backwatered areas, or adversely affects aquatic habitat, FirstLight will perform modeling/GIS studies to evaluate if changes in water level fluctuation range would mitigate for any identified impacts. Modeling software (*i.e.*, HEC-RAS or River 2D or comparable) will be used to develop a GIS to demonstrate changes in tributary or backwater access (including resultant water depth and water velocity modeling) at identified barriers and habitat conditions.

Task 3: Data Analysis and Reporting

Data will be compiled and analyzed after each sampling effort. Data will be developed in tabular and graphic format for inclusion in draft and final report preparation.

The report will be submitted as part of the Initial Study Report as per the ILP process schedule.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to accurately assess the potential effects of the Turners Falls Project and Northfield Mountain Project on tributary and backwater access in the investigation area. The estimated cost for this one-year study is approximately $30,000 to $45,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

It is anticipated that this survey will be conducted in 2014. If flow conditions in 2014 prevent low flow conditions the study will be conducted in 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

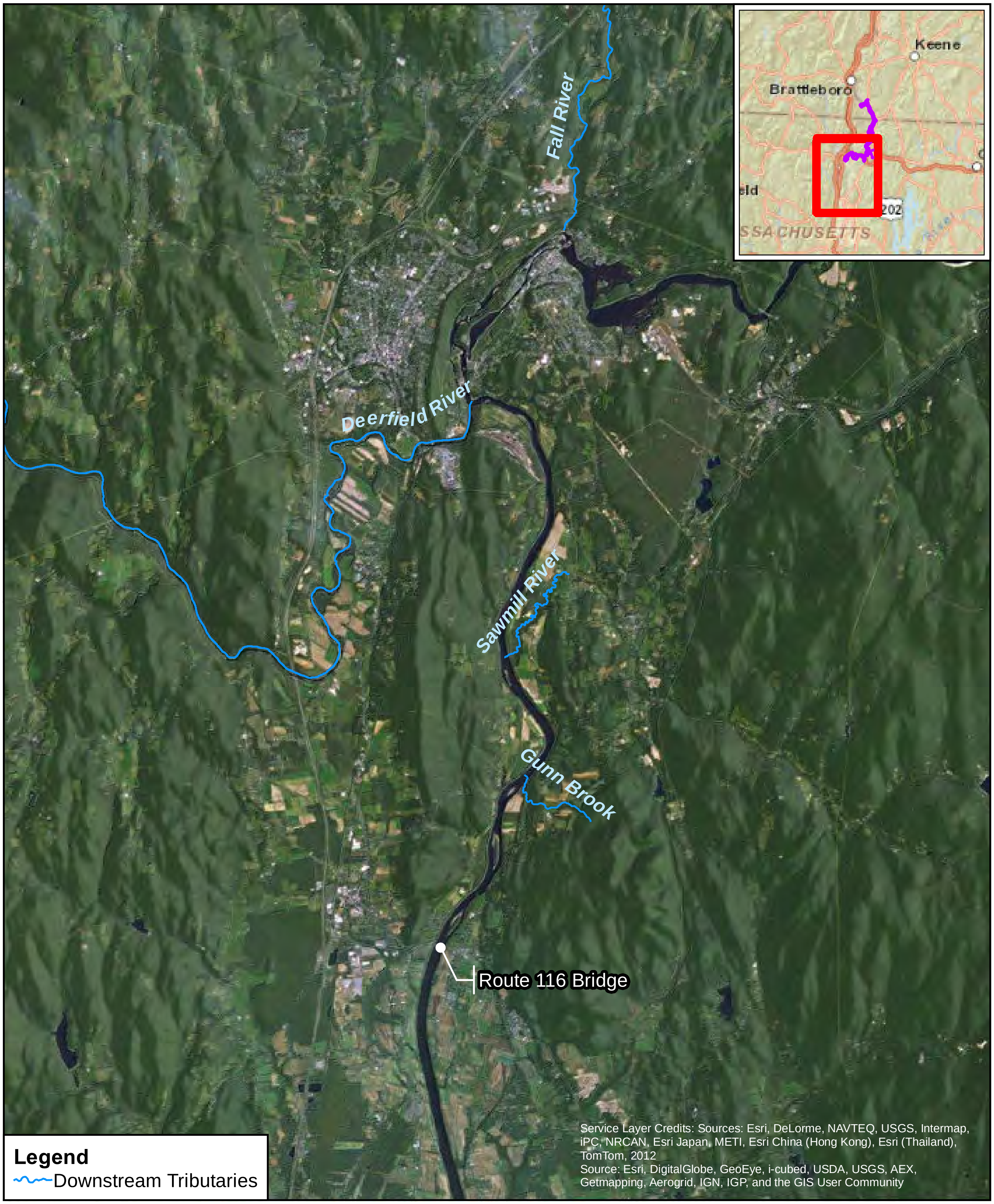
FirstLight Power Resources
GDF SUEZ

FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

Figure 3.3.17-1
Location of Target Tributaries in the Turners Falls Impoundment for FirstLight's Tributary and Backwater Access Study

Path: W:\gis\maps\revised_study_plan\Figure 3.3.17-1.mxd



FIRSTLIGHT POWER RESOURCES

REVISED STUDY PLAN

N

0 1 2 4 Miles

Figure 3.3.17-2
Location of Target Tributaries Downstream of the Turners Falls Dam for FirstLight's Tributary and Backwater Access Study

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3.3.18 Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms

General Description of Proposed Study

In the study request letter from the USFWS, a study to quantify the impacts of the annual Turners Falls Project canal drawdown on emigrating and resident fishes, freshwater mussels and mudpuppies in the canal was requested. Similar requests were also received from the MADFW, NHFGD, NOAA, CRWC, and TU. The stakeholder's indicate that the study request is intended to facilitate the collection of information necessary to conduct effect analyses and to develop reasonable and prudent conservation measures, along with PME measures.

Historically, FirstLight has conducted informal annual surveys of the canal during drawdown events. In 2011, a more extensive survey was conducted and documented in a memo report as explained below under the Existing Information discussion. FirstLight will conduct a similar survey during the 2014 drawdown event, with additional data collection aimed to fulfill the stakeholder's objectives as described below.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to identify and evaluate potential measures to reduce adverse effects due to dewatering for the annual canal drawdown events. The objectives are to:

- Assess whether juvenile shad and American eel abundance in the canal increases leading up to the time of its closure, due to delays in downstream passage (e.g., is fish accumulation occurring).
- Evaluate level of mortality for juvenile sea lamprey from exposure of burrow habitats in the canal.
- Conduct a survey of fish and aquatic organisms (e.g., freshwater mussels and mudpuppies) during the 2014 canal drawdown to document species presence, estimate relative densities, determine status (stranded, alive, dead), and map wetted areas.
- Evaluate measures to minimize aquatic organism population impacts of the canal drawdown.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The CRASC developed *A Management Plan for American Shad in the Connecticut River Basin* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.
2. Maximize outmigrant survival for juvenile and spent adult shad.

The ASMFC Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, has the stated goal of "*Protect, enhance, and restore Atlantic coast migratory stocks and critical habitat of American shad in order to achieve levels of spawning stock biomass that are sustainable, can produce a harvestable surplus, and are robust enough to withstand unforeseen threats,*" and includes the following objectives:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

2. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g. turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

The USFWS seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Turners Falls Project. General goals include the following:

1. Ensure that PME measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Turners Falls Project.

Specific to diadromous fishes, the USFWS goal is to minimize current and potential negative project operation effects on diadromous fishes, including juvenile shad, adult silver eels, and sea lamprey ammocetes.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Historically, FirstLight has observed stranding of juvenile American shad during annual canal drawdown events. In 2011, FirstLight's consultant and staff from Conte Lab conducted a more formal survey to include delineation of the canal into seven distinct zones. Each zone was visually surveyed for juvenile shad and other species, which were counted or estimated depending on numbers present. Any pool areas were documented with photos and represented on aerial photos. A summary report was developed and is provided in Appendix G of this RSP. While no shad were observed, probably because of a flood event prior to the drawdown, a variety of species were documented, including centrarchid and cyprinid species, sea lamprey, carp, perch, mussels, chain pickerel, and American eel. Numbers observed varied by zone and by species.

FirstLight anticipates conducting another survey of the dewatered canal in 2014 utilizing methods similar to those employed during the 2011 survey. Since information regarding the distribution and fate of juvenile sea lamprey in the canal remains unknown, additional efforts to fill this information gap will be included in the study plan for the 2014 drawdown event.

FirstLight believes that Study Nos. 3.3.4 and 3.3.5 will further address the concerns regarding whether outmigrating shad and American eels are impacted by the annual drawdown events.

Project Nexus (18 CFR § 5.11(d)(4))

Previous studies at Cabot Station have documented that juvenile American shad and American eel migrate through the project area during the canal drawdown period. During normal operations (where canal water level elevations are stable), downstream migrants are able to utilize the Cabot bypass facility; however, as the canal water level is drawn down, the bypass is no longer available, and the only routes of egress are through the turbines at Cabot Station and Station No. 1.

Once the canal has been drawn down, much of the canal bed still has a well defined channel with water flowing, although some isolated shallow pools remain until the canal is refilled. During this period, fish (including lamprey ammocoetes), amphibians, and benthic invertebrates may be prone to desiccation, predation or other sources of mortality.

The annual canal drawdown was formerly conducted in July. In response to ISO-NE's request that FirstLight conduct the drawdown outside of the June through August period, FirstLight moved the drawdown to September, which coincides with the part of the migration period for some diadromous species.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

FirstLight believes that, with modifications, the 2011 survey methods are adequate to meet study objectives for documenting the species (fish, freshwater mussels, and mudpuppies) present in the canal during a drawdown event, estimating their relative densities, determining physical status (stranded, alive, dead), and developing a map of wetted areas. Additional efforts, described below, will be included to determine the level of mortality of juvenile sea lamprey due to exposure of burrowing habitat at the downstream end of the canal. Data collected during the 2014 canal drawdown event will be used to inform the selection of potential mitigation measures to be evaluated for minimizing the adverse effects of the drawdown events on aquatic organisms in 2015. FirstLight believes that Study Nos. 3.3.3 and 3.3.5 will address the concerns regarding whether outmigrating shad and American eels are impacted by the annual drawdown events.

Due to the iterative process of conducting survey methods that will be used by FirstLight and stakeholders to identify and evaluate potential mitigation measures, the Study Schedule section below identifies an estimated time line of activities to incorporate a consultation process into this study.

Task 1: Conduct Aquatic Organism Survey of Canal During 2014 Drawdown

Similar to the 2011 survey, the survey will be conducted by segmenting the canal into approximately seven distinct zones (see map in Appendix G) and surveying each of the dewatered zones for observations of fish, mussels, and mudpuppies. The surveys will commence as soon as practicable after dewatering has been completed to avoid potential interference from avian predation of stranded fish. FirstLight proposes to conduct the study on the day following the drawdown, since post-drawdown predation and scavenging by birds and mammals could bias survey results. A field crew of experienced biologists will systematically traverse each of the zones in a meander survey fashion recording observations of estimated number of each species encountered. For each species observed, an assessment of the number of stranded, dead and alive individuals will be estimated. Additional information on the general location of species observations and predominant substrate type will be recorded on standardized field data sheets, as well as relevant weather conditions (air temperature, cloud cover estimate, precipitation, etc.).

For areas that remain sufficiently wetted (greater than 6 inches depth) in Zones 1-6 after the drawdown is completed, backpack electrofishing and/or beach seine techniques will be employed to determine relative abundance of fish in these areas. Standardized backpack electrofishing techniques will be utilized as habitat conditions permit and beach seines may be used in those areas not suited for backpack electrofishing (greater than 3 feet depth). For backpack electrofishing, a single backpack operator with a dip net will be accompanied by one or two additional netters and each sampling event will be standardized by time, such that results can be reported as the number of fish collected per 500 seconds of sampling. Beach seines will be used in appropriate areas where water depth is such that the net wall can extend from the surface to the bottom of the water column, and where the bottom contour is smooth to avoid net hang-ups. Beach seines will be performed with two people, each holding a pole at the end of the wing and towing the net through the wetted area until a specified, pre-determined area has been covered. At the conclusion of the seine sampling event, the wings of the net will be brought together and the bag will be hauled to an appropriate area where the nets content can be sorted for identification and enumeration.

Based on observations during previous drawdown events, leakage through the gatehouse and canal bathymetry allows the majority of Zone 7 to remain sufficiently wetted (see photos below). This leakage combined with the egress through the Keith Drainage Tunnel, appears to provide adequate flow and depth to support aquatic species over the short term. As such, the survey for aquatic organisms in Zone 7 will be focused on the exposed, higher elevation areas only.

Photos (taken during 2011 drawdown survey) depicting typical conditions in Zone 7 during canal drawdown event.

Areas in Zones 2-6 (includes the areas of previous observations of juvenile sea lamprey) with appropriate soft sediment habitat will be further scrutinized to determine the distribution and relative abundance of juvenile sea lamprey (ammocoetes) and mussels. Up to 10 randomly selected 1-m by 1-m quadrats will be sampled in each zone and counts of ammocetes and mussel by species will be recorded. The quadrats will be stratified by bank and channel. The final number and placement of quadrats will be decided prior to the drawdown in consultation with the resource agencies and Conte Lab researchers. The physical status (stranded, alive, dead) of the individuals will also be recorded. These data will be used to extrapolate counts for the entire area of suitable habitat within each zone.

The location of sufficiently wetted areas or pools will be GPS-located for subsequent map generation (including Zone 7). Based on observations during previous drawdown events, a large pool typically remains in the Cabot forebay area for the duration of the drawdown period. A GPS unit will be utilized to record the location and extent of the pool for inclusion on the map of wetted areas. Water quality parameters (temperature, dissolved oxygen, turbidity) will be also measured and recorded in the pools. Water temperature will be continuously monitored in Zone 7 with a long-term temperature logger at a location selected in consultation with resource agencies for the duration of the drawdown event.

Results for aquatic organism sampling will be reported in units of standardized time of effort for electrofishing and also by unit area for the seining and quadrat sampling. Water quality information, fish survey and quadrat data will be summarized in tabular format and included with the graphical canal representation in a report for stakeholder review.

<u>Task 2: Identify and Assess Potential Measures</u>

This task will consist of consulting with agencies and other stakeholders to identify and evaluate potential measures that may reduce adverse effects on fish and mussels in the canal during drawdown conditions. Potential measures may include, but not be limited to, assessment of the need for annual drawdowns; assessment of drawdown timing and frequency; and placement of temporary weirs or baffles in select areas of the canal to enlarge pools that remain during drawdown events or create additional pools to keep specific habitat areas wetted for the duration of the drawdown event. The evaluation will compare the merits and drawbacks of each measure, as well as develop an order-of-magnitude cost estimate. Should FirstLight and stakeholders reach an agreement on appropriate measure(s) to evaluate in the field then engineering design will proceed in Task 3. Stakeholders will also be consulted for development of a study design to assess the effectiveness of the selected measure that will be tested in the field.

Task 3: Design Selected Measure(s)

Upon agreement between FirstLight and stakeholders on appropriate measure(s), if any, to reduce adverse effects on aquatic organisms during drawdown events, engineering design (if applicable) of the selected measure(s) will be developed in consultation with Stakeholders in 2015. Following design, the selected measure will be tested in the field during the 2015 drawdown event.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes the proposed level of effort is adequate to conduct a drawdown survey and design potential measures, if feasible, to reduce the impacts of the annual drawdown events on aquatic organisms present in the canal. The total estimated cost for the proposed study is approximately $35,000 - $55,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

- FirstLight to conduct Task 1 field surveys – September 2014
- Distribute summary report of results Task 1 and initial list of potential measures to be evaluated under Task 2 – January 2015
- Hold meeting with Stakeholders to review Task 1 summary, seek to reach consensus on measure(s) to be field evaluated, and metrics for determining relative success of measure(s) to reduce effects of drawdowns – February – March 2015
- Prepare conceptual design, if applicable, of measure(s) to be evaluated and submit to Stakeholders for review – April – May 2015
- Finalize conceptual design in consultation with Stakeholders, including meetings as determined appropriate – June 2015
- Construct test materials for placement and testing – July – August 2015
- Install and test – September 2015
- Distribute summary report of 2015 results for Stakeholder review – January 2016
- Hold meeting with Stakeholders to review results of testing and conclusions – February – March 2016

3.3.19 Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace

General Description of Proposed Study

An evaluation of the use of an ultrasound array to keep shad out of the Cabot Station tailrace and facilitate upstream movement of American shad to Turners Falls Dam was requested by USFWS, NHFG and CRWC. This study will be conducted in 2015 pending the results of Study No 3.3.1 and Study No. 3.3.2, which include analysis of historic fish passage data.

The location of the proposed array would be in the area of the identified shortnose sturgeon spawning grounds. It would need to be operated during the sturgeon spawning season as the shad upstream migration and sturgeon spawning periods overlap.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to determine if an ultrasound barrier could be used to repel adult shad from the Cabot Station tailrace and guide them into the bypass reach.

The objective of the study would be to establish a high frequency sound (ultrasound) array across the entire Cabot Station tailrace and determine the effect of the ensonified field on upstream migrating radio-tagged shad moving past Cabot Station. This would be accomplished by monitoring the movements and passage of shad and the time shad spend in the tailrace area.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

In 1992, the Connecticut River Atlantic Salmon Commission (CRASC) developed a draft document titled: *A Management Plan for American Shad in the Connecticut River Basin*.

Management Objectives in the plan include the following:

Specific management objectives in the plan include the following: Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually; achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem; and maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010, includes and objective to maximize the number of juvenile recruits emigrating from freshwater stock complexes.

Amendment 3 also includes the following recommendations for upstream passage:

- American shad must be able to locate and enter the passage facility with little effort and without stress.
- Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.

- Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

In spite of the extensive studies and many successes for some species of fish at some station intakes, as yet there is no one behavioral barrier or deterrent that is effective with all species and lifestages of fish. Behavioral barriers are generally still considered experimental.

High frequency sound was used at the James A. Fitzpatrick power plant located on Lake Ontario, and was found to reduce impingement of alewife by more than 80 percent and its use was approved by the regulatory agencies. Similar avoidance by herring species was noted where sound was tested at hydroelectric sites.

American shad and alewife belong to the same family, Clupeidae, and their reaction to high frequency sound may be similar. Information exists about adult shad avoidance of ultrasound. In field trials in the early 1980s to develop a guidance system for downstream-migrants in the First Level Canal of the Holyoke Canal System, adult shad avoided but were not well guided by an ultrasonic array. However, upstream migrants were guided well and even stopped entirely by the ensonified field (Kynard & Taylor, 1984). Creating an ensonified field caused adult shad to leave their preferred location in the river upstream of trashracks at Holyoke Dam as long as the sound system was on.

Blueback herring also avoided the ultrasound field and behaved similar to shad in the Holyoke Canal studies (Kynard & Taylor, 1984). Acoustic barriers have been used for migrating blueback herring on the Savannah River (Richard B. Russell Dam) and Santee River (St. Stephen fish lift) in South Carolina and emigrating blueback herring on the Mohawk River in New York (Crescent Project, FERC No. 4678; Vischer Ferry, FERC No. 4679). Evidence from many studies that attempted to produce behavioral avoidance by adult shad suggests that ultrasound is an effective stimulus (Carlson and Popper, 1997). Evidence suggests that shad and blueback herring may avoid the tailrace of Cabot Station if an ultrasound field was installed; however, simply repelling shad from the Cabot tailrace is not a satisfactory result, for this behavioral barrier to be successful the fish would also have to keep going upstream, without delay, as opposed to dropping down below Cabot.

Project Nexus (18 CFR § 5.11(d)(4))

Studies to assess potential passage solutions are frequently conducted during relicensing proceedings. This study, coupled with the adult shad radio-telemetry study, can provide the information needed to select an approach to resolve upstream shad passage at the Turners Falls Project.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Ultrasound Deployment

This study would establish a high frequency sound (ultrasound) array across the entire Cabot Station tailrace and determine the effect of the ensonified field on upstream migrating shad moving by Cabot Station by monitoring shad behavior. Telemetry methods described in Study No. 3.3.2 will be utilized. Ultrasound testing will be initiated once telemetered shad arrive at Cabot Station. Two test treatments will be evaluated: array on and array off. A minimum of six replicates per treatment per flow condition will be targeted. The first “on” treatment will begin between 10am and noon and will last at least two hours and each “off” treatment will last at least three hours. Testing three days per week for at least two weeks is planned. After the first week of testing a progress email describing the preliminary results will be provided to stakeholders in case schedule adjustments are needed.

Task 2: Reporting

Data collected in Task 1 will be analyzed to determine the effect of the ensonified field on upstream migrating shad. The number of shad detected at the Cabot tailrace with the field on and off will be statistically compared ($p \leq 0.5$) and telemetry data will be analyzed to determine if the fish disperse upstream through the bypass reach or downstream. Environmental and operational data will be recorded and reported during each test period and used to analyze the data. In addition, the data will be analyzed to determine if there is a relationship between the number of readings for an individual tag and the treatment type. The CFD modeling (Study No. 3.3.8) will be coupled with the telemetry results, passage counts and environmental variables (water temperature, river flow) to understand which conditions are preferable for guiding migrating fish to the entrances.

A report will be prepared detailing methods, results, a discussion and conclusions.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The cost for the test would be $55,000 to $70,000. Costs will be related to rental, installation, and operation of the ultrasound system, analysis of data, and production of a final report.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

The study proposed herein will be conducted in the second study season, after the adult shad study described in Study No. 3.3.2, *Evaluate Upstream and Downstream Passage of Adult American Shad*, if, following completion of that study, additional data are required to evaluate the upstream passage of American shad past Cabot Station. American shad migrate up the river when water temperatures are generally between 12 and 20°C; spawning occurs from 14 to 23°C when river flow is generally declining from the spring peak with shad reaching Cabot Station in late April or early to mid- May. The ultrasonic array and shad monitoring equipment will be deployed, calibrated and tested in late March and early April, prior to the arrival of adult shad to the study area. If performed, the study is anticipated to conclude by mid-July 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Literature Cited

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3.4 Terrestrial Wildlife and Botanical Resources

3.4.1 Baseline Study of Terrestrial Wildlife and Botanical Resources

General Description of Proposed Study

In its PAD, FirstLight proposed to conduct a study to obtain baseline information on terrestrial wildlife and botanical resources in the Turners Falls Impoundment, the Bypass Reach, and below Cabot Station within the Project Boundary. The Town of Montague, MA requested that FirstLight complete a wildlife habitat assessment of the Turners Falls Bypass.

Note that terrestrial resources around the Northfield Mountain Project are being studied, as described in Study No. 3.4.2.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to characterize and describe the terrestrial wildlife and botanical resources that use representative upland habitats within and adjacent to the Project Boundary. Specific objectives are:

- Survey and inventory overall existing upland wildlife habitats;
- Note the occurrence of wildlife sighting during the course of the surveys;
- Survey and inventory vegetation cover classes and land use;
- Survey and evaluate the presence of targeted RTE species or associated habitats; and
- Survey and inventory the nature and extent of upland invasive and exotic vegetation species.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

This study plan will provide baseline information to agencies with jurisdiction over wildlife and botanical resources allowing them to address potential Project effects. Resource management goals relevant to terrestrial wildlife and botanical resources studies are described below.

Terrestrial wildlife resources are administered by the USFWS. The mission of the USFWS is to "conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people." In doing so, USFWS enforces wildlife laws, protects endangered species, manages migratory birds, and helps to restore important fisheries. They administer the ESA, designed to protect imperiled species from going extinct.

The conservation and protection of species state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) is an important objective of the Natural Heritage & Endangered Species Program (NHESP) of the MADFW. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), as well as the rare wildlife species provisions and protection of wetlands and aquatic habitats of the Massachusetts Wetlands Protection Act (WPA) (310 CMR 10.59). The MADFW's resource goals and regulatory requirements are to:

- Ensure that protection mitigation and enhancement measures are commensurate with Project effects and meet MESA and the WPA requirements for the Project.
- Conserve, protect, and enhance habitats for state-listed species that will be affected by Project operations.

Massachusetts Invasive Plant Advisory Group (MIPAG) maintains a list of invasive plant species in Massachusetts and provides criteria used in evaluating species. The NHESP management goal is to promote the conservation and protection of species that are not hunted, fished, trapped or commercially harvested in Massachusetts. The NHESP highest priority is protecting the state listed RTE species. The overall goal of the program is the protection of the state's wide range of native biological diversity.

The conservation goals of the VDFW are to:

- Maintain or increase populations of rare, threatened and endangered species in the area of interests;

- Maintain, restore, provide long-term stewardship of, or conserve habitats and natural communities that support rare, threatened and endangered species.

NHFG primary management goals relative to terrestrial and wildlife resources are to restore and maintain critical habitats and populations of the state's species of conservation and management concern.

<u>Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))</u>

The PAD provides a list of plant and wildlife species, as well as dominant vegetative communities in the Project area, but does not provide any site-specific information on the known occurrences of species within the upland habitats of the Project. Additional site-specific data are needed to meet the goal of evaluating Project effects. Studies will supplement existing information regarding vegetation mapping, invasive plants, and presence of RTE species or associated habitat.

In preparation of the PAD, Federal and state agencies were contacted regarding the potential presence of RTE species and critical habitats within the Turners Falls Project and Northfield Mountain Project boundaries and included the USFWS, NMFS, Massachusetts NHESP, VTFWD, and NHFGD. The consultation resulted in the identification of three federally-listed threatened and/or endangered species (Section 4.7.1 of the PAD), 39 state-listed threatened and/or endangered species (Section 4.7.2 of the PAD), 21 state-listed species of special concern (Section 4.7.3 of the PAD) and designated critical habitat (Sections 4.7.4) that are likely or known to occur within the Project Boundary and are detailed in Section 4.7 of the PAD.

Agency consultation revealed no federally designated critical habitat areas within the Turners Falls Project and Northfield Mountain Project areas; however, the Project areas maybe located within or on a portion of State designated Natural Areas classified as priority habitats and/or estimated habitats. Detailed information regarding habitat preferences and life histories of these species can be found in Section 4.7 of the PAD.

<u>Project Nexus (18 CFR § 5.11(d)(4))</u>

The Turners Falls Project and Northfield Mountain Project provide habitat for a variety of wildlife and botanical species. Water levels fluctuations have the potential to affect habitat for a variety of life stages of terrestrial species. An understanding of the terrestrial resources in the project area would provide information on the type and quantity of habitat potentially affected by Project operations.

<u>Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))</u>

A field survey will be conducted within the uplands adjacent to the shoreline of the Turners Falls Impoundment, the Bypass Reach, and below Cabot Station to the Route 116 Bridge in Sunderland to document the type and distribution of terrestrial wildlife habitats, including vegetation communities and plant species, present in the project area. A field survey of wildlife species will be conducted concurrently with other botanical and wetland studies (Study No. 3.5.1).

The geographic area for this study includes the following:

- Upland areas along the Turners Falls Impoundment, including areas within the Project Boundary and areas up to 200 feet from shore where the Project Boundary is along the shoreline;
- Upland areas adjacent to the Bypass Reach;
- The approximate 13+ miles of shoreline and riparian habitat below the Turners Falls Dam to the Rte. 116 Bridge in Sunderland. Riparian areas will be surveyed up to the top of bank in this segment of the study area.

Surveys will be conducted by biologists visually assessing habitats along and above the shoreline from boat and/or walking on FirstLight and public lands during the growing season when vegetation is most conspicuous and readily identifiable. FirstLight will seek permission from adjacent land owners to gain access to privately owned lands that are within the survey area. The presence of any RTE species or habitats will also be noted. Observations of RTE species documented in the Project area will be processed in accordance with applicable State and Federal procedures and all data and records will be available immediately to appropriate organizations (USFWS, MADFW).

Task 1: Literature Review

The initial step prior to the field reconnaissance surveys will include reviewing existing information and data to identify areas of representative communities and potentially suitable habitat for protected species of interest. Using GIS and other available sources of information, a preliminary base map will be produced to assist field surveys. To refine the vegetation and habitat mapping for the study area, the following tasks will be performed:

- Acquire and compile existing GIS vegetation cover type layers from available resources;
- Examine any visible vegetation boundaries in aerial photos or other imagery to fix or update type polygon boundaries, based on field observations;
- Produce a final vegetation type map that displays vegetation type polygon boundaries, the study area, and specific Project components; and
- Use the vegetation type map to produce a table of vegetation types and calculate the percent acres of each vegetation type present in the study area, in areas potentially affected by the Project, and indirectly affected key wildlife habitats.

Task 2: Field Surveys

Field surveys will be conducted to document wildlife habitat and occurrence, vegetative cover types and invasive plant species in the Project area, as described below.

Wildlife and Habitat Type Mapping

The primary objective of wildlife surveys for the Project is to provide information on the distribution and abundance of terrestrial wildlife habitats. General habitat field notes will record dominant vegetation cover classes and land use; habitat types; observations of avian, reptile, amphibian, and mammal species; and locations of upland invasive plant species. Wildlife surveys will be conducted through the use of visual encounter surveys concurrent with the habitat type verification mapping. Pre-survey FirstLight will consult with Agencies to identify known habitats for state-listed species as to ensure that known populations are adequately surveyed and assessed.

Transect lines will be placed randomly or at least objectively with respect to representative habitats present within the study area. The total number of transects and placement will be determined after an initial site reconnaissance and completion of the preliminary GIS base mapping. One transect will be completed for each representative habitat type. The observer will walk a transect at a pace of approximately five minutes per 50 meters, for a total search time of up to approximately two hours. The transect width will be line-of-sight. During these transect searches, an observer will survey the area to either side of the transect, looking for targeted species or indirect signs (i.e., tracks, scat, den areas, nests, etc.) To account for the seasonal variability of wildlife and varying flowering periods when plants are most readily identifiable, for each habitat transect a pre-survey review of fauna and flora likely to occur in each specific habitat identified by the GIS base mapping phase of the study, will research life-histories and plant phenology for identifying survey windows in the season when transect observations should be completed to optimize the likelihood of noting occurrences. The survey period will be from March 2014 through August 2014 and each transect will be surveyed only once, however, qualitative data from other similar surveys efforts will also be noted and included in the overall wildlife census list.

No unique natural communities have been documented by the NHESP within the Turners Falls Project and Northfield Mountain Project area. Unique natural areas are habitats that support or may support, state listed species that are identified by the NHESP as priority habitats. NHESP maintains mappings of these identified areas in the Massachusetts Natural Heritage Atlas 13th Edition.

The NHESP tracks examples of communities that are state ranked (SRank) to reflect a habitat community's rarity and threat within the region and in Massachusetts. A NHESP review of the project resulted in no site specific examples of known natural communities that demonstrate regional rarity and are threatened. Generally, preliminary review of the natural communities were identified as being located in the Turners Falls Project and Northfield Mountain Project area had a SRank value of S4 and S5, which are defined and categorized by NHESP as apparently (S4) to demonstrably (S5) secure in Massachusetts. In addition, a review of the USFWS Environmental Conservation Online System database lists no federally designated critical habitat areas in the Turners Falls Project and Northfield Mountain Project area.

While completing field surveys, if a priority habitat is located or a natural community is noted as having a state ranking of S3, S2, or S1 (Community types that are range from vulnerable S3, imperiled S2 or critically imperiled S1, due to rarity /vulnerability to extirpation) or natural areas where observed federal or state listed species occur, more intensive searches will be performed. Other supplemental techniques, such as broadcast or listening surveys will be used to improve the odds of detecting some more elusive avian and amphibian species. The locations of significant sightings or observations (i.e. bald eagle, or peregrine falcon nests) will be documented through the use of GPS and geo-referenced photographs and then entered into the GIS data base. Data collected will be compiled into a Project area species list.

Bald eagles have been documented nesting on Barton Island in Barton Cove, approximately five miles downstream of the Northfield Mountain Project and slightly upstream of the Turners Falls Dam. Bald eagles also nest on Kidds Island in the impoundment, and are known to perch in riverbank trees and forage over the Connecticut River in the Project Area. During the surveys, field biologists will document the occurrence of any bald eagle nesting and roosting sites and provide an assessment of the status (healthy, diseased, etc.) and level of protection (e.g., within a right-of-way, on protected conservation land) of each site. In addition, the above known areas will be surveyed to confirm the presence or absence of any nesting sites or direct observations of bald eagles. Where encountered, bald eagle nests and roosting trees will be GPS located and photo-documented.

Vegetation Cover Type Mapping

The overall design of the vegetative mapping is to identify all vascular botanical species within the Study Area while focusing on targeted listed species and other RTE plant species as identified during consultation with the NHESP. Botanical assessments will be completed to determine the species composition, structure, and distribution of vegetative communities. The types of data that will be collected within habitat types include percent cover and dominant species within the herbaceous, shrub, and tree stratums, along with the general distribution and juxtaposition of vegetative communities.

Timed-meander surveys will be conducted in representative habitat types encountered within the Study Area. The meander survey will involve walking a wandering path through each habitat and recording species present until a period of time (typically for approximately ten minutes) passes where no new species are added to the vegetation list. Surveyors will compile a list of all plants found within each respective habitat, and will also maintain an overall census list of all plant species identified within the Project Area. Plants will be identified to the species level if possible, or at a minimum, if the plant is outside its phenological peak, the plant will be identified to the genus level if species identification is not possible. If positive identification cannot be completed in the FGS, a voucher sample may be collected, pressed, and preserved for further identification when appropriate.

Prior to the 2014 field survey, biologists will obtain the necessary collecting permit for any voucher samples that may need to be collected from the State Botanist at the Massachusetts NHESP. Biologists will also coordinate with VDFW and NHFG RTE programs if similar collection permits are required for voucher samples prior to any field studies. Other general information that will be gathered during meander surveys will include general health of communities and site quality conditions. Vegetation communities will be classified using the NHESP Classification of the Natural Communities of Massachusetts (Swain & Kersey, 2011).

Sample vegetation plots will also be established in each representative habitat type to collect quantitative information to characterize the different habitats and provide species composition of habitat types. Vegetation plot locations will be selected using NHESP guidelines and protocols. A NHESP Quantitative Community Characterization Form (NHESP Form 3) will be completed for representative habitats to document the results of each plot location. Geo-referenced photographs will also be taken to document site conditions at the time of the survey.

Invasive Plant Survey

The MIPAG maintains a list of 34 noted invasive plant species occurring in Massachusetts and provides criteria used in evaluating species. Invasive plants as defined by the MIPAG are non-native species that have spread into native or minimally managed plant systems in Massachusetts. These plants cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems. Of the 34 plants listed by the MIPAG, a total of 24 invasive species have been identified as having the potential to occur in the Study Area. Invasive plants identified by the MIPAG not included in this study were omitted based on regional occurrence (i.e., occur in coastal areas) or occur in aquatic habitats, which are addressed as part of Study No. 3.5.1. A list of upland invasive plant species with the potential to occur in the Study Area is provided in Table 3.4.1-1.

Table 3.4.1-1: Upland Invasive Plant Species.

Scientific Name	Common Name	Lifeform Type	Notes
Acer platanoides	Norway maple	Tree	Common in woodlands with colluvial soils, grows full sun to full shade dispersed by water, wind and vehicles
Aegopodium podagraria	Bishop's weed	Perennial Herb	Occurs both in uplands and wetlands. Grows in full sun to full shade, spreads aggressively by roots; forms dense colonies in flood plains
Ailanthus altissima	Tree of heaven	Tree	Occurs in uplands, wetlands, grows in full sun to shade. Spreads from root suckers, especially in disturbed areas
Alliaria petiolata	Garlic mustard	Biennial Herb	Widespread, grows full sun to full shade, spreads by seed, especially in wooded areas
Berberis thunbergii	Japanese barberry	Shrub	Wooded uplands and wetlands, grows in full sun to full shade, spread by birds, forms dense stands
Celastrus orbiculatus	Oriental bittersweet	Perennial vine	Grows in full sun to partial shade, berries spread by birds and humans
Cynanchum louiseae	Black swallow-wort	Perennial vine	Grows in full sun to partial shade, forms dense stands, deadly to Monarch butterflies
Elaeagnus umbellata	Autumn olive	Shrub	Grows in full sun, berries spread by birds, aggressive in open areas
Euphorbia esula	Leafy spurge	Perennial herb	Occurs in grasslands
Frangula alnus	Glossy buckthorn	Shrub -Tree	Occurs in uplands and wetlands, grows in full sun to full shade, forms thickets
Hesperis matronalis	Dame's rocket	Perennial herb	Occurs in uplands and wetlands, grows in full sun to full shade, spreads by seed, can form dense stands in flood plains
Lonicera japonica	Japanese honeysuckle	Perennial vine	Widespread, grows full sun to full shade, climbs vegetation, seeds dispersed by birds
Lonicera morrowii	Morrow's honeysuckle	Shrub	Widespread, grows full sun to full shade, dispersed by birds, can hybridize with other honeysuckle species
Lonicera x bella	Bell's honeysuckle	Shrub	Widespread, grows full sun to full shade, dispersed by birds, can hybridize with other honeysuckle species
Polygonum cuspidatum	Japanese knotweed	Perennial Herb-subshrub	Widespread, grows in full sun to full shade, spreads vegetatively and by seed, forms dense thickets
Lysimachia nummularia	Creeping jenny	Perennial herb	Occurs in uplands and wetlands, grows in full sun to full shade, forms dense mats
Lythrum salicaria	Purple loosestrife	Perennial herb	Occurs in uplands and wetlands, grows in full sun to partial shade, high seed production, overtakes wetlands
Phalaris arundinacea	Reed canary grass	Perennial grass	Occurs in uplands and wetlands, grows full sun to partial shade, can form large colonies, common in agricultural settings
Phragmities australis	Common reed	Perennial grass	Grows in uplands and wetlands, full sun to full shade, forms dense stands, flourishes in disturbed areas

Scientific Name	Common Name	Lifeform Type	Notes
Polygonum perfoliatum	Mile-a-minute	Annual vine	Found along fields and road edges in full sun to partial shade, bird and human dispersed
Ranunculus ficaria	Lesser celandine	Perennial herb	Occurs in lowland and upland woods, grows in full sun to full shade, spreads vegetatively and by seed, forms dense stands
Rhamnus cathartica	Common buckthorn	Shrub-tree	Occurs in uplands and wetlands, grows in full sun to full shade.
Robinia pseudoacacia	Black locust	Tree	Occurs in uplands, grows full sun to full shade, aggressive in areas with sandy soils
Rosa multiflora	Multiflora rose	Shrub	Widespread, grows in full sun to full shade, forms thorny thickets, dispersed by birds.

The MIPAG list of invasive plant species provided in Table 3.4.1-1 will be utilized to identify upland invasive species when conducting botanical meander surveys. Surveyors will use methods adapted from the USFS Invasive Species Program, Invasive Species Inventory and Mapping Data Recording Protocols. These adapted methods focus on presence, location, extent, abundance and other site characteristics to provide site infestation information.

The intent of the upland invasive species survey is to document infested areas. Biologists will use GPS at sub-foot accuracy to delineate the boundary of the infestation as defined by the dominant canopy cover of the invasive plant. Lesser areas containing only occasional invasive species will be characterized with a GPS center point and radius necessary to enclose the population will be used. For areas where invasive species are ubiquitous or impractical to map, surveyors will characterize the invasive species population using estimates of aerial coverage and percent of species present. For areas where dense stands of upland invasive species have formed, infestations will be photo-documented and geo-referenced, and an Invasive Species Documentation Form will be completed.

Task 3: Data Analysis and Reporting

A draft and final technical report will be prepared for this study. The report will include methods and results for field surveys: wildlife and habitat mapping, vegetative cover type mapping, and invasive plant surveys. The results of this study will provide both quantitative and qualitative information that will be important in defining and inventorying existing conditions, as well as providing any information on potential project impacts. The report will provide maps of the project area showing locations and extent of habitats, vegetative cover, locations of invasive species, and known eagle roosting and nesting trees. Information will be provided in tabular formats and portrayed on maps as both polygons and point locations, as appropriate.

The report will contain all supporting correspondence among licensing participants.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

This study would likely take one study season to complete. The estimated budget for the study ranges from approximately $60,000 to $80,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

This study will be conducted as follows:

- January – March 2014: Reviewing existing information and data
- March - August 2014: Conduct field reconnaissance surveys
- Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1. The Initial Study Report is due in September 2014. If field efforts run later into the summer such that a complete report cannot be submitted by this date, FirstLight will provide Stakeholders with a study report supplement.

Literature Cited

Swain, P.C., & Kersey, J.B. (2011). Classification of the Natural Communities of Massachusetts: Draft. Retrieved from http://www.mass.gov/dfwele/dfw/nhesp/natural_communities/natural_community_classification.htm. Accessed August 23, 2011.

3.4.2 Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitats

General Description of Proposed Study

FERC requested FirstLight to complete a study to provide baseline information on wildlife and botanical habitats occurring in the Northfield Mountain Project area, and study the effects of Northfield Mountain Project-related land management practices and recreation use on terrestrial habitats.

FirstLight is proposing a study to collect baseline information, which will inform an assessment of Project-related land management practices and recreational use impacts on terrestrial resources on Project lands at the Northfield Mountain Project.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of this study is to gather information necessary to understand the potential effects of land management practices and recreational use on wildlife and botanical resources within the Northfield Mountain Project area. The objectives of this study are to provide supporting information which will provide the basis for an assessment of the potential resource impacts of the Project that were identified during development of the PAD and FERC scoping for the License Application, as follows:

- Identify and describe FirstLight's Project-related land management practices (including the maintenance of Project-related recreation areas) occurring in the Northfield Mountain Project Boundary;
- Provide information pertinent to describe existing wildlife and botanical habitats occurring in the Northfield Mountain Project area;
- Determine if Project-related land management and maintenance practices and the use of Project-related recreation areas has the potential to facilitate the growth and spread of invasive plant species; and
- Provide information to identify if Project-related land management and maintenance practices and the use of Project-related recreation areas may affect existing wildlife and botanical resources (e.g., clearing of vegetation, erosion from recreational activities).

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

This study plan will provide baseline information to agencies with jurisdiction over wildlife and botanical resources allowing them to address potential Project-related effects. The Connecticut River watershed supports a diverse assemblage of plant and wildlife communities that provide various public opportunities, such as bird watching, hiking, and hunting. Consideration of the effects of Project operations, maintenance, land management, and recreational use on these resources is relevant to the Commission's public interest determination.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

The PAD provides baseline information pertaining to the effects of project operation, maintenance, land management, and recreation use on wildlife and botanical habitats and the location of invasive plant species within the Northfield Mountain Project area. FirstLight is proposing to conduct wildlife and botanical studies for the Turners Falls Project as outlined in Study No. 3.4.1 and Study No. 3.5.1; however, those studies only address the Turners Falls Impoundment (lower reservoir for the Northfield Mountain Project) and downstream areas with a focus on assessing Project operations primarily associated with water level fluctuations. Additional information on the location and abundance of invasive plant species and the impacts on wildlife and botanical resources as a result of project-related maintenance and land management practices in the Northfield Mountain Project area are needed to evaluate the Project's full effects on wildlife and botanical resources.

In 2006, FirstLight, formerly operating under the NE Hydro Generating Company name, contracted Tighe & Bond, Inc. to complete a botanical survey on Project lands where land management and recreational activities occurred. The areas surveyed included Bennett Meadow Wildlife Management Area, Barton Cove Campground and a Picnic Area on the Turners Falls Impoundment. The summary report describes the survey efforts that focused on the lower impoundment, which provides insight as to which species are within those areas surveyed and what could potentially be at other sites within the Northfield Mountain Project Boundary. In the MADFW review letter dated April 25, 2007 from the MADFW to Tighe & Bond (NHESP Tracking Number: 06-19884), the MADFW indicated that the Northfield Mountain Recreational Trails are not located within Priority Habitat or Estimated Habitat and concluded that existing uses of the recreational facilities described in the Operation and Maintenance Plan would not require review under the MESA; however, select activities which are regulated by FERC licenses may require review by NHESP during the FERC review process.

FirstLight conducted a recreational facilities inventory at the Turners Falls Project and Northfield Mountain Project during two field visits in October 2011 and July 2012 (see Study No. 3.6.2). The purpose of the inventory was to identify the current formal recreational facilities associated with the Projects. This information was needed to prepare the recreation sections of the PAD. TRC developed a report (2012) of these facilities providing a summary of each formal recreational facility that was inventoried. This report will be used as baseline information as to what types of recreational use could potentially affect wildlife and botanical habitats at the Northfield Mountain Project.

Project Nexus (18 CFR § 5.11(d)(4))

The Northfield Mountain Project provides habitat for a variety of wildlife and botanical species. An understanding of the terrestrial resources in the Project area would provide information on the type and quantity and quality of habitat potentially affected by Project-related land management and maintenance practices and the use of recreational areas.

The Northfield Mountain Project has many recreational features (e.g., a trail system with over 26 miles of trails, observation area, picnic areas) that are inherently attractive. Public recreation sites can affect wildlife behavior (both attracting and displacing) and impact botanical resources (e.g., trampling of vegetation, erosion along trails and spreading invasive species). An analysis of the effects of the maintenance, land management practices, and use of these recreational features on wildlife and botanical resources would help form the basis for determining the Project's effect on these resources.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

For the purposes of this study, the Northfield Mountain Project area includes the lands around Project facilities (e.g., lands around the upper reservoir, parking areas, access roads) and recreational areas (e.g., picnic areas, trails, and hiking areas) on Northfield Mountain.

A field survey of wildlife and botanical species will be conducted concurrently with other field surveys where applicable. Wildlife and botanical resource assessments will be conducted on the terrestrial, wetland, riparian, and littoral areas of the Turners Falls Impoundment, bypass and downstream areas as described in Study No. 3.4.1 and Study No. 3.5.1, which include Project recreation facilities within the

Project Boundary such as Barton Cove campground and Bennett Meadow. Surveys will be conducted by biologists during the 2014 growing season.

Task 1: Literature Review

A pre-survey review of existing information and data will be completed to identify areas of representative communities, land use classes, recreational areas and trails, invasive species and potentially suitable habitat for protected species of interest as identified in Section 4.7 of the PAD. Using GIS and other available sources of information, a preliminary field map will be produced to assist field surveys.

Prior to field investigations, researchers and biologists will review and screen the practices and locations of FirstLight Project-related land use management activities (e.g., areas routinely mowed, vegetation management areas, access roads), and recreational uses (e.g., trails, climbing areas, camping, skiing) at the Northfield Mountain Project.

Task 2: Wildlife and Habitat Type Mapping

The primary objective of wildlife surveys for the Northfield Mountain Project is to provide a general census and information on the distribution and abundance of wildlife habitats. General habitat field notes will record dominate vegetation cover classes; unique or unusual habitat types; and observations of avian, reptile, amphibian, and mammal species. Wildlife surveys will be conducted through the use of visual encounter surveys along transects.

Transect lines will be placed randomly or at least objectively with respect to representative habitats, including representative Project-affected habitats (i.e., areas of vegetation management, recreational use areas). Transects will include non-impacted areas and impacted areas for comparison. The total number of transects will be determined after an initial site reconnaissance in early spring. The observer will walk a transect at a pace of approximately five minutes per 50 meters, for a total search time of up to approximately two hours. The transect width will generally be line-of-sight. During transect searches, an observer will survey the area to either side of the transect, looking for targeted species or indirect signs (i.e., tracks, scat, den areas, nests, etc.).

To account for the seasonal variability of wildlife and varying flowering periods when plants are most readily identifiable, for each habitat transect a pre-survey review of fauna and flora likely occurring in each specific habitat identified during the GIS base mapping phase of the study, FirstLight will research life-histories and plant phenology for identifying survey windows in the season when transect observations should be completed to optimize the likelihood of noting occurrences. The survey period will start in March 2014 and extend to the end of August 2014. Transects will be surveyed only once per season, however, qualitative data from other similar surveys efforts will also be noted and included in a overall wildlife census list.

The NHESP tracks examples of priority habitats and types of natural communities that are state ranked (SRank) to reflect the community's rarity and threat within the region and in Massachusetts. Generally, preliminary review of the natural communities were identified as being located in the Turners Falls Project and Northfield Mountain Project area had a SRank value of S4 and S5, which are defined and categorized by NHESP as apparently (S4) to demonstrably (S5) secure in Massachusetts. No priority habitats or rare natural communities have been documented by NHESP within the Turners Falls Project and Northfield Mountain Project area. In addition, a review of the USFWS Environmental Conservation Online System database lists no federally designated critical habitat areas in the Turners Falls Project and Northfield Mountain Project area.

While completing field surveys if a priority habitat is located or a natural community noted as having a state ranking of S3, S2, or S1 (community types that are range from vulnerable, imperiled or critically imperiled, due to rarity /vulnerability to extirpation), or natural areas where observed federal or state listed species occur more intensive searches will be performed. Other supplemental techniques, such as broadcast or listening surveys will be used to improve the odds of detecting some more elusive avian and amphibian species. Field studies will be conducted on a seasonal basis in order to record species when they are most conspicuous. The locations of significant sightings or observations will be documented through the use of GPS and geo-referenced photographs and then entered into a GIS data base. Data collected will be compiled into a Project area species list.

Task 3: Vegetation Cover Type Mapping

Botanical assessments will be completed to determine the species composition, structure, and distribution of vegetative communities. The types of data that will be collected include percent cover and dominate species within the herbaceous, shrub, and tree stratums along with the general distribution and juxtaposition of vegetative communities. Timed-meander surveys will involve walking a wandering path through each representative habitat type and recording species present until a period of time (usually 10 minutes) passes where no new species were added to the vegetation list. Surveyors will compile a list of all plants found within each respective habitat, and will maintain a list of all plant species identified within the Project Area. An overall plant census list will be provided in tabular format in the final study report.

Plants will be identified to the species level if possible, or at a minimum, if the plant is outside its phenological peak, the plant will be identified to the genus level if species identification is not possible. If positive identification cannot be completed in the FGS, voucher samples can be collected, pressed, and preserved for further identification when appropriate. Prior to the 2014 field survey, biologists will obtain the necessary collecting permit for any voucher samples that may need to be collected from the State Botanist at the Massachusetts NHESP. Other general information that will be gathered during meander surveys will include general health of communities, evidence of erosion, and site quality conditions. Vegetation communities will be classified using NHESP Classification of the Natural Communities of Massachusetts (Swain & Kersey, 2011).

Palustrine habitats will be field-verified using the NWI as a base map. These areas will not be formally delineated, but will be further defined from the existing NWI maps and if applicable expanded to add a better level of detail to the wetlands extent. When observed Non-NWI mapped wetlands will also be located using methods outlined in the ACOE Wetland Delineation Manual and the Regional Supplement to the *Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region* (USACE, 1987; USACE, 2012).

Sample vegetation plots within representative habitat types will also be established to collect quantitative information to characterize the different habitats and provide species composition of habitat types. Vegetation plot locations will be selected using NHESP guidelines and protocols. Sample vegetation plots will be completed for representative areas of Project-related vegetation management and recreational areas. These plots will be used to compare natural undisturbed habitats at the Projects to Project-affected habitats. A NHESP Quantitative Community Characterization Form (NHESP Form 3) will be completed for representative habitats to document the results of each plot location. Geo-referenced photographs will also be taken to document site conditions at the time of the survey.

To refine the vegetation type map for the study area, the following tasks will be performed:

- Acquire and compile existing GIS vegetation cover type, land use, and recreational layers from available resources;
- Examine any visible vegetation boundaries in aerial photos or other imagery to fix or update type polygon boundaries, based on field observations;
- Produce a final vegetation type map that displays vegetation type polygon boundaries, the study area, and specific Project components; and
- Use the vegetation type map to produce a table of vegetation types and calculate the percent acres of each vegetation type present in the study area in general, in areas potentially affected by the Project, and indirectly affected key wildlife habitats.

Task 4: Invasive Plant Survey

The MIPAG maintains a list of 34 noted invasive plant species occurring in Massachusetts and provides criteria used in evaluating species. Invasive plants as defined by the MIPAG are non-native species that have spread into native or minimally managed plant systems in Massachusetts. These plants cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems. Of the 34 plants listed by the MIPAG, a total of 24 invasive species have been identified as having the potential to occur in the Study Area. Invasive plants identified by the MIPAG not included in this study were omitted based on regional occurrence (i.e., occur in coastal areas) or occur in aquatic habitats, which are addressed as part of Study No. 3.5.1. A list of upland invasive plant species with potential to occur in the Study Area are provided in Table 3.4.2-1.

Table 3.4.2-1: Upland Invasive Plant Species.

Scientific Name	Common Name	Lifeform Type	Notes
Acer platanoides	Norway maple	Tree	Common in woodlands with colluvial soils, grows full sun to full shade dispersed by water, wind and vehicles
Aegopodium podagraria	Bishop's weed	Perennial Herb	Occurs both in uplands and wetlands. Grows in full sun to full shade, spreads aggressively by roots; forms dense colonies in flood plains
Ailanthus altissima	Tree of heaven	Tree	Occurs in uplands, wetlands, grows in full sun to shade. Spreads from root suckers, especially in disturbed areas
Alliaria petiolata	Garlic mustard	Biennial Herb	Widespread, grows full sun to full shade, spreads by seed, especially in wooded areas
Berberis thunbergii	Japanese barberry	Shrub	Wooded uplands and wetlands, grows in full sun to full shade, spread by birds, forms dense stands
Celastrus orbiculatus	Oriental bittersweet	Perennial vine	Grows in full sun to partial shade, berries spread by birds and humans
Cynanchum louiseae	Black swallow-wort	Perennial vine	Grows in full sun to partial shade, forms dense stands, deadly to Monarch butterflies
Elaeagnus umbellata	Autumn olive	Shrub	Grows in full sun, berries spread by birds, aggressive in open areas
Euphorbia esula	Leafy spurge	Perennial herb	Occurs in grasslands
Frangula alnus	Glossy buckthorn	Shrub -Tree	Occurs in uplands and wetlands, grows in full sun to full shade, forms thickets
Hesperis matronalis	Dame's rocket	Perennial herb	Occurs in uplands and wetlands, grows in full sun to full shade, spreads by seed, can

Scientific Name	Common Name	Lifeform Type	Notes
			form dense stands in flood plains
Lonicera japonica	Japanese honeysuckle	Perennial vine	Widespread, grows full sun to full shade, climbs vegetation, seeds dispersed by birds
Lonicera morrowii	Morrow's honeysuckle	Shrub	Widespread, grows full sun to full shade, dispersed by birds, can hybridize with other honeysuckle species
Lonicera x bella	Bell's honeysuckle	Shrub	Widespread, grows full sun to full shade, dispersed by birds, can hybridize with other honeysuckle species
Polygonum cuspidatum	Japanese knotweed	Perennial Herb-Shrub	Widespread, grows in full sun to full shade, spreads vegetatively and by seed, forms dense thickets
Lysimachia nummularia	Creeping jenny	Perennial herb	Occurs in uplands and wetlands, grows in full sun to full shade, forms dense mats
Lythrum salicaria	Purple loosestrife	Perennial herb	Occurs in uplands and wetlands, grows in full sun to partial shade, high seed production, overtakes wetlands
Phalaris arundinacea	Reed canary grass	Perennial grass	Occurs in uplands and wetlands, grows full sun to partial shade, can form large colonies, common in agricultural settings
Phragmities australis	Common reed	Perennial grass	Grows in uplands and wetlands, full sun to full shade, forms dense stands, flourishes in disturbed areas
Polygonum perfoliatum	Mile-a-minute	Annual vine	Found along fields and road edges in full sun to partial shade, bird and human dispersed
Ranunculus ficaria	Lesser celandine	Perennial herb	Occurs in lowland and upland woods, grows in full sun to full shade, spreads vegetatively and by seed, forms dense stands
Rhamnus cathartica	Common buckthorn	Shrub-tree	Occurs in uplands and wetlands, grows in full sun to full shade.
Robinia pseudoacacia	Black locust	Tree	Occurs in uplands, grows full sun to full shade, aggressive in areas with sandy soils
Rosa multiflora	Multiflora rose	Shrub	Widespread, grows in full sun to full shade, forms thorny thickets, dispersed by birds.

The MIPAG species list of invasive plants will be utilized to identify targeted invasive species when conducting botanical meander surveys. Surveyors will use methods adapted from the NHESP and the United States Forest Service (USFS) Invasive Species Program, Invasive Species Inventory and Mapping Data Recording Protocols (USFWS, 2010). These adapted methods focus on presence, location, extent, abundance and other site characteristics to provide site infestation information. As land disturbances following Project maintenance activities may favor establishment of invasive plants over native plant communities, survey efforts for invasive species will be focused on disturbed lands, areas of vegetation management, access roads and recreational trails which can be vectors for invasive species propagation.

To document an infested area, biologists will use a GPS at sub-foot accuracy to delineate the boundary of the infestation as defined by the dominant canopy cover of the invasive plant. Areas containing only occasional invasive species will be characterized with a GPS center point and radius necessary to enclose the population. For areas where invasive species are ubiquitous or impractical to map, surveyors will characterize the invasive species population using estimates of aerial coverage and percent of species present within a defined polygon. Sampling areas containing invasive botanical species will be photo-documented and geo-referenced, and an Invasive Species Documentation Form will be completed.

Task 5: Land Management Practices and Recreation Uses

FirstLight will provide information to identify Project-related land management and maintenance practices and the usage of Project-related recreation areas. Annual maintenance activities are typically conducted during the growing season every year and may include vegetation management, erosion control, road maintenance, and other general project maintenance. Recreational use information of the Northfield Mountain study area will be gathered as part of the study plans under Section 3.6 Recreation and Land Use. This information will be analyzed with results from the wildlife and botanical field surveys at the Northfield Mountain Project to identify the relationship between Project facilities, recreational uses and wildlife and botanical resources and identify practices to avoid or minimize impacts.

Task 6: Data Analysis and Reporting

A draft and final technical report will be prepared for this study. The results of this study will provide both quantitative and qualitative information that will be important in defining existing conditions, as well as providing any information on potential project impacts as they relate to preparation of the License Application. The report will include maps of locations of invasive species, habitat types, listed species observations, and recreational uses. Field data collected will be provided in tabular format (e.g., invasive species listing the infestation, species composition, and estimated size of infestation.) The report will contain all supporting correspondence among licensing participants. The draft report will be revised to address final comments by licensing participants.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

This study would likely take one study season to complete. The estimated budget for the study ranges from approximately $40,000 to $60,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

This study will be conducted as follows:

- January – March 2014: Reviewing existing information and data
- March - August 2014: Conduct field reconnaissance surveys
- Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1. The Initial Study Report is due in September 2014. If field efforts run later into the summer such that a complete report cannot be submitted by this date, FirstLight will provide Stakeholders with a study report supplement.

Literature Cited

Swain, P.C., & Kersey, J.B. (2011). Classification of the Natural Communities of Massachusetts: Draft. Retrieved from http://www.mass.gov/dfwele/dfw/nhesp/natural_communities/natural_community_classification.htm. Accessed August 23, 2011.

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3.5 Wetlands, Riparian, and Littoral Habitat

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

General Description of Proposed Study

This study contains multiple elements. In addition to conducting an inventory of wetlands, riparian and littoral zone resources in the Turners Falls Impoundment, the methods in this study contain provisions for assessing Project impacts on state-listed plant species in the Turners Falls Impoundment as well as downstream of Cabot Station, and assessing Project impacts on state-listed invertebrate species that utilize riparian areas downstream of Cabot Station.

Several stakeholder groups submitted a request to FirstLight to study impacts of water level fluctuations due to operations at the Turners Falls and Northfield Mountain Pump Storage Project on riparian, wetland and littoral zone resources in the Turners Falls Impoundment. The USFWS, Town of Gill, LCCLC, FRCOG, CRWC, VANR, NHFG, NHDES, and TNC study requests were similar and requested that the applicant complete studies to obtain baseline information on riparian, wetland, littoral zone, and shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the Project area. Information would be used to determine whether riparian, wetland, submerged aquatic vegetation (SAV) and emergent aquatic vegetation (EAV), littoral, and shallow water (e.g., mid river bars and shoals) habitats are impacted by current water level fluctuations permitted under the license for the Turners Falls Project and Northfield Mountain Project. A baseline inventory will be conducted to map these resources and to determine if there is any unique or important shoreline or aquatic habitats in the Project area.

The MDFW also requested two additional studies related to the above requests. The first request (study request number 23) is to conduct a study to quantify the impacts of water level fluctuations and the current and proposed flow regimes on state-listed rare plant species in the Turners Falls Impoundment, and in the 13+ miles of riverine habitat below the Turners Falls Dam (to the Rt. 116 Bridge in Sunderland).

The second MDFW request (number 19) is to integrate modeled river flows and water levels with a habitat assessment for state-listed riparian invertebrate species. MDFW requested that the model should specifically assess the influence of existing and proposed Project operations on water levels at both known populations and potential habitats for the Cobblestone Tiger Beetle (*Cicindela marginipennis*), state-listed as "Endangered," and the Puritan Tiger Beetle (*Cicindela puritana*), state-listed as "Endangered" and federally-listed as "Threatened", and assess how Project operations may be modified to conserve and enhance existing populations and potential habitats.

As requested by the MDFW, this study will utilize the results of the Hydraulic Study as described in Section 3.2.2 to quantify and assess potential impacts of Project-related water level fluctuations on existing wetlands, riparian and littoral habitat resources including state-listed plant and invertebrate species.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goals of this study are to characterize and describe the wildlife and botanical resources within the Project Area and assess the potential impacts of Project-related reservoir water level fluctuations on identified resources. The specific objectives of this study are to:

- Quantitatively describe and field verify National Wetland Inventory (NWI) mapped wetland types, describe and map shallow water aquatic habitat, including submerged aquatic vegetation (SAV) and emergent aquatic vegetation (EAV), substrate type, invasive species and associated wildlife in the Turners Falls Impoundment and up to 200 feet from the Turners Falls Impoundment shoreline.
- Obtain baseline information, through field surveys, on the locations and population parameters of Massachusetts state-listed rare plant species in the Turners Falls Impoundment and the 13+ miles of riverine habitat below Cabot Station to the Rte. 116 Bridge in Sunderland.
- Analyze how the Project operations affect botanical and wildlife resources with an emphasis on how Project operations influence habitat of state-listed plant species and state-listed invertebrate species including the Cobblestone Tiger Beetle and the Puritan Tiger Beetle.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

This study will provide baseline information to agencies with jurisdiction over wetlands, riparian and littoral resources allowing them to address potential Project effects. The resource management goals identified are listed below.

Wildlife and freshwater fish resources are administered by USFWS, whose mission is to "conserve, protect and enhance and if needed mitigate fish, wildlife and plants and their habitats for the continuing benefit of the American people." In doing so, USFWS enforces wildlife laws, protects endangered species, manages migratory birds, and helps to restore important fisheries. They administer the ESA, designed to protect imperiled species from going extinct. Specific to the Turners Falls Project the Service goals are to:

- Protect, enhance, or restore diverse high quality aquatic and riparian habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
- Minimize current and potential negative Project operation effects on water quality and aquatic habitat.

The conservation and protection of species state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) is an important objective of the Natural Heritage & Endangered Species Program of the MADFW. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), as well as the rare wildlife species provisions and protection of wetlands and aquatic habitats of the Massachusetts Wetlands Protection Act (WPA) (310 CMR 10.59). The MADFW resource goals and regulatory requirements are to:

- Ensure that protection mitigation and enhancement measures are commensurate with Project effects and meet MESA and the WPA requirements for the Project.
- Conserve, protect, and enhance habitats for state-listed species that will be affected by Project operations.

Massachusetts Invasive Plant Advisory Group (MIPAG), a committee where the Massachusetts Natural Heritage Endangered Species Program (NHESP) is represented, maintains a list of invasive plant species in Massachusetts and provides criteria used in evaluating species. The NHESP management goal is to promote the conservation and protection of species that are not hunted, fished, trapped or commercially harvested in Massachusetts. The NHESP highest priority is protecting the state-listed RTE species. The overall goal of the program is the protection of the state's wide range of native biological diversity.

The VANR's resource management goals applicable to this study plan are:

- Protect, enhance, or restore, diverse high quality habitat necessary to sustain healthy aquatic and riparian plant and animal communities.
- Provide an instream flow regime that meets the life history requirements of resident fish and wildlife (including invertebrates such as freshwater mussels) throughout the area impacted by Project operations.
- Minimize the potential negative effects of project operation on water quality and aquatic habitat, and mitigate for loss or degradation.
- Conserve, enhance, and restore Vermont's natural communities, habitats, and species and the ecological processes that sustain them.
- Provide a diversity of fish- and wildlife-based activities and opportunities that allow the safe and ethical viewing, regulated harvesting, and utilization of fish, plant and wildlife resources consistent with the North American model of fish and wildlife conservation.

The New Hampshire Department of Environmental Services is primarily interested in the portion of the Turners Falls Impoundment that is in New Hampshire. NHDES is responsible for ensuring that all state surface waters meet the water quality criteria for their designated classification, including existing and designated uses, and that the chemical, physical, and biological integrity of New Hampshire's surface waters is maintained [Env- Wq 1703.01 (b)].

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

The PAD provides lists of plant and wildlife species whose native ranges overlap with the Project area, but it does not provide any site-specific information on known occurrences of these species in the wetlands, riparian, littoral and shallow water habitats, within or adjacent to, the Project area. In addition, existing information in the PAD does not quantify EAV and SAV in the Project area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the Project area.

Small areas of known invasive SAV beds are present in the Turners Falls Impoundment in the vicinity of Barton's Cove. FirstLight is currently cooperating with the USFWS on hand pulling water chestnut plants in this area. A very small colony exists on the Gill and Montague sides, located between the upstream side of the Dam and the boat barrier.

Additional site-specific data are needed to meet the goal of evaluating Project effects. Studies will supplement existing information regarding vegetation mapping, sensitive plants, invasive plants, and presence of RTE species or associated habitat.

Section 4.6 of the PAD contains information about wetland vegetation mapped in area of the Project, including NWI maps. Other available information including FEMA floodplain maps, USGS 7.5 minute quadrangles, NRCS soil surveys, and aerial photography. While this information provides baseline data for analysis, there are no known site-specific assessments or ground-mapping data of wetland habitats within the Project boundary. Additional site-specific data are needed to evaluate specific Project effects. Field studies will supplement existing information in the following areas:

1. Refine existing mapping, which will include field verifying the NWI mapping; and

2. Identify and classify existing wetlands and other "waters of the U.S." in accordance with USACE practices to define areas subject to federal regulation and policies.

In preparation of the PAD, Federal and state agencies were contacted regarding the potential presence of RTE species and critical habitats within the Turners Falls Project and Northfield Mountain Project boundaries and included the USFWS, NMFS, Massachusetts NHESP, VTFWD, and NHFGD. The consultation resulted in the identification of three federally-listed threatened and/or endangered species (Section 4.7.1 of the PAD), 39 state-listed threatened and/or endangered species (Section 4.7.2 of the PAD), 21 state-listed species of special concern (Section 4.7.3 of the PAD) and designated critical habitat (Sections 4.7.4) that are likely or known to occur within the Project boundary and are detailed in Section 4.7 of the PAD.

Agency consultation revealed no federally designated critical habitat areas within the Turners Falls Project and Northfield Mountain Project areas; however, the Project areas may be located within or on a portion of State designated Natural Areas classified as priority habitats and/or estimated habitats. Detailed information regarding habitat preferences and life histories of these species can be found in Section 4.7 of the PAD.

The MADFW commented that several surveys along this stretch of the River have shown that many state-listed plant species are dynamic local populations and often display meta-population dynamics, changing in size and location from year to year. The MADFW commented that this is particularly true for plant species inhabiting sand bars and high energy shore and cobble islands, including (but not limited to) the state-listed Wright's Spike-rush, Intermediate Spike-sedge, Ovate Spike-sedge, Frank's Lovegrass and Tufted Hairgrass. Large and/or rapid changes in water elevation and/or flow dynamics may cause adverse effects to existing and potential habitat for state-listed plant species. FirstLight is not aware of any studies that evaluate the effects of these changes in water level elevations on the life cycle of state-listed species and in particular, the germination, growth, and dispersal of species inhabiting mudflats, sand bars, and cobble islands. A list of NHESP state-listed species for the Project is provided in Table 4.7.2.5-1 in Section 4.7.2.5 of the PAD.

Additional information is needed to analyze how Project operations have or will alter hydrology in the Connecticut River from below the Vernon Hydroelectric Project downstream to the Holyoke Dam, or how operations have or may affect known wildlife and botanical resources. Of particular concern is how operations have or may affect known populations and potential habitats for state-listed invertebrate species, including the Puritan and Cobblestone Tiger Beetles.

Puritan tiger beetle and the cobblestone tiger beetle populations are limited in Massachusetts. The only known population of each species is found along the Connecticut River, with Puritan tiger beetle known from a single site at Rainbow Beach in Northampton, MA, and cobblestone tiger beetle known from a single site in Montague, MA (first observed in 2000). Detailed surveys of Puritan tiger beetle have been conducted at Rainbow Beach for adults and larvae from 1997 to the present (Davis, 2011[75]).

<u>Project Nexus (18 CFR § 5.11(d)(4))</u>

The Turners Falls Project and Northfield Mountain Project provide a variety of wetland, riparian, and littoral habitat for a range of wildlife and botanical species. Water levels fluctuations have the potential to affect these water sensitive resources. An understanding of the locations and extent of resources in the Project area would provide information on the type and quantity of wildlife, plants, and habitat potentially affected by project operations. The current operating mode, as well as the unknowns with proposed upper reservoir expansion, may affect wetland riparian, littoral and other shallow water habitats and promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that

[75] Unpublished report submitted to U.S. Fish & Wildlife Service, Turners Falls, MA.

explains the relationship between the proposed mode of operation and the type and quantity or wetland, riparian, littoral, shallow water habitats, and invasive species affected would help inform a decision on the need for protection and/or control of these resources in the License.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

A field survey will be conducted within the Turners Falls Impoundment and below Cabot Station to document the type and distribution of wildlife habitats and vegetation communities present in the Project area. The Study Area includes the following:

- Turners Falls Impoundment: survey areas within the Project boundary and areas up to 200 feet from shore where the Project boundary is along the shoreline, extending from the base of Vernon Dam to the Turners Falls Dam.

- The approximate 13+ miles of shoreline and riverine habitat below the Turners Falls Dam to the Rte. 116 Bridge in Sunderland. Riparian areas will be surveyed up to the top of bank in this segment of the study area.

Field surveys will be conducted to observe conditions at the lowest practical water level operational range permitted on a daily operation schedule, under low flow conditions. In addition, the rate and height of water level changes resulting from Project operations during the field season will be cataloged to better understand the correlation of field observations and how they relate to field conditions during survey dates.

Task 1: Literature Review

Prior to the field reconnaissance surveys, existing information and data will be reviewed to identify areas of representative communities and potentially suitable habitat for protected species of interest. Using GIS and other available sources of information, a preliminary field map will be produced to assist field surveys. Pre-survey, biologists will review life histories of wildlife and phenology of listed plants for known listed species at the Project to select field survey windows to optimize observations. Pre-survey, FirstLight will consult with MDFW to identify known habitats for state-listed species and for concurrence on survey windows and identification characteristics.

Task 2: Riparian and Littoral Zone Botanical Survey

Botanical assessments will be completed to determine the species composition, structure, and distribution of vegetative communities. The types of data that will be collected include percent cover and dominate species within the herbaceous, shrub, and tree stratums along with the general distribution and juxtaposition of vegetative communities. Botanical field inventories listed in this task will employ the concepts of timed-meander surveys, which will involve walking a wandering path through each representative habitat type and recording species present until a period of time (typically 10 minutes) passes where no new species were added to the vegetation list. SAV and EAV beds will be surveyed from a boat with use of look-down buckets to aid in identification. SAV and EAV beds will have their perimeter surveyed or will have a center point GPS with a radius offset that will encompass the entire bed.

Surveyors will compile a census list of all plants found within each respective habitat, and will maintain an overall list of all plant species identified within the Project Area. Plants will be identified to the species level if possible, at a minimum if the plant is outside its phenological peak, the plant will be identified to the genus level if species identification is not possible. If positive identification cannot be completed in the FGS, a voucher sample will be collected, pressed, and preserved for further identification when appropriate. Prior to the 2014 field survey, biologists will obtain the necessary collecting permit for any voucher samples that may need to be collected from the State Botanist at the Massachusetts NHESP. Other general information that will be gathered during meander surveys will include general health of communities and site quality conditions. Vegetation communities will be classified using NHESP Classification of the Natural Communities of Massachusetts (Swain & Kersey, 2011).

Sample vegetation plots will also be established to collect quantitative information to characterize the different habitats and provide species composition of habitat types. Vegetation plot locations will be selected using Massachusetts NHESP guidelines and protocols. Massachusetts NHESP Quantitative Community Characterization Forms (Massachusetts NHESP Form 3) will be completed for representative habitats to document the results of each plot location. Geo-referenced photographs will also be taken to document site conditions at the time of the survey.

To refine botanical information for the study area, the following tasks will be performed:

- Acquire and compile existing GIS vegetation cover type layers from available resources;
- Examine any visible vegetation boundaries in aerial photos or other imagery to fix or update type polygon boundaries, based on field observations;
- Produce a final vegetation type map that displays vegetation type polygon boundaries, the study area, and specific Project components;
- Use the vegetation type map to produce a table of vegetation types and calculate the percent acres of each vegetation type present in the study area in general, in areas potentially affected by the Project, and indirectly affected key wildlife habitats.

During botanical surveys, incidental wildlife observations will be noted and reported consistent with Study No. 3.4.1.

Task 3: Sensitive Plant Survey

A sensitive plant survey and completion of a biological evaluation on the locations and population parameters of Massachusetts state-listed rare plant species as identified in Section 4.7 of the PAD will be completed in the Turners Falls Impoundment and the 13+ miles of riverine habitat below the Dam to the Rte. 116 Bridge in Sunderland. FirstLight will seek the necessary permission from adjacent land owners to gain access to privately owned lands that are within the survey area. Several surveys along this stretch of the River have shown that state-listed plant species are dynamic local populations and often display meta-population dynamics, changing in size and location from year to year. This is particularly true for plant species inhabiting sand bars and high energy shore and cobble islands, including (but not limited to) the state-listed Wright's Spike-rush, Intermediate Spike-sedge, Ovate Spike-sedge, Frank's Lovegrass and Tufted Hairgrass. Large and/or rapid changes in water elevation and/or flow dynamics may cause adverse effects to existing and potential habitat for state-listed plant species. This task will collect the necessary field information to evaluate the effects of these changes in water level elevations on the life cycle of state-listed species and in particular, the germination, growth, and dispersal of species inhabiting mudflats, sand bars, and cobble islands. In development of the PAD NHESP identified 36 listed plant species known to have historically occurred in the vicinity of the Project. The full listing of the state-listed rare plant species is provided in Table 4.7.2.5-1 in Section 4.7.2.5 of the PAD. Table 3.5.1-1 provides a list of 22 sensitive plant species of concern taken from the NHESP identified state listed species in the PAD that have a likelihood of inhabiting areas directly affected by water level fluctuations. The species omitted from Table 3.5.1-1 were not included due to habitat requirements of species that would not be found in areas affected by water level fluctuations (e.g., species that require rocky ledges at high elevations, ridgetops, upland talus slopes).

Table 3.5.1-1: Sensitive Plant Species of Concern.

Scientific Name	Common Name	State (MA) Status	Preferred Habitat	Section A=north of Turners Falls Dam B=south of Turners Falls Dam
Alnus viridis ssp. crispa	Mountain alder	Threatened	Occurs in several habitat types, which combine open, exposed areas and cool local temperatures. The most common habitat is exposed ledges, boulders, and cobble bars on the edges of the Connecticut and Deerfield Rivers.	A,B
Aplectrum hyemale	Putty-root	Endangered	Occurs in rich deciduous forests of mesic hardwood subject to occasional flooding by nearby waterways.	B
Arisaema dracontium	Green dragon	Threatened	Occurs in floodplain woodlands, with open to filtered light, typically in moist alluvial sites with annual flooding in lowlands areas along large rivers.	B
Carex grayi	Gray's sedge	Threatened	Occurs in moist alluvial soils of floodplain forests and riverside meadows. Tends to favor the lower slopes of swales and depressions.	A,B
Carex lenticularis	Shore sedge	Threatened	Generally restricted to wet, sandy or gravely beaches of cold ponds and lakes; or seasonally exposed rock cobble bars of large rivers.	A,B
Carex tuckermanii	Tuckerman's sedge	Endangered	Occurs in rich soils of lowland river floodplains including oxbows, lowland depressions, swales, forests, meadows, and vernal pools.	B
Carex typhina	Cat-tail sedge	Threatened	Occurs in seasonal forested floodplains and immediate proximity.	B
Deschampsia cespitosa ssp. glauca	Tufted hairgrass	Endangered	Occurs on rocky and gravely river shores	A,B
Elatine americana	American waterwort	Endangered	Occurs in the open muddy shores of ponds, tidal rivers and tributaries.	B
Eleocharis diandra	Wright's spike-rush	Endangered	Occurs on shady stream banks in floodplains	A,B

Scientific Name	Common Name	State (MA) Status	Preferred Habitat	Section A=north of Turners Falls Dam B=south of Turners Falls Dam
Eleocharis intermedia	Intermediate spike-sedge	Threatened	Occurs in marshes, freshwater mudflats and other wet areas containing muddy substrates. Often found in exposed mud during periods of low water on alkaline river banks and pond shores.	A,B
Eleocharis ovata	Ovate spike-sedge	Endangered	Occurs in the sandy margins of lakes, ponds and rivers.	A,B
Ludwigia polycarpa	Many-fruited false-loosestrife	Endangered	Occurs almost exclusively in seasonal river floodplains with wet exposed mud including oxbows and lowland depressions.	B
Mimulus alatus	Winged monkey-flower	Endangered	Occurs in seasonal floodplains on the banks of stream tributaries to rivers.	A,B
Morus rubra	Red mulberry	Endangered	Typically occurs on steep ledges or rocky slopes but can also be found in floodplains and other rich woodlands.	A
Nuphar microphylla	Tiny cow-lily	Endangered	Occurs in shallow, still or slow-moving waters that are not acidic. Typically found in oxbows, coves and backwaters.	B
Oligoneuron album	Upland Wood Aster	Endangered	Occurs at the edge of floodplains	A,B
Prunus pumila var. depressa	Sandbar cherry	Threatened	Occurs at the edge of floodplain forests, traprock ledges in river channels, sand flats, and riverbed cobbles and gravels near the floodline.	A,B
Rumex verticillatus	Swamp dock	Threatened	Occurs in light shade to full sun in wet and mucky soils.	B
Salix exigua ssp. interior	Sandbar willow	Threatened	Occurs on islands, sandbars and beaches in the seasonal floodplain of rivers where it is typically found in sandy, gravelly and rocky substrates.	A,B
Symphyotrichum tradescantii	Tradescant's aster	Threatened	Fissures and cracks of rocky stream or river banks, adjacent to exposed ledges at or below the high water mark, subject to flooding.	A,B
Tillaea aquatica	Pygmyweed	Threatened	Margins of ponds and rivers, in sandy and/or muddy wet soils.	B

Scientific Name	Common Name	State (MA) Status	Preferred Habitat	Section A=north of Turners Falls Dam B=south of Turners Falls Dam
Trichostema brachiatum	False pennyroyal	Endangered	Open sunny exposures on dry sandy soil, sandstone, or limestones. Known to occur along stream banks and railroad beds.	B

The sensitive plant survey will utilize guidelines and modified protocols established by the Massachusetts NHESP, VDFW Wildlife Diversity Program, and the NHFG Nongame and Endangered Wildlife Program. The sensitive plant survey will document state-listed plant species provided in Table 3.5.1-1. In addition Northeastern bulrush (*Scirpus ancistrochaetus*), a federally listed plant species and frank's love grass (*Eragrostis frankii*), a NHESP species of special concern, will also be included in the sensitive plant survey. Field efforts will particularly focus on plant communities that exhibit meta-populations inhabiting the shoreline, mud flats, sand bars, and high energy shore and cobble island habitat types which are directly affected by water level fluctuations. The shoreline of the study area will be surveyed to locate all high probability areas that have suitable habitat and a high likelihood for sensitive plant associations. In identified areas having high likelihood of sensitive plants a timed- per unit area approach will be conducted to provide a census of the area. The time per unit area will be determined based upon the extent of the survey area, location, and the complexity of the plant diversity and population densities. FirstLight will consult with MDFW for concurrence to establish survey intensity (time per unit area).

Areas that are observed having listed species will include dates and times, the areas that were surveyed, and elevations taken with a level rod of observed species relative to river levels during the time surveyed. These data will be utilized to correlate operational impacts of fluctuating water levels on observed listed species. In addition observed sensitive plant populations will have data collected related to plant health and vigor of that population, including spatial mapping of vigor as it varies across spatial / elevation gradients. Species identified will be recorded for each site investigated and will also be added to the overall plant species census list for the Project.

A hydraulic model developed as part of Study No. 3.2.2 will provide data to determine the contribution of water level fluctuations associated with Project operations. This modeling will enable analysis of how germination, growth, or dispersal of listed plants may be affected by the timing, duration, extent and frequency of Project-related water level fluctuations.

The exact areas of focus will be determined after more extensive review of available information and based on professional judgment in the field. Areas having a known record of special status plants as determined in the pre-survey review and that may be affected by Project operations will be surveyed to cover 100 percent of the area to the extent possible. Positive identification of state-listed plant species will be photo-documented and GPS-located.

Task 4: Invasive Plant Survey

The MIPAG maintains a list of 34 noted invasive plant species occurring in Massachusetts and provides criteria used in evaluating species. Invasive plants as defined by the MIPAG are non-native species that have spread into native or minimally managed plant systems in Massachusetts. These plants cause economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems. Of the 34 plants listed by the MIPAG a total of 9 invasive species have been identified with the potential to occur in the aquatic habitats associated with the Study Area. Invasive plants identified by the MIPAG not included in this study were omitted based on regional occurrence (coastal areas) or occur in terrestrial habitats, which are addressed as part of Study No. 3.4.1. A list of wetland and aquatic invasive plant species with potential to occur in the Study Area are provided in Table 3.5.1-2.

Table 3.5.1-2: Wetland and Aquatic Invasive Plant Species.

Scientific Name	Common Name	Lifeform Type	Notes
Cabomba caroliniana	Carolina Fanwort	Aquatic herb	Chokes waterways
Iris pseudacorus	Yellow Iris	Perennial herb	Wetland habitats, primarily in flood plain areas, grows in full sun to full shade
Lysimachia nummularia	Creeping Jenny	Perennial herb	Problematic in flood plains forms dense mats
Lythrum salicaria	Purple Loosestrife	Perennial herb	Overtakes wetlands, high seed production
Myriophyllum heterophyllum	Variable water-milfoil	Aquatic herb	Chokes waterways, spreads by humans, boat traffic, and possibly birds
Myriophyllum spicatum	Eurasian water-milfoil	Aquatic herb	Chokes waterways, spreads by humans, boat traffic, and possibly birds
Phalaris arundinacea	Reed Canary Grass	Perennial grass	Forms dense stands
Potamogeton crispus	Curly Pondweed	Aquatic herb	Forms dense mats in the spring and persists vegetatively
Trapa natans	Water-chestnut	Aquatic herb	Forms dense floating mats on water

The MIPAG list of wetland and aquatic invasive plant species will be utilized to identify targeted invasive species when conducting botanical meander surveys. Surveyors will use methods adapted from the USFS Invasive Species Inventory and Mapping Data Recording Protocols (USFWS, 2010). These adapted methods focus on presence, location, extent, abundance and other site characteristics to provide site infestation information.

The extent of the study area for riparian and aquatic invasives will be completed along the entire perimeter of the impoundment downstream to Route 116 on both sides of the river, up to the limit of project-influenced streambanks. Aquatic invasive plant species will be located by use of a boat and on foot, with identification of aided by the use of look-down buckets. Invasive infestations occurring in areas outside but adjacent to the impoundment will be surveyed by foot. Survey efforts will map the known areas of invasive water chestnut beds present in the Turners Falls Impoundment in the vicinity of Barton Cove, and if still present, the small colony located between the upstream side of the Dam and the boat barrier on the Gill and Montague sides. To document an infested area, biologists will use a GPS at sub-foot accuracy to delineate the boundary of the infestation as defined by the dominant canopy cover of the invasive plant. The intent of this survey is to document infested areas of invasive plant species. Areas containing only occasional invasive species will be characterized with a GPS center point and radius necessary to enclose the population. For areas where invasive species are ubiquitous or impractical to map, surveyors will characterize the invasive species population using estimates of aerial coverage and percent of species present within a delineated polygon. For areas where dense stands of wetland or aquatic invasive species have formed, areas will be photo-documented and geo-referenced, and an Invasive Species Documentation Form will be completed.

Task 5: Mapping Wetlands and Waters of the United States

Within the Turners Falls Impoundment and up to 200 feet from the Turners Falls Impoundment shoreline, FirstLight will describe and field verify National Wetland Inventory (NWI) mapped wetlands. Initial determination of wetland areas will be conducted through the use of existing information such as existing FirstLight site knowledge, NWI maps, FEMA floodplain maps, USGS 7.5 minute quadrangles, soil surveys, and aerial photography. This information will be transferred and digitized into a GIS and preliminary wetland base maps will be prepared. This GIS wetland overlay will also be incorporated into an overall habitat or cover type map detailing all the habitat areas found in the project area or influenced by the Project.

Using the preliminary base wetland maps, field assessments will be completed to verify, classify and characterize the wetland communities. A team of qualified wetland scientists will complete the field assessments during the 2014 growing season when vegetation is most readily identifiable. Wetland habitats will not be formally delineated, but will be further defined from the existing NWI maps. NWI wetland boundaries will be extended where applicable and if encountered non-NWI wetlands will also be mapped. According to a review of GIS data there are no NHESP certified vernal pools within the Project boundary. There are however, potential vernal pools that will be field verified as part of this study. Any observed vernal pools not officially certified will be GPS located, mapped and photo documented. Vernal pools will be inventoried for any listed species.

Wetlands will be identified using standard federal criteria and methods outlined in the USACE Wetland Delineation Manual and the Regional Supplement to the USACE Wetland Delineation Manual: North Central and Northeast Region (USACE, 1987; USACE, 2012). Wetland types mapped will be classified using the USFWS Cowardin wetland classification system (e.g., palustrine, unconsolidated bottom, riverine aquatic bed) (Cowardin et al., 1979). General wetland verification and mapping will be completed using a GPS at sub-foot accuracy. Points collected in the GPS will be transferred to the GIS data base to assist in the creation of the final wetland presentation including location, type, and extent.

Evaluations and analysis of wetland functions and values will use the standard USACE descriptive approach (also known as the ACE Highway Methodology) (USACE, 1999). The ACE method is a descriptive (qualitative) approach for evaluating the functions and values of wetlands, which directs the user to identify the functions and values associated with a particular wetland based on the presence or absence of certain characteristics. For each wetland type, standard data will be recorded for the most important biotic and abiotic characteristics as the basis for identifying important wetland functions and values. This assessment will be completed holistically for each wetland type. A functional analysis of each wetland is not necessary because wetland "types" are functionally similar. Investigators will identify the "principal" or important functions and values associated with each wetland or wetland type.

Task 6: Project Water Level Fluctuation Assessment

A HEC-RAS model in an unsteady state will provide data to determine the contribution of water level fluctuations associated with Project operations. This hydraulic model will be developed as part of Study No. 3.2.2. Specifically, this information will be used to address how hydraulically connected habitats and vegetation is affected, and how operations have or may affect known populations and potential habitats for state-listed invertebrate species, including the Puritan and Cobblestone Tiger Beetles.

The Puritan tiger beetle is known from a single site at Rainbow Beach in Northampton, MA, and cobblestone tiger beetle known from a single site in Montague, MA (first observed in 2000). Detailed surveys of Puritan tiger beetle have been conducted at Rainbow Beach for adults and larvae.

A cross-section will be established in known areas of cobblestone tiger beetle and Puritan tiger beetle habitat for use in conjunction with the model results. The cross-section information will include depth and substrate measurements. FirstLight will consult with NHESP to determine how many cross-sections will be needed to define the parameters of the model. The model output will provide information on water level elevation changes in relation to Connecticut River flows under a variety of test conditions.

In addition to the water level modeling results at occupied locations for tiger beetles, FirstLight will consult with USFWS and MDFW for concurrence on if additional fine-scale surveying at occupied locations is necessary based on the information collected in the above tasks.

Task 7: Data Analysis

Following field surveys, GIS-based maps will be developed depicting wetland habitats, SAVs, EAVs, invasive species, RTEs, and other related information collected during the study. The field data collected will be geo-referenced as polygons or point data and overlain on orthophotos at a suitable scale. Field data will then be subject to QA/QC procedures, including spot-checks of transcription and comparison of GIS maps with field notes to verify locations of wetland sites and wetlands found. The results of this study will provide both quantitative and qualitative information that will be important in defining existing conditions, as well as providing any information on potential Project impacts as they relate to preparation of the License Application. This study is consistent with methodologies of generally accepted scientific practices and uses standard federal wetland assessment methods developed and used by Federal land management agency personnel.

Task 8: Reporting

A draft report will be prepared for study team review and comment, documenting methods and results. The report will provide the baseline information to defining existing conditions as well as analytical discussions and conclusions of potential Project impacts. The report will include maps of locations of invasive species, habitat types, listed species observations, and recreational uses. Field data collected will be provided in tabular format (e.g., invasive species listing the infestation, species composition, and estimated size of infestation.) The report will contain appendices of survey data and supporting correspondence among licensing participants. The report will be finalized following receipt of input from the study team and revisions to address any final comments by licensing participants. GIS data collected during the surveys will be shared with resources agencies upon request.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

This study will likely take one study season to complete and will be conducted during the 2014 field season. The estimated cost for the study could range from approximately $60,000 to $80,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

This study will be conducted as follows:

- January – March 2014: Reviewing existing information and data
- March - August 2014: Conduct field reconnaissance surveys
- Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1. The Initial Study Report is due in September 2014. If field efforts run later into the summer such that a complete report cannot be submitted by this date, FirstLight will provide Stakeholders with a study report supplement.

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3.6 Recreation and Land Use

3.6.1 Recreation Use/User Contact Survey

General Description of Proposed Study

This study was originally proposed as part of the PAD. FERC has requested a Recreation Facility Inventory and Use and Needs Assessment. In particular, FERC requested that FirstLight conduct a study to determine the existing use and demand at the projects and an assessment of the need to enhance recreation opportunities and access at the Projects. FERC proposed that the data be collected using on-site visitor intercept surveys at formal and informal public recreation areas at the Project reservoirs, tailraces, and riverine areas, including the Turners Falls bypassed reach; and mail and/or internet surveys targeting unique stakeholder groups that may not be practically accessed through on-site surveys (e.g. adjacent residential landowners, residents of the counties in which the projects are located, rock climbers, whitewater boaters).

FirstLight proposes to conduct a user count at the Turners Falls Project and Northfield Mountain Project recreation sites using both pressure tube counters and visual counts, including calibration counts to support the tube counters. FirstLight also proposes to develop and conduct contact surveys to determine the views of the recreating public with regard to the available recreation sites and activities within the Turners Falls Project and the Northfield Mountain Project boundaries and to also request zip code/country of residence information to assist with determining user distribution. It is anticipated that conducting the contact surveys at formal recreation sites will capture use by the majority of Project recreation users, including use at informal sites. This is because the majority of individuals utilizing informal sites within the Projects will access the sites via formal recreation facilities.

The NPS would like FirstLight to survey non-users and suggests using AMC and other NH, VT, and MA organizations to transmit questionnaires to their members. The AWWA, AMC, CRWC, and NE FLOW recommend contacting whitewater outfitters on the Deerfield River and reaching out to AWWA, NE FLOW, and AMC to survey members and conduct internet- based surveys. The CRWC states that the surveys as presently designed do not get at those people who are not using facility for whatever reason. FirstLight is not proposing to conduct a survey of non-users regarding their reasons for not using the recreational opportunities associated with the Projects. FirstLight would need to obtain relevant information that has a Project nexus and to weed out information that is not Project-related, which would require a significant effort. Targeted surveying of advocacy group members regarding their reasons for non-use creates a survey bias. The study is not designed to target specific user groups but is designed to determine what recreational activities are taking place at the Projects and the recreational user's opinion of the recreational experience he/she has encountered. To the extent that whitewater boating is taking place at the Project, that use will be captured by the recreational user survey form. Advocacy groups may state their positions in filings with the Commission.

The AWWA requested that the study plan include collecting data on demand by non-users, including whitewater boaters and through paddlers. If whitewater boaters and through paddlers are encountered during the survey, they will be interviewed just as any other recreational user of the Project. As noted earlier, FirstLight is not proposing to conduct a non-use survey because it will not lead to information useful in informing future license conditions.

The Licensee will review the Massachusetts, New Hampshire and Vermont Statewide Comprehensive Outdoor Recreation Plans (SCORP) and other regional and local recreation plans that may provide data on local and regional recreational needs in proximity to the Projects and will compare recreational needs identified in the plans with recreational opportunities provided by the Projects and identify potential gaps.

The CRWC requests that surveys of fisherman and hunters should include additional pertinent information related to game and harvest. This information is not included in the survey because harvest and game information has no bearing on recreational use and demand and is within the purview of fish and game resource agencies.

In addition, FirstLight proposes to conduct a mail survey targeted at adjacent residential abutters. The targeted mail survey should capture the majority of recreational use that may not originate at formal and informal sites. FirstLight is not proposing to conduct a mail survey of residents of the counties in which the Projects are located because the high cost of a general mail survey outweighs the uncertain benefit of a mail survey. The results of county-wide surveys tend not to be representative of the general recreational user population and produce unreliable results. There are an estimated 97,844 households in the three counties in which the Projects are located. Depending on the survey return rate, the estimated cost of conducting a mail survey, using a modified Dillman method, for 97,844 households could range from $700,000 to more than $1,605,000.00. FirstLight is not proposing to conduct internet surveys as part of this study. Internet surveys are generally not appropriate for quantitative analysis because the results tend not to be representative of the general recreational user population and are not reliable.

FirstLight proposes to use the information from the *Recreation Use/User Contact Survey* in conjunction with the *Recreation Facilities Inventory and Assessment* (Study No. 3.6.2), the *Whitewater Boating Evaluation* (Study No. 3.6.3), the *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats* (Study No. 3.6.4), and the *Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use* (Study No. 3.6.7) to determine the sufficiency of existing recreation facilities in meeting recreation demand at the Projects and to assess the need to enhance recreation opportunities and access at the Projects.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

The objectives of the study are:

- Determine the amount of recreation use and demand at the Turners Falls and Northfield Mountain recreation sites; and
- Interview the recreating public to determine user opinions and goals with regard to the recreation sites, including the perceived adequacy of recreation facilities and access at the Project.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreational opportunities associated with the operation of the Turners Falls and Northfield Mountains Projects.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

Section 4.8 of the PAD provided information regarding recreation resources within the Projects and surrounding area. Recreation use at the Turners Falls Project and Northfield Mountain Project occurs in all seasons and includes motorized and non-motorized boating, fishing, camping, canoeing, climbing, sightseeing, hunting, skiing, hiking, walking, biking, horseback riding, and picnicking. There are multiple recreation facilities within the Projects' boundaries that offer a variety of water-related and upland recreation opportunities. In general, areas associated with the Turners Falls Project and the Northfield Mountain Project are open to the public for recreation use. There is no public access to the upper reservoir, and the reservoir is surrounded by a security fence. It can be viewed, however, from a platform on a nearby trail.

There are 20 formal recreation facilities located within the Turners Falls and Northfield Mountain Projects' boundary. These facilities provide a variety of amenities, including but not limited to boat ramps, camp sites, picnic tables, benches, trails, and interpretive displays. Lands within the Northfield Mountain Project contain Rose Ledge and Farley Ledge, both of which are routinely used by climbers.

The 2009 Form 80 for the Turners Falls Project reported that the total annual daytime use was 36,694 recreation days, and the total annual nighttime use was 4,584 recreation days. The peak weekend daytime average use was 339 recreation days, and the nighttime average was 27 recreation days. The interpretive displays were used at 80% of facility capacity, while the trails were used at 5% of their capacity. Parks and picnic areas in the Project were used at 35% of the facility capacities. The canoe portage and tailwater fishing facilities were used at 10% of their capacities.

The 2009 Form 80 for the Northfield Mountain Project reported that the total annual daytime use was 71,672 recreation days, and the total annual nighttime use was 4,564 recreation days. The peak weekend daytime average was 2,360 recreation days, and the nighttime average was 207 recreation days. The tent/trailer/RV sites and group camps were used at 80% of the facilities' capacities, while the interpretive displays were used at 20% of their capacity. The parks were used at 28% capacity, trails were used at 25% capacity, picnic areas were used at 24% capacity, and the Tour and Trail Center was used at 50% capacity.

Need for Additional Information:

Information on current use and whether existing access facilities in the area are meeting recreation demand would inform a decision on whether additional, designated public access at the Projects is necessary to meet existing and future recreation demand at the Projects.

Project Nexus (18 CFR § 5.11(d)(4))

FERC regulations require that the license application include a statement of the existing recreation measures or facilities to be continued or maintained and the new measures or facilities proposed by the applicant for the purpose of creating, preserving, or enhancing recreational opportunities at the Projects and in their vicinities, and for the purpose of ensuring the safety of the public in its use of Project lands and waters. In addition, recreation is a recognized project purpose at FERC-licensed projects under section 10(a) of the FPA.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

To determine the amount of recreation use at the Projects, the Licensee proposes to conduct a recreation use study in combination with a user contact survey and mail survey.

Task 1: Study Preparation

FirstLight has consulted with various stakeholders in the development of a user contact survey. Prior to initiation of field work in Task 2, FirstLight will determine the survey dates and times. All sampling days will be randomly selected and survey routes will be completed on a rotating basis and at different times of day to account for time-of-day use patterns. FirstLight has also developed a mail questionnaire/survey, based on Dillman approaches for developing mail surveys, which will be designed to ascertain recreational use by residential abutters. The Licensee will review readily available municipal and NGO recreation plans for information regarding recreation use within the Turners Falls and Northfield Mountain Project boundaries. FirstLight will consult with recreation departments in the towns that have them and recreation/open space committees. Staff will also talk with the MA Environmental Police and local police about the various issues regarding recreational use that they observe in the Turners Falls impoundment, bypass, and downstream. A draft user contact survey, a Northfield Mountain trail user survey, and a mail survey of residential abutters are included with this study plan. See Figures 3.6.1-1, 3.6.1-2, and 3.6.1-3. On August 8, 2013, FirstLight held an additional meeting with stakeholders to review and obtain comments on the proposed survey instruments contained herein. Revisions to the surveys were made as a result of the August 8 meeting.

FirstLight will also consult with the Western Massachusetts Climbers Coalition with respect to determining appropriate locations for collection of data from rock climbers.

Task 2: Field Work

The recreation use study will occur over four seasons in order to capture recreational use occurring in spring, summer, winter, and fall. If the study season experiences extremely abnormal weather or economic conditions, the study will be halted and resumed during the second study year. It will be conducted using a combination of pressure tube traffic counters, calibration counts, spot counts, and actual use numbers. Tube counters will be placed at high use facilities within the Projects. These will be used to obtain an estimate of the number of vehicles using the site. The counters will be checked on Friday afternoon and Monday mornings to differentiate between weekday and weekend use.

Information collected with traffic counters will be started the week prior to Memorial Day and counters will be removed during the week after the closing of individual facilities. The counters will be placed on well used entrance/exit driveways accessing Project recreation facilities including driveways leading to local, state, and private facilities open to public recreation, if permission can be obtained from the owner /operators for placement and calibration counts.

Calibration counts will be conducted at each formal Project recreation facility and will be documented on a survey form. These counts will last for at least two hours per site on each calibration day and will be conducted on five (5) days per month which will include three (3) randomly selected weekdays and two (2) randomly selected weekend days. If a month contains a holiday, one (1) day per holiday weekend will be included in addition to the standard calibration days. A stratified random sampling methodology will be used to vary the days, time of day and start locations for the survey route. Times of day will be varied and will include the periods of survey ½ hour before sunrise and ½ hour after sunset during appropriate seasons.

This will ensure that different user groups are captured as part of the study. This information will be used to verify that the traffic counters are functioning properly, determine the average number of individuals per vehicle, and determine the type of recreation use individuals are participating in.

The spot counts will be conducted on five (5) days per month which will include three (3) randomly selected weekdays and two (2) randomly selected weekend days. If a month contains a holiday, one (1) day per holiday weekend will be included in addition to the standard calibration days at all formal recreation areas within the Project. This information will be documented on a survey form. The spot counts will record the number of vehicles parked at a facility to determine the time-of-day use patterns at the sites. FirstLight currently charges a fee for winter recreation use at the Northfield Mountain Project and for their interpretive riverboat cruises. FirstLight will review readily available use records for the interpretive riverboat cruises, winter use at the Northfield Mountain Project, camping reservations, canoe and kayak rentals, and shuttle service use. This information will be combined with the collected field data, when developing the user figures for the Projects. Final recreation use for the formal recreation facilities within the Projects will be summarized by season and activity type for each site. FirstLight will work with State agencies and private groups (e.g., Franklin County Boat Club, Turners Falls Rod and Gun Club, and Northfield Mount Hermon School) that manage existing public and private recreation facilities within the Project boundaries to determine use at their facilities.

A user contact survey (Figure 3.6.1-1) and a Northfield Mountain trail user survey (Figure 3.6.1-2) will be used to determine user opinions and goals with regard to the existing Project recreation facilities and opportunities such as whitewater and other boating opportunities, overnight camping, trail use, and rock climbing. The user contact survey will take place over the course of four seasons and will be administered to visitors at all Project recreation facilities, excluding the Northfield Mountain Visitors Center. The Northfield Mountain trail user survey will be administered at the Northfield Mountain Visitors Center and associated facilities. The survey will also ask for the individuals' zip code to determine how far existing users travel to visit the Projects for recreational purposes. This information will also be used to determine length of stay, number of people in a party, and the opinion of the user with regard to the amount and types of recreation opportunities offered within the Projects' boundaries. The survey will be administered during the calibration and spot count site visits. Incidental counts will be recorded and surveys will be administered to individuals participating in recreation activities at informal locations in the Turners Falls canal along the survey route during calibration and spot count visits.

The CRWC recommends that the user survey be given out at the Sunderland boat ramp and that the river abutters' mail survey should be mailed out to all abutters downstream of the Project down to the Sunderland Bridge (Route 116). FirstLight is not proposing to survey all abutters downstream of the Project or at the boat ramp at Sunderland Bridge. The boat ramp at Sunderland Bridge is not owned by FirstLight and is well outside of the Project area. The further downstream of the Project an abutter is located, the less likely that the survey will yield information relevant to recreation use at the Project. FirstLight believes that the expanded scope will not result in a comparable increase in survey data that is relevant to the Projects, particularly given that FirstLight has no authority with respect to the boat ramp at Sunderland Bridge

The CRWC also requests that a script be provided to the surveyor at the top or each survey. A very brief script has been provided. In addition, FirstLight will train its surveyors prior to initiating field work.

A mail survey (Figure 3.6.1-3), using a modified Dillman method, will be mailed in the spring to residential abutters and a follow-up reminder card will be mailed out approximately two weeks later to those residences who have not returned a survey. It is assumed that approximately 25-40% of the targeted mail surveys will be completed and returned.

The CRCW states that the survey should include specific questions about beach formation, river level fluctuations, use or overuse of the river, conflicts between river users, how long they have been living along the river, what the strengths and weaknesses are to the facilities and to the river. FirstLight has included specific questions that are designed to obtain information on user's opinions on what impacts their recreational experience as well as open-ended questions to allow for these types of responses by those who may have concerns in that regard.

Task 3: Data Entry and Statistical Analysis

Information collected during Task 2 will be entered into spreadsheets for statistical analysis. Information such as the number of recreation days spent at the Projects' recreation sites, length of stay, average number of persons per party, and the percent of the facilities' capacity that is currently being utilized will be determined.

Task 4: Report Writing

The information that is gathered during this effort will be used to complete both the recreation and land management portions of the license application, as well as the FERC Form 80. Information from this study will be incorporated into a Recreation Management Plan along with information from several other studies. The report for this study will contain use figures for each recreation site, as well as, overall recreational use figures for the Turners Falls and Northfield Mountain Projects. Tables will be used to display recreation activities within the body of the report, and a summary of responses to open-ended questions will be provided as an appendix. All survey responses will also be included in an appendix to the report.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort is sufficient to obtain baseline information on recreational usage and demand within the Projects' area. The estimated cost for the recreation inventory and user contact survey outlined in this plan is approximately $115,000-$135,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. FirstLight held additional meetings on June 11 and August 8, 2013.

Field data collection for this study will take place in January 2014 through December 2014. Statistical analysis of the data will occur in 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Figure 3.6.1-1: Draft Recreation User Survey

Interviewer: ___________ Date/Time: _______________ Location: ______________
Weather: ______________ Air Temp: __________Declined Survey: ____________
To be determined Post Survey: Pond Elevation: ________ Flow (cfs): _______________

Good Afternoon. My name is _____ and I am conducting a recreation use survey of visitors to the Turners Falls and Northfield Mountain hydroelectric project areas for FirstLight. We are surveying areas on the Connecticut River from just above the bicycle trail bridge in Montague north to Stebbins Island. Collected information will assist FirstLight in understanding more about land and water based recreation in this area of the Connecticut River. Responses from the survey will remain anonymous. Would you mind answering a few questions?

1. Have you participated in this survey effort before?

   Yes_____ Thank you for your time. We are only interviewing each person once with this survey.

   No_____ Continue with Survey

2. What is your age? _______________ Gender: _______________________

3. How many in your group, including yourself? _________________

4. Which of the following best describes your group? (Check One)

   - ☐ Alone
   - ☐ Family
   - ☐ Friends
   - ☐ Multiple Families
   - ☐ Family & Friends
   - ☐ Organized Outing Group
   - ☐ Educational Group
   - ☐ Other_______

5. How many vehicles did your group use to come here? ____________

6. Have you ever visited the Turners Falls/Northfield Mountain project area before? Yes__ No__

   If yes, typically, how many times a year do you visit the project area for Recreation? ________

7. What is your Zip Code? __________ or Country of Residency?_________

8. When did you arrive and plan to depart?

   Arrived: Date: ________ Time: ______ AM PM

   Estimated Depart: Date: ________ Time: ______ AM PM

9. How much do you think that you will spend during your trip to this section of the Connecticut River?

   ____ less then $100 _____$101 to $500 _____$501-$1,000 _____ greater than $1000

10. During your visit today what is your perception of the amount of use occurring at this site?

1	2	3	4	5
Not Crowded		Somewhat Crowded		Extremely Crowded

11. Please indicate which of the following activities you participate in at the Northfield/Turners Falls Project by season. (Mark all that apply)

Activity	This Trip	Spring (Mar. 1 – May 31)	Summer (June 1 – Aug. 31)	Fall (Sept. 1 - Nov. 30)	Winter (Dec. 1 – Feb. 28)
Backpacking					
Birding					
Camping					
Canoeing					
Dog Walking					
Driving for Pleasure					
Educational Programs					
Fishing from a Boat					
Fishing from Shore					
Fishway Viewing					
Hiking					
Horseback Riding					
Hunting					
Ice Fishing					
Kayaking					
Mountain Biking					
Multi-day Float Trip					
Nature Observation					
Orienteering					
Other:__________________					
Paddle Boarding					
Photography					
Picnicking					
Power Boating					
Riding Jet Skis					
Road Bicycling					
Rock Climbing					
Rowing					
Running					
Sailing					
Sightseeing					
Skiing					
Snowshoeing					
Swimming					
Tubing					
Walking					
Waterskiing					
Whitewater Boating					

12. Of the activities listed above, which is your PRIMARY activity on this trip? __________________

13. Did you experience water level fluctuations today? Yes ____________ No ___________

If yes, please circle one: Rising Water Stable Water Dropping Water Don’t Know

14. Overall, how satisfied were you with the river water level during your trip? (circle number)

1	2	3	4	5
Not Satisfied at all	Slightly Satisfied	Satisfied	Moderately Satisfied	Extremely Satisfied

If less than satisfied could you explain why?______________________________________

15. Please rate the following amenities at this location

	Poor		Fair		Excellent
Parking	1	2	3	4	5
Facility Condition	1	2	3	4	5
Variety of Amenities	1	2	3	4	5
Overall Quality	1	2	3	4	5

Please explain any poor ratings. ____
____

16. What did you like most about your recreational experience today? ___________________________

17. What did you like least about your recreational experience today?___________________________

18. What, if anything, enhanced your recreation experience today? _________________________________

19. What, if anything, detracted from your recreation experience today? ___________________________

20. Does this recreation facility serve your interests? Yes____ No_____
If not why?____
____
____

21. Do you have any additional comments regarding recreation opportunities in this area of the Connecticut River? ____
____
____

Thank you for your time and input.

Figure 3.6.1-2: Northfield Mountain Trail User Survey

Interviewer: ___________ Date/Time: _______________ Location: ______________
Weather: ______________ Air Temperature: ________Declined Survey: ____________

Good Afternoon. My name is _____ and I am conducting a recreation use survey of visitors of the Northfield Mountain trail system and Visitors' Center for FirstLight. Collected information will assist FirstLight in understanding more about land-based recreation at Northfield Mountain. Responses from the survey will remain anonymous. Would you mind answering a few questions?

1. Have you participated in this survey effort before?

Yes___ Thank you for your time. We are only interviewing each person once with this survey.

No____Continue with survey.

2. What is your age? _________________ Gender: __________________

3. How many in your group, including yourself? _________________

4. Which of the following best describes your group? (Check One)

- ☐ Alone
- ☐ Family
- ☐ Friends
- ☐ Multiple Families
- ☐ Family & Friends
- ☐ Organized Outing Group
- ☐ Educational Group
- ☐ Other_______

5. How many vehicles did your group use to come here? __________

Have you ever visited Northfield Mountain before? Yes__ No__

If yes, typically, how many times a year do you visit Northfield Mountain for recreation? ________

6. What is your zip code? _____________ Country of residency? _________________

7. How often, on average, do you use the Northfield Mt. trail system? (circle one response)

Daily Between 3 and 5 times a week 1 or 2 times a week Once a week

A couple of times a month Once a month A few times a year First time user

8. When did you arrive and plan to depart?

Arrived: Date: ________ Time: ______ AM PM

Estimated Depart: Date: ________ Time: ______ AM PM

9. How much do you think that you will spend during your trip to this area of the Connecticut River?

____ less then $100 _____$101 to $500 _____$501-$1,000 _____ greater than $1000

10. During your visit today what is your perception of the amount of use occurring at this site?

1	2	3	4	5
Not Crowded		Somewhat Crowded		Extremely Crowded

11. Please indicate which of the following activities you participate in at the Northfield Mountain by season. (Mark all that apply)

Activity	This Trip	Spring (Mar. 1 – May 31)	Summer (June 1 – Aug. 31)	Fall (Sept. 1 - Nov. 30)	Winter (Dec. 1 – Feb. 28)
Backpacking					
Birding					
Dog Walking					
Educational Programs					
Hiking					
Horseback Riding					
Hunting					
Mountain Biking					
Nature Observation					
Orienteering					
Other:___________________					
Photography					
Picnicking					
Rock Climbing					
Running					
Sightseeing					
Skiing					
Snowshoeing					
Walking					

12. Of the activities listed above, which is your PRIMARY activity on this trip? __________________

13. Please provide your opinion on the Northfield Mountain trail system for the following variables. (check appropriate box for each variable)

Variable	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Trails are in good condition					
Trails are well maintained					
Trails are too steep					
Trails are too flat					
More trails are needed					
There is an appropriate mix of easy, moderate, difficult trails					
Winter trail grooming is sufficient					
Trail signage/markings are adequate					
Trailhead parking is sufficient					
Trail surface material is adequate					

14. Generally, when do you use the trail system? (circle one response)

Weekdays Weekends Both

15. How much time do you generally spend on the trail each visit? (circle one response)

Less than 30 minutes 30 minutes to 1 hour 1 to 2 hours More than 2 hours

16. How did you learn about the Northfield Mountain trails? (circle all that apply)

Local Resident
Word of mouth
Roadside signage
Driving past
Internet web site
Other ___________________

17. Do you also use facilities or amenities at the Northfield Mountain Visitors' Center during your trip to use the trail system? Yes ____ No ____

If yes, what other facilities or amenities do you use?____
____

18. Please rate the following amenities at the Visitors' Center

	Poor		Fair		Excellent
Parking	1	2	3	4	5
Facility Condition	1	2	3	4	5
Variety of Amenities	1	2	3	4	5
Overall Quality	1	2	3	4	5

Please explain any poor ratings. ____
____

19. Do the amenities at the Visitors' Center serve your interests? Yes___ No____

If no, why?______________________________________

20. What did you like most about your recreational experience today? ___________________________

21. What did you like least about your recreational experience today?___________________________

22. What, if anything, enhanced your recreation experience today? _______________________________

23. What, if anything, detracted from your recreation experience today? ___________________________

Questions require a map of the trail system with numbered sections and access points.

24. What portions of the trail system do you use most often? (Sections ____________)

25. Which trail access point do you generally use when you visit the trail? (Access Point______)

26. Where did you park when accessing the trail system? _______________________________

27. Does the Northfield trail system serve your interests? Yes____ No_____
If no, why?____

28. Do you have any additional comments regarding recreation opportunities at Northfield Mountain ?
____
____
Thank you for your time and input.

Figure 3.6.1-3: Residential Abutters Survey

This survey and map, provided by First Light, are a recreational use survey directed at adjacent residential abutters of the Northfield Mountain and Turners Falls Hydroelectric Projects. FirstLight is conducting on-site interviews at public recreation areas on the Connecticut River from just above the bicycle trail bridge in Montague north to Stebbins Island; however these visits may not capture all the potential users, such as residential abutters. To the best of your ability, please respond to the questions below. This information will be used as an aid in understanding more about land and water based recreation in this area of the Connecticut River.

Your responses will remain anonymous and will be used in conjunction with the results of other recreational studies being conducted in connection with the Federal Energy Regulatory Commission (FERC) relicensing of the Turners Falls and Northfield Mountain hydroelectric projects. More information about the relicensing can be found at www.northfieldrelicensing.com.

1. Please categorize your abutting property by type of residence and land use by circling below

Residence: Seasonal Year Round

2. Current Use of Land (Please circle all that apply):

Residential, Landscape, Cropland, Livestock, Tree Growth, Future Residential, Conservation Land,

Other________________________________

3. Do you as an abutting resident access the Connecticut River from your property for recreational purposes? Yes____ No____

4. Is your property adjacent to the Connecticut River? Yes ____ No______ (If no, Skip to Question 8)

5. Do others access the Connecticut River across your private property? Yes___ No____

With your permission?_____ Without your permission?_____

Comments____

6. Do others utilizing the Connecticut River and abutting lands for recreational purposes affect your abutting property? Yes____ No____

If yes, explain____

____

7. Do you have a dock? Yes________ No____

If yes, how many boats are docked at it?_______

What types of boats?___________________________

8. Approximately how many days per year do you use the Connecticut River or the amenities at Northfield Mountain for recreation purposes?

1-25 26-50 51-100 Over 100

9. Do you ever use the recreation sites associated with the Turners Falls and Northfield Mountain hydroelectric projects (see provided map)? No _________ Yes __________

If yes, which ones? ____

10. Do you ever use other sites in this area of the Connecticut River for recreational purposes, which are not shown on the map? No _________ Yes___________________

If yes, for what purposes do you use the site?_________________________________

Also, please identify the location of the site on the provided map.

11 What do you like most about your recreational experiences on this area of the Connecticut River?

____

12. What do you like least about your recreational experiences on this area of the Connecticut River?____

13. What, if anything, enhances your recreation experience on this area of the Connecticut River?

____

14. What, if anything, detracts from your recreation experience on this area of the Connecticut River?

____

15. Overall, how satisfied are you with the river water levels on this area of the Connecticut River? (circle number)

1	2	3	4	5
Not Satisfied at all	Slightly Satisfied	Satisfied	Moderately Satisfied	Extremely Satisfied

If less than satisfied could you explain why?____

16. What recreational pursuits do you usually participate in on the Connecticut River from just above the bicycle trail bridge in Montague north to Stebbins Island (see map)?

Activity	Spring (Mar. 1 – May 31)	Summer (June 1 – Aug. 31)	Fall (Sept. 1 - Nov. 30)	Winter (Dec. 1 – Feb. 28)
Backpacking				
Birding				
Camping				
Canoeing				
Dog Walking				
Driving for Pleasure				
Educational Programs				
Fishing from a Boat				
Fishing from Shore				
Fishway Viewing				
Hiking				
Horseback Riding				
Hunting				
Ice Fishing				
Kayaking				
Mountain Biking				
Multi-day Float Trip				
Nature Observation				
Orienteering				
Other:___________________				
Paddle Boarding				
Photography				
Picnicking				
Power Boating				
Riding Jet Skis				
Road Bicycling				
Rock Climbing				
Rowing				
Running				
Sailing				
Sightseeing				
Skiing				
Snowshoeing				
Swimming				
Tubing				
Walking				
Waterskiing				
Whitewater Boating				

17. Do you have any additional comments regarding recreation opportunities in this area of the Connecticut River?

____
____
____

3.6.2 Recreation Facilities Inventory and Assessment

General Description of Proposed Study

The majority of this study was conducted in 2011 and 2012 in order to collect baseline information on recreation facilities associated with the Projects and a summary of the results were originally presented in the PAD. Due to low snow years in 2011 and 2012, the winter field work of this baseline survey was not conducted until March 2013. This study was designed to confirm the number of existing recreation facilities, the number and types of amenities available at each facility and the overall condition of the facilities. In its study requests, FERC requested information on the condition of existing recreation facilities and access sites at the Projects. The intent of the proposed study is to prepare a summary report that identifies the number of existing recreation facilities and access sites, and the amenities and the overall condition of the facilities and access sites.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The objective of this study is to complete the baseline investigation of the existing recreation facilities within the Turners Falls Project and Northfield Mountain Project boundary with the preparation of a summary report of the results.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreation opportunities associated with the presence and operation of the Turners Falls and Northfield Mountain Projects.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

There are 20 formal recreation facilities located within the Turners Falls and Northfield Mountain Projects' boundary. These facilities provide a variety of amenities, including but not limited to boat ramps, camp sites, picnic tables, benches, trails, and interpretive displays. Below is a brief description of each of the recreation facilities located within the Turners Falls and Northfield Mountain Projects' boundary. The facility locations can be seen in Figure 3.6.2-1.

Cabot Woods Fishing Access: This site is located within the Turners Falls Project on Migratory Way in Montague, MA. This site is owned and managed by the Licensee and is open to the public for day use activities such as fishing, hiking, and picnicking. There are picnic tables, three ADA parking spaces, and 17 parking spaces available at the site.

Turners Falls Branch Canal Area: This site is located within the Turners Falls Project, off of Power Street in Montague, MA. This site is owned and managed by the Licensee and is open for fishing. Parking and benches are available at this site.

Turners Falls No. 1 Station Fishing Access: This site is located within the Turners Falls Project, off of Power Street in Montague, MA. This site is owned and managed by the Licensee and is open for fishing. Parking is available.

Unity Park: This park is located within the Turners Falls and Northfield Mountain Projects, on either side of First Street in Montague, MA. This site is owned by the town of Montague, with a portion on the east side that is owned by the Licensee. The park facilities located on the south side of the road are managed by the town of Montague, while the portion of the park located between the river and the road is managed by the Licensee. The park offers day use activities including walking, fishing, sightseeing, picnicking, and biking. Amenities at the park include restrooms, a playground, parking, ballfields, a basketball court, a paved trail, benches, and picnic tables.

<u>Canalside Trail Bike Path</u>: This bike trail is located within the Turners Falls Project along the Turners Falls Power Canal in Montague, MA. The trail property is leased to and managed by the MA Department of Environmental Management (now MA Department of Conservation and Recreation) and is open for non-motorized public use.

<u>Turners Falls Fishway Viewing Area</u>: This site is located within the Turners Falls and Northfield Mountain Projects, off of First Street in Montague, MA. The fishway is managed by the Licensee and is located at the southern end of Unity Park. The facility is open to the public in the spring to watch migrating fish.

<u>Barton Cove Nature Area and Campground</u>: This Nature Area is located within the Turners Falls and Northfield Mountain Projects, on Barton Cove Road in Gill, MA. The Nature Area is owned and managed by the Licensee and is open to the public for camping, picnicking, and bank fishing. Campsites have a picnic table, fire ring and garbage can. There are two vault toilets and additional portable restrooms located within the campground. There is water access from some of the sites and bank fishing is permitted.

<u>MA State Boat Launch</u>: This launch is located within the Turners Falls and Northfield Mountain Projects, off of Route 2 in Gill, MA. This site is owned and managed by the state of Massachusetts, and is open to the public. The site offers boat launching and bank fishing opportunities. There is a parking lot, boat ramp, dock, and portable sanitation facility.

<u>Barton Cove Canoe and Kayak Rental Area</u>: This site is located within the Turners Falls and Northfield Mountain Projects, off of Route 2 in Gill, MA. This site is owned and managed by the Licensee and offers day use opportunities. There is a canoe/kayak launch, a rental office, picnic tables, parking, and a portable sanitation facility.

<u>Cabot Camp</u>: This camp is located within the Turners Falls and Northfield Mountain Projects, at the end of Mineral Road in Montague, MA. The site is owned and managed by the Licensee and is open to the public as an informal bank fishing area. There is a large parking area and access to a local bike trail from the site.

<u>Northfield Mountain Boat Tour and Riverview Picnic Area</u>: This picnic area is located within the Northfield Mountain Project, off Pine Meadow Road in NorthFGS, MA. This site is owned and managed by the Licensee, and is available for day use activities including interpretive riverboat cruises, picnicking, and bank fishing. The site is accessible from the water and via a paved road. There is a formal parking lot available for those using the site and those who are boarding the riverboat. There are picnic tables, grills, sanitation facilities, and a boat dock at the site.

<u>Northfield Mountain Tour and Trail Center:</u> This site, which is also known as the Visitor Center, is located within the Northfield Mountain Project, off Millers Falls Road (Rt. 63) in NorthFGS, MA. The Center is owned and managed by the Licensee and is available for day use activities. Available opportunities include viewing interpretive displays, picnicking, and educational programs. The Center has restrooms, cross-country ski rental equipment, and parking. It is open for year-round recreational and educational use.

Northfield Mountain Trail System: The trail system is located at the Northfield Mountain Project, off Millers Falls Road (Rt. 63) in NorthFGS, MA. Over twenty-six miles of trail are available for hiking, biking, horseback riding, snowshoeing, and cross-country skiing.

Northfield Mountain Mountaintop Observation Area: This site is located adjacent to the Northfield Mountain Project upper reservoir. The Observation Deck is owned and managed by the Licensee and is accessible by hiking the trail system.

Munn's Ferry Boat Camping Recreation Area: This site is a water access site located on the east side of the river in NorthFGS, MA. The camping area is located within the Turners Falls and Northfield Mountain Projects. This area is owned and managed by the Licensee and is available for overnight use. There are tent campsites each with a trash can, tent platform, picnic table, fire ring and grill. There is also a lean-to site with a trash can, tent platform, picnic table, fire ring and grill. There are pit toilets available at the site. Bank fishing opportunities are also available at this site.

Bennett Meadow Wildlife Management Area (WMA): The Bennett Meadow WMA is managed by the state of Massachusetts, Division of Fisheries and Wildlife. The site is located within the Turners Falls and Northfield Mountain Projects. This site offers day use opportunities; it is open for hunting, and is also used for walking and hiking.

Pauchaug Boat Launch: This site is owned and managed by the state of Massachusetts. The site is located within the Turners Falls Project and Northfield Mountain Project. There is a boat launch, parking and portable sanitation available at this site.

Pauchaug WMA: This WMA is owned and managed by the state of Massachusetts, Division of Fisheries and Wildlife. This site is similar to the Bennett Meadow WMA and is located within the Turners Falls Project and Northfield Mountain Project. The site is open for hunting and is used for walking/hiking and bank fishing.

Governor Hunt Boat Launch/Picnic Area: This site is owned and managed by TransCanada, which owns the Vernon Project. While this area is within the Vernon Project boundary, the area is also located in the area where the Turners Falls Project and Northfield Mountain Project boundaries and the Vernon Project boundary overlap. The area is open for day use opportunities and has a picnic area and boat launch. Recreation opportunities at the site include bank fishing, picnicking, boat launching, and sightseeing.

Turners Falls Canoe Portage (Poplar Street Put-in): Portages around the Turners Falls Dam are available seven days per week for canoes and kayaks. The portage take-out is at the Barton Cove Canoe & Kayak Rental Area. Boaters wishing to proceed downriver of Barton Cove are picked up by the Licensee and driven to just downstream of the Project on Poplar Street in Montague City, where they can continue their trip. The Poplar Street Put-in is owned and maintained by the Licensee and is located at the end of Poplar Street. The site offers a small parking area and an informal access trail to the river.

Project Nexus (18 CFR § 5.11(d)(4))

FERC regulations require that the license application include a statement of the existing recreation measures or facilities to be continued or maintained and the new measures or facilities proposed by the applicant for the purpose of creating, preserving, or enhancing recreational opportunities at the Projects and in their vicinities, and for the purpose of ensuring the safety of the public in its use of project lands and waters. In addition, recreation is a recognized project purpose at FERC-licensed projects under section 10(a) of the FPA.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

As stated in the PAD, the bulk of Task 1 of this study was conducted in 2012 and a brief summary of the results was included in Section 4.8.1. The winter portion of Task 1 was completed in 2013. As set forth, in Task 2,a summary of the results for all four seasons of investigation will be prepared.

Task 1: Study Preparation and Field Work

FirstLight developed and utilized a standardized survey form (See Figure 3.6.2-2) to evaluate each existing recreation facility to determine general condition and available amenities. Information that was gathered during the inventory included whether the site was accessible by water, vehicle, or foot; who owned and managed each site; whether it was formal or informal; the number and types of amenities, if the site was generally ADA compliant; if there was the potential of expansion; amount of available parking; observed activities; available services, and the general aesthetics of the site. The general condition of the site was observed by determining the need for major repairs to existing amenities and whether any safety concerns were noted. Staff also noted the existence of erosion along the Project shoreline associated with the existing sites. Photos of the site were taken and a GPS data point was recorded while in the field for each facility. Field staff traveled the Project area by vehicle and by boat to locate and observe the existing formal and informal sites. Once the work was completed this information was then entered into a GIS format.

The AWWA stated that while the licensee states that it is completing its Recreation Facilities Inventory Assessment, it does not state whether it assessed the presence and adequacy of facilities from the perspective of whitewater boaters and through paddlers. The AWWA also states that the Licensee should extend the Project boundary below Cabot station to include all facilities above the confluence with the Deerfield River. The field work for this survey was completed in 2013 and was intended to gather baseline information regarding existing recreational facilities associated with the Project and inform decision-making regarding recreational studies to be conducted during the ILP. The information from the field work will be included in a summary report to be developed prior to December 2013. The user surveys and additional recreational studies proposed in the RSP are designed to provide further information about a user's recreational experience at the Project, including whether recreation facilities are adequate for serving recreation demand.

The CRWC states there should be much greater detail on the site condition, ADA compliance, and user impact in a numeric ranking format. The intent of the baseline inventory was to record what recreational facilities are currently available and their general condition. Figure 3.6.2-2 does record whether a facility is ADA compliant. The baseline inventory was not intended to be an engineering condition assessment.

Task 2: Summary Development

A summary of the results of the baseline inventory will be prepared, along with maps of the recreation facility locations. The summary will detail the methods used to conduct the inventory and provide a description of each site which includes the available amenities and services; ownership and management; general condition, and a representative photo. A table showing ownership and management of each facility will also be included. The raw data will be included in an Appendix to the summary. FirstLight proposes to use this information in conjunction with (Study No. 3.6.1) the *Recreation Use/User Contact Survey*, the *Whitewater Boating Evaluation* (Study No. 3.6.3), the *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats* (Study No. 3.6.4), and the *Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use* (Study No. 3.6.7) to assess the sufficiency of existing recreational facilities. This information will also be included in the Recreation Management Plan.

NE FLOW and AMC state that the information that has appeared so far in the PAD is inadequate because it lists, as part of the inventory, facilities that are not owned or operated by FirstLight. The intent of all recreational surveys conducted, either as part of baseline information gathering, or as part of the ILP, is to gain an accurate assessment of all recreation taking place at or near the Project, regardless of whether the recreational facility is a formal or informal one, or is or is not owned by the Licensee.

NE FLOW and AMC state the recreation inventory should assess FirstLight's land base and identify what parcels could serve as new primitive campsites or, where deemed necessary, river access locations. FirstLight has included identification of possible new primitive campsites and river access locations for non-motorized boating as part of Study No. 3.6.4 *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats*.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The cost to complete the remaining portion of this study (development of a summary report) is estimated at $15,000-20,000. FirstLight believes that this is sufficient to fully meet the goals of this study.

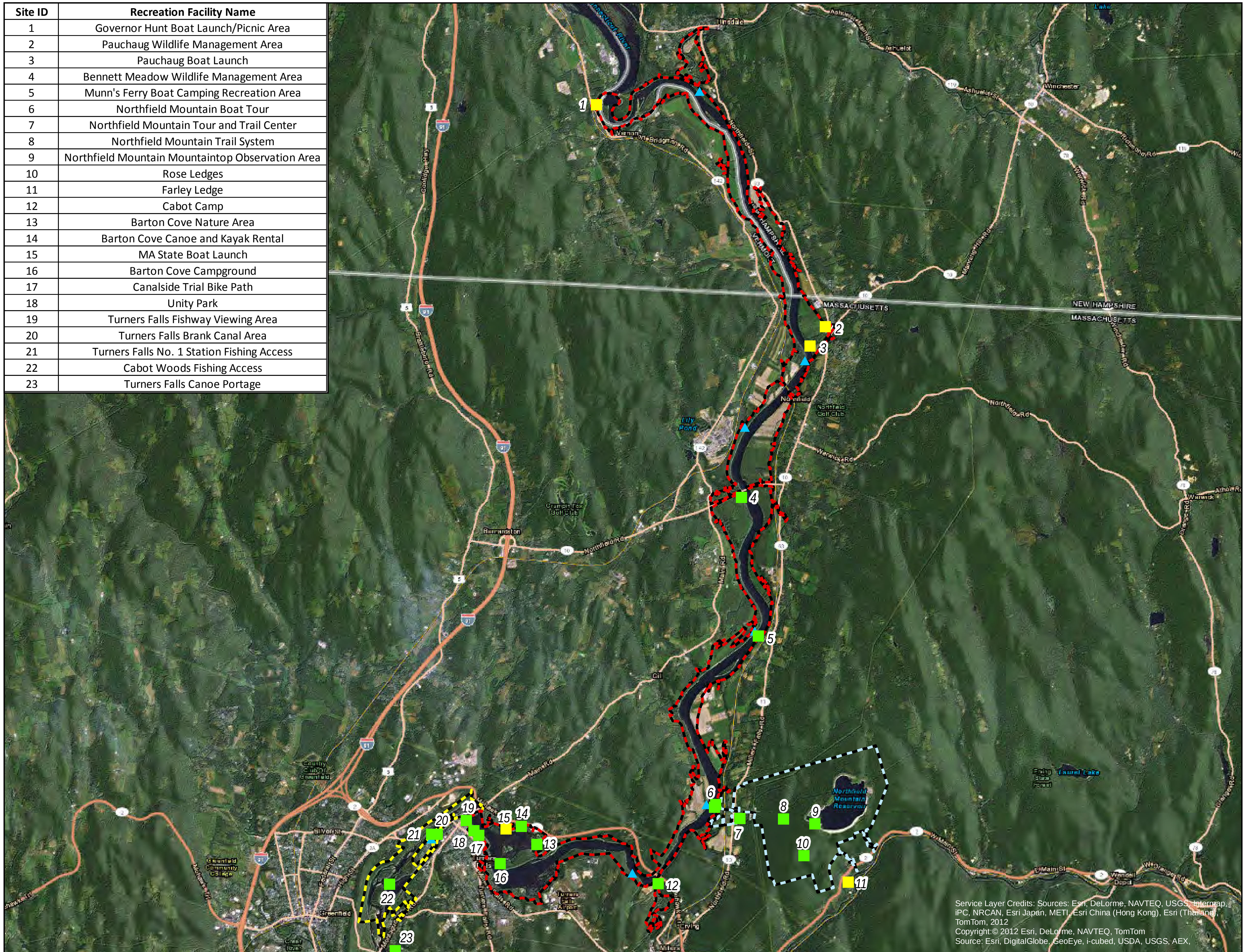
Study Schedule (18 CFR § 5.11(b)(2) and (c))

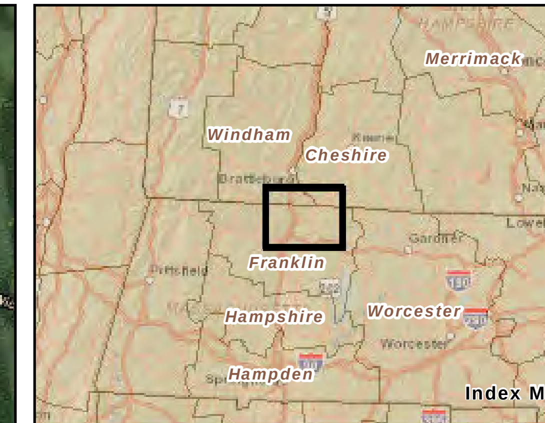
In accordance with 18 CFR § 5.15(c), a Study Plan Meeting was held on May 14, 2013. An additional meeting was held on June 11, 2013. The purpose of the Study Plan Meeting was to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests.

As stated above, the bulk of this study was conducted in the summer of 2012 and a summary of the results was included in Section 4.8.1 of the PAD. The winter portion was completed in 2013 and a summary of the results for all four seasons of investigation will be prepared prior to December 2013.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Site ID	Recreation Facility Name
1	Governor Hunt Boat Launch/Picnic Area
2	Pauchaug Wildlife Management Area
3	Pauchaug Boat Launch
4	Bennett Meadow Wildlife Management Area
5	Munn's Ferry Boat Camping Recreation Area
6	Northfield Mountain Boat Tour
7	Northfield Mountain Tour and Trail Center
8	Northfield Mountain Trail System
9	Northfield Mountain Mountaintop Observation Area
10	Rose Ledges
11	Farley Ledge
12	Cabot Camp
13	Barton Cove Nature Area
14	Barton Cove Canoe and Kayak Rental
15	MA State Boat Launch
16	Barton Cove Campground
17	Canalside Trial Bike Path
18	Unity Park
19	Turners Falls Fishway Viewing Area
20	Turners Falls Brank Canal Area
21	Turners Falls No. 1 Station Fishing Access
22	Cabot Woods Fishing Access
23	Turners Falls Canoe Portage





FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.6.2-1
Recreation Facilities Map

Legend

- Recreation Site Owned by FirstLight
- Recreation Site Owned by Others
- Informal Recreation Site
- Turners Falls Project Boundary
- Turners Falls\Northfield Mountain Project Boundary
- Northfield Mountain Project Boundary

N

0 0.75 1.5 3 Miles

1 inch = 1.5 miles

FirstLight Power Resources
GDF SUEZ

Path: W:\gis\maps\revised_study_plan\Figure 3.6.2-1.mxd

Figure 3.6.2-2: Standardized Survey Form

Inspector:__________________ Date: ____________ Time: ___________ Photo No: ________

Project: _______________ Site Name/Code: _________________ Weather: ________________

Owner: ____ Telephone: _________________

Address: ____

City: _____________________ State: _____ Zip Code: ___________

Facility Type:

Campground____ Picnic Area____ Day Use/Overlook____ Informal____ Launch_____ Marina_____
Hiking______ Ski Area_______

Access:

_____	Water access		
_____	Paved access	______	# of lanes
_____	Unpaved access (conventional motor vehicle)	______	# of lanes
_____	Unpaved access (4WD vehicle)	______	# of lanes
_____	ORV access (ATV)	______	width
_____	Foot access	______	width

Ownership/Management

	Licensee	Federal	State	County	Local	Private	Other
Ownership	_____	_____	_____	_____	_____	_____	__________
Management	_____	_____	_____	_____	_____	_____	___________

Operations:

Staffed ____ Private____ Seasonal_____ Commercial_____ Fee_____ Open/Closed ____

General Area:

Is the area associated with other facilities or activities?______________________________
Potential/need for expansion/enhancement? _______________________________________
Topography: __________________________ Ground cover: _________________________
Erosion/Soils: _________________________ Compaction: __________________________
Approximate Shoreline Footage: ___________ Bank Fishing (Yes/No):_______________
ADA compliant? Obstacles?________________ Rentals?_____________________________

Sanitation Facilities: (Yes/No)

Type:	Unisex	# of Units Women	# of Units Men	Notes (ADA, etc)
Flush	______	________	________	________________________
Composting	______	________	________	________________________
Vault	______	________	________	________________________
Pit	______	________	________	________________________
Portable	______	________	________	________________________
Wilderness	______	________	________	________________________

Site Facilities:

#	Type	Repairs	Material Code	Other Info
_____	Picnic Tables	_________	________	__________________________________
_____	Grills	_________	________	__________________________________
_____	Firepit/ring	_________	________	__________________________________
_____	Trails (specify use)	_________	________	Length?_________________________
_____	Shelter	_________	________	__________________________________
_____	Potable Water	_________	________	__________________________________
_____	Dumping Station	_________	________	__________________________________
_____	Boat Ramp	_________	________	__________________________________
_____	Launching Lanes	_________	________	__________________________________
_____	Playground	_________	________	__________________________________
_____	Showers	_________	________	__________________________________
_____	Benches	_________	________	__________________________________
_____	Interpretive. Displays:	_________	________	__________________________________
_____	Other: __________	_________	________	__________________________________

Material codes; (A) asphalt, (B) Brick, (C) concrete, (CG) compacted gravel, (CRS) crushed gravel, (FE) metal, (G) grass, (GTF) geo-tech fabric, (NS) native soil, (O) other/specify, (P/F) plastic/fiberglass, (RC) rock crib, (S) sand, (W) wood.

Activities occurring:	# of Adults	# of Minors	Total # of users
Picnicking	__________	__________	_______________
Camping	__________	__________	_______________
Walking/hiking	__________	__________	_______________
Swimming	__________	__________	_______________
Beach Activities	__________	__________	_______________
Launching boats	__________	__________	_______________
Fishing	__________	__________	_______________
__________________	__________	__________	_______________

Parking Lots:		Surface Code	Dimensions
# ADA spaces	__________	__________	__________
# regular spaces	__________	__________	__________
# Vehicle & trailer spaces	__________	__________	__________
# of vehicles in lot	__________	Space delineated__________	Curbs__________

Beach/Swim Area: (Yes/No)

	Number	Dimensions	Material	ADA Compliant
Dock/Pier:	_________	________	_______	________
Float: :	_________	________	_______	________

Beach Area Substrate: ___________________________ Swim Area Substrate: ___________________

Dimensions of beach: _________________ Lifeguards _______ Buoyed swim area _________

Campground/Campsite:

	RV sites	Cabin sites	Tent sites	Wilderness sites
Group Sites	__________	__________	__________	__________
Access (foot, orv, car, boat)	__________	__________	__________	__________
# of sites	__________	__________	__________	__________
On site parking	__________	__________	__________	__________
Water front	__________	__________	__________	__________
ADA compliant	__________	__________	__________	__________
Utilities	__________	__________	__________	__________

* (E) Electric, (S) Sanitation, (W) Water, (O) other (specify)

Boat Launch Facilities:

Hard surface _____ Gravel _____ Unimproved _____ Carry In _____ Launch/Load prep area: _____

Docks/Piers/Floats Total Docks____________ Total Slips _____________

Material code:	#1______	#2______	#3______	#4______	#5______
Dimensions:	#1______	#2______	#3______	#4______	#5______
# of slips:	#1______	#2______	#3______	#4______	#5______
ADA compliant:	#1______	#2______	#3______	#4______	#5______

Fishing Piers:

Number: __________________ Combined Length of Piers_______________
Surface code: _________________ ADA compliant: ______________________

Site Aesthetics:

Viewshed from site: __________ Viewshed from shoreline: ____________

1 – No noticeable development
2 – Very limited primitive development
3 – Five (5) or less buildings in view
4 – Six (6) to ten (10) buildings in view
5 – Ten (10) or more buildings in view
6 – Highly developed

Nature of abutting development/land use: ____

Audio perceptions from site: ____

Audio perceptions from shoreline: ____

Evidence of use at site: _____________________________

*(C) Compaction, (E) Erosion, (G) Garbage, (GD) Ground disturbance, (HW) Human waste, (UI) Unauthorized improvements, (V) Vandalism, (VR) Vegetation removal, (O) Other (Specify)

Evidence of Overcrowding: _________________________
*(A) Anecdotal information, (FA) facility/amenity @ capacity, (I) Improper parking, (S) Signage, (SD) site degradation, (U) Unauthorized sites, (W) Waiting lines, (O) Other (Specify)

Notes: ____

Sketch:

3.6.3 Whitewater Boating Evaluation

General Description of Proposed Study

FERC, NEF, AMC, AWWA, NPS, VRC and FCRP submitted requests for a controlled flow whitewater boating analysis on various dates in the spring (for moderate and high flows) and in the summer (for potential scheduled lower flow releases) of the Turners Falls bypass reach. All the requests were similar and requested FirstLight to use accepted whitewater boating evaluation practices to assess the presence, quality, and preferred flow ranges for river based boating resources in the Turners Falls bypass reach. FERC also requested that competing recreational uses and resource needs that may be adversely impacted by any scheduled releases be identified. NEF, AMC, AWWA, NPS, VRC and FCRP also request that access needs for put-in and take-out along the bypass reach be identified and a flow information and distribution system be assessed. FirstLight is proposing to develop and conduct a controlled whitewater boating analysis of the Turners Falls bypass using accepted comparative evaluation practices. FirstLight will consult with stakeholders to develop a comparison flow study methodology, determine the number of flows and volumes to be evaluated, schedule the timing of the evaluation, and to enlist a group of experienced boaters to participate in the evaluation.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The objectives of the study are:

- Assess the effects of a range of bypassed reach flows on whitewater recreation opportunities;
- Determine what watercraft-types would be appropriate to utilize any potential whitewater flows in the bypassed reach;
- Determine the range of flows (minimum through optimal) needed to support various whitewater boating opportunities by watercraft;
- Determine whether current or future demand exists for whitewater boating in the bypassed reach;
- Determine the number of days per month the acceptable and optimum flows for whitewater boating would be available under the Turners Falls Project’s current and any proposed mode of operation;
- Determine any competing recreational uses or other resource needs that may be adversely affected by whitewater boating;
- Identify the need for and define adequate access points, if needed, that provide trails and car-top parking at Great Falls Discovery Center, Station #1 and Cabot Station, and egress at the end of the 2.7 mile bypass run at the confluence of the Deerfield River;
- Conduct an assessment of existing regional whitewater boating opportunities; and
- Prepare a study report that describes the: whitewater boating attributes of the range of flows examined, including level of difficulty, portage requirements; identifies the acceptable and optimal flows for the reach and the frequency of availability of the identified flows under current and any proposed project operation; incorporates relevant results from the *Recreation Use/User Contact Survey* (Study No. 3.6.1), the *Recreation Facilities Inventory and Assessment* (Study No. 3.6.2), and the *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats* (Study No. 3.6.4) including characterization of the suitability of the bypassed reach for whitewater boating, annual recreation use by activity and season of the bypassed reach; whether or not there is a demand for whitewater boating in the bypassed reach; and any

competing recreation uses or other resources in the bypassed reach that could be adversely affected by providing flows for whitewater boating.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreational opportunities associated with the presence and operation of the Turners Falls and Northfield Mountains Projects.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

There is limited information on whitewater boating flows associated with the Turners Falls bypass. The Appalachian Mountain Club *AMC River Guide, Massachusetts, Connecticut, Rhode Island,* Fourth Edition (2006) states there is very little water in the bypass reach except during flood conditions when canoeing is not advised, and that the 3.5 miles of river below the Turners Falls Dam cannot be run even by experienced canoeists.

Anecdotal information indicates that whitewater features exist during high flow conditions in the bypass near the river bend just downstream of Turners Falls Dam and at the so-called "rock dam" located approximately 1.8 miles downstream of the dam, and that the remainder of the bypass is fast current.

Need for Additional Information:

To determine if flows in the bypass area can provide whitewater boating opportunities, a variable flow evaluation will need to be conducted.

Project Nexus (18 CFR § 5.11(d)(4))

FERC policy requires licensees to provide reasonable public recreation opportunities consistent with the safe and effective operation of the Project.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1 – Develop Boating Evaluation Protocol, Logistics and Schedule

Working with NEF, AWWA and AMC, and other interested stakeholders, FirstLight will coordinate selecting dates for spring boating evaluations utilizing natural bypass flows (approximately two flows) and summer bypass evaluations utilizing controlled flows (approximately four flows), scheduling of the evaluations, assembling a team of volunteer boaters (approximately 24 boaters of variable skill levels and with a variety of watercraft, including "tubers"), field logistics, and developing a methodology and comparative evaluation process to rate the bypass flows to meet the study objectives (see Figure 3.6.3-1 for draft evaluation forms). FirstLight will inspect the bypass reach for the presence of rebar in areas subject to flows, and if found, remove the rebar prior to the boating evaluation.

Task 2 – On-Water Boating Evaluation

The boating evaluation will be conducted as designed in Task 1. Two spring dates will be scheduled approximately two weeks apart to evaluate typical spring flows in the bypass. FirstLight will review historical bypass spring flow data and in coordination with NEF, AWWA and AMC based on this data, and schedule dates for the spring evaluations. Participating boaters will complete an evaluation form for each spring flow and a comparative summary evaluation for the two flows after the second boating run. FirstLight will lead and record a post evaluation discussion to discuss the study and to gather additional feedback from the participants.

The summer flows to be evaluated will be established prior to the field evaluations, though flows may be adjusted based on participant boater recommendations during the evaluation provided any adjusted flow(s) can be calibrated at Turners Falls Dam. Evaluation flows will be determined using data from gate rating curves (releases from Turner Falls Dam) and data from the USGS gauging stations below Cabot Station (additional flow from Fall River, Station #1 and Cabot Station) and Montague (to back out flow from the Deerfield River). Participating boaters will complete an evaluation form after each flow and a comparative summary evaluation for all flows upon completion of the final boating run. FirstLight will lead and record a post evaluation discussion to discuss the study and to gather additional feedback from the participants.

<u>Task 3 – Identify and Evaluate Access to the Turners Falls Bypass Reach</u>

FirstLight will identify, investigate, and assess access points that provide trails and car-top parking along the bypass reach including the Great Falls Discovery Center, Station #1, Cabot Station, and at the end of the 2.7 mile bypass run at the confluence of the Deerfield River. This work may be conducted as part of the *Recreation Use/User Contact Survey* (Study No. 3.6.1).

<u>Task 4 – Data Review and Analysis</u>

In AWWA's comment letter on the Updated PSP, they requested the Licensee to examine the extent to which it is able to forego generation or utilize its excess capacity in the Northfield Mountain Upper Reservoir to provide additional flows to enable whitewater boating in the bypass reach. FirstLight believes it is premature to act on AWWA's request because the whitewater boating study has not been conducted to determine if there is a whitewater boating resource in the bypass reach and the demand for such has been identified.

FirstLight will analyze historic flow data to determine the number of days per month spring and summer flows for whitewater boating, as determined by the results of the controlled flow analysis, would be available under the Turner's Falls Project's current mode of operation. An analysis will also be conducted to determine the number and timing of boatable flows for any proposed mode of operation of the Turners Falls Project.

In AWWA's comment letter on the Updated PSP, they state there is no methodology or explanation on how current or future demand for whitewater boating in the bypass reach will be determined.

FirstLight will assess whether current or future demand exists for whitewater boating in the bypassed reach using data from the controlled flow analysis, the *Recreation Use/User Contact Survey* (Study No. 3.6.1), a review and assessment of existing regional whitewater boating opportunities, and regional projections for changes for paddle boating.

In MADFW's comment letter on the Updated PSP, they state the agency will not support seasonally inappropriate flow regimes for whitewater boating (i.e. high flows in mid-summer) as these flows will adversely affect the biota that the Division is seeking to reestablish and protect in the bypassed reach of the Connecticut River.

Based on existing data and data collected from other relicensing studies related to the Turners Falls bypass, FirstLight will identify any competing recreational uses or other resource needs that may be adversely affected by any potential scheduled releases for boating.

Task 5 – Report Development

In CRWC's comment letter on the Updated PSP, they state no details are provided as the content of the study report.

The information gathered during these efforts will be included in a study report addressing the study goals and objectives identified above. Thus the report will contain an assessment of the whitewater boating attributes of the range of flows examined, including level of difficulty, portage requirements; acceptable and optimal flows for the reach and the frequency of availability of the identified flows under current and any proposed project operation; inclusion of any relevant data from the *Recreation Use/User Contact Survey* (Study No. 3.6.1), the *Recreation Facilities Inventory and Assessment* (Study No. 3.6.2), and the *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats* (Study No. 3.6.4) including characterization of the suitability of the bypassed reach for whitewater boating, observed annual recreation use by activity and season of the bypassed reach; assessment of demand for whitewater boating in the bypassed reach; and identification of competing recreation uses or other resources in the bypassed reach that could be adversely affected by providing flows for whitewater boating.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort is sufficient to obtain data to determine the level of whitewater boating opportunities, which may be available with releases in the Turners Falls bypass. The estimated cost for the whitewater boating evaluation outlined in this plan is approximately $60,000 to $65,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), Study Plan Meetings were held on May 14, and June 11, 2013. The purpose of the Study Plan Meetings were to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. On August 8, 2013, FirstLight held an additional meeting with stakeholders to review and obtain comments on the proposed survey instruments contained herein. The Whitewater Boating Evaluation will be conducted in 2014 as follows: develop, and finalize protocols, logistics, and evaluation schedule in winter 2013/2014, conduct spring flow evaluations in April/May 2014, and conduct summer flow and access evaluation in July/August 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Figure 3.6.3-1a: Pre-Run Boater Information Form

PRE-RUN BOATER INFORMATION FORM
Turners Falls Hydroelectric Project, FERC No. 1899
Whitewater Controlled Flow Study

Date:____________________________, 2014

Name:____

1. How would you describe yourself as a boater (what type of boater are you?): _______________
____
____
____
____
____
____
____
___

2. What type of watercraft do you generally use for whitewater paddling? *(Circle one)*

Hard shell kayak	C2
Inflatable kayak	Raft
OC1	Cataraft
OC2	Tube
C1	Other (describe):_________________
Stand up paddle board	

3.

4. How many years have you been using this type of watercraft? ________ Years

5. How would you rate your skill level with this type of watercraft? *(Circle one – whitewater classifications defined on next page)*

    Novice (comfortable running Class II whitewater)
    Intermediate (comfortable running Class III whitewater)
    Advanced (comfortable running Class IV whitewater)
    Expert (comfortable running Class V whitewater)

6. In general, how many days per year do you spend whitewater boating? ____________________

7. What is your age? ______

8. Are you □ male or □ female?

9. Have you boated the by-pass area between Turners Falls Dam and Cabot Station on the Connecticut River before? Yes_____ No_____

Please respond to each of the following statements about your river-running preferences.

	Strongly disagree	Moderately disagree	Slightly disagree	No Opinion	Slightly agree	Moderately agree	Strongly agree
I often run rivers with Class II and III rapids.	1	2	3	4	5	6	7
I often run rivers with difficult rapids (Class IV-V).	1	2	3	4	5	6	7
Running challenging whitewater is the most important part of my boating trips.	1	2	3	4	5	6	7
I often boat short river sections (under 4 miles) to take advantage of whitewater play areas.	1	2	3	4	5	6	7
I often boat river segments to experience a unique and interesting place.	1	2	3	4	5	6	7
I often boat short river segments to run challenging rapids.	1	2	3	4	5	6	7
I select boating opportunities based on length and experience regardless of difficulty.	1	2	3	4	5	6	7
I am willing to tolerate difficult put-ins and portages in order to run interesting reaches of whitewater.	1	2	3	4	5	6	7
I often boat rivers that feature large waves and powerful hydraulics.	1	2	3	4	5	6	7
I often boat steep technical rivers.	1	2	3	4	5	6	7
I enjoy boating both difficult and easy rivers.	1	2	3	4	5	6	7

Class I – Fast moving water with riffles and small waves. Few obstructions, all obvious and easily missed with little training. Risk to swimmers is slight; self-rescue is easy.

Class II – Straightforward rapids with wide, clear channels which are evident without scouting. Occasional maneuvering may be required, but rocks and medium-sized waves are easily missed by trained paddlers. Swimmers are seldom injured and group assistance, while helpful, is seldom needed.

Class III – Rapids with moderate, irregular waves which may be difficult to avoid and which can swamp an open canoe. Complex maneuvers in fast current and good boat control in tight passages or around ledges are often required; large waves or strainers may be present but are easily avoided. Strong eddies and powerful current effects can be found, particularly on large-volume rivers. Scouting is advisable for inexperienced parties. Injuries while swimming are rare; self-rescue is usually easy but group assistance may be required to avoid long swims.

Class IV – Intense, powerful but predictable rapids requiring precise boat handling in turbulent water. Depending on the character of the river, it may feature large, unavoidable waves and holes or constricted passages demanding fast maneuvers under pressure. A fast, reliable eddy turn may be needed to initiate maneuvers, scout rapids, or rest. Rapids may require "must" moves above dangerous hazards. Scouting may be necessary the first time down. Risk of injury to swimmers is moderate to high, and water conditions may make self-rescue difficult. Group assistance for rescue is often essential but requires practiced skills. A strong eskimo roll is highly recommended.

Class V – Extremely obstructed, or very violent rapids which expose a paddler to added risk. Drops may contain large, unavoidable waves and holes or steep, congested chutes with complex demanding routes. Rapids may continue for long distances between pools, demanding a high level of fitness. What eddies exist may be small, turbulent, or difficult to reach. At the high end of the scale, several of these factors may be combined. Scouting is recommended but may be difficult. Swims are dangerous, and rescue is often difficult even for experts. A very reliable eskimo roll, proper equipment, extensive experience, and practiced rescue skills are essential.

Figure 3.6.3-1b: Single Flow Evaluation Form

SINGLE FLOW EVALUATION FORM
Turners Falls Hydroelectric Project FERC No. 1889
Whitewater Controlled Flow Study

Date of run: ____________________

Name: ____

Indicate which flow release this survey corresponds to (check appropriate box):

Flow 1	X cfs	Date/time	
Flow 2	X cfs	Date/time	
Flow 3	X cfs	Date/time	
Flow 4	X cfs	Date/time	

1. Watercraft used (Circle appropriate one):

Hard shell kayak
Inflatable kayak
OC1
OC2
C1
Stand up paddle board
C2
Raft
Cataraft
Tube
Other (describe):_______________

2. Your whitewater boating skill level for the watercraft used for this flow (Circle appropriate one):

Beginner
Novice
Intermediate
Advanced
Expert

3. Please evaluate the boating access for this segment of river (Circle appropriate one):

Put-in Access:	easy	moderate	difficult
Take-out Access:	easy	moderate	difficult

4. Please evaluate this flow for your craft and skill level for each of the following characteristics (Circle one number for each characteristic).

If unacceptable, was flow:

	Totally unacceptable	Unacceptable	Neutral	Acceptable	Totally acceptable	Too Low	Too high
Navigability	-2	-1	0	1	2		
Availability of challenging technical boating	-2	-1	0	1	2		
Availability of	-2	-1	0	1	2		

	Totally unacceptable	Unacceptable	Neutral	Acceptable	Totally acceptable	Too Low	Too high
powerful hydraulics							
Availability of whitewater play areas	-2	-1	0	1	2		
Overall whitewater challenge	-2	-1	0	1	2		
Safety	-2	-1	0	1	2		
Aesthetics	-2	-1	0	1	2		
Length of run	-2	-1	0	1	2		
Number of portages	-2	-1	0	1	2		
Overall Rating	-2	-1	0	1	2		

5. Are you likely to return for future boating in the Turners Falls bypass at **this** flow? (Circle one)

   Definitely no　　Possibly　　Probably　　Definitely yes

6. Based on the International Whitewater Scale (defined below), how would you rate the whitewater difficulty of the river at **this** flow? (if appropriate, provide a range of whitewater classifications for **this** flow)

This flow rates at Class: _________________

- Class I – Fast moving water with riffles and small waves. Few obstructions, all obvious and easily missed with little training. Risk to swimmers is slight; self-rescue is easy.

- Class II – Straightforward rapids with wide, clear channels which are evident without scouting. Occasional maneuvering may be required, but rocks and medium-sized waves are easily missed by trained paddlers. Swimmers are seldom injured and group assistance, while helpful is seldom needed.

- Class III – Rapids with moderate, irregular waves which may be difficult to avoid and which can swamp an open canoe. Complex maneuvers in fast current and good boat control in tight passages or around ledges are often required; large waves or strainers may be present but are easily avoided. Strong eddies and powerful current effects can be found, particularly on large-volume rivers. Scouting is advisable for inexperienced parties. Injuries while swimming are rare; self-rescue is usually easy but group assistance may be required to avoid long swims.

- Class IV – Intense, powerful but predictable rapids requiring precise boat handling in turbulent water. Depending on the character of the river, it may feature large, unavoidable waves and holes or constricted passages demanding fast maneuvers under pressure. A fast, reliable eddy turn may be needed to initiate maneuvers, scout rapids, or rest. Rapids may require "must" moves above dangerous hazards. Scouting may be necessary the first time down. Risk of injury to swimmers is moderate to high, and water conditions may make self-rescue difficult. Group assistance for rescue is often essential but requires practiced skills. A strong eskimo roll is highly recommended.

- Class V – Extremely long, obstructed, or very violent rapids which expose a paddler to added risk. Drops may contain large, unavoidable waves and holes or steep, congested chutes with complex demanding routes. Rapids may continue for long distances between pools, demanding a high level of fitness. What eddies exist may be small, turbulent, or difficult to reach. At the high end of the scale, several of these factors may be combined. Scouting is recommended but may be difficult. Swims are dangerous, and rescue is often difficult even for experts. A very reliable eskimo roll, proper equipment, extensive experience, and practiced rescue skills are essential.

7. What skill level does a paddler need to safely paddle the bypass at **this** flow? (Circle one)

Beginner	Advanced
Novice	Expert
Intermediate	

8. Relative to **this** flow, would you consider the **minimum** acceptable flow (defined as the lowest flow you would return to boat) to be higher, lower, or about the same as this flow? Circle one

Much lower	Higher
Lower	Much higher
No change	

9. Relative to **this** flow, would you consider the **optimum** flow (defined as the ideal flow you would return to boat) to be higher, lower, or about the same as **this** flow? Circle one

Much lower	Higher
Lower	Much higher
No change	

10. Using site numbers or locations, please identify challenging features, rapids or sections and rate their difficulty (using the International Whitewater Scale at **this** flow).

Site numbers/Locations[76]	Rating
____	______

[76] Site numbers/locations will be defined in consultation with the whitewater boating stakeholders during the field investigations for the IFIM study (Study No. 3.3.1)

____ ______

11. Estimate the number of hits, stops, boat drags, and portages you had at **this** flow i.e., did you hit anything and did you have to stop or get out of the boat to continue?).

Number of hits (but did not stop)	______
Number of hits with stops (did not have to get out of boat)	______
Number of hits with stops (had to get out of boat to continue)	______
Number of portages	______

12. Using site numbers/locations on the map provided, identify rapids or sections you portaged and the rate the difficulty of the portages (for **your** type of watercraft at **this** flow)

Place site numbers/location and reason for portage	Easy	Slightly Difficult	Moderately Difficult	Extremely Difficult
__________________________________	1	2	3	4
__________________________________	1	2	3	4
__________________________________	1	2	3	4

13. Did you experience any difficulties during your run **at this flow** (e.g., pinned, wrapped a boat, swam, etc.)? Provide a brief description and location of any difficulty.

Difficulty	Location
_______________________________________	______________________
_______________________________________	______________________
_______________________________________	______________________

14. Provide any additional comments about **this** flow below. If necessary, please use site numbers/locations to identify specific locations.

Figure 3.6.3-1c: Single Flow Evaluation Form

COMPARATIVE FLOW EVALUATION FORM
Turners Falls Hydroelectric Project FERC No. 1889
Whitewater Controlled Flow Study

Date: ________________________, 2014

Name: ____

1. Watercraft used (Circle appropriate one):

   Hard shell kayak
   Inflatable kayak
   OC1
   OC2
   C1
   Stand up paddle board
   C2
   Raft
   Cataraft
   Tube
   Other (describe):________________

2. Your whitewater boating skill level (Circle one):
   Beginner
   Novice
   Intermediate
   Advanced
   Expert

Please answer each of the following questions based on your experience or reaction to the river at each of the flows boated. If you have no opinion about a particular item, leave it blank. Please do not discuss these questions or your responses with other participants.

3. How many times have you boated the Turners Falls bypass of the Connecticut River before this study? (Circle one)

   0 times 1-5 times 6-10 times 11-20 times >20 times

4. A number of factors can affect one's satisfaction with a whitewater trip. How important are each of these factors to you? (Circle one number for each factor)

	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
Availability of features	1	2	3	4	5
Size/difficulty of features	1	2	3	4	5
Driving distance to river	1	2	3	4	5
Accessibility	1	2	3	4	5

	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
Shuttle Availability	1	2	3	4	5
Crowding	1	2	3	4	5
Weather	1	2	3	4	5
Water temperature	1	2	3	4	5
Attractive scenery	1	2	3	4	5
Water quality	1	2	3	4	5
Thrilling experience	1	2	3	4	5
Safe trip	1	2	3	4	5

5. Evaluate the following flows for your craft and skill level. In making your evaluations, consider all the flow-dependent characteristics that contribute to a high quality trip (e.g., navigability, whitewater challenge, safety, availability of features, aesthetics, and length of run). If you did not boat a particular flow(s) during the evaluation, do not rate that flow.

Release Date/Time	Flow (CFS)	Totally Unacceptable	Unacceptable	Neutral	Acceptable	Totally Acceptable
		-2	-1	0	1	2
		-2	-1	0	1	2
		-2	-1	0	1	2
		-2	-1	0	1	2

6. Based on your boating runs on this section of the Connecticut River as part of this study, specify the flows that provide the following types of experiences. (Note: you can specify flows that you did not run/observe, but which you think would provide the type of experience in question).

Flow (cfs)

- From a recreational perspective what is the **minimum acceptable flow** for this run? Note that minimum acceptable differs from minimum flow necessary to navigate. _________
- From your perspective, what is the **optimum flow** for this run? _________

7. Rate the flows evaluated in terms of your craft and skill level

FLOW	CFS	Totally Unacceptable	Unacceptable	Neutral	Acceptable	Totally Acceptable
1 (Date/time)						

2 (Date/time)						
3 (Date/time)						
4 (Date/time)						

8. How important is it to have a variety of flows in the Turners Falls bypass section of the Connecticut River? Rate the importance of having variable flows for the reasons below, or check the box below the table.

A variety of flows is necessary to:	Not at all important	Slightly important	Moderately important	Very important	Extremely important
provide different types of boating experiences;	1	2	3	4	5
provide opportunities for people with different skill levels and watercraft;	1	2	3	4	5

or, □ it isn't important to provide a variety of flow levels for boating.

9. Compared to other rivers of similar difficulty, how would you rate the boating opportunities on the Turners Falls bypass section of the Connecticut River? (Circle appropriate response for each region. If you are unsure about a comparison, leave that item blank.)

Compared to:	Worse than average	Average	Better than average	Excellent	Among the very best
Other rivers within a 1 hour drive					
Other rivers in Massachusetts					
Other rivers in the northeast					
Other rivers in the country					

10. Based on your experience at other regional rivers, use the following scoring system to compare the boating opportunities at these regional rivers to those of the Turners Falls bypass section of the Connecticut River.[77] Assume optimal flow conditions for boating.

Score using the following system:

1 = More desirable than Turners Falls bypass section of the Connecticut
2 = Similar to the Turners Falls bypass section of the Connecticut
3 = Less desirable than the Turners Falls bypass section of the Connecticut
4 = No experience boating the river

[77] Other rivers (and specific river sections) will be identified in consultation with whitewater boating stakeholders prior to the evaluation. Whitewater classifications of rivers and sections will be added to this table once sections are identified

	Westfield	Quabog	Ashuelot	Deerfield Section TBD	Deerfield Section TBD	Deerfield Section TBD								
Suitable for novice boater														
Suitable for intermediate boater														
Suitable for advanced boater														
Size & difficulty of features														
Play boating														
Rafting														
Tubing														
Canoeing														
Kayaking														
Eddy hopping														
Technical maneuvering														
River gradient														
Driving distance to river														
Shuttles														
Access to river														
Parking														
Scenery														
Water quality														
Overall														

11. Any other comments?

3.6.4 Assessment of Day Use and Overnight Facilities Associated with Non-motorized Boats

General Description of Proposed Study

A number of stakeholders requested this study including NPS, AMC, VRC, FCRP, NEF, AWWA, and CRWC. As part of its request for a study of project facilities to support multiple-day self-powered boating trips, NPS/AMC et al request a survey of people who do not use the river or are displaced. FirstLight has proposed to conduct a study of recreation use at the Northfield Mountain Project but does not propose to conduct a survey of non-users or displaced users. It is difficult to identify with any degree of precision the scope of non-users and displaced users and target these groups for a survey. A regional blanket mail survey (to some portion of the populations) to reach these users requires a significant level of effort that is not justified by the typical low rate of return when considering the ratio of non-users and displaced users in relation to the population sampled. In sum, the survey may not provide a statistically valid sample size. FERC regulations require the Licensee to provide an estimate of existing and potential recreational use of the project area as well as measures for creating, preserving and enhancing recreational opportunities at the project. The proposed study plans use standard, FERC- accepted methodologies including a review of the existing day use and overnight facilities associated with carry-in boat launching and water-access camping within the Turners Falls and Northfield Mountain Projects.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

The objectives of the study are:

- Determine the number of overnight recreation facilities located within the Project boundaries, plus downstream areas along both sides of the shoreline of the Connecticut River down to the Sunderland Bridge including the number, capacity, and types of amenities available; .
- Determine if alternate walkable canoe portage trails are feasible;
- Determine the need for and possible locations for future carry-in boat facilities (particularly at Turners Falls Dam, Station #1, Cabot Station, and the Deerfield River Confluence) and overnight facilities;
- Determine if current facilities are adequately spaced for non-motorized boating day use trips;
- Determine if improvements are necessary at existing facilities to meet current and near future use particularly at put-in and take-out facilities; and
- Determine if the seasons of operation are consistent with actual river use.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreational opportunities associated with the presence and operation of the Turners Falls Project.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

Boating, camping, and canoeing use currently occurs within the Projects. The Connecticut River National Blueway, which encompasses the river and its 7.2 million-acre watershed includes Project lands and waters. The AMC River Guide and the Connecticut River Boating Guide: Source to Sea (3rd ed.) describe the Connecticut River between the Vernon Falls Dam and the Turners Falls Dam as a flat water to quick water paddle with overnight camping available at Munn's Ferry and Barton Cove Campground.

There are multiple recreation facilities within the Projects' boundaries that offer a variety of recreation opportunities to the boating community, including the following existing facilities.

Barton Cove Nature Area and Campground: This Nature Area is located within the Turners Falls and Northfield Mountain Projects, on Barton Cove Road in Gill, MA. The Nature Area is owned and managed by the Licensee and is open to the public for camping, picnicking, and bank fishing. Campsites have a picnic table, fire ring and garbage can. There are two vault toilets and additional portable restrooms located within the campground. There is water access from some of the sites and bank fishing is permitted.

MA State Boat Launch: This launch is located within the Turners Falls and Northfield Mountain Projects, off of Route 2 in Gill, MA. This site is owned and managed by the state of Massachusetts, and is open to the public. The site offers boat launching and bank fishing opportunities. There is a parking lot, boat ramp, dock, and portable sanitation facility.

Barton Cove Canoe and Kayak Rental Area: This site is located within the Turners Falls and Northfield Mountain Projects, off of Route 2 in Gill, MA. This site is owned and managed by the Licensee and offers day use opportunities. There is a canoe/kayak launch, a rental office, picnic tables, parking, and a portable sanitation facility.

Munn's Ferry Boat Camping Recreation Area: This site is a water access site located on the east side of the river in NorthFGS, MA. The camping area is located within the Turners Falls and Northfield Mountain Projects. This area is owned and managed by the Licensee and is available for overnight use. There are tent campsites each with a trash can, tent platform, picnic table, fire ring and grill. There is also a lean-to site with a trash can, tent platform, picnic table, fire ring and grill. There are pit toilets available at the site. Bank fishing opportunities are also available at this site.

Pauchaug Boat Launch: This site is owned and managed by the state of Massachusetts. The site is located within the Turners Falls Project and Northfield Mountain Project. There is a boat launch, parking and portable sanitation available at this site.

Governor Hunt Boat Launch/Picnic Area: This site is owned and managed by TransCanada, which owns the Vernon Project. While this area is within the Vernon Project boundary, the area is also located in the area where the Turners Falls Project and Northfield Mountain Project boundaries and the Vernon Project boundary overlap. The area is open for day use opportunities and has a picnic area and boat launch. Recreation opportunities at the site include bank fishing, picnicking, boat launching, and sightseeing.

Turners Falls Canoe Portage (Poplar Street Put-in): Portages around the Turners Falls Dam are available seven days per week for canoes and kayaks. The portage take-out is at the Barton Cove Canoe & Kayak Rental Area. Boaters wishing to proceed downriver of Barton Cove are picked up by the Licensee and driven downstream to Poplar Street in Montague, where they can continue their trip. The Poplar Street put-in is owned and maintained by the Licensee and is located at the end of Poplar Street. The site, which offers a small parking area and an informal access trail to the river, is located outside of the Turners Falls Project boundary.

Project Nexus (18 CFR § 5.11(d)(4))

FERC regulations require that the license application include a statement of the existing recreation measures or facilities to be continued or maintained and the new measures or facilities proposed by the applicant for the purpose of creating, preserving, or enhancing recreational opportunities at the Projects and in their vicinities, and for the purpose of ensuring the safety of the public in its use of Project lands and waters. In addition, recreation is a recognized project purpose at FERC-licensed projects under section 10(a) of the FPA.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Literature Review:

FirstLight proposes to conduct a desk top review of the existing recreation data including recreation facility inventory data collected in 2012-2013 and camping records. This information will be used to determine the locations and spacing between facilities associated with non-motorized boating trips, as well as hours and seasons of operations. Data regarding existing capacity and existing campsite use will be compared to determine if the current facilities are meeting current use needs.

The Licensee will review and take into consideration appropriate federal, state, county and local programs and plans related to recreational use of the waterway within the Projects' boundaries. These plans will include a review of the Connecticut River Paddlers Trail organization's maps and plans, along with the AMC River Guide, "Inland Guides" produced by KM Digital Productions, and the Connecticut River Boating Guide: Source to Sea (3rd ed.). The Licensee will consult with the CT River Paddlers Trail organization about the current work that it is conducting with regard to the location of campsites, put-ins and take-outs on the river within the Project vicinity for overnight non-motorized boating.

Data from the *Recreation Use/User Contact Survey* will be reviewed to assess the need for new or improved facilities to accommodate non-motorized boating use at the Projects. FirstLight will also review land ownership information, existing improvement plans, and aerial photography to determine potential locations for future use sites, if needed and potential improvements for existing sites, if needed.

The Licensee will review traffic direction, road widths, general amount of road use, public safety, property ownership, topography, estimation of construction costs, river flows, and trail lengths when considering potential canoe portage trails and existing or new put-in sites. The Licensee will review the existing information regarding the Poplar Street Put-in and develop potential improvements to the site which may be implemented when and if it is determined that improvements are needed. Information will be field verified and updated as appropriate as part of Task 2.

Task 2: Field Work

A field survey will be used to ground verify the location for potential future use sites and determine the feasibility of developing these sites. Areas that will be visited may include Kidd's Island, Munns Ferry, and other lands as identified by Task 1 or as observed in the field. A review of potential canoe portage trails and potential put-in improvements will also be conducted in the field along with flows at potential put-in locations. FirstLight will observe water flows and depths in the by-pass to determine navigability by non-motorized boats.

The NPS requests that the revised study include a comprehensive assessment of the condition of each site, along with how various ratings (good, fair or poor) are defined and applied. General site conditions were studied as part of Study No. 3.6.2 *Recreation Facilities Inventory and Assessment.* Conditions of the recreational facilities inventoried as part of the baseline study will be included in the summary report to be developed under Study No. 3.6.2. NPS also states the adequacy of the portage at Turners Falls must also be addressed in order to cure existing deficiencies in the opportunities for multi-day paddling trips. As noted herein, a purpose of Study No. 3.6.4 is to assess the adequacy of canoe portage at Turners Falls.

The AMC states that the Trust for Public Lands has developed a map of potential campsites for non-motorized boaters on the Connecticut River in Massachusetts. The map was created as part of the effort to expand the Connecticut River Paddlers' Trail into Massachusetts and Connecticut.

The Licensee contacted the Trust for Public Lands (TPL) regarding the data used to develop their map and TPL has offered to provide data layers showing existing and potential campsite and access locations to the Licensee. This data will be used during the field work to ground verify potential sites as noted above.

Task 3: Report Preparation

Upon completion of field surveys, FirstLight will use the data reviewed and gathered to develop a written report discussing the findings including the sufficiency of current recreation facilities and need, if any, for new or improved facilities and potential improvements with respect to multiple day non-motorized boat trips. A map depicting the current locations of facilities and potential future locations will also be included as part of the report. A table showing ownership and management of existing and potential sites along with the facility type and number of overnight sites will be provided in the report.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort is sufficient to obtain information regarding carry-in boating opportunities within the Turners Falls Project area. The estimated cost for the assessment outlined in this plan is approximately $ 40,000- 45,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), Study Plan Meetings were held on May 14 and June 11, 2013. The purpose of the Study Plan Meetings were to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests.

The literature review will conducted in January – April of 2014, while field work will be completed between May and August of 2014. Report preparation will occur at the end of 2014 and in the beginning of 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

3.6.5 Land Use Inventory

General Description of Proposed Study

This study was proposed by FirstLight as part of the PAD and includes a review of existing land uses occurring on Project and adjacent lands, applicable land use controls such as local zoning, results of other resource studies, and a determination of the appropriate land use designations for lands within the Turners Falls Project and Northfield Mountain Project. Once the existing land uses and land use controls are identified, FirstLight will review available aerial photography and apply an appropriate designation to the Turners Falls Project and Northfield Mountain Project lands. This will aid in future land management decisions for lands within the Turners Falls Project and Northfield Mountain Project boundaries.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

The objectives of this inventory are as follows:

- Identify the current land uses within the Turners Falls Project boundary and the Northfield Mountain Project boundary.
- Identify the current land uses on lands abutting the Turners Falls and Northfield Mountain Project boundaries up to 200 feet.
- Identify current land use controls on lands within the Projects' boundaries and on lands abutting the Project boundaries up to 200 feet.
- Identify Licensee owned lands adjacent to the Project boundary.
- Determine the appropriate land use designations for lands within the Turners Falls Project and Northfield Mountain Project boundaries. Designations will be based on the review of existing uses on lands within the Projects' boundaries and adjacent lands, the results of other resource studies, and land use controls such as local zoning.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

Resource management agencies are interested in the appropriate land designations in order to protect the natural resources within the Northfield and Turners Falls Projects.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information

Section 4.8 of the PAD provided information regarding recreation resources within the Projects and surrounding areas. Lands within the Projects' boundaries are used for operation of the Projects and recreation. There are also areas of agricultural and forested lands, as well as wetland areas located within the Projects. Other land types located within the Projects include open land, medium, low, and very low density residential development, forest, wetlands, open land, powerline/utility, urban, public/institutional, and industrial uses. Associated land use activities also include land maintenance, road and trail maintenance, tree removal, and vegetation clearing. The area surrounding the Turners Falls and Northfield Mountain Projects, from the Northfield Mountain Project north to the Vernon Project, is largely rural with a mix of agriculture lands and some forested areas. The lands south of the Northfield Mountain Project, near the Turners Falls Dam, are largely developed with a mix of residential and industrial uses. There are no Vermont, Massachusetts, or New Hampshire designated natural areas within the Turners Falls and Northfield Mountain Projects' boundaries. The Nolumbeka Project considers their use of the land in the Project area in harmony with the cultural history and attraction to the Great Falls area.

The Licensee has granted permission to others for non-Project uses of Project lands in accordance with the provisions of the Turners Falls and Northfield Projects' licenses. These non-Project uses include uses of Project lands and waters for a parking area, the Conte Fish Lab, a fire pond, a privately owned boat club, private camps, landscaping activities, agricultural uses, communications antennas, docks, a NPDES discharge, and water withdrawals.

Need for Additional Information:

FirstLight will continue to make land management decisions regarding the use of lands within the Projects. In order to guide in decision making for future use of lands within the Projects' boundaries, FirstLight requires updated land use information regarding the current uses of Project lands and of lands within 200 feet of the Projects' boundaries. This information can then be used to determine appropriate land use designations for lands within the Projects' boundaries. The information would be readily available via GIS mapping and can be continually updated as information changes.

Project Nexus (18 CFR § 5.11(d)(4))

Operation of the Turners Falls Project and the Northfield Mountain Project may have the potential to affect land use within the Projects' boundaries.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Literature and Aerial Photography Review

FirstLight proposes to review existing land use controls, because land use controls may impact how land is currently being used. Information reviewed will include local plans, ordinances, statutes, policies, and guidelines that may affect use and/or management of Project lands, along with the results of resource studies conducted as part of the relicensing process. Examples of information that will be reviewed include but are not be limited to the MA River Protection Act, data from the MA GIS database, the 2005 Northfield Open Space and Recreation Plan, 2005 Gill Open Space and Recreation Plan, 2010 Montague Open Space and Recreation Plan, Erving Master Plan, and Sustainable Franklin County – A Regional Plan for Sustainable Development for Franklin County. The Licensee will also review and identify conservation easements within 200' of the Turners Falls and Northfield Mountain Project boundaries to the extent that such information is readily available.

Using aerial photography, FirstLight will also identify land uses and land use controls on lands abutting the Projects up to 200 feet beyond the Projects' boundaries. Identification of uses of lands within 200 feet of the Projects' boundaries will allow for appropriate designation of lands within the Projects taking into consideration abutting property use. This review will utilize existing, publicly available aerial photography and will be ground truthed as necessary.

Task 2: Development and Application of Land Use Designations

FirstLight will use the results of the literature review and the results of the identification of land uses currently occurring within the Projects' boundaries and on adjacent lands to develop appropriate land use designations for lands within the Projects' boundaries. Proposed land use designations may include: agriculture – crop, agriculture – livestock, residential, recreation, industrial, wetlands, and forested. These land use designations may be refined once photo interpretation begins and based on a review of designations used in plans reviewed as part of Task 1. Once land use designations are defined, FirstLight will propose the application of the appropriate designation to lands within the Turners Falls Project and Northfield Mountain Project boundaries.

Task 3: Map and Summary Development

FirstLight will prepare maps showing the existing land uses within the Project boundary and up to 200 feet abutting the Project boundary, as well as a map showing lands owned by the Licensee and existing locations of docks and water withdrawals. A summary of the results of the study including the methodology used will also be prepared. The summary will include the proposed land use designations and definitions, along with the percentage of Project lands in each designation.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort is adequate to obtain baseline information on the existing land uses and land use controls within the Project boundaries and on abutting lands up to 200 feet from the Project boundaries. The estimated cost for this inventory is approximately $15,000-20,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), Study Plan Meetings were held on May 14 on June 11, 2013. The purpose of the Study Plan Meetings were to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. The *Land Use Inventory* will be initiated in 2014 but because the *Inventory* depends in part on the results of other resources studies proposed herein, the *Inventory* will be completed in 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

3.6.6 Assessment of Effects of Project Operation on Recreation and Land Use

General Description of Proposed Study

FirstLight originally proposed this study in the PAD. The study plans to use the information derived from the studies set forth in the Recreation Use/User Contact Survey and the Recreation Facilities Inventory and Assessment to assess the potential impact of continuing operation and maintenance of the Projects on recreation and land use.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

The objective of this assessment is to determine if the operation of the Turners Falls Project and the Northfield Mountain Project has an effect on the recreation facilities or land use within either Project.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreational opportunities associated with the operation of the Turners Falls and Northfield Mountains Projects.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

There are 20 formal recreation facilities located within the Turners Falls and Northfield Mountain Projects' boundary. Section 4.8 of the PAD provided information regarding recreation resources within the Projects and surrounding areas. These facilities provide a variety of amenities, including but not limited to boat ramps, camp sites, picnic tables, benches, trails, and interpretive displays.

Need for Additional Information:

FirstLight will need to review the proposed studies, once completed, to determine if there are effects from Project operations on the existing public recreation sites or on land use within either Project and down to the Sunderland Bridge.

Project Nexus (18 CFR § 5.11(d)(4))

The objective of this assessment is to determine if the operation of the Turners Falls Project and the Northfield Mountain Project has an effect on the recreation facilities or land use within either Project and down to the Sunderland Bridge.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Data Compilation

FirstLight will review the information derived from the studies set forth in the *Recreation Use/User Contact Survey* (Study No. 3.6.1), the *Recreation Facilities Inventory and Assessment* (Study No. 3.6.2), the *Whitewater Boating Evaluation* (Study No. 3.6.3), the *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats* (Study No. 3.6.4), and the *Recreation Study at Northfield*

Mountain, including Assessment of Sufficiency of Trails for Shared Use (Study No. 3.6.7) to assess the potential impact of continuing operation and maintenance of the Projects' on recreation. FirstLight will also review historic and existing water level fluctuation information.

The CRWC asks that surveys be conducted at river access points and mailed to river abutters downstream of the Turners Falls canal to the Sunderland Bridge, such as the rowing program at Deerfield Academy and river users at the Sunderland boat ramp. FirstLight believes that the expanded scope will not result in a comparable increase in survey data that is relevant to the Projects.

Task 2: Data Analysis

FirstLight will compare the information reviewed in Task 1 to determine if there are access issues resulting from water level fluctuations, including any potential impacts to launching watercraft for emergency rescue operations. This will include analyzing inventory data and comparing it to water elevation data on the dates of the surveys. In addition, FirstLight has proposed to develop a hydraulic model of the Turners Falls Impoundment, bypass reach and of the Connecticut River below Cabot Station down to Holyoke Dam (Study No. 3.2.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot Station*), which will also be used in the assessment of impacts to recreational access from water level fluctuations. The Licensee is also proposing to complete *Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace* (Study No. 3.3.9), which will be reviewed as part of this assessment to determine whether direction of flow has an impact on recreational facilities and access. Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability* will collect water level data which will be reviewed as part of this assessment.

Task 3: Report Development

FirstLight will prepare a report with the results of the study, including a determination if there are access issues due to fluctuating water levels and where they may be occurring. Included in the reports will be maps showing project recreation facilities, tables containing user survey results related to water levels, and a summary of the project methodology and conclusions.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the assessment as proposed above is sufficient to determine if the operation of the Projects has an effect on the recreation facilities or land use within the Project. It is estimated that this assessment will cost approximately $15,000-20,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), Study Plan Meetings were held on May 14 and June 11, 2013. The purpose of the Study Plan Meetings were to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests.

The *Assessment of Effects of Project Operations on Recreation and Land Use* will be initiated in the fall of 2014 but because the *Assessment* depends in part upon the results of other studies, the bulk of the assessment will be conducted in 2015. A progress report regarding the status of this study will be provided in 2014 in conjunction with the Initial Study Report.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

3.6.7 Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use

General Description of Proposed Study

A number of stakeholders requested this study including: NPS, AMC, VRC, FCRP, and Ms. Krug. This study is designed to determine the number of existing recreation facilities, the number and types of amenities available at each facility and the overall condition of the facilities associated with the Northfield Mountain Project. This will include a review of the trail system and climbing ledges located within the Northfield Mountain Project boundary.

NPS/AMC et al request that the study of the Northfield Project recreation facilities include a survey that seeks to determine what discourages the public from using the facilities. FirstLight proposes to use the contact and mail surveys conducted as part of the *Recreation Use/User Contact Survey* (Study No. 3.6.1) to seek out what improvements may be needed. As set forth, however, in the *Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boating* (Study No. 3.6.4), FirstLight does not propose to conduct a survey of non-users or displaced users because such a survey will not yield reliable or meaningful information in consideration of the level of effort required.

Ms. Krug requests that FirstLight evaluate trail networks in Franklin County to determine the need for additional trails and to conduct a site visit to some of these trails. This was not adopted because these trails are located outside of the Project area. FirstLight is proposing to gather information regarding the trail needs for mountain biking as part of the user contact survey proposed in *Recreation Use/User Contact Survey* (Study No. 3.6.1).

NPS requests that FirstLight evaluate its expenditures over the term of the current license in support of the facility, its promotion, and usage and extrapolate in current dollars, what would be necessary to bring the facility up to the quality and level of use that applicable FERC regulation prescribe. Past expenditure information is available on the FERC Form 80 and has not been included as part of this study. As part of its license application, FirstLight will provide estimates for any proposed recreational improvements.

Ms. Krug asks for online user surveys to talk to mountain bike groups regarding the needs of mountain bicyclists and assess interest in opportunities at Northfield Mountain. Internet surveys are not appropriate for quantitative analysis because they are not representative of the general recreational user population and do not provide reliable results. FirstLight proposes to use the results of the surveys proposed in the *Recreation Use/User Contact Survey (*Study No. 3.6.1) to seek out what improvements may be needed.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to compile existing data and develop additional information to support a new FERC license application for continued future operation of the Project.

The objectives of this study are as follows:

- Determine whether the Northfield Mountain Tour and Trail Center has met recreation needs and if improvements or additions are necessary at the Center with a consideration of potential needs over the course of the 30 to 50 year new license; and
- Identify uses taking place on the current trail system and whether the current trail system is suitable and adequate for sustaining those uses, including evaluating the condition of existing trails e.g., erosion, drainage, width, slope, or obstacles.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

The resource management goals are to enhance the recreation opportunities associated with the operation of the Northfield Mountain Project.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Existing Information:

The Northfield Mountain Tour and Trail Center, Northfield Mountain Trail System and Northfield Mountain Mountaintop Observation Area provide numerous recreation opportunities within the Northfield Mountain Project boundary. Although they are not formal recreation facilities, Rose Ledge and Farley Ledge provide climbing opportunities to the public. The three formal recreation facilities are described in detail below.

Northfield Mountain Tour and Trail Center: This site, which is also known as the Visitor Center, is located within the Northfield Mountain Project, off Millers Falls Road (Rt. 63) in NorthFGS, MA. The Center is owned and managed by the Licensee and is available for day use activities. Available opportunities include viewing interpretive displays, picnicking, and educational programs. The Center has restrooms, cross-country ski rental equipment, and parking. It is open for year-round recreational and educational use.

Northfield Mountain Trail System: The trail system is located at the Northfield Mountain Project, off Millers Falls Road (Rt. 63) in NorthFGS, MA. Over twenty-six miles of trail are available for hiking, biking, trail running, horseback riding, snowshoeing, and cross-country skiing. Climbers currently utilize a portion of the trail system to access Rose Ledge.

Northfield Mountain Mountaintop Observation Area: This site is located adjacent to the Northfield Mountain Project upper reservoir. The Observation Deck is owned and managed by the Licensee and is accessible by using the trail system.

Project Nexus (18 CFR § 5.11(d)(4))

FERC regulations require that the license application include a statement of the existing recreation measures or facilities to be continued or maintained and the new measures or facilities proposed by the applicant for the purpose of creating, preserving, or enhancing recreational opportunities at the Projects and in their vicinities, and for the purpose of ensuring the safety of the public in its use of Project lands and waters. In addition, recreation is a recognized project purpose at FERC-licensed projects under section 10(a) of the FPA.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Review of Existing Information

The Licensee proposes to use data collected as part of the *Recreation Use and User Contact Survey* (Study No. 3.6.1) to identify opinions of current recreation users of the Northfield Mountain recreation facilities and public education programs offered at the visitor's center. Prior to conducting field work associated with this study, a review of proposed trails, existing aerials and property ownership will be conducted.

Existing hiking and biking trail information for the Northfield Mountain area will be reviewed, as well as best management practices set forth by the International Mountain Bicycling Association, the USFS Trail Classifications, and the MA Department of Conservation & Recreation's Trail Guidelines and Best Practices standards.

Task 2: Field Work

The Licensee will conduct a field review of the current trail system, climbing sites, and the existing portion of the New England National Scenic Trail. This will include locating the sites with a GPS, if the information does not currently exist; photographing and recording the current amenities and conditions of the sites; and determining if there is a need for improvement. Trail characteristics at Northfield Mountain such as grade, cross slope, width, surface material/firmness, width, and drainage will be assessed and typical characteristics will be recorded.

Task 3: Desktop Analysis

A desktop analysis will be conducted to compare field data, survey data, and existing information. The analysis will determine if the current facilities are meeting the existing recreation needs at Northfield Mountain and provide a list of potential improvements that could be completed if the need arises over the course of the license.

Task 4: Report Development

The information collected will be compiled within a written report and will include tables containing recreation user survey results relating to the Northfield Mountain trails and education programs. The report will utilize existing information to determine, if possible, trends in use of the facilities' educational programs and will describe existing educational programs offered at the Northfield Mountain Project. Maps showing the trail locations and amenity locations will also be included.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

FirstLight believes that the proposed level of effort is sufficient to obtain information on recreational facilities and amenities at Northfield Mountain, within the Northfield Mountain Project boundary. The estimated cost for the study outlined in this plan is approximately $55,000-$60,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), Study Plan Meetings were held on May 14 and June 11, 2013. The purpose of the Study Plan Meetings were to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. As set forth in Study No. 3.6.1, a meeting was held on August 8, 2013 to review comments on the Northfield Mountain Trail User Survey (Figure 3.6.1-2).

The review of existing information will be conducted in January through May of 2014. The field work will be completed during all four season of 2014. The desktop analysis will be conducted November of 2014 through February of 2015.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

3.7 Cultural Resources

3.7.1 Phase 1A Archaeological Survey

General Description of Proposed Study

In its PAD, FirstLight proposed to conduct a Phase 1A archaeological survey. FERC and the Town of Montague have requested assessments of archaeological resources. The purpose of the Phase IA archaeological survey is to identify known archaeological sites, as well as locations where there is a high potential for archaeological sites to exist, within the Turners Falls and Northfield Mountain Projects' APE that potentially may be eligible for inclusion in the National Register of Historic Places (NRHP), and to provide recommendations for future Phase IB field surveys to yet unknown resources, and assess possible effects from the Projects' operations on those resources.

The area of investigation will include the FERC-defined APE as identified in the PAD, which includes the Projects' boundaries and any construction, recreational, or known locations effected by project operation outside of the Projects' boundaries. The Project APE is further defined by FERC as: "the lands enclosed by the Projects' boundary and lands or properties outside of the Project's boundaries where project construction and operation or project-related recreational development or other enhancements may cause changes in the character or use of historic properties, if any historic properties exist." The Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO will be consulted with respect to the definition of the APE. For the purpose of providing appropriate context upon which to interpret archaeological resources identified within the Project APE, the Phase IA background literature research may extend beyond the Project APE to include the Connecticut River Valley region. Draft maps of the proposed APE are attached as Figures 3.7.1-1 – 3.7.1-5. A detailed map of the APE, will be prepared and included in the Study Report. The proposed APE will also include the Fuller Farm property, located on Miller's Farm Road, just north of the Northfield Mountain Visitors' Center, which FirstLight is considering removing from the Project boundary as part of its relicensing proposal. See Figure 3.7.1-6.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to assist FERC in meeting its compliance requirements under Section 106 of the NHPA, as amended, by determining if licensing of the Project will have an adverse effect on historic properties.

The objective of the study is to identify known cultural resources listed in or eligible for listing in the NRHP and to identify and assess any potential adverse effects to historic properties from the continuing operation and maintenance of the Projects.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

Section 106 of the National Historic Preservation Act (1966) requires that federal agencies, licensees, and those receiving federal assistance take into account the effects of proposed undertakings on any resource that is listed on or is eligible for the NRHP. As the lead agency, FERC is responsible for fulfilling the requirements of Section 106 in its decision to issue a new license to the Projects.

As stipulated by the regulations that implement Section 106 (36 CFR 800), the Massachusetts, Vermont, and New Hampshire SHPOs represent the interests of their respective States and their citizens, and advise and assist FERC in determining the significance of cultural resources within the APE. FirstLight proposes consulting with the SHPOs and the Narragansett THPO in the development of the survey methodology, identification of existing cultural resources and effects, establishment of its APE, and development of a Programmatic Agreement (PA) and HPMP, if needed.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Information contained in the PAD indicates that Native Americans have occupied the Connecticut River Valley as early as 14,000 years before the present day. Archaeological sites dating from the *Paleoindian* (before 8000 BC), *Archaic* (8000 BC – 1000 BC), and *Woodland* (1000 BC – AD 1600) periods, as well as the early Euro-American exploration, settlement, and industrial periods, may exist on lands bordering the Connecticut River. The Riverside Archaeological District in the Towns of Gill and Greenfield was listed in the NRHP in 1975 in recognition of significant archaeological remains known to exist in the Turners Falls vicinity. European settlement in the Connecticut River basin in what was to later become Northfield Township and the Town of Gill occurred as early as 1672. During King Phillip's War in 1676, Peskeopscut (Turners Falls) was the site of a military encounter between colonial forces under Captain William Turner and Native Americans. Following the American Revolution, transportation improvements included construction of the Upper Locks and Canal (1792-98) from Turners Falls to Montague. After the Civil War, Turners Falls developed as an important center of manufacturing with the establishment of the Turners Falls Company in the early 1870s. In the 1890s, Turners Falls continued to expand with construction of a new paper mill, shoe factory, and leather manufacturers.

To date, there have been no comprehensive, professional archaeological surveys of the Project APE to identify such resources. FirstLight therefore proposes to conduct the Phase IA archaeological survey to identify potential NRHP-eligible archaeological resources in the Projects' APE and provide information to assess potential adverse effects to such resources. FirstLight will consult with the Massachusetts, Vermont, and New Hampshire SHPOs, the Narragansett THPO, and other interested stakeholders such as the Nolumbeka Project during the Phase IA study.

Project Nexus (18 CFR § 5.11(d)(4))

The proposed cultural resources study will provide information on known archaeological sites and areas where there is a high potential for archaeological sites to exist, within the Projects' APE. The resulting technical reports will provide information on which known resources are potentially eligible for inclusion in the NRHP and what potential adverse effects to these resources would be created by the continued operation of the Project. Once the potential adverse effects are determined, the information that is developed during the course of the study may be used as the basis for preparing an HPMP. Guiding the Licensee's actions relating to Section 106 during the term of the new license, an HPMP would discuss how to avoid potential adverse effects or how they would be mitigated. A final HPMP would be filed with the license application.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1 – Meeting with the Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO

FirstLight will consult with the Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO with respect to development of the precise APE for the Projects, the development of a sensitivity model, and archaeological field reconnaissance methodology. In their July 15, 2013 comment letter on the Updated PSP, the Vermont SHPO requested that a consultation schedule be specified in the RSP. In response, FirstLight proposes that a teleconference meeting will be held in October 2013 to discuss the precise APE for the Projects with the aforementioned parties. The Vermont SHPO also requested that the RSP make specific reference to a Phase IB identification survey, Phase II evaluation of recorded archaeological resources, and identification of Traditional Cultural Properties. FirstLight is not proposing to conduct a Phase IB or Phase II survey until after it has reviewed the results of the Phase IA survey with the SHPOs and the Narragansett THPO and consultation determines that such surveys are necessary in light of the Phase IA results. FirstLight is proposing to conduct a *Traditional Cultural Properties Study* (Study No. 3.7.3). During FirstLight's June 12, 2013 PSP presentation, the Vermont SHPO indicated that a 10-meter-wide APE for Phase IB archaeological survey along waterway shorelines has been utilized for hydroelectric relicensing projects in Vermont. FirstLight will attempt to obtain concurrence of this definition of the APE for any future Phase IB archaeological surveys prior to initiation of the Phase IA study in January 2014.

The Phase IA archaeological survey will conform to the professional standards and guidelines established by the SHPOS in each state. As indicated in the Massachusetts SHPO PSP review letter of April 24, 2013, and their review letter of June 21, 2013 of the Project Notification Form, all proposed archaeological investigations in the State of Massachusetts will be conducted under a State Archaeologist's Permit (950 CMR 70). FirstLight will also employ a professionally qualified archaeologist who meets the *Secretary of the Interior's Standards* and has previous relevant experience in the ancient and historic period archaeology of the Connecticut River Valley region to conduct the archaeological studies. Prior to execution of field studies, FirstLight will identify an adequate curatorial facility for records of the investigation and any recovered archaeological materials, with a preference for curation within Massachusetts for the Massachusetts study area.

Task 2 – Background Research

FirstLight proposes to examine archaeological site files, cultural resources reports, and archives located at the Massachusetts, Vermont, and New Hampshire SHPOs, and other local and regional repositories, such as the Great Falls Discovery Center in Turners Falls and the Pocumtuck Valley Memorial Association in Deerfield. The purpose of this work is to examine relevant sources that may contain historical and archaeological information on the two Project areas in order to develop Precontact and historic contexts and an archaeological sensitivity model. As part of this study, FirstLight will endeavor to obtain background information from local historians, researchers, and other persons knowledgeable of the cultural history of the two Project areas.

Task 3 – Development of a Sensitivity Model

FirstLight will develop a sensitivity model, based on its consultation with the SHPOs and the Narragansett THPO, and on its background research to identify areas within the APE that are likely to contain archaeological resources. The development of a sensitivity model will aid in identifying the probable locations of Precontact- and historic-period archaeological sites. Models of Precontact human occupation in the Northeast suggest that populations utilized a variety of environments and ecotones to procure food and other resources and show that some areas were more attractive than others to establish camps and villages. Environmental settings typically associated with Precontact-period occupation include major rivers or creek valleys, rockshelters, springheads, stream confluences, well-drained lands along secondary streams, and bedrock outcrops for lithic resource procurement. Other factors include elevation, slope gradient, aspect, stream order, distance from fresh water, landform, soil type, and soil drainage. During the historic period, settlements were often found along transportation routes, including waterways. The development of a sensitivity model would result in a tripartite division of the APE into areas of High, Moderate, and Low Sensitivity for archaeological resources. FirstLight will consult with the SHPOs and Narragansett THPO to attempt to obtain their concurrence with the sensitivity model.

In addition, the results of the *2013 Full River Reconnaissance Study* (Study No. 3.1.1), will be reviewed and assessed by the professionally qualified archaeologist, in connection with its background research and development of the sensitivity model, and management recommendations will be made in the Phase 1A report, as appropriate.

Task 4 – Field Reconnaissance

FirstLight also proposes to conduct archaeological field reconnaissance of the Turners Falls Project and Northfield Mountain Project areas to confirm the sensitivity models and eliminate areas from further study as warranted. The field reconnaissance will consist of visual examination of selected portions of the Project areas, focusing primarily on landforms that have the greatest potential to contain archaeological resources, and as well as confirming areas of disturbance, steep slope, and wetlands, which would have little potential to contain in situ buried archaeological resources. A limited number of soil cores may be taken to confirm soil characteristics and/or ground disturbances; it is anticipated that no other ground disturbance will be required for this study. The field reconnaissance is anticipated to occur over a three-day period.

Task 5 – Report Development

FirstLight will develop a report that contains a record of its consultation with the SHPOs and the Narragansett THPO, a summary of background research, Precontact and historic-period contexts for the Project environs, a description of the sensitivity model, the methods and results of Phase 1A reconnaissance, maps of the APE, and recommendations to conduct additional investigations. For example, a Phase IB archaeological survey would be conducted in accordance with the results of the study and after consultation with the SHPOs and the Narragansett THPO if it is determined that Project-induced erosion is occurring within resource sensitive areas of the APE. . This report and any subsequent studies, such as Phase II evaluation of any archaeological sites subject to Project-induced erosion, will provide the basis for the development of a project specific Historic Properties Management Plan as well inform the development of Mitigation Plans and Programmatic Agreements to address any adverse effects to historic properties. Completion of these actions will ensure that this Projects' relicensing fully considers potential impacts to historic properties in compliance with the National Historic Preservation Act.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

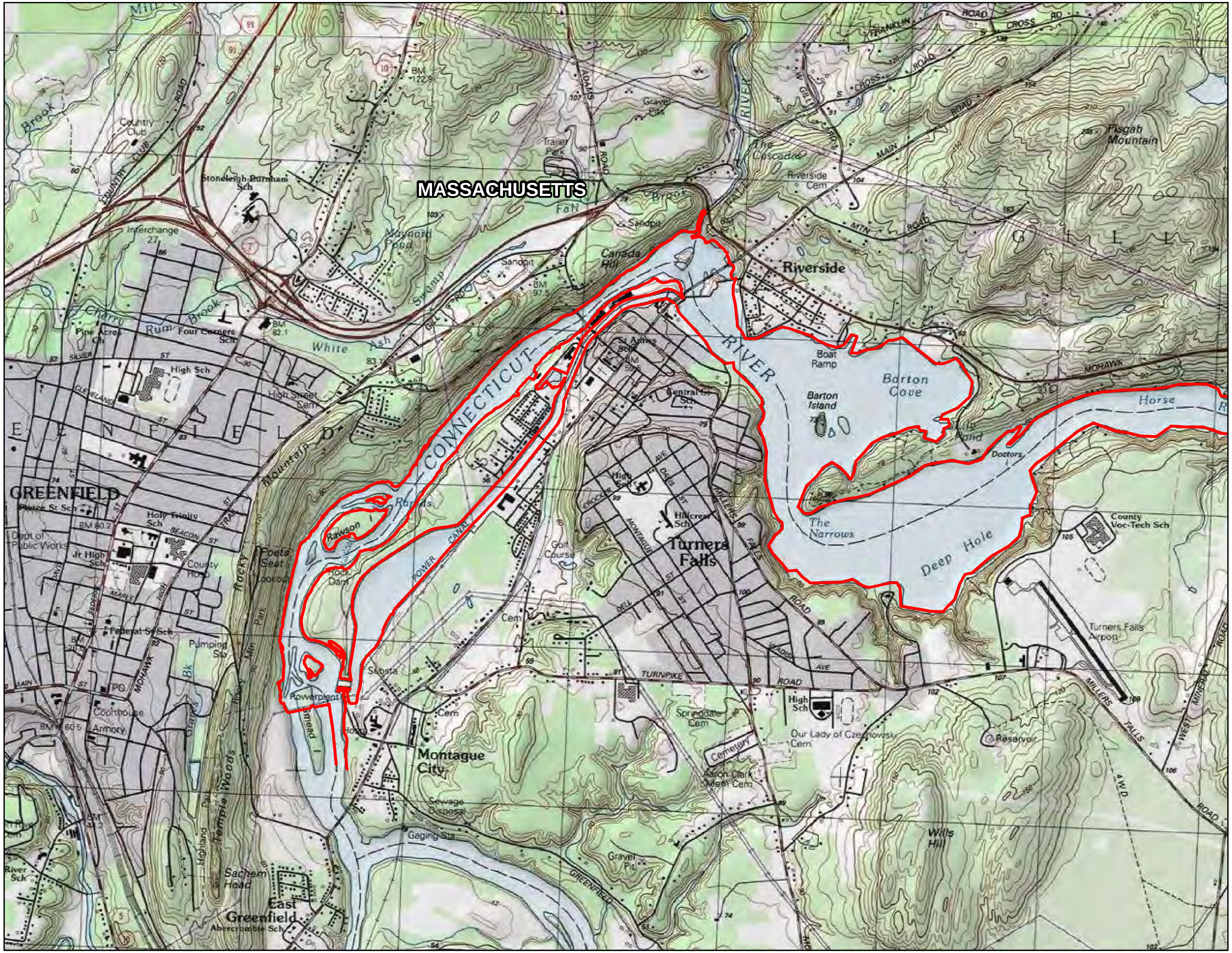
The estimated cost for the Phase IA cultural resources survey is between $60,000 and $70,000. FirstLight believes that the proposed level of effort is adequate to obtain needed information on Precontact and historic cultural resources within the Projects' APE and to determine the need for more intensive field surveys.

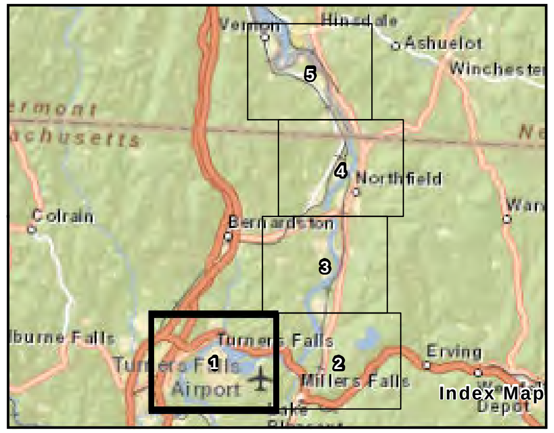
Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), Study Plan Meeting were held on May 14 and June 12, 2013. The purpose of the Study Plan Meetings were to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests.

Background research and development of a sensitivity model for the *Phase IA Archaeological Survey* will occur in winter-spring 2014. *Phase 1A* field reconnaissance will take place in summer 2014. Consultation with the SHPOs and the Narragansett THPO will take place throughout 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1





FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.7.1-1
Proposed Area of Potential Effect (Archaeology)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by 10 meter offset from Normal High Water Mark.

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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1 inch = 2,000 feet

FirstLight Power Resources
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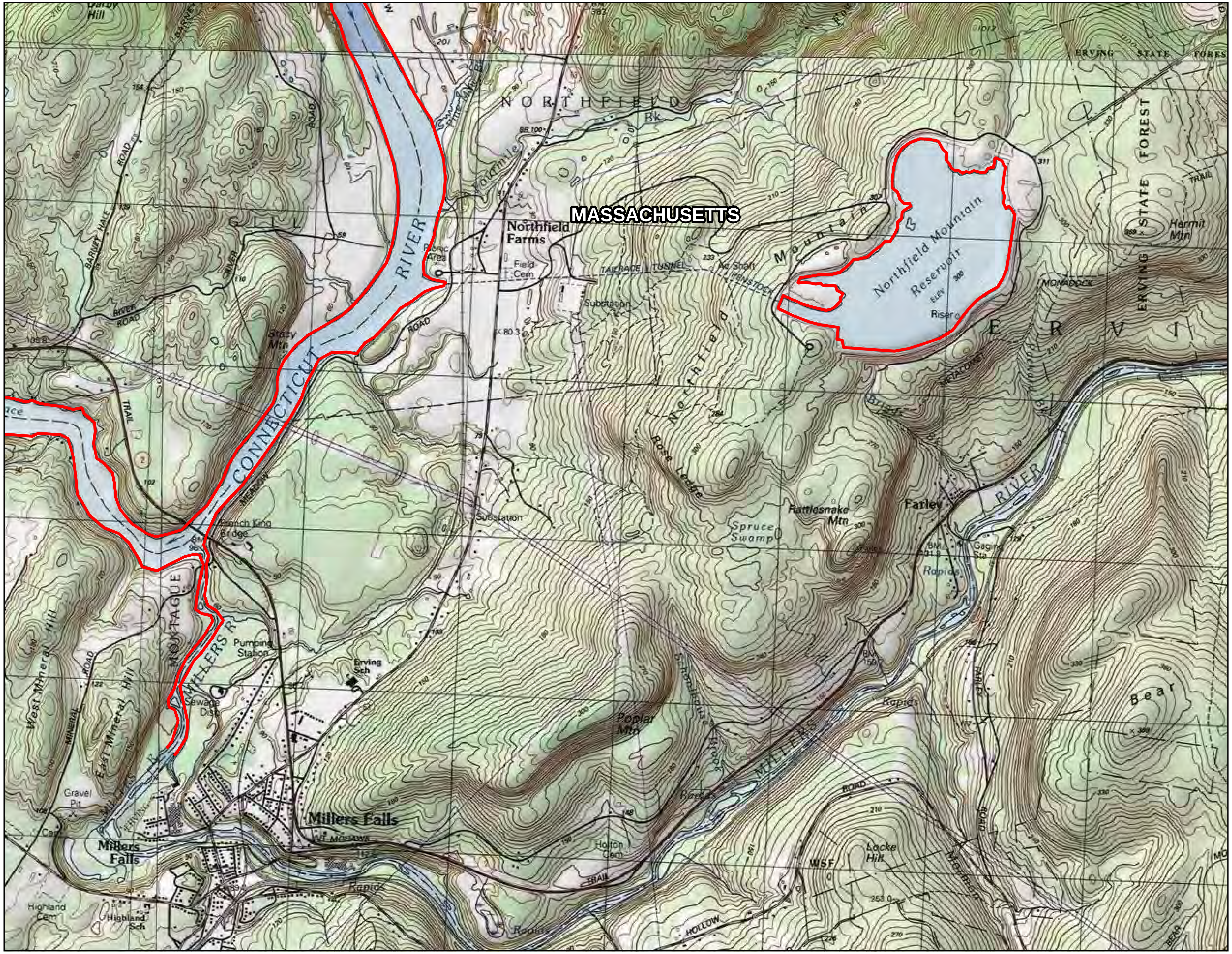

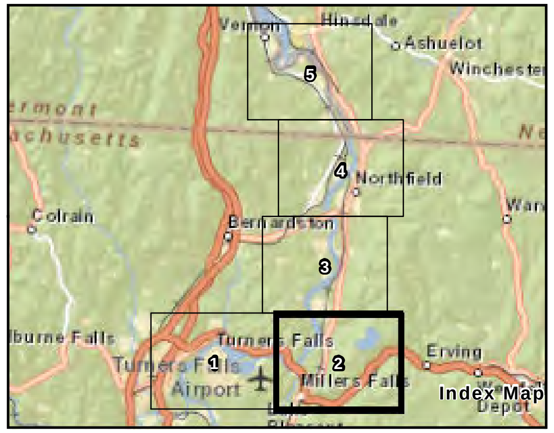

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.7.1-2
Proposed Area of Potential Effect (Archaeology)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by 10 meter offset from Normal High Water Mark.

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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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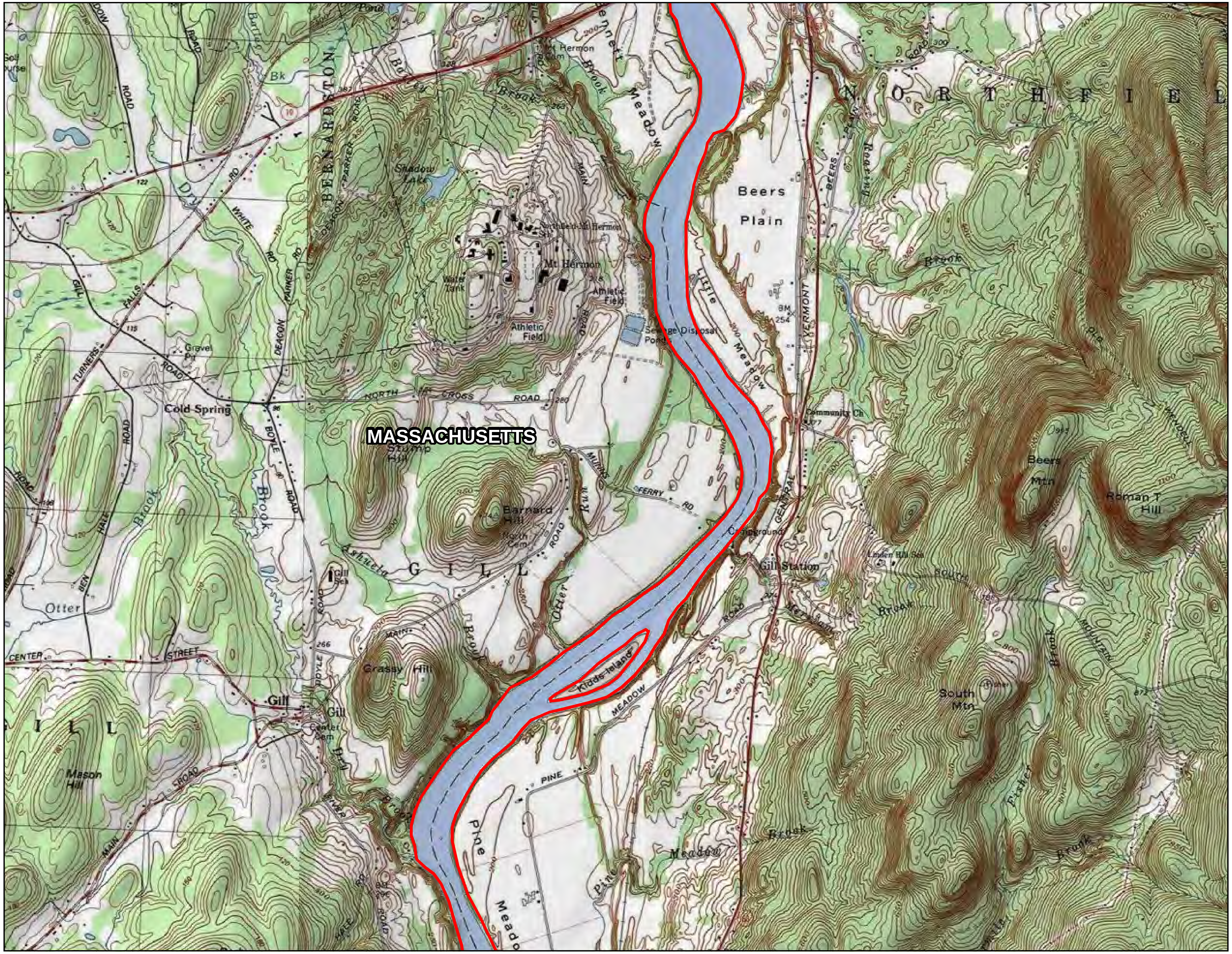

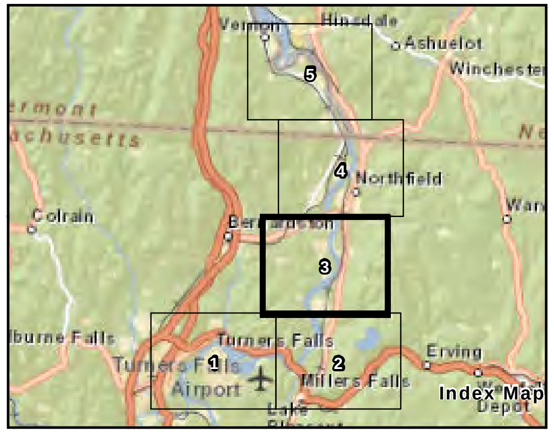

FIRSTLIGHT POWER RESOURCES
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Figure 3.7.1-3
Proposed Area of Potential Effect
(Archaeology)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by 10 meter offset from Normal High Water Mark.

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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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FirstLight Power Resources
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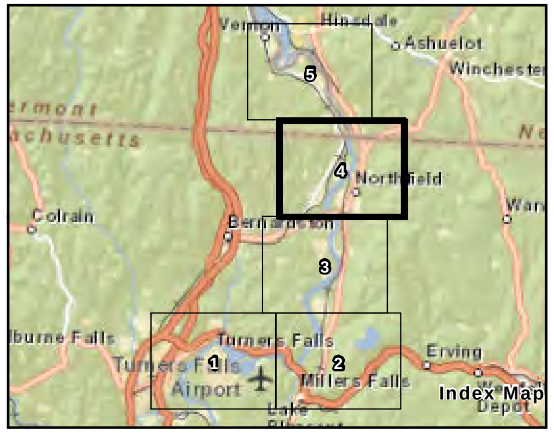

FIRSTLIGHT POWER RESOURCES
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Figure 3.7.1-4
Proposed Area of Potential Effect
(Archaeology)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by 10 meter offset from Normal High Water Mark.

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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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FirstLight Power Resources
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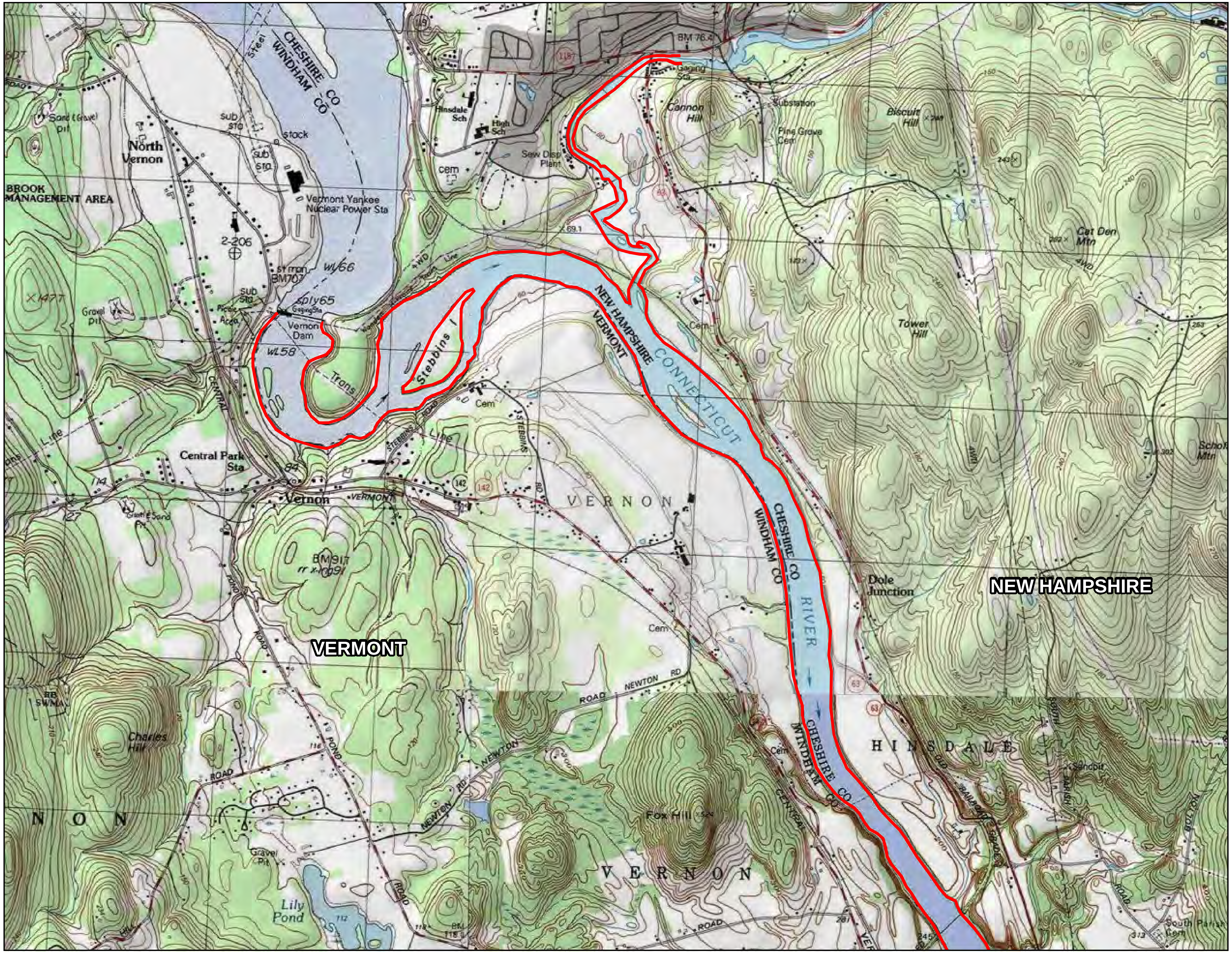

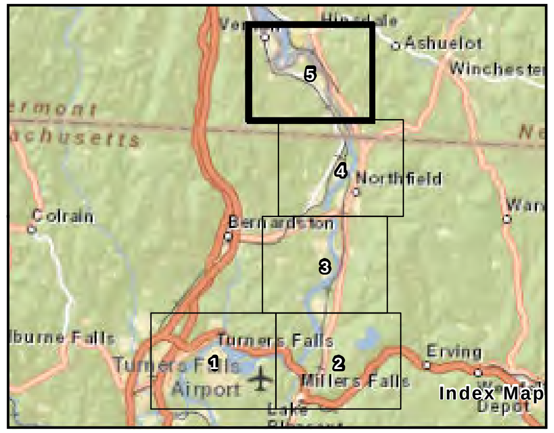

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.7.1-5
Proposed Area of Potential Effect (Archaeology)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by 10 meter offset from Normal High Water Mark.

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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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FirstLight Power Resources
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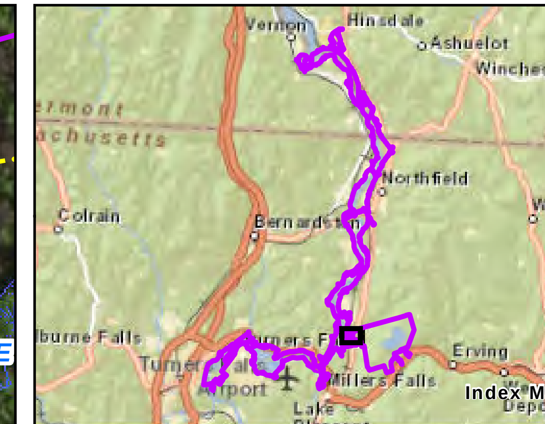

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.7.1-6
Fuller Farm Property Location

Legend

- Northfield/Turners Falls Project Boundary
- Farm Property
- Project Trail
- Agricultural Buffer
- Town Boundary
- NWI Wetland

Water Elevation

- Maximum
- Minimum

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012
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Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

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1 inch = 300 feet

FirstLight Power Resources
GDF SUEZ

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3.7.2 Reconnaissance-Level Historic Structures Survey

General Description of Proposed Study

In its PAD, FirstLight proposed to conduct a Historic Structures Survey. FERC also noted that FirstLight had proposed such a survey. The purpose of the reconnaissance-level historic structures survey is to identify historic resources within the Turners Falls and Northfield Mountain Projects' APE that are listed in or have been determined eligible for listing in the NRHP, to identify resources for further intensive survey and evaluation for NRHP-eligibility, and to assess possible effects from the Projects' operations on those NRHP-listed and –eligible resources. This will be accomplished through consultation with the Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO, site file research and literature review, and field studies. Existing information will be collected from records maintained at the Massachusetts, Vermont, and New Hampshire SHPOs, state and local libraries and historical societies, FirstLight's archives of architectural and engineering records, the Library of Congress, Historic American Building Survey/Historic American Engineering Record (HABS/HAER) and the National Register in Washington, DC.

The area of investigation will include the FERC-defined APE as identified in the PAD, which includes the Projects' boundaries and any construction, recreational, or known locations affected by project operation outside of the Projects' boundaries. The Project APE is further defined by FERC as: "the lands enclosed by the Projects' boundary and lands or properties outside of the Project's boundaries where project construction and operation or project-related recreational development or other enhancements may cause changes in the character or use of historic properties, if any historic properties exist." The Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO will be consulted regarding definition of the APE. Draft maps of the APE are attached as Figures 3.7.2-1 to 3.7.2-5. A detailed map of the APE will be prepared and included in the Study Report. The proposed APE will also include the Fuller Farm property, located on Miller's Farm Road, just north of the Northfield Mountain Visitors' Center, which FirstLight is considering removing from the Project boundary as part of its relicensing proposal. See Figure 3.7.1-6.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to assist FERC in meeting its compliance requirements under Section 106 of the NHPA, as amended, by determining if licensing of the Project will have an adverse effect on historic properties.

The objective of the study is to identify cultural resources listed in or eligible for listing in the NRHP. If it is confirmed that historic properties are present, FirstLight with then move forward to identify and assess any potential adverse effects to historic properties from the continuing operation and maintenance of the Project.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

Section 106 of the National Historic Preservation Act (1966) requires that federal agencies, licensees, and those receiving federal assistance take into account the effects of proposed undertakings on any resource that is listed on or is eligible for the NRHP. As the lead agency, FERC is responsible for fulfilling the requirements of Section 106 in its decision to issue a new license to the Projects.

As stipulated by the regulations that implement Section 106 (36 CFR 800), the Massachusetts, Vermont, and New Hampshire SHPOs represent the interests of their respective States and their citizens, and advise and assist FERC in determining the significance of cultural resources within the APE. FirstLight proposes consulting with the SHPOs and the Narragansett THPO in the establishment of the APE, development of the survey methodology, identification of NRHP-listed and –eligible historic resources, assessment of effects (if any) to the NRHP-listed and –eligible resources, and development of a PA and HPMP, if needed.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

European settlement in the Connecticut River basin in what was to later become Northfield Township and the Town of Gill occurred as early as 1672. During King Phillip's War in 1676, Peskeopscut (Turners Falls) was the site of a military encounter between colonial forces under Captain William Turner and Native Americans. Following the American Revolution, transportation improvements included construction of the Upper Locks and Canal (1792-98) from Turners Falls to Montague. After the Civil War, Turners Falls developed as an important center of manufacturing with the establishment of the Turners Falls Company in the early 1870s. In the 1890s, Turners Falls continued to expand with construction of a new paper mill, shoe factory, and leather manufacturers.

The Turners Falls Historic District, containing residential, commercial, and industrial buildings and structures associated with the nineteenth-century industrial history of Turners Falls, and including historic resources located within the Project boundaries, was listed in the National Register in 1982. Because there have been no comprehensive architectural surveys conducted within the Projects' APE, there is the potential for other NRHP-eligible resources located within the Projects' boundaries in Massachusetts, Vermont, and New Hampshire. These resources may include structures of historic, architectural, or engineering significance, as well as possible historic districts or historic rural landscapes. These resources will be identified during reconnaissance- and intensive –level architectural surveys proposed by FirstLight.

Project Nexus (18 CFR § 5.11(d)(4))

The proposed reconnaissance-level historic structures survey will provide information on known (previously identified and NRHP-listed) historic resources within the Projects' APE and will recommend resources for further intensive survey to establish eligibility for the NRHP. Following the reconnaissance-level survey in each state, FirstLight will consult with the appropriate SHPO and the Narragansett THPO to determine the need (if any) for further intensive survey to identify resources potentially eligible for NRHP listing. Once NRHP eligibility determinations have been obtained for the intensively surveyed resources, potential effects to these historic properties by continued Project operations will be assessed. Information developed during the course of the intensive survey will be used as the basis for preparing an HPMP. Guiding the Licensee's actions relating to Section 106 during the term of the new license, the HPMP will discuss how to avoid potential adverse effects and/or how they will be mitigated. The final HPMP will be filed with the license application.

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1 – Meeting with the Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO

FirstLight will consult with the Massachusetts, Vermont, and New Hampshire SHPOs and the Narragansett THPO with respect to development of the precise APE for the Projects, the development of historic contexts, and field reconnaissance methodology. The proposed reconnaissance- and intensive-level architectural surveys will conform to the professional standards and guidelines established by the

SHPOs in each state. FirstLight will also employ a professionally qualified architectural historian who meets the *Secretary of the Interior's Standards* to conduct the architectural studies.

In their July 15, 2013 comment letter on the Updated PSP, the Vermont SHPO requested that a consultation schedule be specified in the RSP. In response, FirstLight proposes that a teleconference meeting will be held in October 2013 to discuss the precise APE for the Projects with the aforementioned parties. The Vermont SHPO also requested that the RSP make specific reference to a Historic Structures Assessment and Evaluation Report. FirstLight is not proposing to conduct an intensive-level architectural resources survey until after it has reviewed the results of the reconnaissance-level survey with the SHPOs and the Narragansett THPO and consultation determines that a Historic Structures Assessment and Evaluation are necessary in light of the results of the reconnaissance level survey. If an intensive-level architectural survey is recommended, FirstLight would conduct such a survey in 2015 (study year two).

<u>Task 2 – Background Research</u>

FirstLight proposes to examine architectural site files (not available on-line for previously surveyed resources in Vermont and New Hampshire and only partially online for surveyed resources in Massachusetts), cultural resources reports, National Register nominations and determinations of eligibility, historic maps and atlases, historic photographs and illustrations and building records located at the Massachusetts, Vermont, and New Hampshire SHPOs and other research repositories, such as the Great Falls Discovery Center in Turners Falls, the Pocumtuck Valley Memorial Association in DeerFGS, local libraries and historical societies, and at FirstLight's offices. Background research may also identify resources that are less than 50 years old but that may be potentially NRHP-eligible under Criteria Consideration G.

<u>Task 3 – Development of Historic Contexts</u>

FirstLight will use the results of the background research to develop historic contexts to guide the field reconnaissance and will consult with the SHPOs and the Narragansett THPO regarding the required level of detail for the historic contexts.

<u>Task 4 – Field Reconnaissance</u>

FirstLight also proposes to conduct field reconnaissance ("windshield survey") of the Turners Falls Project and Northfield Mountain Project APE to identify architectural resources (buildings, structures, objects, and districts) 50 years or older. The windshield survey will be conducted by vehicle, foot, and/or by boat. Survey and reporting methods (including the use of digital and film camera photography) will follow the relevant Federal and SHPO professional standards and guidelines. FirstLight will employ professionally qualified architectural historians, who meet the *Secretary of the Interior's Standards*.

<u>Task 5 – Report Development</u>

FirstLight will develop a report that contains a record of its consultation with the SHPOs and the Narragansett THPO, a summary of the background research, a description of the historic contexts, results of the windshield survey, maps of the APE, maps showing the location of all NRHP-listed and previously identified resources, and recommendations to conduct an intensive-level architectural survey, depending on the results of the reconnaissance-level survey and after consultation with the SHPOs and the Narragansett THPO.

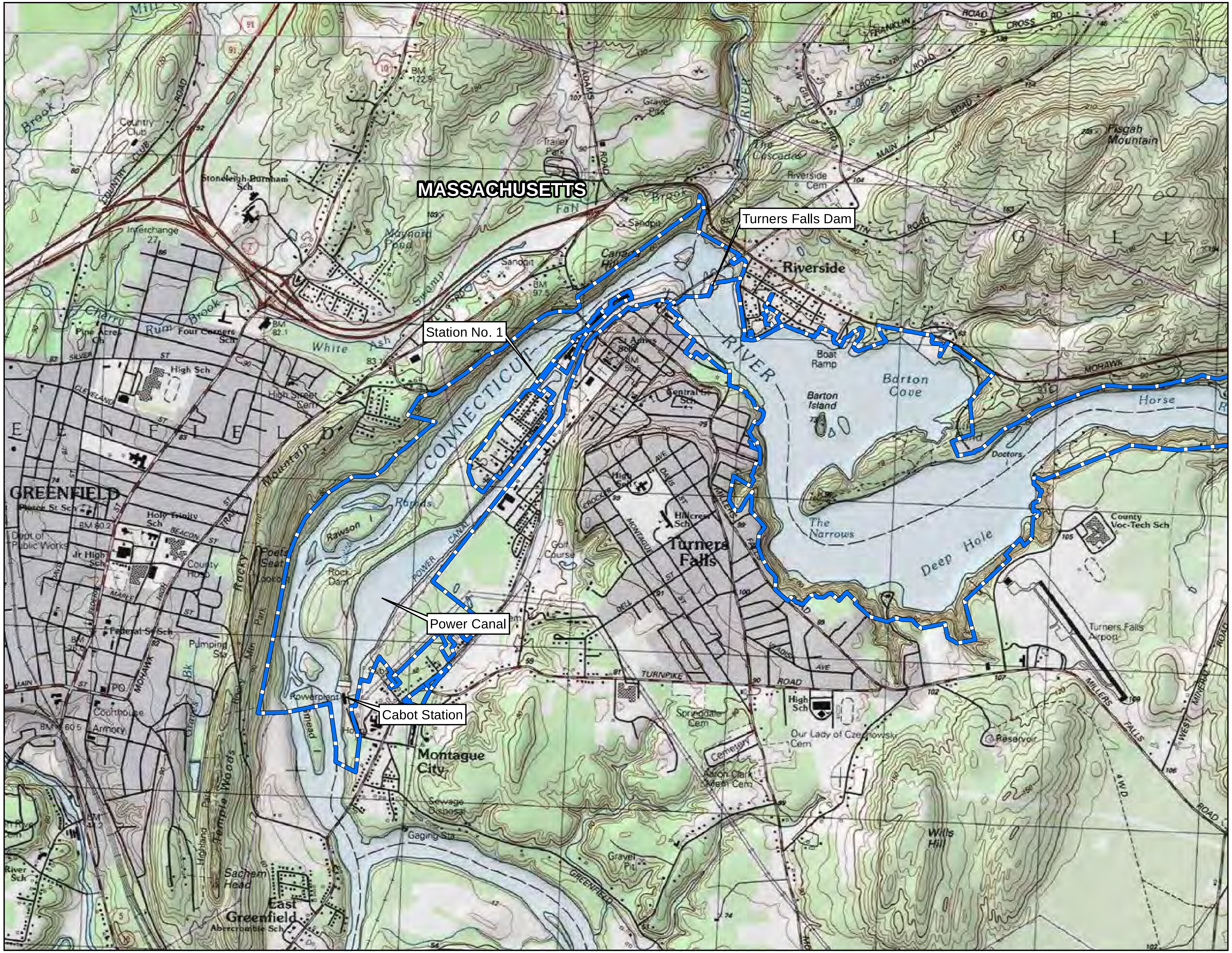
Level of Effort and Cost (18 CFR § 5.11(d)(6))

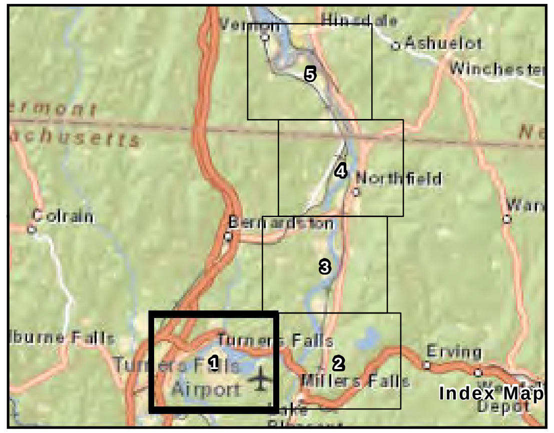
The estimated costs for the background research and windshield survey to identify 50-year-and-older resources within the Projects' APE are approximately $35,000 to $45,000. Costs associated with the intensive-level survey and assessment of effects will be developed following consultation with the SHPOs on the results of the reconnaissance-level survey. FirstLight believes that the proposed level of effort is adequate to obtain initial information on historic resources within the Projects' APE.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), a Study Plan Meetings were held on May 14 and June 12, 2013. The purpose of the Study Plan Meetings were to informally resolve any outstanding issues with respect to FirstLight's PSP and the study requests filed by stakeholders, and to clarify the PSP and any information gathering and study requests. The *Reconnaissance-Level Historic Structures Survey*, including both background research and field work will be conducted during the winter/spring of 2014, with SHPO and Narragansett THPO consultation continuing throughout 2014. The schedule for any intensive-level surveys and assessment of effects to NRHP-listed and –eligible historic resources will be determined following completion of the reconnaissance-level surveys.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.





FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.7.2-1
Proposed Area of Potential Effect
(Historic Structures)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by Northfield Mountain/Turners Falls Project Boundary

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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1 inch = 2,000 feet

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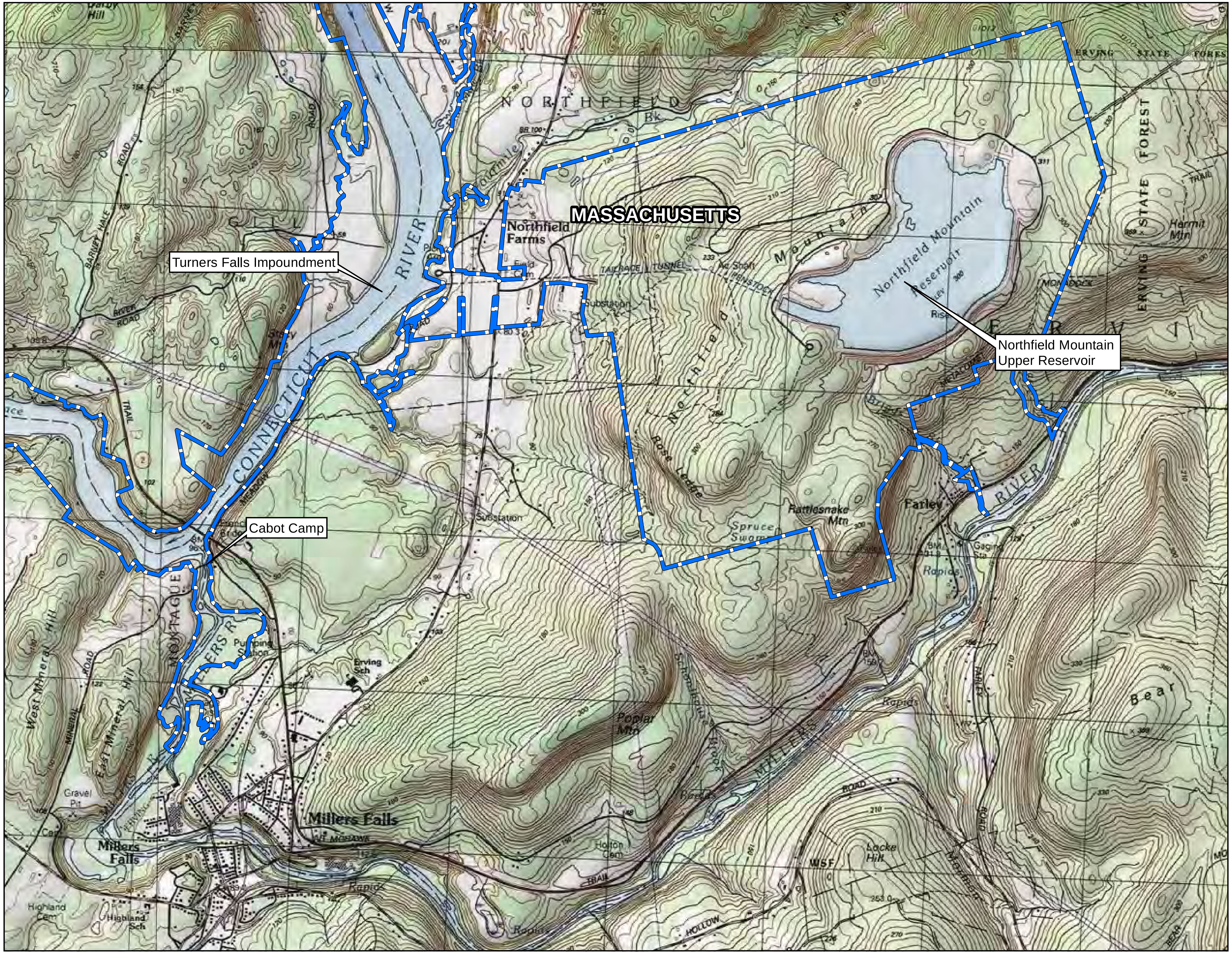

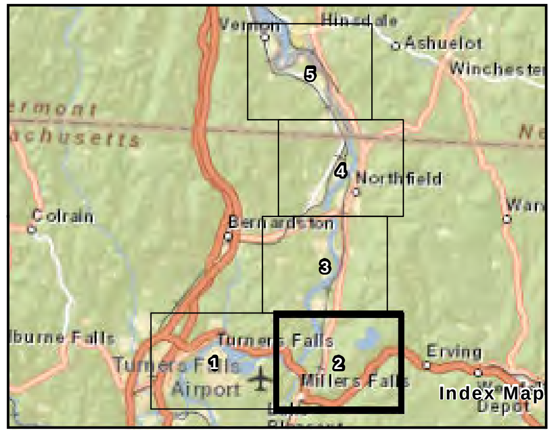

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.7.2-2
Proposed Area of Potential Effect
(Historic Structures)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by Northfield Mountain/Turners Falls Project Boundary

N

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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FirstLight Power Resources
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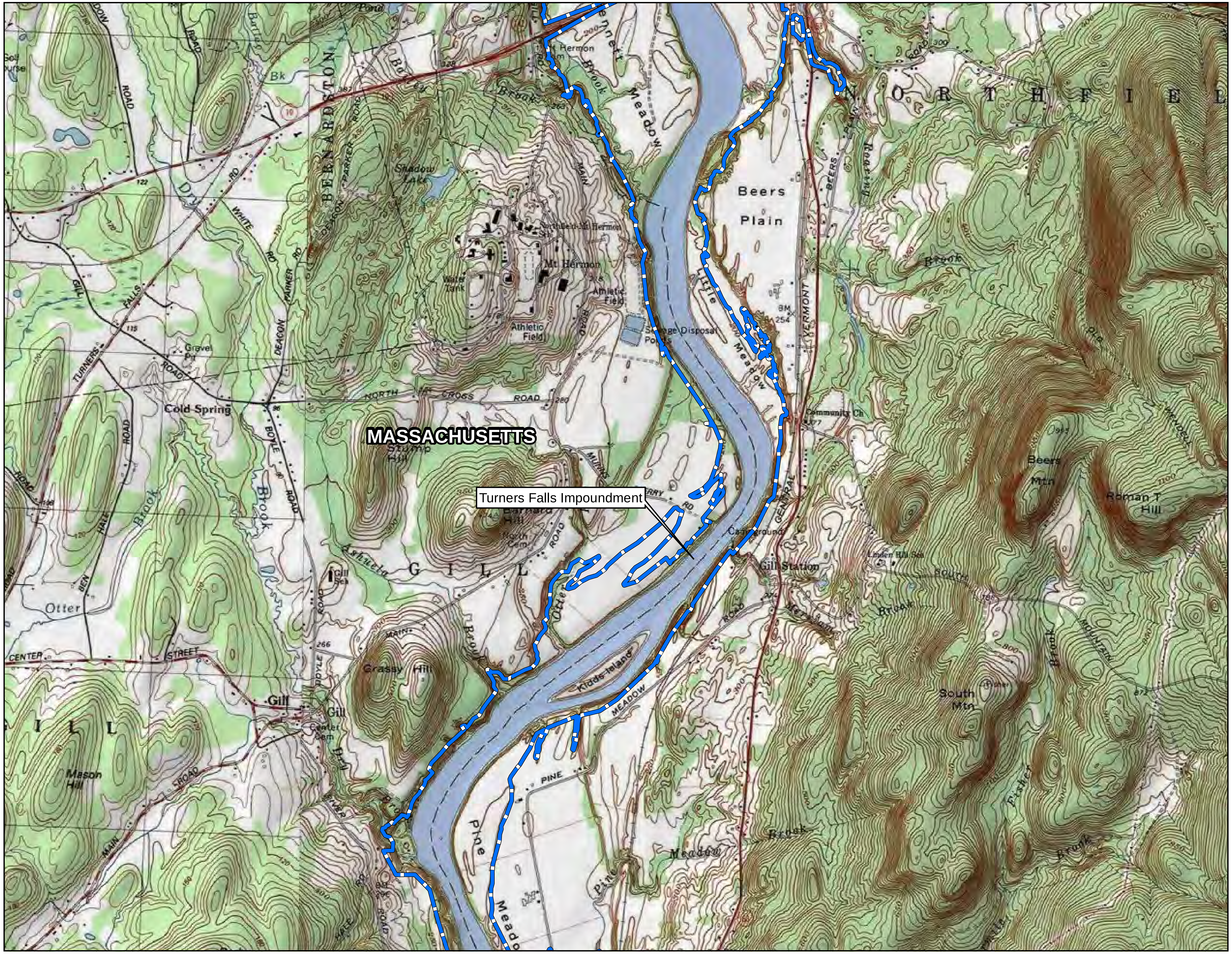

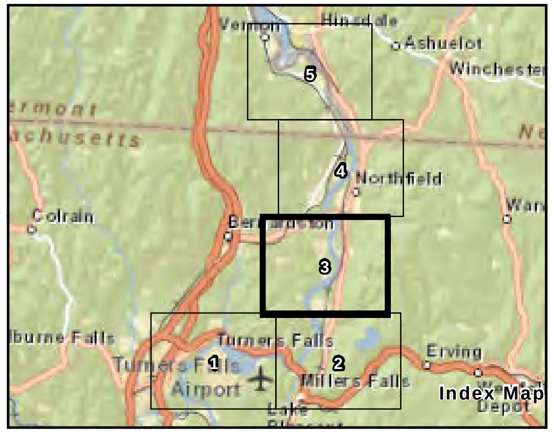

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.7.2-3
Proposed Area of Potential Effect
(Historic Structures)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by Northfield Mountain/Turners Falls Project Boundary

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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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FirstLight Power Resources
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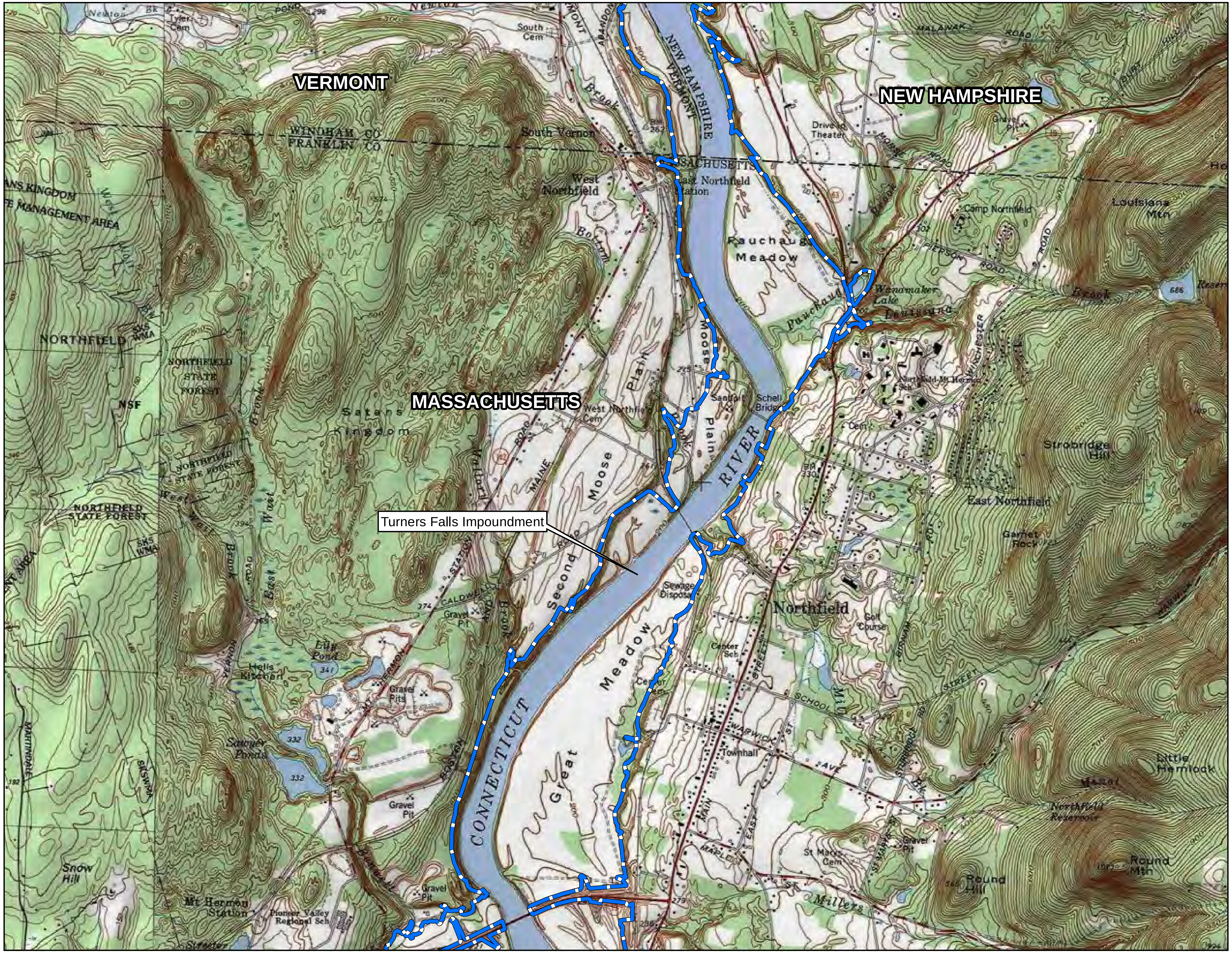

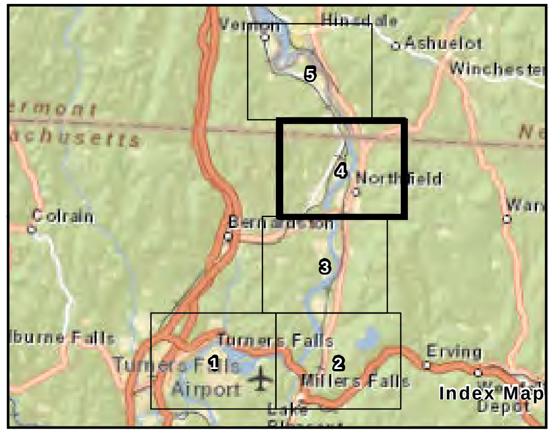

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.7.2-4
Proposed Area of Potential Effect
(Historic Structures)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by Northfield Mountain/Turners Falls Project Boundary

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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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FirstLight Power Resources
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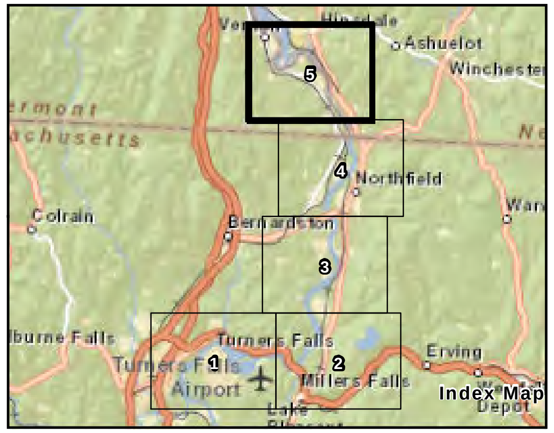

FIRSTLIGHT POWER RESOURCES
REVISED STUDY PLAN

Figure 3.7.2-5
Proposed Area of Potential Effect
(Historic Structures)

Legend

Proposed Area of Potential Effect*

* Proposed Area of Potential Effect defined by Northfield Mountain/Turners Falls Project Boundary

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Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

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FirstLight Power Resources
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3.7.3 Traditional Cultural Properties Study

General Description of Proposed Study

Although the deadline for filing study requests was March 1, 2013, The Nolumbeka Project, Inc. filed a request for a Traditional Cultural Properties (TCP) study by letter dated July 14, 2013. Despite the lateness of the request, FirstLight proposes to conduct a TCP study. TCPs are places associated with the cultural practices or beliefs of a living community, such as an Indian tribe, that are rooted in that community's history and are important in maintaining the continuing cultural identity of the community. As contemplated by National Register Bulletin 38, Guidelines for Evaluating and Documenting Traditional Cultural Properties (Parker & King, 1990), TCPs are already known to the relevant community as they are important in maintaining the continuing cultural continuity of the living community. The study will be conducted in consultation with the Nolumbeka Project, the Narragansett Indian Tribe, the Massachusetts, Vermont, and New Hampshire SHPOs, and other stakeholders with a demonstrated interest.

The purpose of the TCP study is not to document other tribal or ethnographic interests, non-TCP cultural resources, or tribal locations of importance to the Narragansett Tribe, or other stakeholders such as the Nolumbeka Project. As contemplated by National Register Bulletin 38, Guidelines for Evaluating and Documenting Traditional Cultural Properties (Parker & King 1990), TCPs are already known to the community as they are important in maintaining the continuing cultural continuity of the living community. Thus, the purpose of the TPC study is to record existing properties that possess a shared recognition and use by members of the living community for potential listing to the National Register of Historic Places.

The area of investigation will include the FERC-defined APE as identified in the PAD, which includes the Projects' boundaries and any construction, recreational, or known locations affected by project operation outside of the Projects' boundaries. The Project APE is further defined by FERC as: "the lands enclosed by the Projects' boundary and lands or properties outside of the Project's boundaries where project construction and operation or project-related recreational development or other enhancements may cause changes in the character or use of historic properties, if any historic properties exist." The Massachusetts, Vermont, and New Hampshire SHPOs, the Narragansett THPO, and the Nolumbeka Project will be consulted with respect to the identification of the APE. For the purpose of providing appropriate context upon which to document TCPs identified within the Project APE, the background literature research may extend beyond the Project APE to include other parts of the Connecticut River Valley region. Draft maps of the proposed APE are attached as Figures 3.7.1-1 – 3.7.1-5. A detailed map of the APE will be prepared and included in the Study Report.

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goal of the study is to assist FERC in meeting its compliance requirements under Section 106 of the NHPA, as amended, by determining if licensing of the Project will have an adverse effect on historic properties included in, or eligible for inclusion in, the NRHP. These include any prehistoric district, site, building, structure, or object included in, or eligible for inclusion in the NRHP.

The objective of this study is to document any known cultural resources (in this case, TCPs) listed in or eligible for listing in the NRHP within the Projects' APE and to document and assess any potential adverse effects to such properties from the continuing operation and maintenance of the Projects.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

Section 106 of the National Historic Preservation Act (1966) requires that federal agencies, licensees, and those receiving federal assistance take into account the effects of proposed undertakings on any resource that is listed on or is eligible for the NRHP. As the lead agency, FERC is responsible for fulfilling the requirements of Section 106 in its decision to issue a new license to the Projects.

There has been no request for a TCP study by a Native American tribe filed with FERC.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

Information contained in the PAD indicates that Native Americans have occupied the Connecticut River Valley as early as 14,000 years before the present day. Archaeological sites dating from the *Paleoindian* (before 8000 BC), *Archaic* (8000 BC – 1000 BC), and *Woodland* (1000 BC – AD 1600) periods, as well as the early Euro-American exploration, settlement, and industrial periods, may exist on lands bordering the Connecticut River. The Riverside Archaeological District in the Towns of Gill and Greenfield was listed in the NRHP in 1975 in recognition of significant archaeological remains known to exist in the Turners Falls vicinity. European settlement in the Connecticut River basin in what was to later become Northfield Township and the Town of Gill occurred as early as 1672. During King Phillip's War in 1676, Peskeopscut (Turners Falls) was the site of a military encounter between colonial forces under Captain William Turner and Native Americans. Following the American Revolution, transportation improvements included construction of the Upper Locks and Canal (1792-98) from Turners Falls to Montague. After the Civil War, Turners Falls developed as an important center of manufacturing with the establishment of the Turners Falls Company in the early 1870s. In the 1890s, Turners Falls continued to expand with construction of a new paper mill, shoe factory, and leather manufacturers.

In 2008, the Secretary of the Interior determined that the Turners Falls Sacred Ceremonial Hill Site was eligible for listing on the NRHP under criteria A and D. The sacred ceremonial hill site consists of four stone piles located at the Turners Falls Municipal Airport that the Narragansett Indian Tribe and the Wampanoag Tribe of Gay Head claimed are components of a traditional cultural place. The eligibility determination states that the property is associated with events that have made a significant contribution to the broad patterns of Narragansett, Aquinnah-Wampanoag, and Mashpee-Wampanoag history and that the site also has the potential to yield important information about traditional Native American practices, beliefs, and sacred rituals. The eligibility determination also states that the ceremonial site with its component stone features is considered a contributing property within an expanded NR-eligible historic/archaeological district that includes the entire Turners Falls Airport property and extends beyond the boundaries of the airport to encompass traditional cultural places as well as significant concentration of pre-contact archaeological sites on both sides of the Connecticut River in the vicinity of Turners Falls.

The Nolumbeka Project has stated that there several places in the Projects' vicinity that are used today by the tribe for ceremony and other traditional practices associated with the tribes' traditional culture. The Nolumbeka Project has also stated that there are a number of archaeological features in the Projects' vicinity that may yield information about the tribes' cultural history.

To date, there have been no comprehensive, professional cultural resource surveys of the Projects' APE to document such resources. FirstLight proposes to conduct a Phase IA archaeological survey and a Historic Structures Reconnaissance Level Survey to document potential NRHP-eligible archaeological resources and structures in the Projects' APE. See Study Nos 3.7.1 and 3.7.2. FirstLight also proposes to conduct a TCP study to facilitate the documentation of TCPs in the Projects' APE that may be potentially eligible for listing on the NR.

Project Nexus (18 CFR § 5.11(d)(4))

The proposed TCP study will provide documentation of potentially eligible TCPs within the Projects' APE. The resulting technical reports will provide information on which known resources are potentially eligible for inclusion in the NRHP and whether potential adverse effects to these resources would be created by the continued operation of the Project. Once any potential adverse effects are determined, the information that is developed during the course of the study may be used as the basis for preparing an HPMP. Guiding the Licensee's actions relating to Section 106 during the term of the new license, an HPMP would discuss how to avoid potential adverse effects or how they would be mitigated. A final HPMP would be filed with the license application

Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1 – Meeting with the Massachusetts, Vermont, and New Hampshire SHPOs, the Narragansett THPO, and the Nolumbeka Project

FirstLight will consult with the Massachusetts, Vermont, and New Hampshire SHPOs, the Narragansett THPO (NITHPO), and the Nolumbeka Project with respect to development of the precise APE for the Projects. In its comment letter on the Updated PSP, the Vermont SHPO requested that a consultation schedule be specified in the RSP. In its July 14, 2013 study request, the Nolumbeka Project stated that the study area should be the same APE as determined by the SHPOs and NITHPO after consultation with knowledgeable stakeholders, such as the Nolumbeka Project. FirstLight proposes that a teleconference meeting will be held in October 2013 to discuss the precise APE for the Projects with the aforementioned parties.

Task 2 – Tribal Consultation and Documentation of TCPs

The documentation of potential TCPs involves tribal consultation. This work will take into consideration National Register Bulletin No. 38, Guidelines for Evaluating and Documenting Traditional Cultural Properties (Parker & King, 1990). This task anticipates that tribal members will share tribal information on TCPs that may be needed as part of consultation for the Projects.

In order to facilitate documentation of TCPs in the Projects' APE, FirstLight will retain an ethnographer (a specialist in cultural anthropology and archaeology who has previous ethno-archaeological experience in interviewing tribal members) to collect information, through a series of interviews, from the Narragansett Indian Tribe and other interested cultural /stakeholders such as the Nolumbeka Project, on properties that are rooted in the tribe's history and are important in maintaining the continuing cultural identity of the tribal community. Once the ethnographer has been selected, the ethnographer will consult with the NITHPO and the Nolumbeka Project regarding the scope and number of interviews. The interviews will take place at times and locations acceptable to the tribal interviewees and will be conducted on a one-on-one basis. Where acceptable to the Tribe and interviewees, these interviews will be audio-recorded. When this is done a copy of the recording will be subsequently provided to the Tribe and/or interviewee. If appropriate, FirstLight will arrange for an introductory meeting among FirstLight, tribal representatives, and the ethnographer. The oral traditions and information collected during the interviews will be used to help document the potential TCPs.

Tribal members often are reluctant to disclose the location of potential TCPs due to their confidential and sometimes sacred nature or cultural prohibitions. If the tribal members do not wish to disclose the specific locations of any potential TCPs, the ethnographer will consult with the NITHPO and the Nolumbeka Project to attempt to reach an appropriate accommodation.

Task 3 –Background Research

As set forth in the Phase 1A Archaeological Survey, FirstLight has proposed to examine archaeological site files, cultural resources reports, and archives located at the Massachusetts, Vermont, and New Hampshire SHPOs, and other local and regional repositories, such as the Great Falls Discovery Center in Turners Falls and the Pocumtuck Valley Memorial Association in Deerfield. The purpose of this work is to examine relevant sources that may contain historical and archaeological information on the two Project areas. As part of this study, FirstLight will endeavor to obtain background information from local historians, researchers, and other persons knowledgeable of the cultural history of the two Project areas. The ethnographer will review the results of the Phase 1A background research and will conduct additional background research, as appropriate, to help document the continuity of the TCPs identified in Task 2.

Task 4 – Field Visit

Tribal representatives and stakeholders including The Nolumbeka Project and the ethnographer may wish to conduct a field visit to the potential TCPs within the Projects' APE, which were identified to the ethnographer during the interviews of tribal members. The purpose of any field visit would be to enable the ethnographer to obtain additional information to assist in the evaluation of the potential TCPs. The field visit will be completed in one day, and will take place at a time acceptable to tribal representatives and stakeholders, including The Nolumbeka Project.

Task 5 – Report Development

The ethnographer will develop a draft report, which documents the identification of TCPs. It will make recommendations regarding the eligibility of such properties using guidance offered by Parker and King (1990). FirstLight will consult with the NHITHPO and the Nolumbeka Project regarding the results contained in the draft report. Upon finalization, this report and reports from other cultural resources studies conducted in connection with this relicensing, will provide the basis for the development of a project specific Historic Properties Management Plan as well inform the development of Mitigation Plans and Programmatic Agreements to address any adverse effects to historic properties. Completion of these actions will ensure that this Projects' relicensing fully considers potential impacts to historic properties in compliance with the National Historic Preservation Act.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

The estimated cost for the TCP Study is between $53,000 and $63,000. FirstLight believes that the proposed level of effort is adequate to document potentially eligible TCPs within the Projects' APE.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

In accordance with 18 CFR § 5.15(c), Study Plan Meetings regarding cultural resources were held on May 14 and June 12, 2013. FirstLight will initiate consultation on the TCP Study in winter 2014 and will conduct interviews and background research in spring – summer 2014.

Study reporting will be conducted in accordance with FirstLight's Process Plan and Schedule (18 CFR § 5.6(d)(1)), as provided in the PAD, and the FERC's SD1.

Literature Cited

National Historic Preservation Act, 16 U.S.C. §§ 470 et. seq.

Parker, P.L. & King, T.F. National Register Bulletin - Guidelines for Evaluating and Documenting Traditional Cultural Properties. Originally published 1990 (revised 1992 & 1998), U.S. Department of the Interior, National Park Service, Washington, D.C.

3.8 Developmental Resources

3.8.1 Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation

General Description of Proposed Study

A simulation model of the Connecticut River Basin will be used to evaluate the impacts of current and potential alternative modes of operation in the Project area on the timing and magnitude of river flows. Output from the model--- specifically flow data—will be used in other studies to evaluate the impact of current and potential alternative modes of operation on water surface elevations (hydraulic model) and aquatic habitat.

The Connecticut River Joint Commission (CRJC) requested a Connecticut River basin-wide stormwater model. The goals and objectives of the CRJC's study request refer to stormwater; however, the proposed methodology refers to a simulation model as described further below. FirstLight contacted the CRJC to clarify whether they are seeking a basinwide stormwater runoff model or a simulation; it appears they are seeking the latter (simulation model).

Study Goals and Objectives (18 CFR § 5.11(d)(1))

The goals and objective of this study are to:

- To develop a baseline model of the Connecticut River Basin—specifically the reach from TransCanada's Wilder Project to the Holyoke Project-- which includes the following hydropower facilities: TransCanada's Wilder, Bellows Falls, and Vernon Hydroelectric Projects, FirstLight's, Turners Falls Hydroelectric Project and Northfield Mountain Project and Holyoke Gas and Electric's Holyoke Hydroelectric Project.

- The model will be used to determine the impact on hydropower generation and economics due to potential alternative modes of operation. Potential alternative modes of operation could include minimum flows in the bypass reach, changes in the Turners Falls Impoundment fluctuations, changes in operation of the Turners Falls Project relative to peaking operations, etc.

- Flow data generated from the model will be used to inform other studies, notably the hydraulic model and instream flow study.

Resource Management Goals of Agencies/Tribes with Jurisdiction over Resource (18 CFR § 5.11(d)(2))

FirstLight proposed to develop an operations model of the Wilder, Bellows Falls, Vernon, Northfield Mountain, Turners Falls and the Holyoke hydropower facilities in the PAD.

The FRCOG Study Request No. 6 is entitled "*.Model River Flow and Water Levels Upstream and Downstream from the Turners Falls Project Dam Generating Stations and Integration of Project Modeling with Upstream and Downstream Facilities"*. FRCOG is requesting the development of a river model to evaluate the impact of Project operations on flows and water levels in the Project area.

The FRCOG Study Request No. 7 is entitled "*Develop a Comprehensive and Predictive Model of the Electric Generation System Consisting of Five Generation Projects along the Connecticut River to study the Impact and Feasibility of Various changes in Operations on Environmental Resources*. The FRCOG notes that the study objective is to determine whether operating the system (Wilder, Bellows Falls, Vernon, Northfield Mountain, and Turners Falls) as a whole under a single set of operation parameters could serve to mitigate the environmental impacts of current operations.

FirstLight believes that both of FRCOG's study requests can be addressed in the proposed simulation model of the Connecticut River Basin.

Existing Information and Need for Additional Information (18 CFR § 5.11(d)(3))

The Nature Conservancy (TNC), USGS, USACE, and University of Massachusetts (UMass) at Amherst ("Project Partners") have developed a simulation and optimization model of the Connecticut River Basin. Software used for the simulation model is the USACE Hydrologic Engineering Center Reservoir Simulation model or HEC-ResSim. The optimization model was developed using software called LINGO. FirstLight has been working with Project Partners and provided them with engineering and operations data on the FirstLight facilities to enter into the HEC-ResSim model. Project Partners have provided FirstLight with the HEC-ResSim model of the Connecticut River Basin. HEC-ResSim is a simulation model and operates based on a set rules and constraints set by the modeler. The Connecticut River simulation model was developed on a daily time step for the period 1960 to 2003. More recently, The Nature Conservancy is considering extending the flow data to include 2004 to 2012. If the flow data is extended, FirstLight will include the additional years in their HEC-ResSim model.

Daily inflow for the model was developed by the USGS using its Connecticut River Unimpacted Streamflow Estimation (CRUISE) model. FirstLight is using the same daily inflow data, but will convert it to an hourly time step using straight line interpolation.

At the May 14, 2013 meeting, it was requested that more detail be provided on the flow data in the HEC-ResSim model. As noted above, the CRUISE model was used to develop unregulated inflows; however, the HEC-ResSim model would be used to simulate the regulated release from an Army Corps of Engineer Dam or hydropower facility (based on the rules in HEC-ResSim for that dam). For example, the regulated discharges from Vernon Dam (from the HEC-ResSim model) would be added to estimated flows from unregulated tributaries and/or overland sources located between Vernon Dam and Turners Falls Dams based on the CRUISE model, to result in a total inflow to Turners Falls Dam. Further details on the CRUSE model are included in a 15-page discussion paper "*Towards a publicly available, map-based regional software tool to estimate unregulated daily streamflow at ungauged rivers*". For copy of this paper, see the following weblink:
http://static.rcngrants.org/sites/default/files/final_reports/RCN%202007-9%20GIS-based%20application%20manuscript.pdf.

In general, the CRUISE model relies on a regression analysis to estimate flow on ungauged rivers using USGS gaged unregulated rivers. As noted in the paper, daily streamflow is estimated by a four-part process as follows:

(1) Delineation of the drainage area and computation of the basin characteristics for the ungauged location,

(2) Selection of a donor stream gage,

(3) Estimation of the daily flow-duration curve at the ungaged location

(4) Use of the donor stream gage to transfer the flow duration curve to a time series of daily streamflow.

At the May 14 meeting, FERC asked if the license conditions for the 15-Mile Falls Project are reflected in the HEC-ResSim model. The HEC-ResSim model used for this relicensing effort reflects the current FERC licensed conditions of the 15-Mile Falls Project.

<u>Project Nexus (18 CFR § 5.11(d)(4))</u>

Potential changes in project operations at the three TransCanada Projects and FirstLight Projects will have a direct impact on the generation and economic viability at the Turners Falls Hydropower Project and the Northfield Mountain Project. Output from the model, most notably time varying flows, will be used in other studies (hydraulic model, instream flows study).

<u>Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))</u>

FirstLight proposes to conduct the following tasks using the HEC-ResSim simulation model.

<u>Task 1. Modify Model</u>

The Project Partner model provided to FirstLight is on a daily time step. FirstLight will modify the model such that daily unregulated flow data is converted to an hourly time using straight line interpolation. In the end, an hourly time step model will be developed for the period 1960 to 2003. As noted above, if The Nature Conservancy extends the flow record to include 2004-2012, FirstLight will likewise extend the HEC-ResSim model to include the same period. The model provided by Project Partners will be refined further to better simulate the timing of pumping and generating cycles at Northfield Mountain and the use of reservoir storage in the upper and lower reservoirs. Other modifications to the model will include: a) properly simulating the timing and magnitude of fish ladder flows, attraction flows, bypass flows, and b) properly simulating the use of upper and lower reservoir storage.

<u>Task 2: Calibration</u>

The model will be calibrated to flow and generation using observed data for a recent year such as 2002 or 2003[78]. If the model flow data is extended to include 2004-2012, FirstLight will revisit the calibration to include more recent years. Relative to flow, the model predicted daily (and hourly) hydrograph will be compared against the daily (and hourly) hourly hydrograph at the USGS Gage in Montague City, MA, located below Cabot Station. Comparing model predicted flow and observed flow at the gage will indicate if the model is reasonably matching the timing and magnitude of streamflow. In addition to flow, total monthly generation predicted by the model will be compared to the observed monthly generation at the three TransCanada Projects, Northfield Mountain Project and Turners Falls Project. It will be important to review the FirstLight log sheets to determine if there were any station or individual unit outages as the model will not account for outages. The model would over-predict generation if there is a prolonged outage. Based on flow and generation findings, some fine tuning of the HEC-ResSim model may be needed to match observed conditions.

Note that the year selected for calibration (2002 or 2003) may not represent the current project equipment. For example, say in 2007 the turbines at Cabot Station were upgraded meaning that the turbine efficiency would be improved over the turbines in place in 2002 or 2003. For calibration purposes, FirstLight will rely on the equipment installed during the years selected for calibration. Again, as noted above, if more updated flow data becomes available, FirstLight will revisit the calibration to include more recent years.

[78] The inflow data for the model provided to us by TNC terminated in 2003.

Task 3. Establish Baseline Model

Once the model is calibrated, it will be updated to reflect today's equipment and operating conditions and is termed the baseline model. Output from the baseline model including generation, flows and water levels will be used as a basis of comparison to any other model runs.

Task 4. Production Runs

A production run is considered any change made to the baseline model. The HEC-ResSim model allows for simulating alternative modes of operation based on a set of constraints and rules. Alternative modes of operation that can be simulated in the HEC-ResSim model include:

- Changes in the allowable water level fluctuation in a given reservoir;
- Changes in the magnitude and timing of bypass flows;
- Changing the magnitude and timing of fishway flows and attraction flows;
- Changes in the timing and magnitude of hydropower releases;
- Placing maximum discharge constraints on hydropower releases
- Changing the hydraulic capacity at a given facility.

If a stakeholder seeks an alternative mode of operation, such as maintaining bypass flows, the impact on generation, reservoir water levels and flows can be compared between this "Production Run" and the baseline model. For purposes of this study, we have estimated up to 15 Production Runs.

Task 5. Use of Model Output for other Uses

Output from the HEC-ResSim model will be used to inform other studies. These could include the following:

- Study No. 3.2.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot.* Hourly discharge hydrographs from the model could be used to simulate the resulting change in WSEL at transects in the hydraulic model.
- Study No. 3.3.1 *Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station*. The hourly discharge hydrograph from the model at Montague City will be matched with the habitat versus flow relationship developed as part of the Study No. 3.3.1 to generate hourly varying habitat (habitat time series).

Task 6. Report

A report will be developed documenting the model inputs (engineering data, physical data, and flow data), and results from the calibration model, baseline model and Production Runs. Key outputs to the model that will be incorporated in the report will include:

- A table comparing annual and monthly baseline generation with the same for the various Production Runs. The net loss/gain in generation and percentage loss/gain will be computed relative to the baseline model.

- Annual and monthly flow duration curves will be developed for the baseline model and compared with the same for a select number of Productions Runs.

- For select periods, hourly hydrographs will be developed for the baseline model and compared with the same for a select number of Production Runs.

Level of Effort and Cost (18 CFR § 5.11(d)(6))

Because FirstLight is using the HEC-ResSim model initially developed by the Project Partners, the level of effort is less than if developing the model from scratch. However, the model provided to FirstLight will still require significant updates to reflecting the intra-day operation and dispatch of the project, which cannot be simulated in a daily time-step model. Model calibration, establishment of a baseline model, development and simulation of Production Runs and a report are needed. The estimated cost of the modeling effort is on the order of $100,000 to $125,000.

Study Schedule (18 CFR § 5.11(b)(2) and (c))

Development of the simulation model does not require the collection of any field data. As such, FirstLight plans on completing model calibration and establishing a baseline model in 2013. Additional modeling of will be conducted in 2014 and 2015 as field studies are completed that will better inform potential Production Runs. For example after the instream flow study is complete, it will be used to inform potential bypass flows, which will be simulated in the model to evaluate impacts on generation.

3.9 Matrix of Comments and Responses

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
3.1.1	2013 Full River Reconnaissance	NMFS	Task 1b-Just as the land based observation data from task 1c will be used in Study No. 3.1.2, we expect that to some degree, data from the geo-referenced video, particularly on the toe of slopes and lower banks, will also be used in Study No. 3.1.2.	All data collected as part of Study No. 3.1.1 will be made available to be used in Study No. 3.1.2 if deemed necessary by the team conducting the data analyses outlined in 3.1.2. It is anticipated that geo-referenced video and any geo-referenced photographs taken during 3.1.1 will be used to some extent during Study No. 3.1.2.
			Task 4- Given the large amounts of data to be collected, we suggest the data be made available through the use of online mapping services (e.g. ArcGIS.com) such that geospatial data can be used with a web browser.	Adopted. Electronic data will be made available upon request; however, FirstLight is not committing to an online mapping service.
			Task 6- Deliverable #14 mentions that recommendations of potential future stabilization sites will be mapped. The PSP does not mention the methods or factors used to determine these sites. Deliverable #16 mentions that existing stabilization projects will be evaluated but the PSP does not mention what data and what factors will be used to determine the success or failure of the techniques used at each restoration site.	One of the primary purposes of the FRR is to make recommendations for future restoration projects based on the mapping data. Following the ground based survey and reconnaissance data collection, eroded bank sections, or potential future bank erosion areas will be evaluated for restoration. Factors include protection of infrastructure; protection of prime farmland; protection of cultural resources; protection of important habitat; and sediment deposition are considered in these recommendations. The primary factors for the evaluation of the existing restoration sites are their stability. Secondary factors include: construction methods and materials; establishment of native vegetation; habitat suitability; O&M plan recommendations.
			Study Schedule- does not support filing report in September 2012, rather April 2014.	Not Adopted. Filing the FRR study report in September 2014 will make the licensing process more efficient and effective by eliminating the need to FirstLight to complete and file the final FRR report at the same time it is conducting field studies and preparing the September 2014 study reports. It is also consistent with the ILP regulations, which provide for the applicant to file initial study reports together, not whenever they are completed. The April 2014 date serves no specific purpose: it was proposed by FirstLight years ago before the relicensing process began and the PSP was developed.
		MADEP	Defers to FRCOG and CRWC comments.	No comment.
		NHDES	Task 4- NHDES recommends that the study include any changes in operation of the FL Projects during the study period to see if such changes in operation during the study period are related to any apparent trends.	Any change in operations during the study will be tracked and reported in the study,
		CRWC	QAPP needs to be updated and included in RSP.	Adopted. An updated QAPP is in the RSP.
			Task 1a- study should be modified to include the types of erosion present (e.g., undercut banks, topples, slides, slumps, flows), other features indicative of erosion (e.g., tension cracks, exposed roots, leaning trees), and the stage of erosion present.	Adopted. The RSP has been modified to include an evaluation of the types, stages, and indicators of erosion
			Task 3- Relative to land use mapping, CRWC would like confirmation of which land use data mapping layers will be used—will the 2005 land use data layer be used?	The most current published MassGIS land-use data layers at the time of mapping in 2013 will be used.
			Study Schedule- does not support filing report in September 2012, rather April 2014.	Not Adopted. See response to NMFS above.
		FRCOG	Task 1a- study should identify where the erosion is occurring, the type of erosion and the stage or temporal sequence of erosion must be inventoried and understood before ascribing potential causal mechanisms	Adopted. The RSP has been modified to include an evaluation of the types, stages, and indicators of erosion
			Task 1a- To characterize the spatial extent of erosion, data should be gathered on the linear and vertical extent of the specific types of erosion as identified by Field (2007), which can be quantified.	Adopted. The RSP includes mapping both the linear and vertical extent of erosion by boat and land-based surveys, respectively. The specific erosion types identified by FGS, 2007 have been incorporated into the RSP.
			Task 1a- The photographic log of the riverbanks compiled during the fluvial geomorphology study (FGS, 2007) should be updated during the 2013 FRR to provide a method for visually identifying and confirming the condition and location of eroding banks.	Adopted. Geo-referenced photographs and video are to be included in the FRR. Comparisons with photographic logs from FGS, 2007, previous FRR reports, and other researchers will be included in the report.
			Task 1a- Field (2007) recommended that the initial photographic log compiled during his study be compared with continuous digital image logs taken during 2001 and 2004 (NEE, 2005). We would add the continuous digital image logs taken for the 2008 FRR and the 2013 FRR to this list.	Adopted. All previous photographic and video logs available will be evaluated and compared.
		FCD	General Comments- FirstLight's June 28, 2013 filing cover letter states that "(g)iven the size of the Updated PSP and the short turnaround period for stakeholder review, modifications from the original PSP are shown in track-change to allow for easier review." This is not the case for proposed Study Nos. 3.1.1 and 3.1.2. There is no indication in either study of what has changed from the original filing.	FirstLight stated in the cover letter of the Updated PSP that four studies (including 3.1.1 and 3.1.2) had undergone so many changes that "clean" versions were included in the Updated PSP.
			Task 1a- The field data logging worksheet, Table 3.1-1, and the riverbank characterization matrix, Table 3.1-2, continue to be extremely flawed. Stages of erosion and features indicative of erosion are ignored. The erosion types listed in table 3.1-1 include two categories that were identified as being stages of erosion, not types of erosion, by Field in 2007.	This section of the RSP has been revised.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			Task 3- This task is to "evaluate trends in bank erosion in relation to adjacent land use." If it is to evaluate trends it must extend back in time, not just look at current conditions. The width of riparian buffers, for example, should be assessed since the start of Northfield Project operations.	The trend assessment described in this section refers to studying the trends or correlations between land-use practices and erosion. It is not intended to be a temporal trend analysis.
			Study Schedule- does not support filing report in September 2014, rather April 2014.	Not Adopted. See response to NMFS above.
		LCCLC	We urge an approach that documents the type and stage of erosion according to Field (2007) so that maps can be generated that show, for example, the linear extent and location of all types and stages of erosion.	Adopted. The RSP has been modified to include an evaluation of the types, stages, and indicators of erosion
			Task 1a- The photographic log of the riverbanks compiled during the fluvial geomorphology study (FGS, 2007) should be updated during the 2013 FRR to provide a method for visually identifying and confirming the condition and location of eroding banks.	Answered above
			Task 1a- Field (2007) recommended that the initial photographic log compiled during his study be compared with continuous digital image logs taken during 2001 and 2004 (NEE, 2005). We would add the continuous digital image logs taken for the 2008 FRR and the 2013 FRR to this list.	Answered above
		Town Northfield	Same comments as FRCOG	No comment.
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability	NMFS	Study Goals and Objectives- This section states "develop a comprehensive understanding of riverbank erosion". One of the most fundamental concepts of geomorphology is that of change over time. This section is devoid of any reference to time or a time period over which the "comprehensive understanding" is developed. Various data sets mentioned in this study (e.g. monumented transects, water level recorders, bathymetric maps, previous FRR's, previous erosion studies) all provide data from different time periods. FirstLight should clearly state the period of time that will be encompassed for this study.	Study goals and objectives have been revised. A historic geomorphic assessment of the Connecticut River based on the review of aerial imagery, topographic maps, archival documents, and other pertinent datasets will be included in this study as a means of providing context of long term trends in the Connecticut River. Datasets listed in the study will be used in various aspects throughout the course of the study, including in the various data analyses proposed.
			Task 3c. Existing Water Level Monitors – Evaluation of the Maximum Daily Fluctuations of Turners Falls Impoundment Elevation on a Monthly (and Annual) Basis. In addition to the development of a "delta" duration curve, we suggest that a histogram of the "delta" data also be developed. Such a graphic makes it visually easy to determine the "delta" bins that occur most frequently.	Adopted- changes made to RSP.
			Task 3d. Proposed Water Level Monitors – Hydrographs of the Turners Falls Impoundment Elevation versus flow- We suggest that hydrologic routing time be factored in to the analysis.	Adopted- changes made to RSP.
			Task 5c. Evaluation of Round 1 Field Evaluation- The study states "FirstLight will utilize the existing 22 transects so long as they are representative of the range of riverbank features and characteristics." However, to understand the data, this task does not state the types of categories or bins into which an existing transect could fall in order to determine if the transects are indeed representative. Study No. 3.1.1. (2013 FRR) suggests some possible riverbank characteristics for upper and lower banks. Clarification on the types of categories that a transect must fall into would be helpful. With the exception of some transects around the Route 10 bridge, most of the 22 transects are bank to bank cross sections. As such, there are well over 22 banks that have been repeatedly surveyed. The bank conditions on Stebbins Island and Kidds Island could also conceivably be used for analysis. We also note that no mention of stratigraphy or stratigraphic analysis of the banks is made in this section.	Fixed riverbank transects that are representative of the range of riverbank features and characteristics in the impoundment will be identified following the completion of the 2013 FRR and the preliminary land-based assessment described in Study No. 3.1.2. The number of fixed riverbank transects, as well as the categories or bins of each, will not be known until the results of the 2013 FRR have been analyzed. Features and characteristics that will be used to determine the location of the fixed riverbank transects included in this study will be based on the criteria found in Table 3.1.1-1.
			Task 6. Causes of Erosion- Given the varying driving forces acting on the banks (e.g. flowing water, boat wakes, ice debris), we suggest that it will be difficult to discern the exact cause of erosion. However, it might be possible to discern causes of bank erosion that are more likely than others for some locations based on the types of mass wasting and stages of erosion and location of these features on a given bank.	The causes of erosion will be quantified and ranked for each fixed riverbank transect, and the Turners Falls Impoundment in general, based on the results of the various data analyses discussed in the RSP.
			Hydraulic Shear Stress due to Flowing Water (Tractive Force)- The study states "Shield's criteria relates velocity to the particle size of sediment at the point of incipient motion." While this is indeed correct, Shield's 1936 paper was conducted on homogenous sediment in flumes. We recommend that critical dimensionless shear values be used that are appropriate for the specific bank material being modeled which may or may not be homogenous. In other words, uniformly applying a critical dimensionless shear value of the commonly used value 0.06 may or may not be appropriate. This modeling approach also requires an understanding of the Reynolds number and Shield's plot indicates that critical dimensionless shear varies as a function of the Reynolds number. As such, we ask that some discussion of the Reynolds number in terms of how smooth, transitional or rough the flow conditions are would provide helpful context in the analysis.	While Shield's 1936 paper was based on homogeneous sediment in flumes, this approach has been widely utilized in numerous studies in rivers with a wide range of particle size distributions, many much wider than that found in the Turners Falls Impoundment. An appropriate value or range in values for the dimensionless Shield's parameter will be developed by evaluation of the relationship of Reynolds number and the dimensionless parameter based on the range of Reynolds numbers representing flow conditions in the Turners Falls Impoundment. The selection of Shield's dimensionless parameter and its relationship to flow conditions will be discussed in the report documenting results of the study.
			Geotechnical analysis of hydrodynamics of flow and water level fluctuations- Rather than rely on default values for cohesion for a given layer type (e.g. silty sand) we are encouraged to see that the data collected in the field will be used to provide specific cohesion values for each layer in the model. Because the model computes factor of safety as the hydrograph varies, we expect that continued dialogue with FirstLight will allow us to focus on specific time periods in order to limit the amount of output provided by the model.	As noted in the comment, default values for soil properties will not be relied upon as site-specific soil properties will be collected at the detailed study sites. Running of the BSTEM model will include time series of data that include historic fluctuations in water level and flow over time, as well as representative ranges of water level fluctuations and flows to further the understanding of riverbank erosion processes. Discussion on focused approaches to limit model output will be incorporated into the study approach as will the selection of proposed detailed study sites based on results of the 2013 FRR.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			Task 7: Report - To the extent possible, we ask that geospatial datasets be made available to the public.	Adopted. These will be provided upon request.
		MADEP	Request FL to evaluate strategies to manage and minimize sediment release from the power canal. Notes that FL is conducting Study No. 3.3.12. MADEP recommends that their request for strategies evaluated be added as an additional task within 3.3.12 if sediment transport is shown to be a problem below Cabot.	Adopted. The request for strategies evaluation was added to the reporting task in Study Plan 3.312.
		NHDES	Determine how water level fluctuations within the minimum and maximum operating range and discharges from peaking operations at the FL hydroelectric projects contribute to shoreline erosion;	This is part of the overall study.
			Identify and determine the effects of shoreline bank erosion and riverbank failure on other resources (i.e. riparian areas and shoreline wetlands, rare plant and animal populations, water quality, aquatic and terrestrial wildlife habitat, etc.)	The mapping and evaluation of sensitive receptors proposed as part of this study will examine this to some extent, however, the majority of this evaluation will occur as part of the other environmental studies proposed in the RSP.
			Identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce on riverbank erosion within the impoundment and downstream of the tailrace.	An assessment of the success of past riverbank stabilization projects and recommendations for future riverbank stabilization projects is included in Study No. 3.1.1 Full River Reconnaissance.
			Task 5d. Field Evaluation - Round 2. For transects in NH the density of the survey points used to define geometry of the river bank should be specified. The density will need to be quite high to detect changes in riverbank geometry that may be primarily attributable to project operation. NHDES proposed installing horizontal pins into the bank to help measure erosion over the short and long term. If the density of survey points is not considered high enough to detect subtle changes in riverbank geometry, NHDES will likely request that pins be installed at the NH transects as described in its original study request.	Bank pins have previously been used on specific project sites to monitor monthly and yearly bank stability trends. The current RSP will provide a geotechnical evaluation of the river banks, but does not propose to install and monitor bank pins. Regarding specific bank geometry change, the detailed studies will be utilizing the survey of transects at 22 locations which have been surveyed since the 1990s. Transects for detailed study will be monumented for future reference and survey.
			Methodology- the study should compare the water elevations due to project operation to the elevation along the riverbanks below which there is a lack of vegetation, undercutting, etc. and determine if there is a correlation. The study should also address the potential of daily project operations making the riverbanks more prone to erosion (i.e., due to lack of vegetation, undercutting, etc.) and how this may impact the frequency and magnitude of massive erosion when high flows occur.	This is part of the overall study.
			The study should also address how daily project water level fluctuations may impact groundwater levels and movement within the riverbank and the extent to which this may be destabilizing the banks and making them more prone to erosion failure under higher flows.	Pressure transducers were used to measure WSEL fluctuations in the impoundment and groundwater near Bennett Meadow below the Route 10 Bridge in the late 1990's. This data, as well data collected at additional fixed riverbank transects, will be used to analyze the relationship between water level fluctuations and groundwater levels.
			The analysis should also evaluate how changes in operation of the Projects may affect riverbank erosion along the river.	This is part of the overall study.
		CRWC	Compare 1961 aerial photographs to LiDAR and aerial photographs recently obtained by TransCanada. Would like a comparison of riverbank position over time.	A historic geomorphic assessment of the Connecticut River based on the review of aerial imagery, topographic maps, archival documents, and other pertinent datasets will be included in this study as a means of providing context of long term trends in the Connecticut River.
			Task 3: Install Proposed Water Level Monitors in Turners Falls Impoundment- a map showing the water level monitor locations would be extremely helpful. In lieu of that, the table below has the location in miles upstream of the dam, as well as comments. CRWC requests more water level monitors. CRWC would like the water level recorders operable for longer than August-November 2013.	A map showing the water level monitors is provided in Study No. 3.2.2. FirstLight has added one additional monitor- Route 10 Bridge- from that proposed in the Updated PSP. Between the existing and proposed monitors FirstLight believes it has more than adequate coverage. Two gages were placed in the vicinity of Stebbins Island to validate the hydraulic model. FirstLight has proposed to install the water level recorders beyond 2013, if a range of flows and operating conditions are not captured during the period August-November 2013.
			Task 3a and 3d. Hydrographs of Turners Falls Impoundment Elevations vs. Flow- 3a is for the long-term and short-term (2012) monitors. We aren't sure what the end product will be as described. We think that for each water level monitor, there will be a single graph showing each year's hydrograph super-imposed onto the same sheet of paper. This would make a total of six graphs. Is that correct? 3d is for the proposed monitors. Couldn't this be one task with two components? The way these sub-tasks are organized is very confusing. Each graph will show the hydrograph for a proposed monitor, and will also show the Vernon discharge and the Montague gage data. If there are 4 proposed monitors, we think this means 4 graphs, but it is a little confusing. What we would like to see as another task related to 3a and 3d is a single hydrograph showing the period of time that the proposed recorders will run, with hydrograph lines for the 4 long term monitors and for the proposed monitors all on one graph. This would give us one sense of locational variability over the study period.	See explanation provided in RSP.
			Tasks 3c and 3e: Evaluation of Maximum Daily Fluctuation of Turners Falls Impoundment Elevations on a Monthly (and Annual) Basis- 3c is for the long-term and short-term (2012) monitors. This task proposes to make monthly and annual "delta" duration curves for 1) the period of record for each recorder (from 2000 on), 2) for 2010 alone – this is the year that Northfield Mountain was shut down between May and November, and 3) for	Adopted- see changes in RSP.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			times that the Turners Falls dam is not spilling. We think the delta duration curves will provide useful information and we recommend this stays in the study plan, but duration curves don't show seasonal, weekly, or other kinds of patterns, so we would also like to see a graph of the delta over time, as in tasks 3a and 3d, but it won't be a hydrograph it will be a delta graph. This could be done by month or season, so that variations would not be lost. This could be done for the long-term monitors only, for a subset of years and for 2010 separately.	
			Task 3f: Analysis of Flow and WSEL Data to Correlate Project Operations and WSEL Fluctuations- First bullet. We think using mean daily flows will miss the peak flows and fluctuations. We would prefer hourly data used, although one would need to think about what the time gap is between the West Deerfield gage and the Montague City gage. The end result of using hourly data would essentially be a hydrograph for flows just upstream of the Turners Falls Dam, something we currently don't have. There is an old USGS discontinued gage somewhere in this vicinity; perhaps that data could be obtained if that is of any value. Second bullet. The subtracted hydrograph suggested in the above bullet should be plotted on this graph. Second bullet: Don't just concentrate on high flows here, but all flows low and high. In general, we want to know when water levels change, what is the ramping rate? That would be relevant for the Odonate study and other habitat studies.	Not Adopted. The purpose of using mean daily flows is only to provide context on the range and seasonally variability of flows; the intent is not to evaluate sub-daily information in bullet 1. Not Adopted. Water elevation data is already being plotted along with flow data. FirstLight is not proposing to only look at naturally high flows.
			Task 5c: Evaluation of Round 1 Field Evaluation- Transects are buried in this subtask, whereas it is an entire study for TransCanada. During the June 14 meeting, I asked for stratigraphic descriptions of the bank material, and Bob Simons said it would be done during the transect surveys, but I don't see that there is any mention of stratigraphy in the updated PSP.	This section of the RSP has been revised.
			Task 6: Causes of Erosion- This section lists 9 potential causes of erosion (two of which overlap: land management practices and anthropogenic influences to the riparian zone), and then describes how just 3-4 of these will be analyzed (land management is called "spatial analysis," and the studies that look at riparian land management are not referenced here). Therefore, this task seems incomplete and detracts from the study proposal's credibility. We believe it will be impossible to parse out some of the causes of erosion. For example, is erosion at the toe of the slope due to water level fluctuations, hydraulic sheer stress, boat and wind waves, ice or debris. Moreover, it is our opinion that boat wakes are an indirect effect of project operation/existence. In the Massachusetts section of the Connecticut River, the two areas that are heavily used for motor boating are the Holyoke impoundment and the Turners Falls impoundment. No doubt, motor boating would not be as prevalent without the existence of those two dams. The resulting analysis in this task has the feeling of being highly subjective and therefore we feel that there will be lots of money spent on questionable results.	This section of the RSP has been revised. All potential causes of erosion will be identified as part of this study, however, only those causes that are thought to be major contributors to erosion will be analyzed and evaluated in-depth. No comment.
			Task 7 Report- CRWC recommends that the report details provided in TC's Riverbank Transect Study and Riverbank Erosion Study be incorporated into FL's study	This section of the RSP has been revised.
		FRCOG	Task 3- would like more water level monitors in the TF impoundment. FRCOG would like the water level recorders operable for longer than August-November 2013.	FirstLight has added one additional monitor- Route 10 Bridge- from that proposed in the Updated PSP. Between the existing and proposed monitors FirstLight believes it has more than adequate coverage. FirstLight has proposed to install the water level recorders beyond 2013, if a range of flows and operating conditions are not captured during the period August-November 2013.
			Task 5: Field Study and Task 6: Causes of Erosion- It appears that the BSTEM approach is appropriate and may yield useful information. However, it is not clear from the text the number and the location of the proposed data collection points and whether the data collection points correspond to the proposed fixed recoverable transects, the 22 existing transects and/or other locations to be determined. Task 6 should be revised to present a clear, step-by-step methodology that includes appropriate citations and references to standard practices in the disciplines of fluvial geomorphology and geotechnical and soil evaluation.	These sections of the RSP have been revised.
		FCD	Task 2: Geomorphic Understanding of Connecticut River - this study should incorporate documentation of existing conditions at the start of Northfield Project operations as a baseline for riverbank assessments.	A historic geomorphic assessment of the Connecticut River based on the review of aerial imagery, topographic maps, archival documents, and other pertinent datasets will be included in this study as a means of providing context of long term trends in the Connecticut River.
			Task 5c: Evaluation of Round 1 Field Evaluation - This task is based on the results of the arguably flawed FRR methodology. It describes an undefined site selection process for further evaluation. That process should be defined and should incorporate stakeholder involvement.	The FRR methodology and the site selection process for establishing fixed riverbank transects have been revised in the RSP.
			Task 7: Report - This task consists of nothing more than a list of nine bullet points. It should provide a detailed	This section of the RSP has been revised.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			description of each element. It should describe the report development process, and that process should include a draft report for stakeholder and permitting agency review and comment.	
		LCCLC	Disappointed with proposed study.	No comment.
		Town Northfield	Same comments as FRCOG	See responses to FRCOG above.
3.1.3	Northfield Mountain Sediment Management Plan	EPA	Requested that Northfield Mountain Sediment Management Plan be included in the RSP.	Adopted.
3.2.1	Water Quality Study	MADEP	Requested sediment sample above TF Dam.	Not Adopted. FirstLight believes there is sufficient information already on CT River sediment. Further details on past sediment sampling findings included in RSP.
		NHDES	Requested nutrient sampling.	Not Adopted. Not requested by MADEP. MADEP has no nutrient standard.
			Requested that a sampling plan for monitoring in NH be submitted to NHDES for approval prior to sampling.	Adopted. The plan will be sent to NHDES for approval.
			Requested weekly DO and temperature profiles of Turners Falls Impoundment in NH/VT section.	Not Adopted. Three proposed locations are sufficient to characterize DO and temperature stratification.
		CRWC	Requested nutrient sampling in Barton Cove.	Not Adopted. Not requested by MADEP. MADEP has no nutrient standard.
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypass Reach and below Cabot	USFWS	Requested long term monitors to record on 15-minute time step.	Adopted, changes made to RSP.
		NMFS	Requested proposed monitors should be left in place longer to capture wider range of flows.	Adopted with modification. Proposed to remove monitors in winter 2013 and re-install in 2014 if data collected in 2013 does not cover a wide enough range of flows.
			Requested clarification on Max Gen and Min Gen	Adopted, changes made to RSP to explain purpose of max gen and min gen for all facilities.
		NHESP	Requested that study plan reference collection of transects associated with state-listed macroinvertebrate and plant species.	If, as part of other studies, transects are obtained they will be included in the hydraulic model.
		NHDES	Requested that the hydraulic model be calibrated to velocity.	Adopted with modification. FirstLight does not propose to calibrate to velocity for the Turners Falls Impoundment model. FirstLight does propose to use data velocity data collected as part of the IFIM study to further validate the hydraulic model in the reach between Turners Falls Dam and Holyoke Dam.
		CRWC	On page 3-49, boat wakes are listed as a source of water level fluctuations in the Turners Falls impoundment and below Cabot Station. Boat wakes are temporary waves caused by the passage of watercraft. For the purposes of a hydraulic model, boat wakes have no effect on the amount of water in the river at any time, the velocity of water going downstream, or the cross-section of the river bed that contains water. CRWC recommends deleting these two bullets.	Adopted with Changes. FirstLight did not remove the two bullets but noted that boat waves are a form of water level fluctuation.
			Recommends adding "Operation of Northfield Mountain Pumped Storage Project (pumping or generating)" to the list of sources of water level fluctuations below Cabot station.	Adopted- changes made to RSP.
			This study should include a hydraulic analysis of the Turners Falls canal, since upstream and downstream passage goes through the canal.	Not Adopted. As noted in RSP, the power canal water surface elevation does not fluctuate.
			Seeking more water level recorders- particularly above and below French King Gorge.	Not Adopted. The location and number of water level monitoring locations in Study No. 3.1.2 and 3.2.2 are the same. FirstLight did propose one additional monitoring location (Route 10 Bridge), but not above/below French King Gorge.
			Seeking an explanation of max gen, min gen, and Turners Falls.	Adopted. Further explanations are provided in RSP.
			Why are scenarios added for Holyoke and Holyoke Pond level?	These were added because the hydraulics in the lower portion of this reach are impacted by the downstream boundary condition- the water surface elevation at Holyoke Dam.
			Table 3.2.2-4 doesn't factor everything that is coming downstream into the reach below Cabot. Analysis should include releases from Northfield Mountain.	Not Adopted. The primary cause of fluctuations below Cabot is the result of Cabot/Station No. 1 operations or the Deerfield River No. 2 station (on the Deerfield River.)
		TNC	Requested HEC-RAS and digital files.	Adopted.
		Karl Meyer	Requested that hydraulic model of power canal be developed.	Not Adopted as summarized in RSP.
			Requested adding reference regarding shortnose sturgeon to Existing Information.	Not Adopted. A reference for a shortnose sturgeon study has no bearing on the proposed hydraulic model.
			Requested that water level data collected in 2010 (incorrectly noted, it was collected in 2012), should be removed from existing information.	Not Adopted. This information could be helpful in calibrating the hydraulic model.
			Requested additional water level recorders.	Not Adopted. For purposes of the hydraulic model, additional water level recorders are currently not proposed.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
3.3.1	Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station	USFWS	USFWS notes that they will continue to coordinate with other parties and consult with FL on recommended HSI curves for target species and life stages. Additional modifications of species or guild curves are likely to occur during this consultation.	Adopted. FirstLight has included further consultation in the RSP.
			Freshwater mussels- requested that white suckers HSI curves be used as surrogates if no species-specific habitat suitability indices exist for either eastern Elliptio or eastern floater.	Adopted. White sucker HSI criteria are included in the HSI criteria.
			Data Collection- needs resolution as to the range of flows to be simulated in Reach 3, which includes an area above and below Cabot Station.	Added more detail on WSE (i.e. calibration) collection range and how flows in the upper reach will be simulated.
			Dual Flow analysis- requested spatial maps depicting suitable habitat across cells for the 1D modeled reach. Note that on June 20, 2003 call, FL agreed to include a subset of species/life stages would be identified to narrow the number of maps developed. This was not addressed in the Updated PSP.	FirstLight understands the merit in spatially presenting the dual-flow outputs. To date, however, we have not seen any currently available technology that will spatially present dual-flow results from a one-dimensional model. FirstLight will research any available or possible methods for doing this and will utilize any methods requiring a reasonable amount of effort, but we cannot commit to produce such outputs at this time.
			Study Report- needs revision due to cancellation of July 2013 site visit	Adopted- changes made to RSP.
		NMFS	Description of shortnose sturgeon life stage criteria for Reach 4 should be revised and new references added.	Adopted- changes made to RSP.
		MDFW/ NHESP	Add sea lamprey spawning and incubation to Reaches 1 and 2.	Adopted- changes made to RSP.
			Amend Tasks 2-6 to detail the FL's plan to apply appropriate data collection, modeling and analysis methodologies for state listed mussel species in Reach 5.	The RSP has been modified to include a method of assessing state listed mussels in Reach 5.
			Existing Information- FL intends to use a mussel survey slated for the Holyoke Project in 2013 south of Dry Brook in Sunderland. NHESP notes that if FL intends to use data collected from the Holyoke mussel survey that it follow the same methods and procedures for Study No. 3.3.16.	Not Adopted. FirstLight is relying on the presence /absence and location data related to state-listed mussel species for this survey.
			NHESP notes that water surface elevation and hydraulic modeling will not (by themselves) be sufficient to enable an assessment of how project operations impact suitable and potential suitable habitat for freshwater mussel in Reach 5. NHESP notes that study plan should be revised to clarify how IFIM methodologies will be applied.	The RSP has been modified to include a method of assessing state listed mussels in Reach 5.
			Page 3-74 of Updated PSP suggest that host fish and freshwater mussel species will be limited to deep slow and shallow slow guilds. The RSP should include summary of references confirming that all known and potential host fish species will be captured by the proposed guilds.	FirstLight proposes to develop Category I HSI curves by assembling a workshop comprised of credentialed experts with specific expertise in the habitat and ecology of the target state-listed mussel species. This DELPHI workshop group will interactively develop recommended suitability criteria that can be applied to the model.
			NHESP finds that the use of host fish as a proxy for persistent mussel habitat is not preferred or plausible approach and would likely misrepresent mussel habitat availability and persistence.	FirstLight will not use the host fish species as surrogates for state-listed mussel species. See response above.
			The study plan does not include Eastern Silvery Minnow or Burbot- which as listed as state listed species of concern. NHESP requests these species be added to Reaches 1-4.	FirstLight will consult with stakeholders to identify and adopt applicable habitat use guild(s) for these species.
			FL proposes to adapt empirical data collected in Reach 4 during the mussel survey work…. to develop HSI criteria specific to yellow lampmussel. NHESP requests that HSI curves also be developed for eastern lampmussel and dwarf wedgemussel. NHESP notes that if these two species are not found in abundance that data should be collected in adjacent sections of the CT River or defendable sources of literature.	Not Adopted. FirstLight believes that collecting HSI data for eastern lampmussel and dwarf wedgemussel is beyond the scope of the study as it appears to be a research project. Furthermore it is unlikely that sufficient numbers of mussels can be found across a range of habitat conditions to develop a quantitatively sound HSI model. As an alternative, FirstLight proposes to develop Category I HSI criteria by assembling a workshop comprised of credentialed experts with specific expertise in the habitat and ecology of the target mussel species. This DELPHI workshop group will interactively develop recommended suitability criteria that can be applied to the model.
			Use of host fish as proxy for persistent mussel habitat is not a preferred or plausible approach. NHESP requests the study plan be amended to define how additional data will be acquired, or otherwise, define an abundance threshold below which an alternative approach would be used.	Not Adopted. FirstLight will develop Category I HSI criteria by assembling a workshop comprised of credentialed experts with specific expertise in the habitat and ecology of the target mussel species. This DELPHI workshop group will interactively develop recommended suitability criteria that can be applied to the model.
			NHESP notes that FL is not required to assess project impacts on mussels that are not state-listed.	Noted.
			FL notes that mussel habitat suitability will be assessed in all study reaches, and that host fish habitat suitability will be used as a proxy. NHESP prefers to have HSI criteria developed for the three state listed mussels. NHESP prefers to have HSI criteria developed for confirmed host species. The request covers 3.5 pages.	FirstLight will not use the host fish species as surrogates for state-listed mussel species, but instead proposes to develop Category I HSI criteria by assembling a workshop comprised of credentialed experts with specific expertise in the habitat and ecology of the target mussel species. This DELPHI workshop group will interactively develop recommended suitability criteria that can be applied to the model
			Field Data Collection- NHESP requests that "Data collection should include a full velocity profile, with near substrate data collection being particularly important to modeling shear stress. Simulated data should be calibrated to field data collected from transects portraying mussel habitat under various flow conditions and adequately encompass the range of flows observed under current and potential flow regimes".	FirstLight proposes to collect and simulate applicable hydraulic and substrate data as dictated by the HSI criteria developed by the technical DELPHI team for use in this study.
			NHESP notes that data collection methods for Reach 5 are not detailed.	The RSP has been modified to include a method of assessing state listed mussels in Reach 5.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
		CRWC	Notes that "Ensuring that flows in the bypass reach and below Cabot Station are conducive to reproduction and survival of the federally endangered shortnose sturgeon (SNS) is a key element of this study. It is therefore not clear why this section leaves out any mention of shortnose sturgeon".	The study proposes to assess spawning and incubation of shortnose sturgeon.
		TNC	Cautions about developing HSI criteria for yellow lampmussel from a regulated river unless there is documentation of a successfully reproducing and persistent population. TNC suggests that "sufficient age or size structure" be used in addition to "sufficient abundance" as a qualifier to using empirical data.	FirstLight is concerned that insufficient individuals of these species will be found to develop HSI Criteria from this river from empirical data, and therefore proposes to develop Category I HSI curves by assembling a workshop comprised of credentialed experts with specific expertise in the habitat and ecology of the target mussel species. This DELPHI workshop group will interactively develop recommended suitability criteria that can be applied to the model.
			TNC notes that the presence of host fish does not necessarily indicate a successfully reproducing or persistent population. Host fish should not be used as a surrogate if habitat suitability is intended to reflect the habitat necessary for a species to reproduce or persist.	FirstLight will not use the host fish species as surrogates for state-listed mussels, but instead proposes to develop Category I HSI criteria by assembling a workshop comprised of credentialed experts with specific expertise in the habitat and ecology of the target mussel species. This DELPHI workshop group will interactively develop recommended suitability criteria that can be applied to the model.
			Dual Flow analysis- requested spatial maps depicting suitable habitat across cells for the 1D modeled reach. Note that on June 20, 2013 call, FL agreed to include a subset of species/life stages would be identified to narrow the number of maps developed. This was not addressed in the Updated PSP.	FirstLight understands the merit in spatially presenting the dual-flow outputs. To date, however, we have not seen any currently available technology that will spatially present dual-flow results from a one-dimensional model. FirstLight will research any available or possible methods for doing this and will utilize any methods requiring a reasonable amount of effort, but we cannot commit to produce such outputs at this time.
		TU	River immediately below Cabot Station is not a shortnose overwintering habitat	Adopted.
			Include reach lengths for Reaches 3, 4 and 5	Adopted.
			Study plans shows 7 shad spawning areas, Study No. 3.3.6 indicates 15- explain difference	The referenced figure only shows those historical shad spawning areas between Cabot Station and Route 116 Bridge.
			Include juvenile and adult shortnose sturgeon habitat and overwintering habitat in Reach 4 and 5. Add sea lamprey spawning, incubation and zone of passage to Reach 1 and 2.	Adopted.
			Burbot (*Lota lota*) may be able to be included in a guild but their specific life history may require HSI criteria. This species is not addressed in the study plan. It is a state species of special concern and has been identified as inhabiting the bypass reach.	FirstLight will identify and adopt applicable habitat use guild(s) for these species in consultation with agencies and stakeholders.
			In addition to using HSI criteria for host species of fish for an evaluation of mussel habitat, the model should develop a measure of shear stress for the bypass reach.	FirstLight proposes to collect and simulate applicable hydraulic and substrate data as dictated by the HSI criteria developed by the technical DELPHI team for use in this study. Areas with two-dimensional modeling will output bed shear velocity, which can be converted to shear stress.
			As the locations of shad spawning are significant, transects in the IFIM study should be located at each spawning location in reaches 3, 4 and 5. If after the shad spawning survey is completed, there are additional spawning locations identified a transect should also be placed at each location.	A 2-D model is proposed for Reach 3 so the extent of this reach can be evaluated. For Reach 4-5, FirstLight is proposing to place transects in Reach 4 in representative habitat. Each transect depicts homogenous habitat within a longitudinal cell extending a distance upstream and downstream of the actual transect site defined by the study team in the field. Shad spawning habitat will be included in representative cell locations and may be selected using available information pertaining to shad spawning to inform cell boundary loci; however, FirstLight is not proposing to place a transect at every shad spawning locus.
		Karl Meyer	Requested more water level monitoring locations	Not Adopted. The field study will include collecting water elevation and velocity data needed to calibrate a hydraulic model.
			For Reach 1 and 2, add the spawning life stage of blueback herring and pre-spawning for shortnose sturgeon.	Table 3.3.1-1 specifies that the American shad spawning HSI criteria will be used as a surrogate for blueback herring. "Pre-spawning" is not a life stage.
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad	USFWS	More details are needed on the number of fish that will be tagged. Wants FL to develop minimum design parameters that can be refined once the Conte Lab data is reviewed.	Adopted.
			Study needs to include detail with respect to sample sizes, telemetry equipment specifications, and receiver configurations/locations.	Adopted.
			Study needs to include a ballpark number of test/flow configurations given that the number of tests has a bearing on the number of shad that will need to be tagged to ensure adequate sample sizes. USFWS recommends that two flows below 2,500 cfs be evaluated in addition to three test flows between 2,500 and 6,300 cfs.	Adopted
			USFWS recommends that no fewer than 390 shad be double tagged (radio and PIT) for the study, with an equal number of PIT-only tagged fish released. USFWS offered a suggested protocol in their response.	Partially Adopted. FirstLight proposes to radio tag 340 instead of 390 shad. The 50 shad requested to be tracked through the canal was not adopted as explained in the RSP.
			USFWS included locations of receivers and provided comments on the receivers proposed by FL. They want: (1) Cabot tailrace should have both a near field and far field receiver set up, (2) Station 1 tailrace receiver should be sited and configured to pick up shad that are attracted to the Station 1 discharge as well as across the river, (3) The equipment below TF Dam should be set up so that it allows determination of which side of the river the fish are	Partially Adopted. Explanations/justifications for telemetry locations are provided in the RSP.

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			coming up. At all of the ladders, antennas should be located at the fishway exists and entrances. (4) Include receiver in NMPS upper reservoir, (5) Include receiver below Stebbins Island, (6) for downstream movement of post-spawning shad, a PIT antenna on the entrance and exit of the bypass, and telemetry receiver at the Cabot intake is needed	
			USFWS provided a list of telemetry locations and video camera locations.	Partially Adopted. Not including telemetry stations as follows: Station 1 Nearfield Telemetry; Upper Reservoir Telemetry; Cabot Forebay (dropper at bypass entrance); Cabot Fish Ladder (dropper at entrance and exit); Spillway Ladder (dropper at entrance and exit); Entrance to Cabot Ladder (video). Explanations/justifications are provided in the RSP.
			Task 4- Evaluation of Mortality- the plan should specify that the tag time interval that will denote a dead shad should be developed in consultation with USFWS and other stakeholders.	Adopted. As requested FirstLight has proposed an interval in RSP but welcomes agency input.
			Task 5- Reporting- study provides no details on the type of analyses that will be conducted on the data collected. USFWS provided, at a minimum, four bullets listing graphical and tabular analyses, and summary analyses.	Adopted.
			Seeking two years of study.	Not Adopted. Proposes adaptive management based on results from Year 1.
		NMFS	Task 3 Evaluation of Route Selection and Delay- The Updated PSP adds that mobile tracking will be conducted, but it does not provide any details as to the timing, frequency and duration of the mobile tracking efforts.	Adopted
			Task 4- Evaluation of Mortality- Requests that a results and discussion of delay be included in the final report. Understands that motion sensor telemetry tags will be used to detect mortality; however, they seek clarification on the time interval that will be used to denote a dead fish.	Adopted
			Seeking two years of study.	Not Adopted. Proposes adaptive management based on results from Year 1.
			Receiver location in the power canal (Figures 3.3.2-2 and 3.3.2-3). Requests that clarification be given in terms of what assumption is made if a fish is detected at the Cabot Station Forebay but is never detected again at this location, Station No. 1 or the Gatehouse Fish Ladder.	Adopted
		MDFW	Requests sample sizes of fish tagged.	Adopted.
			Requests more detail on mobile tracking including frequency and location	Adopted.
			Requests more than one PIT tag reader is needed per fishway in order to determine direction of travel (upstream vs. downstream).	Adopted.
			Asks if it is feasible to install PIT tag reader(s) at the Northfield intake/discharge or at the Upper Reservoir to directly evaluate entrainment.	Not Adopted. Entrainment will be assumed if the fish is last detected at the Northfield intake.
			Asks why the northernmost extent of the study is Northfield Mount Herman and not Vernon Dam.	The TransCanada study team will be conducting their evaluation concurrently and will have monitoring stations located at the Northfield Mount Herman Boat Launch and below the Vernon Dam. FirstLight will consult with the TransCanada Study Team and will coordinate tag and receiver configurations such that both studies may take advantage of all of the monitoring locations upstream of the Turners Falls Dam.
		CRWC	Task 3: Requests more details be provided on mobile tracking methods.	Adopted.
			Task 4: Ted Castro-Santos pointed out at the meeting that failure to pass can also lead to mortality. Perhaps a distinction needs to be made in this task that you will be assessing "direct mortality," and that "indirect mortality" is also a factor. Please specify whether or not indirect mortality will be evaluated.	Indirect mortality will be addressed through mobile tracking.
			It was noted during the meeting that shad are probably spawning in the canal. The canal itself does not have any receivers other than the Cabot station forebay. For upstream migration, if you get a reading for a fish at the Cabot station forebay but not at the gatehouse ladder, do you assume it has spawned or do you assume mortality? Likewise for an opposite situation for downstream migration. Is there a need for an additional receiver in the canal?	A receiver will be installed near the upper end of the canal, but below the gatehouse.
			A recommendation was made at the meeting to install multiple PIT tag readers at the Cabot fish ladder. If more than one is recommended, perhaps Table 3.3.2-1 could indicate so.	Adopted.
			In order to be able to evaluate downstream passage route selection, and pond fluctuations on upstream and downstream passage, more receivers are needed just upstream of the Turners Falls dam. The updated draft moves the one just upstream of the dam to a spot near a set of old bridge abutments upstream. Fluctuations of the pond at the top end of the gatehouse ladder have been mentioned as a possible problem for fish migration, and there are no receivers that would allow for that evaluation.	Adopted. Additional receivers are proposed
			At the meeting, Ted Castro-Santos recommended 6 receivers in the vicinity of the Northfield Mountain Intake. The updated draft, however, still proposes only 3 receivers.	Adopted. Propose full river coverage above and below Northfield. This may include either 3 or 6 receivers and will be determined in field.
			PIT tag reader should be installed at the Northfield Mountain intake/discharge pipe or at the entrance to the upper reservoir to evaluate entrainment mortality.	Not Adopted. A radio telemetry receiver will be installed at the NMPS Intake. FirstLight will monitor the NMPS intake, should a fish be detected at the intake and not detected again by other monitoring stations (either up- or downstream) then the fish will be classified as entrained. Mortality for entrained

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				fish at NMPS will be assumed to be 100%.
			Why is the northernmost extent of the study at Northfield Mount Hermon and not somewhere closer to the Vernon Dam?	The TransCanada study team will be conducting their evaluation concurrently and will have monitoring stations located at the Northfield Mount Herman Boat Launch and below the Vernon Dam. FirstLight will consult with the TransCanada Study Team and will coordinate tag and receiver configurations such that both studies may take advantage of all of the monitoring locations upstream of the Turners Falls Dam.
		TU	Under Study Goals and Objectives: The last bullet should include time of passage, or no passage, in the canal in addition to passage rates, routes, and Cabot fish bypass effectiveness.	Passage rates will include time of passage (and no passage).
			Under Methodology, Task 1, and Task 2- TU states that the plan lack specificity.	Many details added to RSP.
			Under Task 3, TU requests more detail relative to: (1) Description of radio and PIT tags (size, life expectancy, pulse interval, frequencies, mortality identification, and any additional features to be incorporated, etc.) , (2) Description of fish capture, handling, tagging, and transport methods, (3) Description of release locations, (4) Number of fish to be tagged and intervals of tagging, (5) Location of telemetry antennas and receivers and description of receivers and antenna arrays. This should include identifying how multiple frequencies will be detected simultaneously, (6) Location of PIT antennas, (7) Location of video cameras, (8) Description of bypass flows to be tested and the intervals and duration of each flows release and (9) Where and how frequently water temperatures will be taken. Requests that manually tracking occur more than 2x/week.	Many details added to RSP. Did not adopt request to manually track more than twice per week.
			Task 4: Evaluation of Mortality: The specifics of the tags and information on how the mortality sensor work and will be programmed should be provided. Information about prior use of the mortality tags and their efficacy should be provided. Mortality of tagged fish should be assessed at all telemetry locations and during mobile tracking and not just at the tailraces of Cabot Station and Station #1 and the spillway.	Adopted. Mortality tags will assess mortality at all locations.
			Task 5: Reporting: All data used to develop the report should be provided to the stakeholders in a digital form including all telemetry, PIT tag, and manual tracking data.	Adopted.
			Seeking two years of study.	Not Adopted. Proposes adaptive management based on results from Year 1.
			Recommends tagging at least 300 shad for release at Holyoke and 100 for release above the TF Dam.	Adopted.
			Provided list of telemetry locations and video camera locations.	Adopted with modifications. See RSP.
			Requests that all receivers be able to detect frequencies and codes simultaneously.	Adopted.
			Test flows in Bypass: Recommend test flows of 2,500, 4,000, and 6,300 cfs during sturgeon spawning. Two test flows after spawning- the lower flow would cover and provide flow over the gravel bar downstream of the tailrace and any other area where sturgeon eggs or larvae may be located; the other flow would be between the lower flow and 2,500 cfs. Each of the three bypass flows during the sturgeon spawning period should be done for three days each (4 replicates = 36 days) alternating between flows after each three day period. After sturgeon spawning, the two lower flows should alternate for four days each until the end of the passage season.	Partially adopted. FirstLight adopted USFWS proposed test flow scheme which is addressed in the RSP.
			Reporting- although not replicated in its entirety here, TU describes what they would like to see in the final report.	More details have been provided in the reporting section.
		Karl Meyer	Wants to add study objectives of: (1) Determine route selection, behavior and migratory delays of upstream migrating American shad through the entire Turners Falls Power Canal (2) Describe the effectiveness of the gatehouse entrances. Also wants to add in "and describe the behavior of migratory American in the Turners Falls Power Canal within 500 feet of the gatehouse entrances" and "Evaluate attraction for shad reaching the dam spillway under a range of spill conditions."	Not Adopted. FirstLight believes that the information in hand is more than adequate to describe the movement of shad in the canal and through the gatehouse fishway under a wide range of operating conditions as explained in RSP.
			Task 2- wants radio and PIT tagging of entire power canal.	Not Adopted. FirstLight believes that the information in hand is more than adequate to describe the movement of shad in the canal and through the gatehouse fishway under a wide range of operating conditions.
			Task 3- wants to add that tagged fish will be tracked throughout the power canal during upstream and downstream migration. Wants to add that tagged fish should be released at the top of the Cabot ladder.	Not Adopted. FirstLight believes that the information in hand is more than adequate to describe the movement of shad in the canal and through the gatehouse fishway under a wide range of operating conditions.
			Wants more video monitoring than only at the spillway ladder.	Not Adopted. Radio telemetry will provide needed info.
			Task 4- requests that mortality tagged fish and data should be collected throughout the entire power canal to correct for overall mortality. Wants more fish fitted with mortality tags.	340 shad will be tagged with radio transmitters containing motion sensors to detect mortality during this study.
			On Table 3.3.2-1 several comments are provided relative to the location of telemetry equipment	Many alterations have been made to the receiver configuration. See RSP.
3.3.3	Evaluate Downstream	USFWS	Task 1- USFWS recommends that evaluations start one hour prior to initiation of pumping operations, to assess fish within the zone of pumping influence.	Adopted.

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	Passage of Juvenile American Shad		Releases of radio-tagged fish should be planned to occur in a range of river discharges. USFWS is most interested in accurately determining operation effects in the lease favorable scenario, which is 3 to 4 units pumping.	Adopted.
			Task 2- seeking more details with respect to tagging, holding, and release protocols. Suggested looking at NAI study conducted for Muddy Run. USFWS proposed suggested releases protocols, along with sample sizes. The study should specify whether FL intends to use the same receiver locations as the adult shad telemetry study or not. Recommends that in addition to the locations identified for the adult shad study, an additional receiver be installed at the Gatehouse entrance.	Adopted.
			Task 3- USFWS is seeking an assessment of spill mortality. USFWS recommends, at a minimum, spill mortality be evaluated through the four bascule gates and a tainter gate. A minimum of 25 test fish per gate should be tagged and released immediately upstream of each gate to determine survival. If turbines operate at less than full hydraulic capacity, that condition needs to be evaluated. Likewise, if the units are always operated at peak efficiency, that condition needs to be evaluated. If the units are operated at varying efficiencies, all three conditions should be evaluated (max gate, peak efficiency and min gate).	Adopted. Spill mortality evaluation added to RSP. Peak efficiency operations will be tested.
			Task 4: section lacks detail. USFWS recommends graphical portrayals of each individual fish's movements and timing through the project area, identifying passage route selection. These movements should be analyzed relative to environmental and operational variables. For the turbine entrainment task, survival through each turbine/gate setting tested should be calculated based on the number of tagged fish injected into a given turbine or bascule gate that are alive immediately and 48 hours after turbine passage. Final results should be adjusted for survival of control fish. Any injuries to recaptured fish should be reported. Total through-project survival should be calculated based on these study results. Data should be made available in digital format.	Adopted.
		NMFS	Task 1: The proposed plan does not provide much detail on the flow conditions that could potentially occur during the study. The study should occur during a range of river flows and operational conditions such that the effect of NMPS is relatively large and relatively small compared to total river flow.	Propose to sample over typical flow range.
			Task 2: The Updated PSP does not specifically mention if the same receivers used for the upstream adult American shad (*Alosa sapidissima)* study will be used for this study. The Updated PSP mentions that telemetry studies have had success when test fish are approximately 120mm in length. Given the ILP schedule, we recommend some initial testing occur in 2013 in order to confirm that test fish can indeed be detected. Such information could prove quite valuable as the 2014 field season approaches. The proposed study also states "receivers will be set up above and below the Turners Falls Dam to determine spillage survival." It is not clear how a radio receiver below the dam will determine whether a fish survived via spill.	Adopted. Added table of receivers and spill mortality evaluation,. and collaboration with USFWS plans to determine juvenile growth rates in 2013.
			Task 3: To assess overall project survival, we recommend that mortality for fish passing via spill is an important component of this study. Given the differing hydraulic flow conditions of the bascule gates and tainter gates, it is not clear to us what percent of juveniles pass via these gates. At a minimum, we recommend that spill mortality be evaluated through the four bascule gates and one of the tainter gates. A minimum of 25 test fish per gate should be tagged and released immediately upstream of each bascule gate to determine spill survival	Adopted.
		MDFW	Radio tags- Sample size- how many fish will be tagged?	Adopted.
			Balloon tags- All turbines will be tested "at or near hydraulic capacity". Does this represent normal operation?	Adopted. Will test at best efficiency conditions.
		CRWC	Task 1- Define "pumpback mode.	Refers to when Northfield in pumping water to the Upper Reservoir
			Task 1- Receivers are to be set up above and below the TF Dam to determine spillage survival. How is survival going to be determined using radio receivers? In task 3 it is explained that fish will be recovered from the tailrace, examined for injuries and held for 48 hours to determine latent mortality. We think a similar method should be used for spillage survival, and downstream bypass survival. Otherwise, how will we evaluate whether or not going through the turbines is better or worse, and also evaluate whether changes need to be made to downstream passage	Adopted.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			options. We also think there should be a control group for both.	
			Study Schedule- During the meeting, Kleinschmidt expressed worry that tagging would not be possible for juvenile shad. We wonder, then, if 2013 should be used as a trial period, during which radio and balloon tags could be inserted and tested to see if the study plan is viable. If not, then the licensee will have time to develop an alternative plan.	Partially adopted. There is no longer a proof-of-concept tagging study; rather, the North Attleboro National Fish Hatchery has retained juvenile shad to determine growth rates to ensure that suitable sized juvenile shad are available for fall 2014 tagging.
		TU	Task 1- In addition to the hours of pumping, the hour before pumping at Northfield Mountain should be evaluated to assess fish within the zone of pumping influence prior to the start of pumping.	Adopted.
			Task 2- Additional detail of the receivers, the location and description of antennas, tags, and the manufacturer of tags is needed. Fish should be released far enough upstream that they can select the 'normal' approach to the project so as not to bias the results. Fish released upriver of Barton Cove are constricted at two locations prior to reaching the dam which should be sufficient for them to select a normal approach to the dam. Sample sizes for the releases should be determined for the filing in August. If fewer fish are available, the release numbers should be discussed with all stakeholders when that information becomes available. A schedule for spill releases should be provided in the final study plan. This should ensure that all bascule and Taintor gates are tested. Testing of route selection should not be done during the canal shutdown as the only choice of route selection is spill. It is important to know which route fish chose when both generation and spill are occurring in able to assess overall project survival. Neither Task 1 nor 2 addresses the goal of determining the rate of entrainment at the Northfield Mountain project. Task 1 will hopefully identify the number of juvenile shad entrained at the Northfield Mountain project but it cannot determine the rate of entrainment. The rate of entrainment is the number of fish entrained divided by the population passing the project. Hydroacoustics, assuming complete and accurate data, will only provide the numerator of the equation. The rate of entrainment can be achieved by releasing radio tagged fish above the Northfield Mountain project and monitoring the proportion of those fish entrained.	Adopted.
			Task 4: The report should include a graphical illustration of the movement of each fish. It should report the volume of spill at each gate throughout the testing period. Spill data for the period of out migration should be summarized for the full period of digital records so that an analysis of spill potential can be included in an overall project passage analysis. All data used to develop the report should be provided to the stakeholders in a digital form.	Adopted.
			Study Plan Recommendations- Survival of fish passing over the bascule and through the tainter gates should be evaluated with the Hi-Z Turb'N tags. The landing zone for each of the bascule gates is different which will result in different rates of survival. Twenty five fish should be released over each bascule gate and twenty-five fish through a tainter gate	Adopted.
			Study Plan Recommendations- telemetry study of entrainment at the Northfield Mountain project is needed. As noted above, it is not possible to determine the rate of entrainment with the current study plan. Radio tagged fish should be released above the Northfield Mountain project. Fish should be released two river bends upstream of the Northfield project to allow them time to move downstream in a normal manner.	Adopted.
			Study Plan Recommendations: TU offered telemetry station locations	Explained in RSP
			Study Plan Recommendations: All receivers should be able to detect all frequencies and codes simultaneously. Both FirstLight and TransCanada will be tagging juvenile shad during the fall. Information at FirstLight projects can be augmented by collecting data from fish tagged by TransCanada. Cycling through frequencies and antennas is likely to miss fish with the probability of missed detections increasing with the number of fish tagged. To better enable removal of spurious codes and to facilitate data analysis, all detections should be logged individually.	Adopted
		Karl Meyer	Task 3: Turbine survival should be done for all turbines, with all turbines operating, at both Cabot and Station 1, to capture the broadest range of conditions at these sites.	Not Adopted. Proposed sampling scheme based on agency input in RSP
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls	USFWS	Task 1: The Cabot Station log sluice was removed in the updated PSP, the reason for which is unclear. The log sluice outfall passes 200 cfs from June 1 to November 5, and this flow could attract juvenile eels moving upstream. The rip rap along the banks in the vicinity of the log sluice should be surveyed.	Adopted.
			Task 4: Recommend similar proposal timing as PSP 3.3.3, and provide stakeholders with a report supplement by December 1, 2014 for the eel survey and by December 1, 2015 for the trap collection study. Both the eel survey	Adopted.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			and trap collection require little analysis, and FirstLight should be able to develop a report within 45 days from the date the data collection ends.	
		NMFS	Task 1: It is assumed that the American eel surveys will be conducted on foot.	Comment: Surveys will be conducted on foot or by boat, which will be determined by conditions and access.
			Task 1: It is not clear why the Cabot Station log sluice survey site in the previous version of the proposed study plan is not mentioned in the Updated PSP. Given that this structure passes 200 cfs from June 1 to November 15, it could serve as a potential attraction point for upstream migrating eels.	Adopted.
			Task 2: It is not clear during this study, whether Cabot or Spillway attraction flows will be operating when the fishways are not operational. We recommend a minimum amount of attraction flow from the fishway attraction flow sluices to attract the eels during this study. The other aspect of this study that is unclear is how the traps will be operated when the fishways are operational. We think it might be possible that the attraction water from the fishways could indeed be providing too much water to attract an upstream migrating eel to the ramp.	Adopted
		MADFW	Systematic eel surveys-why was the area around the downstream fish bypass removed from the list of sites to be studied?	Adopted.
			The temporary eel traps are described as being 6 feet long and 1 foot wide. Is 1 foot wide enough to have the 2 different substrates used side by side as the methods describe? Please describe the substrate types to be used.	Adopted.
			Will Cabot or Spillway fishway attraction flows be operated during the period when fishways are not operational to attract eels? How will the traps be run when the fishways are operational?	Adopted
		VANR	The study plan should clarify an end date for the systematic surveys.	Adopted.
			According to Murphy and Willis (1996) systematic surveys are conducted by selecting sampling units and or events at regular intervals. For example, TransCanada is proposing to conduct visual surveys at night, once per week, downstream of each dam on foot (wading) or from a boat from May 1 through October 15 (or when water temperature exceeds 50oF). This sampling regime more closely reflects the definition of systematic and should be considered. Please clarify how this study meets the definition of systematic, as surveying after precipitation events is more impromptu rather than systematic.	Proposed systematic sampling frequency in RSP
			Recorded data will include location, observation of eels (presence, absence) and relative numbers, relative sizes, behaviors, and time/date of observation, recent weather, and current discharge. Please clarify what it is meant by relative, as the term estimated might be more appropriate.	Adopted. Changed to "estimated" where applicable. Sizes are relative, thus no definition is required.
			In addition to visual surveys the Agency requests that eel pot trapping be conducted to gain a better understanding of eel numbers and sizes. Data collected should include location, number captured (or recorded as none captured), estimated sizes, and time and date of observation. Each eel should be assigned a length class (0 to 6 inches, 6 to 12 inches, 12 to 18 inches, and >18 inches). The first 10 individuals within each length class should be individually measured for total length (nearest mm) and wet weight (nearest gram). The first 10 individual eels in the >18-inch length class should also have eye diameter measurements recorded. To facilitate collection of length and weight data as well as prevent unnecessary injuries to the eels, it may be necessary to anesthetize individuals using an appropriate anesthetic for the species (i.e., ice, clove oil, or MS-222).	Not Adopted. We believe the temporary eel ramps will better reflect areas of egress than eel pots. Eels collected in the ramp traps will be measured and grouped into size categories.
		CRWC	Task 1: Why has the Cabot station log sluice survey site been deleted?	Adopted.
			Task 1: Specify whether eels will be released at the point of capture or not.	Adopted.
			Task 2: USGS Conte Anadromous Fish lab researcher Alex Haro (written comments distributed at the meeting) recommended adding the Cabot Station Spillway near north abutment as a survey site, and that has not been added.	Adopted
			Task 2: The updated PSP describes the temporary traps as being 6 feet long and 1 foot wide. I believe we talked about making the traps 6 feet long and 3 feet wide. Is 1 foot wide enough to have the 2 different substrates used side by side as the new paragraph says? Please describe climbing substrate types.	Changed traps to 2 feet wide to accommodate two substrate types.
			Task 2: Alex Haro had pointed out that it is not specified whether Cabot or Spillway fishway attraction flows will be operated during the period when fishways are not operational. How will the traps be run when the fishways are operational?	Adopted
		TU	The first objective is to identify eel concentrations where they occur in the project area. The first bullet limits locating concentrations to pools and wetted structures.	Based on agency comments about including specifics we indicated areas
			The investigation should be the entire project area including the downstream passage discharge	Adopted.
			Task 1: The discharge of the downstream passage (log sluice) should be included in the survey areas.	Adopted.
			Task 1: The Cabot fishway should be evaluated with the addition of some attraction water. Should eels be attracted to the fishway it would be a secure location to deploy a trap in a location (tailrace) to which eels will likely be attracted. Without attraction water it is unlikely that many eels will enter the fishway.	Adopted
			Task 1: If the spillway fishway attraction water system is not used to provide minimum flow after the upstream	Adopted

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			passage season the stilling basin should be evaluated with attraction water.	
			Task 1: The entrance to the spillway ladder and the lower pools of the fishway should be surveyed.	Adopted
			Task 2: Stakeholders should be consulted in determining additional trap locations beyond the three listed.	Adopted
			Task 2: Eel ramps should be covered with plywood to prevent avian predation.	Adopted.
			Task 2: Traps should be checked the day after periods of rain or other events that would precipitate eel movement to prevent overcrowding and mortality.	Adopted.
			Surveys of eel concentrations should be done in 2015 as conditions in the field may change, the number of eels present will likely change, and the conditions that stimulate eels to move upstream are episodic. By surveying a second year the likelihood of surveying when eels are migrating is increased.	Propose surveys via eel ramp traps in Year 2.
			The eel ramps are described as being 12 inches wide. This is insufficient width to accommodate two substrates. Each substrate should be at least 12 inches wide. Substrate selection should be described for use by smaller and larger eels.	Adopted.
			Length and weight data should be collected for all eels captured in 2015. Environmental conditions should also be recorded including: water temperature, turbidity, moon phase, discharge, station operations, etc.	Adopted.
			Location and number of eel ramps should be determined in consultation with the stakeholders.	Adopted
3.3.5	Evaluate Downstream Passage of American Eel	USFWS	Task 1: It is unclear to the Service why the scope and details cannot be determined at this time.	The RSP includes considerably more detail.
			Task 1: Recommends that evaluation start one hour prior to initiation of pumping operations to assess fish presence within the zone of pumping influence.	Adopted.
			Task 2a: Few details on study methodology are provided. Recommends that FirstLight generally follow the protocol outlined in the report "Movement and Behavior of Telemetered Emigrating American Eel in the Vicinity of the Muddy Run Project" (Normandeau Associates Inc. February 2012) with respect to methods and data analysis for the radio telemetry study.	Adopted.
			Task 2a: Recommends that some of the receiver locations identified in the adult shad telemetry study be used for the eel movement study (i.e. the Shearer Farm and NMPS Gill Bank sites) in addition to the NMPS intake. In addition, receivers should be placed at the Turners Falls Gatehouse entrance and outlet to the upper reservoir (unless FirstLight is assuming that every eel picked up by an intake receiver constitutes an entrained eel). The receivers at the NMPS intake should be placed in a manner that provides full depth coverage.	Adopted.
			Task 2a: A minimum of 50 eels should be tagged (refers to Haro recommendation). The final number may be higher depending on how many releases will be needed to test all relevant operating conditions. For example, FirstLight has stated that the project rarely pumps with more than three units. However, if FirstLight requests and is granted by the Commission an increase in the storage capacity of the upper reservoir, then it is possible that the percentage of time when all four turbines are pumping may increase in the future. Therefore, eel movement and entrainment should be evaluated under both of those conditions.	Adopted.
			Task 2a: An adaptive strategy, similar to Muddy Run, should be used at NMPS. Likewise, the hydroacoustic data that will be collected concurrently should be used to inform release times; if weekly review of the hydroacoustic data indicates eel targets at a certain time, the release protocol should be adjusted accordingly.	Adopted.
			Task 2a: Recommended release protocol is to run tests on eight nights (four nights at 3 units pumping and four nights at 4 units pumping) with three releases per night (at dusk, two hours later, and two hours after that) and three test fish per release. This equates to a total of 72 eels.	Adopted.
			Task 2b: To ensure that a sufficient number of eels are exposed to all potential passage routes, recommends that eels also be released immediately downstream of Gatehouse as well as the proposed location in the headpond.	Adopted.
			Task 2b: Recommend that FirstLight generally follow the fish collection, holding, tagging, and release protocol used at Muddy Run.	Adopted.
			Task 2b: The USFWS provided a table of preliminary release protocols including release locations, dates/times, and number of eels per release. See letter for details.	Adopted.
			Task 2b: The USFWS provided a list of radio telemetry receiver locations, similar to the adult shad telemetry study. See letter for details.	Adopted with modifications explained in RSP
			Note that Dr. Haro indicated that it could be difficult to detect fish using the Cabot log sluice; suggested that some assurance be provided that the radio method will have a high degree of detection/reliability in this location; otherwise, use of a PIT system to supplement telemetry data and increase confidence was recommended. Likewise, the plan should confirm that the receivers will be configured to provide full depth coverage at all intakes and other deep (>30 feet) locations.	FirstLight proposes to have field crews sample the log sluice during the passage season instead of relaying on radio telemetry.
			Task 2c: Recommend that manual tracking be performed up to 5 km downstream of Cabot Station; it will also occur on a weekly basis beginning after the first release date and ending in mid-December (or when all viable	Adopted.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			tagged eels have been detected at the Route 116 bridge, whichever occurs first).	
			Task 3: The report should include a graphical illustration of the movement of each fish. All data used to develop the report should be made available to stakeholders in digital format, upon request.	Adopted.
			Task 4: Need to assess spill mortality. Evaluation of spill is critical to both assess potential impacts of various spill release amounts and locations on eel survival, compare spill survival to turbine survival, and to assess whether spill may be one alternative to addressing downstream eel passage at the project.	Adopted.
			Task 4: At a minimum, spill mortality should be evaluated through the four bascule gates (unless FirstLight can provide certainty that these gates will not be used during the downstream adult eel migration period). A minimum of 25 test fish per gate should be tagged and released immediately upstream of each bascule gate to determine spill survival.	Adopted.
			Task 4: If the units typically operate at less than full hydraulic capacity, then that condition also needs to be evaluated. If units are operated at varying efficiencies, each of those conditions must be evaluated (e.g. maximum gate, peak efficiency, and minimum gate) as turbine survival is known to vary depending on turbine unit operations.	Evaluations will be conducted during best efficiency conditions.
			Task 4: FirstLight provides no description of the data analysis for this task. Survival through each turbine/gate setting tested should be calculated based on the number of tagged fish injected into a given turbine or bascule gate that are alive immediately following turbine passage, and after 48 hours, adjusting for survival of control fish. Any injuries of recaptured fish should be documented and reported. Total through-project survival should be calculated based on results of this study, other related studies (i.e. hydroacoustics, telemetry), and historical operations data.	Adopted.
			Study schedule section should specify that an additional year of study may be required due to circumstances such as 1) unfavorable environmental conditions; 2) equipment malfunction; 3) inability to secure sufficient test fish; and 4) inadequate replicates of various locations and operating scenarios.	Adopted.
			The updated PSP does not contain a section on reporting. Reporting for this study plan should include: release numbers, locations, and dates; fish vitals (length, weight, morphometric criteria), river temperature at NMPS, canal, bypass, and below Cabot Station; route selection; all detections of fish; behavior of fish that do not pass the project; delay of fish: location and time; survival of fish passing each project facility; overall project passage effectiveness; and graphic description of the movement of each fish.	Adopted.
		NMFS	Task 1: The sentence "acoustic targets can be filtered by size and supporting data used to apportion the number of fish by size class" is essential for discriminating eels from other species.	This language has not been altered in RSP.
			Task 1: Request an additional year of study in 2015, regardless of whether the 2014 study is deemed "typical".	Not Adopted. FirstLight plans to collect the required information during 2014.
			Task 1: Hydroacoustic data should be coupled with the operational hydrologic conditions so that all reviewers can understand the flow conditions the eels experienced during the study. Support Haro recommendation that the survey encompass 15-20 discrete events. .	Adopted
			Task 1: Also recommend that hydroacoustic evaluations start one hour prior to NMPS pumping operations in order to assess fish that could be present within the zone of pumping influence	Adopted.
			Task 2: The study does not make mention of any methods or metric to assess delay.	Delay will be assessed based on radio telemetry data
			Task 2: Support Haro comments to add a trap collection at the Cabot Station spillway near the north abutment.	Haro comment was related to Study Plan 3.3.4.
			Task 2a and 2b: Recommend that some of the receiver locations from adult shad study be used for this study as well as one at the NMPS intake in order to provide full depth coverage.	Adopted.
			Task 2a and 2b: NMFS expects to be included in the discussion of sample size. Recommend 50 eels/year for Northfield entrainment; 50 eels/year for Turners Route Selection; 50 eels/year for turbine mortality at Station No. 1 50 eels/year for turbine mortality at Cabot Station.	Adopted.
			Task 2a and 2b: NMFS provides a detailed preliminary release protocol in their letter. See letter for details.	Adopted
			Note that Dr. Haro indicated that it could be difficult to detect fish using the Cabot log sluice; suggested that some assurance be provided that the radio method will have a high degree of detection/reliability in this location; otherwise, use of a PIT system to supplement telemetry data and increase confidence was recommended. Likewise, the plan should confirm that the receivers will be configured to provide full depth coverage at all intakes and other deep (>30 feet) locations.	FirstLight proposes to have field crews sample the log sluice during the passage season instead of relaying on radio telemetry
			If Holyoke Gas and Electric is willing to allow a receiver in the vicinity of the Holyoke project, suggests that one is installed there to further confirm viability of non-killed eels.	Proposed receiver downstream of project area.
			Task 2c: A 50 day battery life may not be suitably long enough for motion sensing tags.	Motion sensing tags at a 2 second burst rate lasts up to 1 year.
			Task 2c: Recommend that manual tracking be performed up to 5 km downstream of Cabot Station; it will also occur on a weekly basis beginning after the first release date and ending in mid-December (or when all viable	Adopted.

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			tagged eels have been detected at the Route 116 bridge, whichever occurs first).	
			Task 4: Need to assess spill mortality.	Adopted.
			Task 4: At a minimum, spill mortality should be evaluated through the four bascule gates (unless FirstLight can provide certainty that these gates will not be used during the downstream adult eel migration period). A minimum of 25 test fish per gate should be tagged and released immediately upstream of each bascule gate to determine spill survival.	Adopted.
			Task 4: If the units typically operate at less than full hydraulic capacity, then that condition also needs to be evaluated. If units are operated at varying efficiencies, each of those conditions must be evaluated (e.g. maximum gate, peak efficiency, and minimum gate).	Evaluations will occur during best efficiency conditions
			Task 4: FirstLight provides no description of the data analysis for this task. Survival through each turbine/gate setting tested should be calculated based on the number of tagged fish injected into a given turbine or bascule gate that are alive immediately following turbine passage, and after 48 hours, adjusting for survival of control fish. Any injuries of recaptured fish should be documented and reported. Total through-project survival should be calculated based on results of this study, other related studies (i.e. hydroacoustics, telemetry), and historical operations data.	Adopted.
			Study schedule section should specify that an additional year of study may be required due to circumstances such as 1) unfavorable environmental conditions; 2) equipment malfunction; 3) inability to secure sufficient test fish	Adopted.
		MADFW	Radio telemetry study: What is the sample size?	Detailed in RSP
			The hydroacoustic study should take place for more than one year because of year-to-year variability.	Not Adopted. FirstLight plans to collect the required information during 2014.
			Another receiver site should be added upstream of the Holyoke Dam but downstream of the Route 116 bridge to confirm viability of eels passed downstream.	Adopted
		CRWC	Task 1: We talked at the meeting about providing a table of a range of operating conditions here, but no table or details about the operating conditions have been provided.	Not Adopted. Hydroacoustic data will be collected continuously, during all operating conditions present during the study.
			Task 1: USGS Conte Anadromous Fish lab researcher Alex Haro (written comments distributed at the meeting) recommended 15-20 discreet ground truth events. The draft says 12-18, and so we'd recommend that the mid to upper end of this range be used.	Adopted
			Task 1: Alex recommended the hydroacoustic study take place for more than one year because of year-to-year variability. Only one year of study is proposed, perhaps due to the expense. Is there an equivalent method for this study that is less costly and could be used for more than one year? What is TC doing?	Not Adopted. Current methodology includes a hydroacoustic, field-based component while the TransCanada PSP indicates a literature review.
			Task 2b: Alex Haro recommended adding a site above the Holyoke Dam and downstream of the Route 116 bridge to confirm viability of non-killed eels. No such site has been added.	Adopted
			Task 2b: This draft has also not incorporated Alex Haro's recommendation that spill morality be considered and estimated, and that a metric for delay be developed. CRWC thinks these two additional issues are important.	Adopted.
		TU	Task 1: In addition to the hours of pumping, the hour before pumping at Northfield Mountain should be evaluated to assess fish within the zone of pumping influence prior to the start of pumping.	Adopted.
			Task 2a: Antennas should be located up- and downstream of the project as well as at the intake.	Adopted.
			Task 2a: The sample size should be included in the Study Plan filing due August 12, 2013. It is not anticipated that additional information that would inform the decision will be available after that date and prior to the study.	Adopted.
			Task 2a: A release schedule with times of day/night should be proposed.	Adopted.
			Task 2a: Fish should be released far enough upstream that they can select the 'normal' approach to the project so as not to bias the results.	Adopted.
			Task 2b: Similar to Task 2a, a release schedule for times of day/night should be proposed.	Adopted
			Task 2b: Specific locations for telemetry should be listed in the August 12 filing.	Adopted.
			Task 2b: The specifics of the tags and information on how the mortality sensor work and will be programmed should be provided.	Adopted
			Task 2b: Fish should be released far enough upstream that they can select the 'normal' approach to the project so as not to bias the results.	Adopted.
			Task 3: The report should include a graphical illustration of the movement of each fish. All data used to develop the report should be provided to the stakeholders in a digital form.	Adopted.
			Task 4: HI-Z Turb'N tags should be used to assess mortality of eels passing in spill. Eels can be expected to use spill for passage during high water periods utilized for outmigration.	Adopted.
			The study should continue until all eels have been determined to pass the Turners Falls project, died or until water temperature reaches 5º C.	Adopted
			Releases above the Northfield Mountain project and project operations should ensure, as much as possible, that eels encounter as many pump combinations as possible, including all four units pumping.	Adopted.

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			For the Northfield Mountain project fish should be released two river bends upstream of the project to allow them time to move downstream in a normal manner. At the Turners Falls project fish released upriver of Barton Cove are constricted at two locations prior to reaching the dam which should be sufficient for them to select a normal approach to the dam.	Adopted with changes. Followed USFWS and NMFS recommendations for 5 km upstream of Northfield and 3 km upstream of Turners Falls Dam.
			Evaluate with the intake area of the Northfield Mountain project with hydroacoustics the hour before pumping.	Adopted.
			Survival of fish passing over the bascule and through the tainter gates should be evaluated with the Hi-Z Turb'N tags. The landing zone for each of the bascule gates is different which will result in different rates of survival. Twenty five fish should be released over each bascule gate and twenty-five fish through a tainter gate.	Adopted
			At least 75 eels should be released above the Northfield Mountain project to ensure a reasonable number passing the project during the different pumping scenarios. An additional 50 eels should be released above the Turners Falls project to determine route of passage past that project.	72 are proposed for release above Northfield and 30 above Turners Falls
			TU provided a list of receiver locations (see letter for details).	Adopted
			All receivers should be able to detect all frequencies and codes simultaneously. Both FirstLight and TransCanada will be tagging American eels during the fall. Information at FirstLight projects can be augmented by collecting data from fish tagged by TransCanada. Cycling through frequencies and antennas is likely to miss fish with the probability of missed detections increasing with the number of fish tagged. To better enable removal of spurious codes and to facilitate data analysis, all detections should be logged individually.	Adopted
			Reporting for this study plan should include: release numbers, locations, and dates; fish vitals (length, weight, morphometric criteria), river temperature at NMPS, canal, bypass, and below Cabot Station; route selection; all detections of fish; behavior of fish that do not pass the project; delay of fish: location and time; survival of fish passing each project facility; overall project passage effectiveness; analysis of how project operations affect upstream movement and entry into fishways; and graphic description of the movement of each fish.	Adopted.
		Karl Meyer	Study ticket price is too expensive.	No Comment.
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	USFWS	The Route 116 bridge is in Sunderland, not Holyoke.	Adopted.
			The objective is to both verify and quantify spawning activity. Verification of the presence of spawning alone would be insufficient to assess project impacts.	Adopted
			Since proposed egg collection and monitoring is limited, it is unclear how impacts listed in the project nexus will be addressed, given the proposed study methods.	RSP updated to address this comment
			Methodology: It is unclear why FirstLight deleted the paragraph that began with "The field studies will examine…" The service recommends retaining that paragraph and deleting the new language.	Deleted based on comment from FERC.
			Task 1: USFWS notes that impacts to shad spawning would not be affected by magnitude of flow alone, but could be affected by the frequency of changes and the rate of flow changes.	Adopted. The frequency of changes and rate of flow changes will also be reviewed.
			Task 2: All nine sites from Kuzmeskus (1977) should be surveyed, in addition to any sites identified through mobile tracking of adult shad as part of the radio telemetry study (Study Plan 3.3.2). In addition, as survey crews are moving among historical sites, they should monitor for additional (previously undocumented) spawning sites.	Adopted.
			Task 2: Proposed observational and physical habitat data should be collected at all identified spawning sites between Cabot Station and the Route 116 Bridge, and collected under various operational scenarios.	Adopted.
			Task 2: It is unclear to the Service when observations would be made relative to discharge manipulations. Recommend that field crews observe and count spawning splashes before the flow changes, during the change, and after the change has occurred, as spawning behavior could be altered during both increases and decreases in flow. In addition, a dedicated field crew should be tasked with tracking any radio-tagged fish that may be on spawning sites so that their behavior can be evaluated relative to fluctuations in flow.	Adopted.
			Task 3: Protocol for identifying spawning sites within the Turners Falls Impoundment requires more detail. A trigger should be specified (i.e. similar to the trigger described for surveys below Turners Falls). It may be reasonable to set a combination trigger (e.g. after 2,500 shad pass Gatehouse and river temperatures reach 18C).	Adopted with modification. Did not include a temperature variable in the trigger.
			Task 3: Given how little we know about shad spawning in the Turners Falls Pool, the Service recommends that surveys occur in all waters of suitable depth (as identified in HSI curves).	Adopted.
			The first bullet in the study schedule should read "October 2013 through December 2013" rather than December 2014.	Adopted.
			The timeframe for conducting the field studies should be expanded to include all of May and June (and refine based on passage numbers).	Adopted.
		NFMS	Task 2: All nine sites from Kuzmeskus (1977) should be surveyed, in addition to any sites identified through mobile tracking of adult shad as part of the radio telemetry study (Study Plan 3.3.2). In addition, as survey crews are moving among historical sites, they should monitor for additional (previously undocumented) spawning sites.	Adopted.

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			Task 2: Proposed observational and physical habitat data should be collected at all identified spawning sites between Cabot Station and the Route 116 Bridge, and collected under various operational scenarios.	Adopted.
			Task 2: It is unclear when observations would be made relative to discharge manipulations. Recommend that field crews observe and count spawning splashes before the flow changes, during the change, and after the change has occurred, as spawning behavior could be altered during both increases and decreases in flow. In addition, a dedicated field crew should be tasked with tracking any radio-tagged fish that may be on spawning sites so that their behavior can be evaluated relative to fluctuations in flow.	Adopted.
			Task 3: The protocol for identifying spawning sites within the Turners Falls impoundment (to the base of Vernon Dam) requires more detail. For instance, surveys for shad downstream of the Turners Falls Dam will occur once 10,000 fish have passed the Holyoke Dam. A similar trigger for initiating surveys upstream of the Turners Falls Dam should be specified.	Adopted.
			Task 3: FirstLight states that upstream surveys will target areas of suitable habitat, including those containing flowing waters over coarse substrates. These terms are somewhat vague and undefined and may be overly restrictive. Given how little we know about shad spawning in the Turners Pool, we recommend that surveys occur in all waters of suitable depth (as identified in HSI curves).	Adopted.
			The first bullet in the study schedule should read "October 2013 through December 2013" rather than December 2014.	Adopted.
			Given that temperature and water flows are intrinsically variable, the timeframe for conducting the field studies should be expanded to include all of May and June (and refined based on passage numbers).	Adopted.
		MADFW	Will the Turners Falls Power Canal be added to the study as a survey site as discussed?	Not Adopted. Explained in RSP
		VANR	The Agency requests that eggs also be randomly collected to quantify viability, and to represent a range of conditions that could potentially hinder success.	As requested from other agencies egg collections proposed near areas of spawning
			Density of eggs collected per sample should be determined by enumerating a sub-sample and relating that to volume of water filtered. Spawning activity and fervor should be described subjectively and relatively to other spawning activities observed. Factors affecting egg collection, i.e. water turbulence, high velocities, shallow depth, should be noted. In order to gauge the effects of project operations on shad spawning, collected data should be analyzed and compared to project operational data. The times and dates of all observed spawning activities, substrate description, water measurements (i.e., velocity, temperature, dissolved oxygen, pH, conductivity, and turbidity), and observational characteristics or anomalies (e.g., extensive water roiling or turbulence) should be recorded and related to the operational data.	Adopted
			Observed effects of the projects should be classified per operational regime observations: 1. no effect –no observable effect on spawning, viable eggs were collected; 2. moderate effect – observable possible effect on normal spawning activity; spawning may have been hindered but viable eggs were collected; and 3. adverse effect – project operations likely to have prevented successful spawning of shad; no viable eggs collected.	Adopted
		CRWC	Task 2: Examination of known spawning areas downstream of Turners Falls Dam. During the meeting, we discussed adding the canal to this survey. FirstLight says that some spawning occurs in the canal, and they said they would possibly add it to this study. CRWC recommends that all spawning areas associated with the project area, including in the canal be studied.	Not Adopted. Addressed in RSP
		TU	The Route 116 bridge is in Sunderland.	Adopted.
			The last bullet has changed quantify to verify. The objective should be verify and quantify spawning activity. Task 2 Phase 1 (pg 3-152) states specifically that spawning "… will be observed and quantified by counting splashes …"	Adopted.
			The location of the fifteen known spawning areas should be better described to differentiate the first five areas from the other ten. There are two locations that describe the upstream boundary for the five locations in the first sentence of the second paragraph.	Adopted. All historical locations downstream of the Turners Falls Dam will be surveyed, downstream to the Route 116 Bridge.
			Task 1: There does not appear to be any information in this section concerning development of a schedule which is the title of this task.	Changed "schedule" to "design".
			Task 1: Data from the review of project operations at the Cabot Station and the USGS gage locations should be provided to the stakeholders in a digital format. Similarly, the water level data derived from the hydraulic model should be provided to the stakeholders in a manner that is comparable to the discharge data and the known and potential spawning areas.	Adopted
			Task 1: The section on dewatered areas and deploying ichthyoplankton nets seems out of place either as a part of a schedule or review of historic or model data.	Adopted. Removed sentences since ichthyoplankton netting is covered under Phase 2 of Task 2.
			Task 2: The first sentence states that the field surveys will be based on information from Task 1. Task 1 is either	Clarified. Task 1 identifies typical flow regimes, timing, and potential additional locations to study.

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			development of a schedule or a review of historic operation data and water level changes from the hydraulic model. It is not clear how either will inform field surveys.	
			Task 2: The last sentence in the first paragraph says that surveys "… below Cabot Station will concentrate on the five known spawning locations downstream of the Deerfield River confluence …" As there are 15 known spawning locations below the project, the specific five areas should be better described along with a justification for selecting these locations. Figure 3.3.1-4 shows two locations upstream of the Deerfield River Confluence. An explanation as to why the locations were not selected for study should be provided as they would seem to be the ones most likely to be affected by project operations.	Adopted with changes. All nine sites identified by Layzer (1974) and Kuzmeskus (1977), along with any other sites that FirstLight identifies will be surveyed.
			Task 2: In Phase 1 the observation and quantification of spawning is, on the one hand, stated to occur for a 15-minute interval and, on the other, the time spent observing will be determined by the survey crew. It is also stated that the survey crew will observe all known spawning locations. As there are fifteen previously identified locations and potentially others, the number of areas to be observed in a single night should be better defined.	Needs to be determined in field
			Task 2: As spawning is not equally distributed over the period from sunset to 01:00h, the survey design should vary the time of night that each site is observed.	Needs to be determined in field
			Task 2: The evaluation of impacts of flow fluctuation should not be limited to locations that may become dewatered. [By definition and area that is dewatered will be unsuitable for spawning] The impact of flow fluctuations will, most likely, be observed at locations closer to the project.	Adopted.
			Task 2: Flow manipulations are stated to be done over a range of expected seasonal flow fluctuations and it is also stated that several discharge manipulations **may be** investigated. These are contradictory statements. Several discharge manipulations **will be** investigated.	Adopted.
			Task 2: The baseline rate of spawning should be spawning immediately before the flow changes. To determine if flow fluctuations alter spawning, the field crew should observe and count spawning splashes before the flow changes, during the change, and after the change has occurred. Spawning could be altered during both increases and decreases in flow. Both should be observed.	Adopted.
			Task 2: Deploying ichthyoplankton nets below suspected spawning sites as a means of assessing the occurrence of spawning does not seem to be particularly useful regardless of the likelihood of dewatering. Shad spawning sites can better be identified by observation of splashing. If an egg deposition site is dewatered, egg survival is assumed to be zero without evidence to the contrary.	Shad eggs drift downstream from the location where spawning occurs; thus, dewatering of a spawning area does not necessarily result in zero egg survival. The purpose of the ichthyoplankton nets are to provide assurance that the spawning fish are American shad and not another species, and to determine whether spawning was successful due to the presence of viable eggs.
			Task 4: Two projects can affect spawning in the reach from the Turners Falls dam to the Vernon Station. If spawning occurs within the zone of influence of the Northfield Mountain project, evaluation of project effects is possible by FirstLight. If spawning is upriver of Northfield Mountain, Vernon will be the project most likely to create flow fluctuations. As FirstLight does not operate the Vernon project it is unlikely that the manipulations described in Phase 2 can be done as the plan suggests.	FirstLight plans to work cooperatively with TransCanada
			Study Schedule: Bullet one – the IFIM for reaches 4 and 5 will not be done in 2013.	Correct
			Field survey locations can be preliminarily selected prior to the spawning season but these should be selected in consultation with the stakeholders after the initial field identification of spawning sites.	Not Adopted. This concept is no longer necessary because FirstLight anticipates surveying each site and will not be sampling at a subset.
			Site selection for Phase 2 should include the site closest to the project with a reasonable degree of spawning frequency and two sites downstream where fluctuations from the most extreme peaking are moderate. Sites to be selected with stakeholders based upon initial observations.	Not Adopted. This concept is no longer necessary because FirstLight anticipates surveying each site and will not be sampling at a subset.
			Egg netting below spawning sites before and after flow change.	Adopted.
			Temperature should be recorded continuously at the upper and lower most spawning sites selected for manipulation evaluation.	Adopted.
			TU provided a theoretical schedule.	Adopted with changes. Some concepts no longer apply to this study and were not adopted. See RSP.
		Karl Meyer	Existing information : Information as American shad spawning and spawning habitat is missing for the pool where shortnose sturgeon spawn, the Rock Dam Pool, immediately downstream of that notched ledge in the river.	No comment.
			Task 2: The Turners Falls Power Canal needs to be investigated as a spawning location for American shad. A critical need is to know whether these fish are spawning in the TF Power Canal, milling in the canal, or whether they have expired.	Not Adopted. Explained in RSP
3.3.7	Fish Entrainment and Turbine Passage Mortality Study	USFWS	Task 2: Entrainment of young-of-year shad at NMPS needs to be quantified. We recommend that a similar methodology to that used in the 1992 Northeast Utilities Service Company study (LMS 1993) be used by FirstLight to quantify entrainment of early life stages of shad at the NMPS Project. The sampling should begin July 1 and should continue through October 31.	Annual entrainment of juvenile American shad at Northfield Mountain will be estimated through hydroacoustic monitoring of the pumpback intake area during the period August through October when Young of Year (YOY) American shad may be in the vicinity of the Northfield Mountain intake. FirstLight is not proposing to quantify entrainment of early life stages of shad. Fecundity estimates for American shad range from 400,000-500,000 eggs and their eggs are broadcast spawned. Fecundity

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				estimates tend to be higher for broadcast spawners who do not build protective nests to guard their young from predators. As such, the survival fractions for species with these types of reproduction strategies tend to be lower. Based on published survival fractions from the EPA Regional Analysis Document, 0.0000182% of shad eggs survive to juveniles. Considering this low natural survival, losses at Northfield would not be expected to impact the overall shad population or inform potential protection or mitigation measures to address entrainment at Northfield.
			Task 3: We are recommending that the results of the empirical mortality studies that will be conducted on adult and juvenile shad and adult eels be compared to estimates derived using the Franke *et al.* (1997) model. This comparison should allow further insight into the appropriateness of using a model versus empirical study to calculate turbine mortality at a project.	Mortality of American shad and American eel will be evaluated based on site-specific data generated by Study Nos. 3.3.2, 3.3.3, and 3.3.5, and supplemented by applicable literature data.
			Task 4: The service recommends that FirstLight include a table similar to Tables 2.3-1 and 2.3-2 in the Exelon Muddy Run RSP 33 for eels or shad that summarizes the long-term history of pumping (number of units per hours) at NMPS by month for April through November.	Adopted. Language added to the reporting task.
			Study Schedule: The meeting for this study plan took place on June 4, 2013, not May 14, 2013.	Adopted.
		NMFS	Task 2: We recommend that entrainment of Young of Year shad at NMPS be quantified as goal of this study. We recommend that a similar methodology to that used in the 1992 Northeast Utilities Service Company study (LMS 1993) be used by FirstLight to quantify entrainment of early life stages of shad at the NMPS Project. The sampling should begin July 1 and should continue through October.	Annual entrainment of juvenile American shad and American eel at Northfield Mountain will be estimated through hydroacoustic monitoring of the pump back intake area during the period August through October when Young of Year (YOY) American shad may be in the vicinity of the Northfield Mountain intake. FirstLight is not proposing to quantify entrainment of early life stages of shad. Fecundity estimates for American shad range from 400,000-500,000 eggs and their eggs are broadcast spawned. Fecundity estimates tend to be higher for broadcast spawners who do not build protective nests to guard their young from predators. As such, the survival fractions for species with these types of reproduction strategies tend to be lower. Based on published survival fractions from the EPA Regional Analysis Document, 0.0000182% of shad eggs survive to juveniles. Considering this low natural survival, losses at Northfield would not be expected to impact the overall shad population or inform potential protection or mitigation measures to address entrainment at Northfield.
			Task 3: We recommend that the results of the empirical mortality studies that will be conducted on adult and juvenile shad and adult eels be compared to estimates derived using the Franke *et al.* (1997) model. This comparison should allow further insight into the appropriateness of using a model versus empirical study to calculate turbine mortality at a project.	Mortality of American shad and American eel will be evaluated based on site-specific data generated by Study Nos. 3.3.2, 3.3.3, and 3.3.5, and supplemented by applicable literature data.
		MADFW	The Division is not convinced that no field data collection is necessary. How will realistic numbers for American shad egg and larva entrainment at NMPS be developed?	FirstLight is not proposing to quantify entrainment of early life stages of shad. Fecundity estimates for American shad range from 400,000-500,000 eggs and their eggs are broadcast spawned. Fecundity estimates tend to be higher for broadcast spawners who do not build protective nests to guard their young from predators. As such, the survival fractions for species with these types of reproduction strategies tend to be lower. Based on published survival fractions from the EPA Regional Analysis Document, 0.0000182% of shad eggs survive to juveniles. Considering this low natural survival, losses at Northfield would not be expected to impact the overall shad population or inform potential protection or mitigation measures to address entrainment at Northfield.
			How will "developing a qualitative scale of entrainment risk" translate to an estimate of impacts on fish populations?	The qualitative assessment applies to resident fish species. Population size, structure and recruitment rates of resident species in the Connecticut River project vicinity are undefined and thus such an analysis is beyond the scope of this study.
		VANR	The goal of this study is to assess fish impingement, turbine entrainment, and turbine passage survival at the two Projects. The requestors proposed that a field study be conducted to assess fish entrainment from the Connecticut River at the Northfield Mountain Project. In addition to the desktop analysis as described in the proposed study plan, the Agency requests that estimates be ground-truthed by obtaining a sub-set of the actual numbers impinged or entrained. Results would then be more conclusive.	The inherent variability associated with resident fish entrainment is due to the episodic nature of resident fish movements vs. sampling, and annual variability in riverine resident fish population densities (FERC, 1995). This makes such "ground truthing" comparisons inclusive. Entrainment studies of resident species at best provide rough order of magnitude estimates
		CRWC	Task 1: Not sure how qualitative scale of entrainment potential will translate to estimating impacts on fish numbers.	The qualitative assessment applies to resident fish species. Population size, structure and recruitment rates of resident species in the Connecticut River project vicinity are undefined, but likely vary widely from year to year; thus such an analysis is beyond the scope of this study.
			Alex Haro says careful attention needs to be paid to error around estimates for metrics in desktop and field analysis.	No change made to study plan.
			Task 3. We would prefer more actual mortality data of all life stages.	Not Adopted as explained in the RSP
		TU	As noted in comments for Study Plans 3.3.3 and 3.3.5, entrainment rates, to be determined with a telemetry study for both juvenile shad and American eels, will be needed to estimate entrainment loss.	FirstLight proposes to quantify entrainment rates of American shad and American eel at Cabot and Station Number 1 from data collected during proposed tagging and hydroacoustic studies (Study Nos.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
				3.3.2, 3.3.3, and 3.3.5).
			A long term history of pumping (number of units per hour) should be provided by month for April through November should be provided in tabular form similar to Tables 2.3-1 and 2.3-2 in the Exelon Muddy Run RSP 3.3 for eels or shad (FERC # 2355).	Adopted. Language added to the reporting task.
			The list of sections in the table of contents for the report is noted as 'tentative'. As this is supposed to be the plan, the list, that **will** be included in the report, should be defined.	The table of Contents for the study report is, in fact, tentative at this point and will not be finalized until the researchers sit down to begin writing.
		Karl Meyer	Increase the number of mortality-tagged fish; run tests for all turbines at Station 1 and Cabot, with all turbines operating.	Not Adopted, see comments on Study Nos. 3.3.2, 3.3.3, and 3.3.5 regarding mortality.
3.3.8	Computational Fluid Dynamics Modeling in the Vicinity of the Fishway Entrances and Powerhouse Forebays	USFWS	CFD modeling will be coupled with the telemetry study and passage counts to understand conditions preferable for guiding fish to entrances. FirstLight should also record and evaluate influences of river temperatures and flows on movements and passage information.	The study plan has been revised to specify that FirstLight will use available temperature and flow data in the combined analysis. The analysis will be done, however, as part of the respective telemetry studies, not as part of the CFD study. Revised language is reflected in the general study description.
			FirstLight states that existing information indicates that substantial numbers of down migrating fish use the log sluice/bypass. Given the research that has been done at the USGS S.O. Conte Anadromous Fish Laboratory, this statement is not accurate with respect to eels and should be clarified accordingly.	The study plan has been revised to reflect this comment.
			Task 3: The description of the model does not identify grid size to be used in the model. Without some idea of the size of the grid to be used, it is impossible to know if the CFD modeling will be meaningful. For example, a 2-foot grid cell will not provide fine enough resolution to provide data about sweeping velocities at the intake rack or the capture velocities in front of the downstream bypass. The final study plan should define the grid size and provide justification for the proposed grid size.	FirstLight discussed this issue directly with USFWS. Approximate proposed grid sizes have been incorporated into the study plan. An additional objective has been added to the study plan to address the impetus behind this question, stating that near-rack "sweeping" velocities will be assessed as part of the study.
			Task 4: Since tailwater conditions greatly affect the functionality of both ladder entrances, FirstLight should run the model for different tailwater conditions based on the normal range of tailwater levels.	A series of proposed model runs has been included in the study plan. These include different bypass reach and Cabot station flows, which will result in modeling various tailwater elevations.
		NMFS	Objective number 5 states that the computational fluid dynamics (CFD) modeling will be coupled with the telemetry study and passage counts to understand conditions preferable for guiding fish to entrances. We note that fish movements are also influenced by other variables; therefore FirstLight should also record and evaluate influences of river temperatures and flows on movements and passage information.	See response to USFWS comment #1.
			FirstLight states that existing information indicates that substantial numbers of down migrating fish use the log sluice/bypass. Given the research that has been done at the USGS S.O. Conte Anadromous Fish Laboratory, this statement is not accurate with respect to eels and should be clarified accordingly.	See response to USFWS comment #2.
			Task 3: The description of the model does not identify grid size to be used in the model. Without some idea of the size of the grid to be used, it is impossible to know if the CFD modeling will mean anything. For example, a 2-foot grid cell will not provide fine enough resolution to tell us anything about sweeping velocities at the intake rack or the capture velocities in front of the downstream bypass. The final study plan should define the grid size and provide justification for the proposed grid size.	See response to USFWS comment #3.
			Task 4: We understand that executing a production run is not an insignificant effort and that output options with 3D hydraulic models are vast. Nevertheless, we would like to gain a better understanding of the proposed 9 production runs. Namely, we would like to know what operating condition the licensee will be simulating.	A series of proposed model runs has been developed as part of the revised study plan, for each model. Operational conditions for each run have been summarized in a table.
			Task 4: Since tailwater conditions greatly affect the functionality of both ladder entrances, FirstLight should run the model for different tailwater conditions based on the normal range of tailwater levels.	See response to USFWS comment #4.
		MADFW	A CFD model of the Station No. 1 discharge into the bypass reach could determine potential impacts to fish migrating upstream through the bypass reach.	FirstLight is not proposing CFD modeling at the Station No. 1 tailrace. FirstLight believes that the two-dimensional modeling that is proposed as part of Study No. 3.3.1 for that reach will assess this objective.
		CRWC	Wish to understand the dynamics at the Station No. 1 outfall for upstream migrants and the dynamics just upstream of the Turners Falls dam (at gatehouse and when spilling) for downstream migrants. This study won't look at that.	See response to MADFW comment #1.
			John Warner of the USFWS asked at the meeting whether model would be able to pick up near-rack velocities. There was general agreement among the agencies that they are going to want to see the results of this study for the flows at the rack. CRWC doesn't see how this discussion was addressed in the updated PSP.	See response to USFWS comment #3. Determining near-rack "sweeping" velocities has been added as a study objective.
		Karl Meyer	Note: Three-dimensional CFD Modeling needs to extend 500 feet downstream of the Gate House in the Turner Falls Power Canal to capture the influence of the 14 head gates at the dam on migratory fish behavior and delay.	FirstLight is not proposing CFD modeling at the Gatehouse ladder, as such modeling was recently completed.
3.3.9	Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project	USFWS	The USFWS questioned the use of River2D as appropriate software, due to limitations in modeling vertical walls (based on experience with hydraulic engineers and conversations with Terry Waddle, USGS retired). There are other two-dimensional codes like SMS that may be applicable, and should be considered.	This concern was discussed directly with USFWS. FirstLight is not proposing to model the portion of the Northfield tailrace that contains vertical walls (inside the flow structure), so this should not be a concern. A map of the proposed study extents within the Northfield tailrace has been added to the study plan. If model applicability/stability does become an issue, FirstLight will consult with stakeholders about the possibility of using a different two-dimensional model.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
	Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace		In the initial study plan, this assessment was to occur from the NMPS project to 1 km upstream and downstream of the intake/discharge area. At the May 21, 2013 study plan meeting, stakeholders commented that the distance should be expanded from 1 km to 5 km; however, the Updated PSP does not incorporate this change.	The study plan has been revised to reflect a 5 km radius upstream and downstream of the Northfield tailrace.
			Given the diurnal nature of both shad movement and pumped storage operations, a transient River2D model seems warranted to assess NMPS effects on fish and to inform agency management decisions. The existing steady-state Woodlot model (2007) may be adapted to transient set-up and we recommend this be done.	FirstLight has changed the study plan to reflect that transient modeling will be conducted as part of this study.
			Task 3: The baseline for grid size should be based on getting ten or more cells laterally across the intake/discharge structure and refined moving out. Without this level of resolution, the FirstLight model will not be very accurate or helpful in the proximity of the structure.	The study plan was updated to reflect that the mesh density in the vicinity of the Northfield tailrace will be much denser, possibly in the range of 5-10 ft spacing.
			Because only mean column velocity will be used in the model, we recommend that FirstLight develop separate velocity profiles for the intake. FirstLight's consultant indicated that it would be possible to provide those data, as an acoustic doppler current profiler (ADCP) unit will be used to collect velocity measurements at the intake while gathering calibration data. This effort should be included in the study plan.	A task has been added to the study plan to accommodate this comment. Please see the description of task 2 and task 3 in the revised study plan. While FirstLight will collect velocity profile data as part of the field data collection, it is important to emphasize that field data will only be collected under safe boating condition. Thus, the amount of velocity profile data available to present near the tailrace, particularly under Northfield pumping or generating conditions, may be extremely limited
			While the Updated PSP states that model run results will include 2-D water depths and velocities, FERC's consultant had requested that the study plan include more details regarding how the results would be presented (e.g., vector plots, pseudo-color maps, etc.). It does not appear that FirstLight has addressed this issue.	Tasks 5 and 6 of the revised study plan have been updated to include a more thorough description of anticipated model outputs.
		NMFS	In the initial study plan, this assessment was to occur from the NMPS project to 1 km upstream and downstream of the intake/discharge area. At the May 21, 2013 study plan meeting, stakeholders commented that the distance should be expanded from 1 km to 5 km; however, the Updated PSP does not incorporate this change.	See response to USFWS comment #1
			Given the diurnal nature of both shad movement and pumped storage operations, a transient River2D model seems warranted to assess NMPS effects on fish and to inform agency management decisions. The existing steady-state Woodlot model (2007) may be adapted to transient set-up and we recommend this be done.	See response to USFWS comment #2
			Task 3: The study states that the River2D model will be calibrated against field-collected velocity profiles. Some additional clarification on how these profiles will be measured such as at what depth and with what equipment would be helpful.	The study plan has been revised to provide additional detail on data collection equipment. The intent is to use a boat-mounted survey-grade RTK-GPS linked with a Sontek RiverSurveyor (a type of ADCP). Data will only be collected under safe boating conditions.
			Task 3: The baseline for grid size should be based on getting ten or more cells laterally across the intake/discharge structure and refined moving out. Without this level of resolution, the FirstLight model will not be very accurate or helpful in the proximity of the structure.	See response to USFWS comment #4.
			Task 4: Because only mean column velocity will be used in the model, we recommend that FirstLight develop separate velocity profiles for the intake. FirstLight's consultant indicated that it would be possible to provide those data, as an acoustic doppler current profiler (ADCP) unit will be used to collect velocity measurements at the intake while gathering calibration data. This effort should be included in the study plan.	See response to USFWS comment #5.
			Task 4: While the Updated PSP states that model run results will include 2-D water depths and velocities, FERC's consultant had requested that the study plan include more details regarding how the results would be presented (e.g., vector plots, pseudo-color maps, etc.). It does not appear that FirstLight has addressed this issue.	See response to USFWS comment #6.
		CRWC	CRWC suggests a revision to the fifth goal and objective: Assess flow issues related to pumping and generation, including potential local flow reversal, to impact migrating fish, bank erosion, and paddling.	The study objectives have been slightly reworked for clarity. Please note, however, that FirstLight has not included any assessment on bank erosion or paddling as part of this study. FirstLight feels that these issues are addressed in other study plans.
			Under existing information, and relevant to Task 1, there should be a reference to the *Consent Order and Restoration Plan for Removal of Silt/Sediment* filed by FirstLight to FERC on September 13, 2010. The final attachment to the restoration plan included bathymetric information and a plan for the section of river downstream of the intake/tailrace.	The study plan has been revised to reflect this comment.
			Given the sediment dumping in 2010 and then Hurricane Irene in 2011, CRWC recommends field spot checks of the 2006 HydroTerra bathymetry study before that study is relied upon for the model.	During the data collection, some "spot checks" of the 2006 bathymetry will occur to assess the appropriateness of using the 2006 bathymetry. If FirstLight determines there are substantial changes in bed elevations since 2006, then a full new bathymetry set throughout the study reach will be collected.
			Task 3: How will field-collected velocity profiles be obtained?	See response to NMFS comment #3.
			Task 5: At the meeting, we discussed adding a description of the deliverables here, but nothing has been added. Ralph Abele, in particular, recommended adding a flow conditions table as one of the items in the report.	See response to USFWS comment #6.
3.3.10	Assess Operational Impacts on Emergence of State-Listed	NHESP	The division is concerned about the proposed omission of surveys within the Upper Reservoir and is not aware of any surveys/assessments that confirm the Proponent's assertion that current conditions likely preclude the presence of state-listed species. The study plan should seek to assess operational impacts to all state-listed species with the potential to be impacted by the project. The Division believes that *Enallagma carunculatum* has the potential to utilize habitats within the Upper Reservoir. Project operations in the Upper Reservoir certainly warrant further	Further justification for omitting the Upper Reservoir is provided in the revised study plan.

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	Odonates in the Connecticut River		assessment *if* state-listed odonates are present, making qualitative surveys within the Upper Reservoir a necessary first step toward assessing this issue.	
			It is critical that data collection be sufficient to enable robust statistical analyses of survey results for each species across a variety of habitat conditions. Based on the Study Plan – which is currently limited to four qualitative and four quantitative sites - the Division is concerned that natural heterogeneity/variation will make detection of trends impossible within a robust statistical analysis (including multivariate methods) without sufficiently large sample sizes. The Division recommends that the Study Plan be amended to explicitly state that additional data will be collected (either within the same season or during the next study season) should initial data collection be found to be insufficient. Judgment of sufficiency should be based upon power analyses or similar statistical methods to determine if data collection is sufficient to robustly explain heterogeneity/ variation, and should be confirmed through consultation with the Division. In addition, the Division is willing to work with the Proponent to develop pre-approved, maximum data collection thresholds to guide this process and ensure sufficient data collection. A set of conclusions based solely on non-parametric statistical methods will undermine the utility and analysis power of the study.	Robust statistical analyses for each species across the full range of habitat conditions is a lofty and possibly unobtainable goal considering the rarity of some species and habitat variability, and these challenges may not be overcome simply by increasing sample sizes. The proposed study plan seeks to use <u>existing data</u>, supplemented with <u>field studies</u>, to meet the two goals of the original study request. The work will focus on target species (state-listed species) and their preferred habitats, not all odonate species or every type of habitat in the Connecticut River. This will help to narrow the scope of fieldwork, enable more efficient data collection for target species, and allow for a more focused analysis. FirstLight believes the plan is adequate and will not commit to further data collection based on a subjective and ambiguous standard of "robustness" or sufficient statistical power to use advanced multivariate statistics to explain all heterogeneity/variation.
			Task 3: The Division notes that the Study Plan will likely generate data sufficient to document species *presence* but not species *absence*. Documenting species absence would require more extensive survey effort and does not appear to be proposed at this time. Therefore, the Division recommends that the Study Plan be amended to explicitly acknowledge intent to document species presence, or otherwise include methods sufficient to document species absence.	The plan never stated that it would document absence, as this would be an unobtainable goal. One can never prove absence. We agree that the plan is sufficient to document presence.
			Task 3: The Division believes that specific regions have seen relatively less study compared with others, including: 1) Barton's Cove, 2) Reach 3 (as defined in Study No. 3.3.1), and 3) the reach between the Railroad Bridge and Third Island in Deerfield/Montague. The Study Plan should be revised to confirm that the three reaches to be located below the TFD will be targeted in order to fill the latter two data gaps, and that two study sites be located within the reach between Railroad Bridge and Third Island. Additionally, the Division would suggest that surveys within each study reach focus on state-listed odonate species not yet documented within the target reach, but which are known to occur in similar habitats within other regions of the Connecticut River. These species include, by reach, the following target species: a. Barton's Cove – *Gomphus fraternus* and *Gomphus ventricosus*. b. Reach 3 – *Gomphus fraternus* and *Gomphus ventricosus*. c. Railroad Bridge to Third Island, Montagulie/Deerfield – *Gomphus abbreviatus*, *Gomphus fraternus*, *Gomphus vastus*, *Gomphus ventricosus*, *Neurocordulia yamaskanensis*, *Stylurus amnicola*, and *Enallagma carunculatum*.	The study plan incorporates these suggestions for study areas and target species.
			The Division believes that the Study Plan should stratify effort by habitat type and then standardize effort (amount of time to be spent per unit of area) within each habitat type. This would ensure sufficient coverage of all potential habitats throughout these regions while allowing field work to remain adaptive. Because the purpose of these surveys is to document *presence* of specific state-listed odonates, surveys within a particular reach may cease in advance of the specified effort *if* surveys successfully document the presence of all species suspected to occur within that reach.	Rather than standardize survey effort among habitat types, the plan focuses primarily on the preferred habitats of the target species. We agree that an adaptive approach to document presence of state-listed odonates is the best approach and the study plan reflects that intent.
			Task 3: The Division believes that, at a minimum, surveys should be conducted between May 10th and June 30th, as needed, to capture the emergence periods of all target odonate species.	FirstLight believes that using specific calendar days to dictate a sampling period is arbitrary and does not adequately account for the natural factors that govern odonate development and emergence, specifically water temperature, rivers flows, and weather. FirstLight will monitor these natural development triggers and time the fieldwork to occur at a time when objectives, which may begin as early as early May and extend as late as early September.
			Task 3: In addition to the data parameters proposed on page 3-173, elevation above the water surface, vertical and lateral distance from the water's edge, compass direction of the animal, its lateral aspect, and substrate should also be recorded for all exuvia collected during qualitative surveys.	Most of those parameters have been added to the study plan. The compass direction of the animal and its lateral aspect have not at this point, but could be added if NHESP can explain why these parameters are important to meet the objectives of the study.
			Task 4: Emergence of some state-listed species can begin as early as early-May of any given year, depending on weather conditions; the Study Plan should be amended such that surveys commence in mid-May and extend through the end of August.	FirstLight believes that using specific calendar days to dictate a sampling period is arbitrary and does not adequately account for the natural factors that govern odonate development and emergence, specifically water temperature, rivers flows, and weather. FirstLight will monitor these natural development triggers and time the fieldwork to occur at a time when objectives, which may begin as early as early May and extend as late as early September.
			Task 4: The second paragraph on page 3-174 states that "if possible, emerging larvae will be watched/tracked as they progress upslope, and the time it takes for them to stop and eclose will be recorded." The Division specifically	The study plan provides more detail on this component of the study. Nevertheless, there is still some uncertainty about how effective this sort of data collection would be. There is little guidance in the

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			requested the collection of data sufficient to determine how long emergence takes for state-listed species. The time it takes a teneral to complete the emergence process is a critical piece of information which, in conjunction with a better understanding of the rate and magnitude of water level fluctuations (to be provided by Study No. 3.2.2), is necessary to enable assessment of whether and to what extent water level fluctuations affect the ability of tenerals to complete the emergence process. The Division is concerned that the lack of a robust plan to assess emergence time will undermine the utility and analysis power of the study. Therefore, the Study Plan should be revised to include a study framework geared to sufficiently assess how far tenerals travel **and** how long the emergence process takes. Assessing how long the emergence process takes *where possible* is unlikely to provide data sufficient to answer these questions. See additional comments on Task 3, #2 regarding survey effort.	literature on how to implement such a study in a way that provides robust and representative data, adequately addresses for potential confounding factors, and reduces observer bias. This is a time-intensive observation process that relies on seeing larvae as they exit the water (noting that many emerge at night), and it might be challenging to get a large number of observations for a range of species (especially rare species). As such, FirstLight is providing general details on such a study, but may modify specific details of the study (in consultation with NHESP) depending on how well it works, environmental conditions at the study sites, larval densities, etc.
			Task 4: The Division is concerned that the Study Plan – which would effectively yield survey of 24 linear meters of river – is unlikely to provide sufficient spatial coverage of different habitat conditions (from substrate and vegetative community type to water depth and velocity) nor a sufficient number of data observations for each species (or species group) to enable robust data analysis. One approach to overcome this concern would be to stratify the sampling within known emergence habitat type (e.g., gradually sloping mud banks, natural vegetation, rip rap, etc.) and then ensure sufficient observations are collected within each emergence habitat type. The Division remains available for consultation to help determine appropriate habitat stratification for each species, and to work with the Proponent to develop pre-approved, maximum data collection thresholds to guide this process and ensure sufficient data collection. Modifications of the Study Plan – which might include modifying transects such that they run parallel to the river and ensuring that transects are a minimum of 50m in length, at various upslope distances from the river (terminating at 12m, as proposed) – may greatly improve detection of emergence within different habitat conditions. See additional comments on Task 3, #2 regarding survey effort.	The study plan increased transect width two meters and has included language that more transects may be added depending on habitat variability within each reach, habitat preference of target species, and variability in the density and species composition of exuviae among transects (e.g., low density and high variability may require additional transects). The Task 3 results will help inform this decision, and the plan may evolve further depending on preliminary Task 4 results. All that said, this study plan does not seek to examine every combination of habitat conditions in the Connecticut River, but rather, focus on preferred habitats of target species. Similarly, as this study is focusing on species that may indeed be extremely rare, meeting a subjective standard of "sufficient number of data observations to enable robust data analysis" may not be achievable.
			Task 4: The plan should clarify the parameters under which surveys will occur, including both appropriate weather conditions and flows. Surveys should occur on weekdays and non-holidays to minimize the affect of boat traffic wake on survey results, and should occur on two consecutive days (with suitable conditions) between 4AM (or two hours prior to dawn) to 12PM. Additionally, the Division notes that, in order for surveys to yield an accurate representation of the range of travel distances and emergence time periods, surveys should occur no sooner than 24-48 hours after stabilization of water levels. The Division is concerned that, without stabilization of water levels (e.g., no peaking during a sufficient time window prior to field work), collected data will be biased toward individuals and species that travel far / fast enough to be observed and measured; individuals that do not will have been washed away by water level peaks and therefore escape observation. For similar reasons, surveys should occur no sooner than 24-48 hours after a significant rain event, the magnitude of which should also be specified.	The study plan provides some additional language as noted.
			Task 4: In addition to the data parameters proposed on page 3-174, elevation above the water surface, vertical and lateral distance from the edge of water, the compass direction of the animal, its lateral aspect, and substrate should also be recorded for all exuvia collected during qualitative surveys.	Most of those parameters have been added to the study plan. The compass direction of the animal and its lateral aspect have not at this point, but could be added if NHESP can explain why these parameters are important to meet the objectives of the study.
		CRWC	Task 4 says that water level data will be used to identify the zones along each transect that have low, moderate, to high inundation frequency. The water level loggers that are not permanent and are only hourly will only be run August to November, 2013 and not the study months of June through August. This is one more reason why the loggers should be out for more than one season.	The water level monitors may be in for longer than August-November 2013, pending the range of flows measured- see Study3.2.2 for further details. If there is a sufficient range of flows obtained during the August-November 2013 time period, the water level data will be used to calibrate the hydraulic model. The study months have no bearing on model calibration. Also note that the existing and proposed water level monitors will be set to record every 15 minutes.
			Will the water level analysis be able to show how quickly the river levels increase and/or decrease and the typical range of changes along the banks for the months of the study?	The water level monitors are set to record every 15 minutes, so it will provide information on how quickly water levels rise or fall.
			Task 5 or 6 should reference the boat wake assessment from Study No. 3.1.2 to discuss possible impacts from water level fluctuations exacerbated by boat wakes.	As noted in Study No. 3.1.2 information on boat wakes is being collected to provide information on the amplitude of waves. Note that boat wakes cannot be simulated in the hydraulic model.
3.3.11	Fish Assemblage Assessment	USFWS	The Service reiterates recommendation to add a third time-period when sampling would occur (spring). In order to avoid conflicts with the shortnose sturgeon, the spring sample would focus on the impoundment and bypass reach.	Not Adopted. See RSP for justification
			Sampling will be based upon habitat strata, but no definitions for the strata are provided. Using the upstream boundary of Vernon Dam to the Turners Falls Dam, there is the potential to designate many strata on a variety of important criteria. The Service recommends that an overriding criterion should be whether the area is subject to less of an impoundment effect (Stebbins Island to Ashuelot River Confluence), is in impounded riverine (much of main-stem), off-channel areas (Barton Cove, Miller Rod and Gun Club area), and lower reaches of tributaries (e.g. Ashuelot River, Dry Brook, Millers River, Four Mile Brook). These areas will provide different habitat conditions for different species and/or life stages. Large areas, such as "main-stem" habitat from possibly the Ashuelot River to the Turners Falls Dam, should be defined by depth zones, reflecting nearshore/shallow, mid=channel shallow, deep water, substrate type, and submerged aquatic vegetation beds, as these similarly affect species and life stage	Adopted with modifications. See RSP for new stratification.

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			use.	
			FirstLight states that at least 18 stations will be sampled. The number of stations should be reflective of the stratification designations and should be based on the diversity of habitat types/criteria noted above, which will influence fish species occurrence. The number of replicate samples required within randomly selected strata should be based on observed species catch rates.	Not Adopted. The number of substrata designations will be based on habitat and general location within the river/morphology. However, the number of replicate samples within substrata will be determined by the size of each substratum.
			Sampling based on electrofisher "on-time" should be the standard for effort (the 500 seconds identified in the plan appears reasonable). However, FirstLight should report the distance for each transect.	Adopted
			Gill net set time should be reduced from the 24 hour period stated. A several-hour period (3-4 hours) set at dusk into early evening will increase netting effectiveness and reduce the risk of excessive mortality. Should catch rates be extremely low, longer sets could then be used. Effort should be reported in catch per net hour (with identification of timing: dusk, dusk-evening, evening).	Adopted.
		NMFS	Shortnose sturgeon may be affected if exposed to electric current generated during these activities. Due to the sensitivities of spawning adults and early life stages present in Transect 5 and the presence of juveniles and adults year round in Transect 6, we recommend that the study be modified to eliminate the potential for effects or that FERC initiate formal consultation pursuant to section 7 of the Endangered Species Act (ESA) with NMFS to assess effects of this study.	Study scope has been modified.
			Our preliminary assessment is that to avoid effects to shortnose sturgeon, electrofishing in Transect 6 would need to be removed from the study and a seasonal restriction would be required for transect 5 to ensure that no electrofishing is carried out when shortnose sturgeon may be present (April 15-June 30). We have discussed the possibility of a seasonal restriction for Transect 5 with staff from the State of Massachusetts (MA) and the U.S. Fish and Wildlife Service (USFWS) and it is our understanding that they would not object to this change. However, based on preliminary discussions with MA and USFWS staff, it is NMFS' understanding that the goals and objectives of this study would be negatively impacted if Transect 6 was removed from the study. If electrofishing occurs in Transect 6, adverse effects to shortnose sturgeon may occur.	Sampling will not be performed in the Bypass reach prior to June 30.
			We believe that a Biological Opinion, with an appropriate Incidental Take Statement, is necessary if electrofishing will take place as it is currently proposed for Transect 5 and 6. Because any take of shortnose sturgeon would be incidental to the proposed action, and this study can not be considered to be "directed research" on shortnose sturgeon, authorization under Section 10(a) (1)(A) of the ESA is not appropriate. An example of a Biological Opinion we have produced for similar electrofishing studies is available on our website (http://www.nero.noaa.gov/protected/section7/bo/oldbiops/epa_ct_and_merrimack_ibi_2009_web_archive.pdf)	Sampling will not be performed in the Bypass reach prior to June 30.
		MADFW	Boat electrofishing: Not clear if this will take place in day and night.	Adopted. Boat electrofishing will be performed during the day and night
			Selection of study reaches: FirstLight should describe how the study reaches will be chosen. In the April 15, 2013 PSP, FirstLight cited Kiraly (2012) methods for stratified-random study design. However in the June 28, 2013 updated PSP, FirstLight has removed this citation, and failed to describe how their proposed study still represents a stratified-random design.	Adopted. The design presented by Kiraly et al. (2012) was applicable to stratification of shorelines for boat electrofishing, and was based on a spatial rather than habitat-based stratification. Descriptions of habitat strata delineations are provided in the RSP.
			Potential effects on SNS: The Division believes that a fish assemblage study can be conducted throughout the entire proposed geographic scope without significant impacts to Shortnose sturgeon, and encourages FirstLight to consult with NOAA to choose acceptable methods, locations within all reaches, and time of year to complete the study. Special care needs to be used when employing gill nets as SNS are particularly vulnerable to this gear type. MADFW provided NOAA gill net soak time guidelines from Kahn and Mohead 2010.	Sampling will not be performed in the Bypass reach prior to June 30.
			The Division is concerned about the proposed omission of glochidial assessments because, without a more concrete understanding of which fish species are actually utilized as hosts within the Connecticut River (see Study No. 3.3.1) – and which species are particularly important in enabling mussels to complete this key stage of their life cycle – fish passage and habitat persistence would have to be assessed and ensured for all potential host fish species.	Not Adopted. FirstLight stands by justification for not proposing a glochidial assessment as described in the RSP.
			The Division would suggest laboratory fish trials; based on recent conversations with labs that have recently conducted similar work, such a study offers an established, cost-feasible method to identify primary hosts. Because a known suitable host exists for *Alasmidonta heterodon* (tessellated darter: Michaelson & Neves 1995), laboratory trials should be prioritized to determine suitable hosts for *Lampsilis cariosa* (state-listed as "Endangered") and *Ligumia nasuta* ("Special Concern"). Using a tiered approach to assess host suitability, the study should progress to the next tier only where no suitable primary hosts are found in previous trials. A suitable primary host should be defined as any fish species with > 40% metamorphosis success using established host fish protocols (Johnson et al. 2012 and Fritts et al. 2012).	Not Adopted. FirstLight stands by justification for not proposing a glochidial assessment as described in the RSP.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			Tier 1: ☐ One species of black bass (*Morone salmoides* or *M. dolemieu*) ☐ Striped bass (*M. saxatilis*) ☐ One species of shad/herring (*Alosa spp.*) Tier 2 (if no suitable hosts found above): ☐ One species of sunfish (*Lepomis spp.*) ☐ One species of chub (*Semotilus corporalis* or *S. atromaculatus*) ☐ One species of sucker (*Catostomus spp.*) ☐ Yellow perch (*Perca flavescens*) ☐ One catfish species (Bullhead – *Ameiurus* spp., or Channel catfish – *Ictalurus punctatus*) Tier 3 (if no suitable host found above): ☐ As needed and in consultation with the Division.	
		VANR	Please describe the habitat types, the spatial extent of each station, whether or not stations will be continuous or non-continuous within the study area, how many samples will be collected with each gear type, how the sample locations will be selected in each station, and whether or not all gear types will be used in each station.	Adopted.
			On page 3-178 the licensee states that the proposed study will include a statistically rigorous and comprehensive stratified-random design similar to what has been used successfully on large rivers a high degree of spatial heterogeneity. Please clarify how the study design will accomplish this. Employing a stratified-random sample design ultimately removes bias from the collected data, allows for clear interpretation of results, and provides the best information for making decisions. To capture the spatio-temporal variability, sites/samples should be stratified by habitat type, depth of water, day or night (or time of day), as well as distance from the dam, and season (spring, summer fall).	Adopted.
			The Agency requests that sampling be conducted spring (April-June), summer (July-August), and fall (September-October), in order to capture the temporal variability (i.e. fishes occupy different habitats during different seasons).	Not Adopted. FirstLight believes that an early summer (June) and fall (September) sampling will be sufficient to characterize the fish assemblage in the study area.
			Proposed methods include boat electrofishing (shoreline and littoral habitat), gill nets (deeper, benthic areas), and seine net (wadeable shoreline and littoral habitat). The licensee should also consider employing a benthic trawl in order to actively (vs. passively) target deep water benthic habitat.	Not Adopted. See RSP for details.
			The Agency recommends that sampling methodologies are consistent with the American Fisheries Society national standards as referenced above (Bonar et al. 2009).	Adopted.
			Please specify if electrofishing will occur during the day or night. The Agency recommends a combination of both in order to capture fishes that move inshore during the night (e.g. bass).	Adopted.
			The licensee is proposing that gill nets will be set in selected locations and allowed to fish for 24 hours prior to retrieval. Due to high mortality associated with a 24-hour soak time, the Agency recommends that sets be limited to two hour duration.	Adopted with changes. Proposed gill net set times are 4 hours as requested by the USFWS
		CRWC	Task 1 wording and text in the methodology paragraph above has changed, leaving out many details about how sample locations will be determined. The reference to Kiraly in the April 15 version is gone. It is not clear why these details about methodology are gone; if anything, partners wanted more details. Discussions at the meeting recommended AFS standard methods, but those are not obviously included.	Adopted. More details have been added, along with standardized methods. The design presented by Kiraly et al. (2012) was applicable to stratification of shorelines for boat electrofishing, and was based on a spatial rather than habitat-based stratification. Descriptions of habitat strata delineations are provided in the RSP.
			Task 2: Boat electrofishing. Not clear if this will take place in day and night. During the meeting, it was recommended that night electrofishing be included in order to capture bass and catfish.	Adopted.
			We are glad to see the inclusion of fishing methods for deep and shallow waters. Not included is eel pots, which were recommended by Mass Division of Fisheries and Wildlife during the meeting.	Not Adopted. FirstLight believes that electrofishing will be sufficient to capture eels.
			Task 3: Melissa Grader asked for length, weight, size class to be listed in the report, but there is no mention that these details will be included in the final report. We would like to see details included and summarized in the report.	Adopted.
			The April 15 version of the PSP had a Figure 3.3.11-3 showing the stratum boundary for fish assemblage sampling and a Table 3.3.11-2 with the numbers and description of strata. In the updated PSP, the strata are not defined, and one can't evaluate if Melissa Grader's recommendation that the upper boundary of strata 1 be moved to the Vernon dam was incorporated into the study plan or not.	The study area includes the CT River from Vernon Dam to the Route 116 Bridge.
		TNC	In the last sentence of the second paragraph of the general study description, FirstLight states, "The proposed study will include a statistically rigorous and comprehensive stratified-random design similar to what has been used successfully on large rivers [with] a high degree of spatial heterogeneity." Whereas they cited Kiraly (2012) in the	Adopted. More details have been added, clarifying the stratified-random design. The design presented by Kiraly et al. (2012) was applicable to stratification of shorelines for boat electrofishing, and was based on a spatial rather than habitat-based stratification. Descriptions of habitat strata delineations are provided in

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			original April 15, 2013 PSP, in the June 28, 2013 updated PSP, they removed this citation, but failed to justify how their proposed study design still represents a "statistically rigorous and comprehensive stratified-random design… used successfully on large rivers…" No mention of a stratified-random design occurs again in the rest of the document; the only additional mention of random sampling is on p. 3-181, where it states that additional sites will be randomly selected, but without any additional detail. We strongly support the use of a "statistically rigorous and comprehensive stratified-random design," as it removes bias from the collected data, allows for clear interpretation of results, and provides the best information for making decisions. However, FirstLight needs to clearly indicate how their study design meets this level of quality.	the RSP.
			In the last paragraph of this section (p. 3-180), FirstLight provides a justification for the minimum number of fish (n = 150) that will be collected in each sampled reach. As stated in the PSP, "…a minimum of 150 fish per reach would ensure that most species within a reach were captured…" It should be noted that this justification applies to the level of effort needed to measure species richness (the number of species collected), but does not speak to the level of effort needed to estimate species abundance (the number of individuals collected).	Removed this segment as it was only applicable to an electrofishing study.
			In the first paragraph of the study methodology on page 3-180, FirstLight indicates that the geographic scope of the study could change based on potential impact to shortnose sturgeon. We recommend that before changing the geographic scope, alternative sampling gears that do not impact shortnose sturgeon should be considered for use in areas of concern. Changing the geographic scope of the study would substantially diminish the value of the study, and limit the ability to evaluate the full scope of project effects.	Sampling will not be performed in the Bypass reach prior to June 30.
			The information provided describing site, station, and sample selection is vague, and needs additional clarity, as sampling design is critical to drawing meaningful conclusions from study results. Improper sample selection and replication can lead to an inability to use the collected data. In the general study description, FirstLight mentions that the study design is "stratified-random," but fails to make this clear in the methodology. We strongly support such a study design, as it promotes robust data and clear interpretation of results. However, the claims of such a study design need to be clearly supported.	Adopted.
			On p. 3-180, the PSP states: "The study area will be divided into stations based on habitat type; multiple methods of fish capture will be used in each station." These methods are unclear, and the following questions should be addressed: • What are the habitat types? • What is the spatial extent of each station? • Will the stations be continuous or non-continuous within the study area? • If non-continuous, how will they be selected? • How many samples will be collected with each gear type? • How will these sample locations be selected in each station? • Will all gear types be used in each station?	Clarified. See changes to stratification.
			Task 1: On p. 3-181, the text states, "Prior to field sampling, stations to be sampled will be selected to ensure all habitat types are adequately represented. Alternative sampling locations will also be identified by habitat in case a sampling station is inaccessible." Again, it is not clear how stations or alternative sampling locations will be selected, or at what the spatial scale the station/location sampling will occur.	Clarified.
			Task 1: As presented, the study design does not support a "statistically rigorous and comprehensive stratified-random design." However, we strongly support the use of such a study design, and encourage its development. We support the use of FirstLight's aquatic mesohabitat assessment (FirstLight 2012) to define the habitat types. For a robust, stratified-random design, we suggest that the stations be chosen randomly and proportionally by habitat type. Ideally, this should be done separately for each gear type, so that there are an equivalent number of boat electrofishing, seine, and gill net samples, each selected randomly and independently, and there should be at least three randomly-selected samples of each gear type at each station. This prevents anomalous samples, allows for site-level statistical evaluation, and is standard scientific field design (Eberhardt and Thomas 1991, Krebs 1998). Alternately, and depending on the scale of the samples and stations, different gear types could be considered independent replicates. In this case, each gear type would need to be employed at each randomly-selected station. Because the development of field study design is critical to the ability to use study results, we strongly recommend the inclusion of agency and other stakeholder representatives in the development of the field design for this study.	Adopted with modifications. See RSP.
			Task 2: In the TransCanada study, these have been limited to 2-hour sets to reduce mortality. We suggest that similar methods be employed in this study.	Gill net sets limited to 4 hours per USFWS recommendation
			In their described study methodology, FirstLight has ensured that they will include multiple gear types in their	Adopted.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			study design, but their methods suggest that alternate gear types will only be used in locations where boat electrofishing is not effective. Whereas this is a valid reason, it is important that different gear types are not simply included as a last resort, but are an integral part of the study design in order to reduce bias of relative abundance estimates. The recommendations presented for study design under "Task 1" could address these limitations and biases.	
			In general, if CPUE is calculated separately across species, stations, or sampling techniques, the premise is that values of different species, stations, or sampling techniques could be compared. In order for this to be true, stations or samples within stations must be sampled randomly, and sampling techniques must either also be employed randomly or must be included at each station (depending on the scale of the stations/samples). Otherwise, it is not possible to compare samples and draw any inference concerning differences or similarities among them (Eberhardt and Thomas 1991, Krebs 1998). As mentioned in the general description, it is possible that FirstLight intends for the study design to follow a stratified-random study design, but if so, at present this is unclear.	Adopted. Sampling locations within strata will be randomly selected and independent.
			We also ask that FirstLight make the raw data available in digital format so that agency representatives and other interested parties may conduct additional analyses beyond what is done within the scope of this study.	Adopted.
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	USFWS	FirstLight states that, should field evaluation of spillway gate and bypass flume scenarios be necessary, data will be collected during the fall to avoid potential impacts to shortnose sturgeon spawning and incubation. However, the fall is when FirstLight proposes to conduct a number of downstream passage studies, and manipulating gate settings during that period could influence study results. The Service recommends that simulated events occur during the summer period, to avoid interfering with other relicensing studies.	Adopted.
		NMFS	This section states "Emergency scenarios will not be evaluated in this study because changes in emergency protocols are not anticipated by FirstLight." Despite that emergency protocols will remain unchanged; it was NMFS understanding that information on emergency operations would be included in the analysis of existing operations data that will be provided to the Service. NMFS would recommend this sentence be changed to reflect that all operations data will be analyzed and provided to NMFS for review, including the emergency operations and protocols.	Adopted.
		MADFW	The Division agrees with the proposed study approach. If it can be determined that these spill events can be eliminated (at least any volitional events) it may not be necessary to study further.	FirstLight concurs.
		CRWC	Task 3: In the second paragraph, we had discussed that the random locations be stratified random locations at the meeting, but that recommendation was not captured in the updated draft.	Adopted. At least four random locations will be selected from within each stratum.
			Task 3: Water quality samples for suspended sediment should be collected during discharge events.	Not Adopted. FirstLight proposes to collect data on sediment deposition in the study area.
		TU	In this section the evaluation will be conducted in the fall. In the Study Schedule section it will be conducted in the summer.	The field sampling portion of this study is planned to be conducted in the summer of 2014.
			Task 1: The results of the analysis of historic gate opening data should be presented to all stakeholders. All stakeholders should be consulted to determine if further study is needed. As impacts of gate openings have been documented to release large quantities of debris and sediment during the sturgeon spawning and incubation period it is likely that the full study will need to be completed.	Adopted.
			Task 1: The analysis of gate openings should include emergency openings so that the frequency and magnitude of these events is understood regardless of the ability to alter the timing of emergency events.	Adopted.
			Task 1: The causes of emergency gate openings and the reasons for non-emergency openings should be included in the analysis of gate openings.	Adopted.
			Task 2: The spillage scenarios should be done for the three bypass flows to be tested in the shad telemetry study (3.3.2).	Not Adopted. If field work is necessary for this study, scenarios that involve spillage will be selected in consultation with stakeholders prior to any potential field work.
			Task 2: As the purpose of the study is to evaluate the effect of spill on sturgeon spawning and rearing, the highest spill discharge (emergency or non-emergency) combined with the low bypass and generation flows should be	Not Adopted. If field work is necessary for this study, scenarios that involve spillage will be selected in consultation with stakeholders prior to any potential field work.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			included in the spillage scenarios.	
			Task 3: As the number of strata has not yet been determined, the number of velocity measurement locations should be stated as locations per strata. There should be at least 4 locations per strata.	Adopted.
			Task 3: Velocity measurements should be made for 60 seconds or until the velocity reading stabilizes.	Adopted.
			Task 3: Soak time for the sediment samplers should be determined in collaboration with all stakeholders.	Adopted.
			Task 3: Sediment size should be sampled to determine size (modified Wentworth) and ratio of sizes in addition to a visual inspection and a general categorization.	Not Adopted. Grain size will be determined qualitatively based on dominant particle sizes in each sample. Laboratory analysis for grain size is not proposed.
			Task 4: Emergency protocols should be included in both the initial analysis and the final report.	Adopted.
			Task 4: A final report will be completed if river conditions are suitable for study in 2014. There is no description of how the report will be completed if conditions are not suitable in 2014.	Adopted.
3.3.13	Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat	MADFW	The Division agrees with the proposed approach to study the zone of reservoir fluctuation (176 to 185 ft msl) and shallower areas (less than 1 foot deep at minimum pond elevation).	No comment.
		VANR	The Agency is requesting that the study investigate sedimentation, or the amount of fines within a nest (in addition to nest abandonment, spawning fish displacement, and egg dewatering) as a potential negative impact due to the project's impoundments.	The Updated Proposed Study Plan stated that visual observation will document the sedimentation of eggs.
			In addition to visual surveys, the Agency requests that the licensee deploy egg traps in order to assist in the identification of spawning sites for species such as walleye and white sucker; two riverine fish species which broadcast spawn their eggs. Egg traps should be constructed of standard 8x16 inch concrete blocks wrapped in hog's hair synthetic filter media that forms an ideal surface to collect the broadcasted white sucker and walleye eggs. Egg traps should also be set in some of the lower tributaries with the proper habitat that are influenced by project operations to attempt to locate their spawning sites.	Not Adopted. FirstLight believes this request adds an unnecessary expense to this study.
			The Agency requests that data on the depth of the nesting site, fish species, water quality data (temperature, DO, pH, conductivity, and turbidity) and habitat type (i.e., aquatic weed bed, gravel bar) be recorded. Water level recorders should also be employed to facilitate determining the effects of project operations on spawning of target resident fish species.	Observation on depths, fish species and habitat will be recorded. FirstLight is not proposing install water level recorders as part of this study.
		CRWC	Task 1: Please define what an "event" is.	An event is a duration of time during which surveys will be conducted.
			At the meeting, Ken Sprankle from the USFWS had said that quantification of habitat density is desired. I don't see how this comment was incorporated into the updated PSP.	Aquatic habitat will be documented under Study Plan 3.3.14.
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment	VANR	Due to the higher turbidity in the lower river, the Agency requests that habitat data be collected using a side scan sonar system, and then validated via ponar dredge or through use of a sediment probe to generally classify substrates.	Not Adopted. FirstLight stands by its methods proposed.
			In order to quantify the composition of substrates collected from the ponar grab, the Agency recommends that samples be brought back to the lab for further analysis. Percent composition by weight using the modified Wentworth scale would provide additional information on the aquatic benthic habitat, and would not require much more effort.	Not Adopted. FirstLight believes this request adds an unnecessary expense to this study.
		CRWC	It is not clear how the zone of reservoir elevation will be determined, or how the maps were created in Figure 3.3.14-1. We only have one year of data at the Route 10 bridge. The reservoir fluctuation range cited (176 to 185 ft msl) is relevant for the Turners Falls dam, not all locations along the entire pool.	As stated in the notes on Figure 3.3.14-1, the Study Area was created based on a hydraulic model of the Turners Falls impoundment. Boundary conditions were defined based on HEC-RAS model output for scenarios of water surface elevations 176' and 185' a t the Turners Falls Dam (the currently permitted opera ting range) a t inflow of 1,433 cfs and includes areas that a re one foot deep or less under the minim um elevation of 176' at an inflow of 1,433 cfs. Upstream of the Ashuelot River, the Study Area includes the entire channel due to poor bathymetry coverage and limited effects of the fluctuations at the Turners Falls Dam under the model scenarios stated above.
			Task 1b: It is not clear what data will be collected at each transect or vertical.	As indicated in the RSP we will collect depth, sediment and vegetative cover information
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls	USFWS	The Service recommends that the Green and Sawmill rivers be evaluated to determine if suitable habitat in confluence areas may be affected by project operations, as sea lamprey spawning has been documented in both rivers.	Adopted.
			The last listed objective is too narrow. The study should assess whether the operations of the project are adversely affecting lamprey spawning, not just spawning habitat, since project-induced flow or water level changes could	Adopted

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	Project and Northfield Mountain Project Area		affect spawning behavior without substantial visible sign of direct impact to physical habitat. To this end, the proposed study plan would need to be revised to more closely resemble the study plan proposed by TransCanada for their upstream projects.	
			Task 1: All relevant variables (depth, velocity, and substrate) should be taken into account when determining the amount of remaining suitable habitat.	No longer applicable due to changes in RSP methodology adjustments, although these variables will be recorded.
			Task 1: The stated protocol and nest selection criteria will not be sufficient to fully assess the impact of project operations. It is not clear what is meant by low flow events following high flow events. Since the operations of both projects can result in multiple flow and water level fluctuations daily, these normal project operations need to be assessed. Also, it is not clear if FirstLight proposes that nests would be re-visited only once or more frequently. Lastly, nest selection would be weighted to nests thought to be most likely impacted, but the actual impacts of the project on nests and spawning behavior are not known. We recommend that FirstLight review and adopt the lamprey red observation protocols proposed by TransCanada (USFWS describes robust sampling protocol with daily nest re-visits).	Adopted.
			Task 2: Additional analysis of lamprey nest location data should be undertaken to compare redd locations and results of periodic observations to project operations throughout the spawning period.	Adopted.
			Task 2: Updated PSP provides no details on the types of statistical analyses that will be performed on the data collected. We recommend that the narrative under Task 1, where FirstLight states that appropriate statistical techniques such as ANOVA, regression, and t-tests will be used to compare variables and determine which factors may affect spawning success, be moved to Task 2.	Adopted with changes. Previous statistical methods may no longer apply due to changes in the RSP. More detail has been provided in the Data Analysis section.
			Task 3: The report should include a map of spawning areas and individual redds that are periodically monitored.	Adopted.
			The USFWS recommends a modest-scale radio telemetry study, as proposed by TransCanada to help ensure that data are collected at active nest sites. If a telemetry component is not included in 2014, but an insufficient number of nest sites are observed in 2014, the Service recommends that the study be repeated in 2015, and that the methodology be modified to include a radio telemetry component.	Adopted.
		NMFS	Task 1: The last paragraph of this section states "Shear stresses for dominant substrate types at each of the 30 nests will be determined…." Shear stress is determined through collected field observations and subsequent calculations; typically this is considered analysis, not data collection. Additionally, this sentence is not clear as rivers exert a shear stress on the bed and its particles. It is not clear if the idea is to determine how much shear stress is required to mobilize the dominant particle size in a nest, or if it to simply report the shear stress that river exerts on the dominant substrate at a given nest. Given that depth is a key component of shear stress, and that "the information will be used to determine the likelihood of bed load mobilization or scour" it seems as though the analysis is to determine at what flow the dominant particle size in the nest gets mobilized. Given the complexities of sediment transport with spatial and temporal variability, embeddedness, grain size shapes, roughness within the nest and around the nest, and field measurement limitations, we ask that FirstLight use caution and explicitly state all the hydraulic assumptions being made when conducting this analysis.	FirstLight is no longer proposing this approach. See RSP for changes.
			NMFS describes TransCanada's study approach, and recommends that FirstLight adopt similar methods and analysis.	Adopted.
		MADFW	The Division agrees with the proposed study approach. However project operation may preclude lampreys from even trying to use otherwise good spawning habitat (lampreys may wisely choose not to nest in areas dewatered or scoured by project operations). Is there a way this could be addressed in the study or will these areas become apparent through the IFIM/persistent habitat analysis?	Adopted
		VANR	Recording percent embeddedness would ascertain if sedimentation is having an impact on survival to emergence and should be included in the analysis. VANR provided a reference (Gallagher 2007) on standard methods for redd surveys.	Adopted.
			In order to identify specific lamprey spawning sites within the study area, and observe spawning activity of lamprey, the Agency requests that a minimum of 30 lamprey be radio tagged and tracked to spawning locations. All redds should be enumerated and a sub-sample of redds (to include as much habitat variability as possible) should be chosen to monitor daily. Environmental variables including water velocity, depth, temperature, exposure, and relative condition of redds/area will be measured; and the grounds photographed if possible, over the range of normal project discharges in order to characterize operational effects.	Adopted.
			The Agency requests that success of spawning by sea lamprey within the project-affected areas be characterized by emergence of larvae from capped redds, if larvae emerge, spawning was successful. If eggs do not hatch, and no larvae emerge, spawning was not successful. Emerging larvae should be enumerated and timing of emergence	Adopted.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			relative to redd construction will be documented. Redds should be characterized as to location, range and average depth, general surrounding substrate, and range and average water velocity. Effects of the projects will be classified per operational regime observed as: 1) No effect - no observable difference to habitat/redd structure or lamprey activity – successful spawning documented. 2) Moderate effect – observable difference to habitat/redd structure and/or behavior noticeable but not enough 3) Large effect – observable structural differences to habitat/redds and observable decreased spawning activity – minimal to no successful spawning documented. 4) Severe effect – noticeable habitat/redd degradation, i.e. de-watered, scoured out, and conditions, depth, water velocity, preclude normal spawning activity – no successful spawning documented.	
		CRWC	Most of the changes discussed at the meeting have been incorporated into the updated version, as far as I can tell. At the meeting, Lael Will from VT Fish and Wildlife mentioned that TransCanada was proposing to cap the lamprey nests to determine if there is viable hatching. We'd be interested to know rationale for not doing that here.	Adopted. FirstLight is proposing to cap nests.
		TU	The goals and objectives listed in the study plan do not address the first goal and objective in the NOAA study request which was to "…determine whether the operations of the Projects are affecting the success of this activity [spawning] to occur."	Adopted.
			Task 1: It is unclear what will be the extent of delineation of suitable areas for lamprey spawning, how lamprey redds will be located, and what reaches of the river will be searched for redds.	FirstLight is no longer proposing the original approach. See RSP for changes.
			Task 1: The proposed methodology for evaluating redd success is inadequate. It is unclear if there is a definition of success in this plan by which the lack of success could be measured.	FirstLight is no longer proposing the original approach. See RSP for changes.
			Task 1: The plan notes that the subsample will be divided among different large scale locations. Some of the possible locations are stated but a total list is not provided. A complete list with a plan for how each location will be evaluated is needed. The bypass reach is not affected by peaking and it may be possible to use it as a reference for redds affected by peaking flows.	FirstLight is no longer proposing the original approach. See RSP for changes.
			Task 1: Spawning success cannot be documented merely by the presence of redds or of the condition of redds prior to and after peaking events. Rather, it should be documented with an evaluation of eggs in redds. Redds in areas that are highly impacted by peaking flows should be compared to redds in low impact areas to determine if eggs are present in redds. Similar or a significant difference in the frequency of redds with eggs in the high and low impact areas would be an indicator of spawning success. Similarly the difference in alteration of redds after a peaking event between the high and low peaking impact areas would be an indication of impacts by the project.	Adopted.
			Task 2: Data entry and mapping are insufficient data analysis to explain the influence of project operations.	Adopted.
			TU recommended tagging fifty lamprey at the Holyoke fishlift, and an additional twenty lamprey at the Gatehouse fishway.	Adopted with changes. FirstLight is proposing that 40 lamprey will be tagged at Holyoke, 20 of which will be released upstream of the Gatehouse.
			Data collection should include: Mean water column velocity at the redd site; embeddedness; water depth; presence or absence of eggs in redds.	Adopted.
			An evaluation of nest abandonment should be made after a high water event only for redds that had sea lamprey present immediately before the high water event.	Noted.
			Tags should be compatible with shad telemetry equipment.	Adopted.
			Mobil tracking used to locate lamprey.	Adopted.
			Determine discharge/stage during observations.	Adopted.
			The 'before and after' events should be statistically evaluated.	FirstLight is no longer proposing the original approach. See RSP for changes.
3.3.16	Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station	NHESP	The Study Plan proposes to limit the survey area to the 13-mile reach between Cabot Station and the Route 116 Bridge in Sunderland, and that additional freshwater mussel studies associated with the FERC license of the Holyoke Dam (including portions of the Connecticut River south of Dry Brook in Sunderland) will provide information on the distribution and habitat of state-listed mussel species in Reach 5. If the Proponent intends to use data collected pursuant to methodologies not approved under the Turners Falls Hydroelectric Project (No. 1889), the Study Plan should be amended to confirm that that data will be collected pursuant to the requirements set forth under the final, FERC-approved Study No. 3.3.16.	Based on the RSP, the use of existing information on the distribution of state-listed mussel species in Reach 5 is appropriate and no further mussel surveys are proposed in this reach.
			In the third paragraph on page 3-227, the Study Plan notes that the species most vulnerable to changes in water elevation and flow dynamics would have an affinity for nearshore habitats or other shallow areas, which are most likely to become dewatered or vulnerable to heat stress or predators during periods of low flow. The Division agrees with this assertion, but notes that changes in flow dynamics – including increased flow velocity and sheer stress – also have the potential to significantly impact habitat suitability for rare mussel species in areas that are not susceptible to the factors outlined above. Increases in flow velocity, shear stress and scour are important factors	Adopted.

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			that will have reportedly altered the persistence of habitat used by unionid mussels throughout their lifecycle (Layzer et al. 1993, Layzer & Madison 1995, Layzer & Scott 2006). Indeed, an understanding of how flow dynamics – and therefore the persistence of suitable habitat and refugia – change at relatively fine scales across a range of flow regimes is a crucial component of the Division's assessment of potential project impacts.	
			On page 3-227 the Study Plan recognizes three state-listed species of freshwater mussel (*Lampsilis cariosa*, *Ligumia nasuta*, and *Alasmidonta heterodon*). However, Study No. 3.3.1 only proposes creation of HSI curves for *Lampsilis cariosa* (Page 3-72 footnote). The Division requests that HSI curves be created for all three state-listed species.	FirstLight is proposing to develop HSI criteria for any state-listed species that are documented to occur in the 35-mile reach downstream of Cabot Station to Dinosaurs Footprints, based on existing information and proposed surveys.
			Task 2: The Division requested systematic and sufficient coverage of all potentially suitable habitats in order to ensure detection of state-listed mussels. Indeed, the Division's standard mussel survey protocols require that all suitable habitats within a proposed project area – identified through a comprehensive habitat assessment, as proposed in the Division's original study request - be surveyed concurrent with or subsequent to the assessment. The Division is concerned that the Study Plan does not explicitly describe the criteria to be used in identifying potentially suitable habitat during the habitat assessment, nor ensure that all potentially suitable habitats will be surveyed. Therefore, the Division requests that the Study Plan provide additional detail regarding its plan to provide sufficient and thorough survey coverage of all suitable habitats.	Adopted. The plan has been revised to include a habitat assessment of the 13-mile reach below Cabot Station using NHESPs standard protocols, and the results of this will guide site selection and level of effort for subsequent mussel surveys. This will be done in consultation with NHESP.
			Task 2: The Division requests that each state-listed mussel and the first 50 individuals of non-listed species be tagged with an individual identifier (e.g. Hallprint shellfish tags); individual identification will be useful for long-term monitoring and use in quantitative population estimates.	Not Adopted. Tagging is an element of long-term monitoring that was not requested, nor is being proposed, at this time. FirstLight does not see the value of tagging if there is not long term monitoring plan in place.
			Task 2: The Study Plan suggests that key instream habitat parameters (such as water depth, flow velocity, substrate, water temperature, etc.) will be collected at all survey sites. The Division notes that these instream habitat parameters should be collected pursuant to the applicable standards outlined within Study No. 3.3.1, and that the Proponent explicitly detail (either in situ or by reference to Study No. 3.3.1) the procedures that will govern data collection. The Division notes that data collection should include a full velocity profile in order to understand how velocity and other parameters change both horizontally and vertically. Complete profiles should be conducted in transects perpendicular to the flow of the river channel, including (but not limited to) a minimum of one transect within the mussel population, one transect immediately upstream of the population, and one transect immediately downstream of the population.	Instream habitat parameters will be collected at each site during both the habitat assessment and mussel survey and for individual state-listed mussels during the mussel survey.
			Task 2: The Division would recommend that the Study Plan explicitly specify (either in situ or by reference to Study No. 3.3.1) that velocity measurements will be collected at near-substrate depths within all potentially suitable habitats, and that IFIM models incorporate changes in temperature, velocity, depth, shear stress, and habitat persistence for all lifestages in the mussel lifecycle.	Bottom velocities will be measured for each state-listed mussel that is found during FirstLight's mussel survey. FirstLight is proposing to develop HSI criteria for state-listed species that occur in the study area and these will include criteria for water depth, flow velocity, substrate, and shear stress.
			Task 2: The Division notes that water temperature is a particularly important factor in determining mussel habitat suitability, and that temperature data should be collected and modeled as part of the Study Plan (see Castelli et al., 2012). Of particular concern is the relevance of temperatures during low flows and the rate of temperature change caused by peaking, as thermal thresholds are likely affected by acclimation temperature (Galbraith et al. 2012, Pandolfo et al. 2010). As a minor addition to IFIM fieldwork, we recommend point temperatures be taken at all test flows within a representative subset of transects within suitable mussel habitats.	Thermal modeling is not proposed as part of the IFIM or mussel study, but water temperature will be recorded as part of routine fieldwork for both the mussel habitat assessment and mussel survey.
			Task 3: The Study Plan should provide a greater degree of specificity regarding potentially appropriate sampling methods and detail where/when each survey methods would be employed. At a minimum, the plan should include repeated site visits (to measure detection probability and population size; see Meador et al. 2010) as well as appropriate use of transects and/or quadrat excavation in a percent of occupied patches (depending on patch size). Individual identifier tags (e.g. Hallprint shellfish tags secured with Superglue) should be used on all state-listed species and the first 50 non-listed mussel individuals (see comment on Task 2 above) to better enable population size estimation and long-term monitoring of individuals.	Quantitative mussel surveys are no longer proposed. Tagging is an element of long-term monitoring that was not requested, nor is being proposed, at this time. FirstLight does not see the value of tagging if there is not long term monitoring plan in place.
			Task 3: The Study Plan suggests that additional habitat data – in the form of cross-channel transects – will be collected to support the Study No. 3.3.1, and that transect number will depend on population size and habitat complexity. The Division notes that Study No. 3.3.1will need to be applied within both occupied and unoccupied patches of suitable mussel habitat in order to fully understand project impacts. Given that mussel populations are currently known to occur within Reach 5, transects will need to be located so as to collect data from a sufficient number of suitable sites within this reach and other reaches, if appropriate. The Division notes that transects should be located, and appropriate data collected, pursuant to the applicable standards outlined within Study No. 3.3.1, and that the Proponent explicitly detail (either in situ or by reference to Study No. 3.3.1) the procedures that will govern these details. Proposed transect locations should be submitted to and approved by the Division to ensure	This comment is addressed in the IFIM Study Plan (Study No. 3.3.1).

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			that mussel occurrence data has been accommodated.	
			Task 4: The Study Plan does not reference the need to delineate HSI curves for state-listed mussels, though these are needed to inform habitat modeling in Study No. 3.3.1. HSI curves represent a critical component of Study No. 3.3.1 and related modeling efforts if they are to accurately delineate suitable mussel habitats and assess project impacts. The Study Plan should explicitly outline the Proponents plan for creating data-driven HSI curves for each mussel species. The Division reiterates that HSI curves for state-listed mussels are generally not well understood, and data collection from a suite of both occupied and unoccupied sites is needed to inform curve creation. However, others have been successful at modeling persistent habitat using methods similar to PHABSIM (Parasiewicz et al. 2012, Maloney et al. 2012, Daraio et al. 2010, Morales et al. 2006, and Layzer & Madison 1995).	Adopted. FirstLight is proposing to develop binary HSI criteria for any state-listed species that occur in the project area, as requested. These will be developed using existing information on target species from the Connecticut River and other waterbodies throughout the species range, and expert review.
			Task 4: The Study Plan states that IFIM and hydraulic models will be supplemented with detailed habitat data where state-listed mussels are found. However, the objective of Phase 1 (page 3-226) states that in the absence of detection, potential habitat will be mapped based on species habitat preferences. The Division reiterates that HSI curves represent a critical component of Study No. 3.3.1 and related modeling efforts if they are to accurately delineate suitable mussel habitats and assess project impacts. The Division believes it is possible to create HSI curves, and requests that this Study Plan (and Study No. 3.3.1) identify alternative sources and methods for collecting supplemental data where necessary.	Adopted. FirstLight is proposing to develop HSI criteria for any state-listed species that occur in the project area, as requested.
		CRWC	Minimal changes have been made to this updated version to address comments discussed at the study plan meeting held on June 5, 2013. At the meeting, people were not sure of the extent of the project effect into the lower Deerfield River or the presence of mussels in the lower Deerfield. The updated PSP doesn't reference any schedule for resolving that question or decision that may or may not have been made. CRWC has no further comment on this study.	Not Adopted. FirstLight is not proposing to survey the Deerfield River.
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	USFWS	FirstLight states that larger tributaries have sufficient access during all operational phases due to the large catchment size. This reasoning does not account for channel morphology at the confluence, where large sediment bars or other morphological features may inhibit access during certain operational phases regardless of drainage area. The Service is not convinced that the larger tributaries should be discounted from this investigation.	Adopted.
			The Service recommends that, should flow conditions in 2014 limit the ability to collect low flow/headpond elevation data, the study should be repeated in 2015.	Adopted.
		VANR	The Agency requests that water level recorders (pressure transducers) be employed to determine if water level fluctuations from project operations cause impediments to fish movement into and out of tributaries within the project-affected areas. If the water level drops to 1 foot or less water depth during low impoundment water levels, it should be assumed that movement is impeded. Water level recorders should be placed in tributary areas and operate for an entire year to collect hourly depth changes and water temperature. Additional water quality data should be collected in these areas (temperature, DO, pH, conductivity, and turbidity) if it is found that access to the main river is impeded.	Not Adopted. FirstLight is not proposing install water level recorders in tributaries. The tributary mouths will be visually examined for fish movement impediments under the low pool elevation. Water quality data will be collected as described in Task 1 of this Revised Study Plan.
		CRWC	I don't think we discussed this during the meeting, but in task 1 it defines low pond as 176 feet msl, or as close to practical. This represents the level at the Turners Falls Dam and is the bottom end of the range the license allows (176 to 185 msl at or near the dam). Low discharge in the Connecticut River is defined as a gage height of < 8 feet at Montague. This gage height translates to roughly 7,000 cfs, a level that Figure 4.3.1.2-12 in the PAD says is exceeded 60% of the time. We are not clear how this level represents a low flow level, and we wonder if it would be better defined by the FirstLight gage at Vernon, because the Montague gage incorporates peaking flows from the Deerfield River. At river flows 7,000 cfs and less, the PAD says on page 3-25 that FirstLight tries to maintain the pool height minimum of 180.5. It is good to look at the minimum level allowed in the license, but it might be worth considering the current practice and those effects. Either way, we don't know what the river levels are like closer to the tailrace when Northfield Mountain is pumping water out of the pond at this level.	Not Adopted. Discharges at Vernon are necessarily reflective of conditions at the time downstream of Turners Falls Dam.
			We recommend putting in at least one, but preferably several, loggers in the tributaries to assist with the visual observations. Fourmile Brook is tributary we would recommend. Fall River should also have its own logger, since this one is in the bypass channel and natural flows in the Connecticut River have little bearing on the amount of water in the bypass, unless the dam is spilling.	Not Adopted. FirstLight is not proposing install water level recorders in tributaries. The tributary mouths will be visually examined for fish movement impediments under the low pool elevation. For Fall River, low water conditions will be defined as flows of 400 cfs or less in the bypass reach.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			I am assuming FirstLight has confirmed that there are no "setback areas" in this impoundment as there are in the Vernon impoundment and elsewhere, which we discussed during the meeting, but I don't see any mention of this determination.	FirstLight is not clear what the definition of a "setback area" is in the context of this study. The study plan states that backwater areas will be evaluated.
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms	USFWS	Task 1: In reference to standing water surveys, there are no specifically stated methodologies in this section; rather, references are made to an assessment in 2011. During the May 22, 2013 study plan meeting, a number of stakeholders expressed dissatisfaction with the qualitative nature of that survey. Assessment techniques for fishes in ponded or flowing water when the drawdown is complete should include backpack electrofishers and seine gear. Standard approaches to determine relative abundance may include standardized effort among sample areas with fish captured, identified, enumerated, and reported in a unit of effort/time such as fish/minute using the backpack meter timer.	Adopted.
			Task 1: The plan is not clear as to how frequently the areas of standing water will be monitored. We recommend that at a minimum, those sites be monitored three times (immediately after drawdown is complete, in the middle of the drawdown period, and immediately prior to refilling the canal).	Not Adopted. FirstLight proposes to conduct the study once immediately after the drawdown as sampling during subsequent days would not yield useful information because of avian predation.
			Task 1 Dewatered Area Surveys: The USFWS requests that this survey include zones 5 and 6; the service recommends that 10 quadrats be placed randomly in zones 2 and 6, and 20 quadrats be placed in zones 3, 4, and 5; also recommends stratifying by bank and channel. The final number and placement of quadrats should occur in consultation with the resource agencies and Conte Lab researchers.	Adopted.
			Task 1 Dewatered Area Surveys: The plan should also address how the Station 1 forebay is impacted by the drawdown. If the forebay area also becomes dewatered, it should be surveyed also.	Adopted
			Task 1 Dewatered Area Surveys: The service recommends that all standing pools of water in zones 2 through 6 be mapped with a GPS unit. This information will then be used to develop graphical representations of the canal in a dewatered state, including identifying those pools where water quality data was recorded. Water temperature should be monitored in Zone 7 for the duration of the drawdown with a continuous logger.	Adopted.
			Task 1 Dewatered Area Surveys: Catches may be reported in units of standardized time of effort and also by unit area (quadrats). Water quality information, fish survey and quadrat data should be summarized in tabular format and included with the graphical canal representation in a report to be provided to stakeholders.	Adopted.
			Task 2: The plan should identify that another potential measure to be evaluated is the need for annual drawdowns.	Adopted.
			Task 2: In addition to reaching agreement on measures to assess, this task also needs to include development (through consultation with stakeholders) of a study design to assess the effectiveness of any measures that will be tested in the field.	Adopted.
			Task 3 does not explicitly state that the selected measures will be studied, only that they will be designed. The plan should specify that selected measure(s) will be designed and studied to determine the effectiveness at minimizing adverse impacts to fish and mussels.	Adopted.
			Study schedule: the seventh bullet should read "Install and Test – September 2015"	Adopted.
			The study schedule section also should describe how the proposed schedule fits into the Integrated Licensing Process and procedural deadlines.	Adopted
		NMFS	The goal and objectives of this require a clear understanding of the methods that will be used. The Updated PSP correctly notes that complimentary juvenile shad and American eel studies will provide useful information from hydroacoustic monitoring and tagging of fish to examine the question of delay in the canal.	Clarified methods.
			A standard level of effort, such as a single back-pack operator with dip net and single or pair of people also netting, can be utilized as the habitat conditions permit among the zones (as a standardized level of effort) for a set period of time (500 seconds on-meter). This will allow repeated measures and comparisons among areas. Back-pack shocking will not effectively sample ponded areas where seine nets may be employed. Standardized methods may be developed, single sweep, using bridle/rope. The varied substrates may not permit this net gear.	Adopted.
			Additionally, assessment of sea lamprey ammocetes should be conducted and may include a sampling quadrats among strata using some basic criteria (substrate type and exposed, wetted, submerged), which can be applied to existing aerial images, from a qualitative visual assessment, that can be described with some digital images of these areas for support.	Adopted.
			Fishes may be sampled by electrofishing wetted or ponded/flowing areas. Catches may be reported in units of standardized time of effort and also by unit area (quadrats). Quadrat sizes should be determined based on observed densities one sampling can begin (i.e., 1 m2, or 10 m2). A starting figure may be 10 replicates among strata type which may include 5 types (i.e., exposed, damp/wetted, submerged, flowing and substrate type – fines, gravel, rock). Sampling, as noted, should begin as quickly as possible following the drawdown.	Adopted with changes. Stratification will be by bank and channel. All proposed quadrats will be 1m x 1m.
			The Updated PSP states that the fate of juvenile sea lamprey in the canal remains unknown and additional efforts	Adopted

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			to fill in this information gap will be included. It is unclear how this will be done. The study can be designed to obtain information on relative abundance, distribution, sizes of juvenile lamprey with this survey and document occurrences of exposed/desiccated juveniles. A follow-up repeat of the survey targeting sea lamprey may be conducted prior to re-watering, allowing several days of time since the initial surveys to compare observed data and thus potential infer losses with any detected declines. This will be difficult given the potential movement to ponded areas of some size in the area of Cabot intake as an example.	
		MADFW	The methodology is described as "the 2011 survey methods, with minor modifications". What are these modifications, or are they already incorporated in the text that follows?	Clarified and added new methods.
		CRWC	Under methodology, it says that FirstLight believes that the 2011 survey methods are adequate, with minor modifications. The minor modifications that FirstLight proposes are not specified.	Clarified and added new methods.
			Task 1. FirstLight proposes to segment the canal into seven zones as was done in the 2011 survey. I believe at the meeting, meeting participants said that the wider zones, such as 3 and 4 should be broken in half because there are some areas that are dry and some that are wider.	Not Adopted. These areas will be subsampled as described in the RSP.
			The systematic traverse is not defined, but it seems worth evaluating whether scientific survey methods that involve random transects or random plots of a certain size would yield better results. We are trying to survey large and small things, so systematic traversing might miss things.	Clarified and added new methods.
			Task 2 is to identify and *assess* potential measures. It appears from here and in the schedule that there is no true assessment of the installed measures in 2015, although I think it is implied that success is how wetted the area remains.	Adopted.
			Sediment dredging? How often does it occur, how would affect surveys and PME measures? Boyd mentioned an area that had lots of ammocetes that no longer do since the 2010 sediment debacle. Raise any of that?	No comment.
			Water quality sampling for suspended solids should be done downstream of the Cabot discharge during canal draining and refill/resumption of operation.	Not Adopted. This is a biological assessment of organisms within the power canal.
		TU	Task 1: The method of systematically traversing each of the zones to be surveyed should be described. Based upon the 2011 survey report which is referenced as being, with minor modifications, adequate to met this studies objective, the technique of surveying could best be described as 'walked around and looked'.	Clarified and added new methods.
			Task 1: The plan describes the wetted area in zone 7 as appearing to provide adequate flow and depth to support aquatic species over the short term. This report should verify that supposition.	Clarified and added new methods.
			Task 1: If areas other than zones 2-4 have ammocetes or mussels, those numbers should be evaluated with sub-sampling and total counts estimated based upon the subsample.	Clarified and added new methods.
			Task 1: The method of random sampling should be described.	Adopted.
			Task 1: A definitive number of samples in each area of concentration of mussels or ammocetes should be provided. "Up to 10 randomly selected 1-m by 1-m quadrates…" is insufficiently specific to ensure that the survey is properly conducted.	Adopted.
			Task 1: A description of how the pools and wetted areas will be mapped should be provided.	Adopted.
			Temperature in zone 7 should be logged on an hourly basis at each end of the zone prior to, throughout the drawdown period, and while the canal is being refilled.	Adopted.
			Dissolved oxygen should be measured in zone 7 after the canal is initially drained, mid-way through the drawdown, and at the end of the last day of the drawdown.	Not Adopted. This is a biological assessment of organisms within the power canal.
			Depending on where the Keith Drainage Tunnel is located (no location description is provided) temperature and dissolved oxygen should also be measured downstream of the tunnel as well as at the upper and lower end of zone 7.	Not Adopted. This is a biological assessment of organisms within the power canal.
			The frequency of drawdowns should be listed as a potential measure of mitigation in Task 2.	Adopted.
			As the pools change over time, additional surveys of the size, water temperature and dissolved oxygen in pools in zones 1 to 6 should be made at least two times in addition to the initial survey. One survey should be the last day prior to refilling.	Not Adopted.
3.3.19	Evaluate the Use of an Ultrasound Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station	USFWS	The plan is unclear regarding how the results from 3.3.1 and 3.3.2 will inform the need to conduct the ultrasound array study. Absent all of the radio-tagged shad moving up to the dam without delay at Cabot Station under all spill conditions, it will be necessary to conduct the ultrasound array study. The Service is recommending the shad telemetry study occur in 2014 and 2015, which will allow for one full year of studying shad movement without the array and another with the array (for a portion of the migration season).	The effect of different levels of dam releases that would induce fish to move past the Cabot Station into the bypass reach and up to the dam will be evaluated during Year 1. If results of the Year 1 study indicate a potential to attract shad to the spillway ladder under flow releases that satisfy flow requirements from Study No. 3.3.1 and project operations then a high frequency ultrasound array will be tested at the Cabot Station tailrace in Year 2 that may further reduce shad attraction to the tailrace and guide shad into the bypass reach.
			The plan does not describe specifics on study design, but states the agencies will be consulted to determine a schedule. The USFWS offers additional guidance information in the comment letter (see letter for details).	Adopted.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
	Tailrace		The Service supports recommendation by another stakeholder for video to be used to supplement the telemetry data. Cameras should be deployed inside the Cabot ladder and outside of the entrance.	The Cabot tailrace is the focus of this study not the Cabot Ladder
			The Service recommends hydroacoustics to evaluate how shad respond to the ultrasound array.	FirstLight is proposing to use radio telemetry to evaluate shad response to the ultrasound array
			Although not specified in the Updated PSP, the same telemetry locations described in the Service comments under Study Plan 3.3.2 should be used in the ultrasound study (list provided in comment letter).	Adopted. The same telemetry locations proposed in Study Plan 3.3.2 will be used in the ultrasound array study
			Environmental and operational data should be recorded during each test period and used in data analysis and interpretation.	Adopted.
			FirstLight does not describe the types of analysis that will be conducted on the data collected. FirstLight should use a test that will allow for determination as to whether there is a statistically significant ($p \leq 0.05$) difference in the number of readings with the array on and off. FirstLight should analyze the telemetry data to see if there is a relationship between the number of readings for an individual tag and the treatment type. The video data should be qualitatively summarized. Hydroacoustic data should be analyzed to determine the relationship between the number of targets in the vicinity of the Cabot tailrace and ultrasound treatment.	Partially Adopted. FirstLight is proposing to use radio telemetry to evaluate shad response to the ultrasound array
		CRWC	Task 1: The frequency of the array should be documented.	Adopted
			Task 1: "Telemetry methods like those proposed in Study No. 3.3.2 will be utilized." How many fish will be tagged, or how will you calculate how many fish you need to tag to have viable results? Ted Castro-Santos suggested using a power analysis.	This study is being conducted in conjunction with Study No. 3.3.2
			Task 1: It may be useful to install more radio receivers or PIT tag readers in the bypass channel for this study as opposed to Study No. 3.3.2, because in this case how the fish behave in the bypass channel will be of interest.	This study is being conducted in conjunction with Study No. 3.3.2
		TU	In this section and in the Study Schedule section, the study is predicated on the results of prior studies (shad telemetry and the bypass IFIM). How the results of those studies would influence conducting this study is not described. Specific criteria should be described.	The effect of different levels of dam releases that would induce fish to move past the Cabot Station into the bypass reach and up to the dam will be evaluated during Year 1. If results of the Year 1 study indicate a potential to attract shad to the spillway ladder under flow releases that satisfy flow requirements from Study No. 3.3.1 and project operations then a high frequency ultrasound array will be tested at the Cabot Station tailrace in Year 2 that may further reduce shad attraction to the tailrace and guide shad into the bypass reach.
			It is highly unlikely that all shad under all conditions in 2014 will move directly past the Cabot Station to the dam. As such it will be necessary to conduct the ultrasound study in 2015. As the shad telemetry study should/will be done it 2015 it will be possible to conduct the ultrasound study in 2015 in conjunction with fish tagged for Study No. 3.3.2.	The effect of different levels of dam releases that would induce fish to move past the Cabot Station into the bypass reach and up to the dam will be evaluated during Year 1. If results of the Year 1 study indicate a potential to attract shad to the spillway ladder under flow releases that satisfy flow requirements from Study No. 3.3.1 and project operations then a high frequency ultrasound array will be tested at the Cabot Station tailrace in Year 2 that may further reduce shad attraction to the tailrace and guide shad into the bypass reach.
			Task 1: This section describes a plan to develop a plan as opposed to providing an actual plan. As noted several times above, this is not adequate. FirstLight should provide: ☐ Details on the equipment to be used and how it will be deployed ☐ A proposed schedule for utilizing the ultrasound array. ☐ Intensity of ultrasound ☐ A description and a graphic of the expected field of ensonification ☐ The period of time over which the ensonification will occur ☐ A schedule for ensonification ☐ Flows in the bypass during the trials	A proposed schedule is included in RSP 3.3.19. Flows in the bypass reach will be those described in Study No. 3.3.2. A site visit will be planned with the ultrasound array expert from Alden Lab to develop details should as expected field of ensonification and intensity,
			Task 2: This section does no more than state that data will be analyzed and a report will be provided. Specifics should be provided as to the method of determining successful or unsuccessful deterrence away from the Cabot Station and subsequent movement if movement occurs.	Adopted.
			The array should be tested in an on/off manner beginning with the arrival of telemetered shad at the Cabot Station.	Adopted.
			Testing should occur with two hour on and three or more hour off segments two times during the day beginning after 9:00 and before 11:00 to ensure that sufficient shad are present in the tailrace when the first and last 'on' tests begin.	Adopted with changes. The first "on" treatment will begin between 10am and noon.
			Alternative testing schedules may be appropriate after initial trials. Any change in the testing schedule should be done only after consultation with the stakeholders. After the first week of testing an interim report should be provided to the stakeholders describing the results of the ensonification including: the behavior of fish when the ultrasound is turned on, the movement of the fish up- or downriver, how long fish remain away from the tailrace if	Adopted.

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			they do move away, etc.	
			Testing should occur three days per week for at least four weeks.	Adopted with changes. Testing will occur three days per week for at least 2 weeks as requested by USFWS.
			Hydroacoustics should be employed to assess how the population of fish responds to ultrasound. This will allow evaluation of a larger population of fish than the telemetry fish or video monitoring (below).	FirstLight is proposing to use radio telemetry to evaluate shad response to the ultrasound array
			Video monitoring should be installed at the entrance to the Cabot fishway both inside the fishway and outside the entrance. This will provide data on fish that are not radio tagged. Telemetry data will be used to determine the direction that the fish move after the array is turned on.	FirstLight is proposing to use radio telemetry to evaluate shad response to the ultrasound array
		Karl Meyer	Note: This study should be conducted for two seasons, the same time span accorded to American eel.	Not Adopted. This study will be performed during 2015, after a year of study of tagged shad without the ultrasound array as a variable.
			Historic data has limited value as the quantified presence of shad at the base of TF Dam is missing, and data on the effectiveness of Spillway attraction flow does not exist.	No comment.
			In order to be proven ineffective, delays caused by sonics repelling fish from the Cabot entrance would have to out-compete any delays American shad and blueback herring encounter by being drawn to the Spillway during spring freshet and not find a readable upstream flow or passage at the dam. To this must be added the delay and stress of having river attraction and Spillway flow cut to 400cfs, thus sending them DOWNSTREAM to fight their way into the TF Power Canal.	The purpose of the ultrasound array is to attempt to reduce delay, not introduce delay.
			Question: Should FL be deciding what constitutes delay? Shouldn't American shad dropping back two miles downstream from the TF Spillway to Cabot Station be considered an "unsatisfactory result"?	The purpose of the ultrasound array is to attempt to reduce delay in the vicinity of Cabot Station and promote their migration to the spillway. Study Plan 3.3.2 will study which flows may be conducive to move fish through the bypass to the spillway.
			Note: Ensonification coverage may need to be deployed far enough out into the main stem so as to lead fish out to the thalweg/main flows on the west side of Rawson Island. Simply steering fish out of the Cabot entrance, but then only allowing them the choice of the minimal flows coming down through Rock Dam at the time paltry 400 cfs release would likely keep the fish milling and confused below Station 1.	Study Plan 3.3.2 will study which flows may be conducive to move fish through the bypass to the spillway.
			Note: This should not be a contingent study.	The effect of different levels of dam releases that would induce fish to move past the Cabot Station into the bypass reach and up to the dam will be evaluated during Year 1. If results of the Year 1 study indicate a potential to attract shad to the spillway ladder under flow releases that satisfy flow requirements from Study No. 3.3.1 and project operations then a high frequency ultrasound array will be tested at the Cabot Station tailrace in Year 2 that may further reduce shad attraction to the tailrace and guide shad into the bypass reach.
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources	USFWS	Task 2 Wildlife and Habitat Type Mapping: The Service recommends that all eagle roosting or nesting trees, either previously documented or observed during the surveys , should be recorded, photo-documented, and georeferenced.	Partially adopted. FirstLight is proposing to collect data observed during its survey, and to visit known historical nesting sites. FirstLight is not proposing to visit and collect data on all previously documented roosting trees.
			Task 2: Invasive Plant Survey: FirstLight states that the intent of the upland invasive species survey is to document significant infested areas. The Service recommends the removal of the word "significant".	Adopted.
			Task 3: This section of the plan lacks specificity. For the bald eagle information, we recommended that the report provide maps of the project area showing locations of all eagle roosting and nesting trees. A complementary table should be provided listing the location of trees, whether it is a roosting or nesting site, an assessment of its status (healthy, diseased, etc.) and its level of protection (e.g. within a right-of-way, on protected conservation land). Similarly the invasive plant data should be portrayed on maps as both polygons and point locations, as appropriate. In addition, the invasive data should be provided in tabular format, listing the infestation, species composition, and estimated size of infestation.	Adopted.
			Study Schedule: FirstLight should describe how this timeline fits into the Commission's Integrated Licensing Process and procedural deadlines.	Adopted. The Initial Study Report is due in September 2014. If field efforts run later into the summer such that a complete report cannot be submitted by this date, FirstLight will provide Stakeholders with a study report supplement.
		CRWC	The study area is still not well defined. Under methodology on page 3-248, it states that a field survey of the "shoreline" will be conducted. Under Task 2, it says that field surveys will be conducted "in the Project area." Is it the project area, or is it a shoreline survey? If shoreline only, what distance from the waterline will be surveyed?	Adopted. The study area was clarified in the Revised Study Plan.
			Under methodology on page 3-248, it states that the study will include a survey below Cabot station "to the downstream extent of the Project boundary." The PowerPoint slides from the June 5 meeting say that the survey will be conducted downstream "to Sunderland MA." Which is it? Again, the study area is not well defined.	Adopted. The study area was clarified in the Revised Study Plan.
			Will FirstLight properties like the Barton Cove campground area and peninsula be surveyed in full, or only the shoreline? There are some interesting plants on this peninsula. If areas like this will be surveyed, will the transect methodology change?	Adopted. These areas are within the Project Boundary and will therefore be surveyed.

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			During the meeting, FirstLight consultants said that potential vernal pools would be identified in this study, but there is no mention of that in the updated PSP.	Adopted. Certified vernal pools will be documented under Task 5 of Study Plan 3.5.1.
			Not sure if the methods described are also ideal for bird surveys.	Observation of avian species will be recorded during the field surveys.
			Task 3: No details are provided as to the content of the final report, the data that will be reported.	Additional details added.
			Is there any value to nocturnal surveys?	Nocturnal surveys are not being proposed for this study.
		Nolumbeka	The Nolumbeka Project feels that our first request to do terrestrial wildlife and botanical resources studies on the Wissatinnewag property are congruent with 3.4.1 and would add to the body of knowledge that the Recreational Historic Tourism public would appreciate in their forays to the Turners Falls Gill- Greenfield historic site visits. Nolumbeka would like to take part in this process and would be happy to assist researchers on and around the Wissatinnewag Village Site.	Not Adopted. This property is outside of the project boundary and there is no nexus to the Project.
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitats	CRWC	The study area is defined under methodology on page 3-255 as the lands around Project facilities and recreational areas on Northfield Mountain. We assume this means Project lands to the east of Route 63. Will surveys be done on project lands to the west of Route 63? Our question from 3.4.2 about whether surveys will be done of project lands owned by FirstLight that are not along the shoreline (Bennett Meadow, Barton Cove campground, for example) will holds.	Adopted. These areas are within the Project Boundary and will therefore be surveyed.
			Task 3: What kind of data on plants will be collected? No details given.	Adopted. An overall plant census list will be provided in tabular format in the final study report.
			Task 6: No details are provided as to the content of the final report, the data that will be reported. The FERC representative/consultant at the meeting recommended that plant information include details on seed dispersal and germination in the report. The updated PSP doesn't indicate whether this information will be provided.	Additional details added.
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	USFWS	Task 4: Remove "significant" from "significant invested areas".	Adopted.
			Task 4: Unclear whether FirstLight intends to survey the entire impoundment and 13-mile stretch of river below Turners Falls Dam for wetland and aquatic invasives. The Service recommends that FirstLight survey for riparian and aquatic invasives, by boat or on foot, along the entire perimeter of the impoundment and downstream of the dam to the Route 116 Bridge in Sunderland on both sides of the river. The shoreline area to be surveyed should include aquatic, littoral, and riparian areas up to the limit of the project-influenced extent of the streambanks.	Adopted. The study area was clarified in the Revised Study Plan.
			Task 6: Additional cross-sections and/or fine-scale surveying and mapping of the entire area should be considered so that the areal extent of habitat impacted by various river flow and Holyoke Project pool elevations can be fully assessed.	Adopted. In addition to the water level modeling results at occupied locations for tiger beetles, FirstLight will consult with USFWS and MDFW for concurrence on if additional fine-scale surveying at occupied locations is necessary based on the information collected in the mapping tasks.
			The schedule shows report preparation from September to December 2014. FirstLight should describe how this timeline fits into the Commission's Integrated Licensing Process and procedural deadlines.	Adopted. The Initial Study Report is due in September 2014. If field efforts run later into the summer such that a complete report cannot be submitted by this date, FirstLight will provide Stakeholders with a study report supplement.
		NHESP	Task 1: The Study Plan should be revised to specify that the Proponent will consult with the Division to identify known habitats for state-listed species so as to ensure that known populations are adequately surveyed and assessed.	Adopted.
			Task 1: The Study Plan should be revised to confirm that the Proponent will consult with the Division during this review to ensure concurrence on appropriate survey windows and diagnostic identification characteristics.	Adopted.
			Task 3: The Study Plan should be revised to include appropriate time per unit area thresholds, or otherwise confirm that the Proponent will consult with the Division to establish appropriate time per unit area thresholds in advance of field work so as to ensure concurrence of survey intensity within suitable habitats.	Adopted. FirstLight will consult with MDFW for concurrence to establish survey intensity (time per unit area).
			Task 3: In the first paragraph of page 3-270, the Study Plan states that "dates and times, the areas that were surveyed, and elevations taken with a level rod" will be collected. The Division notes that surveys should, at a minimum, also collect information regarding the spatial extent of the population, number of individuals, substrate, and plant vigor. Data related to plant vigor or health of a particular population should include spatial mapping of vigor as it varies across spatial / elevation gradients; see additional comments on Task 3, #4.	Adopted.
			Task 3: In the first paragraph of page 3-270, the Study Plan suggests that data will only be collected at sites where state-listed plants are located. The primary goals of the study, as stated in the third paragraph of page 3-262, "are [to] quantify the impacts of water level fluctuations and the current and proposed flow regimes on state-listed rare plant species". This, in turn, requires that the study: 1) delineate all suitable habitat for state-listed plants (particularly species inhabiting mud flats, sand bars, and high energy shore and cobble island habitat types); 2) determine habitat suitability preferences for state-listed plants by comparing flow parameters within and between occupied and unoccupied patches of suitable habitat, and 3) assess how quality, quantity, and location of habitat changes over a range of water elevations and inundation frequency/duration/timing. Therefore, the Study Plan should be revised to confirm that all suitable habitats will be identified and mapped, and that data sufficient to enable hydrological modeling of water elevations and timing, duration, and frequency of flooding – including	Partially Adopted. A hydraulic model developed as part of Study No. 3.2.2 will provide data to determine the contribution of water level fluctuations associated with Project operations. This modeling will enable analysis of how germination, growth, or dispersal of listed plants may be affected by the timing, duration, and extent and frequency Project-related water level fluctuations. FirstLight is not proposing to establish specific transects at unoccupied patches of suitable habitat for state-listed plants.

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			cross-sections, as further described below – will be collected from both occupied and unoccupied patches of suitable habitat. The Division notes that the goals and methods referenced here are nearly identical to those outlined for state-listed tiger beetles (see Task 6, below).	
			Task 3: On the last paragraph of page 3-267, the Study Plan states that "this task will collect the necessary field information to evaluate the effects of these changes in water level elevations on the life cycle of state-listed species and in particular, the germination, growth, and dispersal of species inhabiting mudflats, sand bars, and cobble islands." However, the Division notes that the Study Plan does not lay out a framework through which the affects of project operations on the life cycle (including germination, growth, or dispersal) of state-listed plants will be quantified. At a minimum, the Division would suggest that cross-sections (see comments on Task 6, #1 below) be established in both occupied and unoccupied patches of suitable habitat. Fine-scale analysis is necessary to enable accurate hydrologic modeling and facilitate analysis of how germination, growth, or dispersal may be affected by the timing, duration, extent, and frequency of flooding. The Division notes that – because fine-scale variability in elevation, slope, substrate, and flow dynamics have the potential to significantly impact habitat suitability – multiple cross-sections are likely needed to fully understand the extent and quality of habitats at these sites. The Division would strongly encourage the Proponent to consult with the Division prior to initiation of field work in order to seek concurrence that data collection and survey methodology are sufficient to enable fine-scale analyses.	Partially Adopted. A hydraulic model developed as part of Study No. 3.2.2 will provide data to determine the contribution of water level fluctuations associated with Project operations. This modeling will enable analysis of how germination, growth, or dispersal of listed plants may be affected by the timing, duration, and extent and frequency Project-related water level fluctuations. FirstLight is not proposing to establish specific transects at unoccupied patches of suitable habitat for state-listed plants.
			Task 3: Table 3.5.1-1 should be revised to include Upland White Aster (*Oligoneuron album*), state-listed as "Endangered," and identified in the Division's original study request.	Adopted.
			Task 6: The Study Plan suggests that a cross-section will be established in known areas of tiger beetle habitat, for use in conjunction with model results. As outlined above, the Division believes that fine scale variability in elevation, slope, substrate, and flow dynamics has the potential to significantly impact habitat suitability and that multiple cross-sections will be needed to fully understand the extent and quality of habitats at these sites. Additionally, cross-sections should also be placed in unoccupied but potentially suitable habitats to support the analyses further described under #2, below. The Division would strongly encourage the Proponent to consult with the Division prior to initiation of field work in order to seek concurrence that surveys are sufficient to enable fine-scale analyses.	Partially Adopted. In addition to the water level modeling results at occupied locations for tiger beetles, FirstLight will consult with USFWS and MDFW for concurrence on if additional fine-scale surveying at occupied locations is necessary based on the information collected in the mapping tasks. FirstLight is not proposing to establish specific transects at unoccupied patches of suitable habitat for state-listed invertebrates.
			Task 6: The Study Plan does not appear to include a habitat assessment to identify *potential habitat* for state-listed tiger beetles; instead, the Study Plan appears to limit its analysis to known habitats. The Study Plan should be modified to include the Proponent's plan to conduct a habitat assessment for state-listed tiger beetle species sufficient to identify potential habitat within the TFD Impoundment and downstream of the TFD to Rainbow Beach. As requested, field assessments of both existing and potential habitats should involve collecting flood depth, timing, duration, and extent - as well as frequency and changes to substrate characteristics - sufficient to permit assessment of how the quality and extent of both existing and potentially suitable habitat changes over a range of flows. The measurements should be taken over a range of test flows, between the existing minimum flow and maximum project generation flows, and synthesized to quantify habitat suitability for each species under each test flow.	Not Adopted. FirstLight has committed to evaluating potential project affects on these species in areas (outside of the Project boundary) where they are found. FirstLight is not proposing to establish specific transects at unoccupied patches of suitable habitat for state-listed invertebrates.
		NHDES	Requests that the study plan indicate use of field GPS units (with accuracy specified) for mapping	Adopted.
			Requests that data will be uploaded and annotated in GIS so that plant species and their distribution are all georeferenced	Adopted.
			Requests that the shapefiles generated from the field work will be shared with resource agencies such as NHDES	Adopted.
		CRWC	An attempt should be made to eliminate overlap between this study and Study No. 3.4.1, or perhaps the two studies should be merged.	The study area limits were better defined to distinguish between terrestrial habitat surveys performed under Study Plan 3.4.1. The two study plans were not combined.
			The second bullet under Study Area should reference the width of the shoreline surveyed – same as the impoundment (200 ft) or not?	Adopted. The study area was clarified in the Revised Study Plan.
			Tasks 3 and 4 do not provide any details on the data that will be collected during the plant surveys.	The field crew will provide a census list of plants that occur within the study area by habitat type. The study plan states that the field crew will be collecting vegetation sampling points per ACOE vegetation plot methodology.
			Task 3 should contain the same text about landowner permission that was added to page 3-248 of Study No. 3.4.1.	Adopted.
			Task 6: It is not clear how a water level fluctuation assessment that focuses on puritan tiger beetle habitat fits into a plant survey study with no geographic overlap. This task should be moved to another study, such as 3.4.1, or pulled out as its own study.	Not Adopted. The habitat of the puritan tiger beetle is found along the shoreline which is within this study area, similar to habitats of the sensitive plants listed in this study. Both are effected by water level fluctuations and are using the same model for analysis
			Task 8: No details are provided as to the content of the final report, the data that will be reported.	Adopted.
3.6.1	Recreation and Land Use	MADFW	Figure 3.6.1-1 draft survey, item #8: Group all fishing activities (shore, boat, ice) and hunting in the list. Figure 3.3.1-3 draft survey, item #8: Group all fishing activities (shore, boat, ice) and hunting in the list	Adopted. Survey has been reformatted so that the activities are in alphabetic order.

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		NPS	Would like to survey non-users, suggested using AMC and other NH, VT, and MA organizations and transmit questionnaires to their memberships.	Not Adopted. Would require a significant effort to obtain relevant information that has a Project nexus and weed out information that is not Project-related. Surveying members of organizations regarding their reasons for non-use creates a survey bias. The Licensee will review the Massachusetts, New Hampshire and Vermont Statewide Comprehensive Outdoor Recreation Plans (SCORP) and other regional recreation plans that may provide data on local and regional recreational needs in proximity to the Projects and compare recreational needs identified in the plans with recreational opportunities provided by the Projects and identify potential gaps.
			There are no questions related to river level fluctuations and adequacy of access to the river at various times under different operational scenarios. It is well known that under certain operational modes, river access is severely if not completely curtailed. Abutters should be included in any comprehensive survey as they have direct knowledge of operational impacts.	Figure 3.6.1. Questions 13 and 14 address river levels. Figure 3.6.1-3 Question 17 allows abutters to address any recreation concerns which may or may not include operational impacts, while question 15 directly address river levels.
			The number of spaces for regular car spaces should be differentiated from trailer spaces. For example, the state boat ramp at Barton Cove has no parking spaces for regular cars that bring canoes and kayaks on top of their vehicle; all spaces are for trailers only. There is no space for noting the condition of parking spaces, camp sites, docks, or boat launch facilities.	See Figure 3.6.2-2. The form was designed to ascertain the condition of parking spaces, campsites, and other recreational amenities. This information was collected as part of Study No. 3.6.2 and will be reflected in the summary report to be developed. A question was added to figure 3.6.1 asking if there are any additional user comments.
			The "Standardized Survey Form" (Figure 3.6.2-2 in the updated PSP) that is part of Study No. 3.6.2 does not appear to gather data about the dates that a particular day or overnight facility is open to the public. The Draft Recreation User Survey (Figure 3.6.1-1 in the updated PSP) has no questions about user satisfaction for times of year that facilities are not open, only the users experience on the day of the survey.	See Figure 3.6.2-2. The survey form asked if a facility is seasonal. If yes, the dates or seasons of operation were noted in the notes section of the survey form. This information will be available as part of the summary report to be developed. Figure 3.6.1.-1. Adopted. A question will be added asking if there are any additional user comments.
			Weather conditions such as temperature and precipitation should be added to the survey to provide data for the reviewer as to why an area may have been crowded or relatively unused on for example, a weekend holiday.	Adopted. Weather condition information has been added to the Northfield Mountain Survey. Weather condition information is already included on the Recreation User Survey.
			Question 8 should include fishway viewing, and birding/wildlife viewing, rowing, swimming from a boat, swimming from shore, and multi-day float trips. Types of activities should be grouped for easier viewing and choosing, along with a place for respondents to write "other."	Adopted. The survey is revised to include fishway viewing, rowing, birding multi-day float trips and swimming. The activities are now listed in alphabetic order.
			More information should be collected from the responder such as age, gender, whether they are part of a private group or formal program, such as an educational trip.	Adopted. The purpose of the survey is to determine recreation need and the questions are designed to determine need regardless of one's gender or age. It is also our experience that survey respondents do not want to provide this information. Nonetheless, the survey is revised to gather this information. Question 3 of recreational user survey asks whether users are part of a group. This information has been added to the Northfield Mountain Survey as well.
			The revised study should extend the time it is to be conducted beyond Sept 30, allowing it to capture users in the fall and winter seasons which may well account for significant use. The survey also does not account for use by minors; however, by utilizing AMC data, for instance, those users will be identified through family membership data. The revised study should also include a method to reach school groups. Although the towns may or may not have that data, queries should be put to area schools to ID which of them go on field trips and equally important, why they may not visit river based recreational facilities nearby. Additionally, the study data collection phase should extend to two years to allow for vagaries in weather and economic conditions which change from year to year. A single field season may provide good data, but a second year is certainly preferable. The field surveys should also extend to ½ hour before sunrise and ½ hour after sunset. The current proposal to start them ½ hour after sunrise and end ½ hour before sunset will miss many if not most anglers who tend to put in before sunrise and/or may take out after sunset.	We note that NPS' comments regarding seasonality of study and times of surveys appear to be directed at the Updated Study Plans for the upstream TransCanada projects. For instance, FirstLight's Study Plan has always specified that this is a year round study and did not specify times of day. The Study Plan also specified that a stratified random sampling methodology will used to vary the days, time of day and start locations for the survey route. Times of day will be varied and will include the periods of survey ½ hour before sunrise and ½ hour after sunset. Minors will be included when an adult of the group is surveyed. School groups will be captured at the Northfield Mountain Visitors Center. If there are weather or economic extremes during the study year, the study will be suspended and begun again the following year.
		AWWA	The study does not include collecting data from any whitewater boaters. They recommend FL contacting whitewater outfitters on the Deerfield River, and reaching out to AWWA, NE FLOW and AMC to survey members, and conduct internet-based surveys.	Not Adopted. The study is not designed to target specific user groups but is designed to determine what recreational activities are taking place at the Projects and the recreational user's opinion of the recreational experience he/she has encountered. To the extent that whitewater boating is taking place at the Project, that use will be captured by the survey form.
			Would like study plan to include collecting data on demand by non-users, including whitewater boaters and through paddlers.	Not Adopted. If they are encountered during the survey, whitewater boaters and through paddlers just as any other recreational user of the Project will be interviewed. As noted earlier, FirstLight is not proposing to conduct a non-use survey because it will not lead to information useful in determining Project impacts. In addition, review of Massachusetts, New Hampshire, and Vermont SCORPs and local and regional recreation plans will identify unmet recreational needs.
		NE FLOW	Would like study plan to include collecting data on demand by non-users. They recommend FL contacting whitewater outfitters on the Deerfield River, and reaching out to AWWA, NE FLOW and AMC to survey members, and conduct internet-based surveys.	Not Adopted. FirstLight is not proposing to conduct a non-use survey because it will not lead to information useful in determining Project impacts and surveys of narrowly focused interest groups lead to a survey bias since the groups are interest in promoting their activity. FirstLight's survey proposal is consistent with surveys approved by the Commission in hundreds of relicensing proceedings. In addition,

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				review of Massachusetts, New Hampshire, and Vermont SCORPs and local and regional recreation plans will identify unmet recreational needs.
		AMC	Would like study plan to include collecting data on demand by non-users. They recommend FL contacting whitewater outfitters on the Deerfield River, and reaching out to AWWA, NE FLOW and AMC to survey members, and conduct internet-based surveys. We suggest that more sophisticated and contemporary survey techniques be used by the applicant, including more qualitative forms such as focus groups. AMC has a recreation plan for the Connecticut River Blueway.	Not Adopted. FirstLight is not proposing to conduct a non-use survey because it will not lead to information useful in determining Project impacts and surveys of narrowly focused interest groups lead to a survey bias since the groups are interest in promoting their activity. Sample size can be an issue with using focus groups and may not be large enough to draw definitive conclusions. FirstLight's survey proposal is consistent with surveys approved by the Commission is hundreds of relicensing proceedings. In addition, review of Massachusetts, New Hampshire, and Vermont SCORPs and local and regional recreation plans will identify unmet recreational needs. A request has been made to obtain a copy of the plan.
		CRWC	Page 3-276 under third paragraph of the General Description, it describes a mail survey targeted to "adjacent residential landowners." Page 3-279, paragraph above Task 3, it describes a mail survey mailed in the spring to "residential abutters." Because there are some river residents who don't own the land their house sits on (FirstLight owns the land under several seasonal camps), it makes sense to take the word "landowner" out of this study. Those river residents should be sent a survey.	Adopted. Removed the word landowners.
			Task 1: Study Preparation- CRWC recommends, in addition to obtaining copies of recreation plans from the Towns of NorthFGS, Gill, Erving, Montague, and GreenFGS, that FirstLight talk to recreation departments in the towns that have them and recreation/open space committees in smaller towns. We also recommend discussions with the MA Department of Conservation and Recreation for their sense of user type, number, and issues associated with the state-run boat ramps and state-owned or – protected conservation land along the river. Additionally, we recommend contacting the MA Environmental Police and local police to talk to them about the various issues regarding recreational use that they observe in the Turners Falls impoundment, bypass, and downstream of the river. If any statistics have been kept by Northfield Mountain about attendance such as on the Quinnetucket, campsites used, kayaks rented, and the former shuttle service, these should be obtained and also presented in the final report for the previous 10 years.	Adopted. Included in Task 2 of the study. FirstLight will work with State agencies and private groups that manage existing public and private recreation facilities within the Project boundaries to determine use at their facilities. Adopted.
			Task 2: Field Work- Calibration counts are to be done 2 hours per site during each calibration day at each of the 20 formal Project recreation facility listed in Study No. 3.6.2. How many days do you need for statistical purpose? Spot counts are to be conducted five days per month at all 20 formal Project recreation facilities listed in Study No. 3.6.2. TransCanada is proposing to do surveys nine days per month but during a shorter season. A user contact survey will be administrated during the calibration and spot count site visits. Additional information is needed about project sample size goals for the user survey. It is unclear how the proposed methods assure sufficient sample size is obtained. Does the proposed method ensure that sampling over one year only will provide a representative assessment of user uses? A Northfield Mountain trail user survey will be used during the calibration and spot count site visits at Northfield Mountain. It is unclear how the proposed methods assure sufficient sample size is obtained. Does the proposed method ensure that sampling over one year only will provide a representative assessment of user uses? A mail survey will be mailed in the spring to residential abutters. Additional information is needed about project sample size goals for the user survey.	Traffic counters will record information 100% of the time, while the calibrations will be used to augment collected data. Spot counts will be conducted on 15% of the weekdays and 20% of weekend days. In compliance with FERC guidance, these days will be distributed through out the course of a year to get a complete picture of recreation that occurs year round. This study was designed based on the large number of recreation studies that we have completed in the past that have achieved statistically appropriate sampling sizes. During the winter, surveys will be administered to all groups paying at Northfield Mountain, while during other times of the year; the survey will be administered as part of the counts or handed out to individuals visiting the indoor displays. The mail survey will be sent to 100% of the abutters for whom addresses can be found. A 25% return would be an expected sample size.
			We suggest that the Turners Falls canal should also be added to the list of informal site locations.	Adopted. Users of the canal near various formal access areas will be surveyed and counted.
			The surveys as presently designed do not get at those people who are not using facility for whatever reason.	Not Adopted. FirstLight is not proposing to conduct a non-use survey because it will not necessarily lead to information useful in determining Project impacts and surveys of narrowly focused interest groups lead to a survey bias since the groups are interest in promoting their activity. In addition, review of Massachusetts, New Hampshire, and Vermont SCORPs and local and regional recreation plans will identify unmet recreational needs.
			The proposed user survey only surveys those already using amenities. There needs to be a robust proposal for assessing the unmet demand by those not currently using the site.	Not Adopted. FirstLight is not proposing to conduct a non-use survey because it will not necessarily lead to information useful in determining Project impacts and surveys of narrowly focused interest groups lead to a survey bias since the groups are interest in promoting their activity. In addition, review of

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
				Massachusetts, New Hampshire, and Vermont SCORPs and local and regional recreation plans will identify unmet recreational needs.
			Would like study plan to include collecting data on demand by non-users. They recommend FL contacting whitewater outfitters on the Deerfield River, and reaching out to AWWA, NE FLOW and AMC to survey members, and conduct internet-based surveys.	Not Adopted. FirstLight is not proposing to conduct a non-use survey because it will not necessarily lead to information useful in determining Project impacts and surveys of narrowly focused interest groups lead to a survey bias since the groups are interest in promoting their activity. In addition, review of Massachusetts, New Hampshire, and Vermont SCORPs and local and regional recreation plans will identify unmet recreational needs.
			We recommend that the user survey be given out at the Sunderland boat ramp and the river abutters' mail survey should be mailed out to all abutters downstream of the Project down to the Sunderland bridge (Route 116).	Not Adopted. The cost of expanding the study down to the Sunderland bridge will require a significant effort to obtain relevant information that has a Project nexus and weed out information that is not Project-related. The licensee does not own recreation facilities below Poplar Street Put-in and therefore has no jurisdiction over recreation facilities further downstream.
			Task 4: Report Writing- No details are provided as to what the report will contain or how the data will be presented. If any statistics have been kept by Northfield Mountain about attendance such as on the Quinnetucket boat tour, campsites used, kayaks rented, and the former shuttle service, these should be obtained and also presented in the final report for the previous 10 years.	Adopted. See revised Study Plan.
			Figure 3.6.1-1: Draft Recreational User Survey: • A script that the surveyor will say to each user should be at the top of the survey. • Weather categories and a place for air temperature should be added to the survey. • Question 1: If someone answers yes, does the survey continue? • Question 5: Follow up question to this could be what activities have you done on other visits. • Question 8 should include fishway viewing, birding/wildlife viewing, rowing, swimming from a boat, swimming from shore, and multi-day float trips. The list should be organized better to group types of activities for easier viewing and choosing. There should be space for writing something in "other." • It might be useful to collect more information about the survey responder: age, gender, etc. • There should be more questions related to river fluctuation on this survey. Questions should ask whether river fluctuation affected launching and boating, swimming, fishing from shore, accessing shore, scenic quality of shore. • FERC's study request #6 in methods under #4 said that "surveys of fisherman and hunters should include additional pertinent information related to game and harvest." No such questions are in the draft survey. • Please refer to our comments for Study No. 3.6.4 regarding the survey questions. • Please refer to our comments for Study No. 3.6.6. regarding the survey questions. • Please refer to our comments for Study No. 3.6.7. regarding the survey questions. • Portage, other services such as rentals, shuttles, etc.	Adopted. A space for weather currently exists. A survey will be administered only once to a user. Thus, if someone responds that he has filled in the survey previously, then it will not be administered to that user again. On the other hand, if a user has participated in the User Survey, but on a different date is asked to participate in the Northfield Mountain Trail User survey, the user could participate in the Trail survey. Adopted. See revised survey form. Adopted. The survey is revised to include fishway viewing, rowing, birding multi-day float trips and swimming. The list has been organized in alphabetic order. Adopted. The purpose of the survey is to determine recreation need and the questions are designed to determine need regardless of one's gender or age. It is also our experience that survey respondents do not want to provide this information. Nonetheless, the survey is revised to gather this information. Questions13 and 14 of the Recreation User Survey asks about river levels. If user has additional comments they may do so at the end. Not Adopted. This information has no bearing on the amount or types of facilities available and is not related to potential Project impacts. Information on game and harvest is the purview of the fish and game resource agencies. Addressed in those studies.
			Figure 3.6.1-2: Northfield Mountain Trail User Survey: • A script that the surveyor will say to each user should be at the top of the survey. • Please refer to our comments for Study No. 3.6.7. regarding the survey questions. • The first question here should be same as question 1 in the user survey. • No questions relate to user experiences at the Northfield Mountain Mountaintop Observation Area, which is one of the 20 formal recreation sites, and is potentially part of Study No. 3.6.7.	Adopted. Adopted. See revised Survey Form. Adopted. See revised Survey Form.
			Figure 3.6.1-3: Residential Abutters Survey: • There should be an introductory paragraph to the recipient of this survey describing the purpose of the survey. • Question 2: What is the meaning of "regular access?" Regular could be once a year on the same date every year, or every day. • Question 2 is also confusing with regard to the purpose of the question and whether it is related to access via rights of way. Camp owners often access their camps via rights of way through private lands of abutters. Issues and potential conflicts exist regarding one party giving visitors permission to access the rights of way, or land owners not maintaining rights of way and camp owners needing access through other properties, etc. Questions may be refined to get more information about some of these issues to the extent that they are related to Project	Adopted. Adopted. Removed word "regular". Survey to be issued to abutters. Question 5 addresses concerns with regard to access to the river by others on the abutter's land. .

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			lands and Project land usage.
			• Question 4 should be the same list as on the user survey.
			• There should be a question asking if the person has a dock associated with their residence and how many boats are docked to it, and the kind of boats.
			• Questions should ask about beach formation, river level fluctuations, use or overuse of the river, conflicts between river users, how long they have been living along the river, what the strengths and weaknesses are to the facilities and to the river.
			• Question 7: How does an open-ended question like #7 get used in a survey report or survey statistics? Will reviewers have access to each survey response to read these answers?
			• There are no questions related to river level fluctuations, a subject about which we are sure abutters will have much to say and the most hands-on knowledge. Suggested questions are as follows:
			  • As a land abutter/camp owner what impacts on recreation have you experienced in regard to the fluctuation of the river level?
			  • What other impacts have you experienced that might not be associated with recreation?
			  • Are there specific days/times when the fluctuation of the river has completely denied your ability to recreate?
			  • Have you experienced any physical tangible loss because of fluctuation? (if so, what?…be specific)
			• A question should ask whether land use is impacted by project operations to help inform Study No. 3.6.6.
				Adopted. See revised survey.
				Adopted. See revised survey.
				
				Question 17 is designed to be open-ended and to allow room for the interviewee to provide comments on any issues he/she may have regarding his/her recreational experiences at the Project. Question 15 also addresses river water levels.
				Like responses will be grouped and analyzed. All responses will be included in the report appendix.
				
				Not Adopted. Question 16 is designed to be open-ended and to allow room for the interviewee to provide comments on any issues he/she may have regarding his/her recreational experiences at the Project. Question 14 also addresses river water levels.
				
				Not Adopted. Question 17 is designed to be open-ended and to allow room for the interviewee to provide comments on any issues he/she may have regarding his/her recreational experiences at the Project.

		Nolumbeka	Did not ask for a specific change to the study.	No Comment.
3.6.2	Recreation Facilities Inventory and Assessment	AWWA	While the licensee states that it is completing its Recreation Facilities Inventory Assessment, it does not state whether it assessed the presence and adequacy of facilities from the perspective of whitewater boaters and through paddlers. The licensee has made no effort to coordinate its assessment of these facilities with stakeholder groups that have a great interest in utilizing the recreation facilities.	Not Adopted. The field work for this survey was completed in 2013 and was intended to gather baseline information regarding existing recreational facilities associated with the Project. This information will be included in a summary report to be developed in 2014. The user surveys proposed in the RSP are designed to provide further information about a user's recreational experience at the Project, including whether recreation facilities are adequate for serving recreation demand.
			The licensee should extend the project boundary below Cabot Station to include all facilities above the confluence with the Deerfield River.	Not Adopted. The field work for this survey was completed in 2013 and was intended to gather baseline information regarding existing recreational facilities associated with the Project. This information will be included in a summary report to be developed in 2014.
		NE FLOW	The information that has appeared so far in the PAD is inadequate because it lists, as part of the inventory, facilities that are not owned or operated by FirstLight. We recommend this inventory assessment focus on the facilities that are owned and maintained by FirstLight, especially put-ins, take-outs, trails, developed and primitive campsites, and facilities for non-motorized boats.	Not Adopted. The intent of all recreational surveys conducted, either as part of baseline information gathering, or as part of the ILP, is to get an accurate assessment of all recreation taking place at or near the Project, regardless of whether the recreational facility is a formal or informal one, or is or is not owned by the Licensee.
			The inventory should assess FirstLight's land base and identify what parcels could serve as new primitive campsites or, where deemed necessary, river access locations.	This information is being gathered as part of Study No. 3.6.4 Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats.
		AMC	The information that has appeared so far in the PAD is inadequate because it lists, as part of the inventory, facilities that are not owned or operated by FirstLight. We recommend this inventory assessment focus on the facilities that are owned and maintained by FirstLight, especially put-ins, take-outs, trails, developed and primitive campsites, and facilities for non-motorized boats.	Not Adopted. The intent of all recreational surveys conducted, either as part of baseline information gathering, or as part of the ILP, is to an accurate assessment of all recreation taking place at or near the Project, regardless of whether the recreational facility is a formal or informal one, or is or is not owned by the Licensee
			The inventory should assess FirstLight's land base and identify what parcels could serve as new primitive campsites or, where deemed necessary, river access locations. The map should be included by FirstLight in its study of "informal sites" that could be used to support more recreation on the river.	This information is part of Study No. 3.6.4 Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats.
		CRWC	*Figure 3.6.2-2 Standardized Survey Form* • Access: whether or not the access or dock is open to the public should be noted. • Parking lots: The number of spaces for regular car spaces should be differentiated from # of trailer spaces. • Campground/campsite: the season that this facility is open should be noted • There is no space for noting the condition of parking spaces, camp sites, docks, or boat launch facilities. • There should be much greater detail on the site condition, ADA compliance, and user impact in a numeric ranking format.	Adopted. It is currently differentiated on pg 2. under the heading Parking Lots. It is noted on page 1 under the heading operations. Condition is noted under General Area: potential/need for expansion/enhancement, as well as in notes taken in the field. Not Adopted. The intent of the baseline inventory was to record what recreational facilities are currently available and their general condition. Figure 3.6.2-2 does record whether a facility is ADA compliant. This was not intended to be an engineering condition assessment.
3.6.3	Whitewater Boating Evaluation	MADFW	The Division will not support seasonally inappropriate flow regimes for whitewater boating (i.e. high flows in mid-summer) as these flows will adversely affect the aquatic biota that the Division is seeking to reestablish and protect in the bypassed reach of the Connecticut River	Comment acknowledged.
		AWWA	The licensee proposes to study whether current or future demand exists for whitewater boating in the natural	As noted in the RSP, FirstLight is not proposing to conduct a non-use survey because non-use surveys do

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
			bypassed reach. The licensee, however, provides no methodology or explanation as to how it intends to accomplish this objective. The licensee's proposal that it determine demand using its user contact survey of non-whitewater boaters is wholly inadequate	not necessarily lead to relevant information on Project-related impacts. It is premature to conduct a survey on whether there is a demand for whitewater boating until after the whitewater boating evaluation has been conducted and there is a better understanding of whether there is any type of whitewater boating resource even available.
			The licensee should also examine the extent to which it is able to forego generation or utilize its excess capacity in the upper reservoir at Northfield Mountain in order to provide additional flows to enable whitewater boating in the natural bypassed reach.	It is premature to assess foregoing generation or utilizing excess capacity in the Upper Reservoir until it has been determined whether and the type of whitewater boating resource.
		NE FLOW	It is imperative that flows are measured accurately, rather than being estimated. Any sloppiness can create problems after the license is issued.	Adopted. Study No. 3.6.3 has been revised to include methodology for measuring flows.
		AMC	It is imperative that flows are measured accurately, rather than being estimated. Any sloppiness can create problems after the license is issued.	Adopted. Study No. 3.6.3 has been revised to include methodology for measuring flows.
		CRWC	It is not explained how flows will be measured or estimated through the bypass reach during each test run. Task 5: No details are provided as to the content of the study report.	Adopted. Study No. 3.6.3. has been revised to include methodology for measuring flows. Task 5 has been revised to include the types of details that will be included in the report. Note, that the report details were described in the Study Goals and Objectives.
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats	NPS	Extensive work has been done by the Friends of the CT River Paddlers Trail relative to river access campsites in terms of appropriate frequency (how far apart on the river) as well as maintenance and facility needs. Efforts are underway to expand the trail into Massachusetts and Connecticut. This data should be incorporated into the study in order to identify obstacles to multiday paddling trips, which also include the lack of adequate or existing portages around project dams.	Task 1, second paragraph states The Licensee will review and take into consideration appropriate federal, state, county and local programs and plans related to recreational use of the waterway within the Projects' boundaries. This review will also take into consideration efforts such as the efforts by the Friends of the CT River Paddlers Trail.
			FirstLight's land base should be used to identify what parcels could serve as new primitive campsites or, where necessary, river access locations deemed.	Task 2, paragraph 1 states A field survey will be used to ground verify the location for potential future use sites and determine the feasibility of developing these sites.
			The Trust for Public Land map showing potential campsite should be included by FirstLight in its study of "informal sites" that could be used to support more recreation on the river.	Task 1, second paragraph states The Licensee will review and take into consideration appropriate federal, state, county and local programs and plans related to recreational use of the waterway within the Projects' boundaries.
			The revised study should include a comprehensive assessment of the condition of each site, along with how various ratings (good, fair or poor) are defined and applied. The adequacy of the portage at Turners Falls must also be addressed in order to cure existing deficiencies in the opportunities for multi-day paddling trips.	Not Adopted. General site conditions were studied as part of Study No. 3.6.2 Recreation Facilities Inventory and Assessment. Conditions of the recreational facilities inventoried as part of the baseline study will be included in the summary report to be developed under Study No. 3.6.2.
			The revised study should extend the time it is to be conducted beyond Sept 30, allowing it to capture users in the fall and winter seasons which may well account for significant use. The survey also does not account for use by minors. The revised study should also include a method to reach school groups.	FirstLight has proposed year-round studies. See Study No. 3.6.1. and 3.6.2. See responses to same NPS comments in Study No. 3.6.1.
			The study data collection phase should extend to two years to allow for vagaries in weather and economic conditions which change from year to year.	Not Adopted. See responses to same NPS comments in Study No. 3.6.1.
			The field surveys should also extend to ½ hour before sunrise and ½ hour after sunset.	See responses to same NPS comments in Study No. 3.6.1.
		AWWA	The licensee should work closely with groups such as the AMC and the CRWC to identify and survey non-users and displaced users in order to identify the obstacles to their utilization of the river.	Not Adopted. See responses to same AWWA comments in Study No. 3.6.1.
		NE FLOW	We believe the portage trail project belongs in this study.	It is included in Objective 2 of the study.
		AMC	We believe the portage trail project belongs in this study.	It is included in Objective 2 of the study.
			The Trust for Public Land has developed a map of potential campsites for non-motorized boaters on the Connecticut River in Massachusetts. The map was created as part of the effort to expand the Connecticut River Paddlers' Trail into Massachusetts and Connecticut.	Licensee has contacted Trust for Public Lands (TPL) regarding access to their data and TPL indicated a willingness to provide site data to the Licensee, which will be used during Licensee's field investigations for potential campsites and access sites.
		CRWC	Study Objectives: The Study Plan should instead be revised to define the study area as the following: within the Project boundary, plus downstream areas that include the shoreline of the Connecticut River downstream to the Sunderland bridge and the shoreline of the lower Deerfield River from the Route 5/10 Bridge to the confluence with the Connecticut River.	Partially Adopted. See revised study plan.
			The second bullet should be revised to say "Determine if an alternate walkable portage trail around the Turners Falls dam is feasible." Based on comments submitted thus far and comments spoken at the scoping meetings in late January, there is already an established need for an alternate portage.	Adopted
			The last bullet says that one of the study objectives is to determine if the seasons of operation are consistent with actual river use. How will this be determined?	This will be determined using data collected as part of Study No. 3.6.1 Recreation Use/User Contact Survey.
			The "Standardized Survey Form" (Figure 3.6.2-2 in the updated PSP) that is part of Study No. 3.6.2 does not appear to gather data about the dates that a particular day or overnight facility is open to the public.	Under Operations it asks if the facility is seasonal. If it is further information is included in the field notes.
			The Draft Recreation User Survey (Figure 3.6.1-1 in the updated PSP) has no questions about user satisfaction for times of year that facilities are not open.	Respondents can supply this information as part of the open-ended question at the end of the survey.
			CRWC's requested study #26 was for the feasibility of a new portage route around Turners Falls Dam and	Objectives 2 and 5 of the study address feasibility of a new portage route and improved river access

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			improved river access point downstream of Turners Falls canal. We would like to see a desktop and on-the-ground review of a replacement or modification to the Poplar Street access, and we feel that analyzing whether there is a need for this is not necessary, given the existing consensus among users that this site is inadequate. This element of the study should be explicitly laid out in a revised study plan.	downstream of Turners Falls. Additional language has been added to the Revised Study Plan.
			Task 1: Literature Review- CRWC recommends adding two maps to be included on the list of useful resources. "Inland Guides" produced by KM Digital Productions (www.kmdigiprod.com) has produced a "Recreational Guide to the Connecticut River" that is a fold-out map. There is a map that covers Vernon, VT to Turners Falls, MA, and a map that covers Turners Falls, MA to HatFGS, MA. The updated PSP says in the third paragraph of this section that data from the Recreation Use/User Contact Survey will be reviewed to assess the need for new or improved facilities to accommodate non-motorized boating use at the Projects. "Projects" should be revised to say "study area." Relying on the user contact survey for assessing the need for new or improved facilities, however, is problematic for two reasons: 1) other than question 14: does this recreation facility serve your interests, there are no questions in the draft user survey designed to provide useful information for Study No. 3.6.4, and 2) the user survey will be given out to people at the 20 formal recreation use facilities within the project boundary, therefore there will be no assessment of the adequacy or need for facilities downstream of the Project.	Adopted. Question 21 of the survey is open-ended and will allow room for the user to express an interest in additional facilities or amenities. The survey will be administered at Poplar Street Carry-in.
			Task 2: Field Work- CRWC recommends a stakeholder working group meeting in the middle of this task, to go over Task 1 results and visit sites. We see value and efficiency to group discussion in the middle of this task.	At this time, not adopted.
3.6.5	Land Use Inventory	NPS	A comprehensive identification of licensee owned lands adjacent to the project boundary should be included in the application. The proposal by FirstLight to evaluate only lands within the project boundary and a 200 foot strip of abutting lands will not provide adequate data relative to areas which if developed, could adversely impact river resources, from development and impact on aesthetic values to upland land use practices that may adversely impact water quality and sedimentation.	Adopted Not Adopted. Reviewing lands within 200-feet of the Project boundary is a FERC accepted practice. Lands outside of the Project boundary are subject to local and state zoning laws. The purpose of the study is not to assess whether development and land use activities outside the project boundary by non-licensees may affect resources within the boundary. Studies should develop information that informs license conditions but FERC licenses cannot include conditions that control activities on non-project lands.
		CRWC	*Task 1: Literature and Aerial Photography Review*- It is not clear what aerial photography will be used in this task – is this going to be aerial imagery available from Google Earth or MassGIS or something that FirstLight plans to generate using new flight information? Will this study use the MassGIS 2005 land use data layer?	The study plan states "this review will utilize existing, publicly available aerial photography". Yes, the study plan states that data from the MA GIS database will be reviewed.
			Task 2: Development and Application of Land Use Designations- Task 3 (Land use mapping) of Study No. 3.1.1, the Full River Reconnaissance, also looks at land use along the Connecticut River. Based on discussions during the meeting for Study No. 3.6.5, it was my understanding that the two efforts would be essentially be done as one. Therefore, the description of Task 2 for Study No. 3.6.5 should be made more consistent with the description of Task 3 in Study No. 3.1.1. The updated PSP for Study No. 3.6.5 lists seven land use types. The updated PSP for Study No. 3.1.1 says that the plans will be developed using MassGIS data layers of land use. Please see our comments in Study No. 3.1.1 regarding the number of land use categories that are intended to be used, but MassGIS uses more than seven land use types.	Not Adopted. The two studies are reviewing existing land uses from different perspectives and will not be conducted as one study, although information from the FRR will be reviewed when developing land use classifications.
			Task 3: Map and Summary Development- A list of proposed maps should be included in the revised PSP. One of the maps should show land uses with lands owned or flowage rights owned by FirstLight clearly identified. CRWC recommends that a table and/or map be provided in this task that indicates the location, size of docks, and amount of water withdrawn daily or annually.	Adopted. Adopted.
		Nolumbeka	The Nolumbeka Project considers our use of the land in the project area in harmony with the cultural history and attraction to the Great Falls area, and we request to be identified as such in the goals and objectives in consideration in 3.6.5	Adopted. We have included this statement in the Existing Information portion of Study No. 3.6.5.
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use	CRWC	*Task 1: Data compilation*- If the Recreation Use/User Contact Survey is to help inform this study, then the survey questions for river users and river abutters need to be designed to be more informative than the single question currently in the updated PSP user survey. The river abutter survey currently has no questions geared towards river level fluctuations or whether land use on their property is affected by project operation. The surveys will also need to be conducted at river access points and mailed to river abutters downstream of the Turners Falls canal to the Sunderland bridge, such as the rowing program at Deerfield Academy and river users at	Questions 13 and 14 of the recreation user survey ask about river levels. If a user has additional comments they may do so at the end of the survey. The abutters survey question 15 addresses satisfaction with river water levels. Not Adopted. Mailing the river abutters survey to those downstream of the Project down to the Sunderland bridge, will not produce a significant increase in information, compared to the increase in cost that will result from the added surveys.

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			the Sunderland boat ramp. The updated PSP on the top of page 3-318 says that FirstLight will review historic and existing water level fluctuation information, and this paragraph should refer to water level recorder data and river flow and fluctuation data that will be part of Task 3 of Study No. 3.1.2 and Task 2 of 3.2.2.	Adopted.
			Task 3: Report development- Details should be provided as to the content of the report and the ways data will be presented.	Adopted.
3.6.7	Recreation Study at Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use	NPS	Public education programs offered at the visitor's center involves using the Recreation Use and User Contact Survey to identify opinions of current recreation/education users at Northfield Mountain. However, neither river nor trail users are addressed in this survey of educational program users. Records of attendance numbers at Northfield Mountain's educational and school programs, the number of programs offered, and attendance numbers should be provided for the past 10 years. The types of programs and staffing it takes to run them should also be described.	Adopted. See revised surveys. Adopted. Current programs will be described, however programing and necessary staffing evolves as needs and conditions change.
			There is also no information relative to the report's contents, how the data will be presented or what if any, opportunities the RAs and NGOs will have to participate in the evaluation and conclusions provided by the data.	Adopted.
		NE FLOW	We wonder if site visits for educational purposes have been tracked and it would be beneficial to know if the level of activity at Northfield Mountain has diminished in recent years.	Adopted.
		AMC	It would be beneficial to know the level of activity at Northfield Mountain, and the degree to which such programs have been decreased in recent years.	Adopted
		CRWC	*Task 1: Review of Existing Information*- Public education programs offered at the visitor's center has been added to this task, which involves using the Recreation Use and User Contact Survey to identify opinions of current recreation/education users at Northfield Mountain. However, neither the river user nor the trail user survey questionnaire in Study No. 3.6.1 is currently geared to attendees of most of the educational programs. The proposed forms should either be modified, or a survey questionnaire should be developed specific for the educational program users at Northfield Mountain. If Northfield Mountain keeps records of attendance numbers of their educational and school programs, the number of programs offered, and attendance numbers should be provided for the past 10 years. The types of programs and staffing it takes to run them should also be described.	Adopted. See revised surveys. Adopted
			Task 4: Report development- No details have been provided about the content of the report or the ways that data will be presented.	Adopted
3.7.1	Phase 1A Archeological Study	CRWC	Task 1: The study plan meeting was held on June 12, not on June 14, as stated in the updated PSP.	Date was corrected to June 12.
		VT SHPO	The current Phase 1A study plan includes provisions for further consultation with the relevant SHPOs, the Narragansett THPO, and any other interested Native American tribes with regarding to APE definition, the development of an archeological sensitivity model, and an archeological field reconnaissance methodology. The Division looks forward to this consultant and recommends that a specific consultation schedule be provided in the RSP. The RSP should also provide specific reference to the development and implementation of the following Cultural Resource Study Plan components that will be necessary subsequent to the completion of the Phase 1A: • A Phase 1B site identification survey within all archeologically sensitive areas and potential site locations with it eh APE that are actively eroding. This study should include strategies to implement deep testing methods for identification of deeply buried cultural components. • Phase II site evaluation of any archeological site identified in the Project APE as a result of the Phase IB survey or any known site that is located within a portion of the APE that is actively eroding to determine their boundaries and eligibility for inclusion on the National Register of Historic Places. • A phased plan to complete Phase II site evaluation of any remaining currently recorded archeological sites in the Project APE to determine their boundaries and eligibility for inclusion on the National Register of Historic Places. • Identification of Traditional Cultural Properties. • Historic Structures Assessment and Evaluation Report.	FirstLight has proposed that a teleconference meeting will be held in October 2013 to discuss the precise APE for the Projects with the aforementioned parties. FirstLight notes that a Phase IB identification survey, Phase II evaluation of recorded archaeological resources, identification of Traditional Cultural Properties, and a Historic Structures Assessment and Evaluation Report are not part of the Phase IA Archaeological Survey RSP, but will be addressed after it has completed the Phase 1A Archaeological Survey and the Reconnaissance-Level Historic Structures Survey and has more information to determine what additional surveys or measures are necessary. FirstLight will consult with the SHPOs and other stakeholders in determining appropriate next steps and in the development of a Historic Properties Management Plan. FirstLight has proposed to conduct a Traditional Cultural Properties Study (Study No. 3.7.3).
3.7.2	Reconnaissance-	CRWC	The definition of "structure" in the context of this study needs to be a bit better defined.	As noted in Task 1 of Study No. 3.7.2, FirstLight will be consulting with the SHPOs and the Tribe with

No.	Study Name	Commenter	Summarized Comment	FirstLight's Response
	Level historic Structures Survey			respect to the precise APE for the Projects, the development of historic contexts, and field reconnaissance methodology. Consultation will include the types of architectural resources that will be surveyed as part of Tasks 3 and 4.
		VTSHPO	See comments in 3.7.1.	
3.8.1	Evaluate the Impact of Current and Proposed Future Modes of Operation on Flow, Water Elevation and Hydropower Generation	NHDES	One of the objectives in our study request was to compare hourly discharge and water surface elevations at various locations in New Hampshire at current and proposed operating conditions to model results assuming instantaneous run-of-river at the Projects. Running the model assuming instantaneous run-of-river will help place bounds on the possible range of results and provide a relative idea of the sensitivity of the model. NHDES therefore requests that this scenario be run.	The study plan has been updated to conduct up to 15 production runs. If agreed to by the stakeholders then one of the Production Runs could be run of river
		CRWC	Task 5: Stakeholders and/or FERC asked for a full list of the other studies that will be informed by this study.	Adopted- changes made to RSP
			Task 6: No details are provided about how the results of model runs will be presented in a report.	Adopted- changes made to RSP
			During the meeting, it was noted that this study will not look at ramping rates because it relies on an hourly time step. Ramping rates at Northfield Mountain and Turners Falls have the potential to affect habitat, water quality, and recreation use. Will the flow study do that? We need to have a way to evaluate ramping rates.	Not Adopted- the operations model will not be used to evaluate ramping rates as it operates on a hourly time step. This time step is too long to evaluate ramping rates.

4.0 STUDIES NOT INCLUDED IN THE RSP

The following section describes the studies not included in FirstLight's RSP.

4.1 Geology and Soils

4.1.1 Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage Operations

The following groups requested the same study: FRCOG, CRWC, FCD, Town of Gill, and LCCLC. In addition, NHDES and VANR requested a similar study titled *Vernon and Turners Falls Hydroelectric Projects: Shoreline and downstream erosion from water level fluctuation in the impoundment and downstream from peaking operations in New Hampshire.*

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

Proponents state that the study objectives would be to: (1) calculate the total volume of eroded material, calculate resulting nutrient loading of eroded material, and document and describe the three dimensional changes to the bank, including lateral bank recession, changes to bank slope, and the presence and subsequent inundation of pre-project beaches and shoreline since the Turners Falls Dam was raised and the Northfield Mountain Project came on-line; (2) document and describe the changes to banks upstream and downstream of riverbank restoration projects, including bank recession; and (3) identify the changes that have occurred to bed substrate as a result of fine grain material being eroded from the banks and being deposited on the channel bed.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

FRCOG, CRWC, FCD, Town of Gill, and LCCLC are not resource agencies.

Public Interest Considerations (18 CFR § 5.9(b)(3))

Proponents state that fish and wildlife are important public resources and as such it is in the public interest to maintain high quality habitat for migratory diadromous fish. Further, the proponents indicate that eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls Impoundment, the bypass reach, and downstream of Turners Falls Dam reduced the quality of habitat for these species.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

Proponents note several existing studies, including those contained in the PAD relative to Turners Falls Impoundment erosion, including past FRRs, Field Geology Services' 2007 fluvial geomorphic assessment of the Turners Falls Impoundment, and the 2012 investigations conducted by Simons and Associates. The proponents note that historic aerial photography of the Turners Falls Impoundment from 1929 aerials should be gathered and analyzed.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

Proponents state that the construction of the Northfield Mountain Project was contingent upon the raising the Turners Falls Dam crest elevation by 5.9 feet which in turn has lead to water level fluctuations and increased boat activity. As a result, the proponents' state that erosion caused or contributed to the Northfield Mountain Project operation can negatively affect spawning, rearing and migratory habitat for trust species and the endangered shortnose sturgeon.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

Proponents' methodology includes:

1. Determine the net soil loss in cubic yards between 1970 and the present; a density estimate of the eroded material should also be provided. Provide an analysis of where the greatest loss has occurred, location of proximity to the tailrace, soil type, riparian land use, and vegetative cover in that area. Calculate nutrient loadings (nitrogen and phosphorus compounds) to the river system based on soil loss;

2. Obtain copies of the original survey plans for the project, and complete a new survey using the same landmarks used previously. Use pre-operation aerial photos and current aerial photos to complete a 10-foot topographic map of the section of river between Turners Falls Dam and Vernon Dam and the 200-foot buffer regulated under the Massachusetts Rivers Protection Act. Create a single map showing areas of erosion and deposition, and also overlay the Field report's hydraulic modeling analysis of the river channel;

3. With respect to the January 22, 2013 submittal from FirstLight to FERC regarding its long term monitoring transects in the Turners Fall impoundment, we ask that any data errors (as discussed in FGS, 2007) and problems that have occurred over the years at each site be mentioned. We also ask that an analysis for each cross section extending to the top of the bank and including a portion of the floodplain be provided;

4. Take the information presented in Figure 4.2.3-1 "Soils in the vicinity of Turners Falls and Northfield Mountain projects" in the PAD and convert from 63 categories to just a few that are defined in a key that will allow readers to understand which soils are easily erodible, which aren't, and where there is bedrock along the banks;

5. Complete detailed surficial mapping (topographic map or LIDAR) to identify the various geomorphic surfaces, height of benches/terraces above the river level, and types of sediments underlying the surfaces;

6. An analysis on the degree to which boat wakes increase that fluctuation range;

7. Determine erosion and riverbank failure process at identified sites;

8. Determine the effects of erosion on other resources; and

9. Develop a Shoreline Management Plan

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

Proponents' state: "*The level of effort to compile existing information and to make the data available in a map and searching for existing bed substrate material data should not take more than a few days. The level of effort for the bed sampling work will vary based upon how much historic information exists. Much of the effort of this study request is essentially office work that compiles and better presents existing data. While an estimate on the amount of field time required is difficult to make, we estimate that up to two weeks of field work could be required and some of the data collection could be done while other field studies are occurring*."

FirstLight's Rationale for Not Adopting the Proposed Studies

FirstLight does not see the need to conduct historical analysis of soil loss, erosion, nutrient loading, topography, or other geomorphic principles as requested for numerous reasons. First, as FirstLight has explained in many past FERC filings, rivers naturally migrate causing natural bank erosion, especially in the alluvial soils such as those flanking the Turners Falls Impoundment. Erosion could be caused by natural high flows, Project operations, boat wakes, upland management practices and other reasons. Thus, it is unclear why understanding the cubic yards of bank erosion in the impoundment is necessary. Second, in its *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria*, FERC reiterates that FERC uses current conditions as its baseline for evaluating project effects and alternatives and that this consists of the environment as it exists at the time of licensing.[79] FirstLight believes that the request is seeking a comparison to pre-raising-of-the-dam conditions. Finally, it is unclear how the requested data would inform potential PME measures. Additionally, FirstLight is not proposing to conduct topographic mapping or LiDAR along the 20-mile long Turners Falls Impoundment as existing topography is available from other sources and it is expensive. FirstLight will rely on the existing upland mapping obtained from USGS National Map Viewer- more specifically, the USGS 10 meter digital elevation model (DEM).

Relative to the long term monitoring transects as noted in a footnote in FGS, 2007: *FirstLight has independently reviewed the 21 cross sections and checked the over 400 individual data sets and determined that a small percentage of them are suspect and should not be used for analysis. Therefore, it appears the problem is not extensive and it is unlikely the results of the analysis will change. FirstLight is working to resolve the matter.* For future monitoring, the cross sections will be monumented to allow for repeated measurements and they will extend into the floodplain.

FirstLight is proposing in Study No. 3.1.2 *Northfield Mountain/Turners Falls Project Operations Impact on Existing Erosion and Potential Bank Instability* to: (1) develop soils maps as a GIS overlay for use in field investigations, reducing the soil groupings to common types- likely ten, to more easily identify easily erodible soils as requested; (2) evaluate surficial mapping in locations where active or recent streambank erosion is occurring. Fixed recoverable cross-sections will be taken only in the areas of erosion; (3) analyze soils (classification, structure, parent material, etc.) at each transect; (4) conduct an analysis of water level fluctuations; and (5) analyze field collected data on boat (July 12-13, 1997 and July 26-27, 2008). In addition, some information on the number of boats will be obtained as part of the recreation studies; however, FirstLight is not proposing to collect the level of detail sought in the study request.

In regard to the NHDES and VANR original study request, components of the objectives described in Task 7 and 8 are captured in Study No. 3.1.1 *2013 Full River Reconnaissance Study* and Study No. 3.1.2 *Northfield Mountain/Turners Falls Project Operations Impact on Existing Erosion and Potential Bank Instability* therefore FirstLight is not proposing to collect the level of detail sought in the study request. FirstLight is not proposing to develop a Shoreline Management Plan as requested in Task 9.

[79] *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria*, at p. 14 (Federal Energy Regulatory Commission, Office of Energy Projects, March, 2012)

4.1.2 Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River.

The following groups requested the same study: FRCOG, CRWC, FCD, Town of Gill, LCCLC, and NHFGD.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

Proponents state that the study objectives would be to: (1) assess hydraulic and sediment dynamics in the Connecticut River from Vernon Dam to Turners Falls Dam, the upper reservoir at Northfield Mountain, and downstream of the Turners Falls Dam; (2) identify management measures to minimize erosion and sedimentation; (3) determine areas of sediment deposition and beach formation in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas, recreational uses and effects on invasive species, if any. Habitat areas include but are not limited to coves (e.g. Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels; and (4) identify management measures to mitigate for substrate (habitat) impacts and recreational impacts in sediment-starved areas below the dam and sediment accumulation areas upstream of the dam.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

FRCOG, CRWC, FCD, Town of Gill, and LCCLC are not resource agencies.

In NHFGD's original letter they state that in order to meet the objectives of the federal Clean Water Act, MADEP adopted the Massachusetts Surface Water Quality Standards, 314 CMR 4.00. Additionally NHFGD notes, MADEP has designated the Connecticut River as a Class B river for its entire length in Massachusetts, 314 CMR 4.06(5). Class B rivers are assigned the designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation, 314 CMR 4.05(3)(b). Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The anti-degradation provisions of 314 CMR 4.04 require protection of all existing and designated uses of water bodies, and maintenance of the level of water quality needed to protect those uses.

Public Interest Considerations (18 CFR § 5.9(b)(3))

Proponents state that Connecticut River is a valued public resource and that the public has a strong interest in protecting the water quality of the river to maintain its status as a Class B river, as designated by MADEP, 314 CMR 4.06(5).

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

Proponents note that the PAD provides a summary of the work that has been done to characterize streambank conditions of the Turners Falls Impoundment, to understand the causes of erosion, and to identify the most appropriate approaches for bank stabilization. The entities also note the implementation of the *Sediment Management Plan* (revised February 15, 2012) and the *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (S&A, 1999).

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

Proponents state that current water level fluctuations in the Turners Falls Impoundment, combined with proposed increased flow at the Northfield Mountain Project, have resulted/will result in the discharge of large quantities of sediment. Additionally, the proponents assert that sediment from shoreline erosion and riverbank failure is one of the major contributors that negatively affect water quality and habitat by increasing the turbidity and sedimentation, smothering aquatic habitat.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

Proponents' methodology includes:

1. Implementing the Northfield Mountain Pumped Storage Project *Sedimentation Management Plan* over the full range of river flows and pumping/generating cycles. Develop a correlation over the full range of flow conditions between the overall suspended sediment transport through the entire cross section of the river compared to the continuous sampling at the single fixed location. Environmental Protection Agency approval of a Quality Assurance Project Plan is required for valid data acquisition;

2. Add one suspended sediment monitoring site downstream of the tailrace. If equipment continues to be problematic, explore other options. Provide data representative of tailrace discharge conditions and river conditions for two years;

3. Provide data on the daily water level fluctuation changes from the past five years from stations listed in the PAD, and estimate fluctuations within Turners Pool assuming proposed operations and hydraulic conditions;

4. Identify the most appropriate techniques for bank stabilization given the existing and proposed hydraulic conditions;

5. Use previous bathymetric data, if available (Field 2007 recommends putting additional effort into finding a bathymetric survey from 1913 that was partially shown in Reid 1990), and current bathymetric information to look at areas of sediment accumulation. Determine areas of sediment deposition in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas. Habitat areas include but are not limited to coves (e.g. Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas, and channels;

6. Identify recreational uses and impacts in areas known to be impacted by accumulated sediment, such as Barton Cove;

7. Identify invasive species (plant or animal) present in the reaches and determine if erosion and sedimentation in any way contributes to the establishment and/or proliferation of these species;

8. Investigate the formation of beaches using remote sensing, LiDAR at low pool levels or some other mapping technique to understand the processes of beach deposition the distribution of beaches in the pool, the impact of beach deposition on habitat and species, and how can this be related to operation of NMPS;

9. Evaluate management strategies to address the release of accumulated sediment through Northfield Mountain Project works during upper reservoir drawdown or dewatering activities. FirstLight should specifically evaluate the feasibility of the installation of a physical barrier across the bottom of the intake channel designed to prevent the migration of sediment during future drawdowns of the upper reservoir;

10. Evaluate management strategies to minimize flow fluctuations within Turners Pool including coordination with upstream users;

11. Evaluate management strategies to minimize sediment released through spillway gates and the log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities;

12. Identify a prioritized list of locations for bank stabilization projects in the Project Area;

13. Develop a map of land owned by FirstLight within 200 feet of the Connecticut River with an overlay of land use and vegetation cover. Provide land use options aimed at reducing bank erosion;

14. Any historic information of existing bed substrate material in the Turners Falls impoundment, bypass reach or downstream of the project should be collected and assembled. To the extent possible, the location of each sample should be made available on a map. The request for new data would stem from being able to make any valid comparison to changes in bed substrate at a given location, assuming the historic data exist;

15. Identify measures that could be taken to mitigate impacts to recreational use, habitat, or invasive species from sedimentation; and

16. Identify measures that could be taken to change or mitigate sediment starved reaches below the Turners Falls dam.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

Proponents' state: "*Many erosion studies have already been conducted and the cost of expanding the scope of some should be reasonable. A Full River Reconnaissance under the Erosion Control Plan for the Turners Falls Pool of the Connecticut River (Simons & Associates, Inc. dated June 15, 1999) is scheduled for 2013 and should accomplish many of the objectives listed above*."

FirstLight's Rationale for Not Adopting the Proposed Studies

The majority of the tasks outlined in the Proponents' methodology are included in other studies found in the RSP, including:

- Study No. 3.1.1 *2013 Full River Reconnaissance Study* (Tasks 4, 12, 13);
- Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impacts on Existing Erosion and Potential Bank Instability* (Tasks 3, 4, 8);
- Study No. 3.2.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach, and below Cabot Station* (Tasks 3, 10, 16);
- Study No. 3.3.13 *Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat* (Tasks 7, 15);
- Study No. 3.3.14 *Aquatic Habitat Mapping of Turners Falls Impoundment* (Tasks 7, 15);
- 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* (Tasks 7, 15);

- Study No. 3.4.1 *Baseline Study of Wildlife and Botanical Resources at Northfield Mountain Project Area, Turners Falls Impoundment, the Bypass Reach, and below Cabot Station* (Tasks 7, 15);
- Study No. 3.5.1 *Baseline Inventory of Wetland, Wildlife, and Botanical Resources in the Turners Falls Impoundment, Bypass Reach, and Below Cabot Station and Assessment of Operational Impacts* (Tasks 7, 15); and
- Study No. 3.6.6 *Assessment of Effects of Project Operations on Recreation and Land Use* (Task 6, 15)

Tasks 1, 2, and 9 of the Proponents' methodology are included in FirstLight's *Sediment Management Plan* (filed with FERC February 15, 2012). 2013 field activities are currently underway including continuous suspended sediment monitoring at the Route 10 Bridge, continuous suspended sediment monitoring of the intake and discharge lines at the Northfield Mountain Project, and suspended sediment data collection of the entire cross section of the river at the Route 10 Bridge over a range of flows during a one month period. At the end of the monitoring period (2015) FirstLight will propose measures to address the entrainment of sediment into the Project works during upper reservoir drawdown or dewatering activities.

FirstLight does not believe that it is necessary to install an additional suspended sediment monitoring device as requested in Task 2. Suspended sediment monitoring activities outlined in the *Sediment Management Plan* are more than adequate to provide the data requested above and have been approved by FERC, EPA and MADEP. Data collected at the Route 10 Bridge using the LISST-StreamSide, combined with the LISST-SL, will provide a detailed picture of suspended sediment in the mainstem Connecticut River. LISST-HYDRO devices located in the Northfield Mountain Plant are installed in-line to capture water withdrawn from the Northfield Mountain tailrace during pumping and transferred from the upper reservoir to the tailrace during generation. The combination of data collected at these locations will allow for a correlation to be made to determine what, if any, effects Northfield Mountain Project operations have on suspended sediment in the Connecticut River. In the *Sediment Management Plan* FirstLight proposes to continue sampling in 2013 and 2014, but may propose modifications to the sampling program based on sampling results.

FirstLight does not see the need to conduct historical comparisons of bathymetric data, or any geomorphic historical comparisons, for numerous reasons. First, as FirstLight has explained in many past FERC filings, rivers naturally migrate causing natural bank erosion, especially in the alluvial soils such as those flanking the Turners Falls Impoundment. Erosion could be caused by natural high flows, Project operations, boat wakes, upland management practices and other reasons. Therefore, sediment accumulation found throughout the Project area could be caused by several factors. Thus, it is unclear why understanding the historical changes in bathymetry, or other geomorphic processes, is required. Second, in its *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria*, FERC reiterates that FERC uses current conditions as its baseline for evaluating project effects and alternatives and that this consists of the environment as it exists at the time of licensing.[80] FirstLight believes that the request is seeking a comparison to pre-raising-of-the-dam conditions. Finally, it is unclear how the requested data would inform potential PME measures. Additionally, FirstLight is not proposing to conduct topographic mapping or LiDAR along the 20-mile long Turners Falls Impoundment as existing topography is available from other sources and it is expensive. FirstLight will rely on the

[80] *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria*, at p. 14 (Federal Energy Regulatory Commission, Office of Energy Projects, March, 2012)

existing upland mapping obtained from USGS National Map Viewer- more specifically, the USGS 10 meter digital elevation model (DEM).

FirstLight does not use the spillway gates or log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities as suggested in Task 10, therefore management strategies to minimize sediment release will not be evaluated.

In regard to Task 16, it is FirstLight's belief that due to a combination of factors including the bed substrate of the Bypass channel, flood flows, and other hydrologic/hydraulic considerations discussed in Study No. 3.2.2 that mitigation of sediment starved reaches below the Turners Falls Dam is not feasible. Stream power through the upper portion of the bypass reach where bedrock outcroppings are located during high flows is high enough to scour any sediment deposition that may occur.

4.2 Water Resources

4.2.1 Watershed Wide Stormwater Model

The CRJC requested a watershed-wide stormwater model of the entire Connecticut River Basin.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

CRJC lists the study's goals as (1) take a cumulative watershed approach to the management of surface water, a public trust resource; (2) determine the effect on public interests from projected future stormwater flows and the operation of the dams; and (3) recommend measures to manage stormwater flows through the operation of the dams to protect public interests. CRJC lists the study's objectives as (1) identify public interests in the watershed that have a nexus to dam operations; (2) develop an integrated, sharable, and scientifically-rigorous stormwater model for the entire watershed; (3) assess the cumulate effect of the dams on public interests, and (4) recommend license conditions to protect, preserve and enhance public interests.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

CRJC is not a resource agency.

Public Interest Considerations (18 CFR § 5.9(b)(3))

CRJC states that the public needs to know the effects the dams and their operations have on the natural and human environment, particularly in the future when CRJC believes precipitation is expected to be more extreme. CRJC also states that the public needs to know if and how the dams can be operated to benefit public interests in addition to hydropower. CRJC further states that the dams are the most significant factor in regulating stormwater flows in the Connecticut River.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

CRJC states that existing data on the location of resources of concern, while well intentioned, are too often incomplete or inaccurate. They state that since instream and riparian uses are closely tied to the frequency, depth and duration of the inundation by the river, stormwater information needs to be modeled and modernized, as precisely as possible, for accurate application.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

CRJC states that stormwater flows in the river effect nearly every resource under study, from providing whitewater recreational activities to sustaining floodplain biological communities. They state that the dams, in which they impound and then release the water, relies entirely on available stormwater.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

CRJC states that the proposed approach to analyzing water flows is the preferred methodology for forecasting, and evaluating environmental and economic outcomes based on various dam management scenarios. They state that this approach is being utilized in the Connecticut River Watershed Restoration Project that is being undertaken by TNC, USACE, UMass, and the USGS. CRJC states that this study is being performed to help determine how management of large mainstem and tributary dams and water systems can be modified for environmental benefits while maintaining beneficial human uses such as water supply, flood control and hydropower generation.

CRJC notes that use of LiDAR is the preferred methodology for preparing digital elevation models. They noted the use of LiDAR at various locations; however, further detail on the method(s) to evaluate stormwater flows is not provided.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

CRJC states that development of the proposed stormwater model using LiDAR data could cost $2,000,000 or more.

FirstLight's Rationale for Not Adopting the Proposed Studies

It is unclear from CRJC's study request if they are truly seeking a basin-wide stormwater runoff model as the proposed methodology does not provide enough detail. FirstLight believes that two other studies proposed herein will address the CRJC's study objectives and goals. Those studies, and how they would aid in addressing the CRJC's concerns, are listed below.

3.2.2 *Hydraulic Model of Turners Falls Impoundment, Bypass Reach and below Cabot Station*

FirstLight is proposing to develop two hydraulic models. A HEC-RAS hydraulic model of the Turners Falls Impoundment has already been developed. This model will predict the water surface profile of the Turners Falls Impoundment under a range of flows and starting downstream boundary conditions (in short, the water level at the Turners Falls Dam). This model was developed using bathymetric data collected in 2006. The second model will extend from Turners Falls Dam to the Holyoke Dam and will require use of the existing flood insurance study data for the communities along this reach of the river. The model will provide information on water surface elevations at different locations based for a range of flow conditions and project operations..

3.8.1 *Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation*

FirstLight is proposing to use an existing HEC-ResSim model of the Connecticut River basin that was originally developed by TNC, USACE, UMass and the USGS—the same model as cited by CRJC in their proposed methodology. This model will evaluate how current and alternative modes of operation can impact streamflow, water elevations and hydropower generation.

FERC's Study Request criteria require that the requester explain any nexus between project operations and effects on the resource to be studied, and how the study results would inform the development of license requirements 18 CFR § 5.9(b)(5). FERC's handbook "*A Guide To Understanding And Applying The Integrated Licensing Process Study Criteria*," issued March 2012, provides explanation on how FERC applies the study plan criteria in evaluating study requests. Per the guideline, relative to project nexus, it states the study request should clearly explain the connection between the project and its potential effect on the applicable resource. FirstLight does not see a nexus between the project and stormwater runoff, especially in the entire Connecticut River Basin. The only nexus between the project and the timing and magnitude of stormwater runoff the limited area of impervious surfaces associated with the project. CRJC's study request – a stormwater model of the entire Connecticut River Basin- has no nexus to the FirstLight hydropower facilities.

Also, per the guideline 18 CFR § 5.9(b)(6), under proposed methodology the requester is required to explain how any proposed study methodology is consistent with generally accepted practices in the scientific community. The guidance document further notes that the study methodology should be as detailed as possible. It was difficult for FirstLight to understand CRJC's proposed methods as it was detailed and intertwined operations modeling and stormwater modeling.

FirstLight believes that CRJC's request fails to meet FERC's nexus and methodology criteria. However, FirstLight believes that the combination of the hydraulic and operations models will address CRJC's concerns.

4.2.2 Climate Change and Continued Project Operations

The Town of Gill, LCCLC, MADFW, CRWC, NHDES, and the USFWS requested studies on climate change as it relates to continued operation of the projects.

<u>Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))</u>

The Proponents share the same study objectives: (1) quantify thermal loading contributed by each impoundment at each of the hydroelectric projects on the mainstem Connecticut River upstream through Wilder; (2) predict increases in temperature of the impoundments in the next 30-50 years due to climate change; (3) model the effect of various project modifications on river temperature under current conditions and climate change predictions; (4) use climate change prediction models to determine if the projects mitigate for generally warmer air and water temperatures by producing low greenhouse gas-emitting energy; and (5) determine how climate change will impact management of high flow events and whether changes to the dam structures would mitigate any adverse impacts of the existing project flood management protocols.

<u>Relevant Resource Management Goals (18 CFR § 5.9(b)(2))</u>

USFWS states that the proposed study would help it accomplish its general goals of: (1) ensuring that PME measures are commensurate with project effects in order to meet regional fish and wildlife objectives; and (2) conserve, protect, and enhance fish and wildlife habitat affected by the projects. With specific reference to climate change, USFWS states that its goals are to minimize: (1) current and potential negative effects of project operations; (2) deep headpond drawdowns associated with the loss of stanchion logs, which it anticipates will increase due to more frequent climate change induced high flow events; and (3) project-related thermal increases to Connecticut River water temperatures. USFWS and others have developed a National Fish, Wildlife and Plants Climate Adaptation Strategy (Adaptation Strategy) which includes, among other actions, reducing non-climate stressors in order to help fish and wildlife adapt to climate change.

MADFW's statement of resource management goals is identical to USFWS's statement. MADFW further states that the study will facilitate collection of information needed to conduct effects analyses and develop PME measures. The Massachusetts Executive Office of Energy and Environmental Affairs has published the Massachusetts Climate Change Adaptation Report which identifies various strategies to preserve, protect, and restore natural habitats and the hydrology of watersheds.

NHDES states that it is responsible for issuing water quality certifications in New Hampshire under the Clean Water Act and for establishing and administering surface water quality standards. Surface water quality standards include designated uses, which include aquatic life, fish consumption, drinking water, recreation, and wildlife. NHDES also establishes criteria to protect the designated uses and meet the anti-degradation requirement. NHDES states that its surface water criteria for Biological and Aquatic Community Integrity provide for surface waters to maintain a balanced, integrated, and adaptive community of organisms with species composition, diversity and functional organization comparable to similar natural habitats, and that climate change effects on flow and temperature may impact aquatic life and other uses.

<u>Public Interest Considerations (18 CFR § 5.9(b)(3))</u>

CRWC states that the public has a strong interest in protecting and enhancing the fish, wildlife, and plants that depend on the Connecticut River and associated wetlands, banks, and floodplain habitats, and that the study will enable the potential climate change induced effects on these resources and consider potential measures to minimize ecosystem degradation and enhance adaption to climate change.

LCCLC and Gill state that they support the USFWS's resource management goals.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

Proponents all include identical discussions of existing information. They state that the PADs for FirstLight's and TransCanada's projects contain no information relative to climate change and how climate change predictions may impact future operation of the projects, or how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

The proponents state that TransCanada's PAD includes data showing that water temperatures increase from the upstream end of the Wilder Project headpond to the Vernon Project tailrace, but do not link the data to climate change. They also state that TransCanada's project uses stanchion bays to relieve high water levels, but there is no information on how frequently the stanchions are removed or how climate change might affect the frequency and seasonality of removal, with potential impacts to resources in the project reservoirs.

The proponents provide data collected by the National Marine Fisheries Service that shows increasing air temperatures in the Northeast since 1900. They also provide analyses showing that mean water temperatures for the Vernon Dam impoundment increased between 1974 and 2010.

The proponents also reference the summary in the PAD of water quality data for the Turners Falls and Northfield Mountain Pumped Storage (NMPS) projects, and a 1991 study that showed a maximum temperature difference in the Turners Falls reach attributable to the NMPS project operation of 0.21 degrees Celsius.

Proponents' Explanation of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

The proponents state that the projects which dam the Connecticut River have created a series of long impoundments with slow water velocities that cause increased thermal loading and higher water surface temperatures than in free flowing sections of the river. They add that warmer surface waters may be discharged downstream and with a cumulative impact of elevated downstream temperatures. They add that climate change models of the Northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and increased incidence of short-term droughts. They indicate that effects include potential impacts to populations or loss of species not tolerant of warmer temperatures, citing potential impacts to American shad migration as an example. With regard to TransCanada's projects, the proponents state that deep drawdowns from removal of stanchions during high flow events could adversely affect reservoir resources, and that such drawdowns could occur more frequently in the future.

Proponents' Explanation of how Methodology is Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

The proponents state that the study would quantify the thermal loading contributed by each impoundment using data for bathymetry, storage capacity, hydrology, and project operations. The individual impoundment and cumulative surface water temperature predictions would be used to predict future warming based on climate change models.

The study would then consider different potential measures to mitigate the effects of project and climate-change based warming, such as converting projects to run-of-river, making deep-water releases, removing dams, conducting large-scale riparian revegetation, and possibly others.

The proposed study would also "input to climate change models the amount of [greenhouse gas emissions] that would be generated if fossil fuel plants were producing the equivalent amount of net energy as the five hydropower projects to determine the impact on air and surface water temperatures."

Climate change models would be used to predict whether the frequency and timing of high flow events is likely to change in the future. If the models predict that the frequency or timing of high-flow events necessitating the removal of stanchion bays will increase, then the proponents would have the Commission require the licensee to evaluate structural or operational alternatives to mitigate adverse impacts of existing flood management protocols.

Proponents' Description of Level of Effort and Cost, and Why Alternative Studies are Insufficient to Meet the Stated Information Needs (18 CFR § 5.9(b)(7))

USFWS does not include any information regarding level of effort and cost, or why alternative studies are insufficient to meet its stated information needs.

NHDES states that the cost of a thermal loading analysis would be low to moderate because bathymetry data for the Turners Falls Impoundment and Northfield Mountain upper reservoir already exist, and that the remaining work consists of loading data into an appropriate model and computing the estimated load, then comparing it to surface water data from climate change prediction models. It also states that the high flood protocol study should have a low to moderate cost because climate change models already exist. The comments of MDFW, CRWC, LCCLC and Town of Gill are identical to NHDES' comments.

FirstLight's Rationale for Not Adopting the Proposed Study

Although it is reasonable to conclude that the Connecticut River project impoundments affect water temperatures, and that regional air and water temperatures may be elevated in the future because of climate change, the proponents have failed to explain how their proposed study is consistent with accepted practice. While it is possible to estimate future water temperature conditions in the project impoundments with conventional hydrologic studies, monitoring techniques, and predictive models, the proponents have made no effort to explain how such water temperature data and predictions would be married with climate change models to accurately predict the combined effects of the projects and climate change on Connecticut River water temperatures over time. Indeed, they have not identified any climate change models that are sufficiently sensitive to accurately predict changes in the temperatures of individual rivers or the frequency or seasonal distribution of high flow events in the short-term, let alone for the 30-50 year period of a new license. In fact, they identify no specific models at all. The literature citations to the USFWS comments merely cite generally a 2009 report on global climate change impacts in the United States which includes a three page summary of potential impacts to the Northeast and the (now final) Adaptation Strategy. The proponents have also made no effort to show why conventional hydrologic studies, monitoring requirements, and reopener provisions that have been employed in hundreds of other hydroelectric license proceedings are not adequate to address potential impacts of climate change that, to the extent they occur, are likely to develop in an incremental manner over many years. In sum, the study proponents have asserted, but in no way shown, that their requested study is consistent with accepted practice.

The proponents' failure to articulate a detailed, credible study proposal for linking regional climate change to water temperature effects from the Connecticut River hydroelectric projects, individually or cumulatively, is not surprising. A July 2012 report by the Columbia Law School Center for Climate Change Law, *Consideration of Climate Change in Federal EISs, 1009-2011*, reviewed a database of 227 federal agency EISs that substantively address climate change related impacts. The report finds:

> While greenhouse gas emissions from projects are frequently addressed in EISs, the effects of climate change on the proposed projects are considered far less often. *Preparing agencies face considerable scientific uncertainty about the severity and exact nature of climate change impacts at the regional level, and projections are even more difficult at the local level.* EISs of briefly analyze the impacts of climate change on the region or locality in which the project is located without addressing the direct impacts of climate change on the project itself. (p. 8) (emphasis added)

With specific regard to USFWS EISs, the study found:

> USFWS EISs address the impacts of climate change on a project primarily as they relate to specific plant and animal species. EISs address the effects of climate change on the habitat, food resources and behavior of individual species, especially those federally listed as endangered or threatened. *Analysis of the impact of climate change on a project is often limited to a brief discussion of climate impacts on wildlife species or vegetation as a secondary or compounding impact*. These species are discussed primarily in terms of their vulnerability to non-climate related impacts from the project (such as habitat loss or noise), and climate change is mentioned as an additional factor that might increase the cumulative impact on the species. (footnote omitted) (p. 11) (emphasis added)

The Commission has recognized the inadequacy of current day computer modeling to develop information useful for development of specific license requirements in several recent cases. *See, e.g.*, Study Plan Determinations (SPD) for the Susitna-Watana Project No. 14241 (Feb. 1, 2013) at B-8 (rejecting agency requests for comprehensive study of climate change impacts on all resources in the river basin potentially affected by the proposed projects because the results would be too uncertain to rely upon for development of license conditions, the study would be very costly, and existing hydrologic studies and monitoring techniques are sufficient to develop license conditions). By order issued July 18, 2013, the Commission considered in details and denied requests for rehearing of the Director's order, *Alaska Energy Authority*, 144 FERC 61,040. *See also* Lake Powell Pipeline Project No. 12966 (Jan. 21, 2009) Appendix A at 1 at 14-16) (for proposed water supply project with hydroelectric component, accepting applicant's proposal to use literature review and existing US Bureau of Reclamation regional climate change model to estimate potential effects of climate change on Colorado River flows, but finding an absence of climate change models sufficiently finely tuned to make reservoir operation decisions); and Toledo Bend Project No. 2305 (August 6, 2009) Appendix A at 16-17 (finding no evidence of climate change assessment with the accuracy to predict specific resource impacts that could serve as the basis for developing license conditions; and determining that conventional hydrologic studies and monitoring techniques are adequate for the purpose).

In sum, the proponents have not provided any reason for the Commission to require FirstLight to develop a highly problematic study that it is unlikely to produce any information that would be useful for the development of license conditions, particularly when existing methods and approaches are sufficient to develop information that will enable the Commission, licensee, and resource agencies to develop timely, appropriate responses to climate change impacts.

4.3 Fish and Aquatic Resources

4.3.1 Shad Population Model for the Connecticut River

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

In their study request letters, USFWS, NHFG, MDFW, NHDES, CRWC, and TU request that FirstLight develop an American shad population model utilizing existing data to quantify how project operations and potential restoration/mitigation measures impact the Connecticut River shad population.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

Requesting agencies and TU identified Resource Management Goals for this study as defined by the *Management Plan for American Shad in the Connecticut River Basin* (1992). Specific management objectives in the plan include the following: achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually; achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem; and maximize outmigrant survival for juvenile and spent adult shad.

In addition, requests identify a number of broader resource PME goals under the overall relicensing process.

Public Interest Considerations (18 CFR § 5.9(b)(3))

USFWS is a federal resource agency. NHFG, MDFW and NHDES are state resource agencies. CRWC and TU are not public agencies.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

As described in the PAD, the annual number of adult shad passing into the impoundment below Turners Falls rose, with substantial year-to-year variation, until 1992 when numbers began to decline. This decline was not predicted by the predictive abundance model developed by Connecticut Department of Energy and Environmental Protection (CTDEEP). The decline has been noted in other Atlantic coast shad populations as well. Several factors may contribute to the recent decline in the Connecticut River American shad population. Factors include: 1) increased predation mortality, especially by striped bass (Savoy & Crecco, 2004); 2) competition by gizzard shad (Gephard & McMenemy, 2004); and/or 3) reduction of repeat spawners (Leggett et al., 2004). In 2012 the largest number of American shad were lifted at Holyoke Dam since 1992. While reports indicate that the American shad run on the St. John's River in 2012 was also higher than recent years, not all Atlantic coast river experienced similar increases.

Appendix G of the PAD identifies over 30 upstream and downstream fish passage studies that have been conducted at the Turners Falls Project going as far back as 1969 to as recently as 2010. FirstLight has worked diligently with agencies to evaluate effectiveness of fish passage facilities at the Turners Falls Project, including identification of potential improvements that FirstLight anticipates will be evaluated under the relicensing process, such as designs developed for a fish lift to replace the existing Cabot Fishway that were developed in consultation with representatives of CRASC.

Starting in 2008, biologists from the CAFRC have evaluated shad passage through the new Gatehouse Fishway entrance that was constructed in 2007. 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 iterative modifications 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 is 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. FirstLight continues to work with CAFRC and agencies to assess alternative to improve passage at the original entrance.

Historic upstream passage telemetry studies have shown that the Northfield tailrace had no clear effect on shad movement through the impoundment. Some shad turned back upon reaching the Northfield tailrace both during operational and non-operational periods. More recently, the USFWS Connecticut River Coordinator and CAFRC have released radiotagged 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.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

Existing project operations and fish ladder efficiencies have a direct effect on shad populations in the Connecticut River. Low upstream passage efficiencies and delays restrict river access to returning shad and can affect the ability of American shad to reach upstream spawning grounds while the ability to effectively pass downstream may affect outmigration and potential for repeat spawning.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

Population models are commonly used to assess anthropomorphic and natural impacts and are consistent with accepted practice. A model similar to this request was constructed for the Susquehanna River by Exelon (FERC #405, RSP 3.4). The model is constructed in Microsoft Access, and should be adaptable to allow the input of new data and other inputs. Proponents' listed a variety of model inputs.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

The Proponents' state: *"Neither First Light nor TransCanada have proposed any study to meet this need. Estimated cost for the study is expected to be low to moderate. As the model describes the impacts of multiple projects and two owners, both project owners would share the cost of model development."*

FirstLight's Rationale for Not Adopting the Proposed Studies

FirstLight is proposing a suite of upstream and downstream fish passage studies, an instream flow study in the Turners Falls bypass reach and downstream of the Turners Falls and Northfield Mountain Projects, and a desktop entrainment analysis for the Projects. Results of these studies, coupled with the vast number of previous American shad passage studies at the project facilities should be more than sufficient to assess fish passage needs and potential modifications to existing facilities necessary to achieve improved fish passage efficiency. Further, a predictive abundance model already exists which, while historically generating relatively accurate results, did not predict the downturn in returning shad numbers that likely result from difficult to predict variables such as competition and predation of other species. The study requests also include the ability for the model to analyze sensitivity of fish passage efficiencies at all Connecticut River Projects. While there may be a cumulative effect on the overall American shad population in the river, efficiency at a given upstream or downstream hydroelectric facility is independent of FirstLight's fish passage facility efficiencies.

It is unclear to FirstLight how output from the requested population model will contribute to FERC's analysis of project effects and potential PME measures as compared to results of existing and proposed fish passage effectiveness testing.

Literature Cited

Gephard, S. & J. McMenemy. (2004) An Overview of the Program to Restore Atlantic Salmon and Other Diadromous Fishes to the Connecticut River with Notes on the Current Status of these Species in the River. In P.M. Jacobson, D.A. Dixon, W.C. Leggett, B.C. Marcy, Jr. & R.R. Massengill (Eds.) The Connecticut River Ecological Study (1965-1973) revisited: ecology of the lower Connecticut River 1973-2003 (pp. 287-318). Bethesday, MD: American Fisheries Society, Monograph 9.

Leggett, W.C., Savoy, T.F., & Tomichek, C.A. (2004). The Impact of Enhancement Initiatives on the Structure and Dynamics of the Connecticut River Population of American Shad. American Fisheries Society. 16 pp.

Savoy, T.F. & V.A. Crecco. (2004). Factors Affecting the Recent Decline of Blueback Herring and American shad in the Connecticut River. In P.M. Jacobson, D.A. Dixon, W.C. Leggett, B.C. Marcy, Jr. and R.R. Massengill (Eds.) The Connecticut River Ecological Study (1965-1973) revisited: ecology of the lower Connecticut River 1973-2003 (pp. 361-378). Bethesda, Maryland: American Fisheries Society, Monograph 9.

4.4 Aesthetic Study

4.4.1 Noise Level Determination for Northfield Mountain Project Operations

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

The Proponent states that the goal of the study is to evaluate the current level of noise produced by the Northfield Mountain Project as heard by neighbors to the project, to determine if the proposed changes to the project increase the noise level, and to mitigate any present and future noise.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

This request was made by a private citizen, not a resource agency.

Public Interest Considerations (18 CFR § 5.9(b)(3))

The Proponent states that it is in the public's interest that this project and its expansion not negatively impact the quality of life for Northfield Mountain Project's neighbors. Noise negatively impacts quality of life.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

The Proponent does not identify any existing information pertaining to noise levels at the Northfield Mountain Project.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

The Proponent states that: *"Northfield Pump Storage Project runs pumps to move water to a holding reservoir, and turbines to harvest energy from the water. Both these operations involve large equipment that makes a lot of noise. This noise may be broadband, low frequency, or infrasonic pressure or vibration. Increasing the pump and/or turbine operation in frequency, size, or number could impact the amount of noise this equipment makes, so that it is more audible to neighbors. Noise might need to be mitigated e.g. via insulation, or prescribed combinations of equipment running, etc. to reduce noise impact on neighbors."*

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

Additionally the Proponent proposes a 2-part process:

- Part A (1 year): neighbors to the project record unexplained noises including what type of noise and when, compare these lists with operating records of the Northfield Mountain Project to see if correlation exists
- Part B (1 year): If correlation exists, further study would be needed using MADEP protocols. This could be done simultaneously with Part A to increase turn-around time, or left until afterwards on the change it would not be needed. It could also be the first step in the process if Part A was not considered necessary.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

The Proponent states that the cost of determining a baseline noise level and comparing any old/new noises with operating records is relatively low. The Proponent also states, if it is determined that the Northfield Mountain Project is making noise then the cost of measuring the noise level would possibly be in the tens of thousands of dollars. Finally, the Proponent states that mitigating the noise would likely cost several hundred thousand dollars.

FirstLight's Rationale for Not Adopting the Proposed Studies

Due to the location of plant infrastructure deep inside of a mountain, FirstLight does not believe noise levels related to Project operations are at a level outside of the plant that could negatively impact the quality of life of Project neighbors. FirstLight believes the mountain, which the plant is located inside of, acts as a natural insulator of noise. This belief has been confirmed by FirstLight personnel who work outside of the mountain and have not heard excessive noise levels during Project operations. There have been no other allegations of noise disturbance have previously been made since the plant went into service in 1972. Finally, even in the event noise levels were found to be audible to Project neighbors, PME measures would a) not be possible, or b) be far too expensive to be feasible.

Note that on June 28, 2013, FirstLight filed with FERC information concerning the request for the noise study. In this letter, FirstLight again stated that it does not believe there is any nexus between noises the study requesters have heard and operation of the Northfield Mountain Project. FirstLight submitted additional information; specifically: (1) communications between the United States Air Force and FirstLight concerning a study to measure surface vibration from the Project's underground pump generators; and (2) a memorandum to FirstLight from Douglas Leubner (Master of Science in Mechanical Engineering, MSME) who recently conducted vibration analyses for FirstLight in connection with a maintenance issue. The contents of those filings are not replicated herein; however, FirstLight believes these two documents support the conclusion that there is no evidence of any nexus between Project operations and noises that the study requesters, who live a very substantial distance from the deep underground pump generators, are hearing.

4.5 Recreation and Land Use

4.5.1 Contingent Valuation Study

New England Flow, American Whitewater, and The Appalachian Mountain Club (collectively referred to as FLOW) have requested that FirstLight conduct a contingent valuation study of providing paddling flows (e.g., for kayaking, canoeing, whitewater rafting, instructional paddling, and paddle-boarding) in the Turners Falls Project bypass reach.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

FLOW states that the goal of the requested study is to examine the regional economic benefits of various flow release alternatives in the Turners Falls Project bypass reach.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

FLOW is not a resource agency.

Public Interest Considerations (18 CFR § 5.9(b)(3))

FLOW states that the public interest is economic stimulus.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

FLOW states that it is unaware of any existing information regarding the economic potential of the Turners Falls Project bypass reach for paddling flows. It does, however, cite to a study of the economic impacts of whitewater boating on a river in Vermont.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

FLOW states that understanding the economic values that could be provided by flow releases in the Turners Falls bypass for paddling recreation will assist FERC and other stakeholders in balancing the trade-offs associated with lost generation.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

FLOW states that the only methodology that will assess the economic value of paddling flows in the Turners Falls bypass reach is through a contingent valuation study that measures an individual's willingness to pay. FLOW also states that contingent valuation studies provide reliable, comparable information that can be used to frame license requirements.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

FLOW states that data should be collected through surveys and interviews of known paddling clubs, customers of commercial whitewater outfitters, outfitters of tubing equipment and kayakers, canoeists, and rafters of varying abilities. FLOW fails to describe the level of effort or cost that such data collection would entail or the level of effort and cost that other elements of a contingent valuation study would entail.

<u>FirstLight's Rationale for Not Adopting the Proposed Studies</u>

FirstLight disagrees that there is a nexus to Project operation and effects. Contingent valuation studies do not produce a reliable assessment of the potential economic impact of adding recreational opportunity to an area. Further, FERC has consistently found that monetization of non-power resources is inadequate in the context of assessing non-power values under Sections 4(e) and 10(a)(1). The Commission has stated that "for non-power resources such as aquatic habitat, fish and wildlife, recreation, and cultural and aesthetic values, to name a few, the public interest cannot be evaluated adequately only by dollars and cents."[81] In a recent Study Plan Determination, FERC did not adopt a request for a proposed economic study of non-power resources. FERC stated that "[n]othing in the [Federal Power Act] requires the Commission to place a dollar value on non-power resources. Nor does the fact that because the Commission assigns dollar figures to the licensee's economic costs require that the Commission do the same for non-power resources."[82]

FirstLight is proposing to conduct several studies related to recreational use and demand at the Turners Falls Project, including a controlled whitewater flow evaluation in the Turners Falls Project bypass reach, an assessment of access needs for paddling in the Project vicinity, and assessments of use and demand. These studies along with studies regarding other assessments of power and non-power resources at the Turners Falls Project bypass reach will provide FERC with the information it needs to craft a new license for the Project that gives equal consideration to power and non-power values and is in the public interest.

FirstLight also disagrees with FLOW's assertion that the only methodology that will assess the economic value of paddling flows in the bypass reach is through a contingent valuation study. Contingent valuation studies are not generally accepted within the scientific community. It is well settled that contingent value surveys are expensive, subject to bias,[83] and even "[s]tudies conducted in controlled experimental settings suggest that . . . contingent valuation . . . methods may overestimate values[84] producing "implausible" results[85] that fail by trying to reduce FERC's public interest test to a mere mathematical exercise."

Finally, FERC's Study Request criteria require that the requester describe considerations of level of effort and cost. 18 CFR § 5.9(b)(7). FERC's handbook *"A Guide To Understanding And Applying The Integrated Licensing Process Study Criteria*," issued March 2012, provides explanation on how FERC applies the study plan criteria in evaluating study requests. With respect to the level of effort and cost

[81] *See e.g., Great Northern Paper, Inc.*, 85 FERC ¶ 61,316 (1998), *reconsideration denied*, 86 FERC ¶ 61,184 (1999), *aff'd*, *Conservation Law Foundation v. FERC*, 216 F.3d 41 (D.C. Cir. 2000) (nothing in the FPA requires the Commission to place a dollar value on nonpower benefits; nor does the fact that the Commission assigned dollar figures to the licensee's economic costs require it to do the same for nonpower benefits.); *City of Tacoma*, 84 FERC ¶ 61,107 (1998), *order on reh'g*, 86 FERC ¶ 61,311 (1999), *City of Tacoma v. FERC*, 460 F.3d 53 (D.C. Cir. 2006).. *See also*, *Namekegon Hydro Co.*, 12 FPC 203, 206 (1953), *aff'd*, *Namekegon Hydro Co. v. FPC*, 216 F.2d 509 (7th Cir. 1954) (when unique recreational or other environmental values are present such as here, the public interest cannot be evaluated adequately only by dollars and cents); and *Eugene Water & Electric Board*, 81 FERC ¶ 61,270 (1997), *aff'd*, *American Rivers v. FERC*, 187 F.3d 1007 (9th Cir. 1999) (rejecting request for economic valuation of environmental resources that were the subject of 10(j) recommendations).

[82] Office of Energy Projects, Federal Energy Regulatory Commission, *Study Plan Determination for the Susitna-Watana Hydroelectric Project (Project No. 14241)*, February 1, 2013.

[83] Peter A. Diamond, and Jerry A. Hausman, *Contingent Valuation: Is Some Number Better Than No Number?*, Journal of Economic Perspectives, Volume 8, Number 4, Fall 1994, pp 45-64 at 45,46.

[84] National Research Council, Committee on Assessing and Valuing Aquatic and Related Terrestrial Ecosystems, *Valuing Ecosystem Services, Toward Better Environmental Decision-Making*, 2004, at 122.

[85] Kenneth Arrow et alia, *Report of the NOAA Panel on Contingent Valuation*, 1993, at 12, 13.

criteria, FERC explains that to estimate the level of effort and cost, a study proponent should, at a minimum, estimate the number of hours or person-days that would be required to conduct the requested study and identifiable tasks (e.g., report preparation). FERC states that the information gained under this criterion is also useful in weighing the costs and benefits of different methods for obtaining the needed information. While FERC may not reject a study based on cost alone, information on cost and level of effort is necessary for FERC to determine whether the requested information is in line with the magnitude of the potential effect of the Project on particular resources.

The proposed study does not meet this criterion. While FLOW states that data should be collected through surveys and interviews of known paddling clubs, customers of commercial whitewater outfitters, outfitters of tubing equipment and kayakers, canoeists, and rafters of varying abilities they fail to describe the level of effort or cost that such data collection would entail or the level of effort and cost that other elements of a contingent valuation study would entail.

In sum, FirstLight has not included FLOW's proposed study in its RSP because the proposed contingent valuation study will not inform the development of license requirements, is not accepted within the scientific community, and does not describe considerations of level of effort and cost.

4.5.2 Mitigation Impacts of the Connecticut River and Loss of Whitewater Recreation at and above Turners Falls Dam

New England Flow, American Whitewater, and The Appalachian Mountain Club (collectively referred to as FLOW) have requested that FirstLight conduct a study to assess regional whitewater boating resources in order to determine off-site mitigation.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

FLOW states that the goal of the study is to assess the presence, quality, access needs, flow information needs, and preferred flow regimes for regional whitewater boating resources that would mitigate for the loss of whitewater recreation at the Turners Falls Dam.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

FLOW is not a resource agency.

Public Interest Considerations (18 CFR § 5.9(b)(3))

FLOW states that the Turners Falls dam removes the public's opportunity to enjoy a whitewater boating resource and that conducting studies and implementing necessary measures to ensure the public has access to whitewater recreational resources is in the public interest.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

FLOW states that current and historic project operations at the Turners Falls Dam do not provide meaningful information for determining off-site mitigation.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

FLOW states that the construction of the Turners Falls Dam dewatered the Turners Falls bypass reach and the creation of the Turners Falls Impoundment "drowned upstream rapids, which would be sufficient cause for off-site mitigation."

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

FLOW proposes the following "process" steps: desktop analyses of candidate rivers, resource agency identification and feasibility assessment, and inter-agency meetings with stakeholders to explore opportunities for mitigation.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

FLOW states that it is willing to work with FirstLight on an off-site mitigation study to keep costs reasonable and the quality of information high. FLOW has also proposed that FirstLight conduct a controlled-flow whitewater boating study.

<u>FirstLight's Rationale for Not Adopting the Proposed Studies</u>

FLOW's study proposal is in essence a request to explore off-site mitigation opportunities to compensate for alleged impacts caused by initial Project construction. FERC's analysis, however in a relicensing proceeding is based on existing conditions.[86] FERC's environmental review focuses on the fact that the Project already exists and is part of the existing environment.[87] In its *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria,* FERC reiterates that FERC uses current conditions as its baseline for evaluating project effects and alternatives and that this consists of the environment as it exists at the time of licensing.[88] The results of the proposed mitigation study would not inform the development of license requirements to address effects, if any, of Turners Falls Project operation on whitewater boating.

FirstLight agrees that a controlled-flow whitewater boating and paddling study may have a nexus to the current operation of the Turners Falls Project and has included this study proposal in the RSP (Study No. 3.6.3). FirstLight's proposed study will evaluate the effects of Turners Falls operation on the availability of whitewater and other recreational boating in the Turners Falls bypass reach. FirstLight, however, has not included the proposed mitigation study in the RSP because it is not a study designed to evaluate the effects of current Project operation on recreational boating.

Similarly, FLOW's proposed study does not describe a study methodology, but instead a process for identifying off-site mitigation measures. Finally, FLOW fails to explain why its proposed whitewater boating study will not suffice at evaluating the effects, if any, of Turners Falls Project operation on the availability of whitewater boating in the Turners Falls bypass reach.

In sum, FirstLight has not included the proposed request to assess regional whitewater boating resources in order to determine off-site mitigation in the RSP because (1) it is not a study request but a proposal to investigate potential PMEs, (2) it is based on an assumption of pre-project conditions and thus there is no nexus to Project operation, and (3) fails to describe methodology, and level of effort and cost.

[86] *City of Tacoma,* 107 FERC ¶ 61,288, at 62,095 (June 21, 2004).
[87] *City of Tacoma*, 67 FERC ¶ 61,152, at 61,443-44 (1994).
[88] *Guide to Understanding and Applying the Integrated Licensing Process Study Criteria*, at p. 14 (Federal Energy Regulatory Commission, Office of Energy Projects, March, 2012)

4.6 Cultural Resources

4.6.1 Assess Preservation of Cultural, Historical and Educational Resources

Appalachian Mountain Club, Vermont River Conservancy, and Friends of the Connecticut River Paddlers' Trail (collectively referred to as "AMC"), have requested a study regarding public education of the area's cultural resources and preservation of historical documents. The National Park Service and the Nolumbeka Project requested a similar study. Because the Nolumbeka Project's request does not meet FERC's study plan criteria, however, FirstLight has addressed the request in the comment matrix in Table 1.0-1. NPS's study request partially meets FERC's study plan criteria.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

AMC/NPS states that the goal of the study is to determine what actions should be taken to educate the public about an historical site that lies under the Turners Falls Impoundment, to determine what actions should (or should not) be taken to preserve artifacts, and to identify, preserve, and make available historical engineering drawings for the Projects to historians and researchers.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

AMC is not a resource agency. NPS is resource agency within the Department of Interior. NPS states that DOI has recognized the importance of the Connecticut River by designating at as the nation's first National Blueway on May 24, 2012.

Public Interest Considerations (18 CFR § 5.9(b)(3))

AMC/NPS states that historical records and education are valuable public resources.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

AMC/NPS states that there are many history books addressing the 1676 battle at Turners Falls and the King Phillip's War. AMC also cites two books regarding the engineering history of the Turners Falls site.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

AMC/NPS states that the Turners Falls Impoundment covers the site of the 1676 battle and probably artifacts. AMC/NPS also states that there may be Indian artifacts or burial grounds on the Turners Falls Project lands. AMC/NPS states that presumably FirstLight has in its possession historical records relating to the construction of the Turners Falls dam.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

AMC/NPS does not recommend a methodology other than to suggest that study methodology with respect to Native American use of the areas should be left to the Tribes, and to regional professional historians and others. AMC/NPS also notes the identity of a local organization with expertise in historical preservation and museum preservation.

Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))

AMC/NPS does not describe level of effort and cost other than to state that there are academics and museum personnel who could do this study and make recommendations.

FirstLight's Rationale for Not Adopting the Proposed Studies

To the extent that AMC/NPS's request is to study or provide mitigation, protection, and enhancement for impacts resulting from original construction of the Turners Falls dam, as discussed previously in Section 4.5.2 of the RSP, such an approach would be inconsistent with FERC's environmental baseline, which looks at the impact of current Project operation and thus would not inform the development of conditions for a new license for the Turners Falls Project.

AMC/NPS's request is not a request for a study, but a request for PME. FirstLight is proposing to conduct a Phase 1A archaeological survey and a reconnaissance level historic structures survey for both the Turners Falls and Northfield Mountain Projects. See Study Nos. 3.7.1 and 3.7.2. The results of those surveys will inform the need for more intensive archaeological and historic structures surveys. FirstLight is also proposing to conduct a traditional cultural properties study. See Study No. 3.7.3. At the conclusion of cultural resources surveys, depending on survey results, FirstLight may prepare draft and final HPMPs, which will propose protection and mitigation measures for adverse effects, if any, to historic properties that are caused by the continued operation of the Project. It is premature to determine which measures, including education and preservation measures, should be included in the draft or final HPMP.

In sum, FirstLight has not included the proposed request for an assessment of cultural, historical and educational resources in the RSP because (1) it is not a study request but a proposal for PMEs, (2) to the extent it requests an assessment of pre-project conditions, there is no nexus to Project operation, and (3) fails to describe methodology, and level of effort and cost.

4.7 Other Project Relative Issues

4.7.1 Feasibility of Converting the Northfield Mountain Pumped Storage Project to a Closed-Loop or Partially Closed Loop System

The Town of Gill, LCCLC, FRCOG, FCD, and CRWC requested studies on the feasibility of converting the Northfield Mountain Pumped Storage Project into a closed-loop or partially closed-loop system.

Proponents' Description of Study Goals and Objectives (18 CFR § 5.9(b)(1))

Proponents state that the objectives of the study would be to determine: (1) candidate locations for placement of a lower reservoir; (2) costs and logistics of construction and modification of the current facility to convert to a closed-loop or partially closed-loop system; (3) projected savings associated with eliminating need for ongoing mitigation measures, both for stabilizing river banks as well as likely modification to operations that the facility will be required to implement in order to protect habitat and native fauna; and (4) other ancillary costs or savings, such as eliminating requested studies, operational changes, or mitigation measures.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

The Town of Gill, LCCLC, FRCOG, FCD, and CRWC are not resource agencies.

Public Interest Considerations (18 CFR § 5.9(b)(3))

Proponents state that it is in the public interest to ensure high quality habitat for migratory diadromous fish, and the Northfield Mountain project reduces the quality of habitat for these species through increased turbidity and deposition of fine-grained sediments and that the likelihood of entrainment and entrainment mortality.

Proponents' Description of Existing Information (18 CFR § 5.9(b)(4))

Proponents state that data on the environmental effects of the Northfield Mountain project and other facilities that use fresh or salt water for generation and/or cooling are widely available, citing data submitted in the PAD and the required conversion of a coal powered plant from open to closed cycle operation.

Proponents' Description of Nexus to Project Operation and Effects (18 CFR § 5.9(b)(5))

Proponents state that converting the Northfield Mountain project to a closed loop facility would eliminate environmental effects on fisheries, water quality, and erosion of farmland.

Proponents' Explanation of How Methodology Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

Proponents' methodology includes: (1) collate existing geological and hydrologic information of areas surrounding Northfield Mountain, including preliminary design plans for suitable facilities able to accommodate the existing and proposed discharges; (2) provide an engineering analysis of structural modifications necessary to accommodate a full or partial lower reservoir in an alternate nearby location; (3) provide information on whether and how a smaller lower reservoir would act as a buffer to river level fluctuations and change the hydrologic pattern of flow on the Connecticut River, the water quality effects, and decrease the possibility of entrainment; (4) provide an analysis on water losses from evaporation and leakage and how much make-up water would be needed during normal operations by season or month; (5) identify and make available any similar studies conducted during the planning phase of the existing facility in the 1960s or any other time; (6) provide a cost estimate of each option considered and evaluated; and (7) provide an itemized cost estimate of how halting use of the Connecticut River as a lower reservoir would affect other costs, such as eliminating the erosion control program, any ancillary changes to generation at the projects, and fish protection measures.

Proponents state that the study methods are consistent with accepted practice for weighing costs and benefits of environmental impacts.

<u>Proponents' Statement Regarding Level of Effort, Cost, and Why Alternative Studies Will Not Suffice (18 CFR § 5.9(b)(7))</u>

Proponents' state: "The level of effort to compile existing information and to make the data available in a map should be low, as should development of contingency scenarios. Development of contingency scenarios would be low. The majority of the effort of this study request is essentially office work with some engineering and design work required to scope likely costs of various scenarios."

<u>FirstLight's Rationale for Not Adopting the Proposed Studies</u>

The proponents' suggestion that a useful study could be accomplished at low cost with "some engineering and design work" demonstrates a profound lack of understanding of the study costs involved in any major new or modified ground disturbing project. Any study of converting the Northfield Mountain facility to a closed-loop system with a new lower reservoir would essentially require a comprehensive analysis comparable to that required for development of a license application for a major new project or major license amendment. It would necessarily include a comprehensive review of existing geological and hydrologic information and new site-specific geologic investigations of any places where the new lower reservoir and associated project facilities (e.g., new forebay, tunnels, penstocks, and powerhouse), detailed engineering feasibility and costs analyses of potential lower reservoir alternative sites, project facilities, and reconfiguration of the upper reservoir to operate in connection with the new reservoir and facilities, and studies and analyses of environmental effects in any area where a new lower reservoir would be located. The site investigations from the 1960s would be next to, if not entirely, useless for these purposes.

Moreover, the Commission has recently stated that while the Federal Power Act authorizes it to require modifications to an applicant's proposal to ensure that the project is best adapted to a comprehensive plan for developing or improving a waterway, the Commission does not believe it has authority to require a license applicant to construct and operate an entirely different project from the one it has proposed. *See Erie Boulevard Hydropower, L.P.*, 120 FERC ¶ 61,267 at P 97 (2007). That would certainly be the case here.

CRWC summary disagrees with FirstLight's characterization of the scope and scale of the proposed study and adds that there are environmental and monetary costs associated with operation of the Project as currently licensed. These factors, however, will be addressed as appropriate in the comprehensive RSP and the Commission's review of FirstLight's new license application. Nor has CWRC contested the Commission's position regarding the scope of its licensing authority.

4.7.2 Creation of a Decommissioning Fund

The NPS and, jointly, the AMC, Vermont Resources Conservancy (VRC), and Friends of the Connecticut River Paddlers Trails (FCRPT) (collectively, the study proponents) have requested studies related to decommissioning of the licensed projects. NPS seeks a study of the "financial production" of each project, which would be used in the Commission's public interest analysis to evaluate a requirement for the licensee to have a decommissioning fund for each project. AMC, VRC, and FCRPT seek a study to "determine the appropriate decommissioning costs at the end of the project's lifetime and how such costs should be funded….in advance."

Proponents' Descriptions of Study Goals and Objectives (18 CFR § 5.9(b)(1))

The study proponents state that the goal of their proposed studies is the establishment of a decommissioning fund, so that the public will not be burdened by the cost of decommissioning the projects.

Relevant Resource Management Goals (18 CFR § 5.9(b)(2))

NPS is a federal resource agency. NPS states generally that its management goals with respect to the Connecticut River watershed are to promote a "water-based approach to conservation, outdoor recreation, education, and sustainable economic opportunities" and to "establish community-driven conservation and recreation for the 21st century."

Public Interest Considerations (18 CFR § 5.9(b)(3))

AMC, VRC, and FCRPT are not resource agencies. They state that the requested study is in the public interest because the project might one day be abandoned and the public might be required to bear the costs of remediating the site(s).

Proponents' Description of Existing Information and Need for Additional Information (18 CFR § 5.9(b)(4))

The study proponents allege that there are thousands of abandoned dams on New England waterways. They add that the physical and financial viability of the projects is at risk from various factors, such as extraordinary storms, foreign ownership, and international currency market fluctuations. NPS contends that decommissioning funds are commonly required for federally licensed facilities.

AMC, VRC, and FCRPT state that there appears to be no published information on the economic viability of the projects, which they believe is needed in order to establish their proposed decommissioning funds. NPS says essentially the same thing.

Proponents Description of Nexus Between Project Operation and Effects on Resources (18 CFR § 5.9(b)(5))

The study proponents state that there is a direct nexus between Project operations and the economic viability of the projects.

Proponents Explanation of How Methodology is Consistent with Accepted Practice (18 CFR § 5.9(b)(6))

The study proponents state that the financial viability portion of the study would follow "normal procedures" in accounting and financial management.

Proponents' Description of Level of Effort and cost, and Why Alternative Studies are Insufficient to Meet the Stated Information Needs (18 CFR § 5.9(b)(7).

The proponents state that the study would be "relatively inexpensive" and that they are not aware of any means other than decommissioning funds to protect the public.

FirstLight's Rationale for Not Adopting the Proposed Studies

The proposed studies are not appropriate because the Commission has consistently denied requests for the establishment of decommissioning funds in new licenses. The Commission has found that such funds "unnecessarily tie[] up substantial amounts of the capital of financially sound licensees . . . . for extensive periods." Project Decommissioning at Relicensing; Policy Statement, FERC Stats. and Regs.¶ 31,011 at p. 31,234 (1995). Also, the Commission has not required a decommissioning fund where: (1) there is no evidence the project is economically or physically unsound; (2) no party has suggested decommissioning in the foreseeable future; (3) there is no evidence indicating that the physical life of the project will end during the term of the new license; or (4) there is no indication that the licensee would lack the financial resources to decommission the project if it were to be decommissioned. *See, e.g., Wis. Valley Improvement Co.*, 80 FERC ¶ 61,054 at p. 61,164 (1997); *N. States Power Co.-Wisconsin*, 78 FERC ¶ 61,120 at p. 61,460 (1997); *N. States Power Co.*, 78 FERC ¶ 61,363 at p. 62,511 (1997); *Wolverine Power Supply Coop., Inc.*, 85 FERC ¶ 61,030 at p. 61,090-91 (1998); *Potlatch Corp.*, 72 FERC ¶ 61,029 at p. 61,173 (1995). All these factors are present here. The Commission's policy has been found to be reasonable on judicial review. *See Kelley v. FERC*, 96 F.3d 1482, 1490 (D.C. Cir. 1996). Since there is no reason to impose the requested license condition, there is no reason to require the proposed studies.

In addition, the study requests are flawed because:

- The proponents' suggestion that extreme weather events put the licensed projects at risk has no support. The proponents have made no effort to explain how the existence of abandoned dams in New England, the vast majority of which are on small rivers or streams, and which were built as often as two hundred years ago using long since outdated construction methods, bear any relation to Commission-licensed projects, which are subject to perhaps the most rigorous dam safety requirements in the world.
- The useful physical and economic life of the projects cannot be determined. The Turners Falls project has been operating continuously for decades and there is no indication it cannot continue to be operated indefinitely. Similarly, all of the 17 pumped storage projects licensed by the Commission since 1958 and constructed are still operating and there is no reason to think any of them is approaching the end of its physical or economic life. Northfield Mountain is no different.
- The proponents' unsupported assertions notwithstanding, there are no "normal procedures" for estimating the potential cost of hypothetical decommissioning at an uncertain future time which could be far beyond the life of the next licenses, or even the next licenses after those. Any number of decommissioning scenarios that might be considered, and it is impossible to know with any certainty in advance which scenario would be adopted, let alone what engineering or environmental reviews would be appropriate, or the distant future legal and regulatory landscape.

Finally, NPS has made no effort to explain how the proposed study relates to its generally stated goals of promoting conservation and recreation. Rather, it merely cites the hypothetical future default which the Commission, with judicial approval, has stated is insufficient to require a decommissioning fund.