Before the Federal Energy Regulatory Commission

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

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

FirstLight

VOLUME II OF V (PUBLIC), PART 1 OF 4

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

DECEMBER 2020

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EXHIBIT E – ENVIRONMENTAL REPORT

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EXHIBIT E – ENVIRONMENTAL REPORT

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(5) Proposed action and action alternatives.

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

For each resource area addressed include:

(A) A discussion of the affected environment;

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

(C) Any unavoidable adverse impacts.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1 INTRODUCTION

1.1 Application for a New License

FirstLight MA Hydro LLC is the owner of the Turners Falls Hydroelectric Project (Turners Falls Project, FERC No. 1889). Northfield Mountain LLC is the owner of the Northfield Mountain Pumped Storage Project (Northfield Mountain Project, FERC No. 2485). Throughout Exhibit E of this license application these two entities are collectively referred to as FirstLight. Throughout Exhibit E of this license application the Turners Falls Project and Northfield Mountain Project are collectively referred to as the Project. FirstLight is filing with the Federal Energy Regulatory Commission (FERC or Commission) a combined Exhibit E for the Project, while separate Exhibits A-D, F-H are being filed for the Turners Falls Project and Northfield Mountain Project.

FirstLight, in accordance with Sections (§§) 5.17 and 5.18 of Title 18 of the Code of Federal Regulations (CFR), is filing with FERC separate Applications for New License for Major Project- Existing Dam. The current license for the Turners Falls Project was issued on May 5, 1980 and expired on April 30, 2018. The current license for the Northfield Mountain Project was issued on May 14, 1968 and also expired on April 30, 2018. FirstLight is currently operating the Turners Falls Project and Northfield Mountain Project under annual licenses.

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

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

The power canal is approximately 2.1 miles long and has a design capacity of approximately 18,000 cfs. Several entities withdraw water from the power canal. The major ones are FirstLight’s Station No. 1 and Cabot Station. Station No. 1 is located closer to the beginning of the power canal and Cabot Station is located at the downstream terminus of the power canal. The generation and hydraulic capacity of Station No. 1 are 5,693 kW and 2,210 cfs, respectively. The generation and hydraulic capacity of Cabot Station are 62.016 MW and 13,728 cfs, respectively.

The Turners Falls Project is equipped with three upstream fish passage facilities, including (in order from downstream to upstream): the Cabot fishway, the Spillway fishway, and the gatehouse fishway. The Cabot fishway moves migrating fish from the Connecticut River into the power canal. The Spillway fishway moves migrating fish from the Connecticut River into a gallery leading to the gatehouse fishway, where they rejoin fish that have passed to this point via the Cabot fishway; however, some fish do drop out into the power canal. The gatehouse fishway moves fish from the power canal to above the Turners Falls Dam. A downstream fish passage facility is located at Cabot Station, at the downstream terminus of the power canal. Assuming no water is being spilled at the Turners Falls Dam, fish moving downstream pass through the gatehouse (which has no racks) and into the power canal.

The TFI extends approximately 20 miles upstream to just below the Vernon Hydroelectric Project (FERC No. 1904), which is owned and operated by Great River Hydro (GRH). To provide storage capacity for the

Northfield Mountain Project, the TFI elevation may vary, per the FERC license, from a minimum elevation[1] of 176.0 feet to a maximum elevation of 185.0 feet constituting a 9-foot range as measured at the Turners Falls Dam. The usable storage capacity in this 9-foot range, as measured at the Turners Falls Dam, is approximately 16,150 acre-feet.

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

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

1.2 Purpose of Action and Need for Power

1.2.1 Purpose of Action

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

Issuing new licenses for the Turners Falls Project and Northfield Mountain Project would allow FirstLight to continue to generate electricity at each facility over the term of the new license, making electric power from a renewable resource available to serve regional demand. As discussed in Section 1.2.2 below, the Northfield Mountain Project will support intermittent renewable resources such as wind and solar by using power to pump during periods of excess supply from wind/solar and generating during periods when power from wind/solar decline and replace generation from carbon emitting resources.

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

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

1.2.2 Need for Power

The Turners Falls Project and Northfield Mountain Project are located within the Independent System Operator-New England (ISO-NE) power system, which is responsible for dispatch and movement of wholesale power in CT, ME, MA, NH, RI and VT. ISO-NE is an independent, non-profit, Regional Transmission Organization, responsible for reliably operating New England's approximately 32,000 MW bulk electric power generation and transmission system. New England's electric power generation fleet is undergoing a rapid transformation as states take legislative and regulatory actions to restrict the use of fossil fuels and move to carbon free, intermittent resources of solar and wind for the electric supply. Fast ramping resources such as the Northfield Mountain Project and Cabot Station will be increasingly important to ISO-NE as it will need to manage system reliability when the instantaneous supply from solar and wind changes throughout each day. Also, Cabot Station's fast ramping capability will allow ISO-NE to use a carbon free resource instead of needing to start fast-starting internal combustion engines that burn either natural gas or oil. It is also envisioned that as the solar and wind fleets expand there will be times when those resources might need to be curtailed to balance supply with electric demand. In those instances, the Northfield Mountain Project will be able to pump using the excess renewable energy and store it so that it can be used at other times instead of fossil fuel based generation. Therefore, both the Northfield Mountain Project and Cabot Station will play important roles in helping the New England states meet their carbon reduction goals.

Turners Falls

The Turners Falls Project is operated to meet peak demand (when flows are less than the hydraulic capacity of the project), voltage control, and reserve capacity facility within the regional electrical system. The Turners Falls Project consists of Cabot Station and Station No. 1 having a total electrical capacity of 67.709 MW and an average annual generation of 331,764 MWh of carbon free energy (based on period 2011-2019).

The 62.016 MW Cabot Station is the largest carbon-free hydroelectric project in Massachusetts (MA) and one of the largest in New England, which is an essential component in helping the region meet its greenhouse gas reduction goals. The 331,764 MWh/year of renewable carbon free energy is enough to power 35,000 homes while preventing 160,000 tons of CO_2 from being released if that electricity demand was served by even the most efficient natural gas generator.

Unlike many other forms of carbon free generation which are available only when the wind is blowing and the sun is shining, the Turners Falls Project can provide carbon free generation when ISO-NE needs to respond to an unplanned breakdown of another generation resource. Without the ability to call on Cabot Station's and Station No. 1's hydroelectric output on short notice, ISO-NE could need to start quick-start combustion turbines, burning either natural gas or oil, to replace other generation sources or to maintain reliability when customer demand rises quickly. Additionally, as more solar resources are added to New England's generation mix, ISO-NE will need to use fast ramping resources, like Cabot Station and Station No. 1, to serve load as the sun begins to set and solar generation diminishes rapidly. This phenomenon is referred to as the "duck curve" and is already evident in areas such as California which has large amounts of solar generation. Substantial wind generation is also projected to be added to the generation mix, which also is intermittent in nature, further increasing the demand for fast ramping resources.

Northfield Mountain

The Northfield Mountain Project is vitally important to the reliability and efficient operation of the New England electric grid. With the Upper Reservoir at its current maximum elevation of 1000.5 ft, it can operate at full generating capacity output from its four (4) generating units for approximately 8.5 hours and produce 8,729[2] MWh of power. The Northfield Mountain Project has a total electrical capacity of 1,166.80 MW and

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[2] This number was historically published as 8,475 MWH, but with the completion of efficiency improvement work on all four units, the new value is 8,729 MWH between elevations 1000.5 and 938 feet and 10,779 MWH between elevations 1004.5 and 920 feet.

an average annual generation of 890,049 MWh (based on period 2011-2019). During high electrical demand periods, the Northfield Mountain Project is called upon by ISO-NE to meet electrical demands, including significant short term (hour-to-hour) demands, or held for quick start contingency response as needed to meet the circumstances.

During many periods of the year, ISO-NE calls upon the Northfield Mountain Project to balance the system to accommodate both changes in load and generation. Since 2001, FirstLight has obtained six (6) temporary amendments from FERC to utilize additional Upper Reservoir storage that the Northfield Mountain Project was designed to provide during ISO-NE declared emergencies. During these times, possessing reliable energy supplies and significant operating flexibility at the Northfield Mountain Project to address both load and supply changes (e.g. changing interchange schedules, accommodating block loading of other units' commitment and decommitment) is critical to ISO-NE's reliable operation of the power system. The Northfield Mountain Project provides critical energy, operating reserves and operational flexibility to ISO-NE system operation.

The value of the Northfield Mountain Project was demonstrated following the August 14, 2003 major blackout in the New York ISO (NY-ISO) grid. On August 15, ISO-NE disconnected all electrical ties to the New York electrical system to prevent the blackout from spreading further. When it was time to rejoin the two power grids, due to the Northfield Mountain Project's size and operational flexibility, ISO-NE requested the connection be made at the Northfield Mountain Project. Once the lines were energized, final adjustments were made by having the Northfield Mountain Project reduce generation to allow for a smooth synchronization of the two systems. The interconnection of the two large power systems allowed NY-ISO to begin restoration of the north portion of the NY power grid.

More recently, on April 1, 2020, a fault in the switchyard of a New England nuclear plant caused that plant to trip offline. Despite the loss of over 1,200 MW of power, within seconds the Northfield Mountain and Bear Swamp pumped storage projects were called upon to fill the energy gap. To put the magnitude of the Northfield Mountain Project into perspective, New England's largest lithium battery, a 6 MW battery in Nantucket, can only provide 0.5% of the power of the Northfield Mountain Project. In the aggregate across New England, battery storage can only supply 20 MW of capacity (through 2019), or 1.7% of the storage ability of the Northfield Mountain Project. Another factor is battery storage is only available for a limited duration of time, whereas the Northfield Mountain Project can provide power to the grid for a much longer period of time.

The Northfield Mountain Project's storage capability has other significant advantages. It can store renewable, carbon-free energy from solar, wind and hydro generation. The Northfield Mountain Project can store off-peak clean energy and deliver it during peak demand to avoid generation from gas and oil-fired units. In addition, intermittent renewables such as solar and wind, require reactive fast start devices such as the Northfield Mountain Project to fill the power gap when these sources are not producing power. It is expected that these intermittent sources will continue to grow in the future including thousands of megawatts of wind turbines along the MA, Connecticut, and Rhode Island (RI) coasts and thousands of megawatts of solar energy. The Northfield Mountain Project is a perfect complement to these carbon free, intermittent resources that will become the foundation of New England's electric supply in the coming decades.

The Turners Falls Project and the Northfield Mountain Project provide power that displaces generation that would likely be obtained from non-renewable sources, displaces the operation of fossil-fueled thermal electric facilities and reduces power plant emissions, thus creating both grid reliability and an environmental benefit.

1.3 Applicable Statutory and Regulatory Requirements

Issuance of a new license for each facility is subject to numerous requirements under the FPA and other applicable statutes[3]. The major acts and related requirements are described below. Actions undertaken by FirstLight or the agency with jurisdiction related to each requirement also are described.

1.3.1 Clean Water Act

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

In June 2020, the United States Environmental Protection Agency (USEPA) published a final rule substantially revising its regulations governing Section 401. The final rule went into effect 60 days after publication in the Federal Register, or September 11, 2020. The final rule clarifies the scope of MADEP's review of the Turners Falls and Northfield Mountain Projects under Section 401 of the CWA and contains new requirements for certification applications. Some key aspects of the USEPA's final rule include:

- The certifying authority's review and action under Section 401 are limited to the water quality impacts from point source discharges from the permitted project. Section 401 does not extend to the federally licensed activity as a whole. Non-point source pollution is excluded.
- Section 401 conditions, including conditions based on "any other appropriate requirement of State law" in Section 401(d), are limited to considerations of "water quality".
- The certifying authority must act on a Section 401 certification request within a reasonable period of time, which shall not exceed one year. The CWA does not contain provisions for tolling the timeline for any reason, including to request or receive additional information from the project proponent. Withdrawal and resubmittal of the application does not toll the timeline; neither will additional information requests by the certifying agency extend the timeline. Material changes to a proposed project may result in the need to submit a new certification request.
- A certification request must contain certain required information in order to trigger the one year period for state agency action.
- The applicant must request a meeting with the certifying agency no later than 30 days prior to filing the certification request and document its request. FirstLight will make the required meeting request to MADEP at the appropriate time.

1.3.2 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) requires Federal agencies to consult with the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) to ensure that their actions are not likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of critical habitat for these listed species. FirstLight has been

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[3] Certain PM&E measures proposed in this AFLA, if adopted by FERC, may require separate permitting including issuance of a dredge and fill permit from the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act.

designated as FERC's non-federal representative for purposes of informal consultation with the USFWS and NMFS under Section 7 of the ESA, which is ongoing.

Two federally endangered species under the ESA occur in the Turners Falls Project area, including Shortnose Sturgeon (SNS) and Puritan Tiger Beetle (PTB). FirstLight has developed separate Draft Biological Assessments (BAs) to evaluate the impacts of relicensing on these two federally endangered species. The Draft BAs are included as Appendices to this Exhibit E. FirstLight provided the USFWS (PTB) and NMFS (SNS) with preliminary Draft Biological Assessments (BAs) prior to this filing for review and comment. FirstLight held several meetings with those agencies and provided supplemental information and analysis to address their questions and comments.

As discussed in this Exhibit E, relicensing of the Turners Falls Project and Northfield Mountain Project is expected to have no effect on PTB and is likely to adversely affect but not jeopardize the continued existence of the SNS.

The Northern Long-Eared Bat (NLEB) is a species impacted by the disease white-nose syndrome. Due to declines caused by white-nose syndrome and continued spread of the disease, the NLEB was listed as threatened under the ESA on April 2, 2015. FirstLight addresses the NLEB as part of the BA for PTB. FirstLight has developed a Bald Eagle[4] Protection Plan for the protection of any bald eagles that may be affected by the Turners Falls Project and Northfield Mountain Project (separate plans were developed for each Project and are included in this AFLA).

1.3.3 Magnuson-Fishery Conservation and Management Act

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

1.3.4 Coastal Zone Management Act of 1972

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

The official MA coastal zone includes the lands and waters within an area defined by the seaward limit of the state's territorial sea, extending from the MA-NH border south to the MA-RI border, and landward to 100 feet inland of specified major roads, rail lines, other visible rights-of-way. The Turners Falls Project and Northfield Mountain Project are not located within the state's coastal zone boundary and do not affect any land or water use or natural resource of the state's coastal zone. Therefore, the Turners Falls Project and Northfield Mountain Project are not subject to MA coastal zone program review. In correspondence dated June 9, 2015, the MA Office of Coastal Zone Management confirmed that the relicensing of the Turners Falls Project and Northfield Mountain Project is not an activity subject to the state's federal consistency review. The state's letter is attached as Appendix A-Massachusetts Coastal Zone Management Letter dated June 9, 2015 (Exhibit E, Part 3 of 3).

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[4] Bald eagles are present in the Project area.

1.3.5 National Historic Preservation Act of 1966

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

As part of its role as FERC's non-federal representative, FirstLight developed and executed several studies to identify and assess, in consultation with the MA Historical Commission (MHC), VT Division of Historic Preservation (VDHP), NH Division of Historic Resources (NHDHR), and potentially affected Indian tribes, any adverse effects on historic properties resulting from continued operation of the Turners Falls Project and Northfield Mountain Project, as required under 36 CFR § 800.5. The results of those studies are discussed in Section 3.3.8 Cultural Resources and provide the basis for FirstLight's Historic Properties Management Plan (HPMP) for each facility, which are being filed as part of this amended Final License Application (AFLA).

1.4 Public Review and Consultation

The Commission's regulations (18 CFR § 5.1(d)) require an applicant to consult with appropriate Federal and state agencies, Indian tribes, and members of the public that may be interested in the proceeding before filing an application for a license. In addition, Section 5.18(b)(5)(ii)(G) requires documentation of such consultation in the form of a list of consulted entities. Confirmation of FirstLight's prefiling consultation is included in Section 6.0 of Exhibit E.

1.4.1 Scoping

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

On December 21, 2012, the Commission issued a notice of commencement of proceeding stating FERC intended to prepare an EIS for the Turners Falls Project and Northfield Mountain Project together with three other hydroelectric projects owned and operated by then TransCanada (now GRH), located in series on the Connecticut River above the Turners Falls Dam. These three GRH projects previously had the same license expiration date as the Turners Falls Project and Northfield Mountain Project (April 30, 2018). However, on January 16, 2015, TransCanada requested a 1-year license extension, which was granted by FERC on July 22, 2015 making the new license expiration date April 30, 2019. On May 9, 2019, the FERC authorized continued operation of the three GRH projects and thus they are now operating under annual licenses. The projects in downstream to upstream order include Vernon Hydroelectric Project (FERC No. 1904), Bellows Falls Hydroelectric Project (FERC No. 1855) and Wilder Hydroelectric Project (FERC No. 1892).

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

The Commission held three public scoping meetings as follows:

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

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

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

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

1.4.2 Interventions

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

1.4.3 Relicensing Studies

1.4.3.1 FERC's Determination on Revised Study Plan

Pursuant to 18 C.F.R. § 5.11 of the Commission's regulations, FirstLight filed its Proposed Study Plan (PSP) on April 15, 2013 and distributed the PSP to interested resource agencies and stakeholders for review and comment. In addition, pursuant to 18 C.F.R. § 5.11(e), FirstLight held an initial meeting on all studies in the PSP at the Northfield Mountain Visitor Center at the Northfield Mountain Project on May 14, 2013. Thereafter, FirstLight held ten resource-specific study plan meetings to allow for more detailed discussions on each PSP and on studies not being proposed. On June 28, 2013, although not required by FERC regulations, FirstLight filed with the Commission an Updated PSP to reflect further changes to the PSP based on comments received at the meetings. On or before July 15, 2013, stakeholders filed written comments on the Updated PSP. FirstLight filed with FERC a Revised Study Plan (RSP) on August 14, 2013, which addressed stakeholder comments.

On August 27, 2013 Entergy Corp. announced that the Vermont Yankee Nuclear Power Plant (VY), located on the downstream end of the Vernon Impoundment on the Connecticut River and upstream of the Turners Falls Project and Northfield Mountain Project, would be closing no later than December 29, 2014. With the closure of VY, certain environmental baseline conditions were anticipated to change during the relicensing study period.

On September 13, 2013, FERC issued its first Study Plan Determination Letter (SPDL) in which 20 studies were approved or approved with FERC modifications. However, due to the impending closure of VY, FERC did not act on 18 proposed or requested studies pertaining to aquatic resources. The SPDL for these 18 studies was deferred until after FERC held a technical meeting with stakeholders on November 25, 2013, regarding any necessary adjustments to the proposed and requested study designs and/or schedules due to the impending VY closure. FERC issued its second SPDL on the remaining 18 studies on February 21, 2014, approving the RSP with certain modifications. In total, there were 38 studies included in FirstLight's RSP and an additional one (1) study emanating from the study dispute described next. Thus, the total number of FERC-approved studies was 39. Table 1.4.3.1-1 lists the studies and whether FERC approved or modified the proposed study in its September 13, 2013 and February 21, 2014 Determination Letters.

1.4.3.2 FERC's Determination Regarding Study Disputes

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

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

1.4.3.3 Other FERC Determinations on Studies

Following issuance of the first two FERC Determination Letters, FERC issued an additional seven Determinations from January 22, 2015 through January 22, 2019. For each of the seven Determination Letters, FERC reviewed the study reports and addressed the following:

- Determinations on Requested Modifications to Approved Studies, which could include a) adopting the request for further analysis, b) adopting parts of the request for further analysis or c) not adopting the request or no further analysis is needed.
- Determinations on New Studies, which could include a) approving the requested study, b) approving the requested study with modifications and c) not requiring the study.

Table 1.4.3.3-1a (January 22, 2015, January 15, 2016, June 29, 2016), Table 1.4.3.3-1b (February 17, 2017, June 27, 2017, May 31, 2018) and Table 1.4.3.3-1c (January 22, 2019) summarize FERC Determinations for the 39 studies.

Note for each of the Determinations requiring additional information, FirstLight filed the requested information, held the required study results meeting, filed meeting minutes, and addressed comments provided by stakeholders on the study reports.

1.4.3.4 Comments on the Draft and Final License Applications

Draft License Application

On December 2, 2015, FirstLight filed with FERC and made available to stakeholders, a Draft License Application (DLA). Because not all of the FERC-required studies were complete, the DLA did not include a FirstLight PM&E proposal and the environmental effects sections were incomplete. Eleven letters regarding FirstLight's DLA were filed with FERC within the 90-day comment period, which ended on March 1, 2016. Table 1.4.3.4-1 lists the commenters and the dates of their letters.

In its cover letter transmitting the DLA, FirstLight requested a waiver of the requirements to submit a Supporting Design Report (SDR) as the Turners Falls Project and Northfield Mountain Project are subject to FERC Part 12 Dam Safety regulations. In its March 1, 2016 response, FERC stated the following relative to the SDR "*Based on the licensing proposal presented in the DLA, FirstLight does not need to file a Supporting Design Report. However, if FirstLight modified its proposal in its FLA or amended FLA, Commission staff may require FirstLight to file a Supporting Design Report*". A full SDR is not included in Exhibit F; however, FL completed a preliminary analysis of its proposed plunge pool located below the Turners Falls Dam bascule gate 1, as the plunge pool would have some influence on a portion of the dam. Further information is contained in Exhibit F.

Final License Application

On April 29, 2016, FirstLight filed with FERC and made available to stakeholders a Final License Application (FLA). In its filing, FirstLight stated that it would file an AFLA after completion of all relevant environmental studies. Because major studies were still in progress, FirstLight did not include a PM&E proposal and the environmental effects sections remained incomplete. On May 13, 2016, FERC issued its "*Notice of Application tendered for filing with the Commission and establishing Procedural Schedule for Licensing and Deadline for Submission of Final Amendment*". In its letter, FERC noted the application was "not ready for environmental analysis". The letter further stated that "*After FirstLight completes and files the outstanding study reports and amended final license application, Commission staff will issue a revised* *procedural schedule with target dates for the post-filing milestones listed below*. The post-filing schedule milestones were all listed as to-be-determined (TBD).

Between May 2016 and the present, FirstLight completed all of the FERC-required studies, and conducted several additional studies and analyses, not required by FERC, that FirstLight determined necessary to inform development of its AFLA PM&E proposals. FirstLight designed and conducted the non-FERC required studies in close consultation with the appropriate resource agencies and filed the study results with FERC. In addition, FirstLight engaged in a series of confidential relicensing settlement meetings with federal and state resource agencies, non-governmental organizations, and other stakeholders. While this process did not culminate in a relicensing settlement agreement, the discussions were extremely helpful in informing FirstLight's development of the proposed PM&E measures included in the AFLAs.

References

Federal Energy Regulatory Commission. (2008). Preparing Environmental Documents, Guidelines for Applicants, Contractors, and Staff. Washington, DC: Office of Energy Projects, Division of Hydropower Licensing.

Table 1.4.1-1: Scoping Comment Summary

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

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

Table 1.4.3.1-1: FERC Study Determination Summary

Study No.	Study Name	**Studies Proposed by FirstLight in its RSP**	**Studies Approved or Modified by FERC in its 09/13/13 Determination**		**Studies Approved or Modified by FERC in its 02/21/14 Determination**	
			Approved	**Modified**	**Approved**	**Modified**
3.1.1	2013 Full River Reconnaissance	X		X		
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing and Potential Bank Instability	X		X		
3.1.3	Northfield Mountain Project Sediment Management Plan	X		X		
3.2.1	Water Quality Monitoring Study	X				X
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypassed Reach and the Connecticut River below Cabot Station	X		X		
3.3.1	Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station	X				X
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad	X				X
3.3.3	Evaluate Downstream Passage of Juvenile Shad	X				X
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls Project (two year study)	X	X		X	
3.3.5	Evaluate Downstream Passage of American Eel	X				X
3.3.6	Impact of Project Operation on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects	X				X
3.3.7	Fish Entrainment and Turbine Mortality Study	X				X
3.3.8	Computational Fluid Dynamics Modeling of the Fishway Entrances and Powerhouse Forebays	X		X		
3.3.9	Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace	X		X		
3.3.10	Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River	X				X
3.3.11	Fish Assemblage Assessment	X				X
3.3.12	Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station	X			X	
3.3.13	Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat	X				X
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment	X			X	
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas	X				X
3.3.16	Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station	X				X
3.3.17	Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary Backwater Area Access and Habitat	X			X	
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms	X				X
3.3.19	Evaluate the Use of an Ultrasonic Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace	X	This study plan was formally approved by FERC on February 25, 2016			X
3.3.20	Entrainment of American Shad Ichthyoplankton at the Northfield Mountain Pumped Storage Project	Based on discussions between USFWS, NMFS, MADFW, FERC and FirstLight on April 25, 2016, FirstLight committed to a second year of field work in 2016.				
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources at the Turners Falls Impoundment, in the Bypass Reach and below Cabot Station within the Project Boundary	X	X			
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitat	X	X			
3.5.1	Baseline Inventory of Wetland, Riparian, and Littoral Habitat in Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species	X		X		
3.6.1	Recreation Use/User Contact Survey	X		X		
3.6.2	Recreation Facilities Inventory and Assessment	X		X		
3.6.3	Whitewater Boating Evaluation	X		X		
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats	X		X		
3.6.5	Land Use Inventory	X	X			
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use	X	X			
3.6.7	Recreation Study of Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use	X		X		
3.7.1	Phase 1A Archaeological Survey	X		X		
3.7.2	Reconnaissance-Level Historic Structures Survey	X		X		
3.7.3	Traditional Cultural Properties Study	X		X		
3.8.1	Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation	X		X		

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Table 1.4.3.2-1: Summary of Communications Regarding Study Dispute

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

Table 1.4.3.3-1a: FERC Study Determination Summary

Study No.	Study Name	Studies Approved or Modified by FERC in its **01/22/15 Determination**						Studies Approved or Modified by FERC in its **01/15/16 Determination**						Studies Approved or Modified by FERC in its **06/29/16 Determination**					
		Requested Modifications to Approved Studies			Requested New Studies			Requested Modifications to Approved Studies			Requested New Studies			Requested Modifications to Approved Studies			Requested New Studies		
		Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required	Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required	Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required
3.1.1	2013 Full River Reconnaissance		X																
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing and Potential Bank Instability		X							X									
3.1.3	Northfield Mountain Project Sediment Management Plan																		
3.2.1	Water Quality Monitoring Study				X														
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypassed Reach and the Connecticut River below Cabot Station									X									
3.3.1	Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station			X															
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad				X														
3.3.3	Evaluate Downstream Passage of Juvenile Shad							X											
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls Project (two year study)		X																
3.3.5	Evaluate Downstream Passage of American Eel				X			X											
3.3.6	Impact of Project Operation on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects					X										X			
3.3.7	Fish Entrainment and Turbine Mortality Study							X											
3.3.8	Computational Fluid Dynamics Modeling of the Fishway Entrances and Powerhouse Forebays														X				
3.3.9	Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Project Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace	X													X				
3.3.10	Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River																		
3.3.11	Fish Assemblage Assessment				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															
3.3.13	Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat	X																	
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment		X																
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas																		
3.3.16	Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station																		
3.3.17	Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain									X									

Study No.	Study Name	Studies Approved or Modified by FERC in its **01/22/15 Determination**						Studies Approved or Modified by FERC in its **01/15/16 Determination**						Studies Approved or Modified by FERC in its **06/29/16 Determination**					
		Requested Modifications to Approved Studies			Requested New Studies			Requested Modifications to Approved Studies			Requested New Studies			Requested Modifications to Approved Studies			Requested New Studies		
		Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required	Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required	Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required
	Project on Tributary Backwater Area Access and Habitat																		
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms				X					X									
3.3.19	Evaluate the Use of an Ultrasonic Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace																		
3.3.20	Entrainment of American Shad Ichthyoplankton at the Northfield Mountain Pumped Storage Project					X									X				
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources at the Turners Falls Impoundment, in the Bypass Reach and below Cabot Station within the Project Boundary																		
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitat																		
3.5.1	Baseline Inventory of Wetland, Riparian, and Littoral Habitat in Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species													X					
3.6.1	Recreation Use/User Contact Survey			X															
3.6.2	Recreation Facilities Inventory and Assessment		X																
3.6.3	Whitewater Boating Evaluation									X									
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats									X									
3.6.5	Land Use Inventory																		
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use																		
3.6.7	Recreation Study of Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use																		
3.7.1	Phase 1A Archaeological Survey																		
3.7.2	Reconnaissance-Level Historic Structures Survey																		
3.7.3	Traditional Cultural Properties Study																		
3.8.1	Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation																		

Table 1.4.3.3-1b: FERC Study Determination Summary

Study No.	Study Name	Studies Approved or Modified by FERC in its **02/17/17 Determination**						Studies Approved or Modified by FERC in its **06/27/17 Determination**						Studies Approved or Modified by FERC in its **05/31/18 Determination**					
		Requested Modifications to Approved Studies			Requested New Studies			Requested Modifications to Approved Studies			Requested New Studies			Requested Modifications to Approved Studies			Requested New Studies		
		Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required	Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required	Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required
3.1.1	2013 Full River Reconnaissance																		
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing and Potential Bank Instability			X															
3.1.3	Northfield Mountain Project Sediment Management Plan																		
3.2.1	Water Quality Monitoring Study																		
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypassed Reach and the Connecticut River below Cabot Station																		
3.3.1	Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station	X																	
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad			X															
3.3.3	Evaluate Downstream Passage of Juvenile Shad			X												X			
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls Project (two year study)																		
3.3.5	Evaluate Downstream Passage of American Eel																		
3.3.6	Impact of Project Operation on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects																		
3.3.7	Fish Entrainment and Turbine Mortality Study			X															
3.3.8	Computational Fluid Dynamics Modeling of the Fishway Entrances and Powerhouse Forebays																		
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																		
3.3.10	Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River									X									
3.3.11	Fish Assemblage Assessment																		
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															
3.3.13	Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat																		
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment																		
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas	X																	
3.3.16	Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station																		
3.3.17	Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary Backwater Area Access and Habitat																		

Study No.	Study Name	Studies Approved or Modified by FERC in its **02/17/17 Determination**						Studies Approved or Modified by FERC in its **06/27/17 Determination**						Studies Approved or Modified by FERC in its **05/31/18 Determination**					
		Requested Modifications to Approved Studies			Requested New Studies			Requested Modifications to Approved Studies			Requested New Studies			Requested Modifications to Approved Studies			Requested New Studies		
		Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required	Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required	Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms																		
3.3.19	Evaluate the Use of an Ultrasonic Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace																		
3.3.20	Entrainment of American Shad Ichthyoplankton at the Northfield Mountain Pumped Storage Project																		
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources at the Turners Falls Impoundment, in the Bypass Reach and below Cabot Station within the Project Boundary																		
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitat																		
3.5.1	Baseline Inventory of Wetland, Riparian, and Littoral Habitat in Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species		X																
3.6.1	Recreation Use/User Contact Survey																		
3.6.2	Recreation Facilities Inventory and Assessment																		
3.6.3	Whitewater Boating Evaluation																		
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats																		
3.6.5	Land Use Inventory																		
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use																		
3.6.7	Recreation Study of Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use																		
3.7.1	Phase 1A Archaeological Survey																		
3.7.2	Reconnaissance-Level Historic Structures Survey																		
3.7.3	Traditional Cultural Properties Study																		
3.8.1	Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation									X									

Table 1.4.3.3-1c: FERC Study Determination Summary

Study No.	Study Name	Studies Approved or Modified by FERC in its **01/22/19 Determination**					
		Requested Modifications to Approved Studies			Requested New Studies		
		Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required
3.1.1	2013 Full River Reconnaissance						
3.1.2	Northfield Mountain/Turners Falls Operations Impact on Existing and Potential Bank Instability						
3.1.3	Northfield Mountain Project Sediment Management Plan						
3.2.1	Water Quality Monitoring Study						
3.2.2	Hydraulic Study of Turners Falls Impoundment, Bypassed Reach and the Connecticut River below Cabot Station						
3.3.1	Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station		X				
3.3.2	Evaluate Upstream and Downstream Passage of Adult American Shad						
3.3.3	Evaluate Downstream Passage of Juvenile Shad						
3.3.4	Evaluate Upstream Passage of American Eel at the Turners Falls Project (two year study)						
3.3.5	Evaluate Downstream Passage of American Eel						
3.3.6	Impact of Project Operation on Shad Spawning, Spawning Habitat and Egg Deposition in the Area of the Northfield Mountain and Turners Falls Projects						
3.3.7	Fish Entrainment and Turbine Mortality Study						
3.3.8	Computational Fluid Dynamics Modeling of the Fishway Entrances and Powerhouse Forebays						
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						
3.3.10	Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River						
3.3.11	Fish Assemblage Assessment						
3.3.12	Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream from Cabot Station						
3.3.13	Impacts of the Turners Falls Project and Northfield Mountain Project on Littoral Zone Fish Habitat and Spawning Habitat						
3.3.14	Aquatic Habitat Mapping of Turners Falls Impoundment						
3.3.15	Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas						
3.3.16	Habitat Assessment, Surveys, and Modeling of Suitable Habitat for State-listed Mussel Species in the CT River below Cabot Station						
3.3.17	Assess the Impacts of Project Operations of the Turners Falls Project and Northfield Mountain Project on Tributary Backwater Area Access and Habitat						

Study No.	Study Name	Studies Approved or Modified by FERC in its **01/22/19 Determination**					
		Requested Modifications to Approved Studies			Requested New Studies		
		Adopted	Adopted in part	Not Adopted	Approved	Approved with Modifications	Not Required
3.3.18	Impacts of the Turners Falls Canal Drawdown on Fish Migration and Aquatic Organisms						
3.3.19	Evaluate the Use of an Ultrasonic Array to Facilitate Upstream Movement to Turners Falls Dam by Avoiding Cabot Station Tailrace						
3.3.20	Entrainment of American Shad Ichthyoplankton at the Northfield Mountain Pumped Storage Project			X			
3.4.1	Baseline Study of Terrestrial Wildlife and Botanical Resources at the Turners Falls Impoundment, in the Bypass Reach and below Cabot Station within the Project Boundary						
3.4.2	Effects of Northfield Mountain Project-related Land Management Practices and Recreation Use on Terrestrial Habitat						
3.5.1	Baseline Inventory of Wetland, Riparian, and Littoral Habitat in Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species						
3.6.1	Recreation Use/User Contact Survey						
3.6.2	Recreation Facilities Inventory and Assessment						
3.6.3	Whitewater Boating Evaluation						
3.6.4	Assessment of Day Use and Overnight Facilities Associated with Non-Motorized Boats						
3.6.5	Land Use Inventory						
3.6.6	Assessment of Effects of Project Operation on Recreation and Land Use						
3.6.7	Recreation Study of Northfield Mountain, including Assessment of Sufficiency of Trails for Shared Use						
3.7.1	Phase 1A Archaeological Survey						
3.7.2	Reconnaissance-Level Historic Structures Survey						
3.7.3	Traditional Cultural Properties Study						
3.8.1	Evaluate the Impact of Current and Potential Future Modes of Operation on Flow, Water Elevation and Hydropower Generation						

Table 1.4.3.4-1: List of Comment Letters Filed with FERC on FirstLight's Draft License Application

Commenter	Date of Letter
United States Fish and Wildlife Service	02/22/2016
Massachusetts Division of Fish and Wildlife	02/25/2016
Town of Montague, MA	02/29/2016
Karl Meyer	02/29/2016
Massachusetts Department of Environmental Protection	03/01/2016
The Nature Conservancy	03/01/2016
National Marine Fisheries Service	03/01/2016
Connecticut River Watershed Council	03/01/2016
United States Department of the Interior, National Park Service	03/01/2016
American Whitewater, Appalachian Mountain Club, New England Flow	03/01/2016
Federal Energy Regulatory Commission	03/01/2016

2 PROPOSED ACTIONS AND ALTERNATIVES

This section describes the existing Turners Falls Project and Northfield Mountain Project (i.e., the No-Action Alternative) and FirstLight's proposed changes (i.e., FirstLight's Proposal, which includes Turners Falls and Northfield Mountain). Section 2.1 describes the No-Action Alternative, the baseline from which to compare all action alternatives. Section 2.2 describes FirstLight's Proposal. Section 2.3 describes alternatives considered but not analyzed in detail in this document.

The Turners Falls and Northfield Mountain Projects are located in the Connecticut River Basin which includes other hydropower facilities and flood control projects that have been in existence for more than the last 50 years. As described in Section 3.1 General Description of River Basin of this Exhibit E, several of these upstream projects have storage capacity significant enough to influence the magnitude of inflows to the Turners Falls Project on a seasonal, daily or intra-daily basis. The USACE flood control projects on tributaries located upstream of the Turners Falls Project influence flows on a seasonal basis and their operation is fixed relative to the operation of the Turners Falls Project and Northfield Mountain Project moving forward. Similarly, the basin's largest hydropower project, the Fifteen Mile Falls Project, which includes the Moore, Comerford, and McIndoes Developments has the ability to store and release water and influence flows on a daily basis to downstream projects including Turners Falls and Northfield Mountain. The Fifteen Miles Falls Project was licensed in 2002 for a 40-year term and its operation is fixed relative to the Turners Falls and Northfield Mountain licensing proceeding.

Downstream of the Fifteen Mile Falls Project are, from upstream to downstream, the Dodge Falls[5], Wilder, Bellows Falls and Vernon hydroelectric projects. The latter three projects, which are owned by GRH and are going through relicensing on the same timeline as the Turners Falls Project and Northfield Mountain Project, have the ability to influence flows on an intra-daily basis. The most downstream Vernon Project discharges into the TFI. Thus, understanding the future operation of these three projects, and in particular the Vernon Project discharge regime, becomes a critical piece of information, both for evaluating flow proposals and alternatives in this Exhibit E, as well as in implementing any future license conditions at the Turners Falls Project and Northfield Mountain Project.

To fulfill its current licensing obligations FirstLight had to make assumptions relative to the inflow from the Vernon Project for the operating proposals addressed in this Exhibit E. For the No Action Alternative, FirstLight assumed existing operating conditions at its projects as well as at the Wilder, Bellows Falls, and Vernon Projects. For alternatives considered but rejected that are tied to upstream flows (e.g. run-of-river operation at Turners Falls) FirstLight assumed similar operation at the Wilder, Bellows Falls, and Vernon Projects. For FirstLight's proposal, it has assumed that the Wilder, Bellows Falls and Vernon Projects would provide the drainage area prorated amount of any minimum bypass flows and/or downstream flows proposed at the Turners Falls Project.

The ultimate integrated operation of the Wilder, Bellows Falls, Vernon, and Turners Falls Projects, as well as the Northfield Mountain Project will be determined by FERC as part of the NEPA process. This future operation will represent a new paradigm for the river operations in this part of the Connecticut River. As described later, FirstLight's proposal relative to implementing up and down ramping, and Cabot Station peak demand flow restrictions, in particular, will take coordination between FirstLight and GRH to make sure the hydropower resource is used to its maximum benefit within the new license constraints. As part of that coordination, FirstLight believes it is essential for FERC to require GRH in any new license issued

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[5] The Dodge Falls Project (FERC No. 8011) is owned by Dodge Falls Associates, LP and was issued a FERC exemption in 1984.

for the Wilder, Bellows Falls, and Vernon Projects to provide the following information to FirstLight River Operations Personnel[6] on a daily basis:

1. Day ahead hourly projections of total Vernon outflow (generation flows and spillage) provided by 8:00 am each day to FirstLight River Operations Personnel. FirstLight River Operations Personnel will use this information to schedule their river operations within the constraints of their license and hourly inflow from Vernon. FirstLight will take appropriate steps to ensure that the Vernon flow discharge information provided to its River Operations Personnel will not be communicated to individuals involved in marketing operations on behalf of FirstLight or any of its affiliates;
2. Day ahead hourly total Vernon outflow projections will be updated once the day ahead power bidding market closes and ISO-NE issues the day ahead schedule;
3. If ISO-NE updates the day ahead hourly total Vernon outflow schedule then that schedule will be provided to FirstLight within two (2) hours of GRH receiving an update from ISO-NE;
4. In same day operations GRH will supply FirstLight with deviations in the total Vernon outflow schedule in real time as well as an updated hourly projection for the remainder of the day. GRH will provide this information each time its outflow deviates from the last hourly projection.

FirstLight is seeking this information as it operating proposal includes a) seasonally varying bypass flows on an or-inflow, whichever is less basis, b) seasonal up- and down-ramping rates below Cabot Station (cfs/hour), c) seasonal up-ramping rates in the TFI at the Turners Falls Dam (ft/hour), d) seasonal maximum peak demand flow restrictions on an hourly basis at Cabot Station (cfs/hour) and e) seasonally varying whitewater releases on an or-inflow, whichever is less basis. Because the operating proposal includes adjustments on an hourly basis, it is critical that FirstLight have reliable Vernon total discharge information in order to operate the Project as proposed.

2.1 No Action Alternative

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

2.1.1 Existing Project Facilities

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

Features of the Turners Falls Project are shown in Figure 2.1.1-1.

Also located on the power canal is the Turners Falls Hydro, LLC (TFH) hydroelectric project (FERC No. 2622) and the Milton Hilton, LLC project (unlicensed). TFH is owned and operated by Eagle Creek Renewable Energy. The TFH project has an operating range of approximately 60 cfs to 289 cfs, when generating; however, the TFH project only operates at 289 cfs. The TFH project tailrace discharge is

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[6] FirstLight agrees that the information provided to it shall be used solely for the purpose of operating its downstream hydroelectric licenses in accordance with the conditions established by FERC. Accordingly, it will agree to conditions that will restrict information provided pursuant to this request shall not be provided, either directly or indirectly, to any of its employees, consultants, agents or any other representative that are engaged in FirstLight's merchant activities, including but not limited to such activities as submitting bids to NEPOOL and/or ISO-NE in connection with the dispatch of any of its generating units.

located approximately 0.3 miles downstream of the Turners Falls Dam, which is upstream of the Station No. 1 tailrace discharge. The TFH project is also undergoing relicensing, with a license expiration date of February 28, 2021. TFH has various indentures recorded with the Franklin County of Deeds providing for water rights from the power canal. TFH coordinates its project operations with FirstLight under an off-license water use agreement, which provides that TFH will only generate when the naturally routed flow in the Connecticut River increases to 15,000 cfs, in exchange for certain compensation paid to TFH. TFH presently does not contribute to existing FERC-required bypass flows even though it has first call on water through its indentures on the water in the power canal. In its license application (February 5, 2019), TFH sought flexibility to operate continuously in the event the water use agreement is terminated. Since TFH and FirstLight both take water out of the canal, they have a joint obligation to provide flows to maintain aquatic habitat and provide for fish passage in the 0.3-mile long section of the bypass reach from the Turners Falls Dam to its tailrace. If TFH opts to exercise its right to first call on water, it will have responsibilities for maintaining bypass flows. Because it is unclear over the term of the next TFH project license whether it, or FirstLight, will terminate the water use agreement and TFH operates continuously, FirstLight's operating proposal in Section 2.2.4 accounts for the TFH project operating continuously.

The Milton Hilton, LLC project is owned by a private developer and has a hydraulic capacity of 113 cfs. It discharges approximately 0.5 miles downstream of the Turners Falls Dam (downstream of TFH, but upstream of the Station No. 1 tailrace). Like the TFH project, it has various indentures providing for water rights from the power canal. It also has the same off-license water use agreement with FirstLight, which provides that they will only generate when the naturally routed flow in the Connecticut River increases to 15,000 cfs, in exchange for certain compensation paid. Because it is unclear if they, or FirstLight, will terminate the water use agreement and the project operates continuously, FirstLight's operating proposal in Section 2.2.4 accounts for the project operating continuously.

The Northfield Mountain Project consists of a) the Upper Reservoir dam/dikes; b) an intake channel; c) pressure shaft; d) an underground powerhouse; e) a tailrace tunnel and f) the TFI. It also includes recreation facilities and use areas.

Features of the Northfield Mountain Project are shown in Figure 2.1.1-2.

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

2.1.2 Existing Project Boundary

The Northfield Mountain Project boundary includes the area around the Northfield Mountain Project and the perimeter of the TFI, however, it does not include the Turners Falls Dam or the area below the Dam. The Turners Falls Project boundary also includes the perimeter of the TFI (overlapping with the Northfield Mountain Project boundary) and an area below the Turners Falls Dam down to Cabot Station. Figure 2.1.2-1 shows the overlapping Project boundary, and the separate Turners Falls and Northfield Mountain Project boundaries. The combined Project Boundary for the Turners Falls Project and Northfield Mountain Project contains 7,246 acres of land and 2,238 acres of flowed land.

These lands are located in three states- MA, NH, and VT. The majority of the combined Project Boundary (which includes the TFI ~6,150 acres) is located in Franklin County, MA in the towns of Erving, Gill, Greenfield, Montague and Northfield. The northern reaches of the TFI extend into the towns of Hinsdale, in Cheshire County, NH (727 acres) and the town of Vernon, in Windham County, VT (369 acres).

2.1.3 Existing Project Safety

The Turners Falls Project has been operating for more than 40 years under its existing license[7] and the Northfield Mountain Project has been operating for more than 52 years under its existing license[8]. During this time FERC staff has conducted operational inspections focusing on the continued safety of the

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[7] The Turners Falls Project license was issued on May 5, 1980 and expired on April 30, 2018.

[8] The Northfield Mountain Project license was issued on May 14, 1968 and expired on April 30, 2018.

structures, efficiency and safety of operations, compliance with the licenses and proper maintenance. In addition, both Projects have been inspected and evaluated every five (5) years by an independent consultant and a consultant's safety report has been submitted for FERC's review.

2.1.4 Existing Project Operations

The Turners Falls Project consists of two hydro generating facilities- Cabot Station and Station No. 1. Cabot Station is used at all river flows. During low flow periods [between the hydraulic capacity of 1 Cabot unit (2,288 cfs) and all 6 Cabot units (13,728 cfs)], Cabot Station operates to meet peak demand. During high flows in excess of 13,728 cfs, it operates as a base load plant. Station No. 1 is a base load plant and typically operates when inflows to the TFI are less than the minimum efficient hydraulic capacity of a single Cabot Unit (~2,100 cfs) or when inflows exceed the hydraulic capacity of Cabot Station.

The Northfield Mountain Project is a pumped storage hydroelectric facility. Water is pumped from the TFI to the Upper Reservoir which has 12,318 acre-feet[9] of useable storage available for pumped storage operations. Typically, pumping occurs during low-load periods or periods of excess supply when energy costs are low, while generation occurs during high-load periods when energy costs are high.

2.1.5 Existing Environmental Measures

Water Level and Flow Management

- Under the FERC license for the Turners Falls Project, FirstLight is required to release a continuous minimum flow of 1,433 cfs or inflow (equivalent to 0.2 cfs x the drainage area in square miles), whichever is less, below the Project. FirstLight typically maintains the minimum flow requirement through discharges at Cabot and/or Station No. 1.
- Under the FERC license, a continuous minimum flow of 200 cfs is maintained in the bypass reach starting on May 1 and increases to 400 cfs when fish passage starts by releasing flow through a bascule gate at the Turners Falls Dam. The 400 cfs continuous minimum flow is provided through July 15, unless the upstream fish passage season has concluded early, in which case the 400 cfs flow is reduced to 120 cfs to protect the federally endangered SNS. The 120 cfs continuous minimum flow is maintained in the bypass reach from the date the fishways are closed (or by July 16) until the river temperature drops below 7°C, which typically occurs around November 15th.
- Under the FERC license, the TFI elevation may fluctuate between 176.0 feet and 185.0 feet, as measured at the Turners Falls Dam.
- Under the FERC license, the Northfield Mountain Upper Reservoir elevation may fluctuate between 1,000.5 feet and 938 feet NGVD29.

Upstream and Downstream Fish Passage

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

Recreation

- FirstLight maintains several public recreation facilities within the Project Boundary of both the Turners Falls Project and Northfield Mountain Project as described in detail in Section 3.3.6 Recreation Resources.

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[9] Note that initial estimate of the Upper Reservoir storage quantity in 1968 was 12,750 acre-feet (appears in the FERC license order); however, the actual useable storage is closer to 12,318 acre-feet

2.1.6 Measures in Current FERC Licenses

The following is a description of key license requirements for the Turners Falls Project and Northfield Mountain Project.

Turners Falls Project

Article 19 requires the License to take reasonable measures to prevent soil erosion on lands adjacent to streams or other waters, stream sedimentation, and any form of water or air pollution. The Commission, upon request or upon its own motion, may order the Licensee to take such measures as the Commission finds to be necessary for these purposes, after notice and opportunity for hearing

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

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

Article 32 requires the Licensee to operate the Turners Falls Project in accordance with its agreement with the USACE for the coordinated operation of the Turners Falls Project for flood control.

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

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

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

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

Article 37 – Article 37 was deleted from the license per an amendment dated October 6, 1980.

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

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

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

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

Article 43 was added to replace Article 27 per an amendment dated October 6, 1980.

Northfield Mountain Project

Article 19 requires the License to allow free public access to project waters and adjacent project lands owned by the Licensee.

Article 20 requires the license to be responsible for and minimize soil erosion and siltation on lands adjacent to the stream from the construction and operation of the project.

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

Article 40 requires the Licensee, following consultation with the USFWS and fishery agencies of the Commonwealth of Massachusetts, to study or pay for the cost of studies relating to fish protection at the Northfield Mountain Project, and undertake further study if the Commission finds that changed conditions or changed use of the Connecticut River fishery so warrant.

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

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

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

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

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

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

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

2.2 FirstLight's Proposal

2.2.1 Proposed Project Facilities

2.2.1.1 Proposed Generation Facilities

Turners Falls Project

Station No. 1 Upgrades

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

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

FirstLight anticipates completing this work within three (3) years of license issuance as shown in Table 2.2.1.1-1.

Table 2.2.1.1-1 FirstLight's Proposed PM&E Measures at Station No. 1 at the Turners Falls Project

Proposed PM&E Measure	**Task**	**Estimated No. of Years after License Issuance PM&E Measure becomes Operational**		
		1	**2**	**3**
Modifications to Station No. 1 (within 3 years of license issuance)	Engineering/Design	▨		
	Permitting (assumed not needed)			
	Construction		▨	
	Operational			▨

Northfield Mountain Project

FirstLight is not proposing any changes to existing developmental (i.e., generation) facilities at the Northfield Mountain Project. All of the Northfield Mountain Project turbine-generators have been upgraded in recent years.

2.2.1.2 Proposed Non-Generation Facilities

Turners Falls Project

FirstLight is proposing various non-generation facilities at the Turners Falls Project as described below.

Turners Falls Project- Infrastructure Needed to Pass Winter Bypass Flows

FirstLight proposes to provide a bypass flow of 300 cfs, or inflow, whichever is less, as measured just below the Turners Falls Dam, from December 1 to March 31. There are two water conveyance structures at the Turners Falls Dam, including bascule gates and tainter gates. The tainter gates are designed to discharge flows greater than approximately 5,000 cfs. Of the four bascule gates, bascule gate no. 1 is pond following, meaning the crest of the bascule gate can be adjusted to pass a desired flow at a given TFI water level. FirstLight proposes to use this bascule gate to pass the winter flow; however, some modification to the gate is needed. Specifically, FirstLight proposes to add heaters to the gate to prevent ice build-up. The proposed schedule for heating Bascule Gate No. 1 is in Table 2.2.1.2-1.

Table 2.2.1.2-1 FirstLight's Proposed PM&E Measures at Turners Falls Dam at the Turners Falls Project

Proposed PM&E Measure	**Task**	**Estimated No. of Years after License Issuance PM&E Measure becomes Operational**		
		1	**2**	**3**
Heating of Bascule Gate No. 1 to pass winter bypass flows (within 3 years of license issuance)	Engineering/Design	▨		
	Permitting (assumed not needed)			
	Construction		▨	
	Operational			▨

Turners Falls Project- Proposed Upstream and Downstream Fish Passage Facilities

FirstLight proposes to construct various upstream and downstream fish passage facilities at the Turners Falls Project. Table 2.2.1.2-2 lists each proposed fish passage PM&E measure and the approximate number of years after license issuance it would become operational. A more detailed schedule (Gantt chart) was developed for all PM&E measures at Turners Falls which is included in Appendix A- FirstLight's Protection, Mitigation& Enhancement Measure Schedule (Exhibit E, Part 3 of 3). Note that the Gantt chart schedules and schedules included in the tables in this section may be slightly different as the tables are less granular than the Gantt chart schedules. For example, construction may show as an 8-month effort in the Gantt chart schedule, but as a year in the tables. The Gantt chart helped to determine the timing on when a proposed PM&E measure could become operational.

Table 2.2.1.2-2 FirstLight's Proposed PM&E Measures for Upstream and Downstream Fish Passage at the Turners Falls Project

Proposed PM&E Measure	Task	Estimated No. of Years after License Issuance PM&E Measure becomes Operational												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Upstream Fish Passage														
Install Permanent Ultrasound Array in the Cabot Tailrace to deflect American Shad to the Bypass Reach (within 6 years from license issuance)	1 year further testing	▨												
	Engineering/Design		▨	▨										
	Permitting				▨									
	Construction					▨								
	Operational						▨							
	Monitoring/Evaluation						SD	M	M	P				
Construct a new Spillway Lift with Palisade Entrance at the Turners Falls Dam (within 6 years of license issuance)	Engineering/Design	▨	▨											
	Permitting			▨										
	Construction				▨	▨								
	Operational						▨							
	Monitoring/Evaluation						SD	M	M	P				
Construct an Eelway near the Turners Falls Dam (interim passage within 1 year of license issuance, siting studies in the first year of the Spillway Lift operation, permanent eelway within 9 years of license issuance)	Interim Eelway		▨	▨	▨	▨	▨	▨	▨	▨				
	Siting Temporary Passage							▨						
	Engineering/Design								▨					
	Permitting									▨				
	Construction										▨			
	Operation of Permanent Eelway										▨			
	Monitoring/Evaluation										SD	M	M	P
Retire Cabot Fish Ladder							▨							
Retire Entrance Portions of gatehouse ladder in canal							▨							
Downstream Fish Passage														
Construct a Plunge Pool below Bascule Gate No. 1 located at the Turners Falls Dam. This work would likely be conducted at the same time as the Spillway Lift construction (Plunge pool constructed in concert with Spillway Lift, within 6 years from license issuance)	Engineering/Design	▨	▨											
	Permitting			▨										
	Construction				▨	▨								
	Operational						▨							
	Monitoring/Evaluation						SD	M	M	P				
Construct a Bar Rack at the entrance to the Station No. 1 Forebay (within 8 years from license issuance)	Engineering/Design				▨	▨								
	Permitting						▨							
	Construction							▨						
	Operational								▨					
	Monitoring/Evaluation								SD	M	M	P		

SD- Shakedown, M- Monitoring, P- Potential additional year of monitoring pending previous years monitoring results

For all of the fish passage structures described below, FirstLight has included some level of detail; however, FirstLight recognizes that further consultation with the USFWS, NMFS and MADFW will occur. Thus, some of the high level design details described below could change following agency consultation.

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

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

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

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

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

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

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

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

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

Turners Falls Project- Proposed Recreation Features

Table 2.2.1.2-3 lists FirstLight's proposed recreation features for the Turners Falls Project and the estimated number of years after license issuance the recreation facilities become operational. Any recreation feature located upstream of the Turner Falls Dam was assigned to the Northfield Mountain Project (described later), which is consistent with the existing Northfield Mountain Project license. Any recreation feature located below the Turners Falls Dam was assigned to the Turners Falls Project.

Table 2.2.1.2-3 FirstLight's Proposed PM&E Measures for Recreation at the Turners Falls Project

		Estimated No. of Years after License Issuance PM&E Measure becomes Operational			
Proposed PM&E Measure	**Task**	**1**	**2**	**3**	**4**
Create a formal access trail for a put-in just below the Turners Falls Dam (within 4 years of license issuance)	Engineering/Design	▨			
	Permitting		▨		
	Construction			▨	
	Operational				▨
Create a formal trail and steps for a take-out at Poplar Street (within 4 years of license issuance)	Engineering/Design	▨			
	Permitting		▨		
	Construction			▨	
	Operational				▨

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

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

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

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

Turners Falls Project- Management Plans

FirstLight has also developed the following Turners Falls Project Management Plans which are included in the AFLA:

- Recreation Management Plan.
- Historic Properties Management Plan
- Bald Eagle Protection Plan
- Invasive Plant Species Management Plan

Northfield Mountain Project

Northfield Mountain Project- Periodic Dredging of the Upper Reservoir Intake Channel

FirstLight proposes to conduct bathymetric mapping of the Upper Reservoir at least once every two (2) years to help understand the location, volume, and rate of sediment accumulation in the Upper Reservoir. If the results of the bathymetric survey indicate an average sediment depth throughout the middle of the intake channel of five (5) feet or greater, an internal detailed review by an engineering team will be initiated and planning for future sediment removal will commence. The detailed review will include an evaluation as to whether sediment levels have increased to the point where the check dam and/or intake channel geometry would not be able to prevent an excessive release of sediment to the Connecticut River during an unplanned or planned dewatering. The engineering review team will prepare a report of its findings and recommendations. FirstLight will then notify the appropriate agencies and inform them of the next steps.

Once the five (5) foot threshold has been reached, sediment removal will commence within three (3) years unless there is a technical and engineering basis for a longer period of time, which would be submitted to USEPA, MADEP, and FERC for review and comment. After reaching the five (5) foot threshold, and until sediment removal occurs, FirstLight will perform bathymetric surveys and detailed engineering reviews annually.

Further details regarding this dredging is documented in a Sediment Management Plan entitled *Upper Reservoir Dewatering Protocols*, which FirstLight previously filed with FERC on June 30, 2017. FirstLight proposes that this Sediment Management Plan can be amended over time, so long as the amended plan provides an equivalent level of protection and is approved by USEPA, MADEP and FERC.

Northfield Mountain Project- Proposed Fish Passage Structure

FirstLight proposes to install a barrier net to prevent the entrainment of migratory fish when the Northfield Mountain Project is pumping. Table 2.2.1.2-4 outlines when the barrier net would become operational.

FirstLight has included some level of detail regarding the barrier net, however, it recognizes that further consultation with the USFWS, NMFS and MADFW will occur. Thus, some of the design details described below could change following agency consultation.

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

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

Conceptual level drawings of the barrier net is included in the Northfield Mountain Project Exhibit F.

Table 2.2.1.2-4 FirstLight's Proposed PM&E Measures for Fish Passage at the Northfield Mountain Project

Proposed PM&E Measure	Task	Estimated No. of Years after License Issuance PM&E Measure becomes Operational												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Upstream/Downstream Fish Passage														
Install a Barrier Net at Northfield Mountain Intake/ Tailrace to prevent entrainment (within 5 years license issuance).	Engineering/Design	▨	▨											
	Permitting			▨										
	Construction				▨									
	Operational					▨								
	Monitoring/Evaluation					SD	M	M	P					

SD- Shakedown, M- Monitoring, P- Potential additional year of monitoring pending previous years monitoring results

Northfield Mountain Project- Proposed Recreation Features

Table 2.2.1.2-5 lists FirstLight’s proposed recreation features for the Northfield Mountain Project and the estimated number of years after license issuance the recreation facilities become operational.

Table 2.2.1.2-5. FirstLight’s Proposed PM&E Measures for Recreation at the Northfield Mountain Project

		Estimated No. of Years after License Issuance PM&E Measure becomes Operational			
Proposed PM&E Measure	**Task**	**1**	**2**	**3**	**4**
At Riverview, relocate the existing Boat Tour Dock given that it would be enclosed by the proposed Barrier Net (within 4 years of license issuance)	Engineering/Design	▨			
	Permitting		▨		
	Construction			▨	
	Operational				▨
Create a new access trail with stairs for a put-in at Riverview (within 4 years of license issuance)	Engineering/Design	▨			
	Permitting		▨		
	Construction			▨	
	Operational				▨
Create a formal access trail for a put-in at Cabot Camp (within 3 years of license issuance)	Engineering/Design	▨			
	Permitting	▨			
	Construction		▨		
	Operational			▨	

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

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

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

Conceptual level drawings of the proposed recreation features are included in the Recreation Management Plan.

Northfield Mountain Project- Management Plans

FirstLight has also developed the following Northfield Mountain Project Management Plans which are included in the AFLA:

- Recreation Management Plan.
- Historic Properties Management Plan

- Bald Eagle Protection Plan
- Invasive Plant Species Management Plan

In addition to these plans, FirstLight previously filed with FERC on June 30, 2017 a Sediment Management Plan entitled *Upper Reservoir Dewatering Protocols*, discussed above.

2.2.2 Turners Falls and Northfield Mountain Proposed Project Boundary

As described in Exhibit G for the Turners Falls Project and Exhibit G for the Northfield Mountain Project, FirstLight is proposing changes to each Project boundary as summarized below.

Turners Falls Project and Northfield Mountain Project Overlapping Project Boundary Changes

- The removal of a 0.2 acre parcel of land at 39 Riverview Drive in Gill, MA. FirstLight has no ownership rights on this residential parcel and land rights are not needed for Project operations or any other Project purpose. None of the lands FirstLight proposes to exclude from the Project boundary contains historic properties eligible or potentially eligible for the National Register of Historic Places.

Northfield Mountain Project Boundary Changes

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

- The addition of 135.5 acres[10] of land south of the Northfield Switching Station located in the Towns of Northfield and Erving in Massachusetts. Some of these lands are currently owned by Eversource and are necessary to include recreation trails associated with the Northfield Mountain Trail and Tour Center that are not currently enclosed in the Project Boundary.

Turners Falls Project Boundary Changes

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

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

2.2.3 Proposed Turners Falls Project and Northfield Mountain Safety

The Turners Falls Project and Northfield Mountain Project are subject to FERC's continued dam safety oversight under Part 12 of FERC's regulations. FirstLight anticipates FERC will continue to inspect both facilities during the new license term to assure continued adherence to FERC-approved plans and specifications, any special license articles pertaining to construction, operation and maintenance, and accepted engineering practices and procedures.

2.2.4 Proposed Project Operations

FirstLight proposes several operational changes as summarized in Section 2.2.5.

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

2.2.5 Proposed License Conditions

FirstLight proposes the following relative to operations. Note that Draft License Articles are attached in Appendix B- Draft License Articles for the Turners Falls Project and Northfield Mountain Project (Exhibit E, Part 3 of 3).

2.2.5.1 Turners Falls Project

Operational Regime

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(f) Cabot Emergency Gate Use. The Licensee shall use the Cabot Emergency Gates under the following conditions: a) in case of a Cabot load rejection[11], b) in the case of dam safety issues such as potential canal overtopping or partial breach, and c) to discharge approximately 500 cfs between April 1 and June 15 for debris management. The Licensee shall avoid discharging higher flows through the gates from April 1 to June 15 whenever possible; however, if necessary, the Licensee shall coordinate with NMFS to minimize potential impact to SNS in the area below Cabot Station.

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

Turners Falls Impoundment Water Level Management

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

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

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

Whitewater Boating Flows

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

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

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

Operating Priorities

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

In the event of a conflict among the operational requirements of this license, the Licensee shall maintain the priority listing below with 1 being highest priority. Flood flows operations will always take priority over any resource specific restriction. After flood flow operations, the priorities are bypass flows followed by operating improvements for SNS, PTB, odonates and finally whitewater flows.

Restriction	Resource Protected	Priority (1- highest, 6- lowest)							
		4/1-4/30	5/1-5/15	5/16-5/31	6/1-6/30	7/1-7/31	8/1-8/15	8/16-8/31	9/1-3/31
Flood Flow Operations	Public safety	1	1	1	1	1	1	1	1
Bypass Flows, or-inflow, 24 hrs/day	Aquatic Species	2	2	2	2	2	2	2	2
Up/Down Ramping 2,300 cfs, 24 hrs/day	Shortnose Sturgeon	3	3	3					
Minimum flow below Cabot Station, or-inflow, 24 hrs/day					3				
Add no more than 2 additional Cabot Units from 1 am to 2 pm	Puritan Tiger Beetle					3	3	3	
Up Ramping 1 Cabot Unit/hr, 8 am to 2 pm	Odonates			4	4	4	4	4	
TFI elevation rate of rise <0.9 ft/hr as measured at the Turners Falls Dam, 8 am to 2 pm				5	5	5	5	5	
Whitewater Flows, or-inflow, Weekend, 4 hrs/day, flows ranging from 2,500 to 5,000 cfs	Public					6	6	6	6 (Sep, Oct only)

Fish Passage

(a) The Licensee shall construct the following fish passage facilities, which shall become operational in the years shown below.

Fish Passage Feature	No. of Years after License Issuance Fish Passage Feature becomes Operational
Permanent Ultrasound Array at the Outer edge of the Cabot Tailrace	6 years
Spillway Lift	6 years
Plunge Pool below Bascule Gate No. 1	6 years
Station No. 1 Exclusion Structure	8 years
Temporary Upstream Eel Passage	2-9 years
Permanent Upstream Eel Passage	10 years

(b) The Licensee shall consult with the USFWS, NMFS and the MADFW in the design of each of the above facilities. The Licensee shall provide a minimum of 60 days for USFWS, NMFS, and the MADFW to comment and make recommendations before filing the designs of each facility with the Commission. If the Licensee does not adopt a design recommendation, the filing must include the Licensee's reasons, based on project-specific information. The Commission reserves the right to require changes to the designs. Construction associated with any of the designs must not begin until the Licensee is notified by the Commission that the design is approved. Upon Commission approval, the Licensee must implement the plan, including any changes required by the Commission.

(c) The Licensee shall file with the Commission, within one year from the date of completion of each fish passage facility, “as-built” drawings of the completed facilities.

Upgrade Station No. 1

(a) Within three (3) years of license issuance, the Licensee shall modify Station No. 1 to automate such that the units can operate over a range of flows instead of single gate settings.

Modifications to Turners Falls Dam Bascule No. 1 Gate

(a) Within three (3) years of license issuance, the Licensee shall modify Bascule Gate No. 1 and equip it with heaters such that that gate can be safely operated during freezing temperatures to maintain winter bypass flows.

Recreation Management Plan

The Licensee shall implement the Recreation Management Plan filed with the Commission as part of this AFLA.

Historic Properties Management Plan

The Licensee shall implement the Historic Properties Management Plan filed with the Commission as part of this AFLA.

Invasive Plant Species Management Plan

The Licensee shall implement the Invasive Plant Species Management Plan filed with the Commission as part of this AFLA.

Bald Eagle Protection Plan

The Licensee shall implement the Bald Eagle Protection Plan filed with the Commission as part of this AFLA.

Northern Long-Eared Bat Protection Measures

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

<u>Northfield Mountain Project</u>

Operational Regime

(a) Flood Flow Operations. The Licensee shall operate the Northfield Mountain Pumped Storage Project in accordance with its existing agreement with the United States Army Corp of Engineers (USACOE). This agreement, memorialized in the *Reservoir and River Flow Management Procedures* (1976), as it may be amended from time to time, governs how the Northfield Mountain Pumped Storage Project shall operate during flood conditions and coordinate its operations with the Licensee of the Turners Falls Hydroelectric Project (FERC No. 1889).

(b) Upper Reservoir Water Level Management: The Licensee shall operate the Northfield Mountain Pumped Storage Project Upper Reservoir between elevation 1004.5 and 920 feet NGVD29.

Fish Passage

(a) The Licensee shall construct and operate a barrier net located in the Northfield Mountain Pumped Storage Project tailrace/intake and have it operational within five (5) years of license issuance.

(b) The Licensee shall consult with the USFWS, NMFS and the MADFW in the design of the barrier net located in the Northfield Mountain Project tailrace/intake. The Licensee shall provide a minimum of 60 days for USFWS, NMFS, and the MADFW to comment and make recommendations before filing the designs of each facility with the Commission. If the Licensee does not adopt a design recommendation, the filing must include the Licensee's reasons, based on project-specific information. The Commission reserves the right to require changes to the design. Construction associated with any of the design must not begin until the Licensee is notified by the Commission that the design is approved. Upon Commission approval, the Licensee must implement the plan, including any changes required by the Commission.

(c) The Licensee shall file with the Commission, within one year from the date of completion of the barrier net, "as-built" drawings of the completed facility.

Upper Reservoir Sediment Management Plan

The Licensee shall implement the Sediment Management Plan entitled *Upper Reservoir Dewatering Protocols* filed with the Commission on June 30, 2017, provided that if FirstLight determines that modifications to the Sediment Management Plan are necessary or desirable and documents that the modifications are not anticipated to reduce the effectiveness of the Plan, the Sediment Management Plan can be amended with the written concurrence of USEPA and MADEP.

Recreation Management Plan

The Licensee shall implement the Recreation Management Plan filed with the Commission as part of this AFLA.

Invasive Plant Species Management Plan

The Licensee shall implement the Invasive Plant Species Management Plan filed with the Commission as part of this AFLA.

Bald Eagle Protection Plan

The Licensee shall implement the Bald Eagle Protection Plan filed with the Commission as part of this AFLA.

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Northern Long-Eared Bat Protection Measures

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

2.2.6 Proposed License Term

Given the magnitude of capital investment and the proposed operational changes, FirstLight proposes a 50-year license term for both the Turners Falls Project and Northfield Mountain Project.

2.3 Alternatives Considered But Eliminated From Further Analysis

FirstLight considered but eliminated from further analysis the following alternatives:

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

2.3.1 Retire the Project

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

In SD2, FERC stated:

> *Decommissioning some or all of Connecticut River projects would require denying the relicense applications and surrender or termination of the existing licenses with appropriate conditions. There would be significant costs involved with decommissioning the projects and/or removing project facilities. The projects provide a viable, safe, and clean renewable source of power to the region. Based on the 17 factors (to be considered when determining whether a more thorough analysis of decommissioning is warranted), outlined in The Interagency Task Force Report on NEPA Procedures in FERC Hydroelectric Licensing,*[12] *we do not consider decommissioning to be a reasonable alternative for the Connecticut River projects, at this time.*

2.3.2 Issue a Non-Power License

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

> *A non-power license is a temporary license the Commission would terminate whenever it determines that another governmental agency is authorized and willing to assume regulatory authority and supervision over the lands and facilities covered by the non-power license. At this time, no governmental agency has suggested a willingness or ability to take over any of these five projects.*

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

> *No party has sought a non-power license, and we have no basis for concluding that the TransCanada and FirstLight projects should no longer be used to produce power. Thus, we do not consider a non-power license a reasonable alternative to relicensing the projects.*

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

2.3.3 Federal Agency Takeover of the Project

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

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

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

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

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

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

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

References

None

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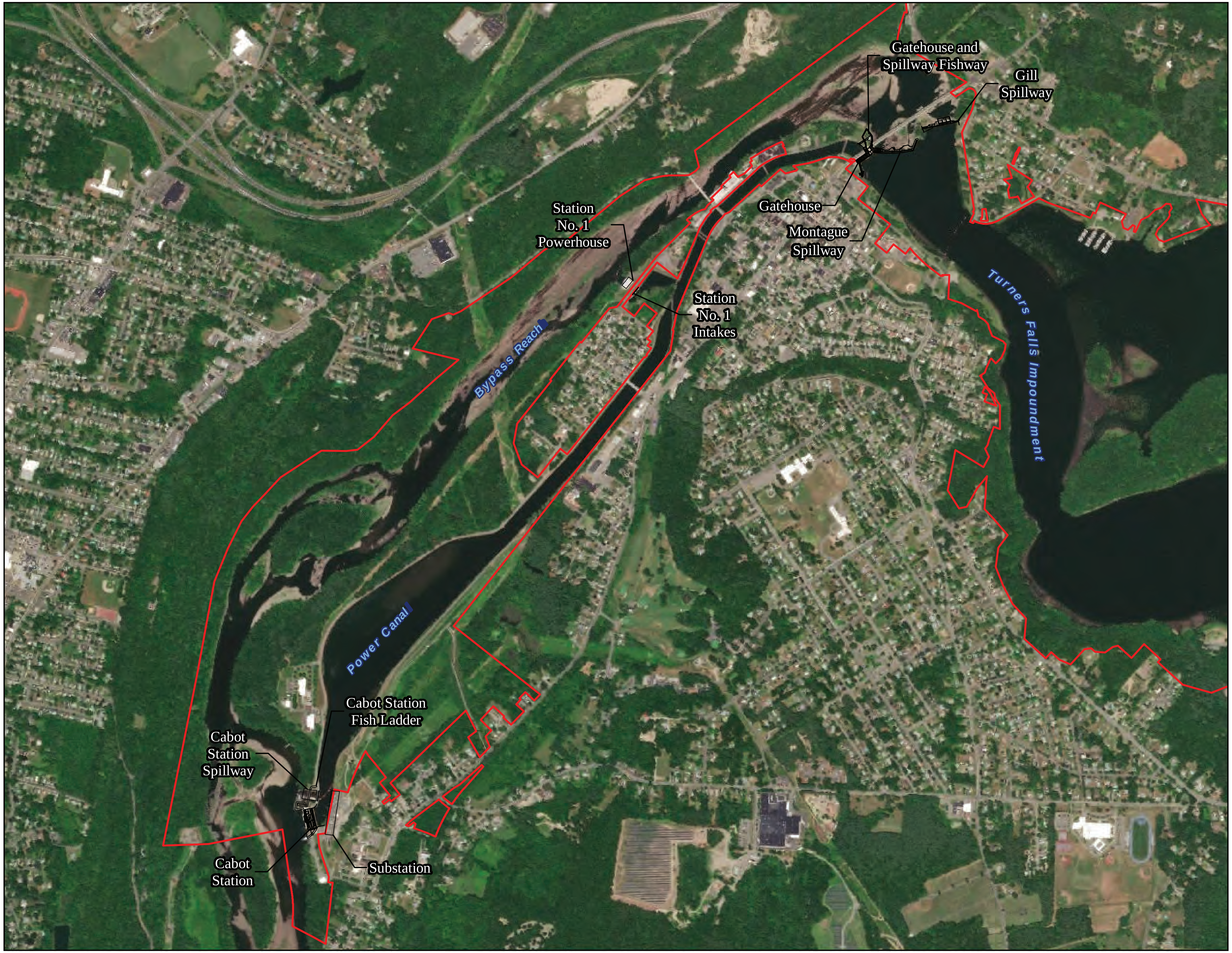

FIRSTLIGHT MA HYDRO LLC
Turners Falls Hydroelectric Project No. 1889

Amended Final License Application
Exhibit E

Figure 2.1.1-1
Turners Falls Hyroelectric Project
Features

Legend

🟥 Project Boundary

N

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS,

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Feet

1 inch = 1,200 feet

FirstLight

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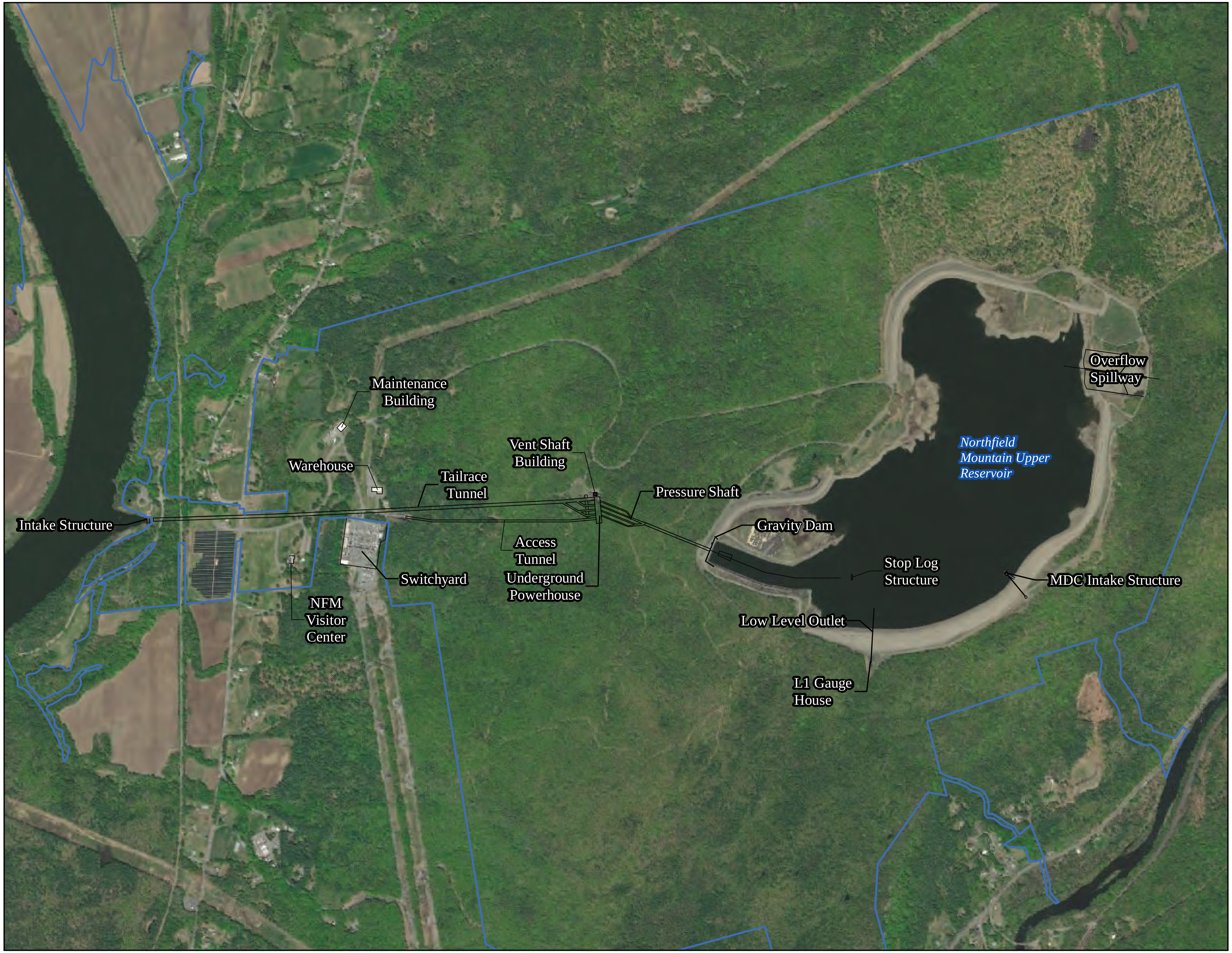

NORTHFIELD MOUNTAIN LLC
Northfield Mountain Pumped Storage Project No. 2485

Amended Final License Application
Exhibit E

Figure 2.1.1-2
Northfield Mountain Pumped Storage
Project Features

Legend

▭ Project Boundary

N

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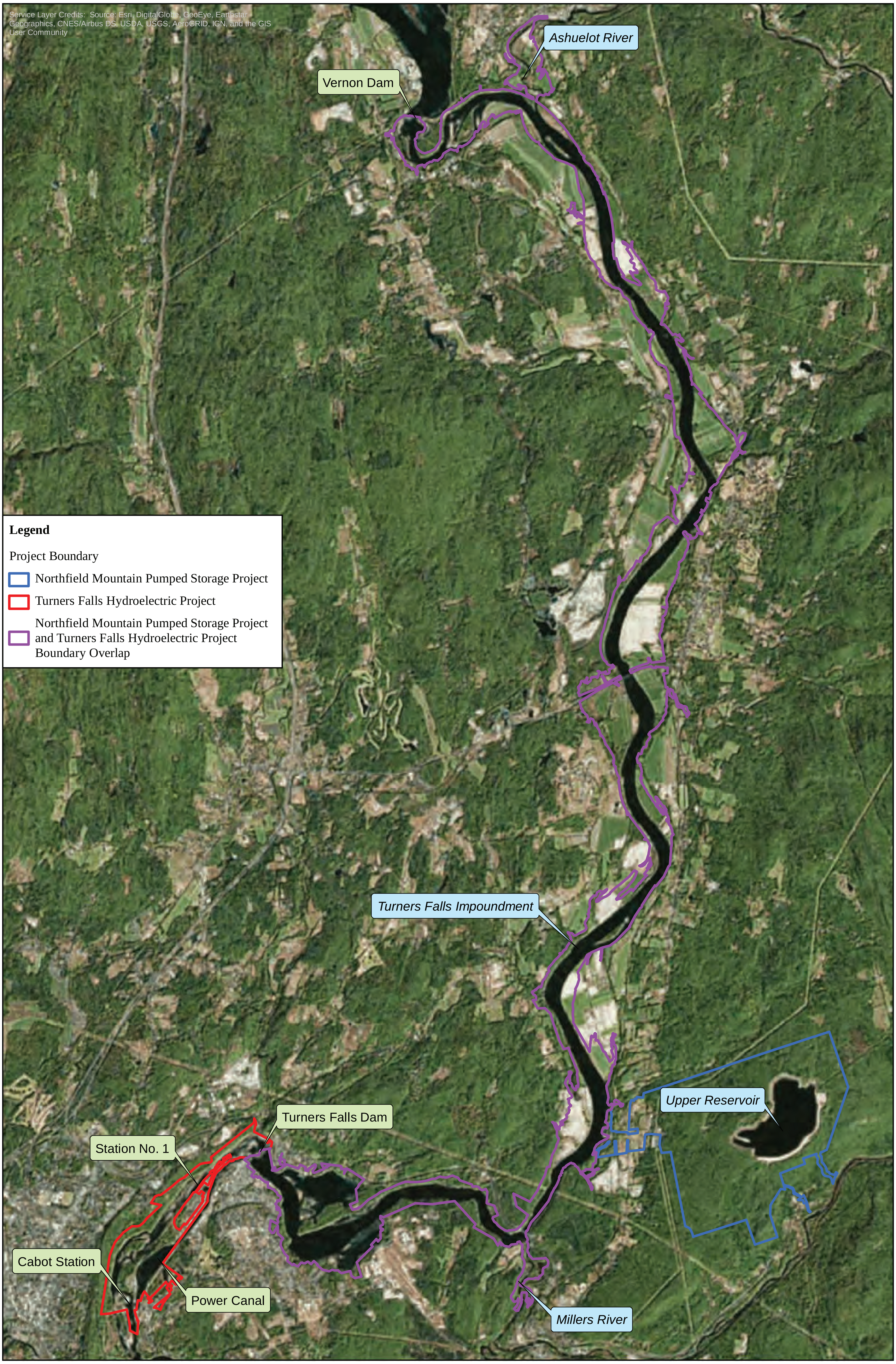

FirstLight

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

Amended Final License Application Exhibit E

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Figure 2.1.2-1:
Turners Falls and Northfield Mountain Project Boundary Map

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3 ENVIRONMENTAL ANALYSIS

3.1 General Description of River Basin

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

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

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

3.1.1 Topography

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

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

3.1.2 Climate

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

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

3.1.3 Land and Water Use

3.1.3.1 Major Land Uses

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

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

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

3.1.3.2 Major Water Uses

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

3.1.3.3 Basin Dams and other Energy Producers

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

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

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

3.1.3.4 Tributary Streams

Major tributaries to the TFI include the Ashuelot River in NH, 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 Project tailrace. Additionally, the Deerfield River, which drains 665 mi^2 from the west, enters the Connecticut River just downstream of the Cabot Station tailrace.

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

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

References

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Zimmerman, J. (2006). *Response of physical processes and ecological targets to altered hydrology in the Connecticut River basin*. Northampton, MA: The Nature Conservancy Connecticut River Program.

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

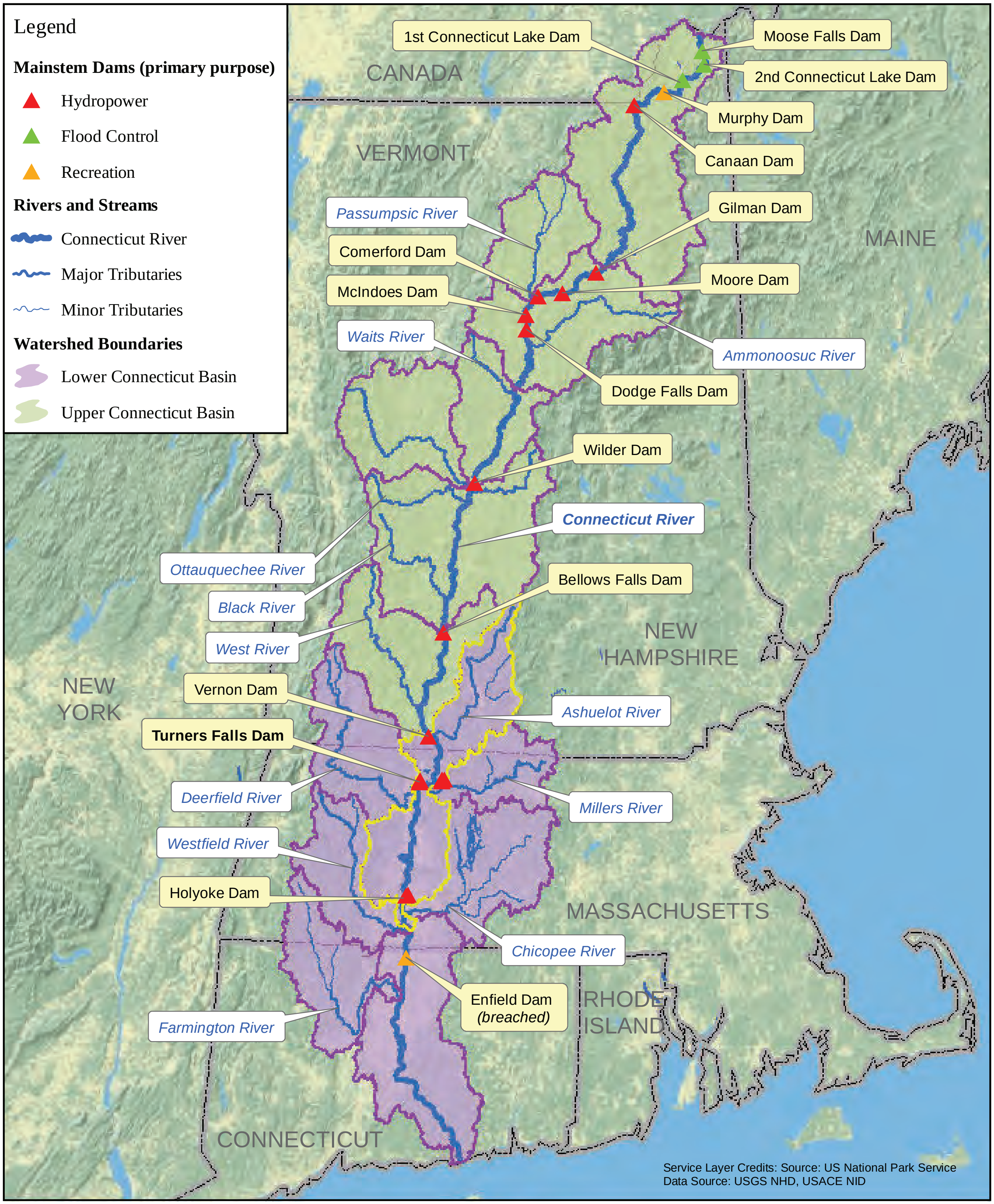
Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Temperature (°F)	27	30	38	50	60	69	74	73	65	54	44	31
Average Precipitation (in)	3.2	3.0	3.5	3.9	4.1	4.1	3.6	3.5	3.5	3.6	4.1	3.8

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

Table 3.1.3.3-1: Hydropower Projects on the Connecticut River

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

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



Service Layer Credits: Source: US National Park Service
Data Source: USGS NHD, USACE NID

FirstLight

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

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Amended Final License Application
Exhibit E

0 15 30 60
Miles

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

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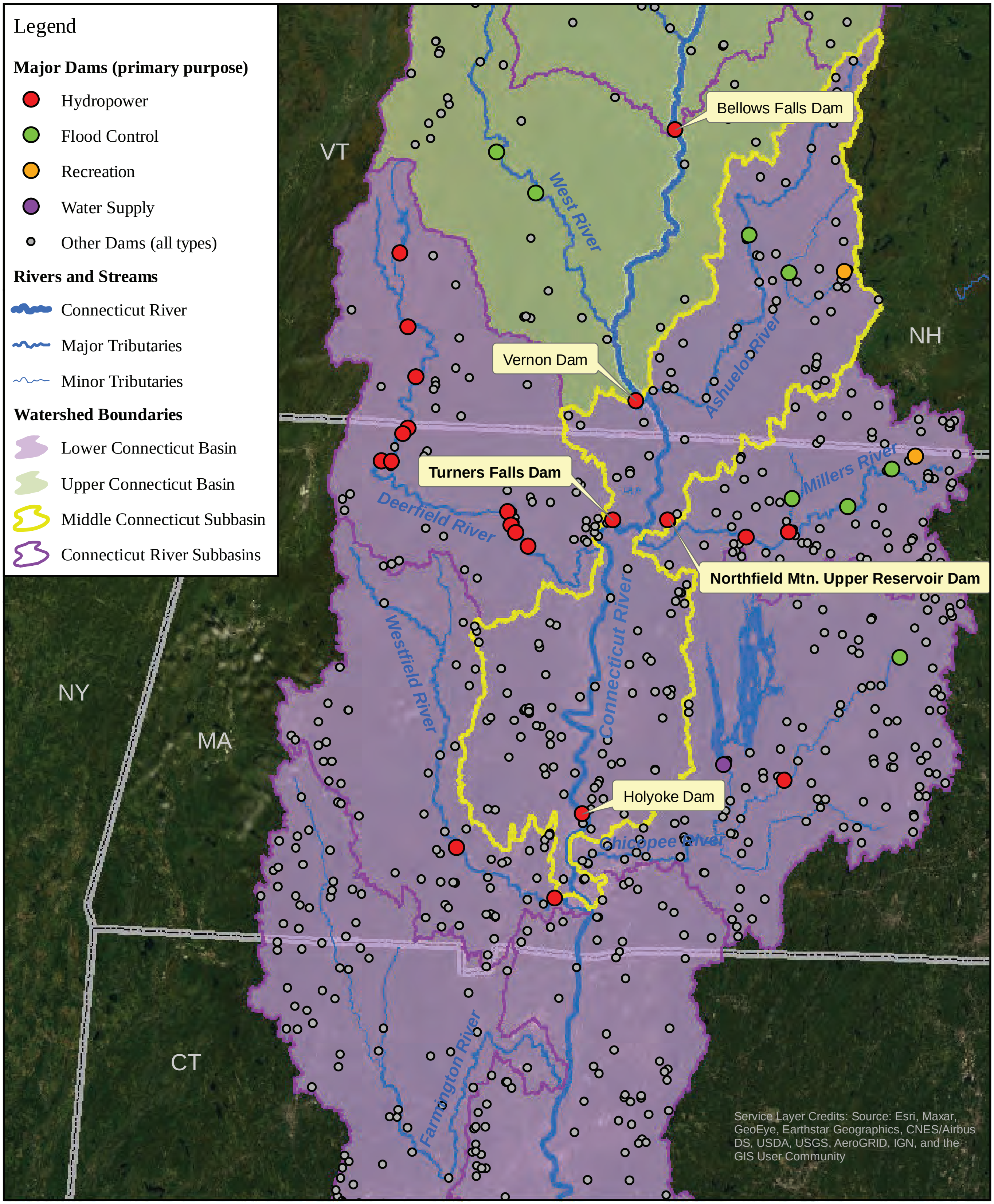

Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Amended Final License Application
Exhibit E

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

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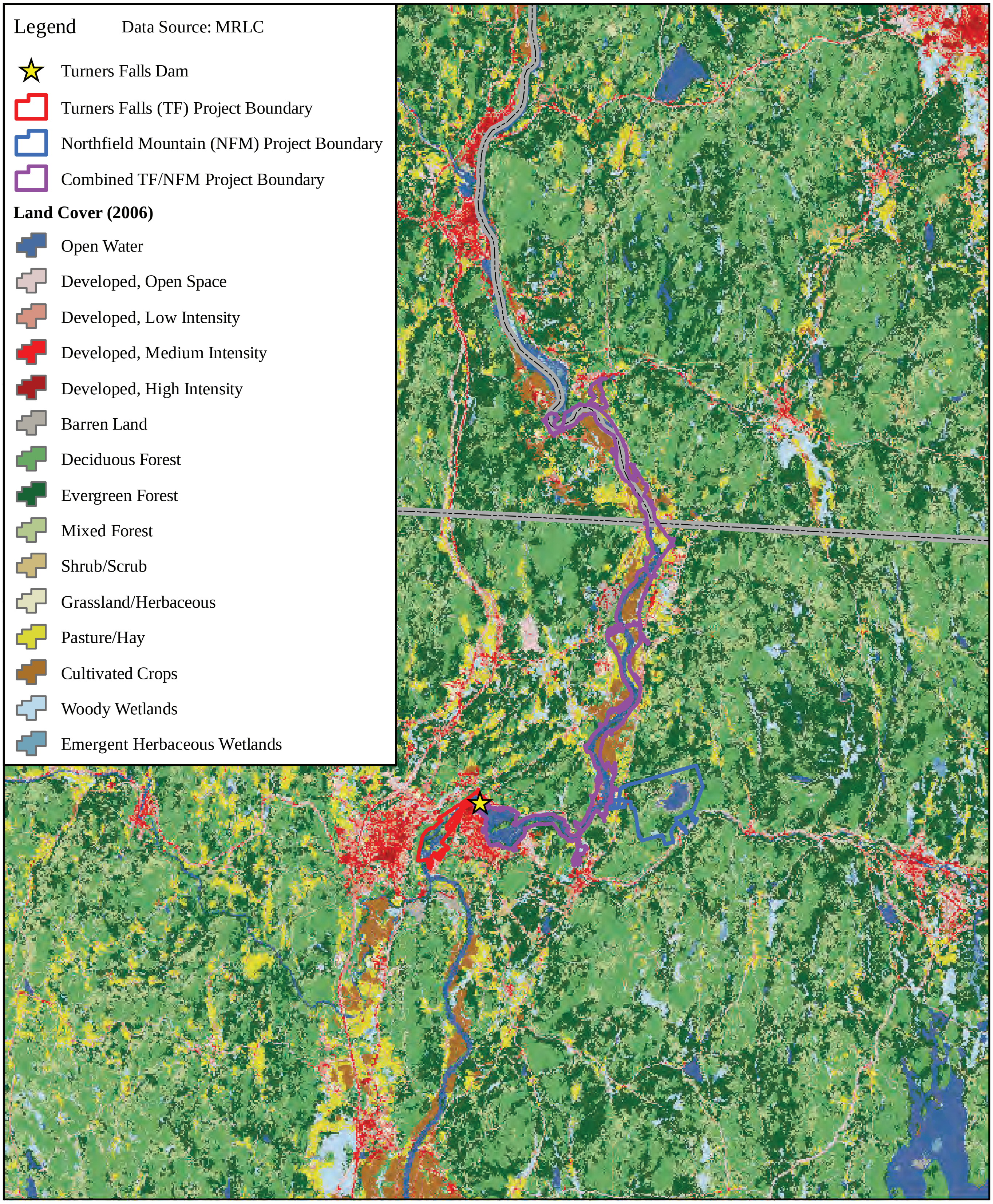

Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

FirstLight

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Amended Final License Application
Exhibit E

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Miles

Figure 3.1.3.1-1
Land Cover in the
Project Vicinity

3.2 Cumulative Effects

3.2.1 Cumulatively Affected Resources

The Code of Federal Regulations (CFR) at 18 CFR § 5.18(b) requires Exhibit E to include a discussion of “cumulative effects” as follows:

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

This section summarizes cumulatively affected resources in accordance with 18 CFR 5.18(b).

It should be noted that on July 16, 2020 the Council on Environmental Quality amended the NEPA regulations found at 40 CFR Part 1500 *et seq.* 85 F.R. 43304-43376 (Jul. 16, 2020), which included changes to the concept of “cumulative impacts.” These amendments are scheduled to go into effect on September 14, 2020. In particular, Section 1508.1(g) of the amended NEPA regulations eliminated the term “cumulative impacts” and defined “effects or impacts” as follows:

> *(g) Effects or impacts means changes to the human environment from the proposed action or alternatives that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives, including those effects that occur at the same time and place as the proposed action or alternatives and may include effects that are later in time or farther removed in distance from the proposed action or alternatives.*
>
>> *(1) Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic (such as the effects on employment), social, or health effects. Effects may also include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial.*
>>
>> *(2) A “but for” causal relationship is insufficient to make an agency responsible for a particular effect under NEPA. Effects should generally not be considered if they are remote in time, geographically remote, or the product of a lengthy causal chain. Effects do not include those effects that the agency has no ability to prevent due to its limited statutory authority or would occur regardless of the proposed action.*
>>
>> *(3) An agency's analysis of effects shall be consistent with this paragraph (g). Cumulative impact, defined in 40 CFR 1508.7 (1978), is repealed.*

Once the recent amendments go into effect the procedure for identifying and evaluating cumulative effects under NEPA may change.

FERC noted the following in SD2 relative to cumulative effects, which includes the effects of the three (3) GRH Projects and FirstLight’s Turners Falls Project and Northfield Mountain Project:

> *Based on information in the Pre-Application Documents and staff analysis of the written comments submitted from agencies and other stakeholders on the SD1 document and comments from the January 2013 public scoping meetings, we identified the following resources that may be cumulatively affected by the proposed operation and maintenance of the five Connecticut River Projects: water quality and quantity*[13] *(including power generation), fishery resources (including anadromous and catadromous fish and fish passage), floodplain communities, freshwater mussels, sediment movement, recreational uses and rare, threatened and endangered species.*

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

3.2.2 Geographic Scope of Analysis for Cumulatively Affected Resources

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

> Due to the extensive seasonal storage capacity at Moore reservoir, we have identified the geographical extent of cumulative effects on water quantity and water quality *to include the Connecticut River from the base of Moore dam to the mouth of the Connecticut River at Long Island Sound. We chose this geographic area to recognize the cumulative operational influences of the upstream water storage, and the operations of the five Connecticut River projects on water quantity throughout this area and subsequently on water quality that could occur downstream to the mouth of the Connecticut River at Long Island Sound.*
>
> Because hydroelectric dams influence both upstream and downstream fish migration within river systems, we have identified the geographical extent of potential cumulative effects on anadromous, catadromous, and diadromous fish species *to include the Connecticut River from Long Island Sound upstream to each species' historical habitat range.*
>
> We have identified the geographical extent of cumulative effects on *resident fish species, freshwater mussels, and sediment movement to include the upper extent of the Wilder reservoir downstream to the Route 116 Bridge in Sunderland,*[14] *Massachusetts. We chose this geographic area because the operation of the five projects could be a contributing factor to sediment movement within the river and cumulative effects on resident fisheries and freshwater mussel habitat in this area.*
>
> We have identified the geographic scope of cumulative effects on *terrestrial and floodplain communities to include the 100-year floodplain (as defined by the Federal Emergency Management Agency) adjacent to the project-affected areas from the upstream extent of the Wilder reservoir downstream to the Route 116 Bridge in Sunderland, Massachusetts. We chose this geographic area because the operation of the projects, in combination with other land uses in the Connecticut River Basin, may cumulatively affect floodplain communities adjacent to project reservoirs and downstream riverine reaches in this area.*
>
> The presence of multiple dams on the Connecticut River may cumulatively affect multi-day paddle trips. *Based on our independent review and stakeholder comments, we find the geographic scope of the cumulative effects on* recreation for multi-day paddling trips *on the Connecticut River may extend as far upstream as Murphy Dam (RM 383) in Pittsburg, New Hampshire, where the natural*

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

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

> *riverine reaches become navigable (CRWC, 2007; American Whitewater, 2013)*[15] *and downstream to the Holyoke dam (FERC No. 2004), the most downstream dam, in Holyoke, Massachusetts.*

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

3.2.3 Temporal Scope of Analysis for Cumulatively Affected Resources

The temporal scope of the cumulative effects analysis addresses past, present, and future actions and their effects on each affected resource. Based on the expected term of a new license, the temporal scope of analysis addresses reasonably foreseeable actions for 40-50 years into the future.

3.2.4 Past, Present and Reasonably Foreseeable Future Actions

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

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

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

3.3 Proposed Action and Action Alternative

3.3.1 Geology and Soils

3.3.1.1 Affected Environment

3.3.1.1.1 Geology

Bedrock Geology

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

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

Turners Falls Project

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

Northfield Mountain Project

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

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

Surficial Geology

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

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

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

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

Terrace and Floodplain Surfaces

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

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

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

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

3.3.1.1.2 Soils

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

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

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

3.3.1.1.3 Shoreline and Streambank Characterization

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

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

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

As noted in the 2013 FRR report (FirstLight, 2014), 84.8% of the total length of the TFI riverbanks were found to have None/Little erosion[16], 14.1% Some erosion, 0.5% Some to Extensive erosion, and 0.6% Extensive erosion. Furthermore, 5.5% of the total length of TFI riverbanks were found to have Potential Future Erosion, 0.6% Active Erosion, 9.1% Eroded, 83.5% Stable, and 1.3% in the Process of Stabilization. Table 3.3.1.1.3-1 presents summary statistics of the TFI streambank features and characteristics as noted during the 2013 FRR, while Table 3.3.1.1.3-2 provides definitions for each classification. Figure 3.3.1.1.3-1 (5 maps) depicts the extent of current erosion found along the streambanks of the TFI. Additional discussion pertaining to bank erosion conditions and causes is presented in Section 3.3.1.2.1.

3.3.1.1.4 Suspended Sediment

TFI suspended sediment values have been observed to have a strong correlation to flow. That is, the highest suspended sediment concentration (SSC) values are often observed during the highest periods of flow while the lowest SSC values are often observed during the lowest period of flows. During a three year observation period (2013-2015), three mainstem flow thresholds were observed in regard to SSC values: <12,000 cfs, 12,000-35,000 cfs, and >35,000 cfs. Median SSC values for mainstem flows below 12,000 cfs observed during this period (as measured in the vicinity of the Route 10 Bridge) were 2.9 mg/L while flows between 12,000-35,000 cfs and greater than 35,000 cfs had observed median SSC values of 12.45 mg/L and 144.61 mg/L, respectively (FirstLight, 2016). Figure 3.3.1.1.4-1 demonstrates this relationship.

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

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

typical high, moderate, and low flow periods are shown in Figures 3.3.1.1.4-2 – 3.3.1.1.4-4. Table 3.3.1.1.4-1 demonstrates the seasonal range of flows and SSC values observed during the three year observation period (2013-2015).

3.3.1.2 Environmental Effects

Environmental issues and concerns pertaining to geology and soil resources as identified by FERC in SD2 included: (1) effects of Project induced water level fluctuations in TFI, on shoreline stability and river bank erosion, particularly where erosion might impact protected plant species, critical wildlife habitat, adjacent structures, recreational use facilities, and/or private landowners within the Project boundary; (2) effects of Turners Falls Project operation on river bank erosion in the bypass reach and downstream of Cabot Station; and (3) effects of Project operation and maintenance on sedimentation and sediment transport and the potential effect on aquatics and shallow water habitat, including areas such as Barton Cove and backwater areas. Each of these potential environmental issues is discussed in the ensuing sections.

3.3.1.2.1 TFI Shoreline Stability and River Bank Erosion

Extent of Erosion

Numerous studies have been conducted since 1979 to characterize TFI bank conditions, to understand the causes of erosion, and to identify the most appropriate approaches for bank stabilization. In 1998, the results of historic study efforts were used to inform the development of the Erosion Control Plan (ECP) (S&A, 1999). The primary goal of the ECP was to address stabilization and preventative maintenance of erosion sites in the TFI, regardless of cause.

As part of the ECP, an initial reconnaissance-level survey of the length of the TFI shoreline was conducted to identify any bank erosion sites regardless of the cause of erosion. The survey resulted in the development of a list of the 20 most severely eroded sites found throughout the TFI. Following development of this list, the Licensee began stabilizing these sites using various techniques, including bio-engineering. The 1998 list served as the basis for the construction of approximately 26,125 linear feet of stabilization efforts since 1999. Fifteen of the 20 sites identified in 1998 have been stabilized. Of the five (5) sites not stabilized, two (2) are located in areas where extreme hydraulic conditions exist that are proximate to non-Project related manmade structures (just below Vernon Dam and just upstream of the Route 10 Bridge), one (1) site is located on an island (island locations have typically not been as high priority to repair as bank locations), and two (2) other sites were not selected for stabilization based on feedback from stakeholders and landowners. Table 3.3.1.2.1-1 denotes the current status of the 20 most severely eroded sites identified during the 1998 FRR. Figure 3.3.1.2.1-1 (5 maps) shows the locations where stabilization efforts associated with the ECP have occurred.

In addition to the 26,125 linear feet of TFI banks that have been stabilized since 1998, previous stabilization work associated with construction of the Northfield Mountain Project totaled 25,900 feet of rip-rap or rip-rap with vegetation plus an additional 2,600 feet of grading and planting. An additional 2,000 feet of experimental stabilization was also constructed by the USACE in the 1970s. Overall, approximately 56,625 linear feet (10.7 miles) of TFI banks have been stabilized through construction of the Northfield Mountain Project, implementation of the ECP, or other efforts (e.g., USACE).

Over the past 22 years, TFI bank erosion conditions have improved. The 1998 FRR identified 3.4% of TFI banks as being ‘Severely Eroded’ while the 2013 FRR found that only 0.6% of banks were classified as having ‘Extensive’ erosion.[17] The majority of the 20 most severely eroding sites identified in 1998 have successfully been treated, are now stable and supporting heavy vegetation, and have not experienced any significant erosion. Moreover, erosion sites in 1998 were quite large in magnitude and stark in appearance with very little vegetation and significant potential for ongoing erosion and sediment production. By

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[17] Due to classification differences between the 1998 and 2013 FRR’s “Severely Eroded” and “Extensive Erosion” were the most severe erosion classifications for the 1998 and 2013 FRR, respectively.

contrast, during the 2013 FRR, eroding sites were found to be generally smaller in magnitude with a greater degree of vegetation. In addition, it was observed that from 2008 to 2013 there has been an increase in bank stability and, therefore, a corresponding decrease in eroding banks (FirstLight, 2014). The trends observed during the 2013 FRR have remained consistent since that time.

As a means of comparison, and to put the TFI banks into context with respect to erosion processes in other sections of the Connecticut River, Simons & Associates (S&A) examined and compared bank erosion in the TFI to other reaches of the Connecticut River in 2012 (FirstLight, 2012). This evaluation included impoundments upstream and downstream of the TFI and free-flowing stretches of the river. The results of this assessment found that the segment of river with the greatest extent of eroding banks is the un-impounded northern reach (Pittsburg, NH down to Gilman Dam, approximately 85 miles) (FirstLight, 2012). The evaluation concluded that the TFI banks are in the best condition (more stable and less eroding) when compared to any other part of the Connecticut River (FirstLight, 2012).

Causes of Erosion

Existing Conditions

The causes of erosion in the TFI were evaluated in Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability* (Study No. 3.1.2). Study No. 3.1.2 evaluated and identified the causes of erosion, and the forces associated with them, in the TFI and determined to what extent they are related to existing Project operations (FirstLight, 2017a). The causes of erosion identified in Study No. 3.1.2 (FirstLight, 2017a) were determined via state-of-the-science modeling (i.e., Bank Stability and Toe Erosion Model (BSTEM)) and supplemental engineering analyses at 25 detailed study sites located throughout the study reach. The detailed study sites spanned the longitudinal extent of the TFI and were representative of the riverbank features, characteristics, and erosion conditions found throughout the study reach. The results from the 25 detailed study sites were then extrapolated throughout the TFI such that each riverbank segment identified during the 2013 FRR had a dominant and, in some cases, contributing cause(s) of erosion assigned to it. The complex hydrologic and hydraulic characteristics of the TFI were also examined in-depth and accounted for during this process. Such characteristics were found to be just as important to erosion processes as were riverbank features and characteristics.

Input parameters to BSTEM were based on a variety of factors including field-collected geotechnical and geomorphic data as well as hydraulic and operations modeling outputs. BSTEM utilized a series of production runs that examined various operating scenarios to determine erosion rates and causes of erosion (e.g., Northfield Mountain On (baseline – existing conditions), Northfield Mountain Off (meaning the Northfield Mountain Project is not operating), boat waves on/off, etc.). Upon preparation of the AFLA, modifications to the underlying hydraulic and operations models were made to ensure a direct comparison to the results of the BSTEM modeling of FirstLight's proposed operating regime (discussed later in this section).

Revised modeling of existing conditions covered the same period as the original study (i.e., 2000-2014) but utilized the HEC-ResSim Operations Model as opposed to historic data. The HEC-ResSim modeling consisted of two model runs – "Baseline" and "Northfield Mountain Off". The "Baseline" HEC-ResSim model run consisted of:

- historical flows from Vernon, Millers River, and Ashuelot River;
- Northfield Mountain On; and
- TFI water surface elevations (WSEL) at the Turners Falls Dam based on reservoir imbalance[18] scripting and the other constraints of the existing license.

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[18] FirstLight typically maintains a slightly positive imbalance meaning there is slightly more water in the total system (TFI and Upper Reservoir) than the storage capacity of the Upper Reservoir between elevation 938 feet and elevation 1,000.5 feet.

The "Northfield Mountain Off" HEC-ResSim model run consisted of:

- historical flows from Vernon, Millers River, and Ashuelot River;
- Northfield Mountain Off; and
- TFI WSEL was modeled as a function of Vernon inflow and the other constraints of the existing license. Because Northfield Mountain is not operating under this scenario there is no need to simulate the reservoir imbalance as in the baseline model.

The "Northfield Mountain Off" model run was made to isolate the impact of its operation on potential shoreline erosion.

Hourly outputs from the HEC-ResSim model for each scenario were then used as the downstream boundary condition (the TFI WSEL at the Turners Falls Dam) in the TFI HEC-RAS Model. Outputs from the TFI HEC-RAS Model consisting of hourly WSELs at different locations along the TFI and the energy gradeline slopes were then used as hydraulic input for BSTEM. BSTEM was then re-run at each detailed study site to examine the impact of existing Project operations on erosion. The results of the existing conditions BSTEM model runs were later compared to the BSTEM runs examining FirstLight's proposed operating regime. The results of the updated modeling are discussed below and were found to be consistent with the primary findings of Study No. 3.1.2. More detailed discussion pertaining to the updated modeling conducted for the AFLA is included in Appendix A- Geology and Soils- Updated Results (Exhibit E, Part 3 of 3).

In summary, the results of the updated BSTEM modeling, and other analyses conducted for Study No. 3.1.2, found that current hydropower operations have a very limited impact on bank erosion in the TFI. In particular, BSTEM modeling and analyses conducted for Study 3.1.2 reached the following conclusions:

- Naturally occurring high flows have the greatest impact on erosion in the TFI. Natural high flows are the dominant cause of erosion[19] at every detailed study site within the TFI for which causes of erosion could be determined, except for one located near Barton Cove. This equates to approximately 86% of all riverbank segments in the TFI. Moderate flows were a contributing cause of erosion[20] at approximately 10% of all riverbank segments;
- Approximately 76% of all riverbank segments do not have a contributing cause of erosion because high flows are so dominant;
- Turners Falls Project operations were not found to impact bank erosion;
- Northfield Mountain Project operations are not a dominant cause of erosion at any riverbank segment in the TFI. They are a contributing cause of erosion at one detailed study site (i.e., 8BR), which accounts for approximately 2% of the total riverbank segments (approximately 4,700 ft.) when extrapolated. Site 8BR has previously been restored and, therefore, has a very low rate of erosion (i.e., 0.73 ft^3/ft/yr.);
- Boat waves are a dominant cause of erosion at approximately 14% of all riverbank segments and a contributing cause of erosion at approximately 12% of all riverbank segments. The influence of boat waves on erosion is greatest in the Lower Reach (Reach 1- reach locations are shown in Figure 3.3.1.2.1-2);
- At eight (8) of the 25 detailed study sites it was not possible or appropriate to assign a cause of erosion because modeled erosion was so small. Specifically, at these sites, the total amount of erosion (ft^3/ft/yr.) under the baseline-existing condition fell below the 5th percentile of the total erosion modeled for all sites and is within the minimum survey error used for calibration. Because the amount of total erosion at those sites falls below what is considered a measurable amount of erosion, assigning a cause to that erosion would not be appropriate, nor is it necessary given the very small amount of erosion that was occurring;

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[19] Dominant causes of erosion are responsible for greater than 50% of the erosion at a given site.

[20] Contributing causes of erosion are responsible for greater than 5% (but less than 50%) of the erosion at a given site.

- Based on analysis of historic information from the Connecticut River, as well as other river systems, ice has the potential to be a naturally occurring cause of erosion in the TFI in the future given the right climactic and hydrologic conditions. Due to the hydrologic and hydraulic characteristics of the TFI, it is anticipated that hydropower operations will have limited to no impact on ice as related to bank erosion (FirstLight, 2017a);
- Land management practices outside of FirstLight's control and anthropogenic influences are a potential contributing primary cause of erosion at 44% of all riverbank segments in the TFI (101,000 ft.) (FirstLight, 2017a); and
- Potential secondary causes of erosion such as wind waves, animals, seepage and piping, and freeze-thaw were found to be insignificant in causing erosion in the TFI beyond limited, localized areas where they may exist (FirstLight, 2017a).

Figure 3.3.1.2.1-2 depicts the dominant and contributing causes of bank erosion at each detailed study site throughout the TFI based on the updated BSTEM modeling. Figure 3.3.1.2.1-3 depicts the extrapolated causes of erosion for each bank segment throughout the TFI. The extrapolation of erosion causes follows the same methodology as described in FirstLight (2017a). Table 3.3.1.2.1-2 presents a matrix of the dominant and contributing causes of erosion under existing conditions as well as the total amount of erosion modeled at each detailed study site based on the updated BSTEM modeling.

Proposed Operating Regime

Additional BSTEM runs were also executed to quantify the change in bank erosion rates under FirstLight's proposed operating regime. The same general methodology used to analyze existing conditions was used for analyzing the potential effect of the proposed operating regime on riverbank erosion in the TFI. That is, the same detailed study sites and geotechnical and geomorphic parameters were used, and the same period of record was examined (i.e., 2000-2014); however, the hydraulic and operations model inputs were modified to reflect the proposed operating regime. As with the existing conditions scenario, the HEC-ResSim operations model was used to simulate the proposed operating regime. The HEC-ResSim proposed operating scenario consisted of:

- historical flows from the Millers and Ashuelot Rivers;
- Vernon outflows, including minimum flow requirements based on a drainage area proration of the minimum flow requirements in the Turners Falls bypass reach from FirstLight's proposal;
- Northfield Mountain On with FirstLight's proposed expanded Upper Reservoir limits[21]; and
- TFI WSEL modeled using reservoir imbalance scripting and the other operating constraints of FirstLight's proposed operating regime (e.g., Cabot Station up- and down-ramping, Cabot Station maximum flow restrictions, etc.).

Hourly output from the HEC-ResSim model were used as the downstream boundary condition (the TFI WSEL at the Turners Falls Dam) in the TFI HEC-RAS Model. Output from the TFI HEC-RAS Model consisting of hourly WSEL and energy gradeline slopes were then used as input to BSTEM to examine the impact of the proposed operating regime on bank erosion.

Given the number of operational changes under FirstLight's operating proposal, BSTEM analysis was not able to isolate only Northfield Mountain operations as was done under the original study. Instead, the cumulative impact of all Turners Falls/Northfield Mountain operational changes was quantified. In other words, analysis of FirstLight's operating proposal examined the potential impact of all operational changes that could potentially alter the TFI WSEL, including: (1) Northfield Mountain operational changes (i.e., increased range of the Upper Reservoir), (2) Cabot Station and Station No. 1 operational changes, and (3)

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[21] The actual operation of a pumped storage facility the size of Northfield Mountain is dependent upon a number of factors that are tied to the real time supply and demand of electricity. The generation and pumping predicted by the Operations Model is an approximation based on one pump-generation schedule. It is anticipated that on the ground conditions in the supply and demand market will be variable and not tied to a single pump-generation schedule.

bypass and below Cabot Station downstream minimum flow modifications. In addition, the FirstLight operating proposal also affects the flow in the TFI, generation and pumping flows from Northfield Mountain, and inflow from Vernon. Although FirstLight's proposal results in numerous operational changes, these changes typically do not have a noticeable effect on the velocity and WSEL in the TFI during natural high flow conditions.

The results of the BSTEM modeling examining FirstLight's proposed operating regime found that natural high flows are still the dominant cause of erosion throughout the TFI, with Project operations having minimal impact. More specifically, BSTEM modeling of FirstLight's proposed operating regime found the following:

- The dominant causes of erosion do not change under the proposed operating regime. Natural high flows continue to have the greatest impact on erosion in the TFI, with boat waves having the greatest impact in the Lower Reach. High flows are the dominant cause of erosion at 86% of the riverbank segments, while boat waves are the dominant cause at 14%;
- There is no appreciable difference in the modeled amount of erosion between the existing and proposed operating regimes at all detailed study sites, with the exception of Site 12BL;
- Site 12BL results in an increase of 4.22 ft^3/ft/yr. of erosion under the proposed operating regime. The increased amount of erosion observed under the proposed operating regime is boat wave driven. The 'wave on' BSTEM scenario results in 7.36 ft^3/ft/yr. of erosion at this site, while the 'wave off' scenario results in 0.24 ft^3/ft/yr.;
- There are no contributing causes of erosion at approximately 74% of all riverbank segments due to the dominance of either high flows or boat waves;
- The proposed operating regime is a contributing cause of erosion at two detailed study sites – Sites 8BR and 75BL, which accounts for approximately 8% of all riverbank segments in the TFI (approximately 19,130 ft.). Site 8BR has been previously restored and, therefore, has a very low rate of erosion (i.e., 0.81 ft^3/ft/yr.). Site 75BL has a moderate rate of erosion (i.e., 3.68 ft^3/ft/yr.). The proposed operating regime is only responsible for 11% (Site 8BR) and 8% (Site 75BL) of the modeled erosion at these sites; and
- Moderate flows remain a contributing cause of erosion at Sites 119BL and 87BL, which accounts for approximately 4% of all riverbank segments. Boat waves are a contributing cause of erosion at Sites 87BL and 26R, which accounts for approximately 14% of all riverbank segments.

Figure 3.3.1.2.1-4 depicts the dominant and contributing causes of erosion at each detailed study site throughout the TFI under the proposed operating regime. Figure 3.3.1.2.1-5 depicts the extrapolated causes of erosion for each bank segment throughout the TFI. The extrapolation of causes of erosion follows the same methodology as described in FirstLight (2017a). Table 3.3.1.2.1-3 presents a matrix of the dominant and contributing causes of erosion under the proposed operating regime as well as the total amount of erosion modeled at each detailed study site.

3.3.1.2.2 Bypass Reach and Downstream River Bank Erosion

In SD2, FERC identified the effects of Turners Falls Project operation on river bank erosion in the bypass reach and downstream of Cabot Station as a potential environmental issue pertaining to geology and soil resources.

Bypass Reach

The bypass reach originates at Turners Falls Dam and extends approximately 2.5 miles downstream to Cabot Station. The bypass reach varies in width from approximately 200 ft. at its narrowest point to 1,200 ft. at its widest. Approximately 850 feet downstream of the Turners Falls Dam is the confluence with the Fall River[22], which is the only significant tributary to the bypass reach. In addition, the Spillway Fishway

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[22] The Fall River has a drainage area of about 34.2 square miles.

is located on river left at the Turners Falls Dam, while the Station No. 1 tailrace is located approximately one mile downstream of the dam. The bypass reach consists of several islands and channels, is composed primarily of bedrock, ledge outcrops, and cobble/boulders, and consists of banks that vary in height but are generally not considered high. The shoreline throughout the bypass reach is largely vegetated. In general, erosion is limited throughout the bypass reach.

Flow throughout the bypass reach primarily consists of Turners Falls Dam releases, attraction flow from the Spillway Fishway (during fish passage season), Fall River flow, and Station No. 1 releases[23]; however, natural flows are the dominant hydrologic influence throughout the bypass reach. Under the current license, the Project is required to provide seasonally varying continuous bypass minimum flows ranging from 120 cfs to 400 cfs depending on the time of year. The maximum hydraulic capacity of Station No. 1 is 2,210 cfs. As such, during normal operations when there is ample flow to generate at Cabot Station and Station No. 1, the maximum total amount of flow that is attributed to the Project within the bypass reach below Station No. 1 is about 2,610 cfs (upstream of Station No. 1 it is 400 cfs). Flows in excess of the power canal capacity of about 18,000 cfs are passed over the Turners Falls Dam. Flows of 18,000 cfs are equaled or exceeded during March (34%), April (82%), May (48%) and June (13%) and may also occur during other times of the year in response to less frequent and shorter duration natural high flow events. During maintenance activities (e.g., power canal dewatering, debris control, etc.) Connecticut River flow may be diverted as spill over the Turners Falls Dam.

Under FirstLight's proposal, in Reach 1[24], flows below Turners Falls Dam would range from 300 cfs during the winter months to 4,290 cfs in April and May[25]. Station No. 1 would be operated more regularly than currently to supply increased flows to the bypass reach ranging from 1,000 cfs in September through November to full generation (2,210 cfs) during the months of April and May. On an annual basis, a flow of 18,000 cfs and 30,000 cfs are equaled or exceeded approximately 21% and 10% of the time, respectively. More details on the proposed seasonal flow regime are provided in Section 2.2.5. Additional discussion pertaining to the long-term hydrology is presented in Section 3.3.2.

Due to the geomorphic characteristics of the bypass reach, at bypass flows equal to or less than those attributed to the Project (i.e., 2,610 cfs[26] under existing conditions, 6,500 cfs under proposed), the WSEL generally rests below the toe of the bank[27], or low on the bank, the majority of the time. Water velocities during such periods are generally low along the banks. As a result, the potential for erosion to occur during such periods is likely minimal. As natural flows increase so do the corresponding water velocity and WSEL. During periods of moderate to high natural flows, the WSEL rises and rests at higher elevations along the bank face which, when combined with increased water velocity, has the potential to result in hydraulic erosion processes occurring along the face of the bank. To demonstrate this, three representative transects were examined within the bypass reach – T-10 (upstream of Station No. 1), T-3 (downstream of Station No. 1), and Location 5 (downstream of Rawson Island but upstream of Cabot Station) (Figure 3.3.1.2.2-

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[23] Also located on the Turners Falls power canal is the Turners Falls Project owned by Eagle Creek Renewable Energy (FERC No. 2622, 288 cfs capacity) and the former PaperLogic hydro now owned by Milton Hilton, LLC (no FERC license, 113 cfs capacity)

[24] Reach 1 in the bypass, extends from the Turners Falls Dam to Station No. 1. Details pertaining to the individual reaches are provided in Section 3.3.2 and Section 3.3.3.

[25] Note that FirstLight's proposed bypass flows, including Turners Falls Dam discharges and Station No. 1 discharges are all on an or-inflow, whichever is less, basis. For example, if inflow in April is too low to maintain 4,290 cfs from the Turners Falls Dam and 2,210 cfs from Station No.1, the bypass flows would be reduced as discussed in Section 2.2.5.

[26] 2,610 cfs= 400 cfs min flow + Station No. 1 full capacity of 2,210 cfs.

[27] For this analysis, the toe of bank was estimated as the location of the change in grade, substrate, and cover on the bank.

1)[28]. At each transect, a WSEL duration analysis was conducted to compare the percent of time WSELs equal or exceed the toe of the bank at each site (Figures 3.3.1.2.2-2 to 3.3.1.2.2-4). The WSEL duration curves for baseline and FirstLight's proposal was based on output from the HEC-ResSim model which was then used in the reach specific hydraulic model to determine the transect WSEL corresponding to baseline and FirstLight's proposal flows. In addition to the WSEL duration curves, also shown on Figures 3.3.1.2.2-2 to 3.3.1.2.2-4 is the transect channel bed elevations and the WSELs at flows of 4,290 cfs (FirstLight's proposal), 18,000 cfs and 30,000 cfs (see the secondary x-axis on the figures).

As observed in Figure 3.3.1.2.2-2, at T-10 the right and left toe of bank are identified as approximately El. 127 and 126, respectively. Under existing conditions, the WSEL rests at or just below El. 126 approximately 75% of the time, while under the proposed operating regime it rests at or below the toe approximately 60% of the time. WSELs at T-10 are slightly higher under the proposed operating regime as a result of the proposed increased bypass flows. FirstLight's maximum proposed bypass flow (i.e., 4,290 cfs) corresponds to a WSEL of approximately El. 128, which is approximately 1-2 ft. above the toe of bank. As observed in Figure 3.3.1.2.2-2, the WSEL rests above the toe of the bank approximately 40% of the time. During these periods, the WSEL is slightly above the toe of the bank 25% of the time within the proposed operating range of the Project and well above the toe of the bank 15% of the time as a result of natural moderate to high flows, which include substantial spillage over Turners Falls Dam. The remaining 60% of the time, the WSEL is below the toe of the bank. Although the WSEL rests above the toe of the bank under the proposed operating regime more than under existing conditions, water velocity and the potential for erosion during such periods are likely to be low. It is not until the WSEL rises on the bank and water velocity increases due to increased natural flows that the majority of erosion would be likely to occur [see the red (30,000 cfs) and purple (18,000 cfs) dashed lines on Figure 3.3.1.2.2-2. Similar behavior is observed at T-3 downstream of Station No. 1 as demonstrated in Figure 3.3.1.2.2-3.[29]

Location 5 is downstream of Rawson Island but upstream of Cabot Station (Figure 3.3.1.2.2-1). Although this location is upstream of Cabot Station it can still be hydraulically influenced by Cabot Station operations. As a result, the maximum flow attributed to the Project under the proposed operating regime at this location is 20,500 cfs (i.e., 6,500 cfs from the bypass plus the maximum hydraulic capacity of Cabot Station (i.e., about 14,000 cfs[30])). As observed in Figure 3.3.1.2.2-4, the maximum flow attributed to the Project under the proposed operating regime in this area (i.e., 20,500 cfs) equates to a WSEL of approximately El. 116 ft., which is slightly above (left toe) or below (right toe) of the bank. The WSEL at this location is equal to or lower than the toe of the bank approximately 85% of the time. The only time when the WSEL exceeds the toe of the bank in this area is during periods of moderate to high natural flows beyond the influence of the Project.

Due to the geomorphic and hydraulic characteristics of the bypass reach, the potential for erosion to occur within the flow range attributed to the Project is very low. If erosion were to occur throughout the bypass reach, it would be the result of natural moderate to high flows and the corresponding increased water velocities and WSELs of such flows.

Downstream of Cabot Station

A similar analysis as that described in the previous section was conducted to examine the potential for erosion downstream of Cabot Station. Cabot Station is located at the downstream extent of the bypass reach, approximately 0.6 miles upstream of the confluence with the Deerfield River. For the purpose of this analysis, one representative location downstream of Cabot (but slightly upstream of the Deerfield River

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[28] T-10 and T-3 are transects used for the Instream Flow Study as defined in more detail in Section 3.3.3. Location 5 is a transect drawn perpendicular to the flow at node number 16,170 in the River2D hydraulic model also used for the Instream Flow Study.

[29] Note that since T-3 is located downstream of Station No. 1, the maximum flow attributed to the Project increases to 6,500 cfs when the maximum hydraulic capacity of Station No. 1 is considered.

[30] Each Cabot Station unit has a hydraulic capacity of 2,288 cfs for a total of 13,728 cfs.

confluence) was examined – Location 9 (Figure 3.3.1.2.2-1). The Deerfield River has a hydrologic influence on Connecticut River flows downstream of the confluence.

As demonstrated in Figure 3.3.1.2.2-5, although Cabot Station operations can influence the WSELs and flows throughout this downstream reach, the dominant hydrologic influence pertaining to erosion are natural moderate and high flows. The maximum flow attributed to the Project under the proposed operating regime downstream of Cabot Station (i.e., 20,500 cfs) equates to a WSEL of approximately El. 114 ft. at Location 9, which is at or below the toe of the bank (Figure 3.3.1.2.2-5). The WSEL at this location is equal to or lower than the toe of the bank approximately 85% of the time. The only time when the WSEL exceeds the toe of the bank in this area is during periods of moderate to high natural flows beyond the influence of the Project.

As discussed in the previous section, the potential for erosion is generally low during periods when the WSEL rests at or below the toe of the bank due to the geomorphic and hydraulic characteristics of the area. During periods of moderate to high natural flows, the WSEL rises and rests at higher elevations along the bank face which, when combined with increased water velocity, has the potential to result in hydraulic erosion processes occurring along the face of the bank. Given this, if erosion were to occur throughout the area immediately downstream of Cabot Station, it would be the result of natural moderate to high flows beyond the range of control by the Project and the corresponding increased water velocities and WSELs of such flows.

3.3.1.2.3 Sediment Transport and Sedimentation

In SD2, FERC identified the effects of Project operations and maintenance on sedimentation and sediment transport and the potential effect on aquatics and shallow water habitat, including areas such as Barton Cove and backwater areas as a potential environmental issue pertaining to geology and soil resources.

Sediment Transport

FirstLight conducted Study No. 3.1.3 *Northfield Mountain Project Sediment Management Plan* (Study No. 3.1.3) to evaluate suspended sediment dynamics in the Project area and to develop a plan to avoid or minimize the entrainment of sediment into the Northfield Mountain Project works during Northfield Mountain Upper Reservoir maintenance drawdowns (FirstLight, 2016).

The results of the study indicate that Connecticut River SSC values have a strong correlation to flow, with the highest SSC values observed during the highest flow periods and the lowest SSC values observed during the lowest flows. Review of available SSC data collected at the Northfield Mountain tailrace indicates that the Northfield Mountain Project generally pumps more suspended sediment into the Upper Reservoir than is transported back to the river during generation. This is especially true during high flow periods when the Northfield Mountain Project is pumping with three (3) or four (4) units. The results of the computational hydrodynamic modeling of the Upper Reservoir confirmed these findings. The Upper Reservoir modeling found that the root cause of sedimentation in the Upper Reservoir likely begins with relatively high concentrations of entrained bed and suspended sediment loads from the Connecticut River being transported during pumping phases (FirstLight, 2016). The water and sediment are transported at a high velocity through the conduit system to the Upper Reservoir. As the water and sediment combine with water already in the intake channel, the wider and deeper intake channel leads to a deceleration of the sediment rich pumped water and subsequent deposition of the sediment. Exit velocities are lower in the intake channel under generation than in the river intake and conduit system during pumping, meaning that much of the deposited sediment is not re-entrained during generation (FirstLight, 2016).

Changes in operating procedures (i.e., lowering the Upper Reservoir drawdown to elevation 920 feet) and/or physical modifications to the Upper Reservoir intake channel (i.e., narrowing its width) which were analyzed as part of Study No. 3.1.3 were found to have minimal impact on reducing the amount of sediment entrained in the Upper Reservoir (FirstLight, 2016). Additionally, based on the current geometry of the Project works, the modeling found that flushing deposited sediment back to the Connecticut River would result in that sediment being deposited at the tailrace tunnel exit for potential re-entrainment during subsequent pumping cycles. Based on these findings, and the current layout of the intake channel, these potential sediment management measures were not considered given their limited effectiveness. Furthermore, Computation Fluid Dynamics (CFD) and physical modeling of the tailrace area indicated that the construction of sediment exclusion structures also would have limited effectiveness (FirstLight, 2016).

Of the various measures evaluated, hydraulic dredging was found to be the most viable. The pilot hydraulic dredging operation successfully removed sediment from within and upstream of the Upper Reservoir intake channel without having any material sediment impacts to the Northfield Mountain Project works or sediment discharges to the Connecticut River. In addition, the availability of the Northfield Mountain Project for generation and pumping was not affected by the dredging operations.

Based on the results of the modeling conducted for Study No. 3.1.3, during normal Northfield Mountain Project operations (i.e., generation) material sediment releases are highly unlikely due to a combination of factors including the physical characteristics of the sediment, the velocity of the water, the configuration of the Upper Reservoir intake structure, and the water level of the Upper Reservoir. Given this, proposed environmental measures discussed in Section 3.3.1.4 focus on minimizing the entrainment of sediment into the Northfield Mountain Project works and Connecticut River during dewatering activities.

Sedimentation

A dam has existed in the general location of the present day Turners Falls Dam since 1798, during which time sediment transport processes typical of a reservoir system have occurred. As previously discussed, during periods of high flow, the Connecticut River transports substantial amounts of suspended sediment, which is either deposited within the TFI or transported downstream over the bascule gates or beneath the taintor gates at the Turners Falls Dam. Sediment deposition has occurred over the past 222 years and, although deposition may still occur on a year-to-year basis, a balance of sediment inflow and outflow likely occurs over a long period of time (i.e., years to decades). Such a dynamic is typical of reservoirs which have existed for so long. Review of available cross-section survey data appears to demonstrate this dynamic.

Cross-section surveys have been conducted at set transect locations annually since 1999. In the Barton Cove area, this includes cross-sections BC1, BC2, BC3, and BC5. Review of available survey data for the period 1999-2015 indicates that on a year-to-year basis a moderate amount of sediment deposition or loss may occur at these locations. The amount of sediment deposition or loss observed in a given year is the result of several natural variables including, but not limited to, the amount of precipitation and magnitude of high flow events that may occur. As observed in Figure 3.3.1.2.3-1, although sediment deposition or loss may occur year to year, neither the deposition nor loss rates appear to be significant. For the period examined (i.e., 1999-2015), the combination of the four transects in Barton Cove were found to be net depositional, with approximately 4,400 square ft[31]. of sediment deposited collectively. This equates to a depositional rate of approximately 275 square ft/year combined at the four survey cross-sections for the 16 year period.

3.3.1.3 Cumulative Impacts

FERC's SD2 identified sediment movement as a resource that may be cumulatively affected by the proposed operation and maintenance of the five Connecticut River projects currently undergoing relicensing (i.e., Turners Falls Project, Northfield Mountain Project, and the three GRH projects). As demonstrated in the previous sections, natural moderate to high flows are the dominant force pertaining to shoreline erosion and sediment transport in the Project area. During periods of high flow, the potential for erosion increases as does the Connecticut River's ability to transport large quantities of suspended sediment. All suspended sediment entering the TFI is either deposited within the TFI, Northfield Mountain Upper Reservoir or power canal or transported downstream over the Turners Falls Dam bascule gates or beneath the tainter gates, if operating. The Project passes sediment which originates from upstream sources. As

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[31] These are cross-sectional surveys thus the units are in square feet.

demonstrated in Study No. 3.1.3, the Northfield Mountain Project generally pumps more suspended sediment into the Upper Reservoir than is transported back to the river during generation. This is especially true during high flow periods when the Northfield Mountain Project is pumping with three (3) or four (4) units. With that said, suspended sediment can be transported to the Upper Reservoir during pumping operations regardless of the number of units operating; however, more sediment is typically pumped proportionally with more units operating.

Regarding the potential effect of maintenance activities on sediment movement within the Connecticut River, FirstLight has developed several protocols intended to avoid or minimize the entrainment of sediment into the Northfield Mountain Project works, and the Connecticut River, during Northfield Mountain Upper Reservoir maintenance drawdowns (FirstLight, 2016). A summary of these proposed environmental measures is provided in Section 3.3.1.4.3.

3.3.1.4 Proposed Environmental Measures

3.3.1.4.1 TFI Shoreline Stability and River Bank Erosion

As demonstrated in Section 3.3.1.4.1, natural high flows are the dominant cause of erosion at 86% of all bank segments throughout the TFI, with boat waves the dominant cause of erosion at the remaining 14%. Project operations are not a dominant cause of erosion (i.e., responsible for greater than 50% of erosion) at any detailed study sites throughout the TFI. Under the proposed operating regime, Project operations are a contributing cause of erosion (i.e., responsible for greater than 5% but less than 50% of erosion) at only two of the 25 detailed study sites (i.e., Site 8BR and 75BL) equating to approximately 19,130 linear feet of shoreline in the TFI.

Site 8BR and the associated extrapolated riverbank segments (approximately 4,700 linear feet) are located at previously restored bank segments. The total erosion modeled at Site 8BR is 0.81 ft^3/ft/yr. under the proposed operating regime, indicating that minimal erosion occurs annually at the previously restored site. Results of the BSTEM modeling found that the proposed operating regime only contributed to approximately 11% of erosion processes at the site. Thus, proposed project operations will have minimal effects on this minimally eroding site and, therefore, additional remediation measures are not necessary.

Site 75BL and the associated extrapolated bank segments equate to approximately 14,430 linear feet of TFI shoreline. The total erosion modeled at Site 75BL is 3.68 ft^3/ft/yr. under the proposed operating regime. Results of the BSTEM modeling found that the proposed operating regime only contributed to approximately 8% of erosion processes at the site. In addition, approximately 6,700 linear feet (46%) of the extrapolated bank segments associated with Site 75BL are located within the French King Gorge, which is dominated by bedrock and boulders and where minimal to no erosion occurs. Although some erosion is observed in localized segments of this area, the results of the 2013 FRR indicate that the bank segments in this area are largely considered stable (see Appendix J of the FRR Study Report – FirstLight, 2014).

Under the existing license, 56,625 linear feet (i.e., 10.7 miles) of TFI banks have been stabilized through various efforts at the cost of millions of dollars to FirstLight. Such restoration efforts were conducted regardless of whether Project operations were the cause of erosion and have helped contribute to the overall improvement in erosion throughout the TFI. As demonstrated through Study No. 3.1.2, and subsequent analysis, naturally occurring high flows are the dominant cause of erosion throughout the TFI. Results of recent erosion studies have indicated that there has been an increase in bank stability and a corresponding decrease in eroding banks since 1998 and that the TFI banks are in the best condition (more stable and less eroding) when compared against any other part of the Connecticut River. Under the proposed operating regime, Project operations are a contributing cause of erosion at Sites 8BR and 75BL, equating to approximately 19,130 linear feet of shoreline in the TFI. However, Site 8BR (and the associated bank segments) has already been restored, has a very low rate of erosion (i.e., 0.81 ft^3/ft/yr.), and the proposed operating regime only contributes to 11% of erosion processes at the site (i.e., 0.09 ft^3/ft/yr.). Site 75BL has a moderate rate of erosion (i.e., 3.68 ft^3/ft/yr.) of which the proposed operating regime only contributes to 8% of erosion processes at the site (i.e., 0.29 ft^3/ft/yr.). Of the bank segments associated with Site 75BL, 6,700 linear feet are in the vicinity of the French King Gorge and are composed of bedrock or boulders. The remaining 7,730 linear feet are in areas generally classified as being stable during the most recent FRR. As a result, FirstLight is not proposing any PM&E measures in these areas.

With that said, under the proposed operating regime, boat waves were found to be the dominant cause of erosion throughout the Barton Cove area (equating to approximately 14% of the TFI shoreline) (Figure 3.3.1.2.1-5). Although hydropower operations were not found to be a dominant or contributing cause in this area, BSTEM modeling indicates that erosion increases by approximately 4.22 ft^3/ft/yr. at Site 12BL under the proposed operating regime as a result of boat waves. The 'wave on' BSTEM scenario results in 7.36 ft^3/ft/yr. of erosion at this site, while the 'wave off' scenario results in 0.24 ft^3/ft/yr., a 97% reduction. Given this, FirstLight recommends that the Commonwealth of MA manage the Barton Cove area as a "no wake zone" under the new license to minimize the impact of boat waves on shoreline erosion in this area.

3.3.1.4.2 Bypass Reach and Downstream River Bank Erosion

As demonstrated in Section 3.3.1.2.2, erosion occurring in the bypass and downstream reaches, if any, is the result of moderate to natural high flows and not Project operations. As such, FirstLight is not proposing any PM&E measures regarding bypass and downstream erosion.

3.3.1.4.3 Sediment Transport and Sedimentation

In order to have the flexibility to dewater when needed and to minimize the risk of adverse environmental impacts when a dewatering occurs, FirstLight will employ a monitoring program to determine the amount of sediment that is present in the Northfield Mountain Upper Reservoir at a given time. The monitoring program will be based on bathymetric surveys of the Upper Reservoir and intake channel, which will be conducted at least every two (2) years.

The results of the bathymetric surveys will be reviewed by FirstLight to determine: the estimated depth, location, and shape of accumulated sediment as well as the estimated incremental amount of sediment which has accumulated between surveys. Based on FirstLight's review of the aforementioned accumulated sediment characteristics, excavation of the intake channel and/or other target areas will be planned and initiated as needed to minimize the potential for entrainment of sediment into the Project works and the Connecticut River during dewatering. Excavation of the accumulated sediment would occur via methods including, but not limited to, hydraulic dredging prior to dewatering or mechanical excavation after dewatering. The specific method will be developed based on the location and amount of sediment, the necessary time frame for removing the sediment, and then-available technologies and methods. FirstLight will notify MADEP, FERC, and USEPA in advance of any excavation activities. A survey of the excavated area will be conducted following completion of the excavation activities to establish an updated baseline. The process of regular monitoring and periodic excavation will reduce the amount of accumulated sediment to levels where the risk of entraining significant amounts of sediment into the Northfield Mountain Project works and the Connecticut River is minimized.

The decision to initiate excavation activities and the protocols that would be followed for such excavations will be determined in accordance with FirstLight's *Northfield Mountain Pumped Storage Project Sediment Management Plan Upper Reservoir Dewatering Protocols – June 2017* (FirstLight, 2017b). The aforementioned protocols were submitted to the MADEP, FERC, and USEPA on June 30, 2017 via electronic filing.

3.3.1.5 Unavoidable Adverse Impacts

The operation of the Northfield Mountain Project under FirstLight's proposal would continue to alter water levels on an intra-daily time step in the TFI. The results of BSTEM modeling conducted for the AFLA indicate that the proposed operating regime is a contributing cause of erosion for approximately 19,130 linear feet of shoreline in the TFI (i.e., responsible for 11% of erosion at Site 8BR and 8% at Site 75BL). As noted in Section 3.3.1.4.1, the absolute amount of erosion in these areas is small, and the contribution of hydropower operations is also small. At Site 8BR, a previously restored site, the total rate of erosion is

0.81 ft^3/ft/yr., of which the proposed operating regime contributes only approximately 11% (i.e., 0.09 ft^3/ft/yr.). At Site 75B the total rate of erosion is 3.68 ft^3/ft/yr., of which the proposed operating regime contributes approximately 8% (i.e., 0.29 ft^3/ft/yr.). Almost half of the bank segments associated with Site 75BL are located in the vicinity of the French King Gorge and are composed of bedrock or boulders. For these reasons, FirstLight has not identified any measures that are necessary to mitigate these unavoidable impacts.

In addition, as indicated in Study No. 3.1.3, there is no practical way to prevent sediment from being transported to the Northfield Mountain Upper Reservoir during pumping cycles. The continued operation of the Northfield Mountain Project under FirstLight's proposal would result in suspended sediment transport to, and deposition in, the Upper Reservoir. However, as identified in Section 3.3.1.2.3, FirstLight has proposed appropriate measures to mitigate this impact, particularly with regard to re-deposition of sediments from the Upper Reservoir into the TFI.

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

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

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

Riverbank Features	Characteristics					
Upper Riverbank Slope	Overhanging 1.8%	Vertical 1.6%	Steep 28.0%	Moderate 59.8%	Flat 8.8%	
Upper Riverbank Height	Low 15.5%	Medium 5.7%	High 78.8%			
Upper Riverbank Sediment	Clay -	Silt/Sand 95.6%	Gravel -	Cobbles -	Boulders 0.9%	Bedrock 3.5%
Upper Riverbank Vegetation	None to Very Sparse 1.9%	Sparse 1.3%	Moderate 17.1%	Heavy 79.7%		
Lower Riverbank Slope	Vertical 0.8%	Steep 2.3%	Moderate 27.5%	Flat/Beach 69.4%		
Lower Riverbank Sediment	Clay <0.1%[32]	Silt/Sand 59.6%	Gravel 7.9%	Cobbles 8.7%	Boulders 11.9%	Bedrock 11.9%
Lower Riverbank Vegetation	None to Very Sparse 88.3%	Sparse 3.5%	Moderate 3.2%	Heavy 5.0%		
Type of Erosion	Falls-Undercut 43.4%	Falls-Gullies 0.03%	Topples 1.1%	Slide or Flow 6.2%	Planar Slip 1.1%	Rotational Slump 1.5%
Potential Indicators of Erosion	Tension Cracks <0.10[33]%	Exposed Roots 38.1%	Creep/Leaning Trees 62.7%	Overhanging Bank 12.7%	Notch 5.0%	Other 1.1%
Stage of Erosion	Potential Future Erosion 5.5%	Active Erosion 0.6%	Eroded 9.1%	Stable 83.5%	In Process of Stabilization 1.3%[34]	
Extent of Current Erosion	None/Little 84.8%	Some 14.1%	Some to Extensive 0.5%	Extensive 0.6%		

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[32] Clay was found in few segments of the river but where some clay was found the sediment was dominated by another type of sediment either vertically or horizontally within a segment. When this occurred, the segment was classified using the dominant sediment type. For example, some clay was observed in segment 342 (just downstream of Vernon Dam on the left bank) but the segment was classified using the dominant sediment type.

[33] Tension cracks can only be observed from land-based observations. Some tension cracks were observed during the land-based survey and are reported at those sites as indicated in the notes for the land-based work. Tension cracks were not observed to be significant in the more general top of bank observations when walking along the length of the Impoundment.

[34] While originally not one of the Revised Study Plan erosion condition classifications, one riverbank segment was classified as being "In the Process of Stabilization" due to the fact that riverbank stabilization work was being constructed at this particular segment (421, Bathory/Gallagher 2013) during the 2013 FRR. A gravel beach at the top of the lower riverbank had been placed along with large woody debris. Vegetation was then being planted to provide additional stabilization on the gravel beach as well as extending other vegetation onto portions of the upper riverbank.

Table 3.3.1.1.3-2: Riverbank Classification Definitions

RIVERBANK CHARACTERISTICS *(Upper and Lower)*[35]	
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[36]
Riverbank Height	**Low –** height less than 8 ft. above normal river level[37]
	Medium – height between 8 and 12 ft. above normal river level
	High – height greater than 12 ft. above normal river level
Riverbank Sediment	**Clay –** any sediment with a diameter between .001 mm and 2 mm
	Silt / Sand – any sediment with a diameter between .062 mm and 2 mm
	Gravel – any sediment with a diameter between 2 mm and 64 mm
	Cobbles – any sediment with a diameter between 64 mm and 256 mm
	Boulders – any sediment with a diameter between 256 mm and 2048 mm
	Bedrock – unbroken, solid rock
Riverbank Vegetation	**None to Very Sparse –** less than 10% of the total riverbank segment is composed of vegetative cover
	Sparse – 10-25% of the total riverbank segment is composed of vegetative cover
	Moderate – 25-50% of the total riverbank segment is composed of vegetative cover
	Heavy – 50 % or greater of the total riverbank segment is composed of vegetative cover
Sensitive Receptors	Important wildlife habitat located at or near the riverbank.
EROSION CLASSIFICATIONS	
Type(s) of Erosion[38]	**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.[39]
Stage(s) of Erosion	**Potential Future Erosion –** riverbank segment exhibits multiple or extensive indicators of potential erosion

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

[36] Beaches are defined as a lower riverbank segment with a flat slope

[37] For the purpose of this report, Normal Water Level was defined as water levels within typical pool fluctuation levels, but below Ordinary High Water (186').

[38] FGS, 2007

[39] Segments with features classified as "Other" exhibited various erosion processes that did not fit in one of the existing classification categories.

	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[40] –** 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

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

Table 3.3.1.1.4-1: Seasonal Range of Flows and SSC (2013-2015) [41]

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

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

Table 3.3.1.2.1-1: Twenty Sites with Highest Erosion Rank from the Erosion Control Plan (1998) and Current Status

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

Table 3.3.1.2.1-2: Matrix of Dominant and Contributing Causes of Erosion – Existing Conditions

Site	Hydraulic Reach	Station	Total Erosion Under Baseline (ft^3/ft/yr)	Dominant Causes				Contributing Causes			
				Northfield Mountain Project Operations	High Flows	Vernon Operations	Boats	Northfield Mountain Project Operations	High Flows	Moderate Flows	Boats
11L	4 - Upper	100000	0.07^	-	-	-	-	-	-	-	-
2L*		94500	6.77		X						
303BL		94000	0.61		X						
18L		87000	1.41		X						
3L		79500	6.08		X						
3R*		79500	0.33		X						
21R		79250	2.35		X						
4L	3 - Middle	74000	0.02^	-	-	-	-	-	-	-	-
29R		66000	Failure occurs at first time step, cannot determine primary cause(s)								
5CR		57250	7.35		X						
26R		50000	1.13		X						X
10L		49000	0.15^	-	-	-	-	-	-	-	-
10R*		49000	0.00^	-	-	-	-	-	-	-	-
6AL*		41750	0.00^	-	-	-	-	-	-	-	-
6AR*		41750	0.02^	-	-	-	-	-	-	-	-
119BL	2 - NFM	41000	6.02		X					X	
7L		37500	4.17		X						
7R		37500	1.95		X						
8BL		32750	0.36		X						
8BR*		32750	0.73		X			X			
87BL		30750	3.58		X					X	
75BL		27000	3.42		X					X	
9R*	1 - Lower	6750	0.07^	-	-	-	-	-	-	-	-
12BL		6500	3.14				X				
BC-1R		4750	0.03^	-	-	-	-	-	-	-	-

* Indicates restoration site. Erosion amounts shown represent post-restoration condition

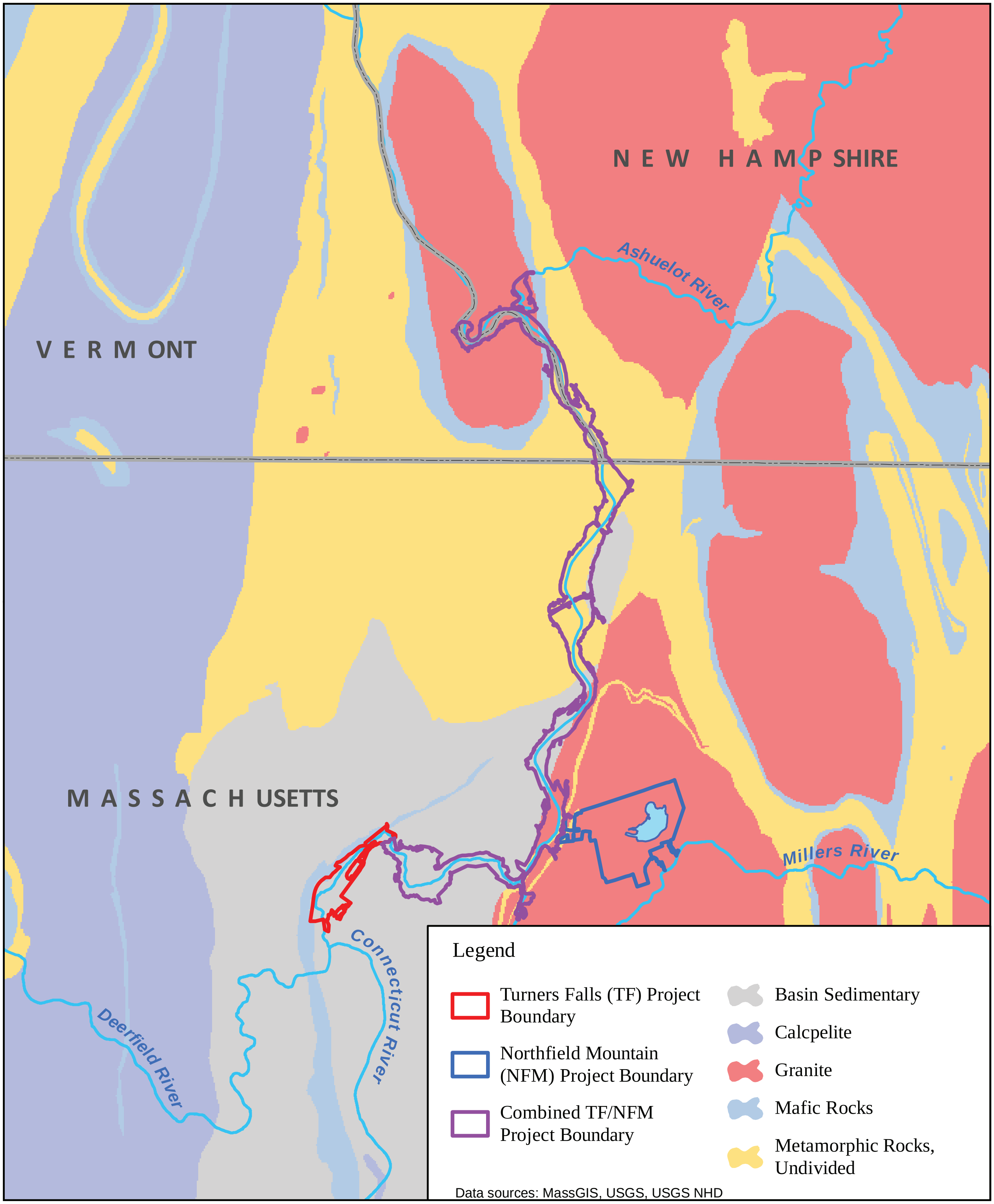
^ Erosion less than 0.161 ft^3/ft/yr., which falls below what is considered a measurable amount of erosion

Table 3.3.1.2.1-3: Matrix of Dominant and Contributing Causes of Erosion – Proposed Conditions

Site	Hydraulic Reach	Station	Total Erosion Under Baseline (ft^3/ft/yr)	Dominant Causes				Contributing Causes			
				Cumulative TF/NFM Proposed Operations	High Flows	Vernon Operations	Boats	Cumulative TF/NFM Proposed Operations	High Flows	Moderate Flows	Boats
11L	4 - Upper	100000	0.06^	-	-	-	-	-	-	-	-
2L*		94500	6.48		X						
303BL		94000	0.62		X						
18L		87000	1.15		X						
3L		79500	6.05		X						
3R*		79500	0.32		X						
21R		79250	2.33		X						
4L	3 - Middle	74000	0.02^	-	-	-	-	-	-	-	-
29R		66000	Failure occurs at first time step, cannot determine primary cause(s)								
5CR		57250	7.32		X						
26R		50000	1.16		X						X
10L		49000	0.16^	-	-	-	-	-	-	-	-
10R*		49000	0.00^	-	-	-	-	-	-	-	-
6AL*		41750	0.00^	-	-	-	-	-	-	-	-
6AR*		41750	0.02^	-	-	-	-	-	-	-	-
119BL	2 - NFM	41000	5.89		X					X	
7L		37500	4.25		X						
7R		37500	2.00		X						
8BL		32750	0.37		X						
8BR*		32750	0.81		X			X			
87BL		30750	3.65		X					X	X
75BL		27000	3.68		X			X			
9R*	1 - Lower	6750	0.07^	-	-	-	-	-	-	-	-
12BL		6500	7.36				X				
BC-1R		4750	0.02^	-	-	-	-	-	-	-	-

* Indicates restoration site. Erosion amounts shown represent post-restoration condition

^ Erosion less than 0.161 ft^3/ft/yr., which falls below what is considered a measurable amount of erosion



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

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Exhibit E

Figure 3.3.1.1.1-1 Bedrock Geology in the Vicinity of the Turners Falls Project and Northfield Mountain Project

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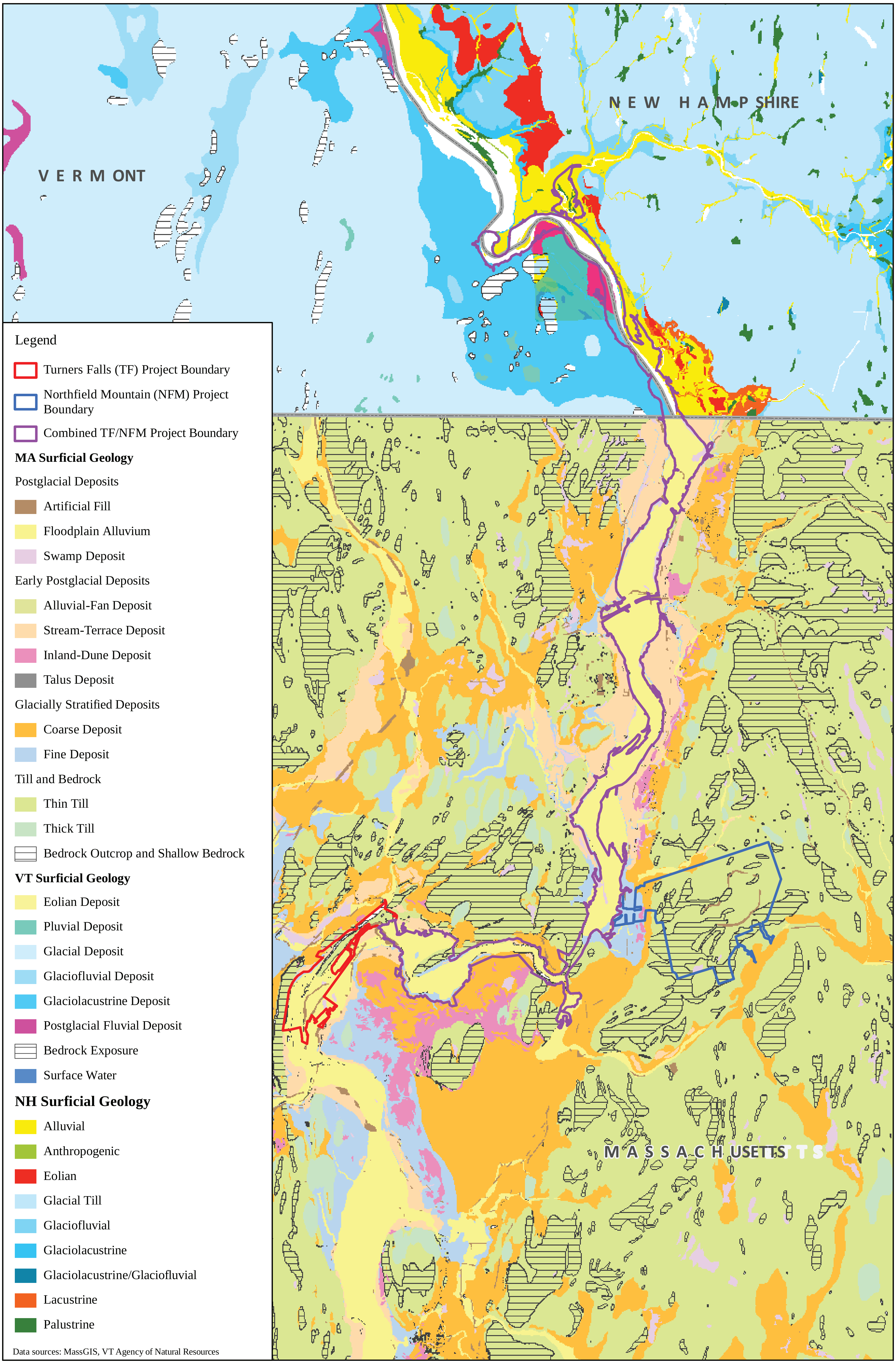

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Turners Falls Hydroelectric Project No. 1889

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Figure 3.3.1.1.1-2: Surficial Geology in the Vicinity of the Turners Falls Project and Northfield Mountain Project

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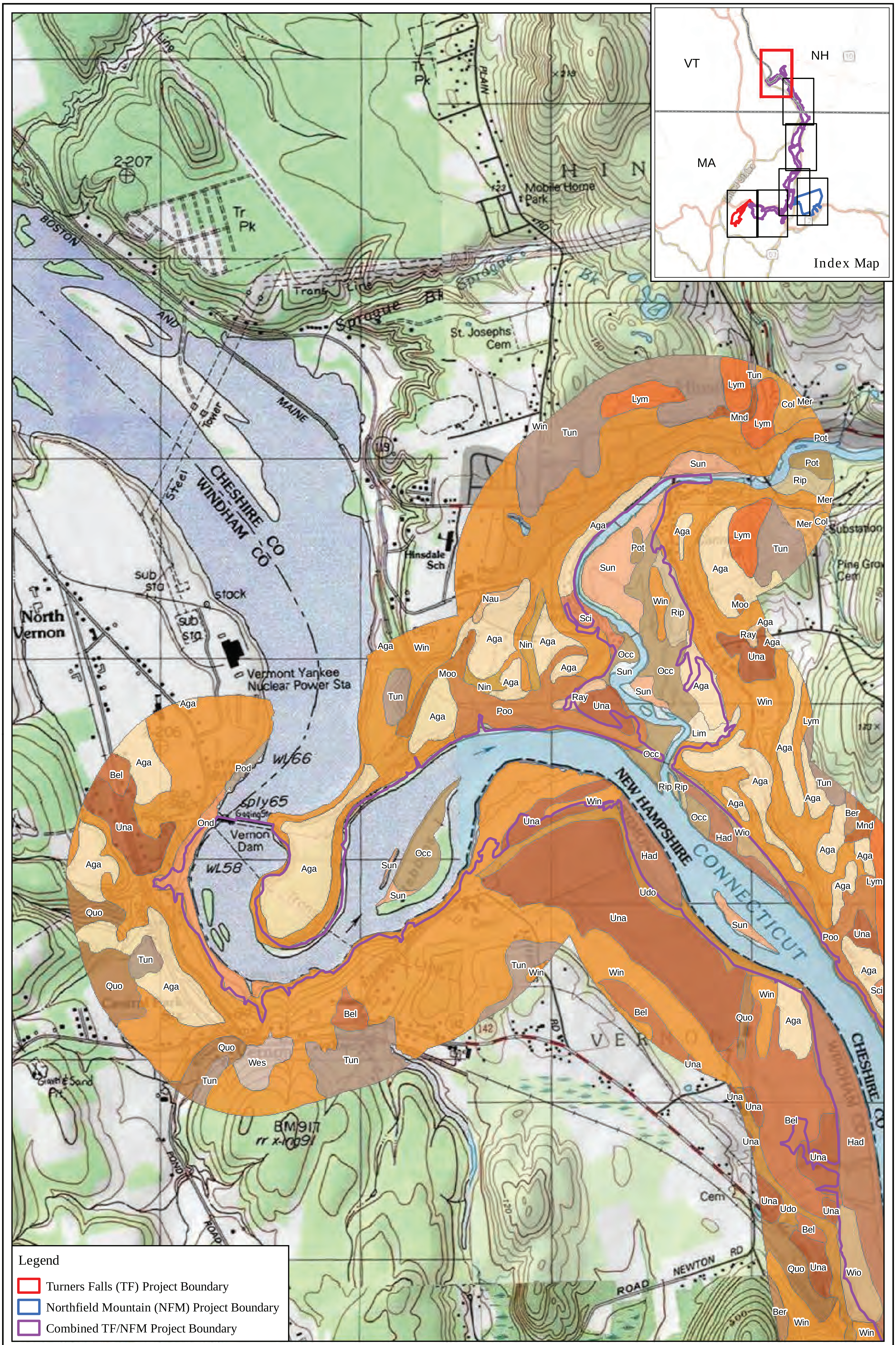

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls Project and Northfield Mountain Project
Map 1

FirstLight

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Data sources: SSURGO; Franklin County, MA

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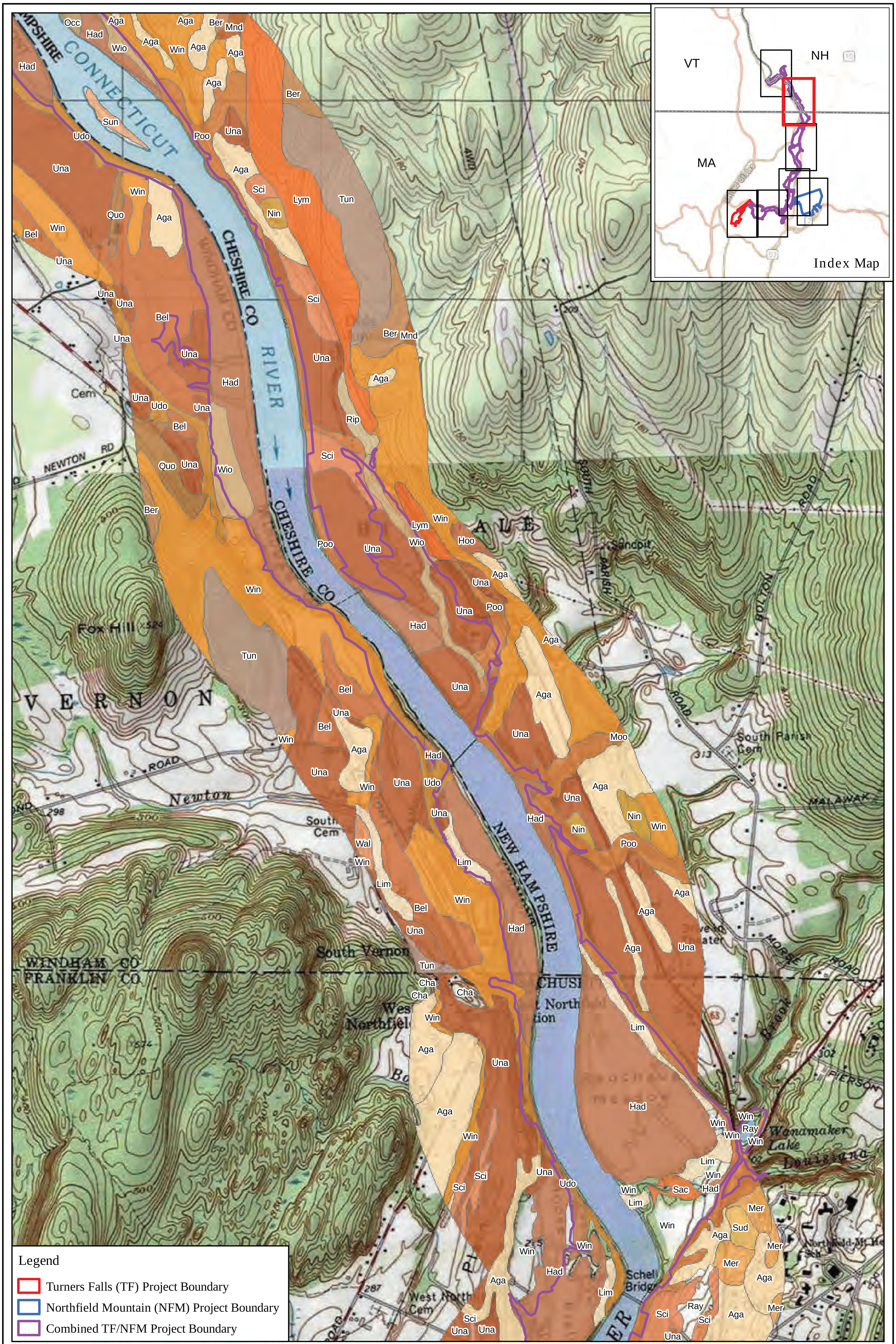

Legend

🟥 Turners Falls (TF) Project Boundary

🟦 Northfield Mountain (NFM) Project Boundary

🟪 Combined TF/NFM Project Boundary

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

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

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Data sources: SSURGO; Franklin County, MA

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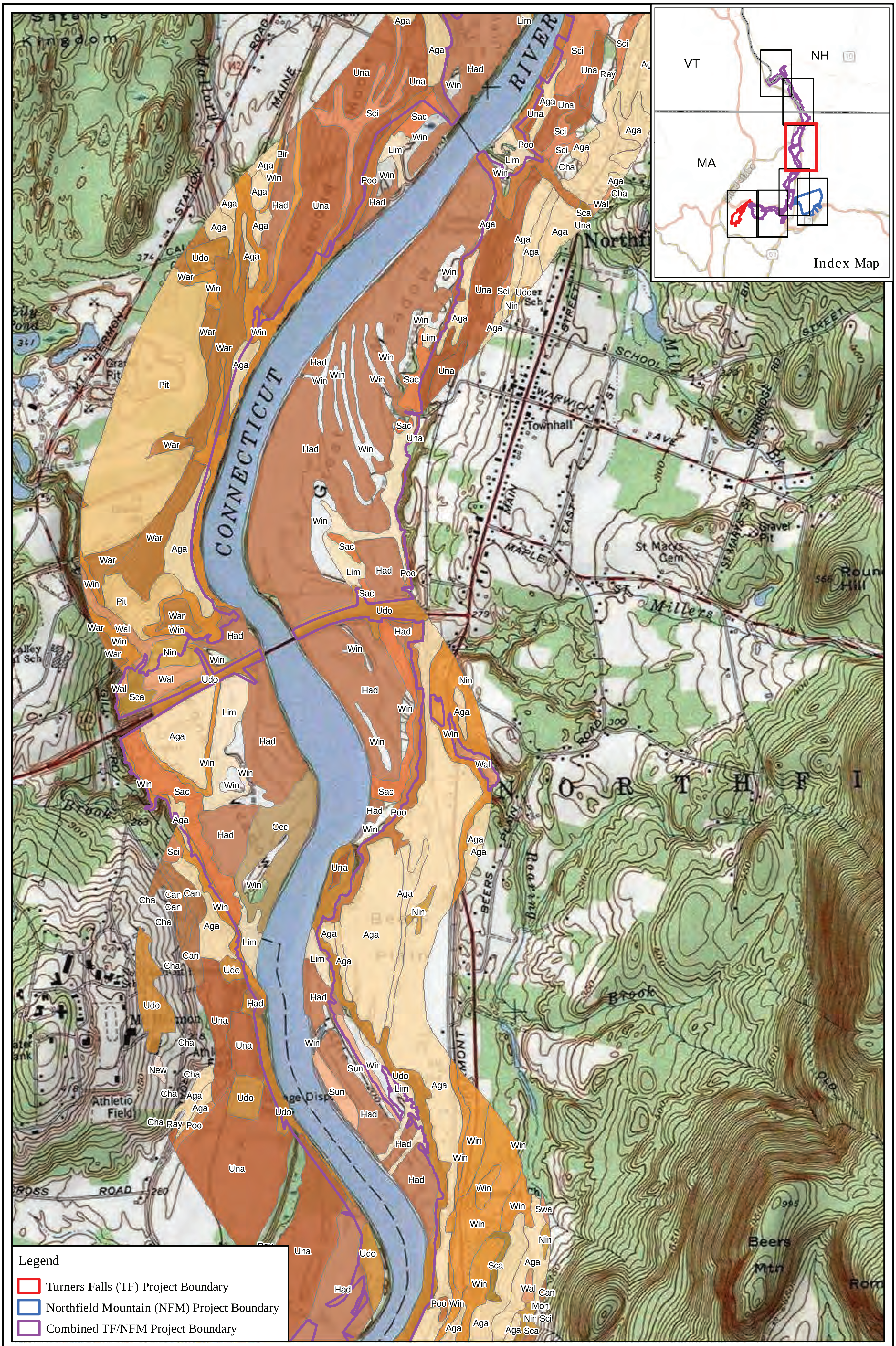

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls Project and Northfield Mountain Project
Map 3

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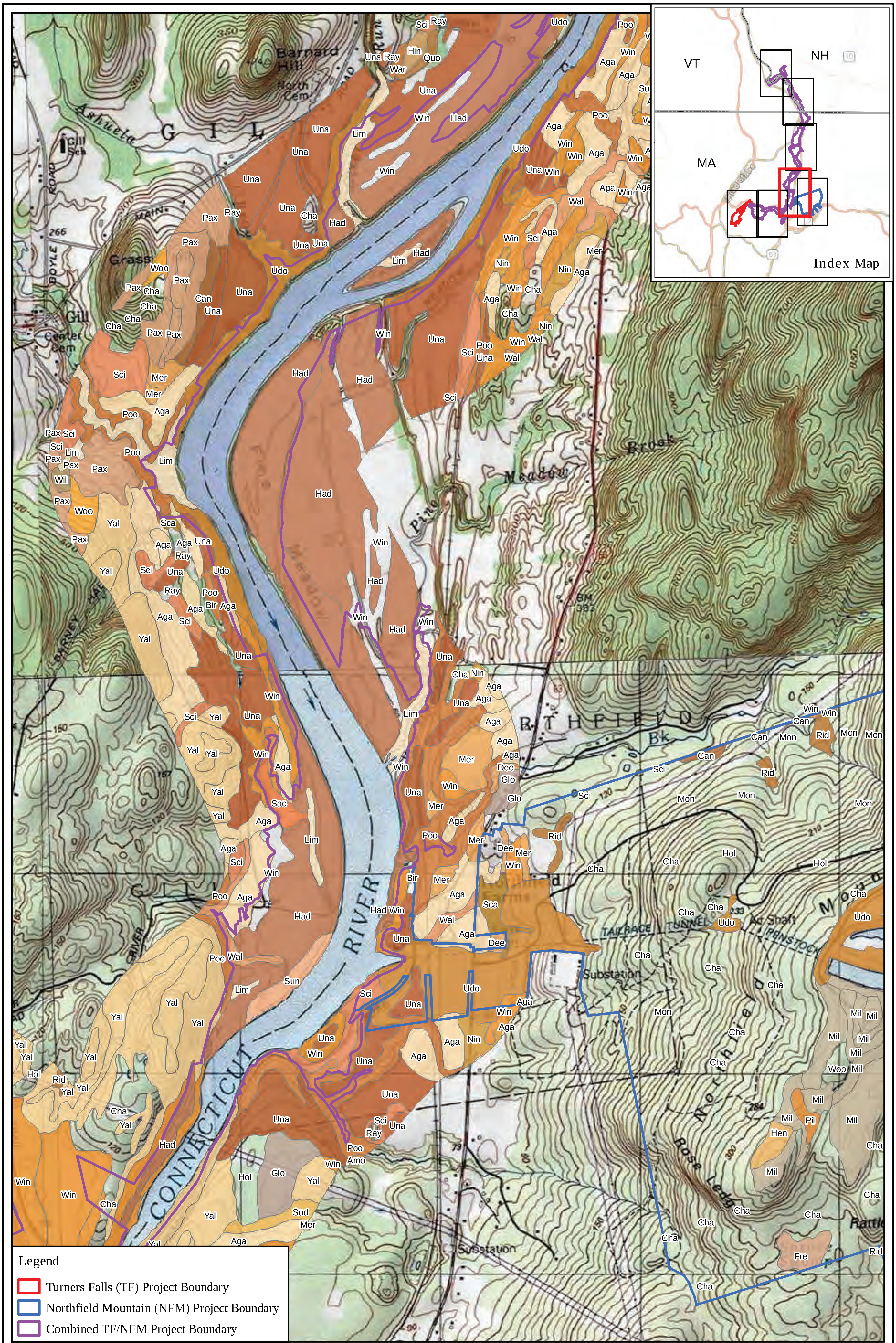

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🟥 Turners Falls (TF) Project Boundary

🟦 Northfield Mountain (NFM) Project Boundary

🟪 Combined TF/NFM Project Boundary

Northfield Mountain Pumped Storage Project No. 2485
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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls Project and Northfield Mountain Project Map 4

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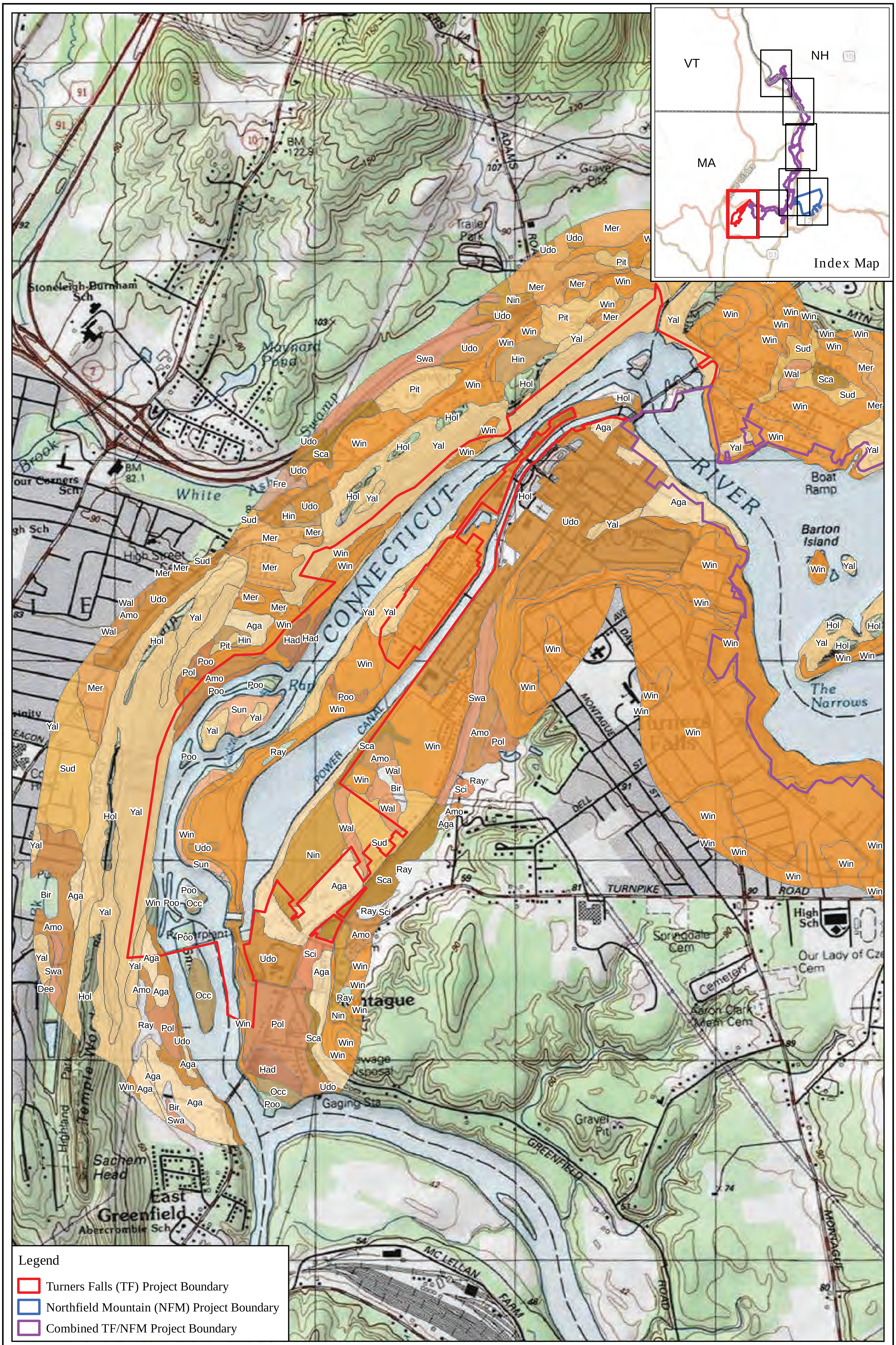

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🟥 Turners Falls (TF) Project Boundary

🟦 Northfield Mountain (NFM) Project Boundary

🟪 Combined TF/NFM Project Boundary

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

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

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Data sources: SSURGO; Franklin County, MA

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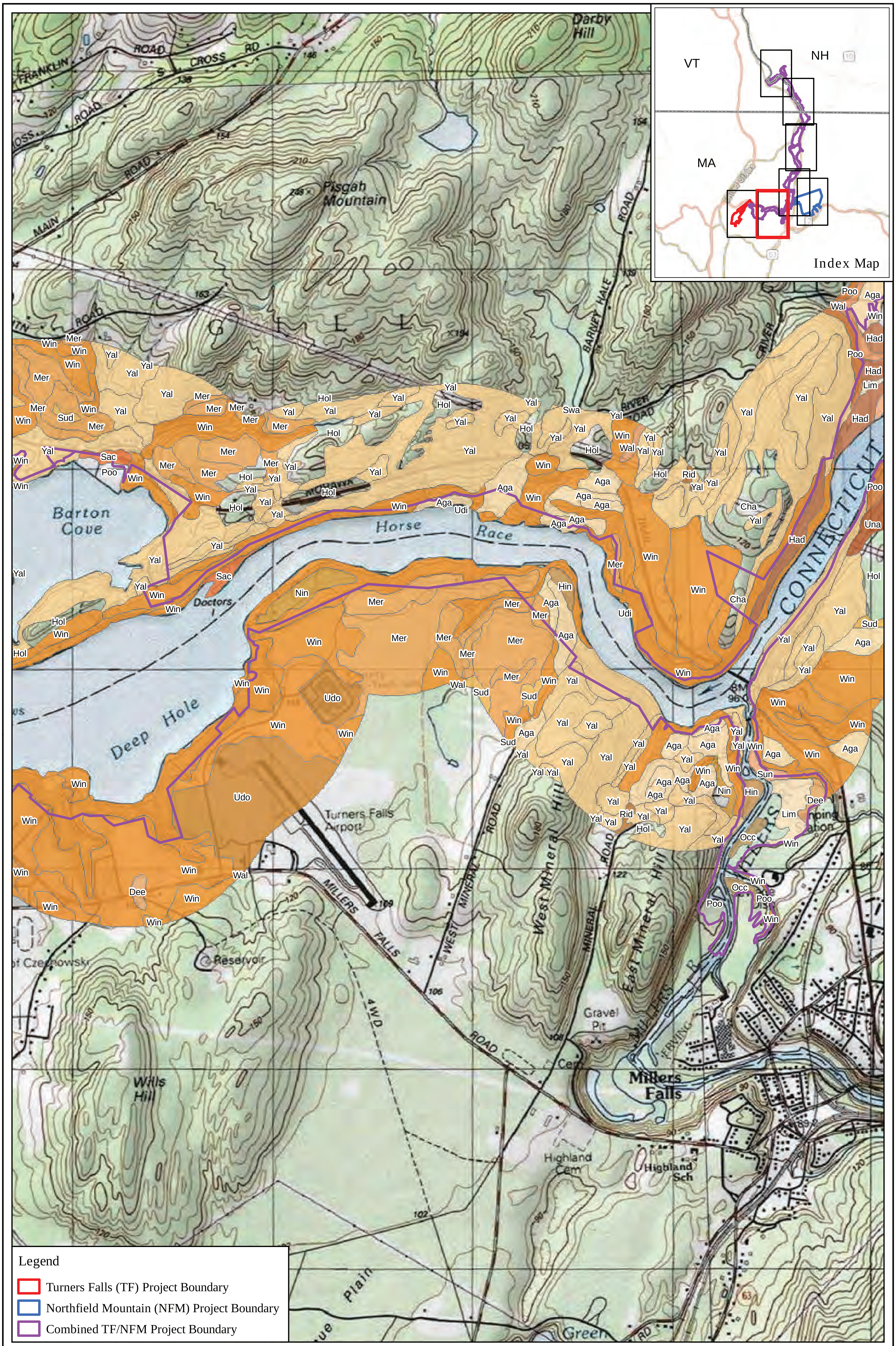

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N

0 750 1,500 3,000
Feet

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

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Data sources: SSURGO; Franklin County, MA

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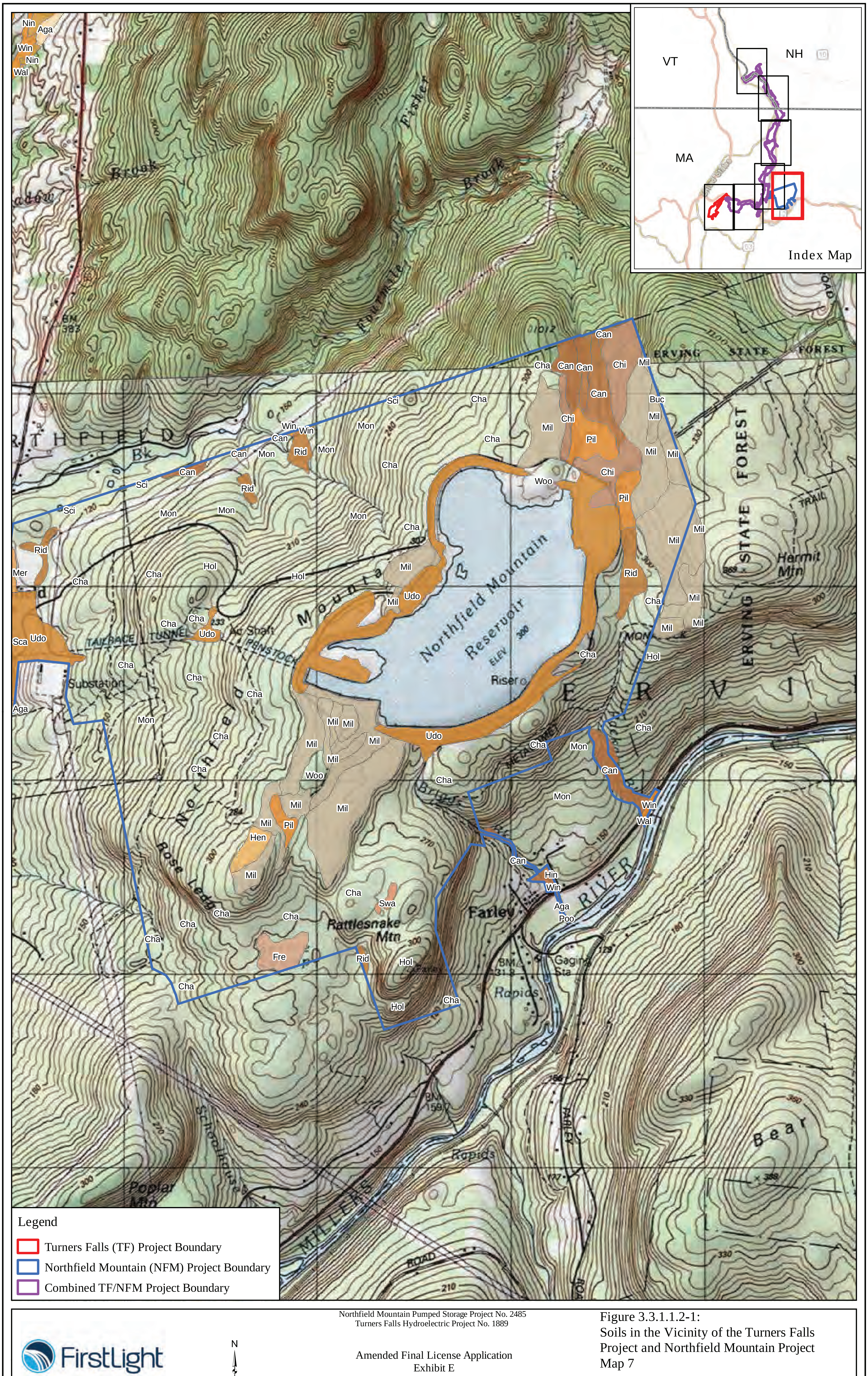

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Figure 3.3.1.1.2-1:
Soils in the Vicinity of the Turners Falls Project and Northfield Mountain Project
Map 7

N

0 750 1,500 3,000
Feet

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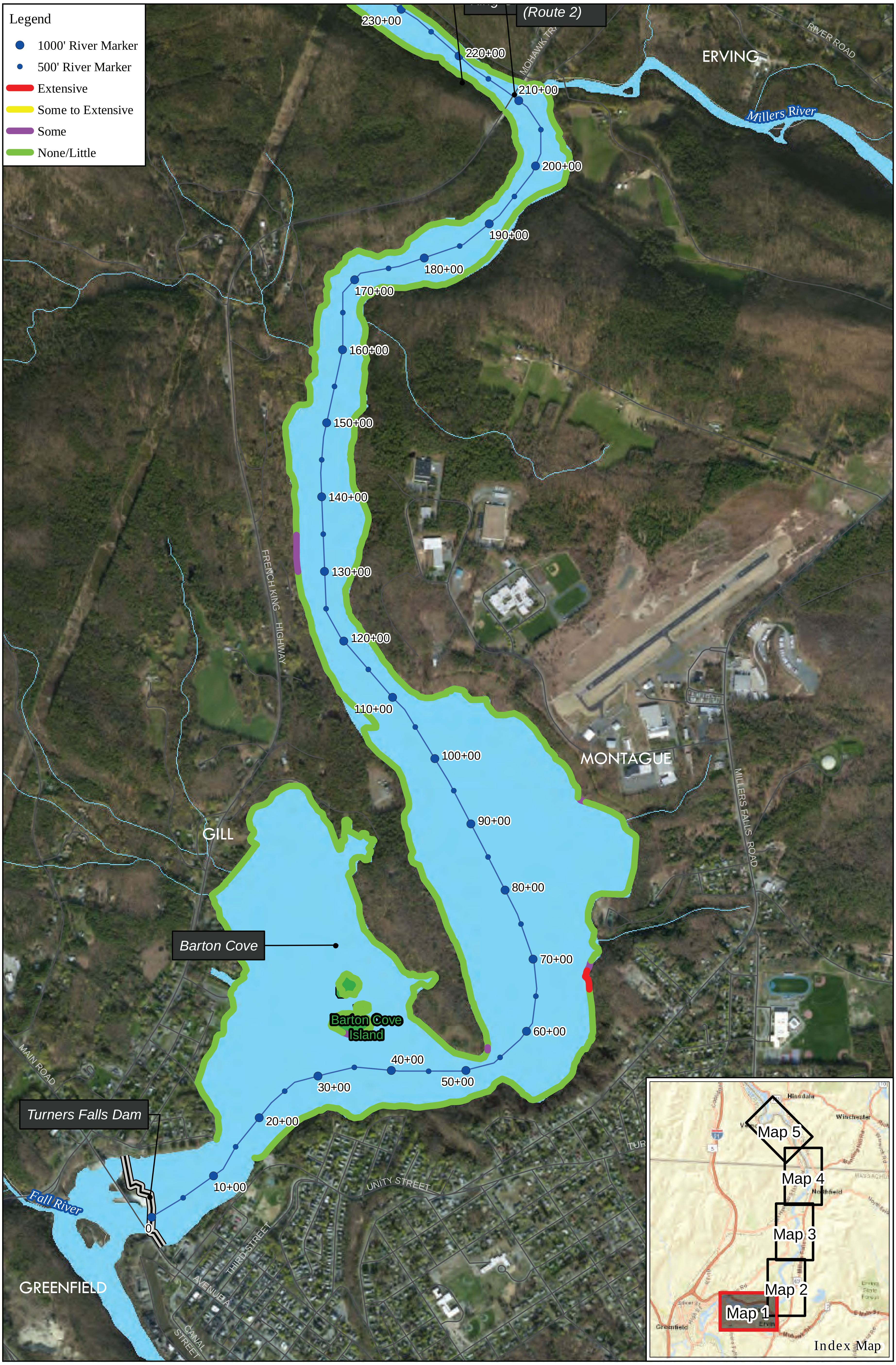
Figure 3.3.1.1.2-1:
Legend for Soils in the Vicinity of the Turners Falls Project and Northfield Mountain Project

(Page 8 of 8)

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



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0 650 1,300 2,600
Feet

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

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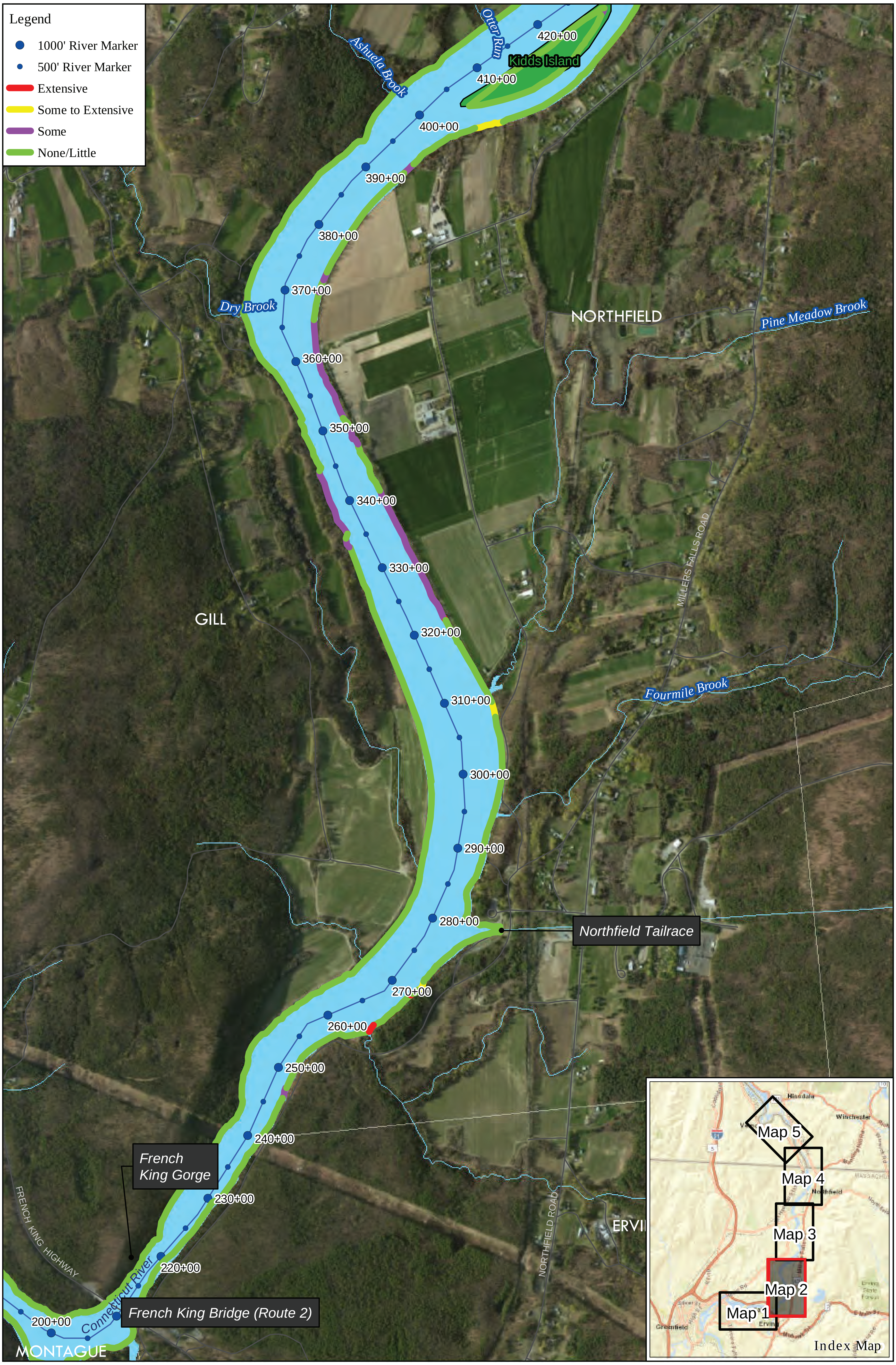

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Feet

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

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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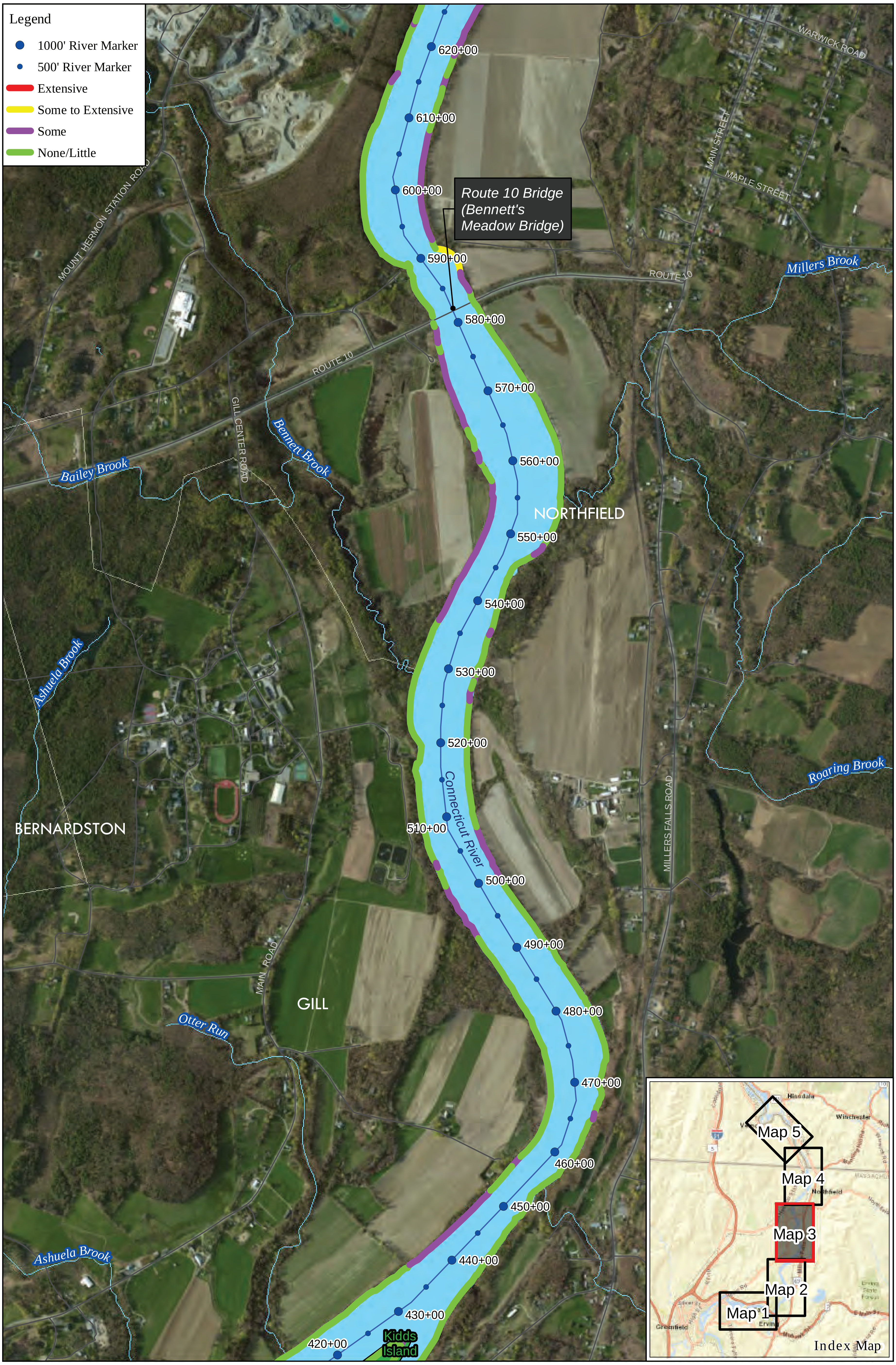

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Feet

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

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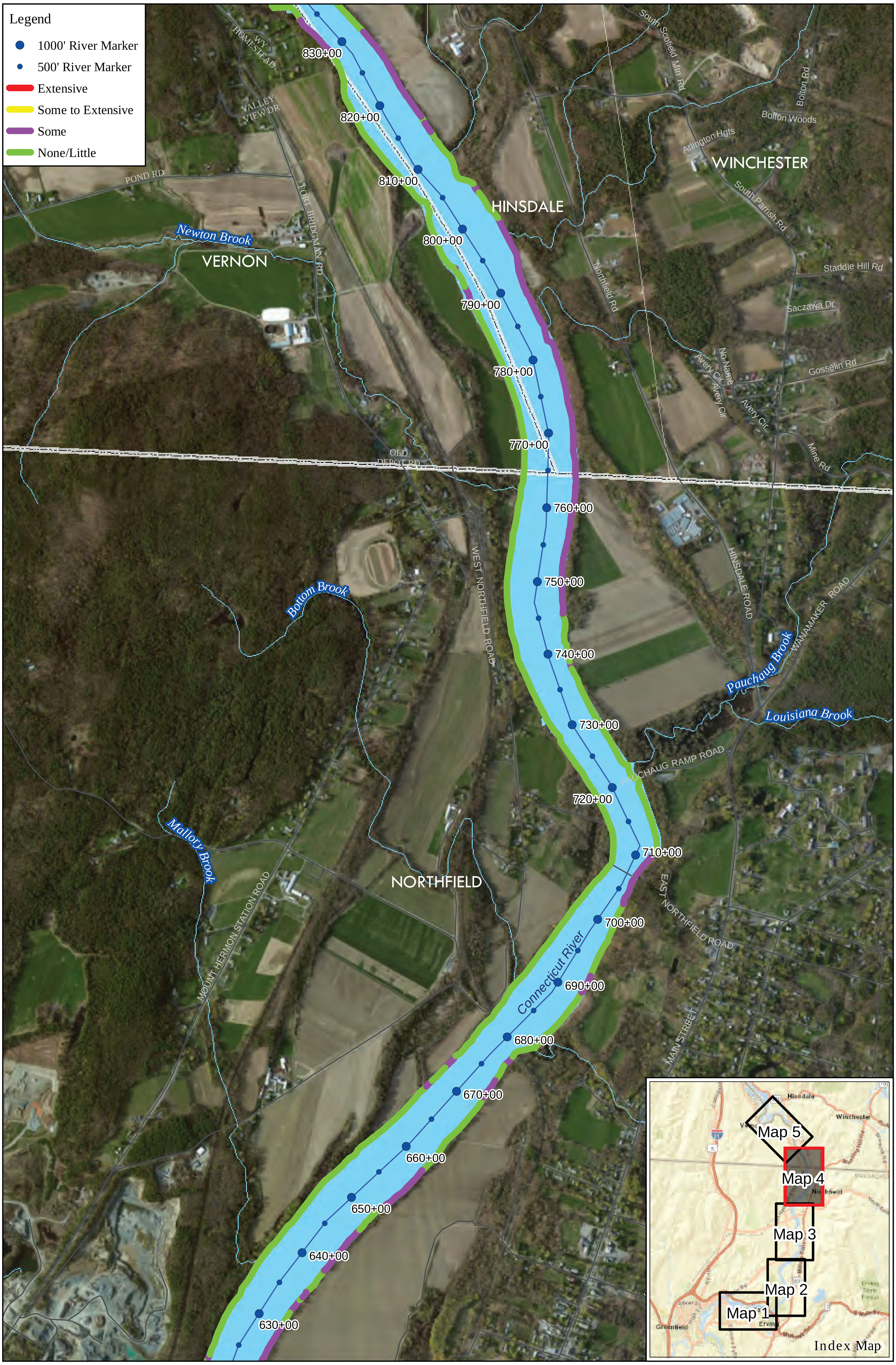

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Feet

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

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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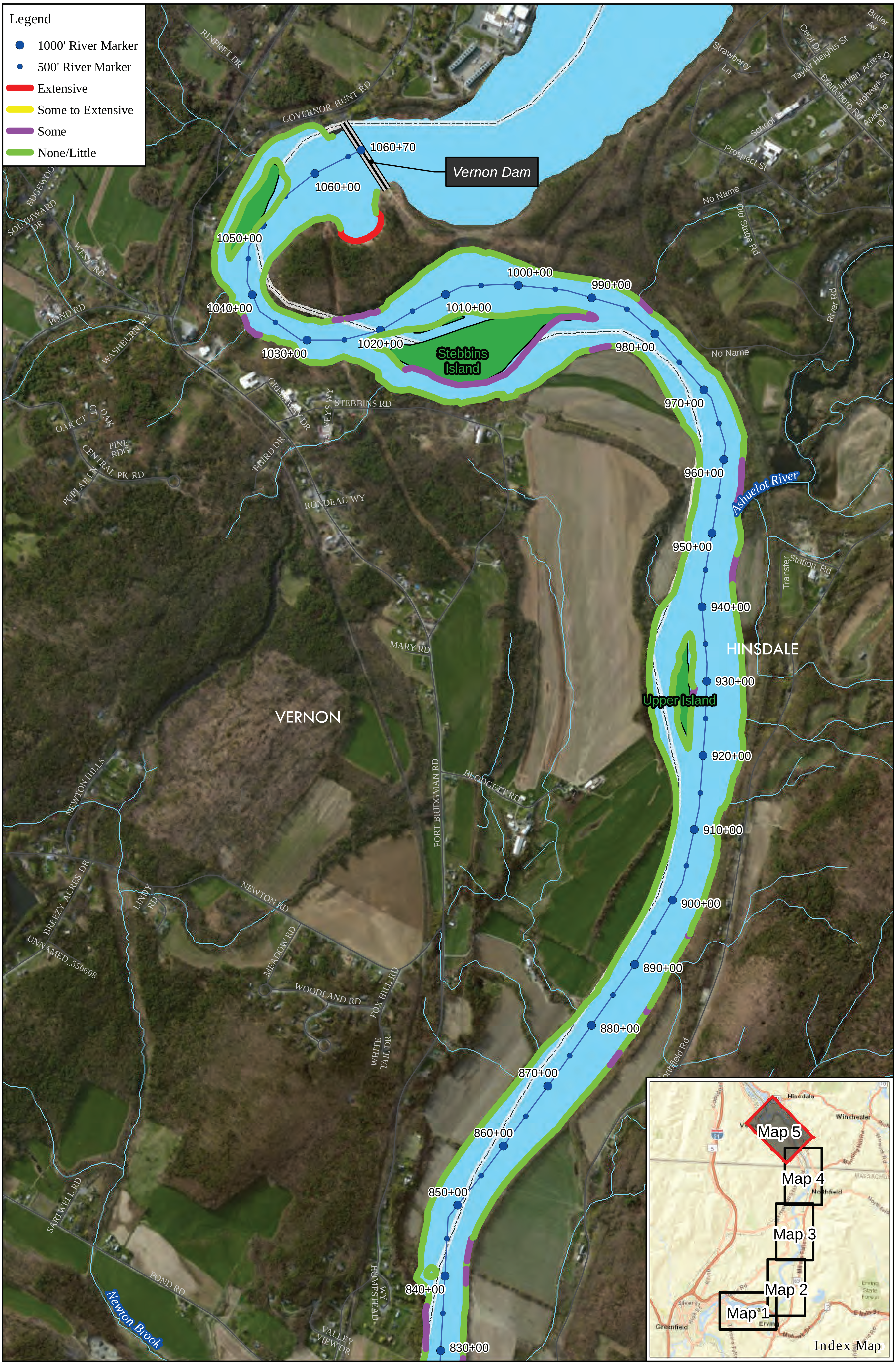

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Feet

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

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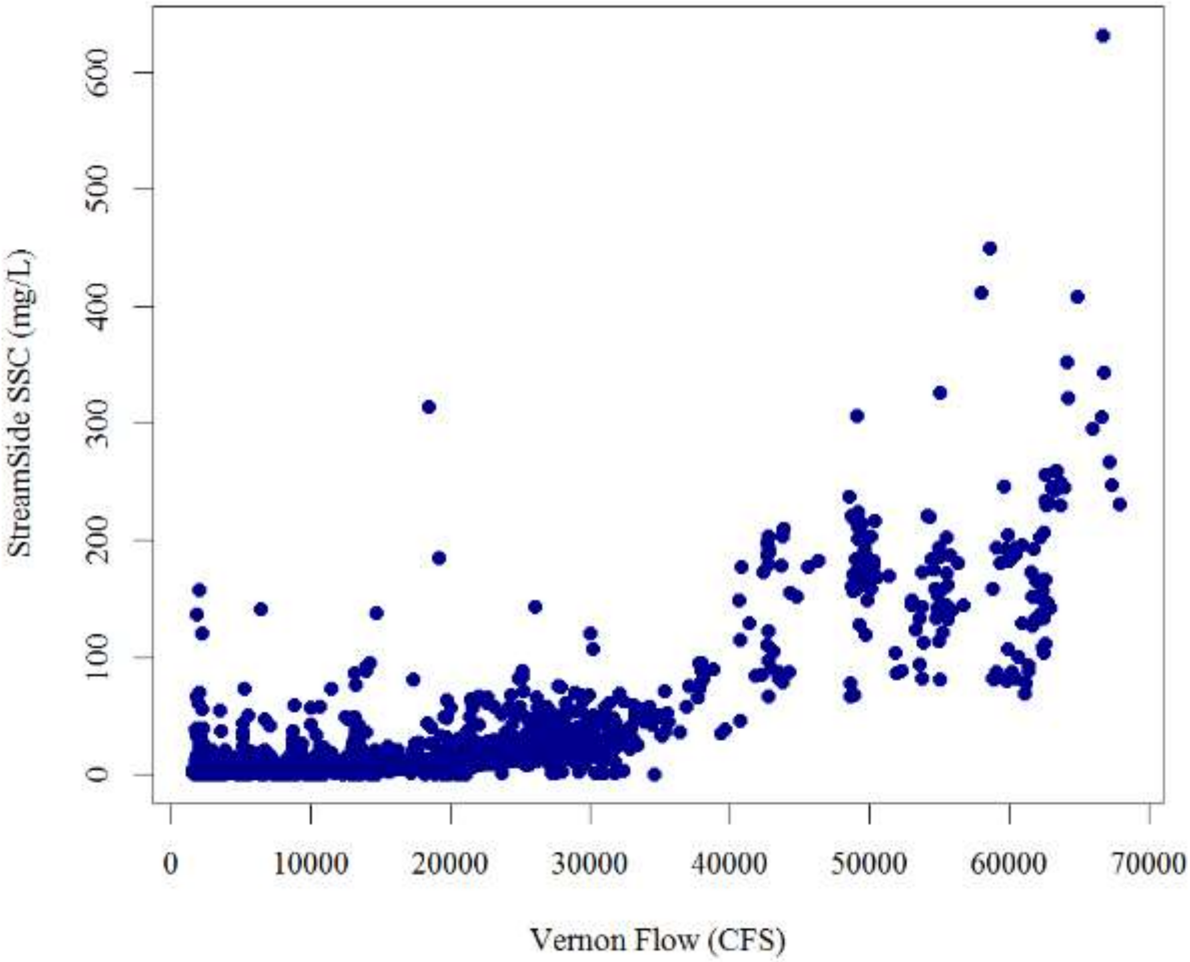

Figure 3.3.1.1.4-1: Connecticut River SSC versus Vernon Discharge (2013-2015)[42]

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[42] As measured in the vicinity of the Rt. 10 Bridge located in the TFI.

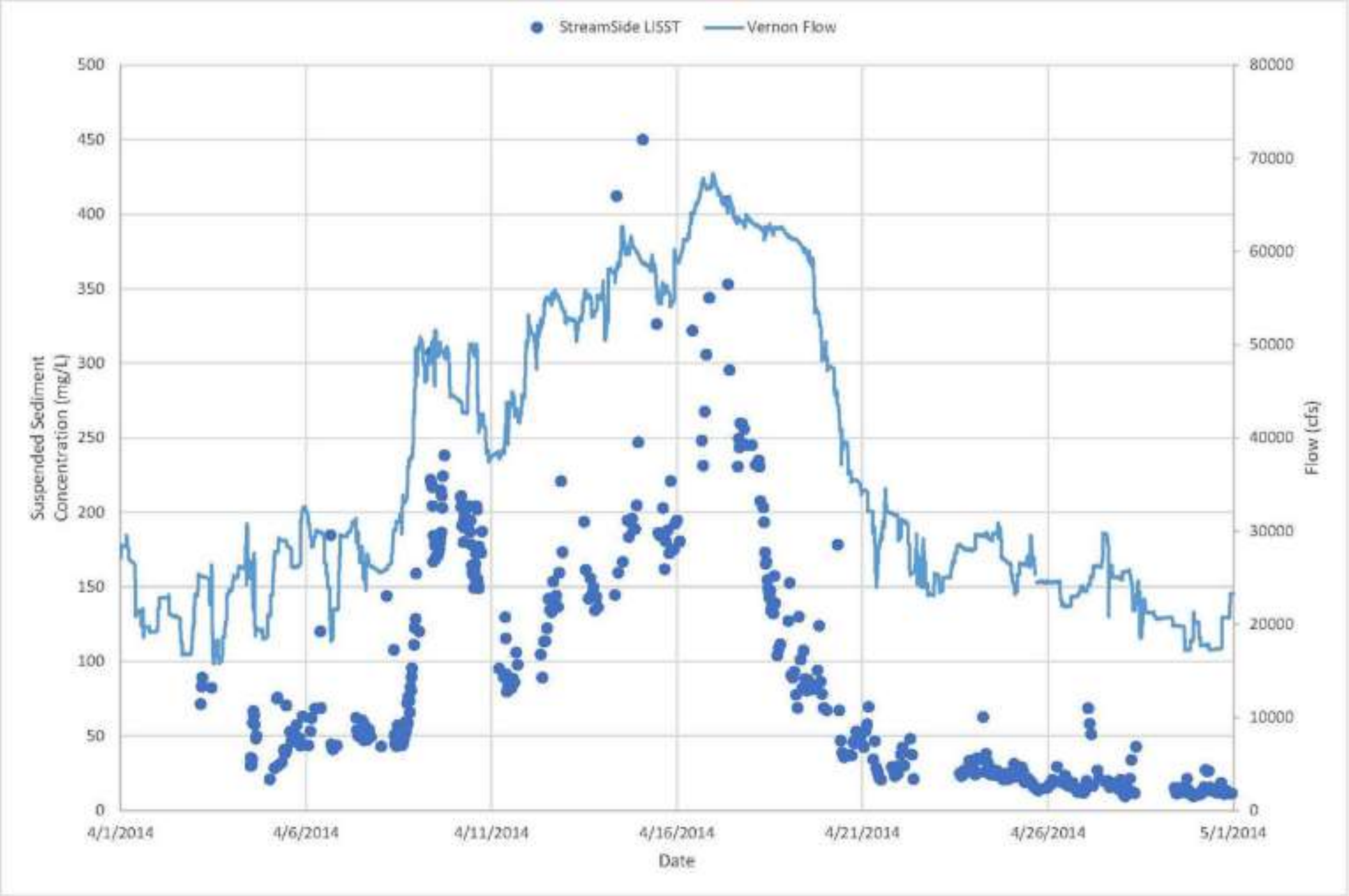

Figure 3.3.1.1.4-2: 2014 Spring Freshet – SSC versus Flow[43]

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

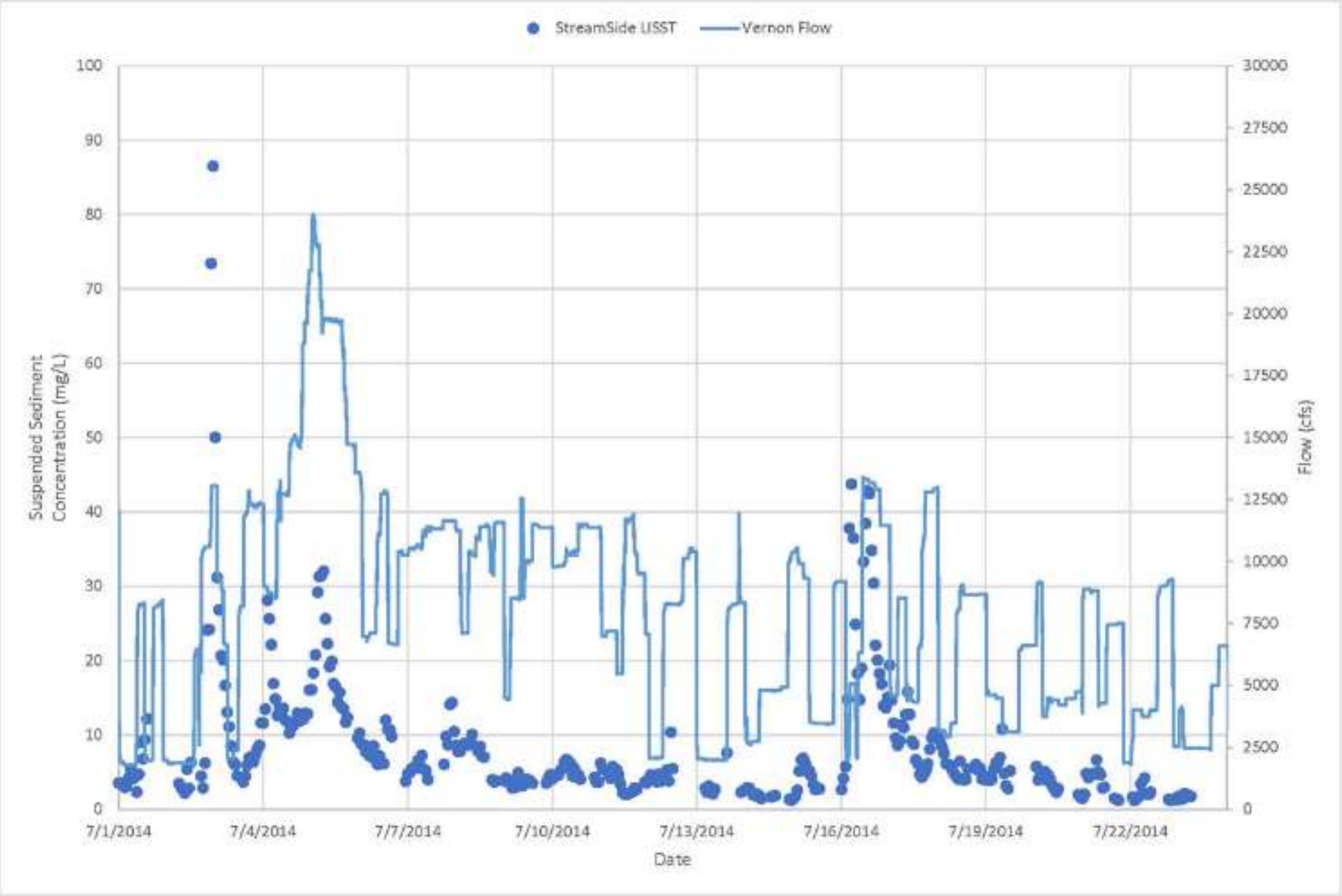

Figure 3.3.1.1.4-3: Typical Summer Period – SSC versus Flow[44]

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

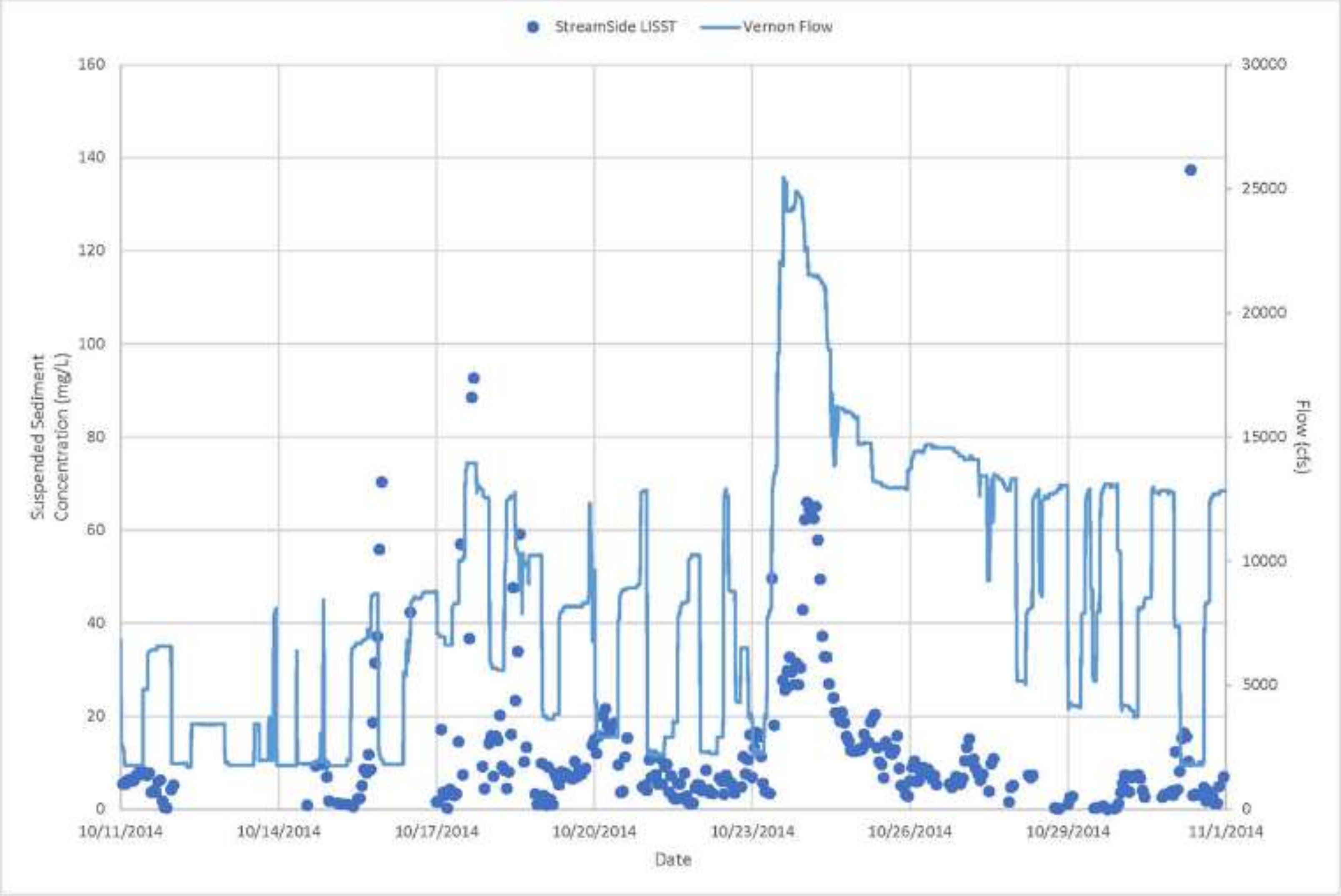

Figure 3.3.1.1.4-4: Typical Fall Period – SSC versus Flow[45]

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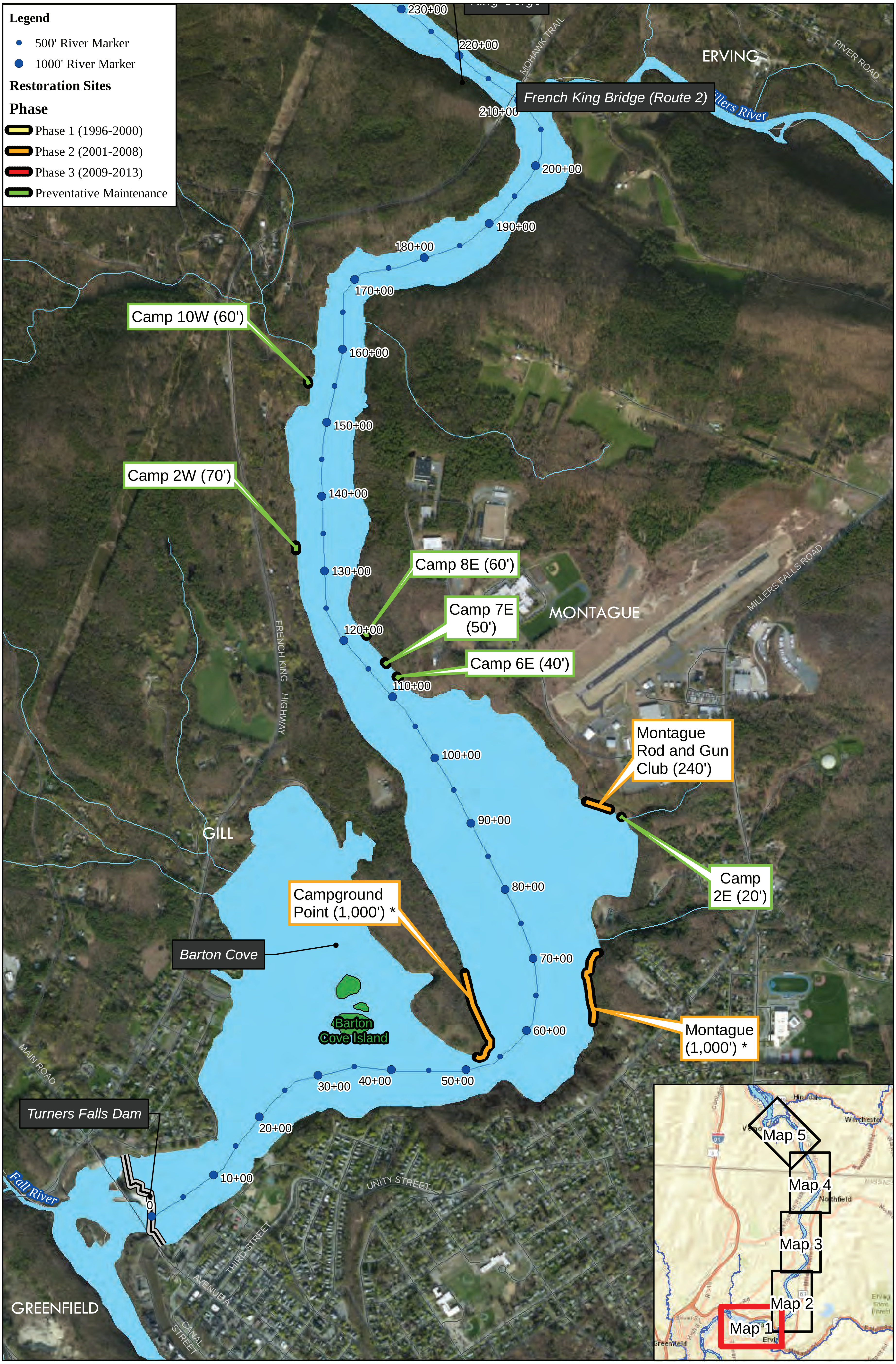
[45] SSC values were measured in the vicinity of the Rt. 10 Bridge in the TFI.



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0 625 1,250 2,500
Feet

Figure 3.3.1.2.1-1:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 1

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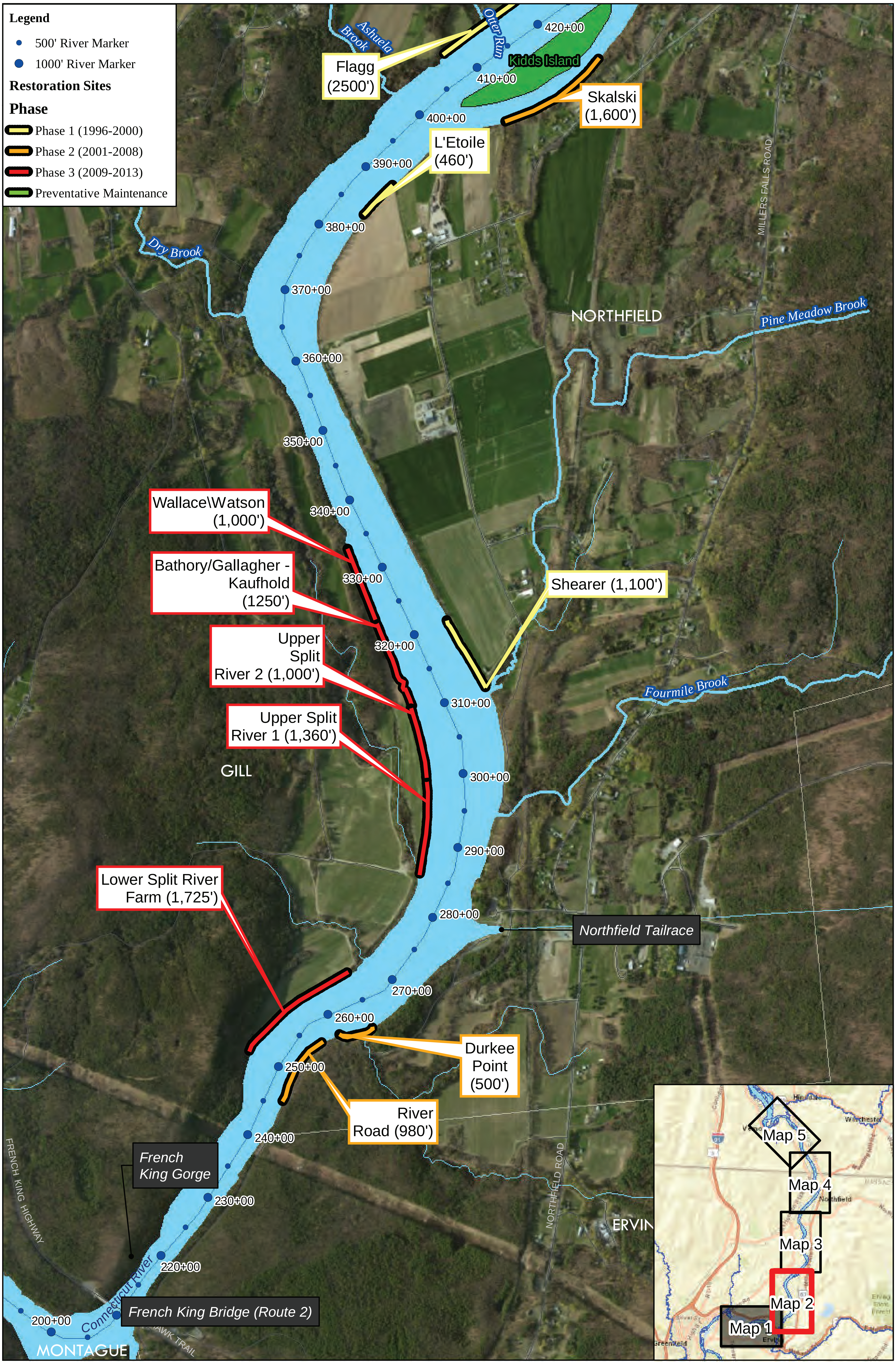

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Figure 3.3.1.2.1-1:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 2

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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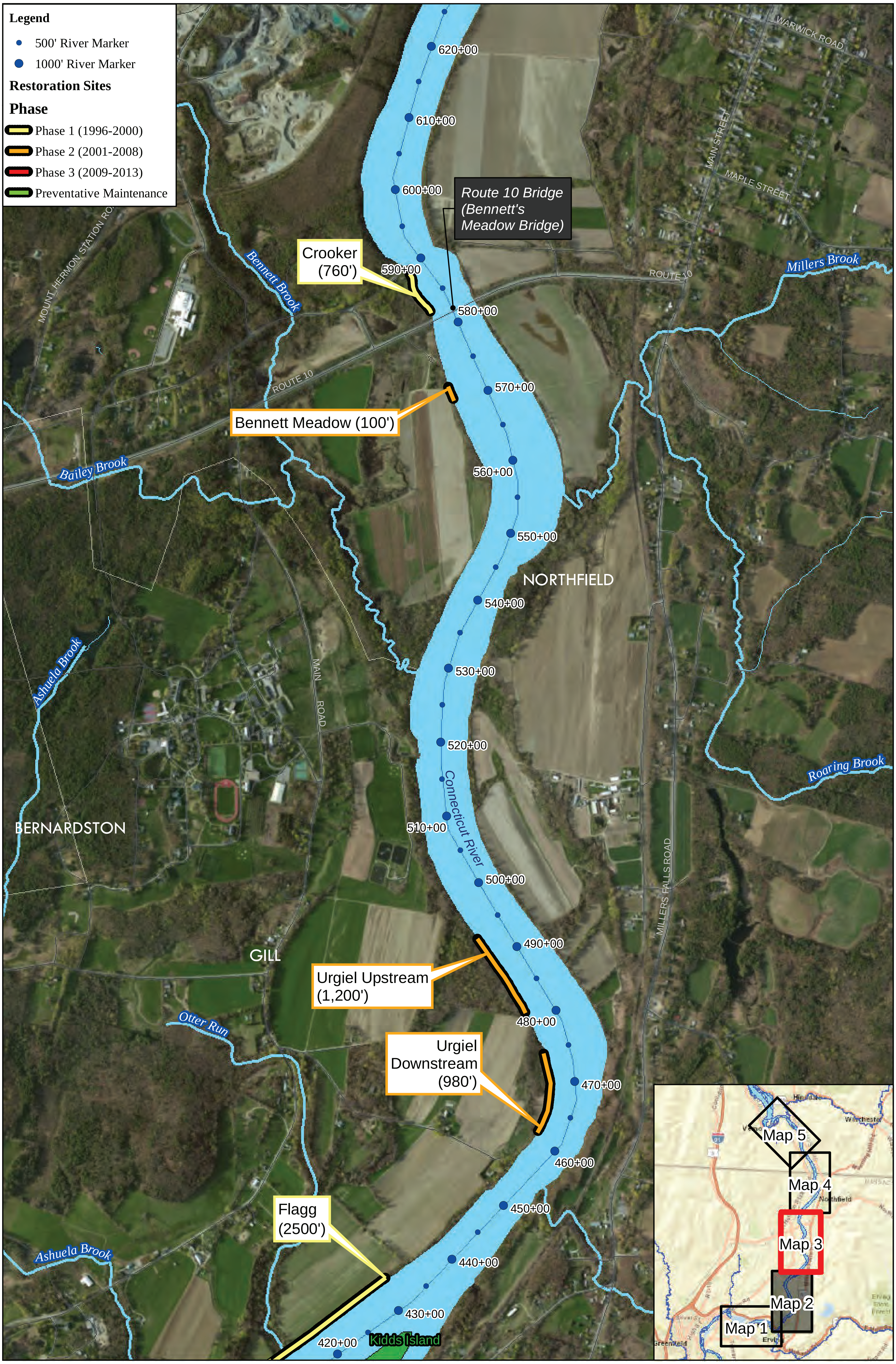

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0 625 1,250 2,500 Feet

Figure 3.3.1.2.1-1:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 3

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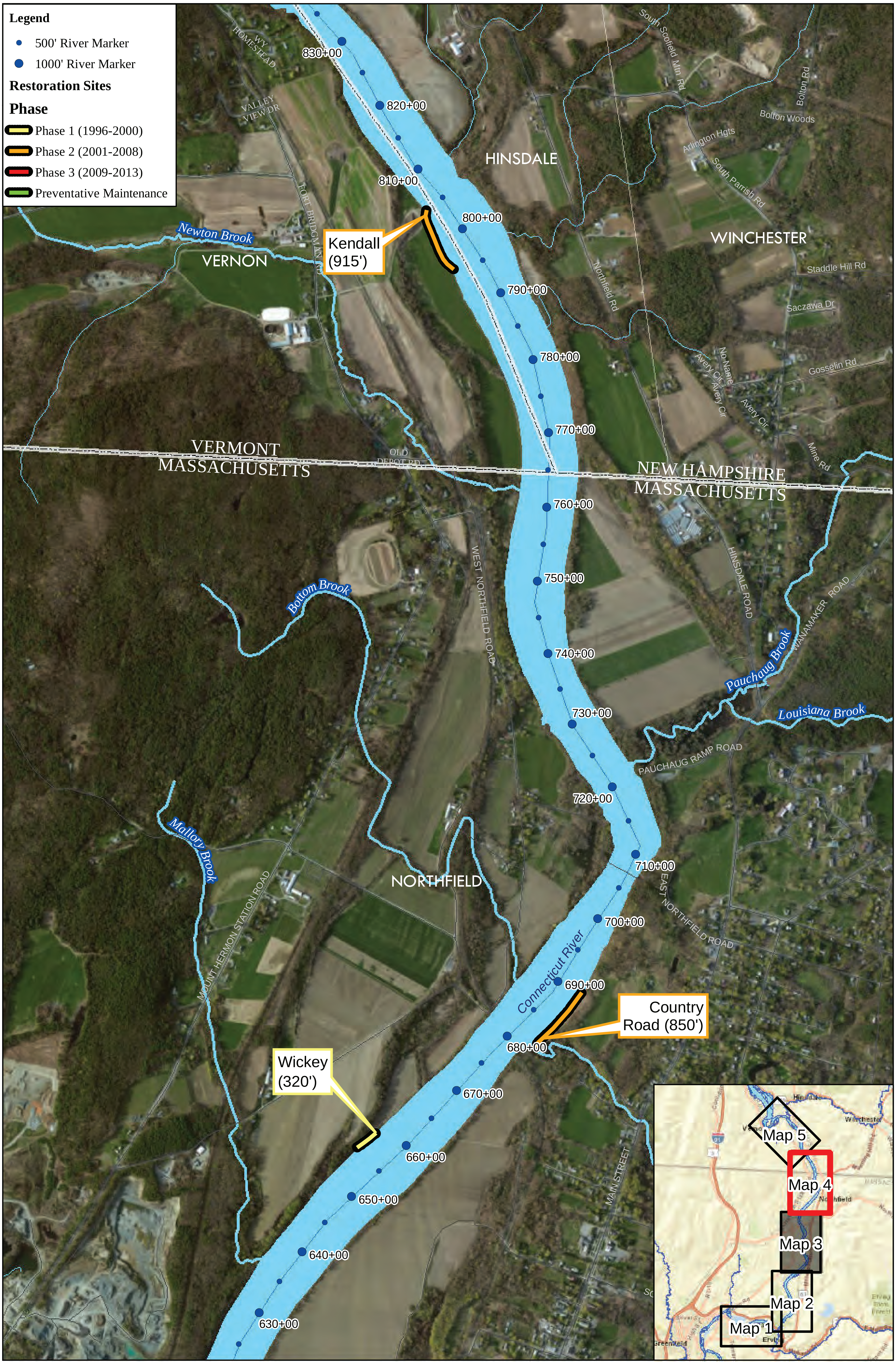

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Feet

Figure 3.3.1.2.1-1:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 4

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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0 625 1,250 2,500 Feet

Figure 3.3.1.2.1-1:
Turners Falls Impoundment Bank Restoration Sites Associated with the Erosion Control Plan
Map 5

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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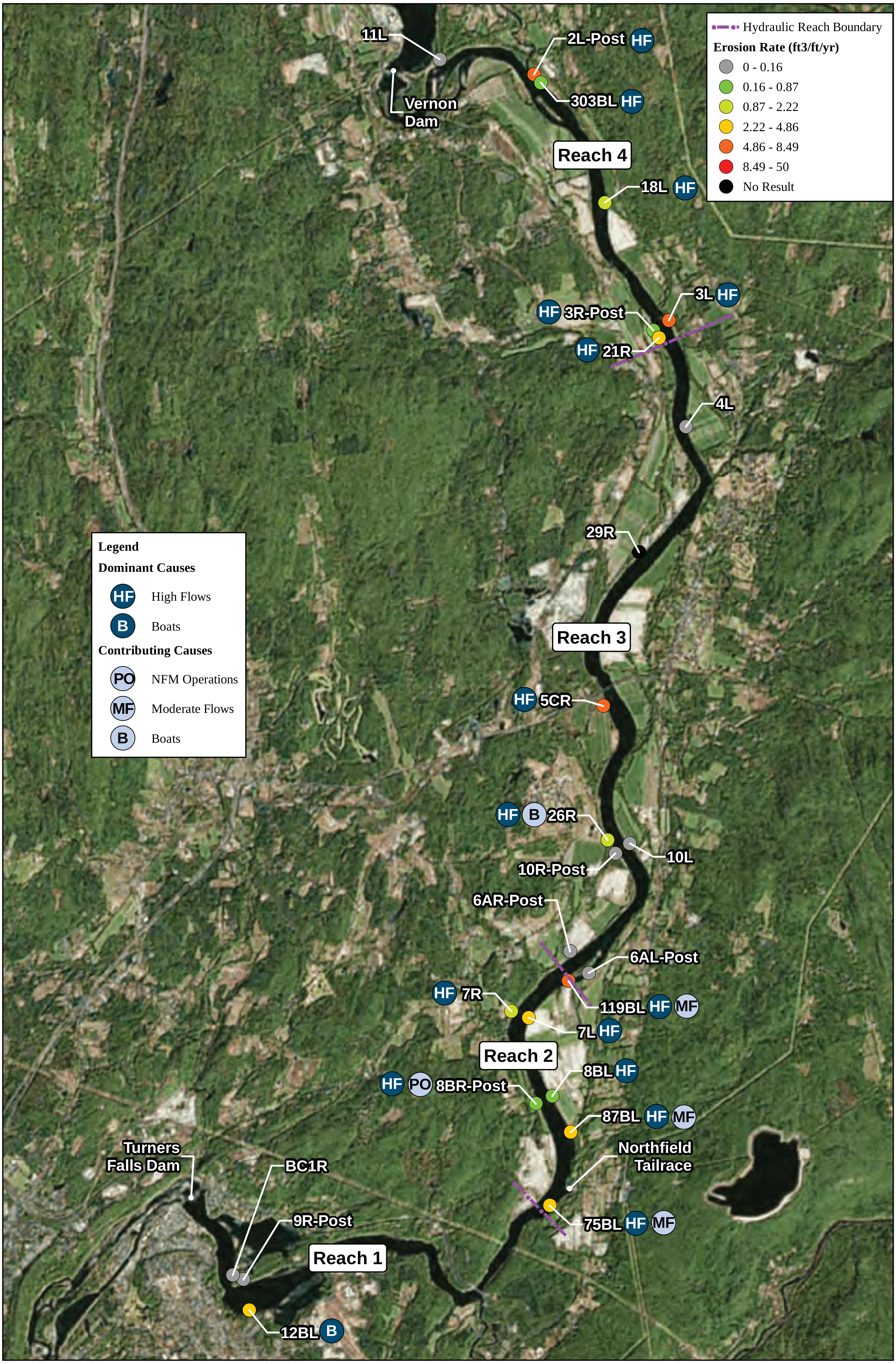

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0 0.625 1.25 2.5 Miles

Figure 3.3.1.2.1-2:
Dominant and Contributing Causes of Erosion at each Detailed Study Site – Existing Conditions

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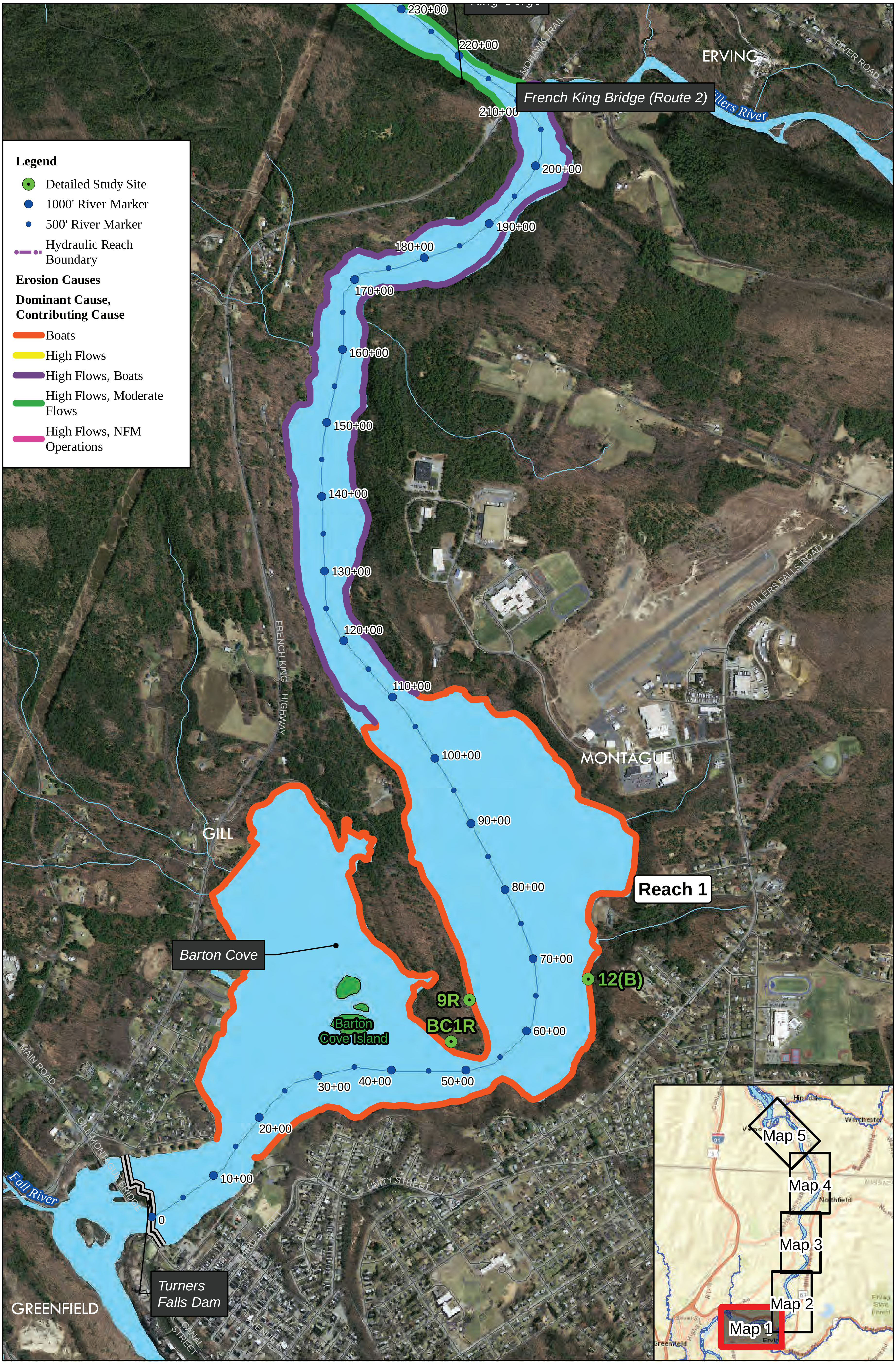

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0 625 1,250 2,500 Feet

Figure 3.3.1.2.1-3:
Final Extrapolation of the Causes of Erosion for each Riverbank Segment in Turners Falls Impoundment – Existing Conditions
Map 1

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

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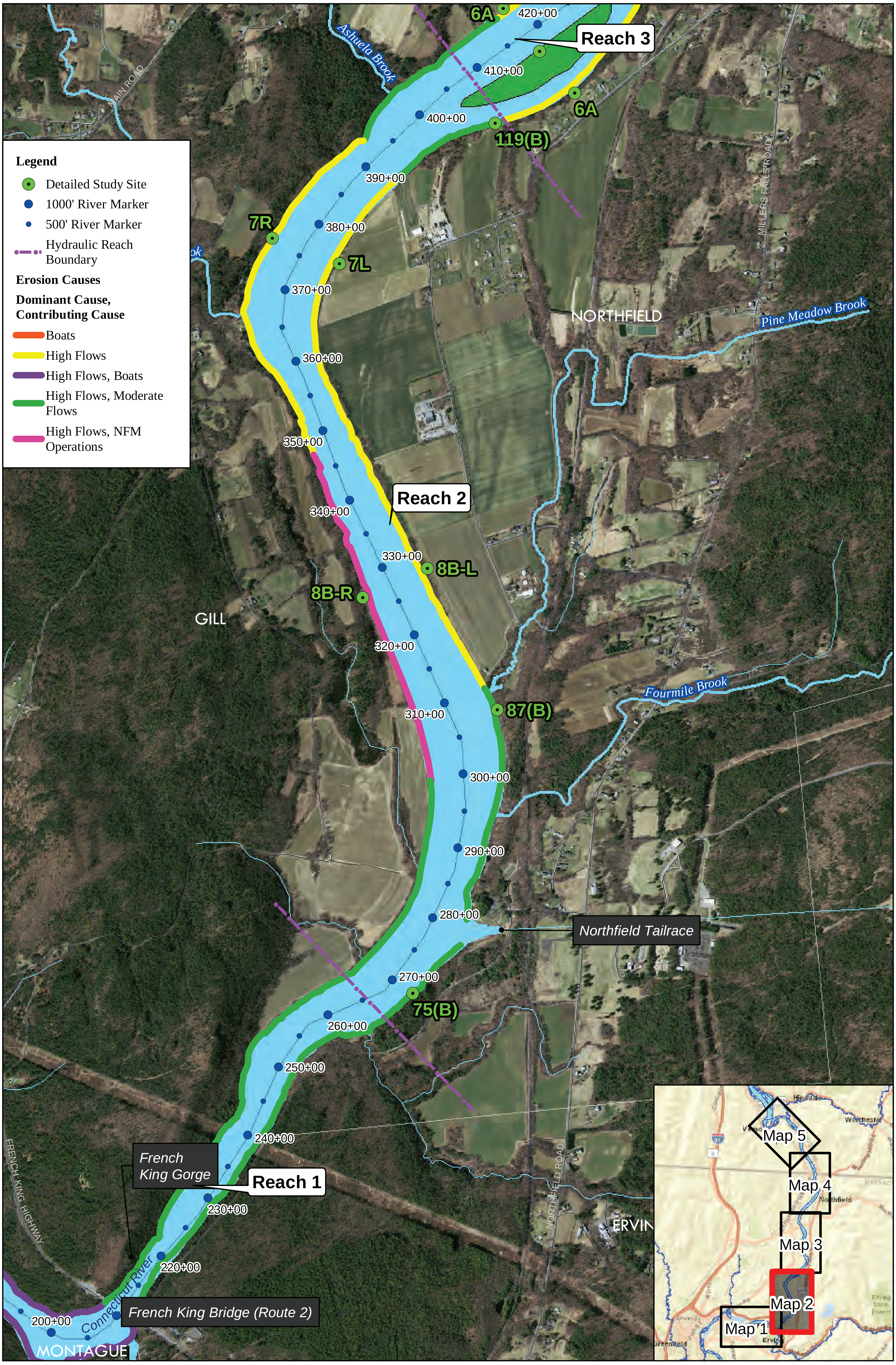

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Feet

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Figure 3.3.1.2.1-3:
Final Extrapolation of the Causes of Erosion
for each Riverbank Segment in Turners Falls
Impoundment – Existing Conditions
Map 2

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

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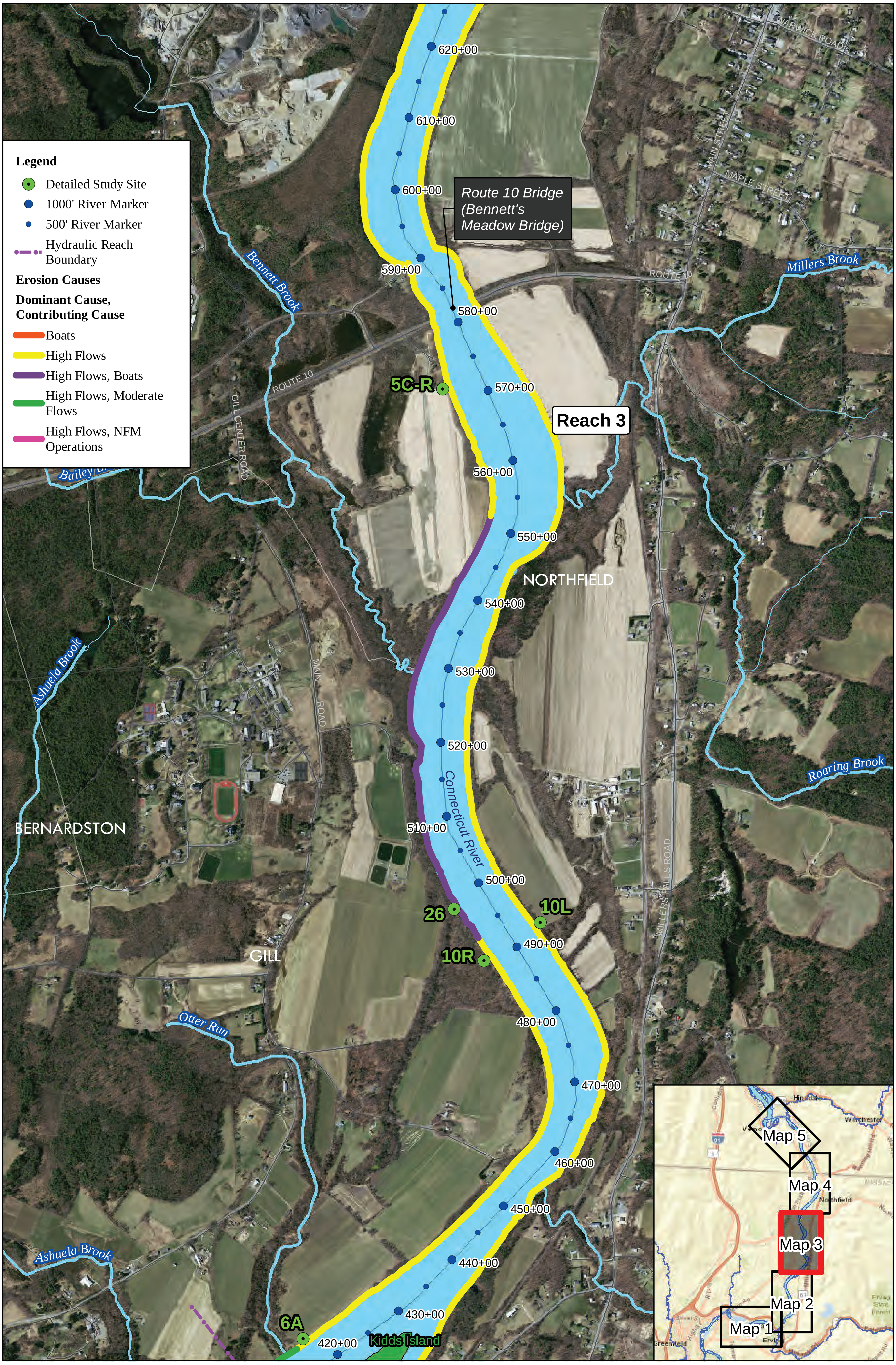

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Figure 3.3.1.2.1-3:
Final Extrapolation of the Causes of Erosion for each Riverbank Segment in Turners Falls Impoundment – Existing Conditions
Map 3

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

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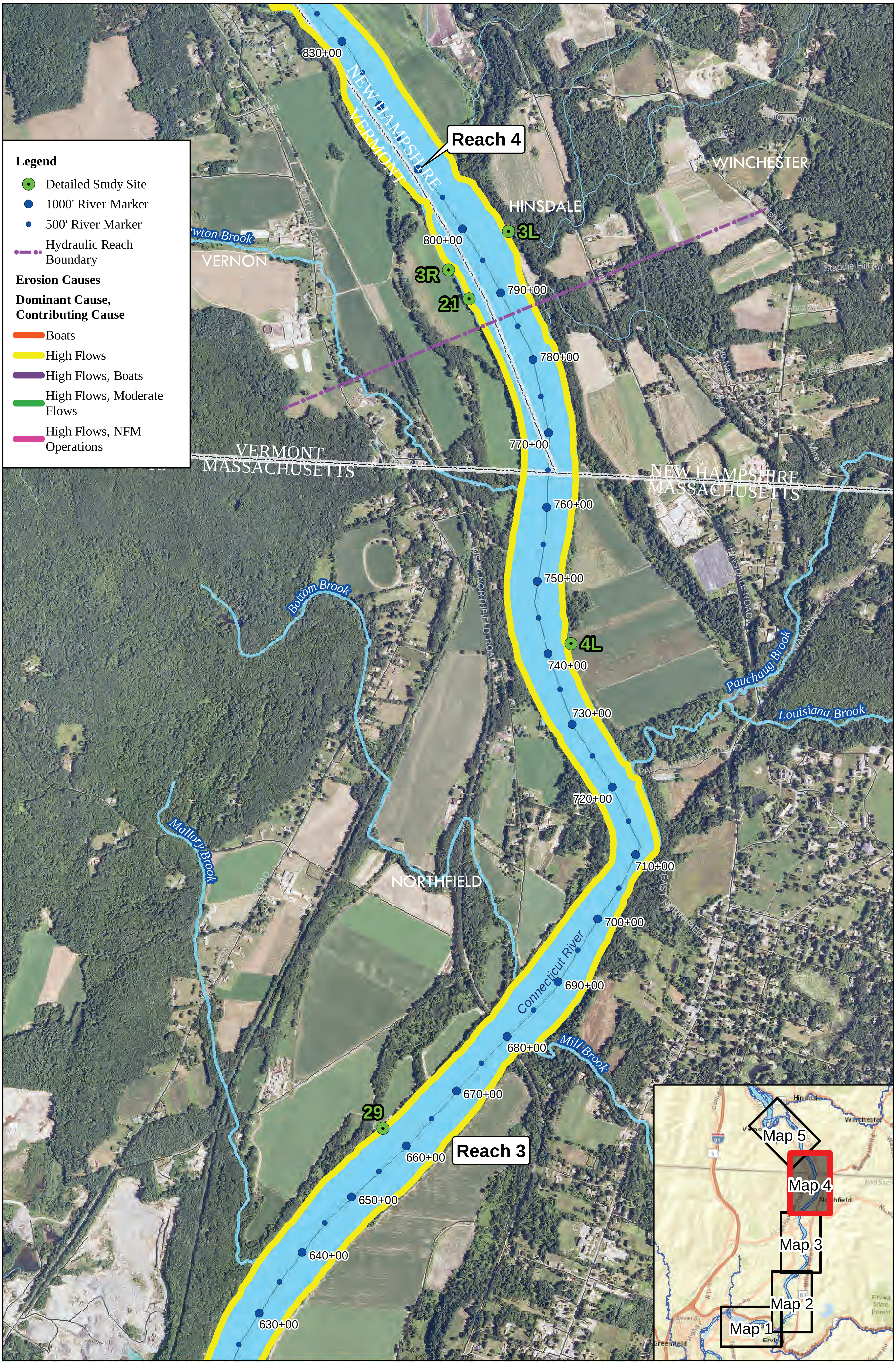

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Figure 3.3.1.2.1-3:
Final Extrapolation of the Causes of Erosion
for each Riverbank Segment in Turners Falls
Impoundment – Existing Conditions
Map 4

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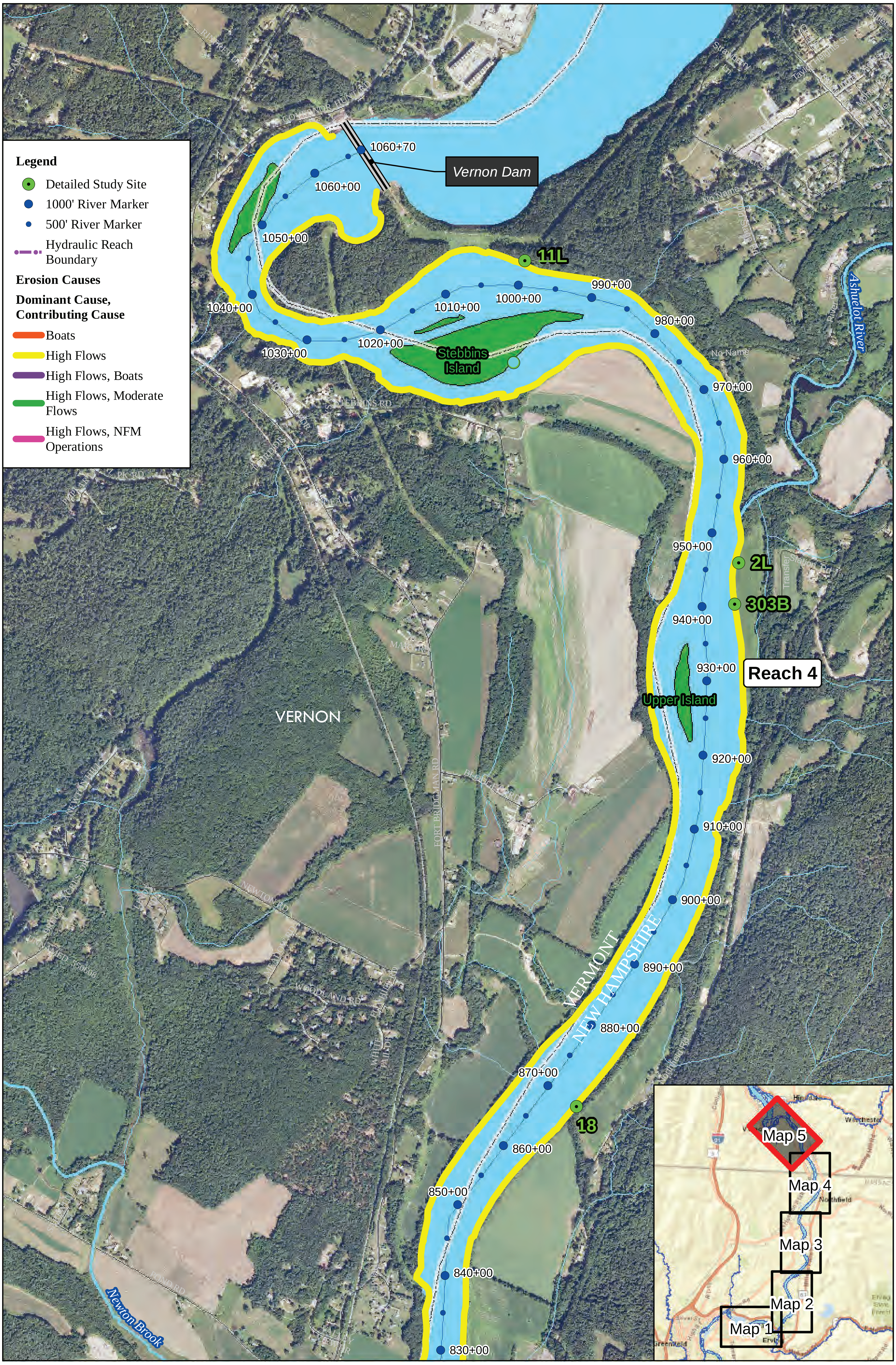

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Figure 3.3.1.2.1-3:
Final Extrapolation of the Causes of Erosion for each Riverbank Segment in Turners Falls Impoundment – Existing Conditions
Map 5

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

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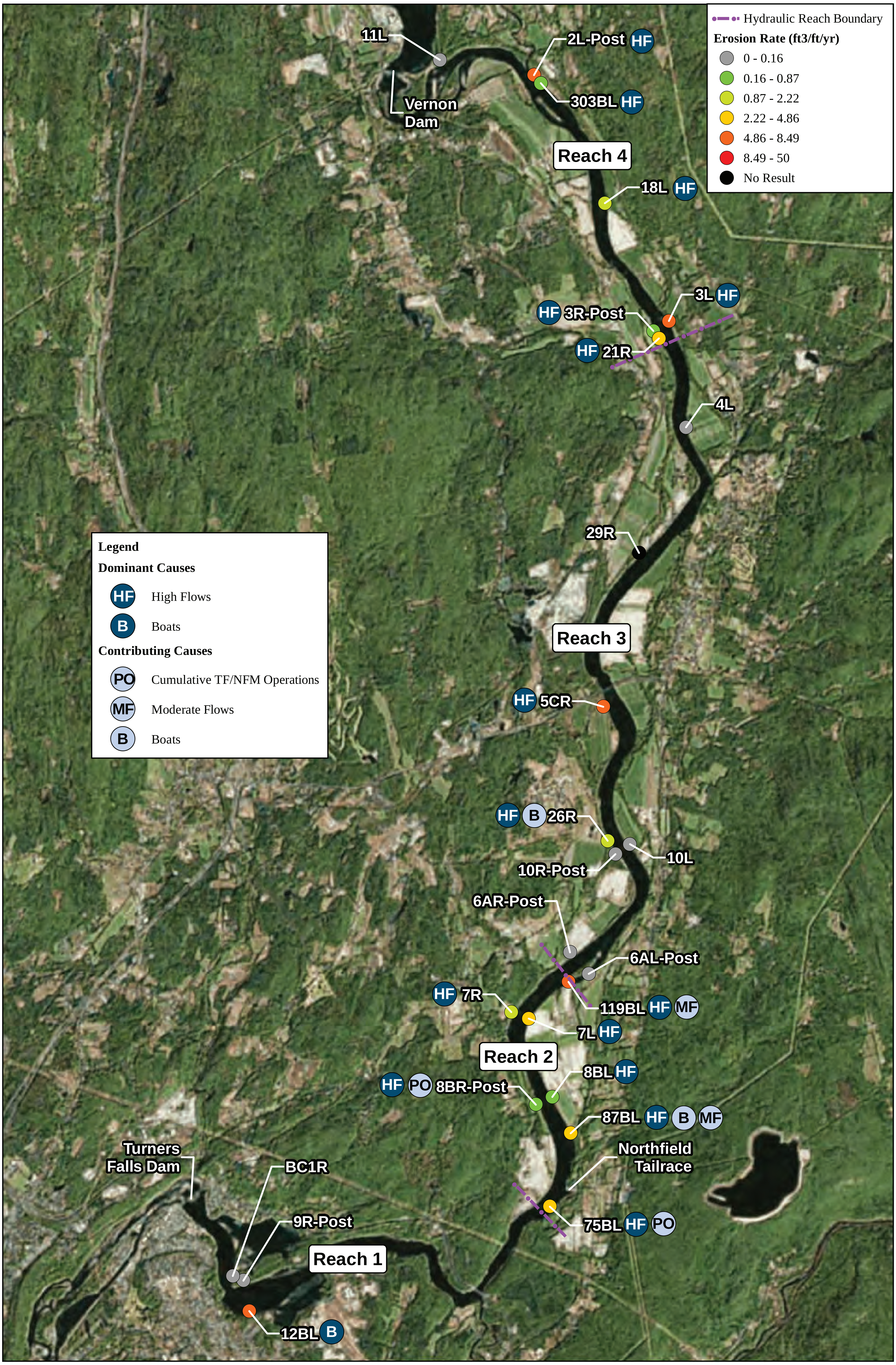

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Figure 3.3.1.2.1-4:
Dominant and Contributing Causes of Erosion at each Detailed Study Site – Proposed Conditions

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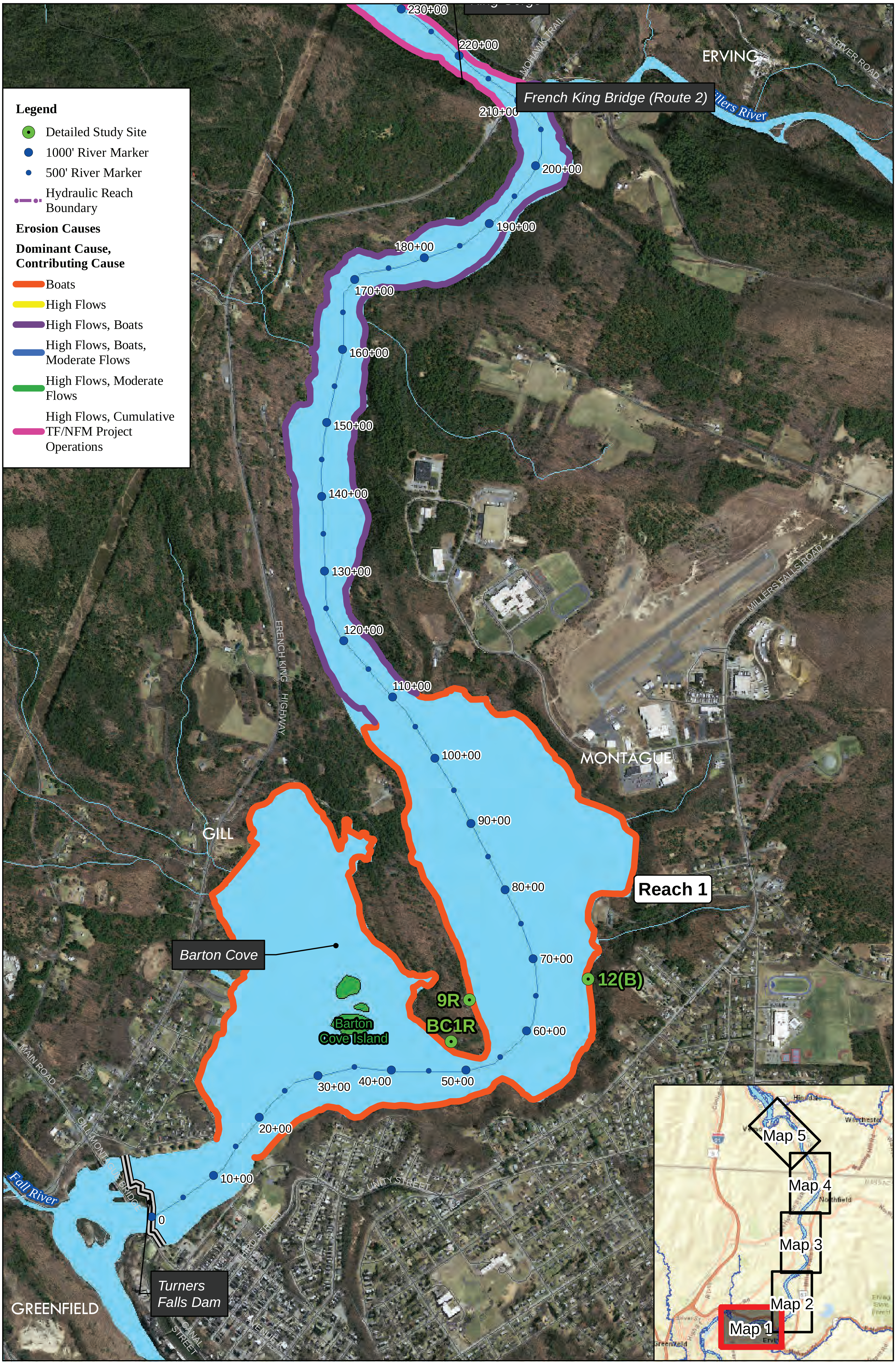

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0 625 1,250 2,500 Feet

Figure 3.3.1.2.1-5:
Final Extrapolation of the Causes of Erosion for each Riverbank Segment in Turners Falls Impoundment – Proposed Conditions
Map 1

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

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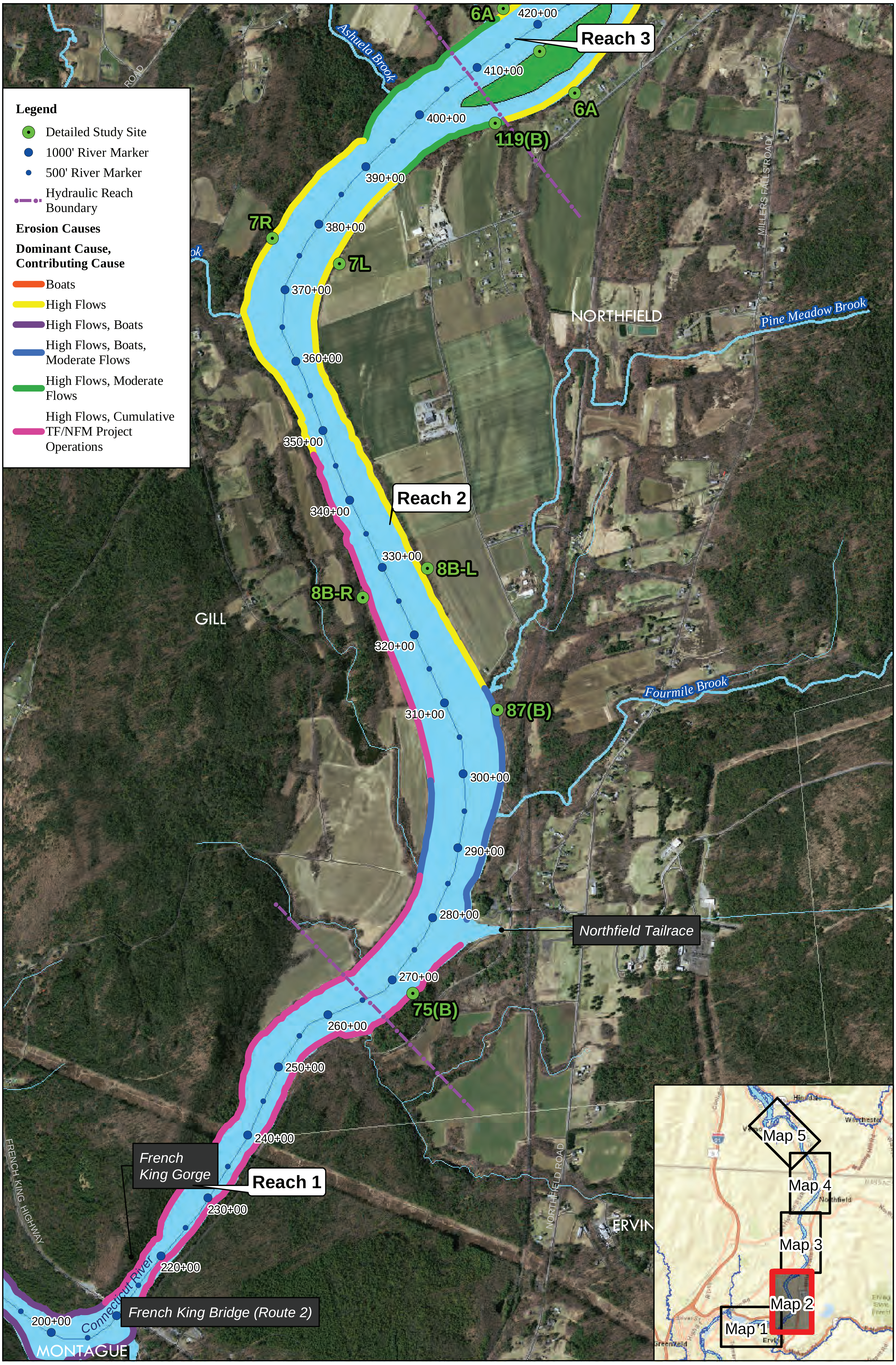

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Figure 3.3.1.2.1-5:
Final Extrapolation of the Causes of Erosion for each Riverbank Segment in Turners Falls Impoundment – Proposed Conditions
Map 2

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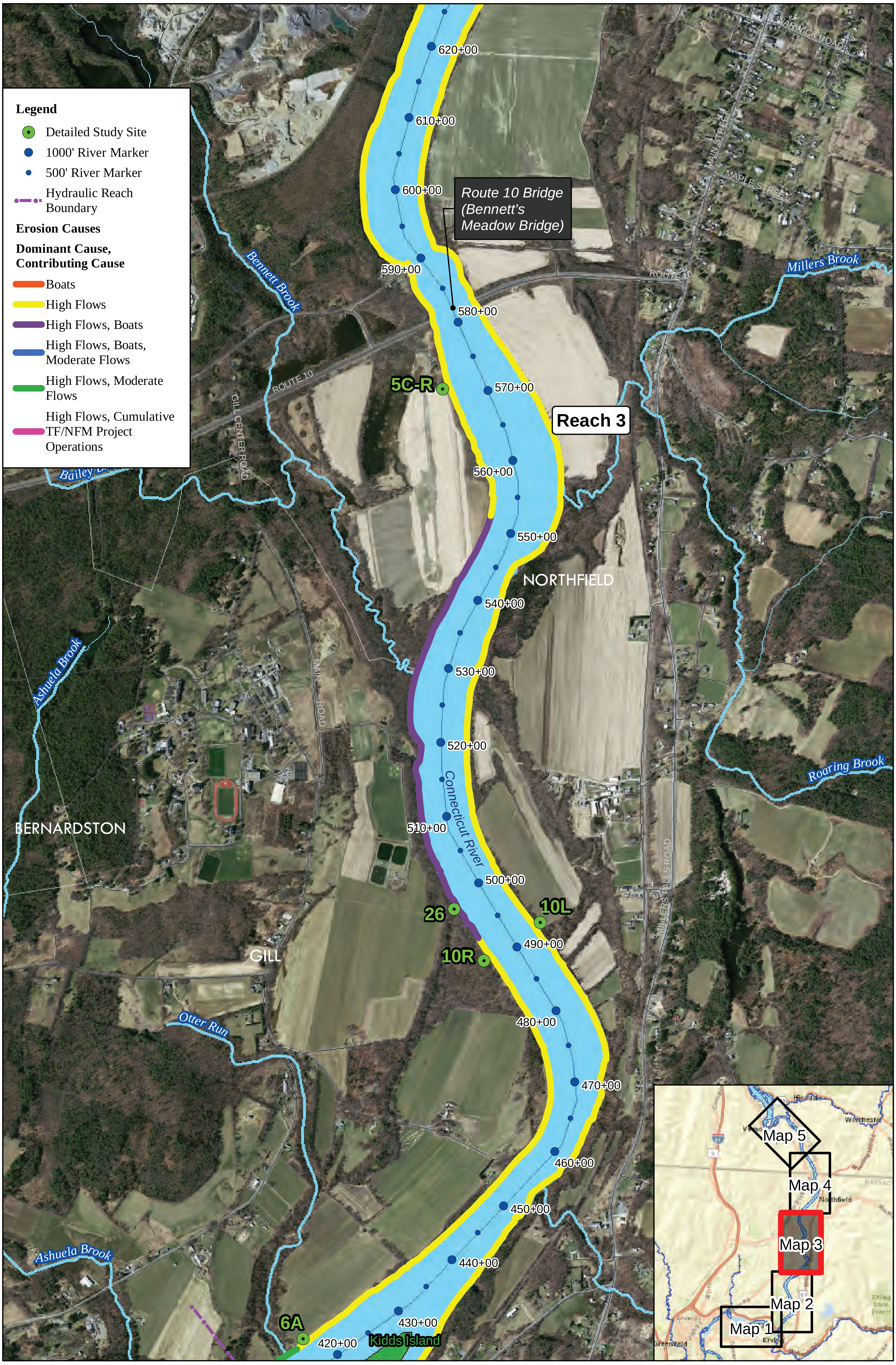

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Feet

Figure 3.3.1.2.1-5:
Final Extrapolation of the Causes of Erosion for each Riverbank Segment in Turners Falls Impoundment – Proposed Conditions
Map 3

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

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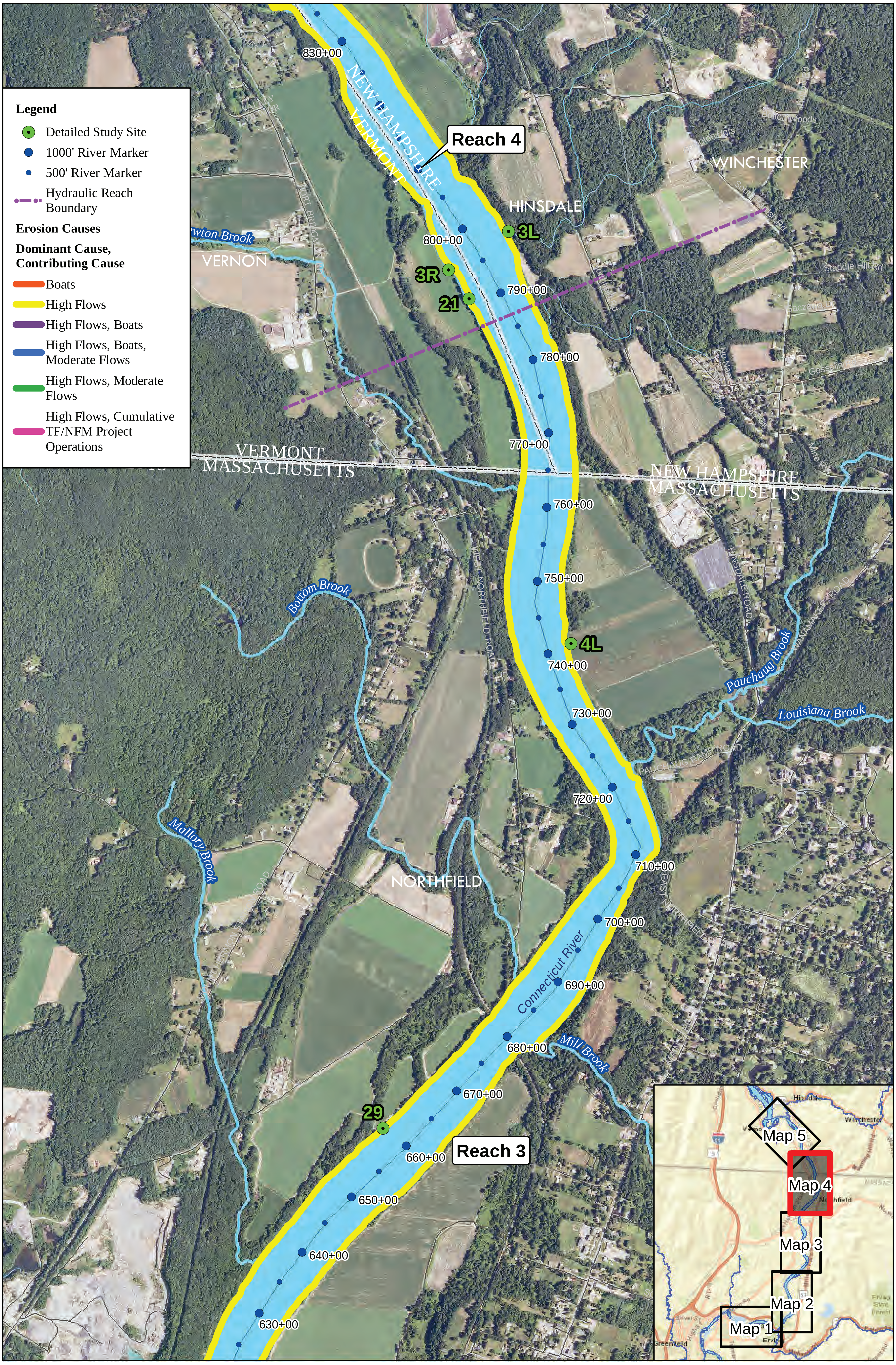

FirstLight

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

Amended Final License Application

0 625 1,250 2,500
Feet

Figure 3.3.1.2.1-5:
Final Extrapolation of the Causes of Erosion
for each Riverbank Segment in Turners Falls
Impoundment – Proposed Conditions
Map 4

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

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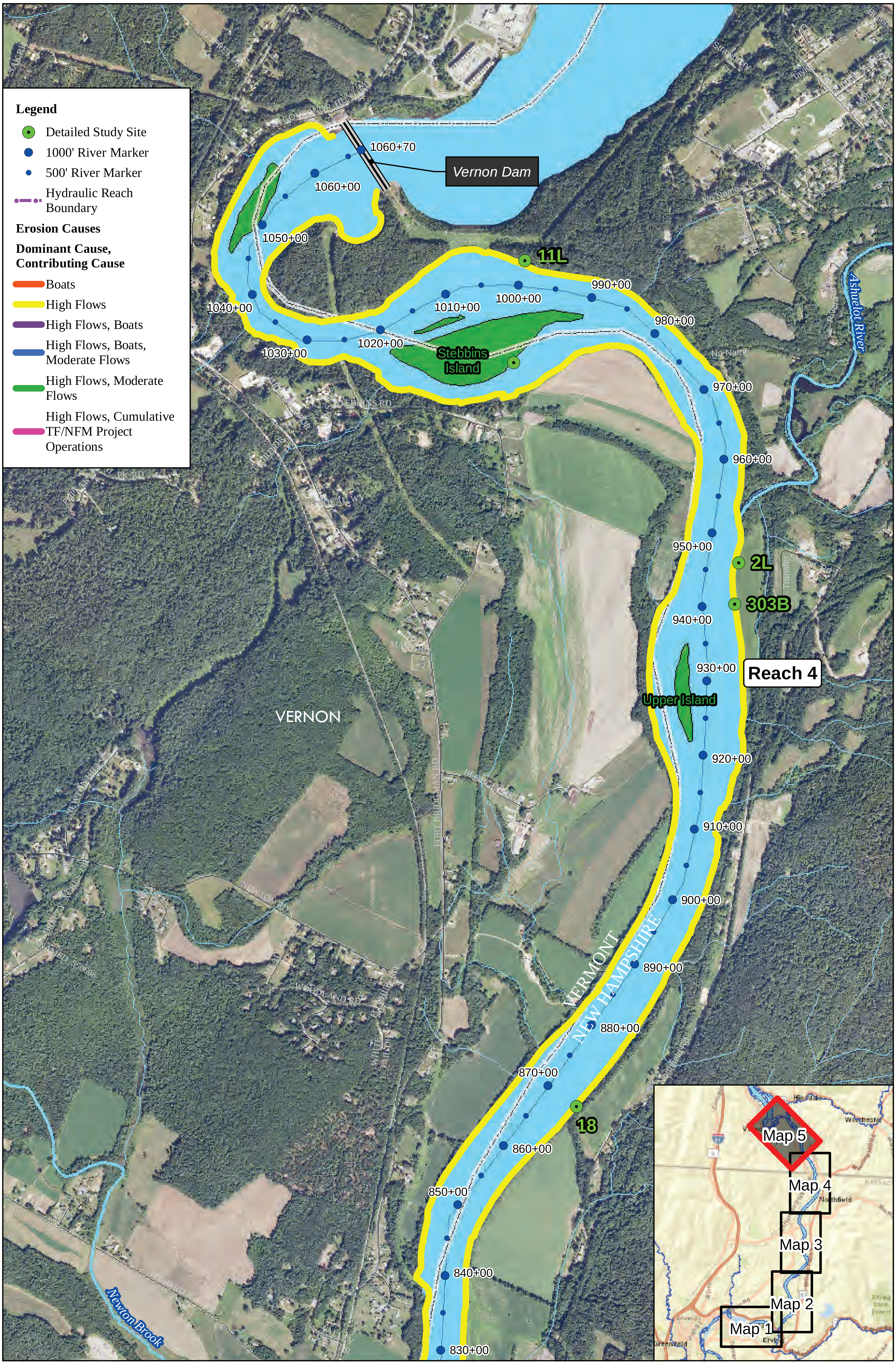

Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Amended Final License Application

0 625 1,250 2,500
Feet

Figure 3.3.1.2.1-5:
Final Extrapolation of the Causes of Erosion for each Riverbank Segment in Turners Falls Impoundment – Proposed Conditions
Map 5

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

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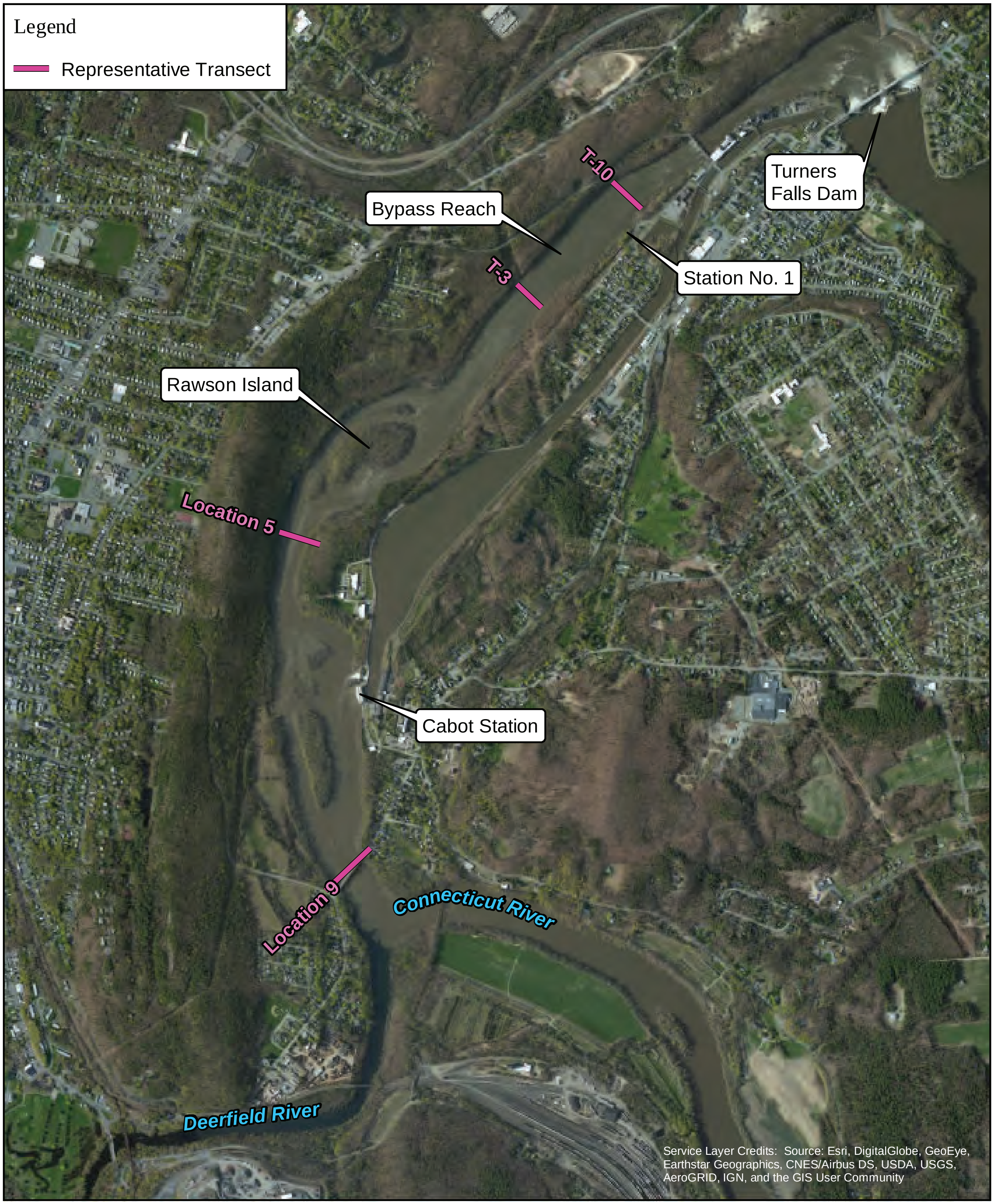

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Northfield Mountain Pumped Storage Project No. 2485
Turners Falls Hydroelectric Project No. 1889

Amended Final License Application
Exhibit E

Figure 3.3.1.2.2-1: Location of Representative Transects Downstream of Turners Falls Dam

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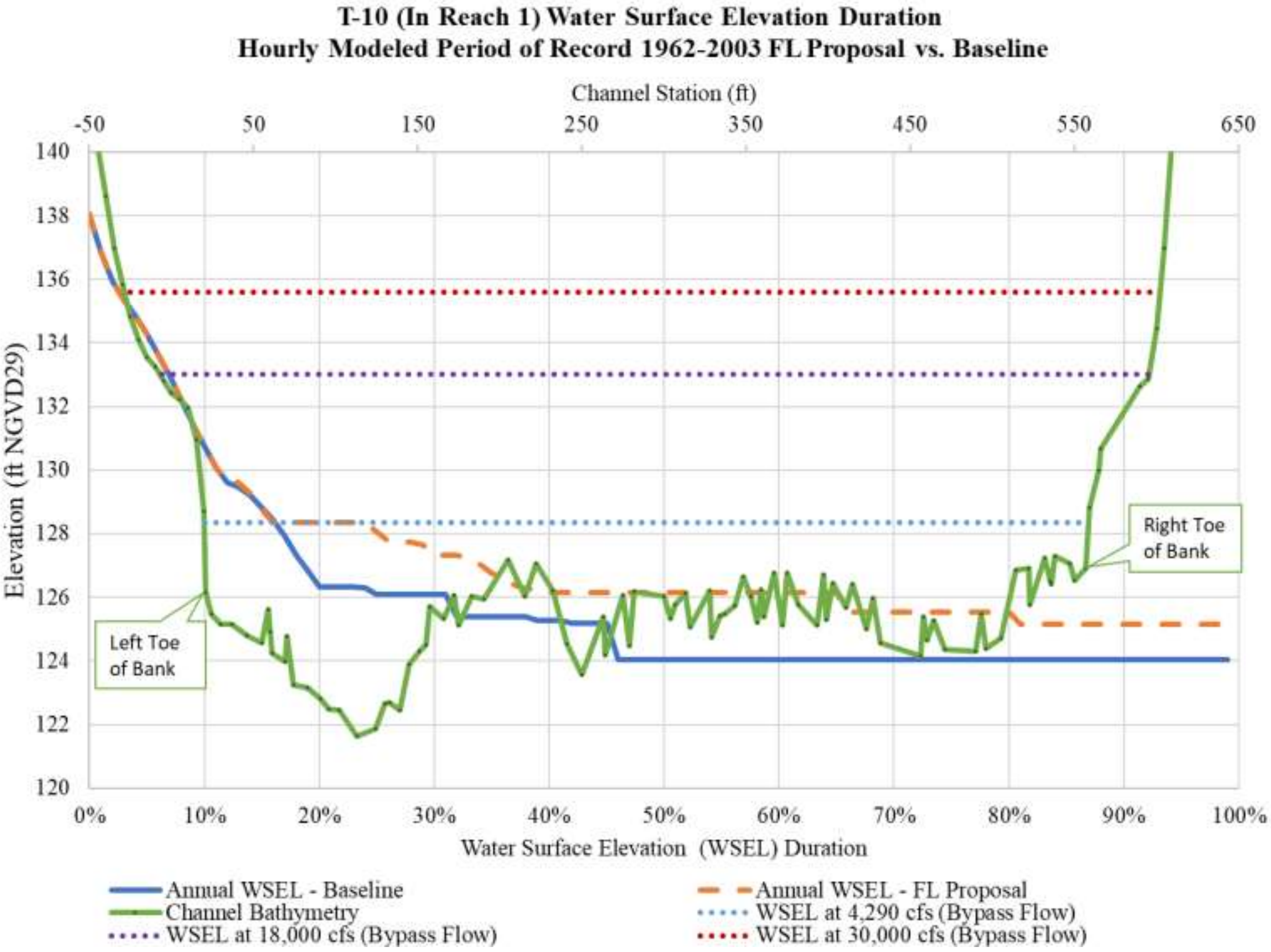

Figure 3.3.1.2.2-2: Transect T-10 Water Surface Duration Analysis

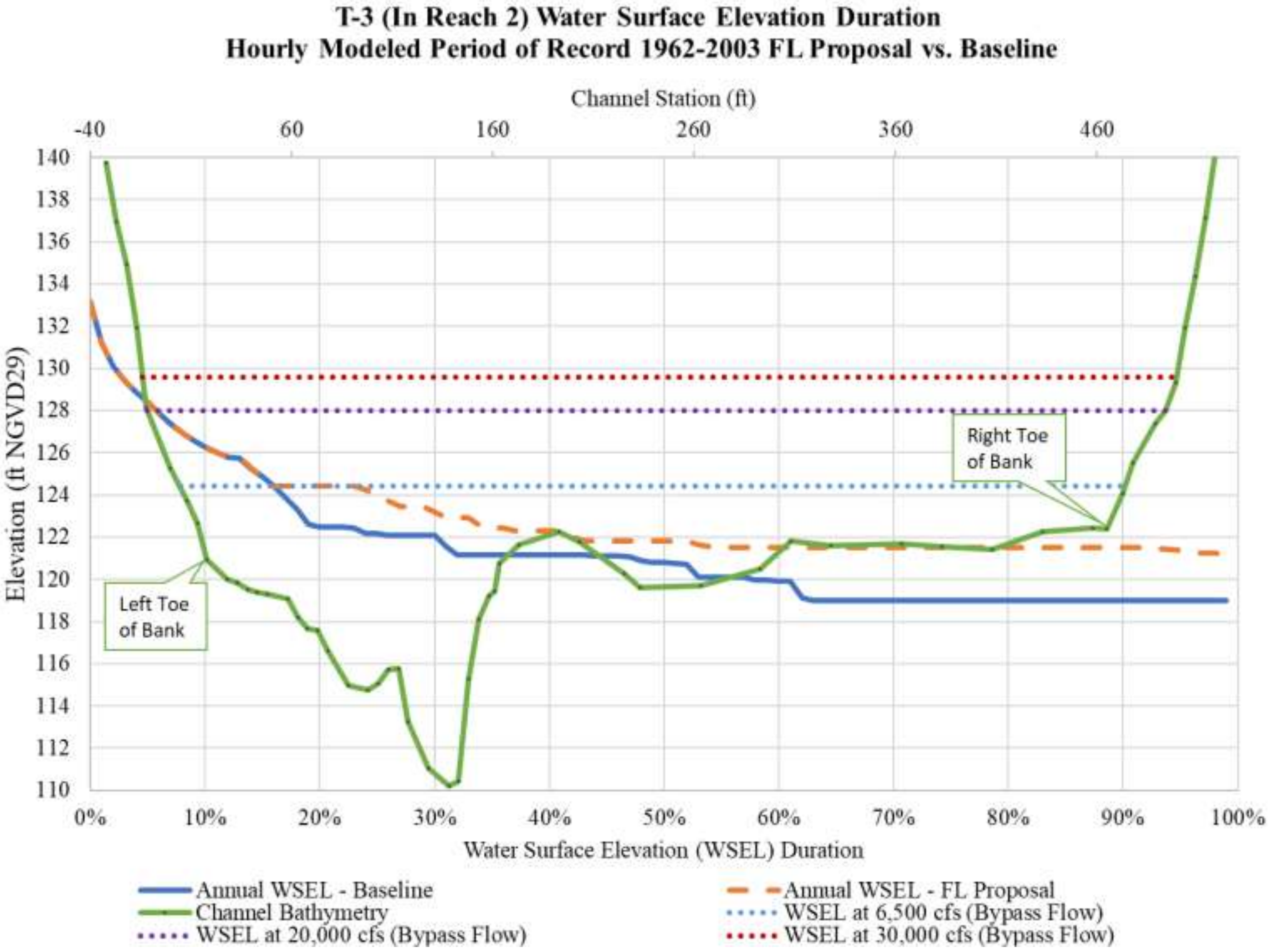

Figure 3.3.1.2.2-3: Transect T-3 Water Surface Duration Analysis

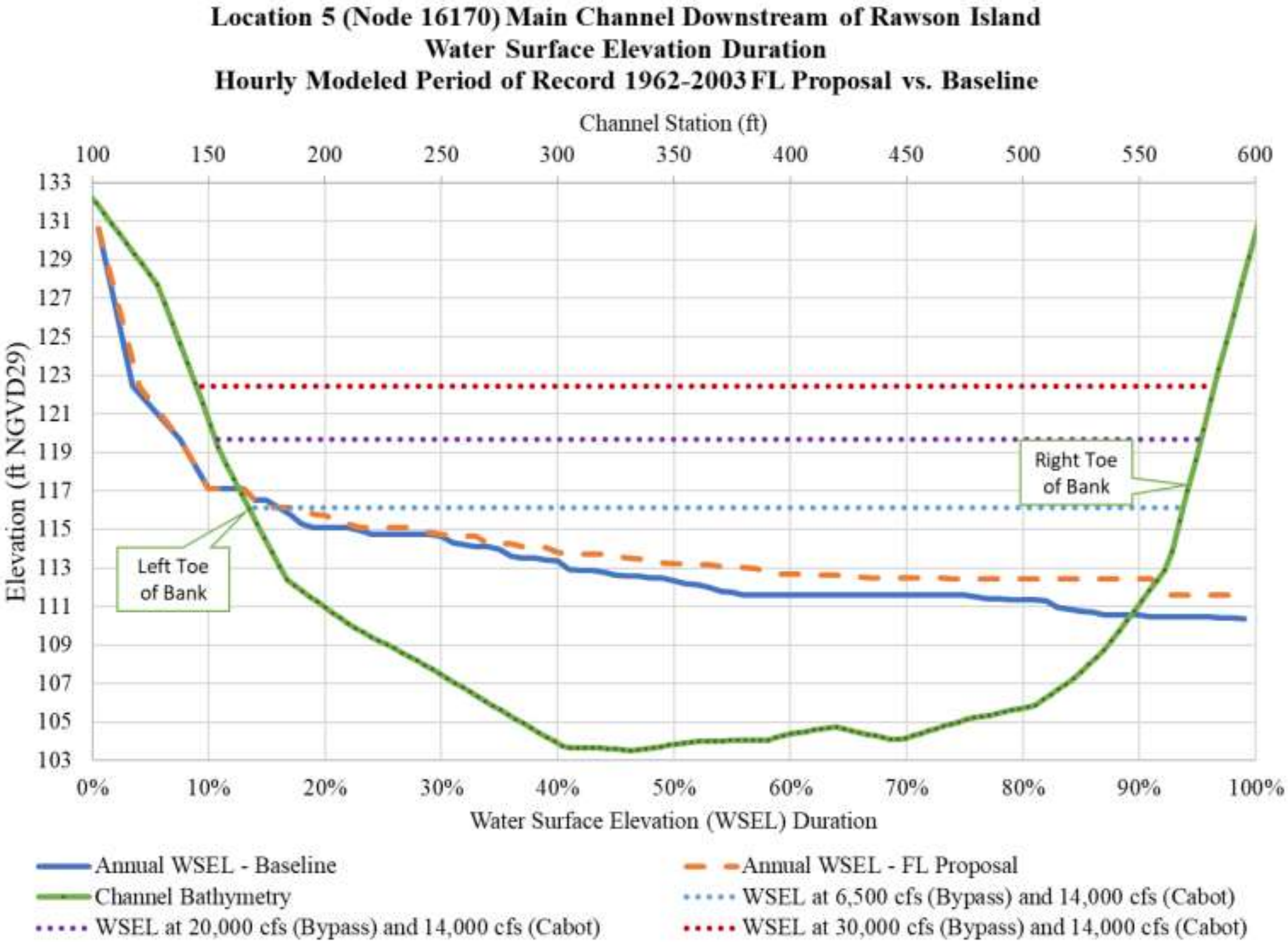

Figure 3.3.1.2.2-4: Location 5 Water Surface Duration Analysis

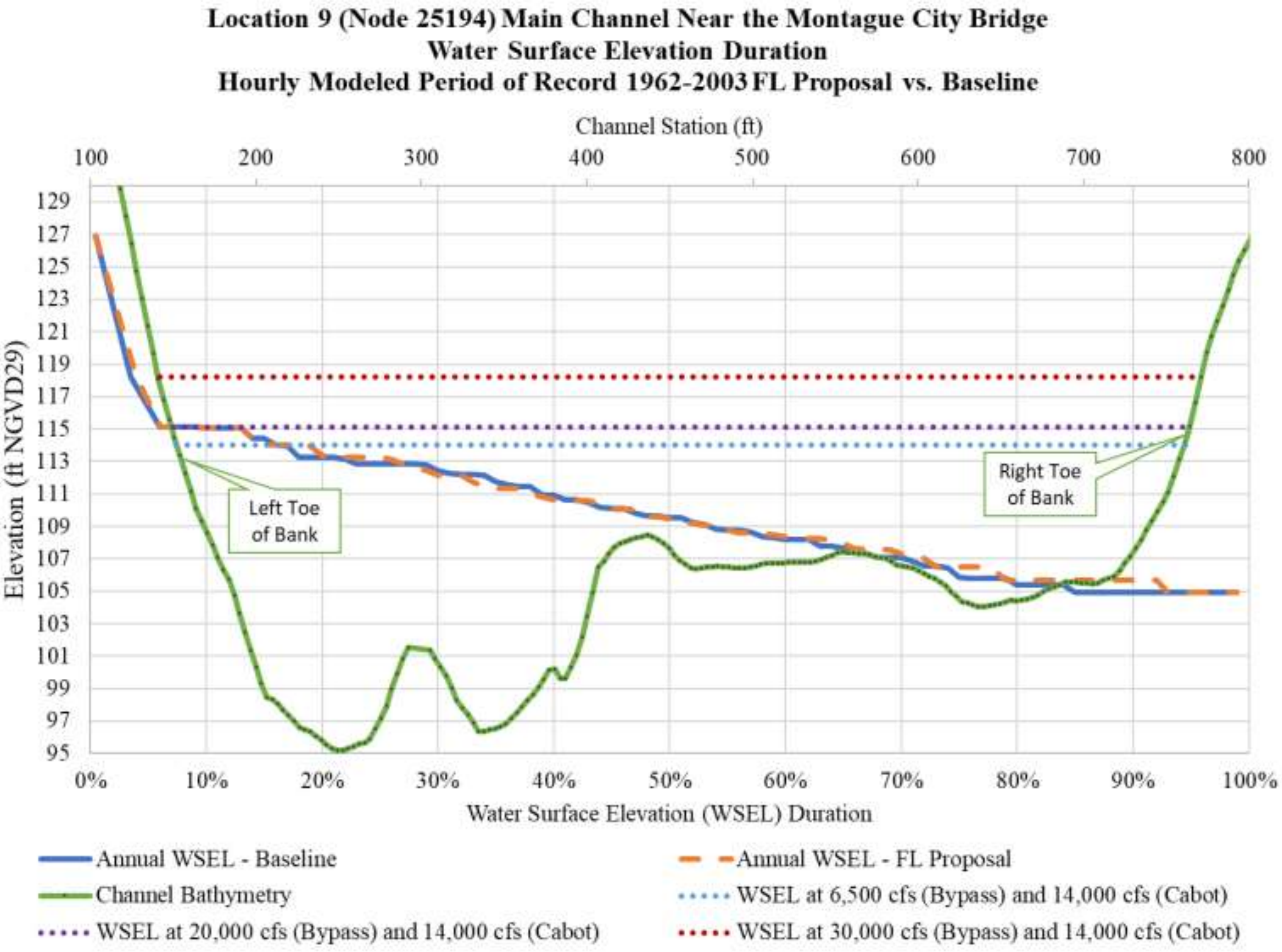

Figure 3.3.1.2.2-5: Location 9 Water Surface Duration Analysis

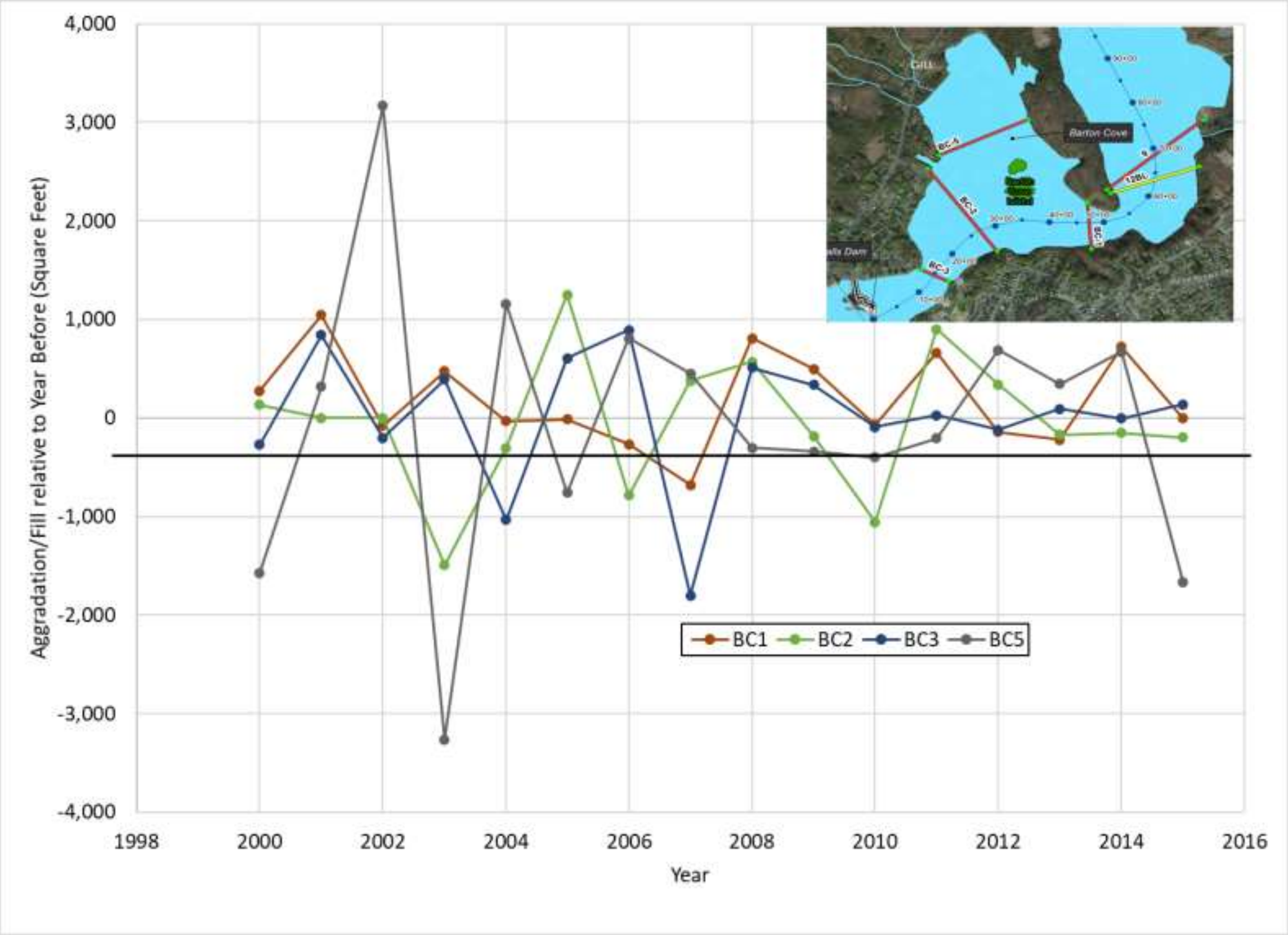

Figure 3.3.1.2.3-1: Transect BC1, BC2, BC3 and BC5 Sedimentation Rates (in square feet) from 2000-2015

3.3.2 Water Resources

3.3.2.1 Affected Environment

3.3.2.1.1 Water Quantity

The Connecticut River drains an area of 11,250 mi^2. The total watershed area upstream of the Turners Falls Dam is 7,163 mi^2. Within MA, the Connecticut River traverses approximately 67 river miles and drains approximately 2,728 mi^2.

3.3.2.1.1.1 Upstream Dams

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

• Second Connecticut Lake	• 506 million ft^3 (11.6 thousand ac-ft)
• First Connecticut Lake	• 3.33 billion ft^3 (76.4 thousand ac-ft)
• Lake Francis	• 4.33 billion ft^3 (99.3 thousand ac-ft)
• Moore Reservoir	• 4.97 billion ft^3 (114.1 thousand ac-ft)
• Comerford Reservoir	• 1.28 billion ft^3 (29.4 thousand ac-ft)

Pursuant to a 1993 Headwater Benefit Agreement between predecessor companies of GRH (formerly TransCanada), FirstLight pays an annual headwater benefit fee to GRH for the seasonal operation of its storage reservoirs (primarily driven by Moore Reservoir), which provides an incremental increase in generation at Cabot and Station No. 1. The Northfield Mountain Project does not receive (or pay) any headwater benefit from these upstream projects.

In addition to the seasonal storage reservoirs, the next three projects (operated by GRH) above Turners Falls Dam- namely Vernon, Bellows Falls, and Wilder, which operate to meet peak demand, whereby flows can fluctuate on an hourly basis. Like Turners Falls Dam, the minimum flow at Vernon Dam is equivalent to 0.2 cfs per square mile of drainage area or 1,250 cfs, which is provided from generation. The Vernon Hydroelectric Project has a station hydraulic capacity of 17,130 cfs.[46] When operating at full capacity, the Vernon Project exceeds the full hydraulic capacity of the Turners Falls Project (i.e., 15,938 cfs), not accounting for incremental inflow from the 897 mi^2 between the two dams. The magnitude and timing of discharges from the Vernon Project are critical to the operation of the Turners Falls Project and Northfield Mountain Project.

Article 304[47] of the Vernon Hydroelectric Project FERC license requires GRH to coordinate project operations with FirstLight. On May 28, 2003, GRH (then US Gen New England, Inc.) and FirstLight (then Northeast Generating Company) reached a hydro operating agreement relative to the coordinated operations between the Vernon Project and Turners Falls and Northfield Mountain Project. That agreement includes the following steps GRH must take relative to reporting the Vernon Project's generation schedule.

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[46] Great River Hydro, License Application, Exhibit A.

[47] Article 304 of the Vernon Project license was added to the license in 1992 (59 FERC ¶62,267) and generally requires the Licensee to develop and file with the Commission a coordination agreement with the licensee of certain downstream facilities in the event that the regional central dispatch system was ever discontinued. The dispatching of these hydropower projects under that system was discontinued several years ago in connection with the restructuring of the New England power markets.

1. By 8:00 am each day, GRH is to fax FirstLight its estimate of the total discharge (cfs-hours) expected the next day at its Vernon Project.
2. When GRH receives the hourly dispatch schedule for the next day from the Independent System Operator-New England (ISO-NE), GRH will fax its Vernon Project schedule to FirstLight. GRH generally receives the ISO-NE report between 12:00 pm and 2:00 pm.
3. If any subsequent dispatch schedules are received during the day showing changes in the project hourly flow schedules, the updated schedule for the Vernon Project will be sent by fax to Northfield.

The agreement also calls for GRH to transmit to FirstLight the instantaneous total discharge and tailwater elevation at the Vernon Project. The current agreement is problematic for FirstLight as it receives inaccurate next day total Vernon Project discharge volumes, and multiple, or sometimes no, real-time updates of the Vernon Project discharges.

The ultimate integrated operation of the Wilder, Bellows Falls, Vernon, and Turners Falls Projects, as well as the Northfield Mountain Project will be determined by FERC as part of the NEPA process. This future operation will represent a new paradigm for the river operations in this part of the Connecticut River. As described later, FirstLight's proposal relative to implementing up and down ramping, and Cabot Station peak demand flow restrictions, in particular, will take coordination between FirstLight and GRH to make sure the hydropower resource is used to its maximum benefit within the new license constraints. As part of that coordination, FirstLight believes it is essential for FERC to require GRH in any new license issued for the Wilder, Bellows Falls, and Vernon Projects to provide the following information, which is similar to the 2003 hydro operating agreement, to FirstLight River Operations Personnel[48] on a daily basis:

5. Day ahead hourly projections of total Vernon outflow (generation flows and spillage) provided by 8:00 am each day to FirstLight River Operations Personnel. FirstLight River Operations Personnel will use this information to schedule their river operations within the constraints of their license and hourly inflow from Vernon. FirstLight will take appropriate steps to ensure that the Vernon flow discharge information provided to its River Operations Personnel will not be communicated to individuals involved in marketing operations on behalf of FirstLight or any of its affiliates;
6. Day ahead hourly total Vernon outflow projections will be updated once the day ahead power bidding market closes and ISO-NE issues the day ahead schedule;
7. If ISO-NE updates the day ahead hourly total Vernon outflow schedule then that schedule will be provided to FirstLight within two (2) hours of GRH receiving an update from ISO-NE;
8. In same day operations GRH will supply FirstLight with deviations in the total Vernon outflow schedule in real time as well as an updated hourly projection for the remainder of the day. GRH will provide this information each time its outflow deviates from the last hourly projection.

FirstLight is seeking this information as its operating proposal includes a) seasonally varying bypass flows on an or-inflow, whichever is less basis, b) seasonal up- and down-ramping rates below Cabot Station (cfs/hour), c) seasonal up-ramping rates in the TFI at the Turners Falls Dam (ft/hour), d) seasonal maximum peak demand flow restrictions on an hourly basis at Cabot Station (cfs/hour) and e) seasonally varying whitewater releases on an or-inflow, whichever is less basis. Because the operating proposal includes

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[48] FirstLight agrees that the information provided to it shall be used solely for the purpose of operating its downstream hydroelectric licenses in accordance with the conditions established by FERC. Accordingly, it will agree to conditions that will restrict information provided pursuant to this request shall not be provided, either directly or indirectly, to any of its employees, consultants, agents or any other representative that are engaged in FirstLight's merchant activities, including but not limited to such activities as submitting bids to NEPOOL and/or ISO-NE in connection with the dispatch of any of its generating units.

adjustments on an hourly basis, it is critical that FirstLight have reliable Vernon total discharge information in order to operate the Project as proposed.

3.3.2.1.1.2 Hydrology and Streamflow

USGS streamflow monitoring gages located on the Connecticut River and its tributaries in the Project area are described below and shown in Figure 3.3.2.1.1.2-1.

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

Over 87% of the drainage area at the Turners Falls Dam is from inflow received by the Vernon Hydroelectric Project. The remaining 13% of drainage area is from tributaries to the TFI, primarily the Ashuelot and Millers Rivers. A USGS gage was located directly below Vernon Dam, and was active from approximately Oct 1944 to Sep 1973. The gage was discontinued by the USGS when the Turners Falls Dam was raised causing the backwater, at times, to extend to the base of Vernon Dam thus impacting the gage's rating curve. Based on review of available gage data, and the hydraulic capacity of the Vernon Hydroelectric Project (i.e., 17,130 cfs), GRH controlled discharges into the TFI approximately 84% of the time on an annual basis for the period examined. Vernon's hydraulic capacity was exceeded 16% of the time. The annual and monthly mean and median flows, and flow per square mile of drainage area, are shown in Table 3.3.2.1.1.2-1.

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

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

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

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

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

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

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

This gage is located downstream of Cabot Station and approximately 1,000 feet downstream from the mouth of the Deerfield River (total drainage area of 665 mi^2). The gage has a period of record from April 1940 to present. USGS remarks for the gage indicate that flow is regulated by power plants and by upstream reservoirs in the watershed.

Using the gage's 1941-2016 period of record, the annual and monthly mean and median flows, and flow per square mile of drainage area, are shown in Table 3.3.2.1.1.2-2.

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

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

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

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

Based on the hydraulic capacity of the Turners Falls Project (i.e., 15,938 cfs), on an annual basis, FirstLight can control discharges from the Project approximately 76% of the time, while 24% of the time the hydraulic capacity of the Turners Falls Project is exceeded. For the 1940 to 2016 period, the annual and monthly mean and median flows, and flow per square mile of drainage area, are shown in Table 3.3.2.1.1.2-3.

In addition to the streamflow gages described above, FirstLight maintains several WSEL gages as shown in Figure 3.3.2.1.1.2-2. Note that all FirstLight WSEL gages are based on the same vertical datum (National Geodetic Vertical Datum of 1929 (NGVD29)). FirstLight also maintains hourly data (elevations, discharges, generation, and pumping) on daily log sheets. Hydraulic models were developed in support of the licensing effort using the streamflow, WSEL and operations data, as described below.

3.3.2.1.1.3 Project-Related Data and Hydrologic/Hydraulic Models

This section summarizes the various models that were developed as part of this licensing, including:

- Operations Model (HEC-ResSim[49]);
- Hydraulic Models of the TFI and below the Montague USGS Gage to Holyoke Dam (HEC-RAS[50]);
- Two-dimensional hydraulic model of the TFI and sections of the bypass Reach (River 2D);
- Bypass Reach (Reaches 1, 2, 3), Reach 4 (Montague USGS Gage to Sunderland Bridge) and Reach 5 (Sunderland Bridge to Holyoke Dam) hydraulic and habitat models; and,
- Computational Fluid Dynamics (CFD) Models at existing fish passage structures. Discussion in the ensuing sections provides a general overview of each model as well as key findings of the TFI and Downstream HEC-RAS models. Key findings of the other models are discussed in Section 3.3.3.

Operations Model (HEC-ResSim)

As part of the relicensing process, FERC approved Study No. 3.8.1 *Evaluate the Impact of Current and Potential Future Modes of Operations on Flow, Water Elevations, and Hydropower Generation*. The study report was filed with FERC on March 1, 2017 (FirstLight, 2017a). As part of this study, FirstLight developed an operations model of the Connecticut River (Operations Model), which included the following hydropower facilities: GRH's Wilder, Bellow Falls, and Vernon Hydroelectric Projects, FirstLight's Turners Falls Project and Northfield Mountain Project, and Holyoke Gas and Electric's Holyoke Project

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[49] HEC-ResSim- Hydrologic Engineering Center- Reservoir System Simulation
[50] HEC-RAS- Hydrologic Engineering Center- River Analysis System

(Figure 3.3.2.1.1.3-1). The operations model was developed using the HEC-ResSim program as described in Study Report 3.8.1 (FirstLight, 2017a). The model is on an hourly time step for the period 1962 to 2003.[51] The model was used to simulate baseline and FirstLight's operating proposal. Outputs from the operations model (e.g., flows, WSEL) were fed into other models, including the hydraulic models described in the ensuing sections.

The operations model includes considerable "scripting" such that operations at the Turners Falls Project and Northfield Mountain Project operate collectively. The operations model was calibrated to observed generation, flows and water levels. Figures demonstrating the calibration of the model can be found in Appendix A- Water Resource Duration Curves (Exhibit E, Part 3 of 3) and include:

- Monthly and annual duration curves of the TFI WSEL at the Turners Falls Dam under Historic (Observed 2000-2016) and Modeled Baseline (1962-2003) Conditions;
- Monthly and annual duration curves of inflow to the TFI under Historic (Observed Calculated 1941-2016) and Modeled Baseline (1962-2003) Conditions; and
- Monthly and annual duration curves of flow at the Montague USGS Gage under Historic (Observed 1941-2016) and Modeled Baseline (1962-2003).

As demonstrated in Appendix A- Water Resources- Duration Curves (Exhibit E, Part 3 of 3), there is generally good agreement between the observed and modeled WSEL at Turners Falls Dam, inflow to the TFI, and flow at the Montague USGS Gage. While the monthly flow duration curves between historic and modeled baseline conditions are very similar for most months, during the low flow months of July, August and September, the historic flow values are lower than modeled conditions. This difference is likely due to the lack of minimum flow requirements for the early portion of the historic period of record (1941-2016), especially on mainstem Connecticut River dams. In the HEC-ResSim modeled baseline conditions, current operational conditions (including minimum flow requirements) were included for the entire period of 1962-2003.

Turners Falls Impoundment Hydraulic Model (HEC-RAS)

As part of the relicensing process, FERC approved Study No. 3.2.2 *Hydraulic Study of Turners Falls Impoundment, Bypass Reach and Below Cabot.* This study involved developing several hydraulic models, including a one-dimensional HEC-RAS hydraulic model of the TFI (TFI HEC-RAS Model). The TFI HEC-RAS model determined the impact on WSEL fluctuations due to a) the Vernon Project, b) the Northfield Mountain Project, c) the Turners Falls Project, and d) inflow from the Ashuelot and Millers Rivers. The model was used to produce WSEL, velocities, energy gradeline slopes, and other parameters at each transect. Outputs from the model were used as inputs to other models, including BSTEM as discussed in Section 3.3.1. The Study No. 3.2.2 report was filed with FERC on March 31, 2015 (FirstLight, 2015a) and an addendum to the report was filed with FERC on February 4, 2016 (FirstLight, 2016a).

The hydraulic model was well-calibrated to various TFI WSELs that were measured using water level loggers placed throughout the TFI as described in the Study Report 3.2.2 (FirstLight, 2015a). The TFI HEC-RAS model simulated current operations. Model inputs included the observed Vernon Dam discharge, Ashuelot/Millers River inflow, and the TFI elevation as measured at the Turners Falls Dam (downstream boundary). Hourly historic conditions were modeled from January 1, 2000 to September 30, 2014. In addition, the TFI HEC-RAS model was used to determine hourly WSELs at different locations along the TFI under baseline conditions and FirstLight's proposal (1962-2003) using the baseline and FirstLight proposal operations model outputs. Those outputs included Vernon discharges, inflows from the Ashuelot

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[51] Model inflows were obtained from the Connecticut River Unimpacted Streamflow Estimation (CRUISE) model that was developed by the USGS. The period of record of the CRUISE model ended in 2003. FirstLight had hoped to extend the period of record to 2012 or later but based on extensive correspondence with the USACE and the Nature Conservancy, it was not possible to extend the period of record past 2003.

and Millers River, Northfield Mountain pump and generation flows, and the WSEL at the Turners Falls Dam (which served as the downstream boundary condition).

Summary of Key Findings

Under the current license, the WSEL at the Turners Falls Dam is allowed to fluctuate between 176 and 185 feet. As described in Exhibit B, FirstLight is required by an agreement with the USACE to lower the WSEL at the Turners Falls Dam during high flows so that the peak WSEL does not exceed the flood of record under similar inflows. Based on hourly data, the observed median WSEL as measured at the Turners Falls Dam is 181.3 feet.

Under most flow conditions the approximately 20-mile long TFI acts as a riverine impoundment due to constrictions such as the French King Gorge, inflow from the Vernon Hydroelectric Project, inflow from major tributaries including the Ashuelot and Millers Rivers, and a steeper gradient river channel above Stebbins Island (located just below the Vernon Hydroelectric Project). Results of the modeling found that the WSEL at locations throughout the TFI is generally within one to two feet except under high flow conditions when the TFI WSEL gradient increases. With that said, daily WSEL fluctuations do occur within the TFI as a result of variations in the inflow from the Vernon Hydroelectric Project (which operates to meet peak demand when inflows are below its maximum generation capacity of 17,130 cfs), operation of the Northfield Mountain Project, and variations in the WSEL at the Turners Falls Dam. WSEL variations at the Turners Falls Dam are a result of the variation in flow from upstream sources, gatehouse operations at the Turners Falls Dam, and Cabot Station operations. TFI WSELs are also controlled by spill at the Turners Falls Dam and generation at Station No. 1. Based on the TFI HEC-RAS model, the daily variation within the TFI is 1 to 4 feet about 90% of the time.

The results of the modeling scenarios summarized in Study No. 3.2.2 (FirstLight, 2015a), found the following general conclusions based on steady state modeling:

- When the Northfield Mountain Project is idle, the difference in the WSEL with Vernon at its maximum generation versus Vernon at its minimum flow ranges from slightly over 6 feet at the Vernon tailrace to slightly over 1 foot at the Northfield Mountain Project tailrace;
- When Vernon is at its minimum flow, and the Northfield Mountain Project is at its maximum generation, the TFI impoundment is relatively flat except when the WSEL at the Turners Falls Dam is near 176 feet, which is an extremely rare occurrence;
- When Vernon is at its maximum discharge and the Northfield Mountain Project is idle, the difference in the WSEL at the Vernon tailrace, with the Northfield Mountain Project at maximum pumping is about -0.1 feet, and with the Northfield Mountain Project at maximum generation is about 0.8 feet;
- When Vernon is at its maximum generation, the difference in the WSEL when the Northfield Mountain Project is at maximum generation or pumping is about 0.9 feet at the Vernon tailrace and slightly over 4 feet at the Northfield Mountain Project tailrace;
- Under low flow conditions from Vernon and when the Northfield Mountain Project is idle or pumping, the WSEL at the Turner Falls Dam is the most controlling factor for the majority of the WSEL in the TFI. However, at the Vernon tailrace, the WSEL generally does not fall to under 181 feet even under lower WSELs at the Turners Falls Dam;
- Under low flow conditions, the French King Gorge does not a have a substantial effect on the WSEL in the TFI; and
- At higher flow conditions, especially above 20,000 cfs, the French King Gorge becomes more of a hydraulic control affecting WSELs in the middle and upper TFI.

Finally, review of available transect stage versus discharge rating curves at various locations throughout the longitudinal extent of the TFI indicate that in the upstream portions of the TFI (especially above the French King Gorge), the WSELs are less dependent on the WSEL at Turners Falls Dam. This is further demonstrated in Appendix B- Water Resources- TFI Rating Curves (Exhibit E, Part 3 of 3), which presents stage versus flow rating curves for various locations at flows between 1,000 and 30,000 cfs and varying downstream boundary WSELs at Turners Falls Dam. Furthermore, travel time through the TFI is variable and also a function of the factors described above; however, under normal circumstances, travel time through the TFI is about 6 to 8 hours from Vernon Dam to Turners Falls Dam.

Downstream Hydraulic Model (HEC-RAS)

As part of Study No. 3.2.2, FirstLight developed a one-dimensional, unsteady HEC-RAS model from the Montague USGS Gage downstream to Holyoke Dam (the Downstream Model).[52] After calibration, the Downstream Model was used to a) determine the historical WSELs at numerous locations under various Cabot Station operating conditions, b) develop transect rating curves, c) conduct travel time calculations, and d) analyze the attenuation of releases from the Turners Falls Project. The lag and attenuation analyses were based on additional modeling conducted during the Instream Flow Incremental Methodology (IFIM) studies when FirstLight had water level loggers at numerous locations throughout Reach 4 and 5[53]. In addition to determining the lag and attenuation of flows released from the Turners Falls Project (specifically Cabot Station), the supplemental modeling provided additional model validation. Two periods of historical data were modeled for the lag and attenuation analysis – July 1 to October 25, 2012 (Holyoke Dam WSEL provided by the USFWS) and June 13 to July 11, 2017 (as part of the field work associated with an addendum to Study Report 3.3.1 *Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station*).

In addition, the Downstream Model was used to examine varying Holyoke Dam impoundment elevations. Since about 2008, the Holyoke Dam, located approximately 33 miles below Cabot Station, has operated in a modified run-of-river condition with a WSEL as measured at the dam between about 99.47 and 100.67 feet (personal comms. Paul Ducheney – HG&E).[54] As a result, the historic time period for the Downstream Model was January 1, 2008 to September 30, 2014 due to the change in operations at Holyoke Dam.

Finally, the Downstream Model, coupled with the Operations Model, was used to examine baseline and FirstLight's operating proposal. Output, specifically flow at the Montague gage location from the operations model under baseline and FirstLight's proposal, was used as inflow to the upper portion of the Downstream Model for such analyses. Tributary inflow to the Connecticut River from Montague to Holyoke was calculated similarly to that which was described in Study Report 3.2.2 (FirstLight, 2015a) and added to the hydraulic model which did not vary between the baseline and FirstLight's proposal. A low (99.47 ft) and high (100.67 ft) Holyoke Dam impoundment elevation (downstream boundary condition) was used for baseline and FirstLight's proposal. Since the completion of Study Report 3.2.2, the Downstream Model was updated to include additional detailed cross-sectional data obtained in Reaches 4 and 5 as part of the IFIM study. These additions did not noticeably change the results summarized in Study Report 3.2.2.

Summary of Key Findings

Based on the results of the modeling scenarios summarized in Study Report 3.2.2 (FirstLight, 2015a), the following general conclusions of the effects of Project operations on the downstream reach were made:

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[52] FirstLight had a variance on the geographic extent of the study. Rather than terminating the upstream extent of the Downstream Model at the Turners Falls Dam, it was terminated at the Montague USGS Gage.

[53] Reach 4 is from the Montague USGS Gage to the Sunderland Bridge (Route 116) and Reach 5 is from the Sunderland Bridge to the Dinosaur Footprints Reservation area, about 4 miles upstream of Holyoke Dam.

[54] The current Holyoke impoundment operating band is the result of various studies, agency consultation, and license amendments implemented to protect Puritan Tiger Beetle at Rainbow Beach. In studies performed by Holyoke Gas & Electric (HG&E), the lower limit was shown to reduce impoundment elevations and water level fluctuations at Rainbow Beach when inflows are less than 11,000 cfs (HG&E, 2012; HG&E, 2015).

- The WSEL difference between maximum generation at both the Turners Falls Project and Deerfield River Project and maximum generation only at the Turners Falls Project and minimum flow at the Deerfield River Project is about 0.5 feet at the Montague Gage and decreases to slightly more than 0.2 feet near Mitch's Marina;
- When flows are above approximately 11,000 cfs, a constriction in the Connecticut River (near the Dinosaur Footprints Reservation) about 4 miles upstream of Holyoke Dam, begins to control upstream WSELs as much or more so than the WSEL at Holyoke Dam; and
- The influence of the WSEL at the Holyoke Dam, even under low flows is generally less than 0.2 feet at the Route 116 Bridge and falls to basically zero at the Montague USGS gage.

The Downstream Model was also used to develop transect rating curves, conduct travel time calculations, and analyze attenuation of releases from the Turners Falls Project. Transect rating curves for steady state conditions at seven locations in the Downstream Model are provided in Appendix C- Water Resources- Downstream Rating Curves (Exhibit E, Part 3 of 3). As demonstrated in Appendix C- Water Resources- Downstream Rating Curves (Exhibit E, Part 3 of 3), the effects on Holyoke WSELs are very limited in Reach 4 but become more pronounced in Reach 5 under low flow conditions.

Several unsteady analyses using historic data were also conducted to demonstrate lag and attenuation throughout the study area. As previously noted, two periods were analyzed for this analysis – July 1 to October 25, 2012 and June 13 to July 11, 2017. Weekly hourly plots for the 2012 period were included in Appendix A of the Puritan Tiger Beetle (PTB) Biological Assessment (BA)[55] filed with the Commission as part of the AFLA. The plots show the observed flow at Montague (secondary y-axis). Plots for the 2017 time period are included in Appendix D- Water Resources- Downstream Hydrographs (Exhibit E, Part 3 of 3) and include observed flow at Montague (secondary y-axis), observed WSELs at Holyoke Dam, observed WSELs at three (3) transects (T2, T5 and T7) and the modeled WSEL at Rainbow Beach. Figure 3.3.2.1.1.3-2 shows the locations of the transects in Reach 5. Figure 3.3.2.1.1.3-3 provides a 4-day example plot. As demonstrated in the figure, there was a general 8 to 12 hour delay from the start of the peak demand at Cabot Station until the occurrence of the peak WSEL at Rainbow Beach (approximately 25 miles downstream).

In addition to the lag and attenuation analysis, FirstLight also modeled synthetic hydrographs to estimate how Cabot peak demand releases are attenuated and lagged in Reaches 4 and 5. The 34 synthetic scenarios and resulting figures were provided as Appendices B and C of the PTB BA. Figures 3.3.2.1.1.3-4 through 3.3.2.1.1.3-6 provide examples of some of the figures. As demonstrated in the figures, attenuation of the Cabot Station peak demand discharges downstream on the Connecticut River are largely a function of the distance downstream and the duration and magnitude of the peak demand flow. A summary table of the results for the synthetic modeling at the Route 116 Bridge and Rainbow Beach is also included Appendix B of the RTE-Puritan Tiger Beetle Biological Assessment. Table 3.3.2.1.1.3-1 contains a small portion of the larger summary table that is provided in the PTB BA. As observed in the table, the arrival of the peak at Rainbow Beach is delayed by about seven (7) to 14 hours depending on several variables. This indicates that the modeled peak WSEL arrives at Rainbow Beach slightly faster during higher baseflow conditions in the Connecticut River and/or a higher amount of Cabot peak demand generation.

Modeling was also conducted to estimate the timing and amount of effect the variation in WSEL at Holyoke Dam (the downstream boundary condition of the Downstream Model) has on WSELs in Reach 5 under different flow conditions. FirstLight also modeled how WSEL changes at Holyoke Dam are translated upstream to areas including Rainbow Beach in Reach 5 under steady state flow conditions. The results of this analysis are presented in Figures 3.3.2.1.1.3-7 and 3.3.2.1.1.3-8. This modeling indicated that WSELs at Holyoke Dam are relatively quickly translated upstream to areas such as Rainbow Beach. Based on this, and other analyses, it is clear that the hydraulic constriction at the "Narrows" near the Dinosaur Footprints

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[55] The Puritan Tiger Beetle Biological Assessment is included in Exhibit E (see Appendix D- RTE-Puritan Tiger Beetle Biological Assessment, Exhibit E, Part 3 of 3)

State Park becomes an important control at flows greater than approximately 11,000 cfs. As observed in the figures, the WSELs at Rainbow Beach are affected by the 1.2 foot variation at the Holyoke Dam by about:

- 1.1 ft at 2,000 cfs;
- 0.9 ft at 4,000 cfs;
- 0.7 ft at 6,000 cfs;
- 0.5 ft at 10,000 cfs;
- 0.3 ft at 15,000 cfs; and
- 0.2 ft at 20,000 cfs.

Turners Falls Impoundment- 2-D Hydraulic Model (River2D)

As part of the relicensing process, Study No. 3.3.9 *Two-Dimensional Modeling of the Northfield Mountain Pumped Storage Intake/Tailrace Channel and Connecticut River Upstream and Downstream of the Intake/Tailrace* was conducted to determine the magnitude and direction of velocities in the Northfield Mountain Project intake/tailrace under numerous flow scenarios. The study report was filed with FERC in December 2015 (FirstLight, 2015b) and included:

- Assessment of velocities and flow fields at, and in proximity to, the Northfield Mountain Project intake/tailrace structure when pumping or generating and its potential to interfere with migratory fish movement.
- Assessment of the potential for velocity barriers in the TFI due to pumping and generating at the Northfield Mountain Project alone or in combination with generation flows from the upstream Vernon Project and downstream Turners Falls Project.
- Characterization of water column velocity profiles in the immediate vicinity of the Northfield Mountain Project intake/tailrace (i.e., inside the boat barrier).
- Assessment of the potential for Northfield Mountain Project operations to create undesirable attraction flows to the intake/tailrace area that may result in entrainment or delay of migratory fish.
- Assessment of potential migratory fish impacts due to flow reversals under:
    - Pumping conditions, such that the river flows from the Turners Falls Dam toward the Northfield Mountain Project intake/tailrace; and
    - Generating conditions, such that the river flows from the Northfield Mountain Project intake/tailrace toward Vernon Dam.

This study focused on the velocity ranges at three locations:

- Site 1: Near Kidds Island about 2.5 miles upstream of the Northfield Mountain Project tailrace;
- Site 2: Just upstream and downstream of the Northfield Mountain Project tailrace; and
- Site 3: In the French King Gorge area, about 1.2 miles downstream of the tailrace.

Discussion pertaining to model results related to fish passage and protection are included in Section 3.3.3.

Bypass Reach and Reaches 4 and 5 Hydraulic and Habitat Modeling (Including PHABSIM, River2D, and HEC-RAS)

As part of the relicensing process, FERC approved Study No. 3.3.1 *Conduct Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station*. The study included developing one dimensional models for portions of Reaches 1, 2, 4, and 5 as well as two dimensional models for the lower part of Reach 2 and for Reach 3. The study report was filed with FERC in October 2016 (FirstLight, 2016a) with multiple addendums having been filed since (as discussed in Section 3.3.3). This study and the addendums assessed the effects 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 (i.e., 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 (referred to as Reach 5), the assessment focused on state or federally listed mussels. Figures 3.3.2.1.1.3-9 and 3.3.2.1.1.3-10 provide location maps of the reaches. Descriptions of each reach are summarized below.

Bypass Reach

The 2.5-mile long bypass reach runs from Turners Falls Dam to Cabot Station tailrace.

Reach 1. This reach is approximately 0.75 miles long, extending from the Turners Falls Dam downstream to the confluence with the Station No. 1 tailrace. There is a large plunge pool immediately below the dam and the Fall River confluence is about 0.16 miles 850 feet) downstream of the dam. Stream channel structure and geomorphology are controlled primarily by bedrock.

Reach 2. This reach is approximately 1.0 mile long extending from the Station No. 1 tailrace downstream, terminating at the Rawson Island complex and a geological feature including a natural ledge drop known as “Rock Dam”. Stream channel structure is controlled primarily by bedrock. The downstream-most segment (Reach 2B) of this reach is a pool that terminates in a bifurcated channel at the Rock Dam/Rawson Island complex.

Reach 3. This reach extends from below the Rock Dam/Rawson Island complex downstream to the Montague USGS gage (~1.5 miles). A portion of Reach 3 is upstream of the Cabot Station tailrace is within the bypass reach. This reach contains several islands and splits both upstream, across, and downstream from the Cabot Station powerhouse. Hydraulic effects are complex and include flow-dependent backwatering from Cabot Station upstream to Rock Dam, as well as flow between islands. The portion of Reach 3 downstream of the Cabot Station tailrace includes the confluence with the Deerfield River just above the Montague USGS gage.

Reach 4. This reach is approximately nine (9) miles long and extends from the Montague USGS Gage downstream to the Route 116 Sunderland Bridge. Flow in this reach consists of combined flows through the Turners Falls Project and Deerfield River discharges. This section of river is alluvial and low gradient, with a well-defined channel and embankments.

Reach 5. This reach extends 22 miles from the Route 116 Bridge downstream to a natural hydraulic control in the vicinity of Dinosaur Footprints Reservation. This reach becomes increasingly impounded by Holyoke Dam with distance downstream. It is a low gradient, alluvial reach and hydraulics in this reach are influenced by Holyoke Dam operations (1.2-foot water level operational range) and flow from upstream (i.e., combined flows from the Turners Falls Project, Deerfield River, and minor tributaries).

Additional details of the reaches including aquatic habitat are provided in Section 3.3.3. A combination of hydraulic and aquatic methods and models were used in these areas including:

- Upper Portions of Reach 1:
    - Plunge Pool Assessment
    - Zone of Passage
    - Physical Habitat Simulation (PHABSIM) 1-D Single Transect
- Lower Portion of Reach 1 and Reach 2
    - Water Surface Profile (WSP) model within the USFWS’s PHABSIM computer programs
- Reach 2B and Reach 3
    - Two-dimensional (2-D) River2D model
- Reach 4
    - PHABSIM and HEC-RAS
- Reach 5
    - PHABSIM and HEC-RAS

The hydraulic and habitat modeling resulted in weighted useable area (WUA) versus flow relationships for different aquatic species and life stages. The results from the River2D modeling were also used to investigate existing velocity barriers to American shad migration near Rawson Island. The River2D model was also used for Study 3.3.12 *Evaluation of Emergency Gate and Bypass Flume Discharges* (FirstLight, 2017b) to analyze and determine changes in velocities and sediment mobilization in the vicinity of Cabot Station during emergency spill gate releases. In addition, these studies were key in FirstLight's analysis of their proposed action flow recommendations, which are based on the habitat use by species and life stages throughout the year, availability of water throughout the year, varying hydrology during each bio-period of interest, and the operational and economic constraints of the Project.

Fishway Entrances and Powerhouse Forebay Modeling (CFD)

As part of the relicensing process, FirstLight completed the FERC approved Study No. 3.3.8 *Computational Fluid Dynamics (CFD) Modeling in the Vicinity of the Fishway Entrances and Powerhouse* (FirstLight, 2016c). CFD models were developed at the following locations:

- Cabot tailrace including the Cabot Ladder entrance (upstream);
- Spillway below bascule gate 1 including the Spillway Ladder entrance (upstream);
- Juncture of the power canal and the Station No. 1 forebay (downstream); and
- Power canal leading into the Cabot trashracks and downstream bypass sluice (downstream).

This study report was filed on February 1, 2016 (FirstLight, 2016c) with an addendum filed in October of 2016 (FirstLight, 2016d). This study report and the addendum discuss the following:

- Characterized the hydraulics of current (existing) conditions and any changes to fishway attraction flows, turbine operations, and log sluice gates;
- Developed a series of velocity maps at select discharges showing approach velocities and flow fields that may create a response in fish;
- Characterized the flow field in front of the Cabot Station and Station No. 1 intakes using velocity maps and cross-sectional plots;
- Assessed whether fish are directed to the downstream passage surface bypass weir near Cabot Station; and
- Characterized the near-rack "sweeping" velocities at the Cabot Station and Station No. 1 intakes.

FirstLight integrated the CFD modeling results along with other studies to evaluate the impact of Project operations on migratory fish including a) Study 3.3.2 *Evaluate Upstream and Downstream Passage of Adult American Shad,* b) Study 3.3.3 *Evaluate Downstream Passage of Juvenile American Shad,* c) Study 3.3.5 *Evaluate Downstream Passage of American Eel,* and d) Study 3.3.15 *Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Area*. These studies included telemetry data to determine how tagged migratory fish respond to different operating conditions. The telemetry studies, coupled with the CFD hydraulic evaluations, were used to determine the impact of Project operations on migratory fish movement. The effects to migratory fish movement under existing conditions were described in detail in the above mentioned aquatic studies. The effects to migratory fish movement under FirstLight's proposed operations as compared to baseline conditions can be found in Section 3.3.3.

Water Withdrawals

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

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

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

FirstLight is aware of four additional water withdrawals[56] in the MA reach of the TFI where no MAWMA water registrations and permits were obtained from the MADEP. From north to south, they include:

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

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

3.3.2.1.2 Water Quality

Water Quality Standards and Classifications

Massachusetts

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

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

New Hampshire

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

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[56] One additional withdrawal in Gill, MA off Main Street, is in the state/federal permitting process. The applicant is Nourse-Patterson, LLC

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

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

Vermont

The state-line between VT and NH is the ordinary low water mark on the western bank of the Connecticut River which in some locations is now inundated by the impoundments created by dams[57]. However, VT considers most of the Connecticut River to be a Class B waterbody. VT's water numerical quality standards for Class B waters include *E. coli* are not to exceed 77 organisms/100 ml and DO levels shall not be less than 5 milligram/liter (mg/l) and 60% saturation at all times (for warm water fish habitat waters). VT's water quality standards also include narrative protective criteria.

Historical Water Quality

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

Water Quality Assessment and Impairments

Every two years, states must file a document called the "Integrated List" to comply with sections 303d and 305b of the Clean Water Act. The Integrated Lists for MA and NH divide the Connecticut River into distinct segments for the purpose of determining water quality uses and impairments. The 2018 Integrated Lists for MA and NH[58] report that the entire Connecticut River is water quality impaired. Impaired waters are listed as "Category 5," indicating that a total maximum daily load (TMDL) study is required for that particular water body.

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

Based on NH's Watershed Report Card (NHDES, 2018), the Connecticut River from the Vernon Dam downstream to the state line (Segment NHRIV802010501-05) is listed as impaired (Category 5 – TMDL Needed). This segment supports swimming and boating uses but does not meet state standards for supporting aquatic life due to aluminum and copper from unknown sources. NH's general statewide fish consumption advisory due to mercury applies to this segment of the Connecticut River.

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

[58] The NH 2020 Section 305(b) and 303(d) Consolidated Assessment and Listing Methodology is in draft form (October 16, 2020).

The VT Integrated List (VTDEC, 2018) indicates that the Connecticut River from the Vernon Dam downstream to the state line (Segment VT13-05) is impacted by flow alteration (Part F - Waters Altered by Flow Regulation). The aquatic life support use is impacted by fluctuating flows due to hydropower production.

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

The MA Integrated List (MADEP, 2019) indicates that from the NH/VT border to the Route 10 Bridge crossing the TFI (Segment MA34-01, 3.5 miles) in MA, the Connecticut River is listed as impaired (Category 5- Waters Requiring a TMDL) due to "flow regime modification" and "alteration in stream-side or littoral vegetative covers."

The section of the river between the Route 10 Bridge crossing the TFI and the Turners Falls Dam (Segment MA34-02, 11.4 miles) is listed as impaired by MADEP (Category 5- Waters Requiring a TMDL) due to "flow regime modification" and "alteration in stream-side or littoral vegetative covers." Additionally, Barton Cove (Segment MA34122) is listed as impaired for non-native aquatic plants (Eurasian water milfoil).

From the Turners Falls Dam to the confluence with the Deerfield River (Segment MA34-03, 3.7 miles), the Connecticut River is listed as impaired (Category 5- Waters Requiring a TMDL) due to "dewatering," "flow regime modification," *E. coli* bacteria, and total suspended solids.

From the confluence with the Deerfield River to Holyoke Dam (Segment MA34-04, 34.5 miles), the Connecticut River is listed as impaired (Category 5- Waters Requiring a TMDL) due to *E. coli* bacteria.

The Northfield Mountain Upper Reservoir (Segment MA34061) is listed as a MA Category 3 Waters, meaning "No Uses Assessed."

2008 Massachusetts Water Quality Monitoring Data (Technical Memorandum CN 322.1)

Water quality sampling in the Connecticut River Watershed was conducted by MADEP in May – September 2008. This effort includes one location in the Connecticut River in the Project area: Station CTBERN, 800 feet north of the Route 10 Bridge in Northfield (Figure 3.3.2.1.2-1). The parameters included in the sampling at Station CTBERN were DO, pH, conductivity, water temperature, total dissolved solids, total suspended solids, ammonia, total nitrogen, total phosphorus, E. coli bacteria, hardness, true color, and turbidity.

Water quality data collected at Station CTBERN is summarized in Table 3.3.2.1.2-2 and Table 3.3.2.1.2-3. The data were used by the MADEP to assess the status of the designated uses as defined in the MA Surface Water Quality Standards.

Data collected from Station CTBERN between May and September 2008 were used to assess water quality conditions as the river entered the state of MA. All measurements were indicative of good water quality conditions (MADEP, 2013).

NHDES Water Quality Data

The NH Department of Environmental Service (NHDES), assisted by the USEPA, assessed the entire Connecticut River mainstem in NH in 2004. The parameters included in the sampling were bacteria, DO, pH, specific conductance, temperature, and metals. Sampling locations included the Connecticut River at the Route 10 Bridge in Northfield, and the Ashuelot River (tributary to Connecticut River) at the Route 119 Bridge in Hinsdale, NH.

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

Connecticut River Conservancy Volunteer Monitoring

The Connecticut River Conservancy (CRC) conducted a volunteer water quality monitoring program in the Connecticut River in 2007 and 2008. Sampling was conducted at six (6) locations, which included four (4) sites in the Connecticut River. One of these sites was located in the TFI, at the Franklin County Boat Club docks at Barton Cove in Gill, MA (Figure 3.3.2.1.2-1). Parameters included water temperature, DO, conductivity and transparency.

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

In addition, the CRC has monitored bacteria at the Barton Cove state boat launch on a weekly basis from the week after Memorial Day to the first week of October since 2010. Data from 2010 and 2011 were collected by the CRC, in cooperation with Franklin Regional Council of Governments (FRCOG), the Pioneer Valley Planning Commission (PVPC) and the University of MA Water Resources Research Center. Barton Cove's state boat launch *E. coli* data from 2012 to 2019 are compared with corresponding daily average flows from the Montague USGS gage and the MA water quality standard in Figure 3.3.2.1.2-2. The same *E. coli* and flow data, in addition to instances samples were collected during a wet weather event, are displayed in Table 3.3.2.1.2-5.

All of the corresponding *E. coli* measurements from 2010 met the MA Water Quality Standard. Several samples from each season exceeded the MA Water Quality maximum standard of 235 colonies/100 ml for *E. coli* from 2011 to 2019, however the occurrences where the standard was exceeded have reduced in number and magnitude since 2015.

River flows were appreciably higher in 2011 when compared to 2010. The low daily average flows observed during the 2012 sampling period were comparable to those of 2010[59] (USGS, 2018). Five (5) out of the 19 samples (26%) collected exceeded the MA water quality standard in 2012. The highest flows corresponding to sampling events from 2010 to 2015 were observed in 2013. Thirteen (13) of the 19 samples (68%) collected exceeded the MA water quality standard in 2013. 2014 had similar results to 2013 with 13 of the 20 samples (65%) collected exceeding the MA water quality standard. Counts were lower in 2015 with seven (7) of the 20 sampling events (35%) resulting in exceedances. Counts continued to be lower since 2015 averaging only 17% for 2016 through 2019. (CRC, n.d).

In addition to the monitoring for *E. coli* at the Barton Cove state boat launch, CRC publishes *E. coli* sampling results collected by the Greater Northfield Watershed Association in the TFI at the Pauchaug Brook boat launch in Northfield. This site has been sampled every other week from late May through August since 2013. The *E. coli* data from 2013 to 2019 are compared to the daily average flows from the Montague USGS gage and the MA water quality standard in Figure 3.3.2.1.2-3. The same *E. coli* and flow data, in addition to instances samples were collected during a wet weather event, are displayed in Table 3.3.2.1.2-6.

Only two out of the 49 total sampling events since 2013 from the Pauchaug Brook state boat launch resulted in an exceedance of the MA water quality standard for *E. coli*. There was one exceedance in 2013 of 276

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[59] As described earlier, the Montague USGS gage is about 1,000 feet downstream of Cabot Station and below the confluence with the Deerfield River.

colonies/100 ml, one wet-weather exceedance in 2014 of 980 colonies/100 ml, and no exceedances between 2014 and 2019 (CRC, n.d).

USGS Water Quality Monitoring

Water quality measurements were occasionally taken by the USGS at the Montague City gage site. Data includes physiochemical measurements and nutrients collected most recently in 2006-2007, as shown in Table 3.3.2.1.2-7.

Recently, physiochemical and nutrient measurements were also collected by the USGS on the Connecticut River at the Route 10 Bridge in Northfield gage[60] site from 2017 to 2020, approximately weekly. Representative data from 2019 and 2020 are shown in Table 3.3.2.1.2-8. This site has also been continuously monitored for temperature, specific conductance, DO, pH, dissolved organic matter, and turbidity since 2018. Turbidity was an average of 2.9 Formazin Nephelometric Unit (FNU) for the period of record. Six (6) spikes in turbidity of greater than 20 FNU correspond to high flow periods in excess of 35,000 cfs as measured downstream at the Montague USGS gage. DO saturation was between 90% and 110% for most of the period of record, with the average being 98% and the lowest being 85% (6.9 mg/L) in July 2018. Observed pH values were between 6.9 and 8.0 for the period of record, with an average of 7.4.

In addition to collecting data from these sites, a study of total nitrogen concentrations and loads was conducted by the USGS from December 2002 to September 2005 at 13 river sites in the upper Connecticut River Basin. In this study, the mean annual load and yield of total nitrogen at the Connecticut River at North Walpole, NH, was estimated at 9.60 million pounds/year and 1,750 (pounds/mi^2)/year, respectively. The mean annual load and yield of total nitrogen leaving the upper Connecticut River Basin, as estimated at the Connecticut River at Thompsonville, CT, was 21.6 million pounds/year and 2,230 (pounds/mi^2)/year, respectively (Deacon *et al.*, 2006).

Long Island Sound Nitrogen TMDL study

The Connecticut River accounts for 70% of freshwater entering Long Island Sound (the Sound) every year. An overabundance of nitrogen has been identified as the primary cause of hypoxia (low DO) in the Sound. Hypoxia is a serious problem affecting the overall health and abundance of fish, shellfish and other organisms, and occurs during the late summer months.

The USEPA approved the Long Island Sound nitrogen TMDL on April 3, 2001 with the goal of ultimately reducing nitrogen load and in turn, increasing DO levels. Under this policy, the USEPA specified a 58.5% reduction in human generated nitrogen from point and nonpoint sources over 15 years following several phases of implementation. Primary sources enriching the Sound with nitrogen include sewage treatment plant discharge, runoff and atmospheric deposition. Limiting these sources will reduce nitrogen loading and help to improve water quality (NYSDEC, 2000).

USEPA Connecticut River Fish Tissue Contaminant Study

The Connecticut River Fish Tissue Contaminant Study (Hellyer, 2006) was a collaborative federal and state project designed to provide a baseline of tissue contaminant data from several fish species, to better understand the risk to human health from eating Connecticut River fish, and to learn what threat eating these fish poses to other mammals, birds, and fish. For this study, the Connecticut River was divided into eight (8) sampling reaches with Reach 4 of the study being the TFI.

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[60] USGS gage 01161280 Connecticut River near Northfield, MA which has been active since May 31, 2018, with earlier grab samples, also records gage height on a 15 minute interval and only spot flow values. Flows at this location in the TFI can be influenced by generation or pumping at the Northfield Mountain Project, water level management at the Turners Falls Dam, Vernon Project discharges and inflows from the Ashuelot River.

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

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

Existing Water Quality

As part of the relicensing process, FERC approved Revised Study Plan No. 3.2.1 *Water Quality Study*. As noted earlier, closure of the VT Yankee Nuclear Power Plant (VY)[61], located upstream of the TFI, would change certain environmental baseline conditions during the relicensing study period. Due to the impending closure of VY, the implementation of the water quality study was delayed for a year. Consequently, a final report detailing the 2015 study was filed with FERC on March 1, 2016 (FirstLight, 2016e).

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

A total of 18 water quality sampling stations were located from below Vernon Dam to downstream of Cabot Station as summarized in Table 3.3.2.1.2-9. Sampling sites were located in the TFI (Sites 1-7), bypass reach (Sites 8-9), power canal (Site 10), below Cabot Station and above the Deerfield River confluence (Site 11) and below Cabot Station below the Deerfield River confluence (Sites 12-18). See Figures 3.3.2.1.2-4 (overview map and 6 blown up maps) for the sampling locations. At each sampling site one of the following was measured a) continuous temperature and DO, b) vertical profiles of temperature and DO, or c) continuous temperature (see Table 3.3.2.1.2-9).

Continuous water temperature data were collected every 15 minutes from early April to mid-November 2015. DO and temperature profiles were collected bi-weekly from early April to mid-November 2015 at three (3)[62] relatively deep locations within the TFI as shown in Figures 3.3.2.1.2-4.

Weather and flow conditions during the 2015 water quality sampling study period generally reflected typical conditions for the study area. April and May 2015 experienced less precipitation in comparison to long-term averages. June was very wet and cool. The summer months of July and August had fairly typical conditions, as did October. September was warmer than usual, and November was warmer and also drier than usual. August was the warmest month and November was the coolest month during the 2015 monitoring period. Overall, flow conditions during the 2015 field sampling effort followed the typical seasonal trend of high flows in the spring, low flows in the summer, and then increasing flows in the fall.

All applicable MA water quality standards were met throughout the duration of the 2015 Water Quality Study (Study No. 3.2.1) sampling period. Some changes were observed in water quality based on project operations but none causing any violation of applicable water quality standards. DO supersaturation was noted at several sites, but was most prevalent in the bypass reach, correlating with greater spillage at Turners Falls Dam. Sites downstream of Cabot Station had similar rates of change in temperature regardless of Cabot Station operation.

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[61] VT Yankee is located just upstream of the Vernon Dam in the Vernon Impoundment.

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

3.3.2.2 Environmental Effects

3.3.2.2.1 Water Quantity

The following subsections address the expected water quantity effects of FirstLight's proposed operation. As described in more detail in Section 2.2, the water quantity portion of FirstLight's operating proposal generally consists of:

- FirstLight proposes to operate the TFI, as measured at the Turners Falls Dam, between 176 and 185 ft year-round. FirstLight also proposes to limit the rate of rise of the TFI WSEL, as measured at the Turners Falls Dam, to be less than 0.9 feet/hour from May 15 to August 15 between the hours of 8:00 am and 2:00 pm for the protection of odonates.
- FirstLight proposes to operate the Northfield Mountain Project Upper Reservoir between elevation 1004.5 and 920 feet.
- FirstLight proposes seasonally varying bypass flows (considerably higher than baseline conditions) via a combination of Turners Falls Dam spill and Station No. 1 generation. All bypass flows are on an or-inflow, whichever is less, basis where inflow is the naturally routed flow (NRF[63]);
- FirstLight proposes baseloading of one Cabot unit (~ 2,300 cfs) in June on an or-inflow, whichever is less, basis where inflow is the NRF.
- FirstLight proposes up- and down-ramping rates of 2,300 cfs/hour from Cabot Station from April 1 to May 31, 24 hours/day for the protection of Shortnose Sturgeon, subject to certain exceptions identified in FirstLight's proposal.
- FirstLight proposes an up-ramping of 2,300 cfs/hour from Cabot Station from June 1 to August 15, 8:00 am to 2:00 pm for the protection of odonates, subject to certain exceptions identified in FirstLight's proposal.
- FirstLight proposes to add no more than 4,600 cfs additional flow from Cabot Station from 1:00 am to 2:00 pm from July 1 to August 31 for the protection of PTB, subject to certain exceptions identified in FirstLight's proposal.
- FirstLight proposes 4-hour duration whitewater boating releases from the Turners Falls Dam on an or-inflow, whichever is less basis, where inflow is the NRF, on weekends in June, July, August, September, and October.

Turners Falls Impoundment

Proposed operational changes that have the potential to impact TFI WSEL and flow include all of FirstLight proposal bullets listed above. To analyze potential changes in flow and WSEL between baseline conditions and FirstLight's proposal, hourly data from the Operations Model were used to develop flow and elevation duration curves. TFI WSEL duration curves, as measured at the Turners Falls Dam, were developed on a monthly basis for baseline and FirstLight's proposal [Figure 3.3.2.2.1-1 (Jan-Mar), Figure 3.3.2.2.1-2 (Apr-Jun), Figure 3.3.2.2.1-3 (Jul-Sep) and Figure 3.3.2.2.1-4 (Oct-Dec)] Review of the figures indicates that the TFI WSEL under FirstLight's proposal will generally be: (1) similar to baseline conditions in Jan, Feb, Mar, and Aug), (2) slightly lower in Apr, May, and Jun, and (3) slightly higher in Jul, Sep, Oct, Nov, and Dec.

To further analyze TFI WSEL changes, histograms of modeled maximum daily WSEL changes at four representative locations throughout the TFI were developed using the TFI HEC-RAS Model for baseline conditions and FirstLight's proposal. The maximum daily TFI WSEL changes were then binned into 0-0.4 ft, 0.4-0.8 feet, and so on in similar increments ending with over 4.8 feet. The cumulative percentage was also computed. The four locations analyzed include:

- Near Vernon Dam (about 20 miles upstream of Turners Falls Dam)- Figure 3.3.2.2.1-5;
- Pauchaug Boat Launch (about 13.4 miles upstream of Turners Falls Dam)- Figure 3.3.2.2.1-6;

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[63] NRF is defined as Vernon Discharge + Ashuelot River USGS gage flow + Millers River USGS gage flow.

- Riverview Boat Launch, just upstream from the Northfield Mountain Tailrace/Intake (about 5.2 miles upstream of Turners Falls Dam)-Figure 3.3.2.2.1-7; and
- At Turners Falls Dam- Figure 3.3.2.2.1-8.

As demonstrated in the histograms, limited changes in the daily maximum fluctuation of the TFI are observed when comparing baseline conditions and FirstLight's proposal. Additional information and analyses pertaining to water level fluctuations and their potential impact on other resources are presented in sections- Aquatic, Terrestrial, Threatened and Endangered Species, and Recreation.

Bypass Flows

Under the current FERC license for the Turners Falls Project, FirstLight MA Hydro LLC (hereinafter referred to as FirstLight) is required to release a continuous minimum flow of 1,433 cfs or inflow, whichever is less below the Turners Falls Project. 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 bypass reach starting on May 1 and increases to 400 cfs when fish passage starts by releasing flow through a bascule gate. The 400 cfs continuous minimum flow is provided through July 15, unless the upstream fish passage season has concluded early in which case the 400 cfs flow is reduced to 120 cfs to provide a zone of passage for Shortnose Sturgeon. The 120 cfs continuous minimum flow is maintained in the bypass reach from the date the fishways are closed (or by July 16) until the river temperature drops below 7°C, which typically occurs around November 15.

Under FirstLight's proposal, flow releases to the bypass reach would be substantially increased to enhance aquatic and other resources as summarized below.

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

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

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

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

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

Date	**Total Bypass Flow**[2]	**Turners Falls Dam**	[3]**Station No. 1**
FirstLight will reduce its Station No. 1 discharge by 289 cfs. If the Milton Hilton, LLC project is operating, FirstLight will reduce its Station No. 1 discharge by 113 cfs.			

Under FirstLight's proposal, attraction flow will be required for the new Spillway Lift. The attraction flow will be part of the Turners Falls Dam discharge. FirstLight proposes to close the Cabot ladder after the Spillway Lift and ultrasound array in the Cabot tailrace are functioning properly. In addition, FirstLight proposes to close the two entrances to the gatehouse ladder at the same time the Cabot ladder is retired.

Finally, FirstLight is not currently required to provide whitewater releases in the bypass reach under its existing license. Under FirstLight's proposal it proposes to provide the following whitewater flows on an or-inflow basis, where inflow is the NRF.

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

To illustrate changes in the bypass reach flow regime under baseline conditions and FirstLight's proposal, a series of hourly flow duration curves were created for the following bypass reach segments:

- Reach 1 just below the Turners Falls Dam (excludes Fall River flow)- Annual Flow Duration Curve under baseline and FirstLight's proposal (Figure 3.3.2.2.1-9). As the figure shows, under FirstLight's proposal considerably more water is being provided directly below Turners Falls Dam.
- Station No. 1 Discharge- Annual Flow Duration Curve under baseline and FirstLight's proposal (Figure 3.3.2.2.1-10). As the figure shows, under FirstLight's proposal it is proposes to pass a portion of the bypass flow through Station No. 1.
- Total Bypass Flow (includes Turners Falls Dam Discharge and Station No. 1 discharge)- Annual Flow Duration Curve under baseline and FirstLight's proposal (Figure 3.3.2.2.1-11). Again, as the figure shows, under FirstLight's proposal considerably more water is being maintained in the bypass reach.
- Cabot Station Discharge- Annual Flow Duration Curve under baseline and FirstLight's proposal (Figure 3.3.2.2.1-12). As the figure shows, under FirstLight's proposal more water is being spilled, thus less water is available for generation.
- Flow at Montague USGS Gage- Annual Flow Duration Curve under baseline and FirstLight's proposal (Figure 3.3.2.2.1-13). As expected the annual volume of flow below the Turners Falls Project is essentially the same under baseline and FirstLight's proposal.

In addition to the annual flow duration curves described above, for each location additional duration curves were developed to match the timing of FirstLight's bypass flow proposal: April 1-May 31, June 1-15, June 16-30, July 1-August 31, September 1-November 30 and December 1-March 31 (see Appendix E- Water Resources- Model Duration Curves (Exhibit E, Part 3 of 3).

These figures generally show the following changes to generation at Cabot Station and Station No. 1 as well as in the flows released to the bypass reach:

- Substantial increases in the flow in the bypass reach, including from Station No. 1 which provides flows to the bypass reach approximately one mile below Turners Falls Dam;

- Decreases in flows (generation) at Cabot Station due to higher bypass flows released from Turners Falls Dam and Station No. 1; and
- Higher baseflows at Montague especially in the April through August period due to less peak demand operations at Cabot Station.

Downstream Flows in Reaches 4 and 5

Releases from the Turners Falls Dam, Turners Falls Project, and inflow from the Deerfield River flow provide the majority of the flow in the Connecticut River at Holyoke Dam. There are several other smaller tributaries entering the Connecticut River before Holyoke Dam.

Under FirstLight's proposal, flows downstream of the Turners Falls Project would be affected by a combination of higher bypass flows, Cabot Station baseloading in June, Cabot Station up- and down-ramping restrictions, and Cabot Station maximum flow limitations. In general, these changes would result in lower daily fluctuations of flows and water levels. To illustrate the changes that would occur under the FirstLight's proposal, histograms of modeled maximum daily WSEL changes at five representative locations downstream of Cabot Station (Figure 3.3.2.2.1-14) were developed using the Downstream Reach HEC-RAS Model for baseline conditions and FirstLight's proposal. This was done only for flows less than 18,000 cfs, the approximate power canal capacity and under FirstLight's operational control. The maximum daily WSEL changes were then binned into 0-0.7 ft, 0.7-1.4 ft and so on in similar increments. The cumulative percentage was also computed. The five locations analyzed include: at RM 118.508 (near Montague) (Figure 3.3.2.2.1-15), RM 115.07 (Figure 3.3.2.2.1-16), RM 112.36 (Figure 3.3.2.2.1-17), RM 109.52 (Figure 3.3.2.2.1-18), and RM 94.298 (Rainbow Beach) (Figure 3.3.2.2.1-19), respectively.

The full set of monthly histograms are provided in Appendix F- Water Resources- Downstream Histograms (Exhibit E, Part 3 of 3).

As observed in the figures, under FirstLight's proposal, daily variations in the flow and WSELs below Cabot Station would be substantially less than baseline conditions. Additional and more detailed analyses comparing flows and WSELs between the Baseline and the Proposed Action scenarios in Reach 4 and 5 are presented in the following other resource areas: Aquatic, Terrestrial, Threatened and Endangered Species, and Recreation.

3.3.2.2.2 Water Quality

All applicable water quality standards were met throughout the duration of the 2015 Water Quality Study (Study No. 3.2.1) sampling period.

DO results from within the TFI, the bypass reach, the power canal, and below Cabot Station (i.e., Site 1 through Site 11) remained above the MA water quality standard of 5.0 mg/L minimum for Class B warm water fisheries. The minimum observed DO concentration was 5.8 mg/L (and 71.1% saturation) at Site 11 below Cabot Station.

The water temperatures observed at each location remained below the MA water quality standard of 28.3°C for Class B warm water fisheries. The maximum instantaneous temperatures observed across all sites ranged from 26.4°C to 28.1°C. Monthly average water temperatures were very similar among all locations. August was the warmest month for all locations with an average water temperature of approximately 25°C.

DO and temperature profiles collected at the three sites in the TFI showed no evidence of thermal stratification and only a slightly negative DO gradient at times. The water column at all three profile locations was generally well-mixed throughout the sampling period.

Minor, short-term changes in water temperatures and DO at the Northfield Mountain Project tailrace were observed during periods of generation at the Northfield Mountain Project. The highest concentrations of DO were also most commonly observed in the bypass reach downstream of Turners Falls Dam where DO supersaturation (over 100%) was observed at times; generally found to increase in relation to spillage from Turners Falls Dam.

Water temperature and DO levels in the power canal tracked similarly to conditions at the boat barrier in the TFI. Similarly, water quality conditions just downstream of Cabot Station (Site 11) tracked closely to conditions in the power canal while Cabot Station was generating. When Cabot Station was off-line, downstream conditions were dictated by flow and water quality conditions in the bypass reach.

Water temperature patterns were similar from site to site in the Connecticut River downstream of Cabot Station (Site 11-18) regardless of Cabot Station operations during periods of low flow. Monthly average water temperatures from Sites 11-18 were within a range of +/- 1.0°C. Daily water temperature fluctuations and hourly temperature rates of change were greater at locations further downstream of Cabot Station (Sites 12-18) in comparison to just downstream of Cabot Station (Site 11). The maximum rate of change for temperature was 1.5°C/hr. Average rates of change below Cabot Station were typically up to 0.2°C/hr. The study results show that the Project had no adverse effects on water quality, specifically, DO and water temperature parameters.

Under FirstLight's proposal, it is expected that water quality conditions will be similar to baseline conditions except in the bypass reach. DO concentrations in the bypass will increase due to spillage over bascule gate 1 at the Turners Falls Dam which will serve to aerate the discharge. It is possible that because it is a surface discharge water temperature could potentially increase in the bypass.

3.3.2.3 Cumulative Effects

The Council of Environmental Quality (CEQ) NEPA regulations in effect as of the date of this AFLA define "cumulative effects" as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR §1508.7). In July 2020, CEQ amended its regulations and repealed the definition of cumulative effects in 40 CFR §1508.7, effective on September 14, 2020. The change in regulation may affect the future analysis of cumulative effects under NEPA and otherwise but have been described in this section based on the definition in effect as of the date of this AFLA.

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

The potential impact of the Project is associated with whether the continued operation of the Turners Falls Project and Northfield Mountain Project affects water quantity and quality of the Lower Connecticut River, which had already been altered by construction of numerous dams.

Water Quantity

The cumulative impact of the Project on the affected resource occurs within the context of the presence of a series of hydroelectric facilities having the potential to collectively affect the water quantity of the Connecticut River. The Project contributes to the alteration of the Connecticut River's hydrology, particularly in terms of water levels and flow regime. The Project directly influences TFI water levels and streamflow in the reach between the Turners Falls Dam and Holyoke Dam. In addition, downstream of the Turners Falls Project, water levels especially in the lower part of Reach 5, closer to the Holyoke Dam, are affected by the water level management by the Holyoke Project. However, other than evaporative losses, the Project does not result in any net water loss to the Connecticut River Basin. It is difficult to quantify specific Project impacts, because TFI inflows are highly regulated by upstream hydroelectric projects and seasonally storage reservoirs. While the FERC license permits water levels to fluctuate between 176 and 185 feet at the Turners Falls Dam, in practice FirstLight maintains water levels high enough to push flow through the gatehouse while still being able accommodate pumped-storage operations.

The Project does not directly alter the water quantity of the Connecticut River on a long-term basis and, therefore, does not impact water quantity in Long Island Sound. FirstLight's proposal, in combination with other activities within the watershed, will not alter this condition for the reasonably foreseeable future.

Water Quality

The cumulative impact of the Project on the affected resource occurs within the context of the presence of a series of hydroelectric facilities having the potential to collectively affect the water quality of the Connecticut River. DO and water temperature measured throughout the Project area met applicable state water quality standards. The Project does not result in local impacts to the water quality of the Connecticut River and, therefore, does not impact the area downstream of the Project. FirstLight's proposal, in combination with other activities within the watershed, will not alter this condition for the reasonably foreseeable future.

3.3.2.4 Proposed Environmental Measures

3.3.2.4.1 Bypass Reach Flows

FirstLight proposes increase bypass flow via spill at the Turners Falls Dam and from Station No. 1. The amount and flow split between releases at the Turners Falls Dam and Station No. 1 would vary on a seasonal basis and would enhance the aquatic habitat and fish passage in the bypass reach as described in more detail in the Aquatic Resources section of the AFLA. Whitewater boating flows, to be released at the Turners Falls Dam, are proposed for one Saturday in July and August, and three Saturdays in September and October.

3.3.2.4.2 Cabot Station Operations

FirstLight proposes the following at Cabot Station:

- limit up- and down-ramping at Cabot Station to 2,300 cfs/hour between April 1 and May 31, 24 hours/day, to protect Shortnose Sturgeon habitat, subject to the deviations described in Section 2 of this AFLA.
- Baseload one Cabot Station unit from June 1 -30 on an or-inflow, whichever is less, basis.
- limit up-ramping at Cabot Station to 2,300 cfs/hour from June 1 to August 15, 8:00 am to 2:00 pm to protect odonates subject to the deviations described in Section 2 of this AFLA.
- add no more than 4,600 cfs of additional flow from Cabot Station from July 1 to August 31 between 1:00 am and 2:00 pm for the protection of Puritan Tiger Beetle subject to the deviations described in Section 2 of this AFLA.

3.3.2.4.3 Turners Falls Impoundment

FirstLight proposes to continue to operate the TFI, as measured at the Turners Falls Dam, between elevation 176 and 185 feet. Also, FirstLight proposes to limit the rate of rise of the TFI WSEL, as measured at the Turners Falls Dam, to be less than 0.9 feet/hour from May 15 to August 15 for the protection of odonates.

3.3.2.5 Unavoidable Adverse Impacts

Water levels in the TFI would continue to fluctuate based on operations of the Northfield Mountain Project, Turners Falls Project operations, and Great River Hydro's Vernon Project. Cabot Station peak demand operations, while more limited under FirstLight's proposal, would continue to alter flow on an intra-daily time step in the Connecticut River below Cabot Station.

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Table 3.3.2.1.1.2-1: Connecticut River below Vernon Dam (USGS Gage No. 01156500), Drainage Area= 6,266 mi^2, Period of Record: Oct 1944-Sep 1973 (cfs)

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

Data Source: USGS, mean daily flows

Table 3.3.2.1.1.2-2: Connecticut River at Montague City, MA (USGS Gage No. 01170500), Drainage Area= 7,860 mi^2, Period of Record: Apr 1940-Dec 2016 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	12,152	11,513	20,626	38,014	22,561	12,229	7,451	6,419	6,051	9,695	13,153	13,983	14,487
Mean/sq mi	1.55	1.46	2.62	4.84	2.87	1.56	0.95	0.82	0.77	1.23	1.67	1.78	1.84
Median	9,800	9,400	15,500	33,400	18,800	9,915	5,660	4,690	4,640	6,735	10,900	11,200	9,750
Median/sq mi	1.25	1.20	1.97	4.25	2.39	1.26	0.72	0.60	0.59	0.86	1.39	1.42	1.24

Data Source: USGS, mean daily flows

Table 3.3.2.1.1.2-3: Estimated Connecticut River at Turners Falls Dam Drainage Area= 7,163 mi^2, Period of Record Oct 1940-Dec 2016 (cfs)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean	10,231	9,491	18,068	34,656	20,413	10,993	6,650	5,770	5,543	8,645	11,503	12,018	12,821
Mean/mi^2	1.30	1.21	2.30	4.41	2.60	1.40	0.85	0.73	0.71	1.10	1.46	1.53	1.63
Median	8,013	7,641	13,163	30.336	17,304	9,001	4,976	4,156	4,084	5,974	9,654	9,575	8,478
Median/mi^2	1.02	0.97	1.67	3.86	2.20	1.15	0.63	0.53	0.52	0.76	1.23	1.22	1.08

Data Source: Estimated from manipulation of USGS gages

Table 3.3.2.1.1.3-1: Synthetic Hydrograph Modeling Summary for Rainbow Beach under Low Holyoke Conditions

Baseflow (cfs)	Number of Cabot Units	Length of Cabot Station Peak Demand (hours)	Maximum WSEL increase at Rainbow Beach (ft)	Delay of the Cabot Peak Demand (hours)
2,000	2	2	0.14	8.75
2,000	2	4	0.28	10
2,000	2	8	0.54	12.5
2,000	2	12	0.71	14.75
6,000	2	2	0.21	7
6,000	2	4	0.39	8.5
6,000	2	8	0.67	10.75
6,000	2	12	0.86	14.5
2,000	6	2	0.49	8.25
2,000	6	4	0.99	9
2,000	6	8	1.85	11
2,000	6	12	2.41	14.25
6,000	6	2	0.63	6.75
6,000	6	4	1.16	7.75
6,000	6	8	2.00	10.5
6,000	6	12	2.50	13.75

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

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

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

Table 3.3.2.1.2-2: MADEP 2008 Water Quality Data Results on the Connecticut River at the Route 10 Bridge – Physical Parameters

Date	Sample Depth (m)	Temp (°C)	pH	Conductivity (µS/cm)	TDS (mg/L)	DO (mg/L)	DO (% sat)
Station CTBERN – Connecticut River at Route 10 Bridge							
05/30/08	1.2	18	7.4	129	83	9.5	102
06/04/08	1.1	19.9	7.3 i	138 i	88 i	8.9	99
06/27/08	0.4	20.2	7.1	93	60	8.5	96
06/27/08	--	20.2 m	--	--	--	8.5 m	96 m
07/02/08	0.5	21.9	7.2	103	66	8.2	95
07/25/08	--	20	7.2	79	51	9.6	106
07/30/08	0.8	21.9	7.1	82	53	8.2	95
09/18/08	--	20.1 m	--	--	--	8.9 m	98 m

Notes:
i = potentially inaccurate reading
m = method SOP not followed, only partially implemented, or not implemented at all

Table 3.3.2.1.2-3: MADEP 2008 Water Quality Data Results on the Connecticut River at the Route 10 Bridge – Biological and Chemical Parameters

Date	Time (24 hr)	E. coli (CFU/ 100mL)	Turbidity (NTU)	Hardness (mg/L)	True Color (PCU)	NH3-N (mg/L)	TN (mg/L)	TP (mg/L)	TSS (mg/L)
Station CTBERN – Connecticut River at Route 10 Bridge									
05/06/08	9:20	2	5.1	--	<15	0.02	0.36	0.015	6
06/03/08	9:31	4	1.7	48	<15	<0.02	0.52	0.014	1.9
07/01/08	9:24	60	4.1	36	19	0.02	0.43	0.027	5.5
07/29/08	9:27	50	5.2 b	29	29	0.02	0.37 h	0.019 h	6.3
09/03/08	9:38	<10	--	--	--	--	--	--	--
09/09/08	9:40	220	2.2	--	26	0.03	0.38	0.011	1.9

Note: b = blank contamination (indicating possible bias high and false positives)
h = holding time violation (usually indicating possible bias low)

Table 3.3.2.1.2-4: CRC 2007-2008 Water Quality Data Results on the Connecticut River at Franklin County Boat Club Docks

Date	Time (24 hr)	Air Temp (°C)	Water Temp (°C)	Transparency (cm)	Specific Conductance (µS)	DO (mg/L)	DO (% sat)
08/30/2007	8:33	22.9	25.2	>120	146.2	7.22	86.1
09/20/2007	8:32	16.7	20.0	>120	138.7	7.33	99.3
10/23/2007	8:33	17.5	17.0	>120	134.8	7.81	82.0
06/11/2008	8:57	21.8	23.7	>120	126.7	9.55	113.1
07/09/2008	8:50	25.8	26.5	>120	104.5	8.52	105.1
08/13/2008	8:33	19.1	20.3	>120	80.7	8.52	93.5
09/09/2008	8:49	19.3	23.1	>120	117.4	7.14	83.3
09/18/2008	10:12	19.3	20.7	—	120.3	8.41	93.3
10/07/2008	8:43	10.8	14.9	>120	126.4	8.06	79.7

Sources: Donlon, 2008 and Donlon, 2009

Table 3.3.2.1.2-5: Yearly CRC Bacteria Sampling Results on the Connecticut River for Barton Cove, 2010-2019

Year	Max Exceedance Concentration[a] (colonies/100ml)	Flow at Max Exceedance (cfs)	Total No. Exceedances	Exceedances During Wet Weather Events[b]	Number of Sampling Events (May - October)
2010	NA	NA	0	0	17
2011	1,553	25,200 & 10,600	6	1	11
2012	2,419.6	4,680	5	0	19
2013	>2,419.6	12,700	13	4	19
2014	>2,419.6	29,200 & 10,400	13	10	20
2015	1,120	34,600	7	5	20
2016	1,203	4,000	3	0	19
2017	816	2,840	2	0	19
2018	488	7,410	4	2	18
2019	435	4,150	3	2	16
TOTAL	**---**	**---**	**56**	**24**	**178**

[a] Result indicates exceedance of MA Criteria for single *E. coli sample* of 235 colonies/100ml.
[b] "Wet" signifies wet weather event defined as >0.1 inches of rain in 24 hours.

Note: Bacteria counts were generally determined on a biweekly basis between Memorial Day to the first week in October.

Sources:
2010-2011 *E. coli* and weather data: http://www.umass.edu/tei/mwwp/ctrivermonitoring.html,
2012 – 2015 *E. coli* and weather data: https://connecticutriver.us/it-clean
USGS gage 01170500 at Montague, MA: http://waterdata.usgs.gov/ma/nwis/current/?type=flow

Table 3.3.2.1.2-6: Yearly CRC Bacteria Sampling Results on the Connecticut River at the Pauchaug Brook Boat Launch, 2013-2019

Year	Max Exceedance Concentration[a] (colonies/100ml)	Flow at Max Exceedance (cfs)	Total No. Exceedances	Exceedances During Wet Weather Events[b]	Number of Sampling Events (May - August)
2013	275.5	18,900	1	0	7
2014	980.4	29,200	1	1	7
2015	--	--	0	0	8
2016	--	--	0	0	7
2017	--	--	0	0	6
2018	--	--	0	0	7
2019	--	--	0	0	7
TOTAL	**---**	**---**	**2**	**1**	**49**

[a] Result indicates exceedance of MA Criteria for single *E. coli sample* of 235 colonies/100ml.
[b] "Wet" signifies wet weather event defined as >0.1 inches of rain in 24 hours.

Note: Bacteria counts were generally determined on a biweekly basis between Memorial Day to the first week in October.

Sources:
2012 – 2015 *E. coli* and weather data: https://connecticutriver.us/it-clean
USGS gage 01170500 at Montague, MA: http://waterdata.usgs.gov/ma/nwis/current/?type=flow

Table 3.3.2.1.2-7: Select Water Quality Data of the Connecticut River at the USGS Montague City Gage

Date/Time	Discharge (cfs)	pH	Nitrogen, total (mg/L)	Ammonia, as N (mg/L)	Nitrate + Nitrite (mg/L)	Orthophosphate (mg/L)	Phosphorus, total (mg/L)
10/26/2006 09:15	21,600	7.0	0.47	0.011 e	0.190	< 0.018	0.075
12/15/2006 07:30	16,000	7.3	0.46	0.023	0.285	0.013 e	0.040
02/08/2007 11:30	7,790	6.9	0.63	0.034	0.458	0.020	0.033
03/29/2007 11:00	53,800	7.0	0.75	0.030	0.339	0.012 e	0.142
04/20/2007 11:00	78,800	7.0	0.63	0.010 e	0.254	0.011 e	0.160
05/03/2007 11:15	35,200	7.0	0.49	0.011 e	0.268	0.012 e	0.034
05/17/2007 11:45	24,200	7.3	0.52	0.014 e	0.287	0.009 e	0.033
06/28/2007 12:00	2,430	7.3	0.51	0.020 e	0.310	0.013 e	0.016
08/02/2007 12:30	1,790	7.5	0.46	< 0.020	0.257	0.017 e	0.015
09/06/2007 08:00	1,750	7.4	0.39	0.014 e	0.238	0.013 e	0.008
Nutrient Criteria Reference Conditions for Ecoregion VIII Streams - Subecoregion 58 (Northeastern Highlands)							
Minimum			0.34		0.010		0.002
Maximum	-	-	0.84	-	2.850	-	0.450
25th percentile			0.42		0.160		0.005

Notes: Water quality data collected at this gage location ends on 9/6/2007. “e” = estimated. Nutrient criteria from USEPA, 2001

Table 3.3.2.1.2-8: Select Water Quality Data on the Connecticut River at Route 10 Bridge from USGS Northfield Gage

Date/Time	Nitrogen, total (mg/L)	Ammonia, as N (mg/L)	Nitrate + Nitrite (mg/L)	Orthophosphate (mg/L)	Phosphorus, total (mg/L)
04/23/2019 10:30	0.87	0.01	0.201	<0.012	0.247
05/21/2019 12:15	0.38	0.01	0.167	<0.012	0.077
06/18/2019 10:15	0.36	0.02	0.172	<0.012	0.012
07/16/2019 13:30	0.35	0.01	0.219	<0.012	0.005
08/20/2019 10:45	0.39	<0.01	0.195	<0.012	0.057
09/17/2020 11:30	0.39	0.02	0.189	<0.012	0.007
10/15/2019 11:00	0.4	0.02	0.18	<0.012	0.011
12/18/2019 11:15	0.36	0.01	0.137	<0.012	0.133
02/18/2020 12:15	0.39	0.02	0.283	<0.012	0.011
03/17/2020 11:00	0.36	0.01	0.185	<0.012	0.021
Nutrient Criteria Reference Conditions for Ecoregion VIII Streams - Subecoregion 58 (Northeastern Highlands)					
Minimum	0.34		0.010		0.002
Maximum	0.84	-	2.850	-	0.450
25th percentile	0.42		0.160		0.005

Notes: Nutrient criteria from USEPA, 2001

Table 3.3.2.1.2-9: Water Quality Monitoring Sampling Locations

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

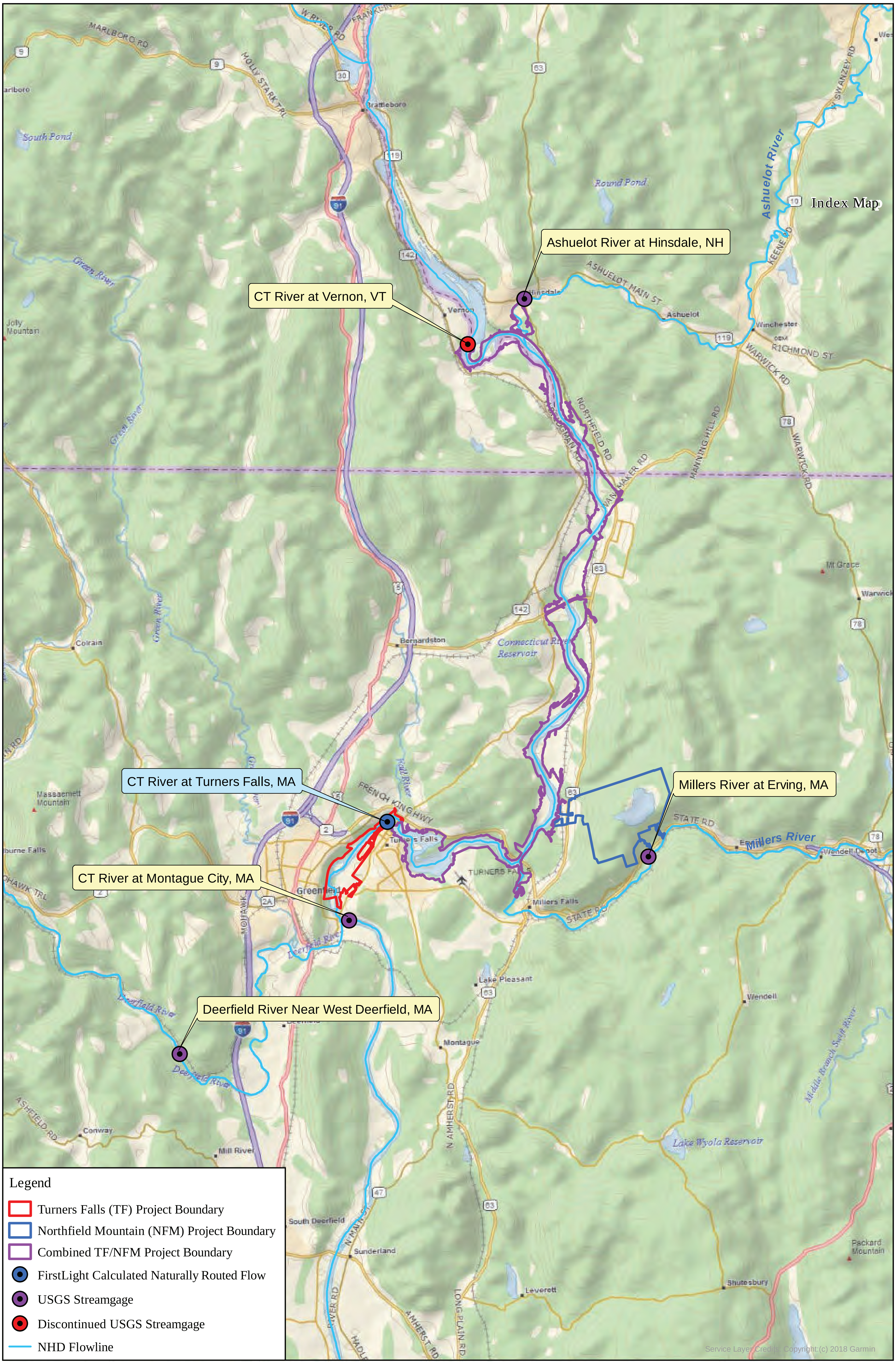

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Figure 3.3.2.1.1.2-1:
USGS Stream Gage Locations

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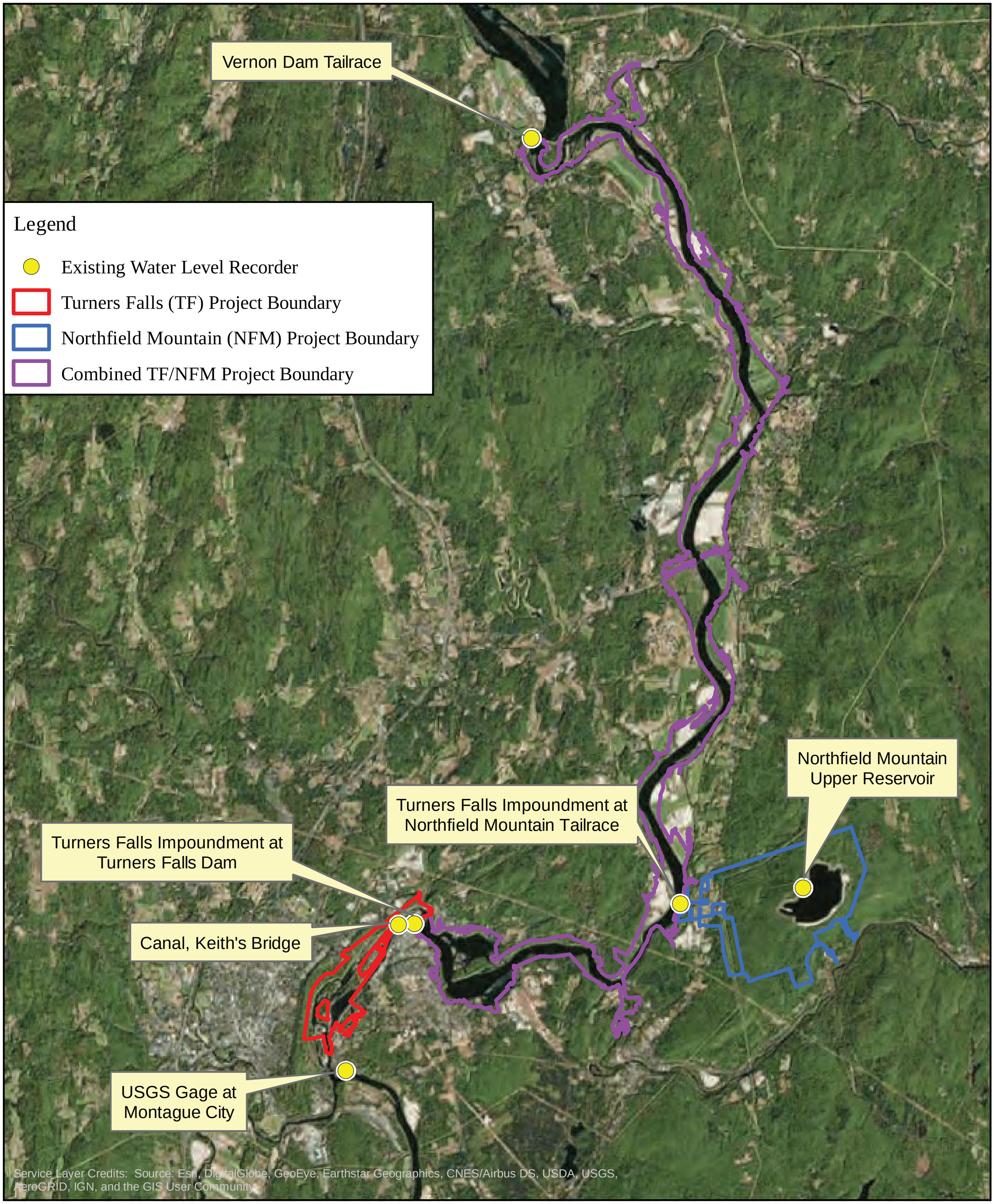

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Figure 3.3.2.1.1.2-2:
Existing Water Level Recorders

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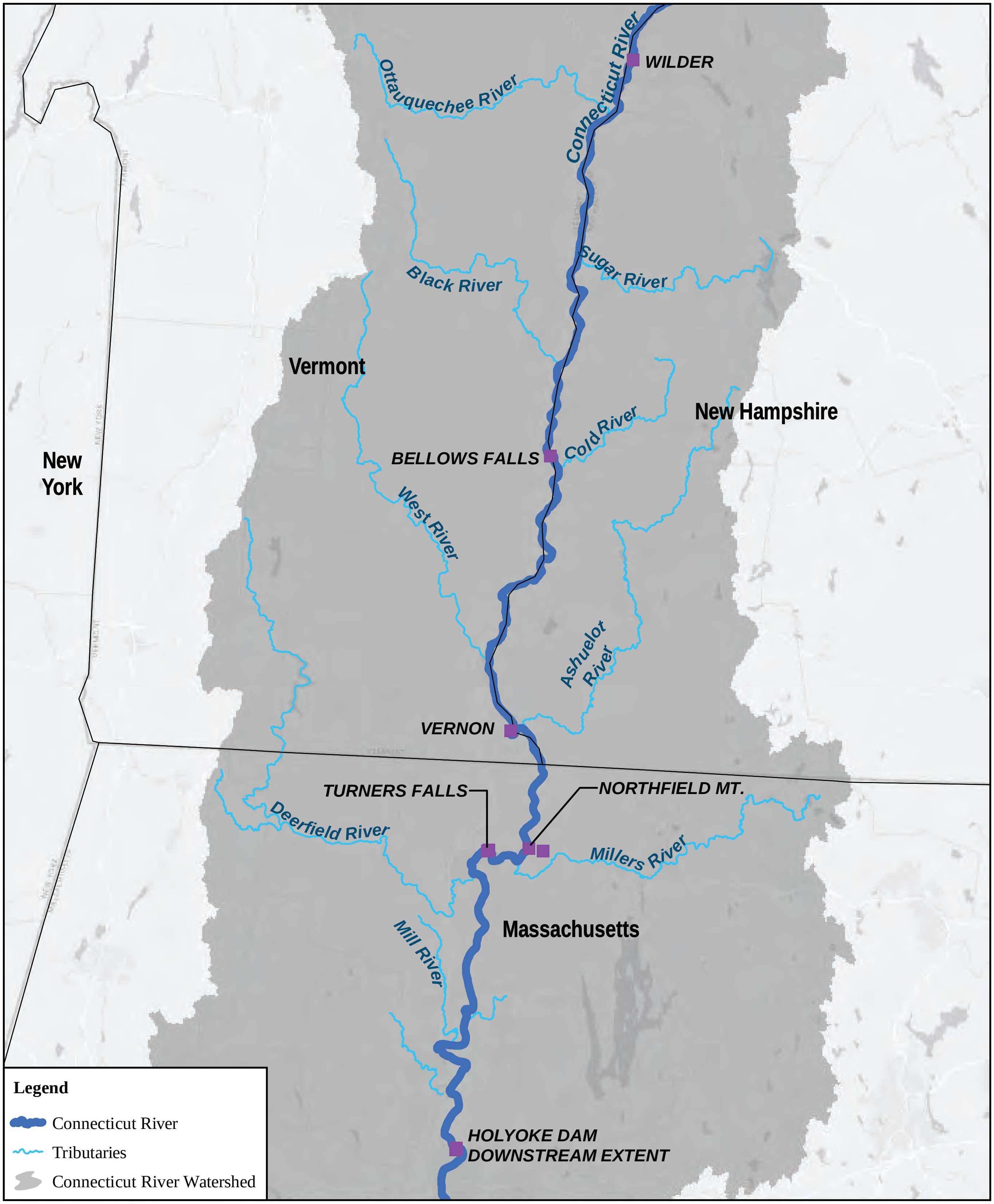

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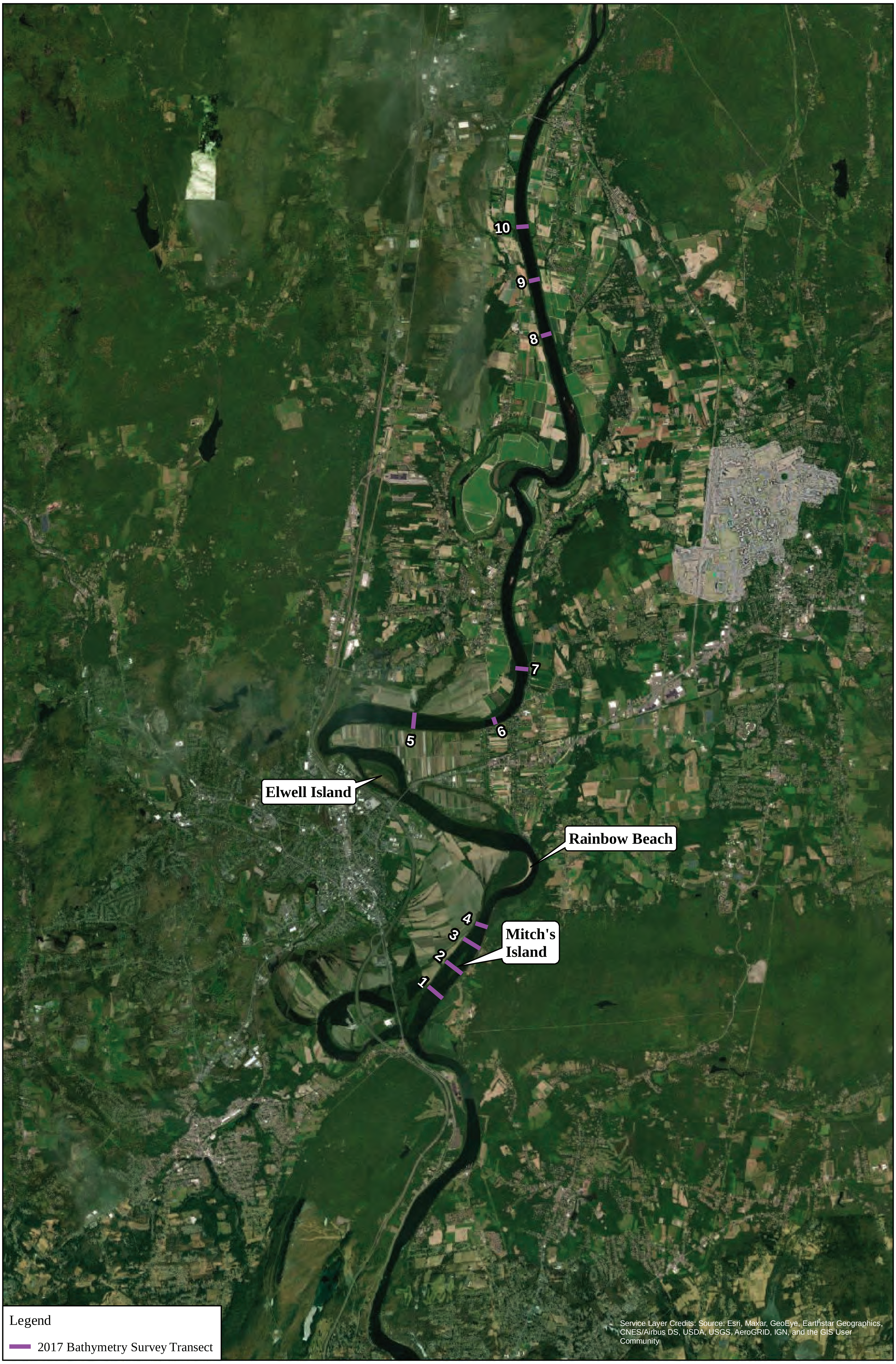
Figure 3.3.2.1.1.3-1:
FirstLight's HEC-ResSim Operations Model-Geographic Extent



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

Study 3.3.1 - IFIM Reach 5

Figure 3.3.2.1.1.3-2:
Location of Transects T2, T5,
and T7 in Reach 5

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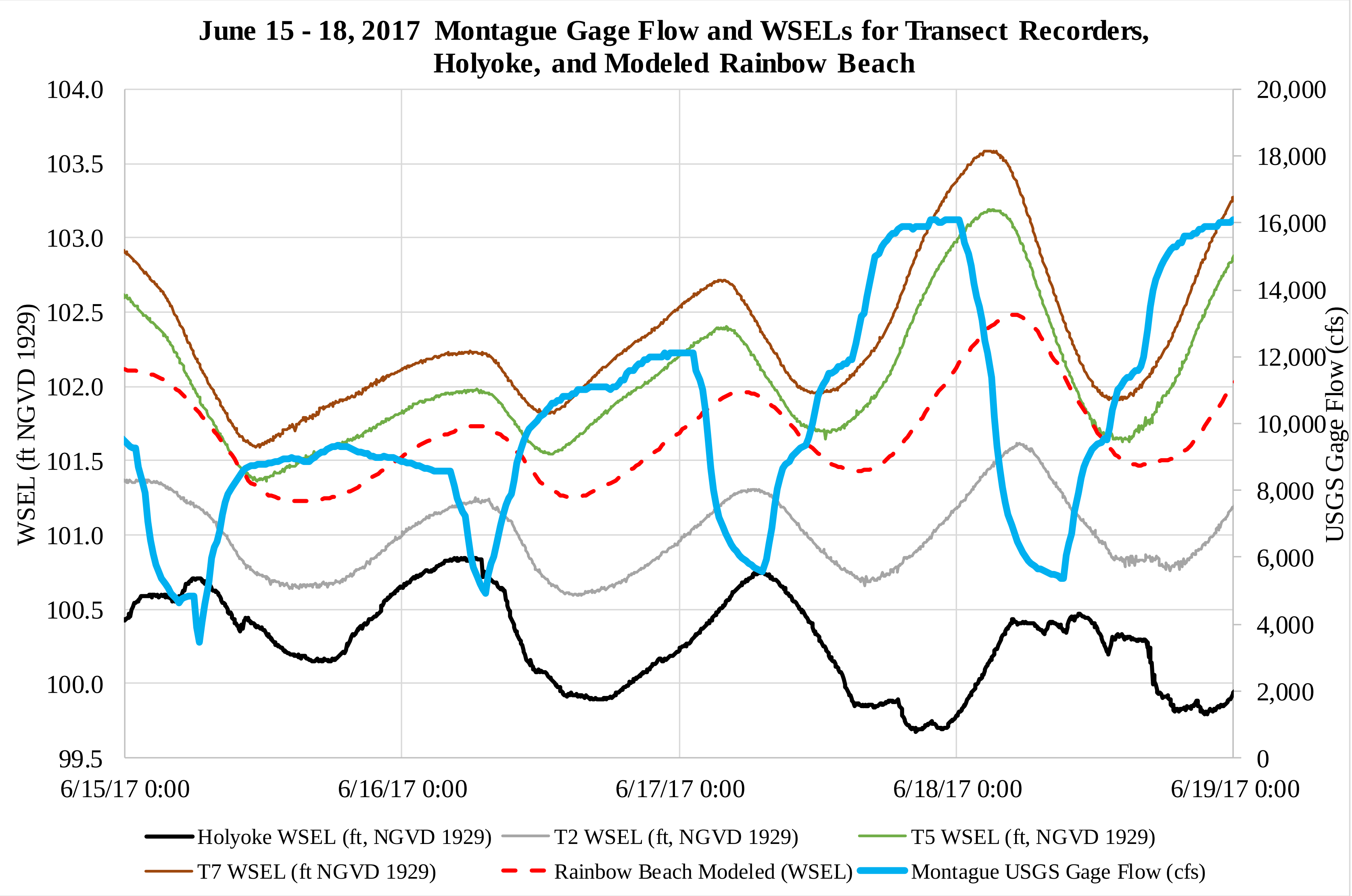

Note: River Mile Locations: T2: 92.3, Rainbow Beach: 94.3, T5: 99.1, and T7: 101.1.

Figure 3.3.2.1.1.3-3: Modeled and Water Level Data in the lower part of Reach 5 for June 15-18, 2017

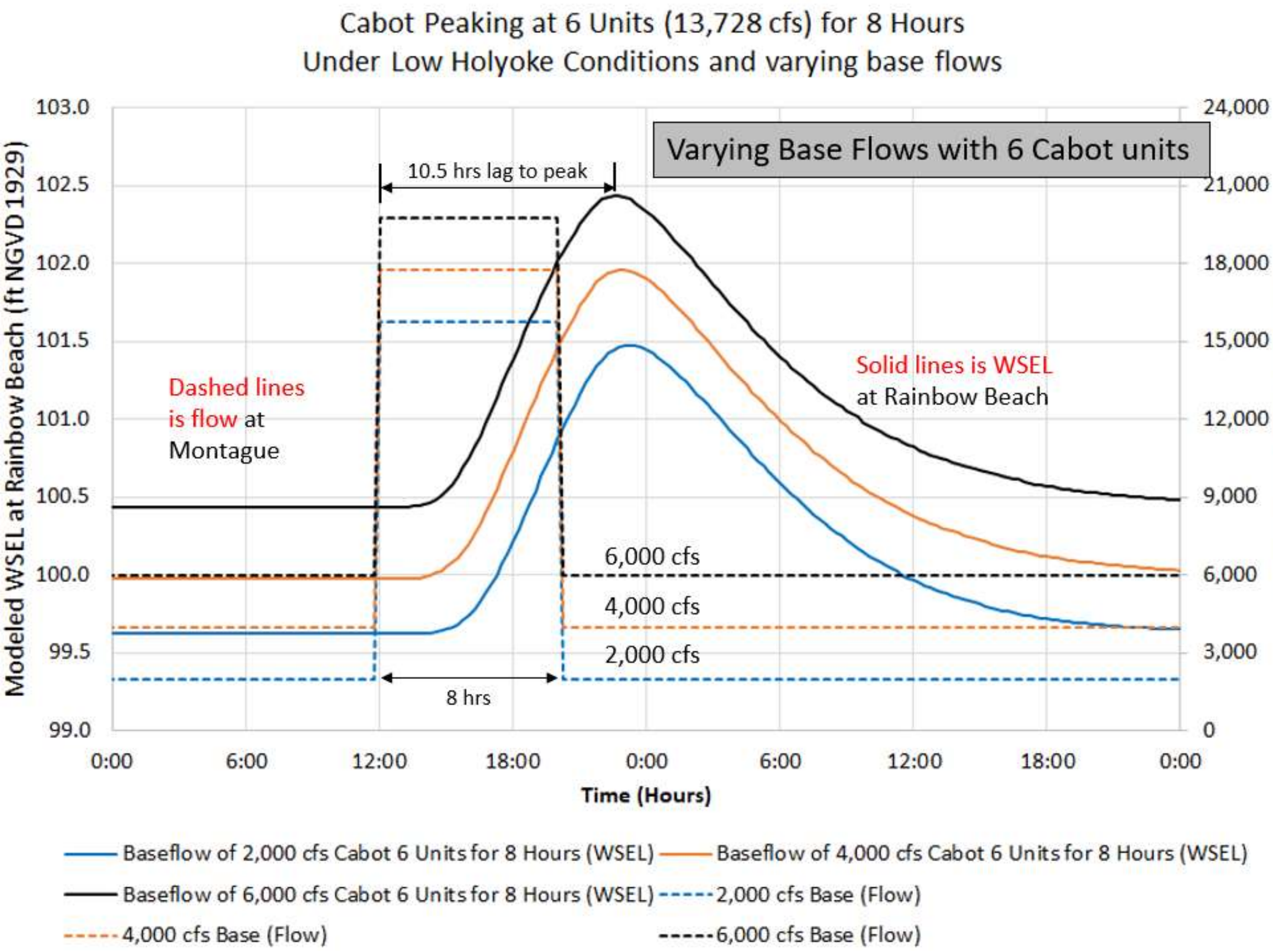

Figure 3.3.2.1.1.3-4: Rainbow Beach synthetic hydrograph: varying base flows with 6 units for 8 hours under low Holyoke conditions

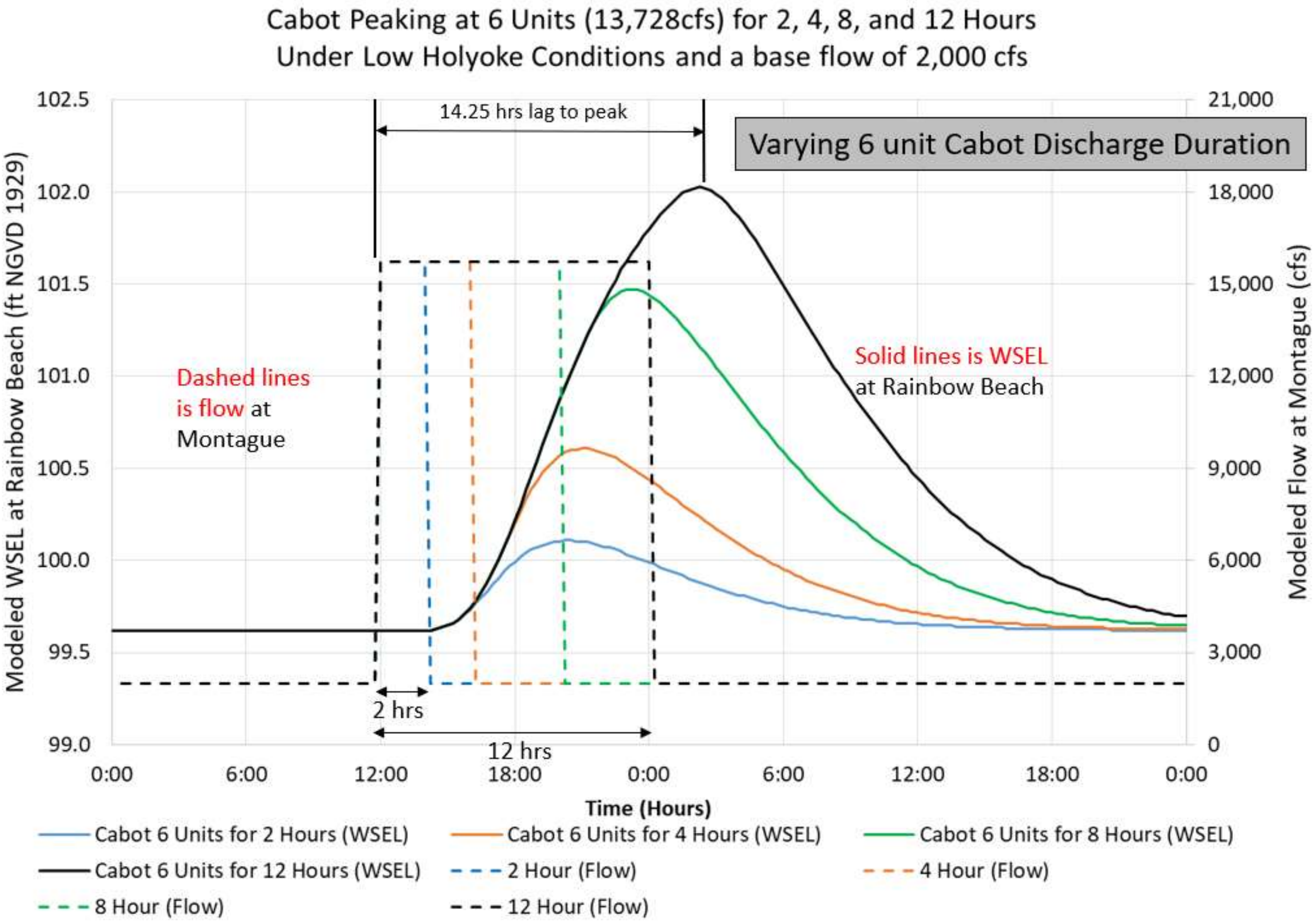

Figure 3.3.2.1.1.3-5: Rainbow Beach synthetic hydrograph: varying Cabot duration, 6 units, base flow of 2,000 cfs, and low Holyoke conditions

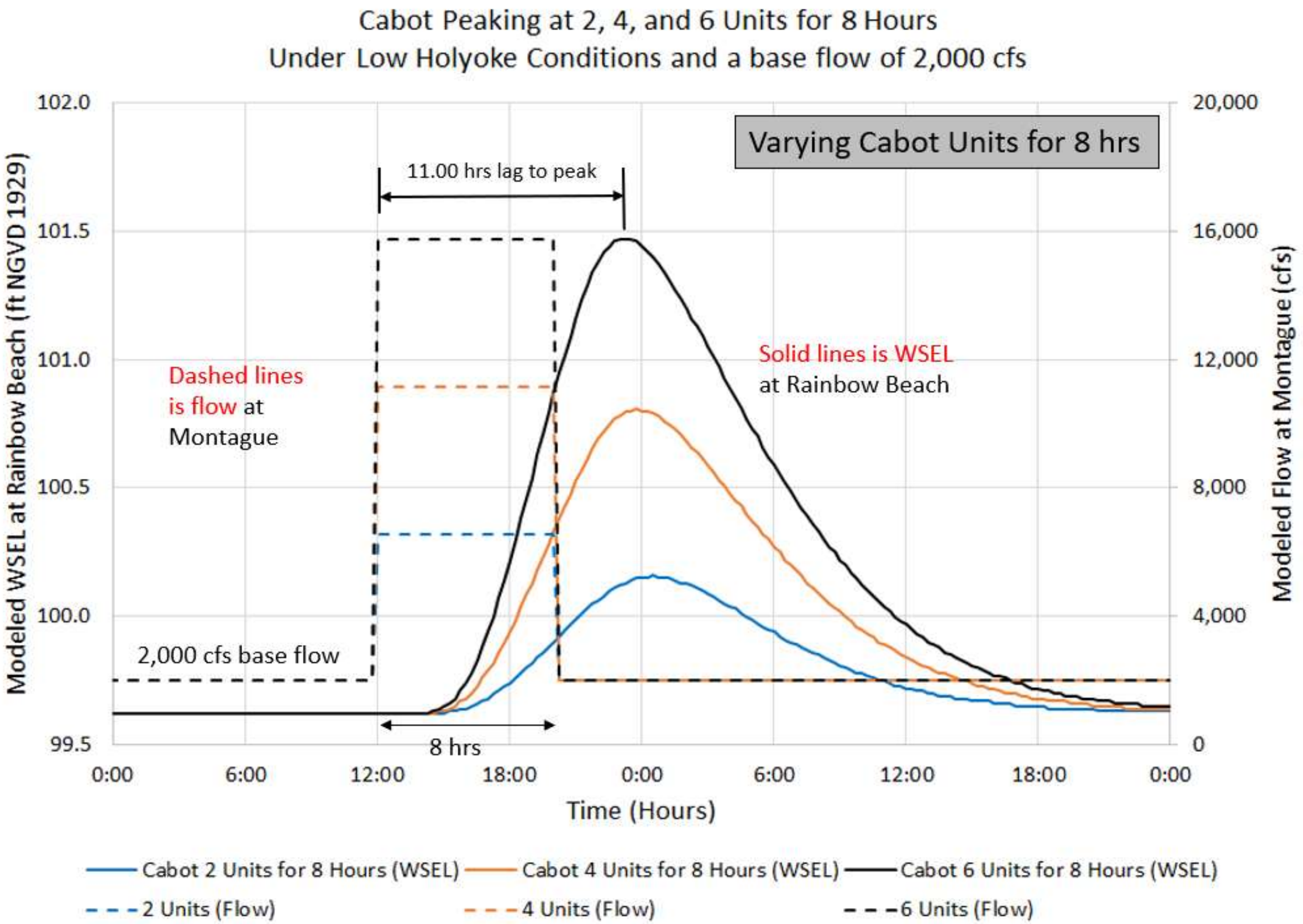

Figure 3.3.2.1.1.3-6: Rainbow Beach synthetic hydrograph: varying Cabot units, 8 hours, base flow of 2,000 cfs, and low Holyoke conditions

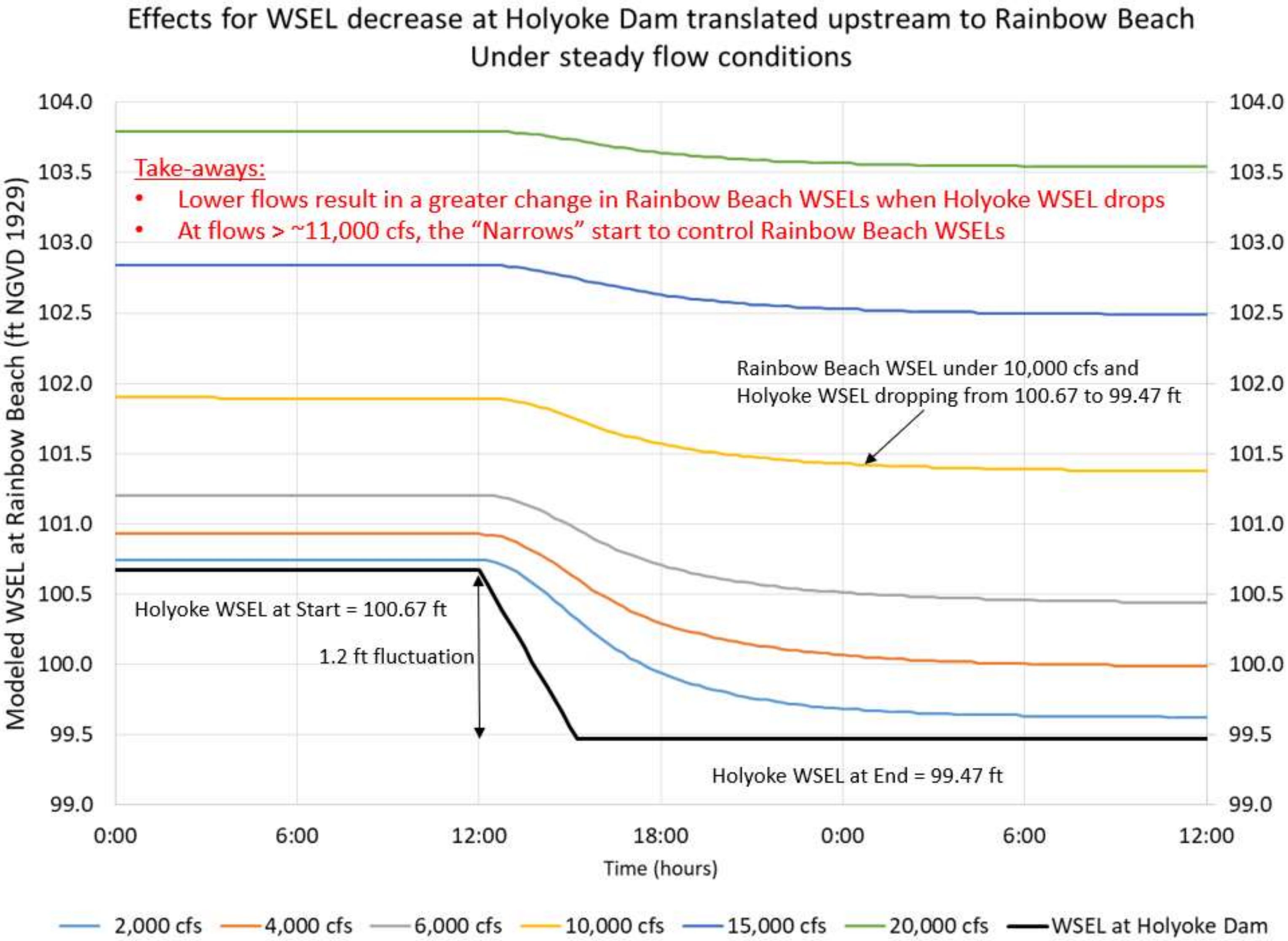

Figure 3.3.2.1.1.3-7: WSELs changes at Rainbow Beach based on WSEL decreases at Holyoke Dam

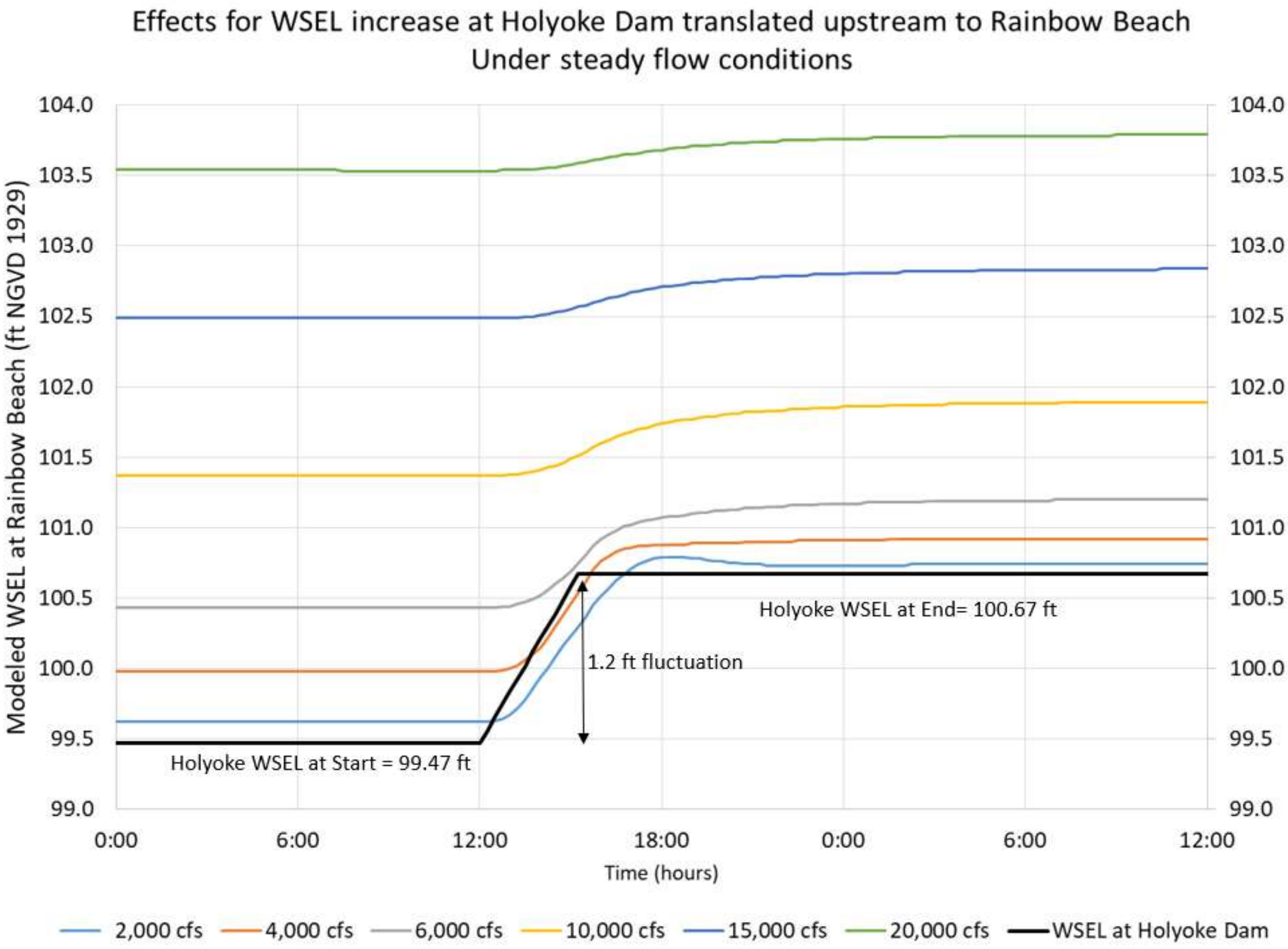

Figure 3.3.2.1.1.3-8: WSELs changes at Rainbow Beach based on WSEL increases at Holyoke Dam

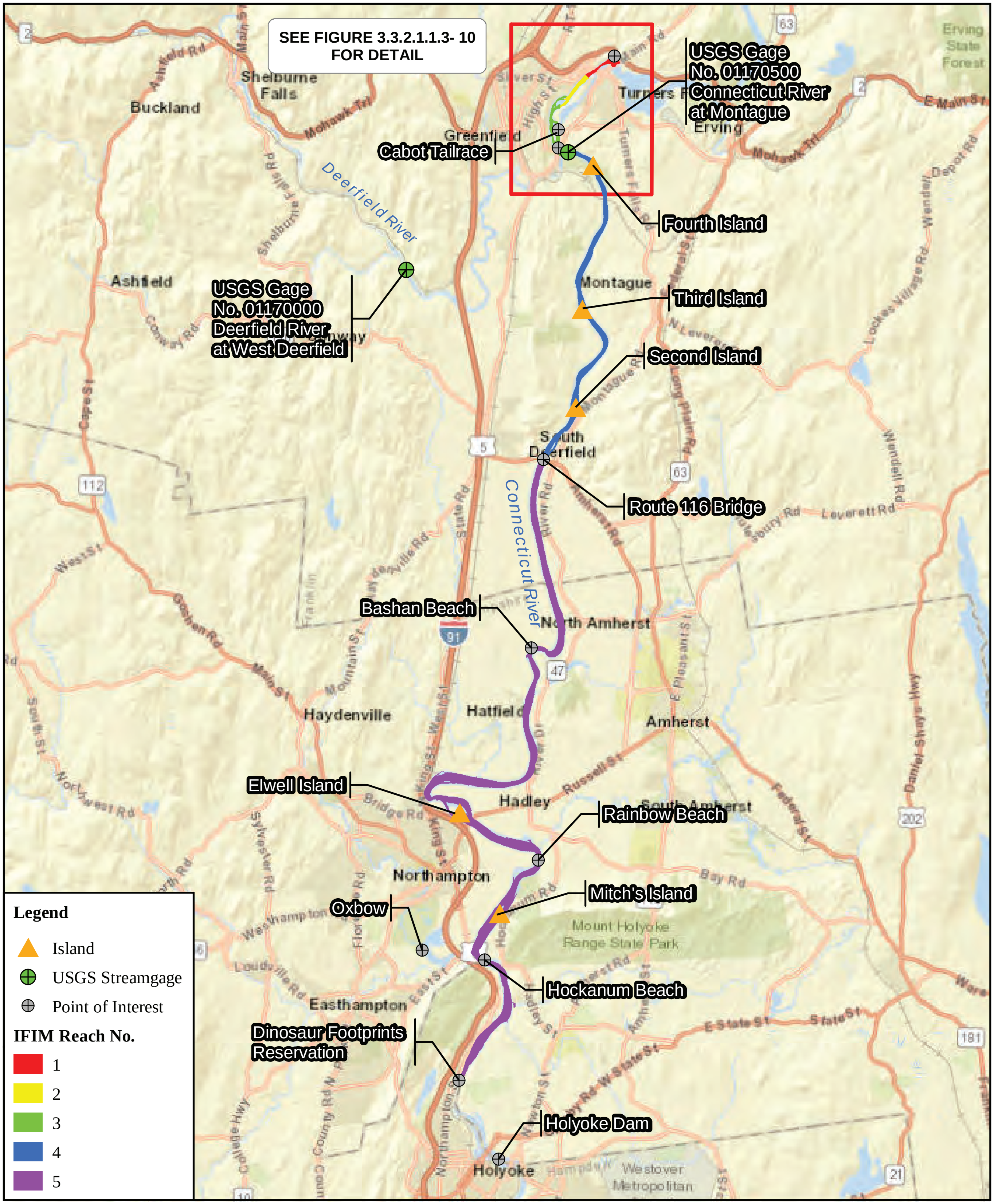

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Figure 3.3.2.1.1.3-9:
Instream Flow Study Reaches 1-5

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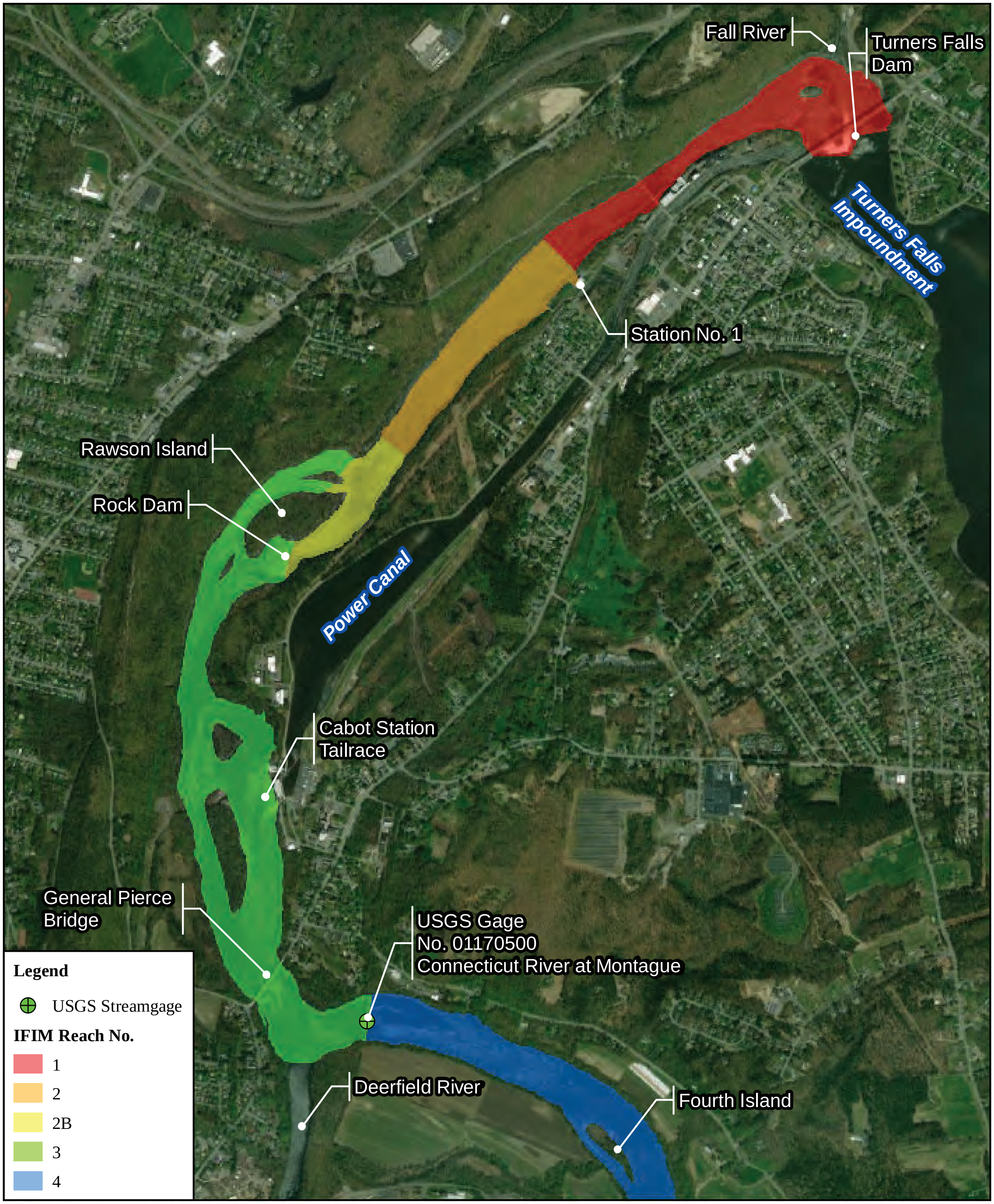

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Figure 3.3.2.1.1.3-10:
Instream Flow Study Reaches 1-4

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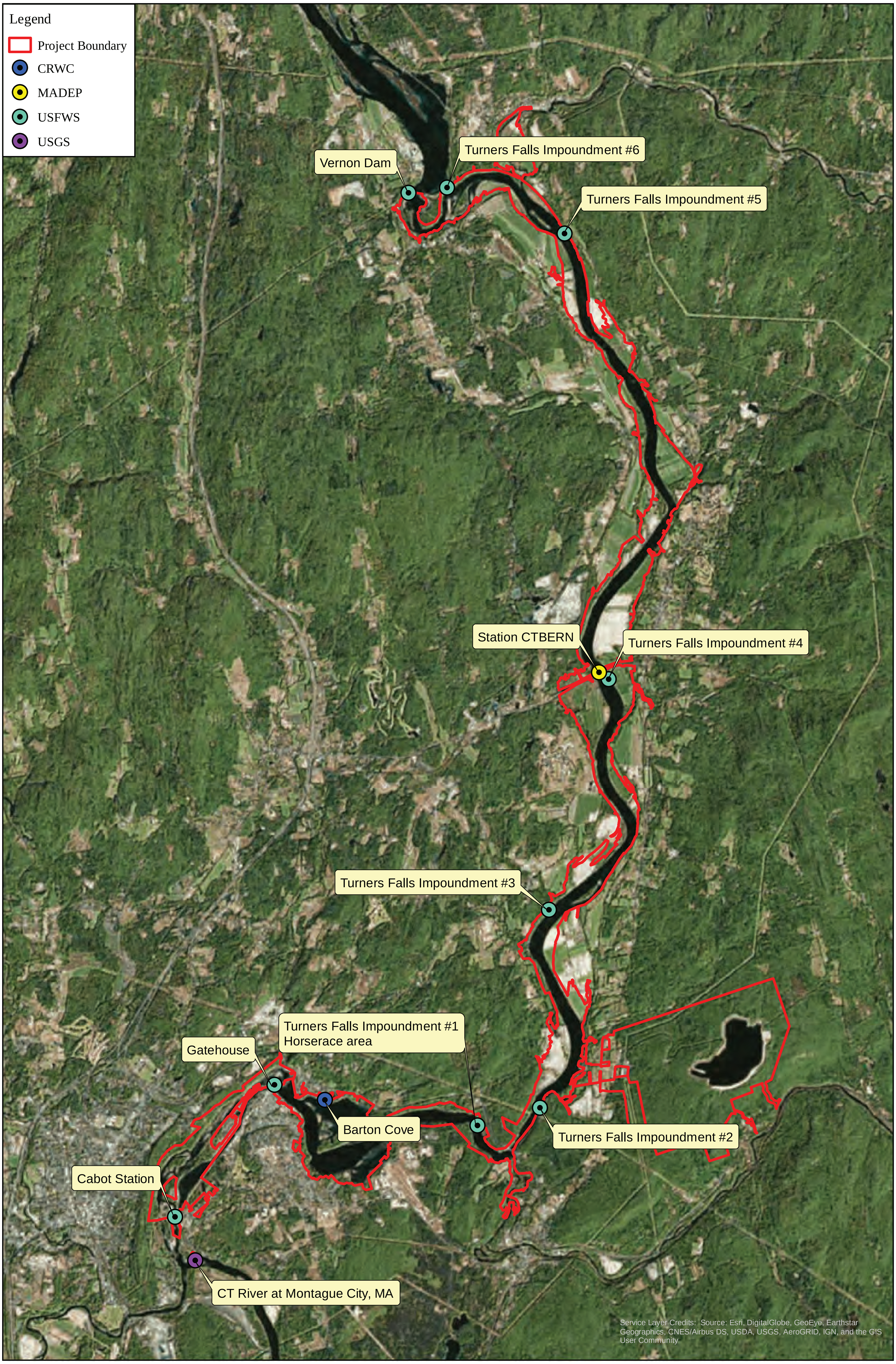

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Figure 3.3.2.1.2-1:
Water Quality Sampling Locations
(Agency and Volunteer Groups)
in the Vicinity of the Project

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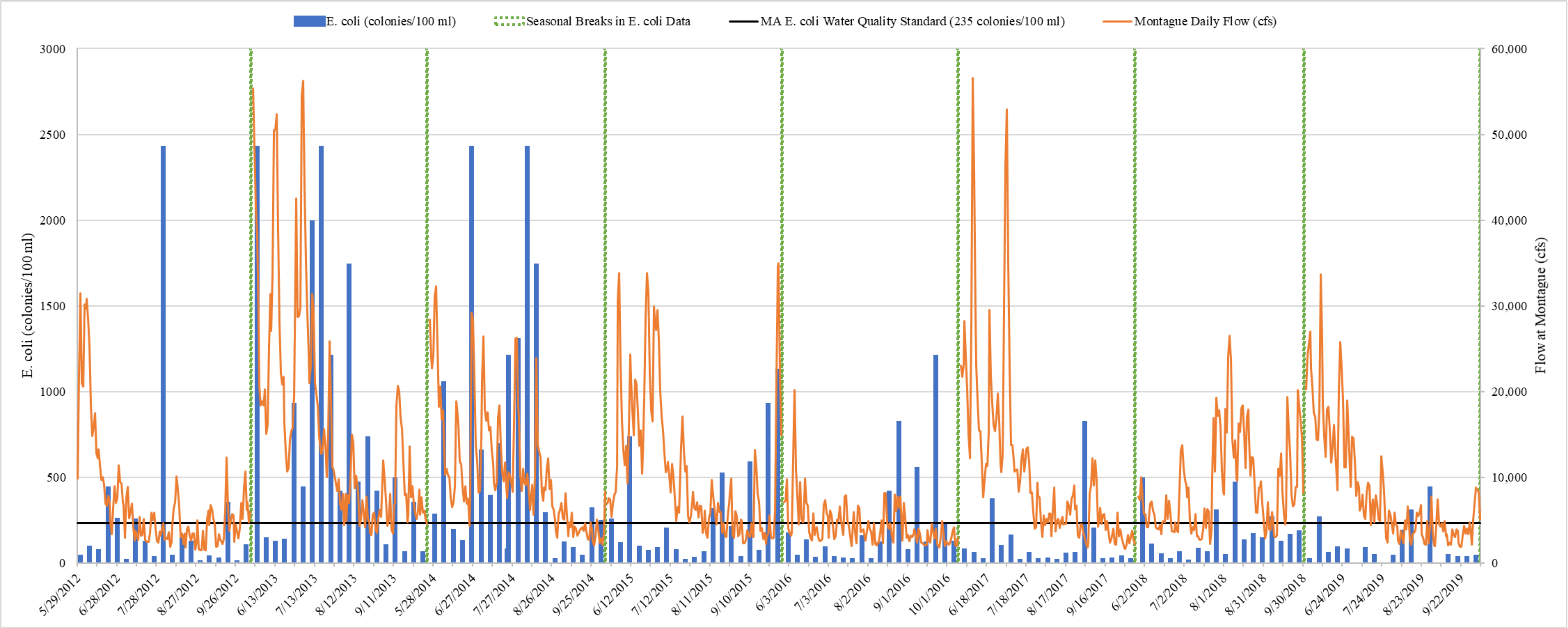
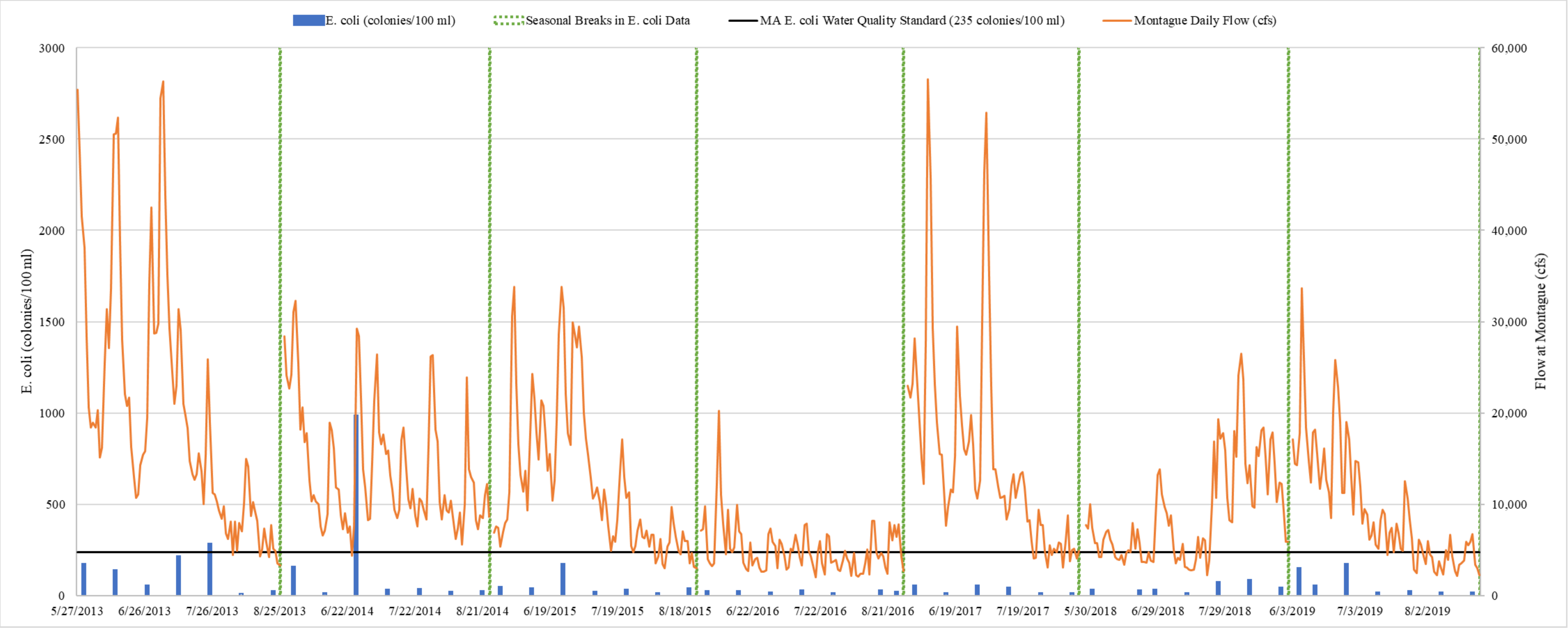


Figure 3.3.2.1.2-2: *E. coli* Colony Bacteria Counts at Barton Cove in Comparison to the Connecticut River Flow at Montague (2012 – 2019)

Sources:
2012 – 2019 *E. coli* data: https://connecticutriver.us/it-clean
USGS gage 01170500 at Montague, MA (http://waterdata.usgs.gov/ma/nwis/current/?type=flow)

Figure 3.3.2.1.2-3: *E. coli* Colony Bacteria Counts at Pauchaug Brook Boat Launch in Comparison to the Connecticut River Flow at Montague (2013 – 2019)



Sources:
2013 – 2019 *E. coli* data: https://connecticutriver.us/it-clean
USGS gage 01170500 at Montague, MA (http://waterdata.usgs.gov/ma/nwis/current/?type=flow)

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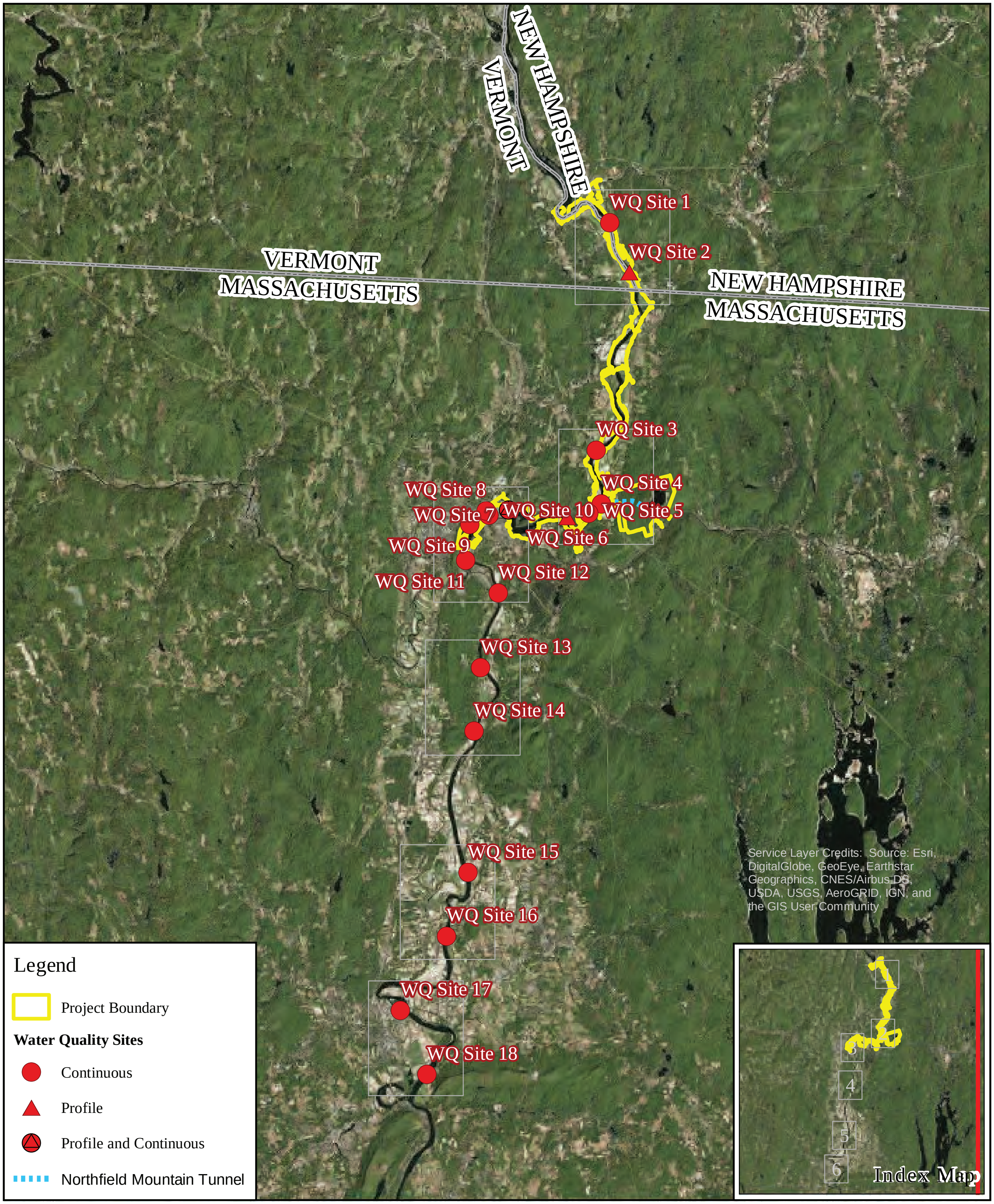

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Figure 3.3.2.1.2-4:
Overview of Water Quality Sampling Locations

Map Index

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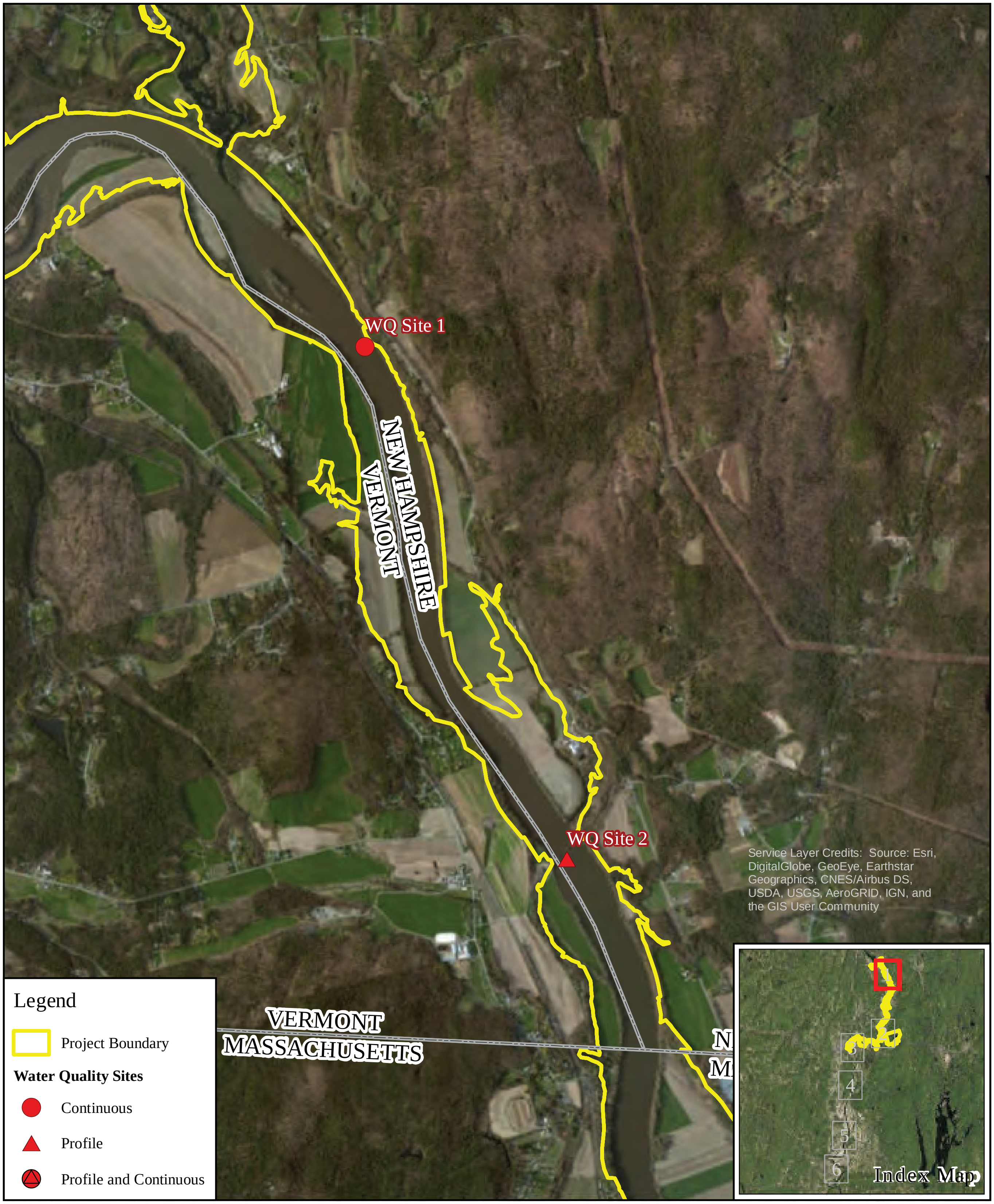

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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N

0 0.25 0.5 1 Miles

Figure 3.3.2.1.2-4:
Overview of Water Quality Sampling Locations

Map 1 of 6

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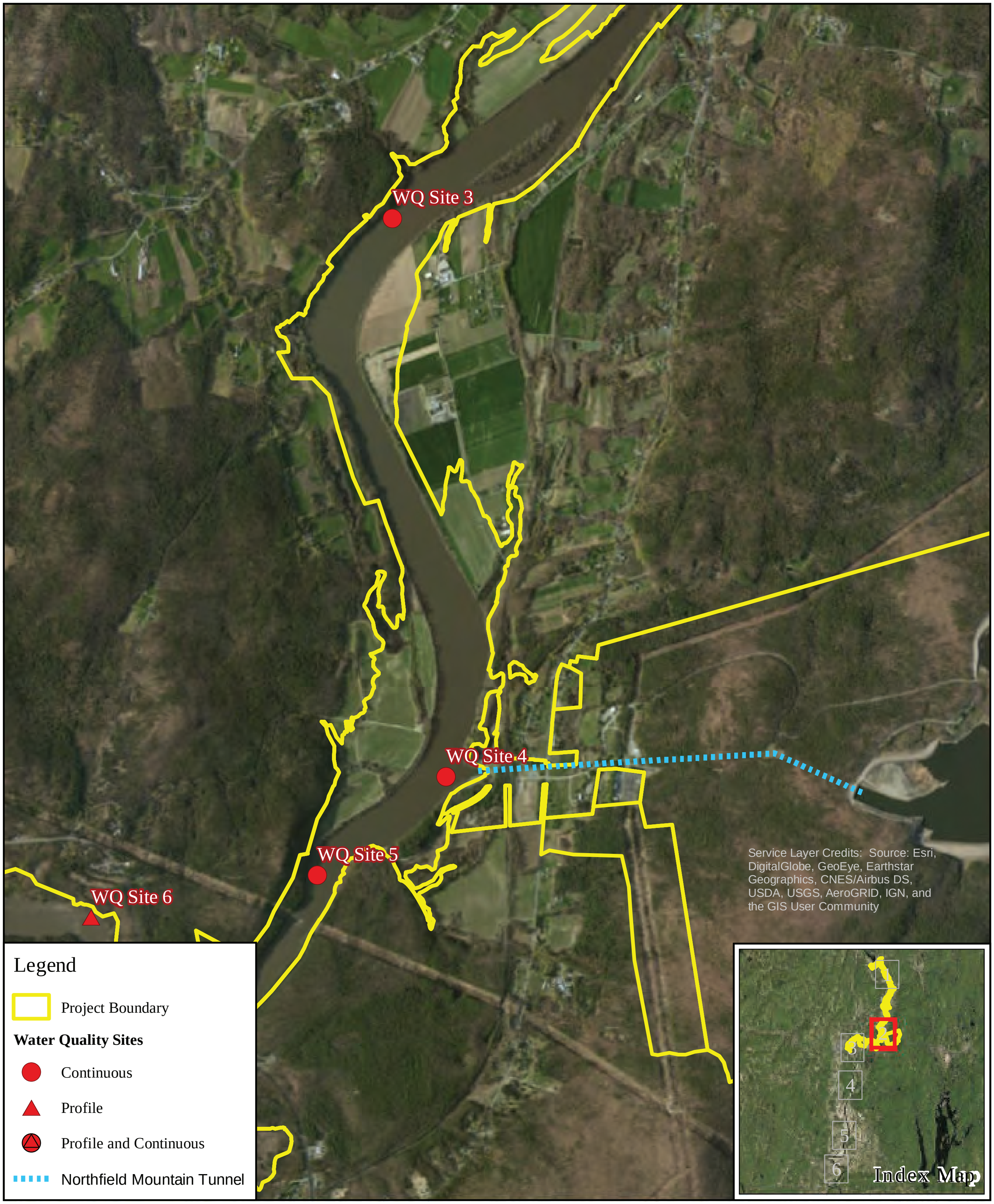

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FirstLight

N

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0 0.25 0.5 1
Miles

Figure 3.3.2.1.2-4: Overview of Water Quality Sampling Locations

Map 2 of 6

Path: W:\gis\maps\Exhibit_E\amended_combined\figure_3_3_2_1_2-4.mxd

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FirstLight

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N

0 0.25 0.5 1
Miles

Figure 3.3.2.1.2-4: Overview of Water Quality Sampling Locations

Map 3 of 6

Path: W:\gis\maps\Exhibit_E\amended_combined\figure_3_3_2_1_2-4.mxd

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N

0 0.25 0.5 1 Miles

Figure 3.3.2.1.2-4:
Overview of Water Quality Sampling Locations

Map 4 of 6

Path: W:\gis\maps\Exhibit_E\amended_combined\figure_3_3_2_1_2-4.mxd

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0 0.25 0.5 1
Miles

Figure 3.3.2.1.2-4:
Overview of Water Quality Sampling Locations

Map 5 of 6

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Figure 3.3.2.1.2-4:
Overview of Water Quality Sampling Locations

Map 6 of 6

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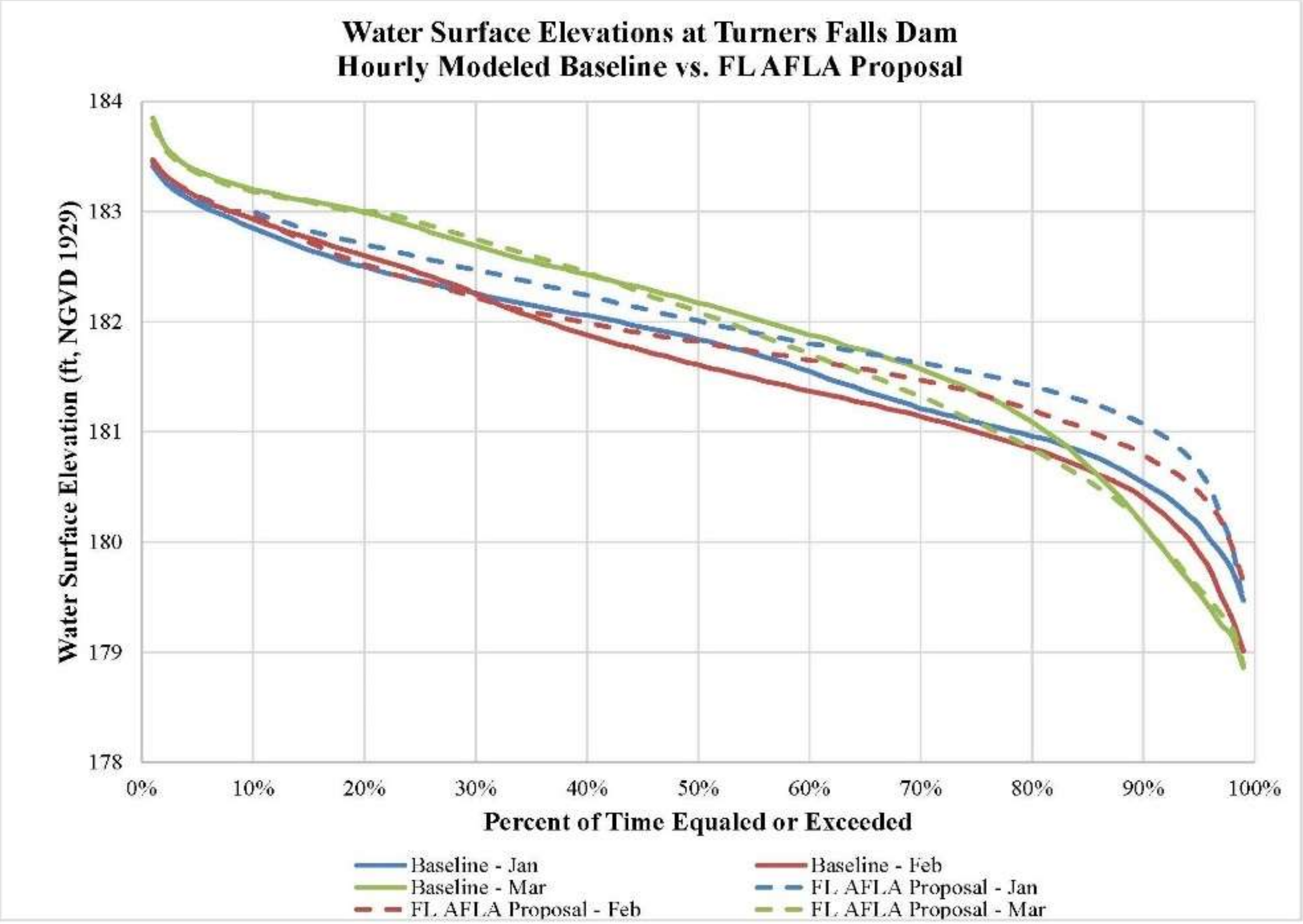


Figure 3.3.2.2.1-1: Monthly (Jan, Feb, and Mar) WSEL Duration Curves for TFI

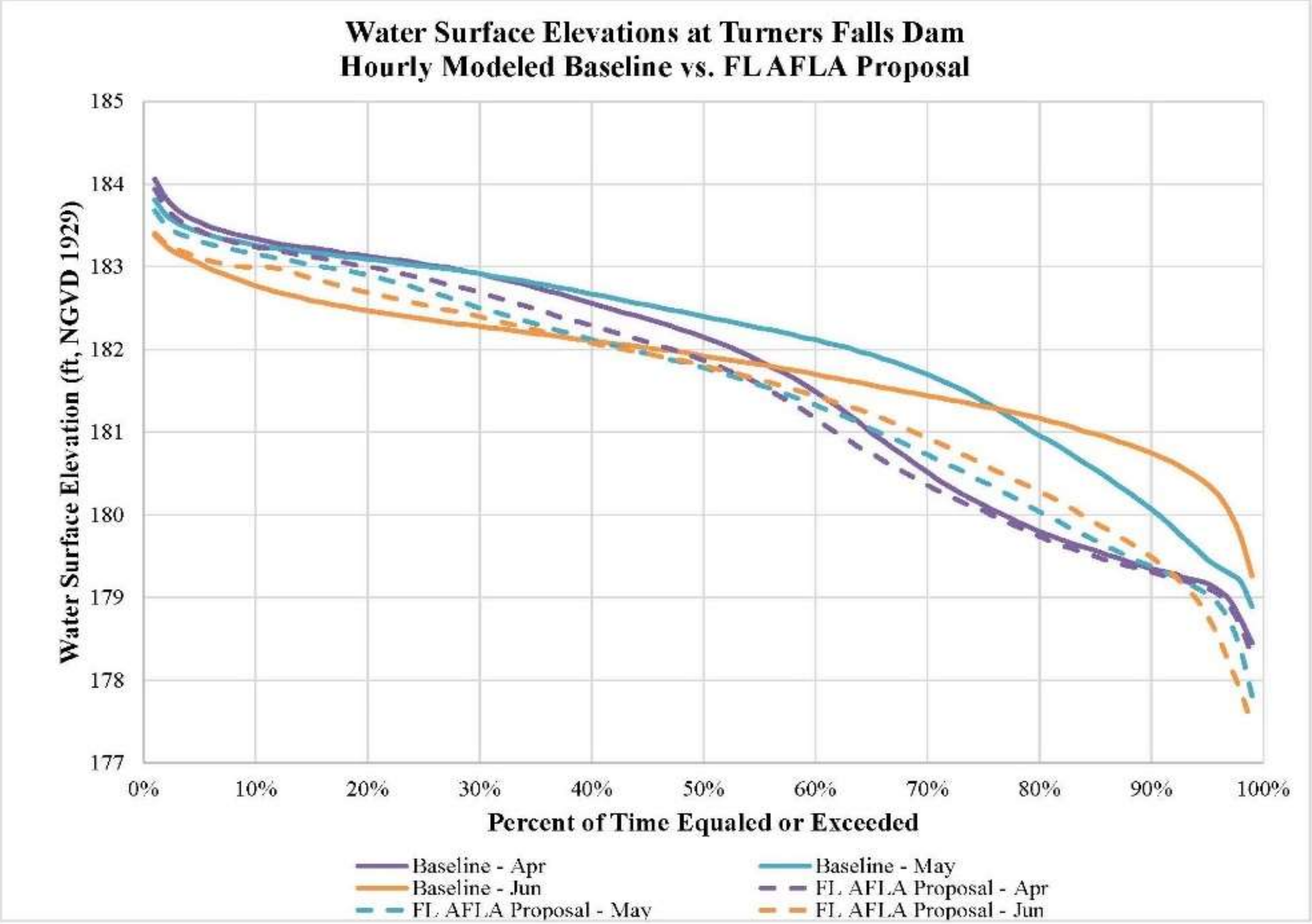


Figure 3.3.2.2.1-2: Monthly (Apr, May, and Jun) WSEL Duration Curves for TFI

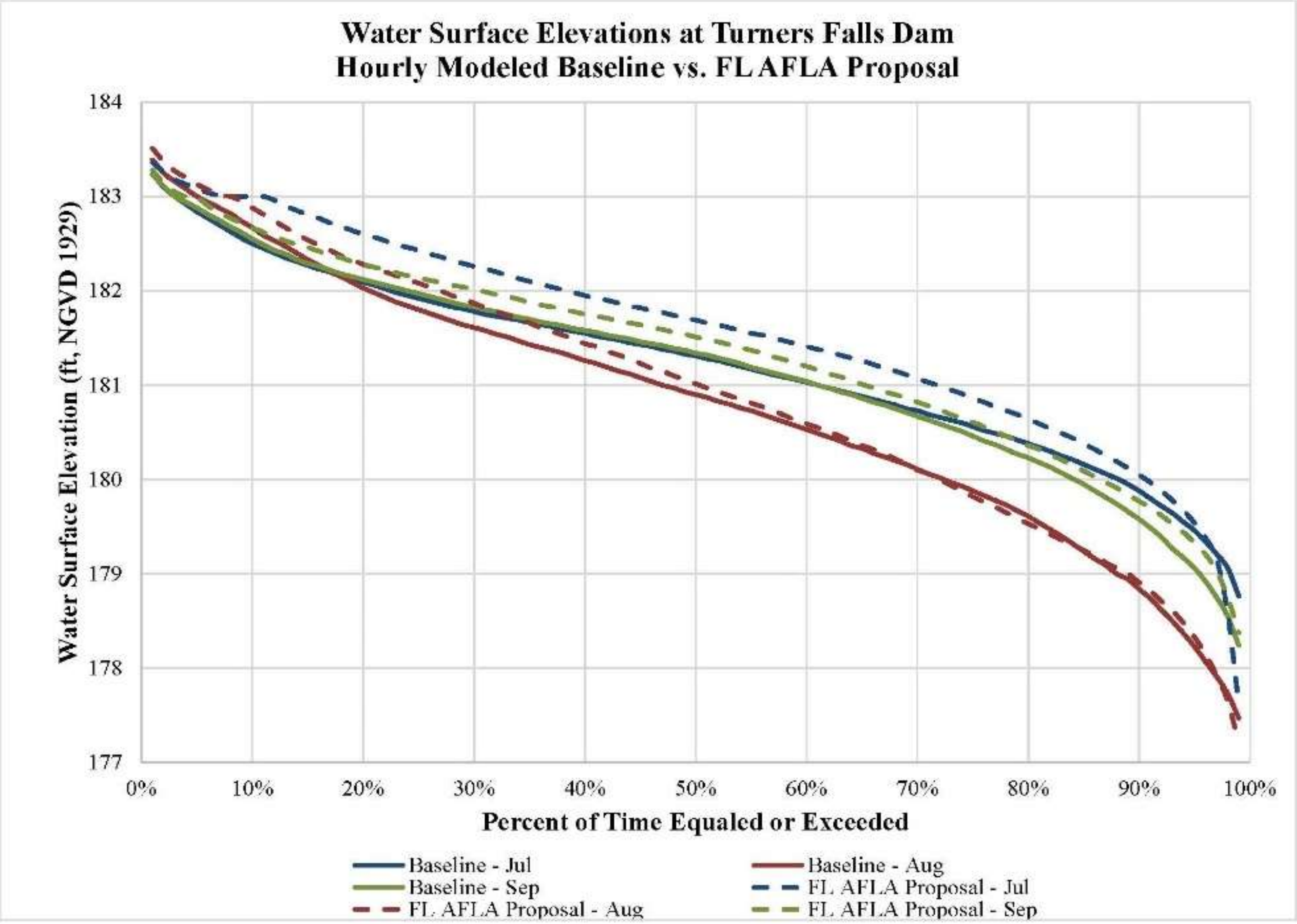


Figure 3.3.2.2.1-3: Monthly (Jul, Aug, and Sep) WSEL Duration Curves for TFI

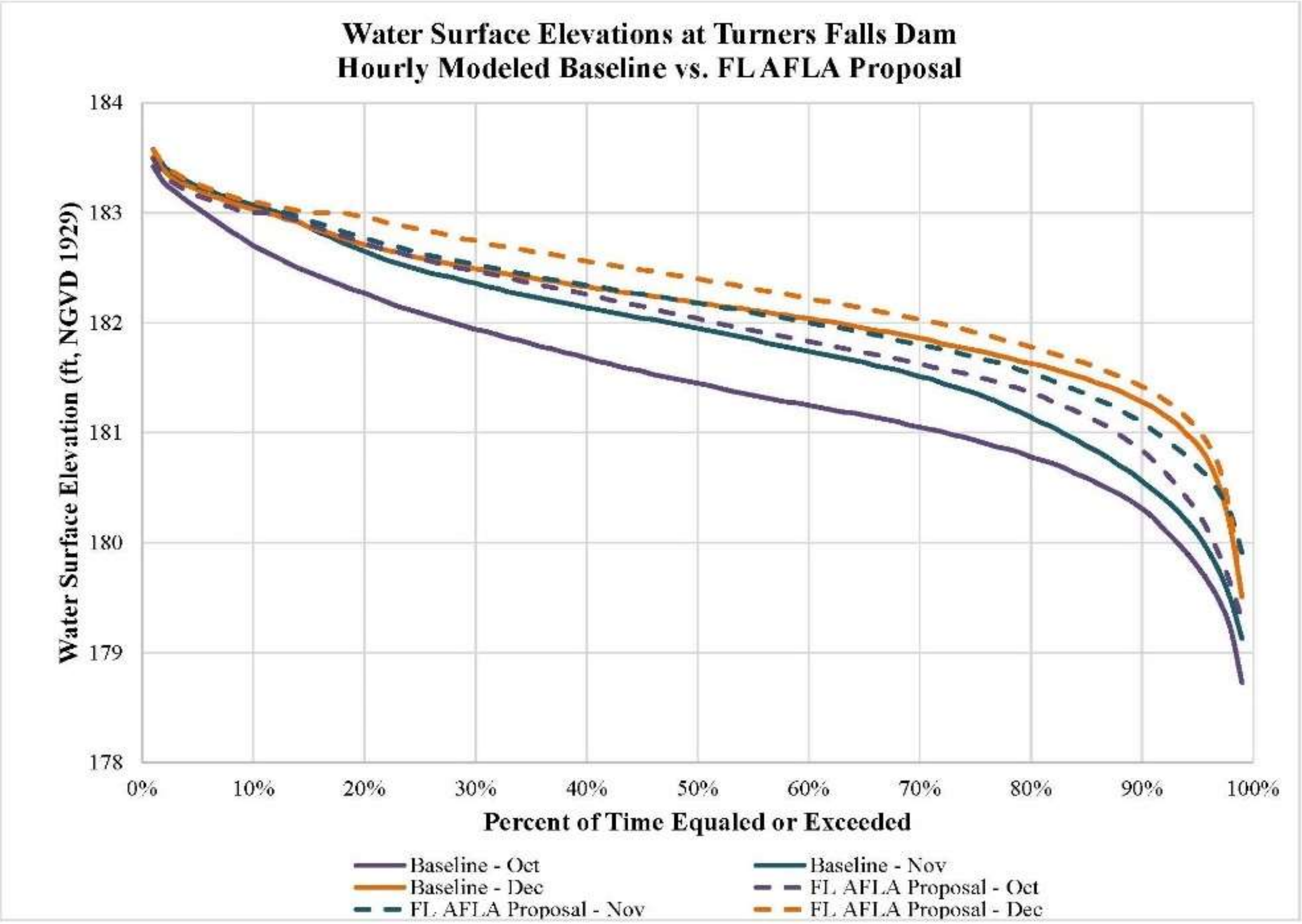


Figure 3.3.2.2.1-4: Monthly (Oct, Nov, and Dec) WSEL Duration Curves for TFI

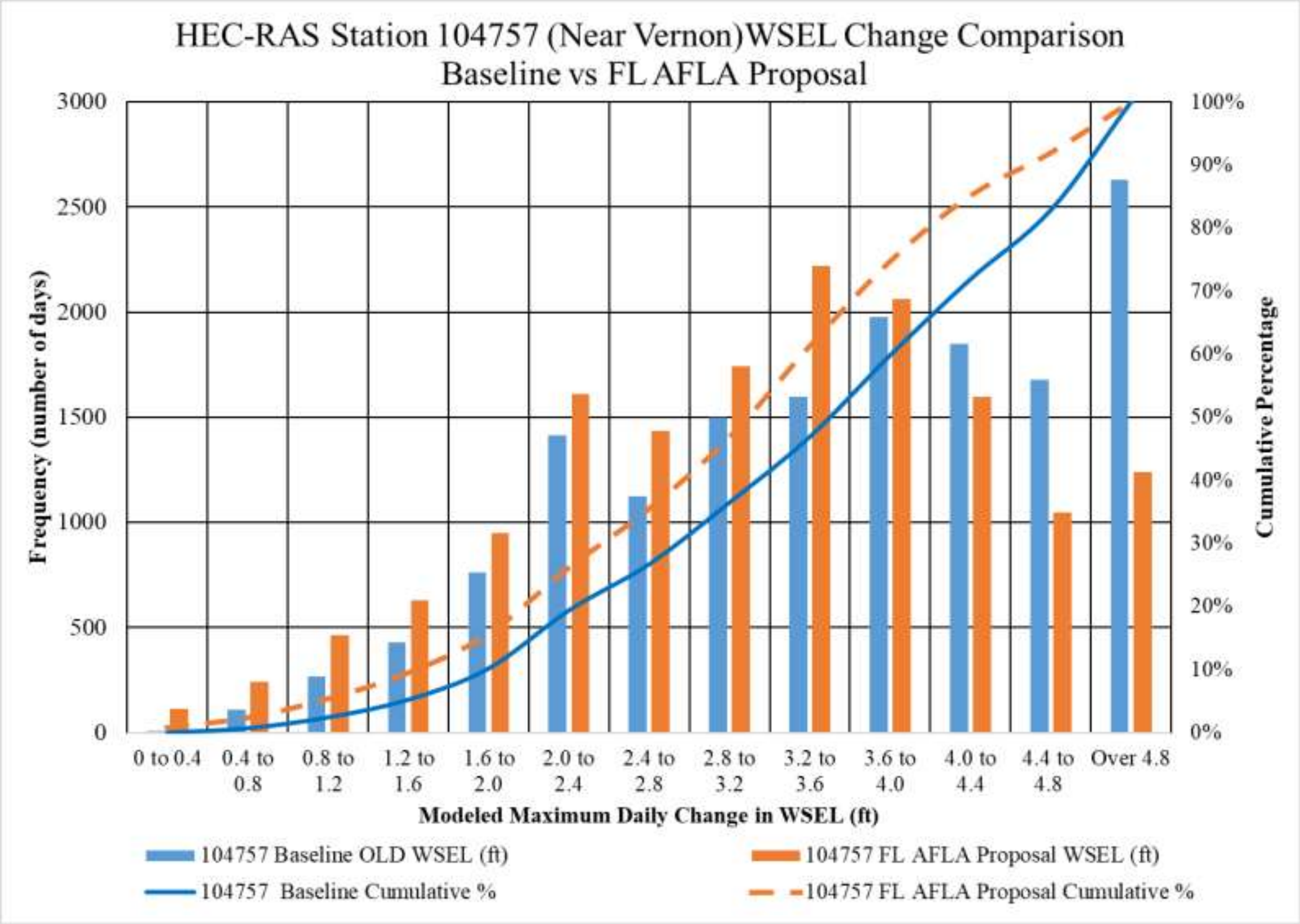


Figure 3.3.2.2.1-5: Annual Maximum Daily Change Histogram in TFI near Vernon Dam

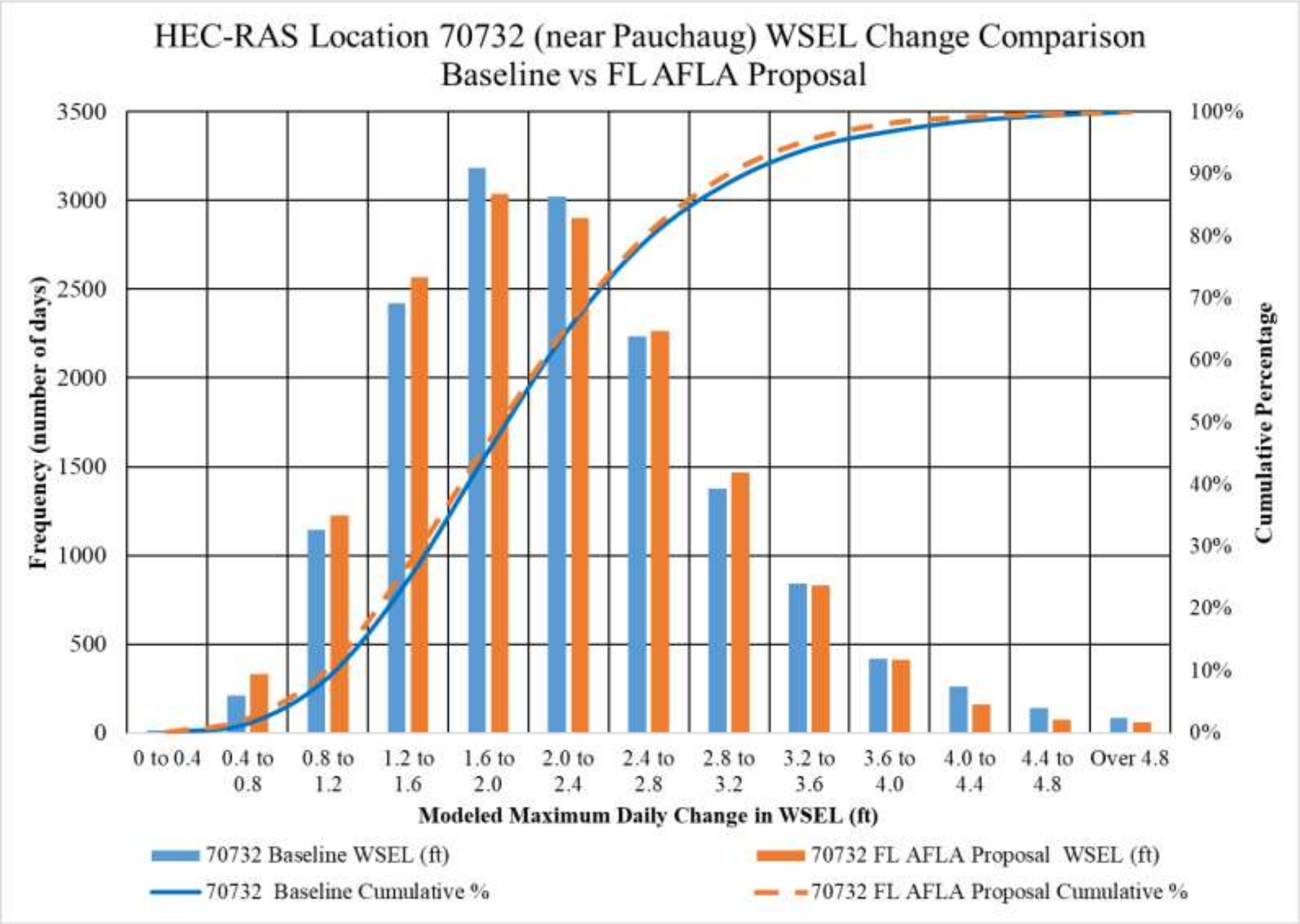


Figure 3.3.2.2.1-6: Annual Maximum Daily Change Histogram in TFI near Pauchaug

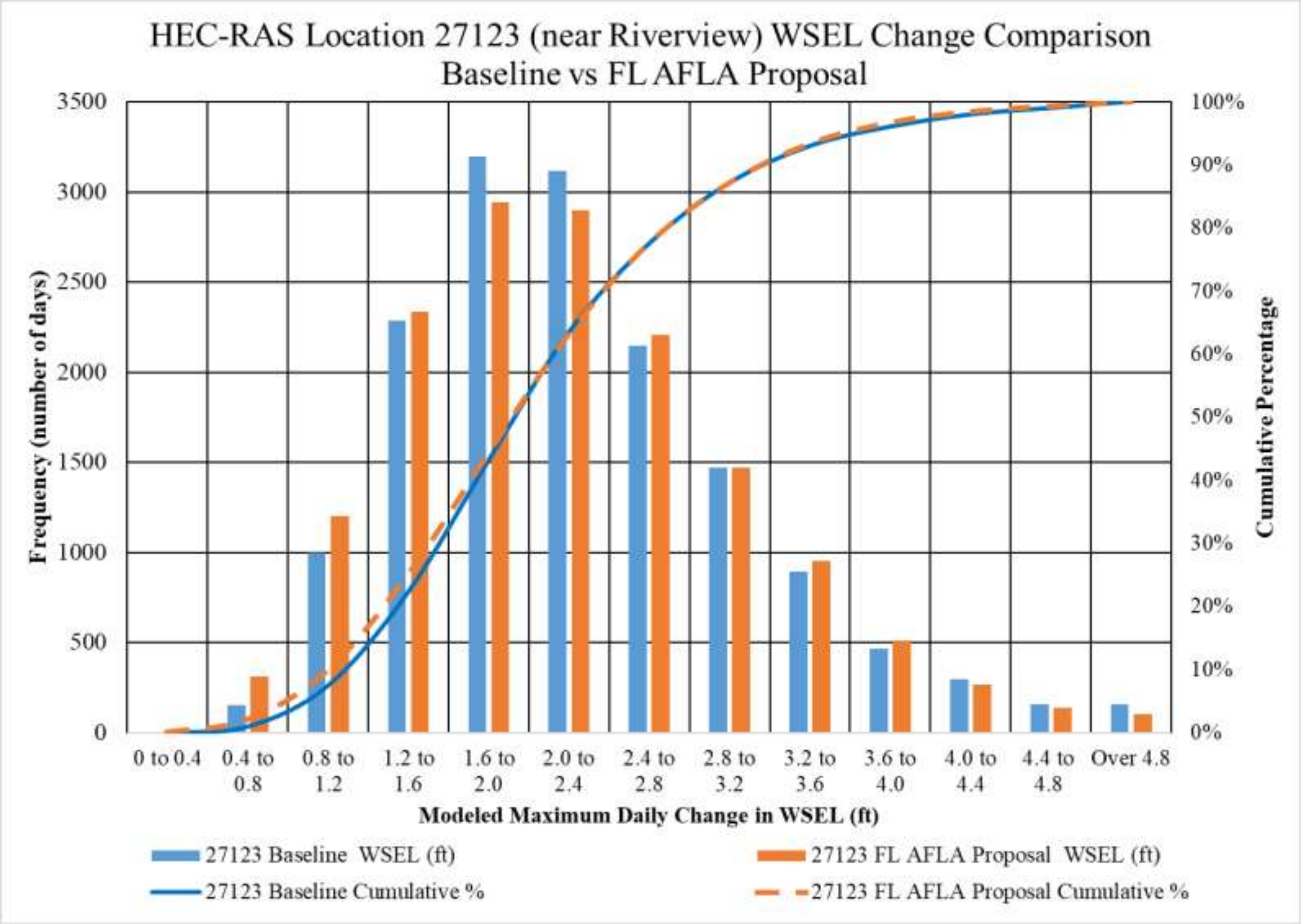


Figure 3.3.2.2.1-7: Annual Maximum Daily Change Histogram in TFI near Riverview

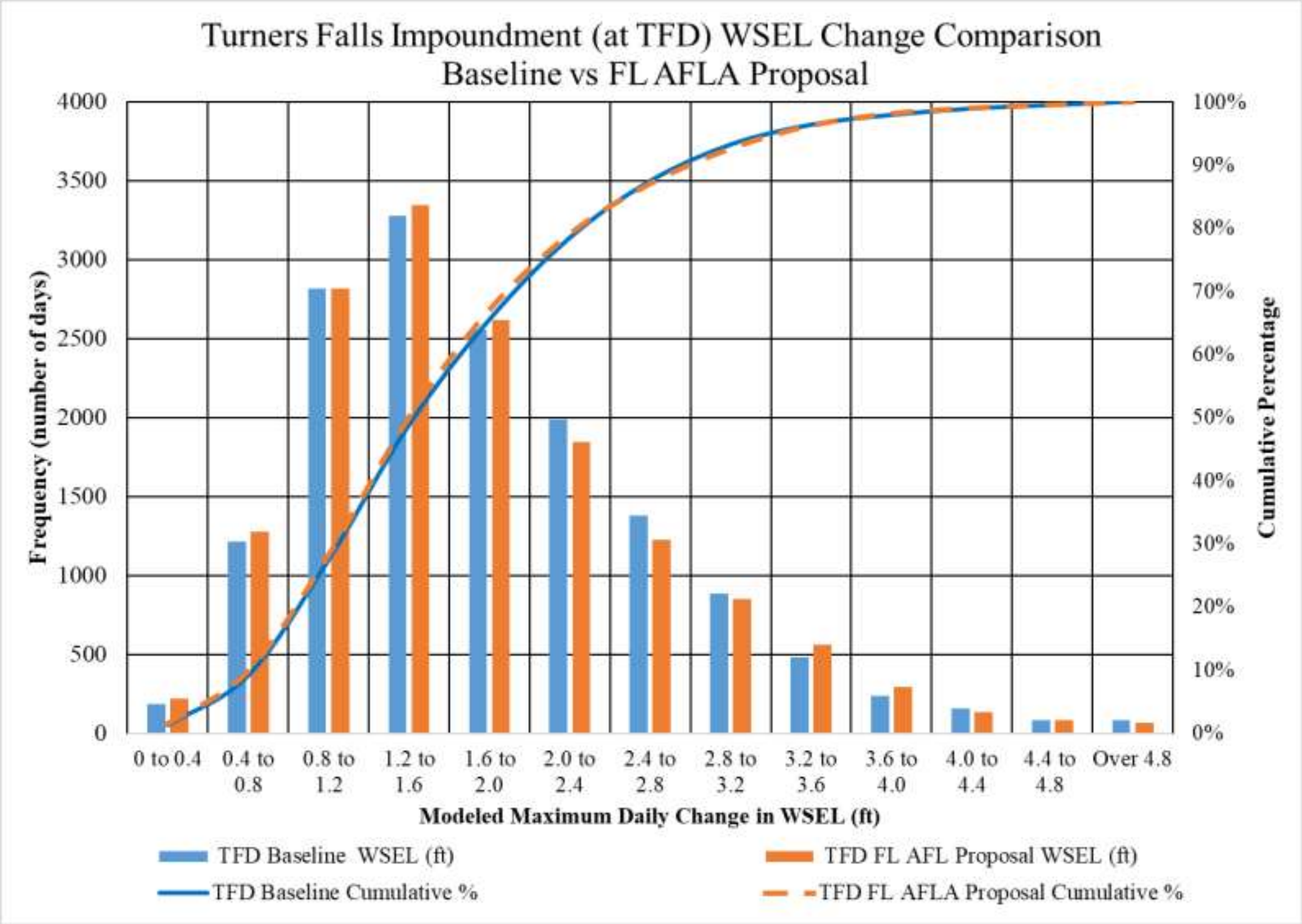


Figure 3.3.2.2.1-8: Annual Maximum Daily Change Histogram at Turners Falls Dam

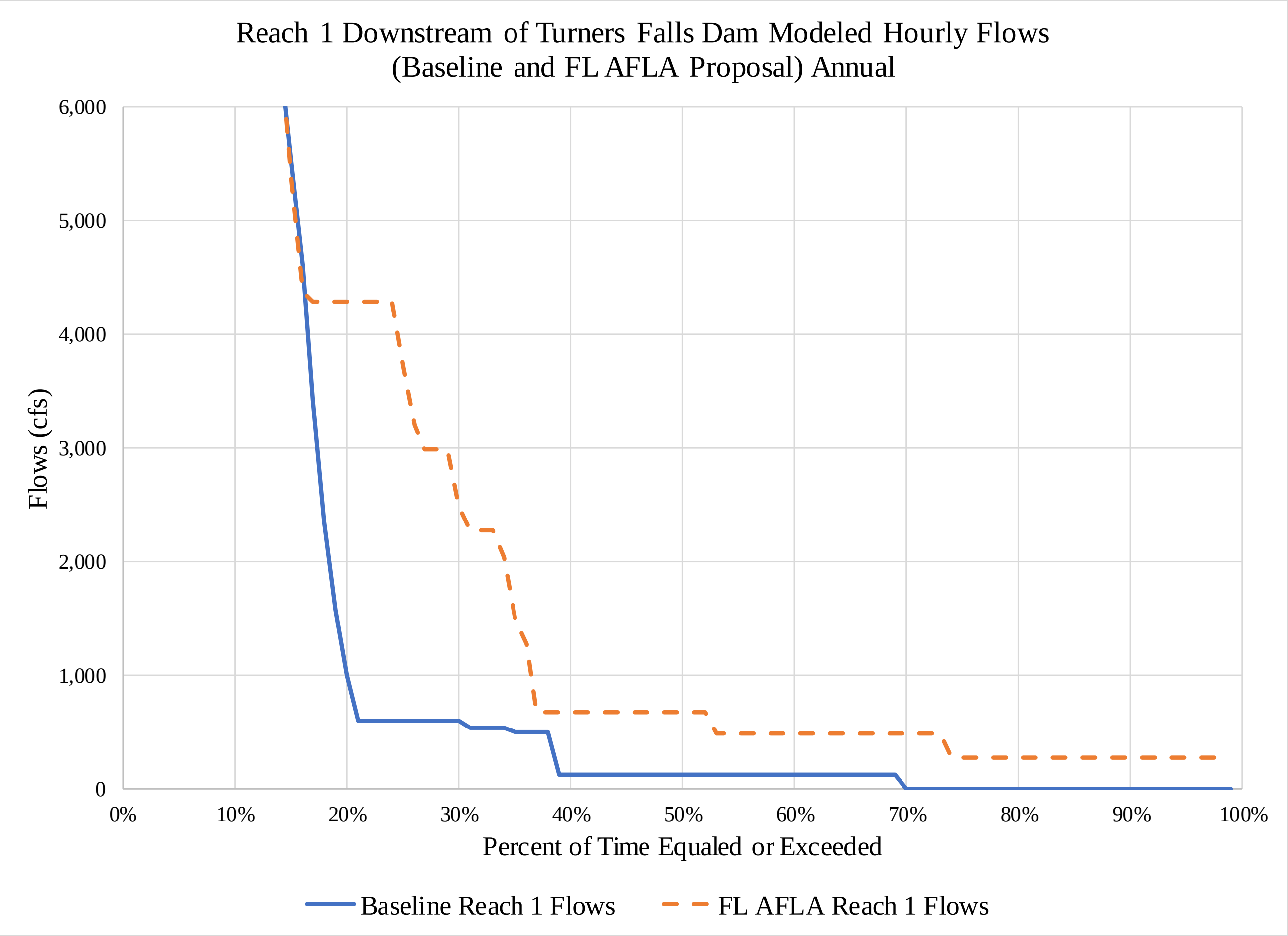


Figure 3.3.2.2.1-9: Annual Duration Curve Downstream of Turners Falls Dam

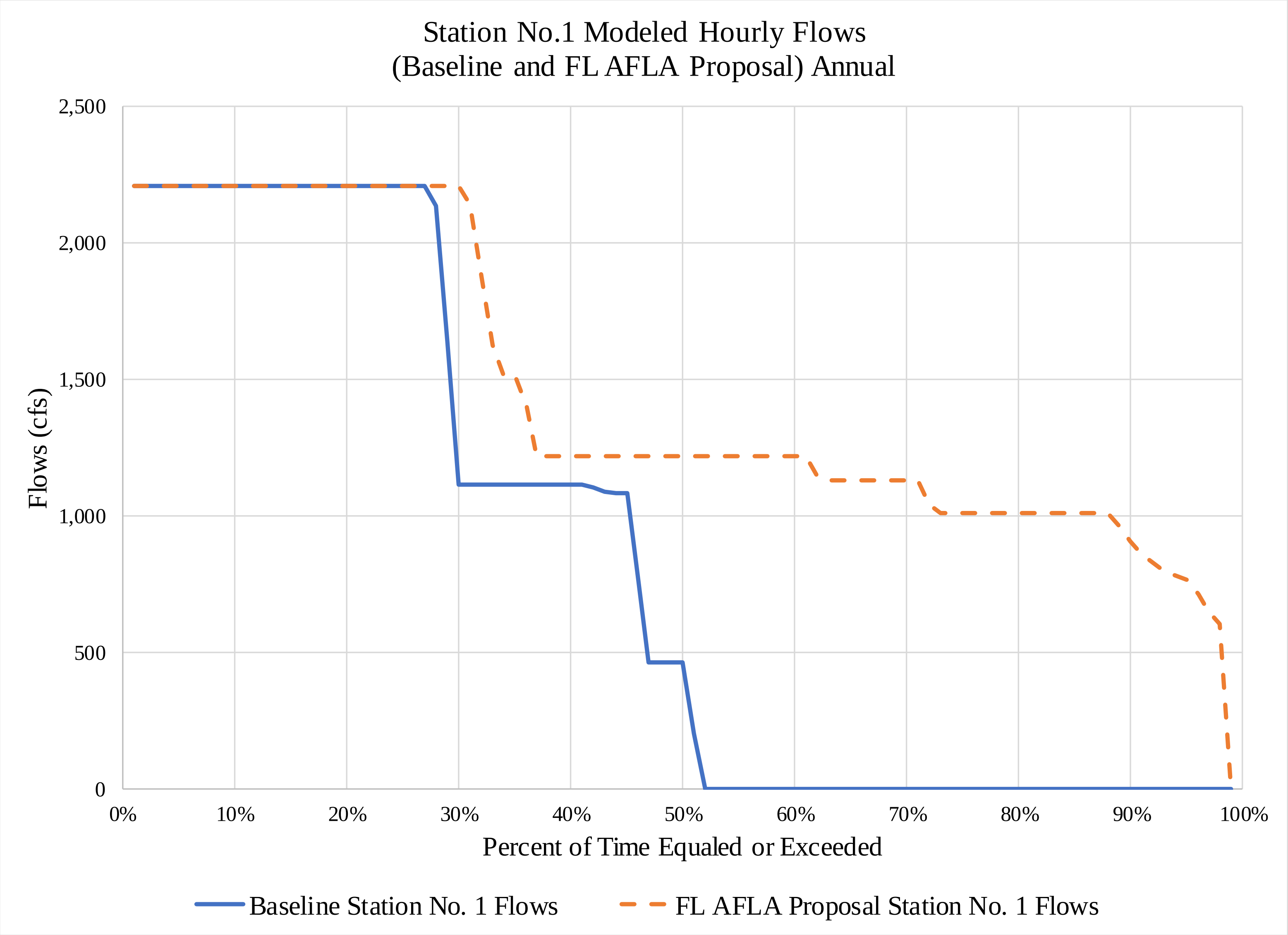


Figure 3.3.2.2.1-10: Annual Duration Curve for flow through Station No. 1

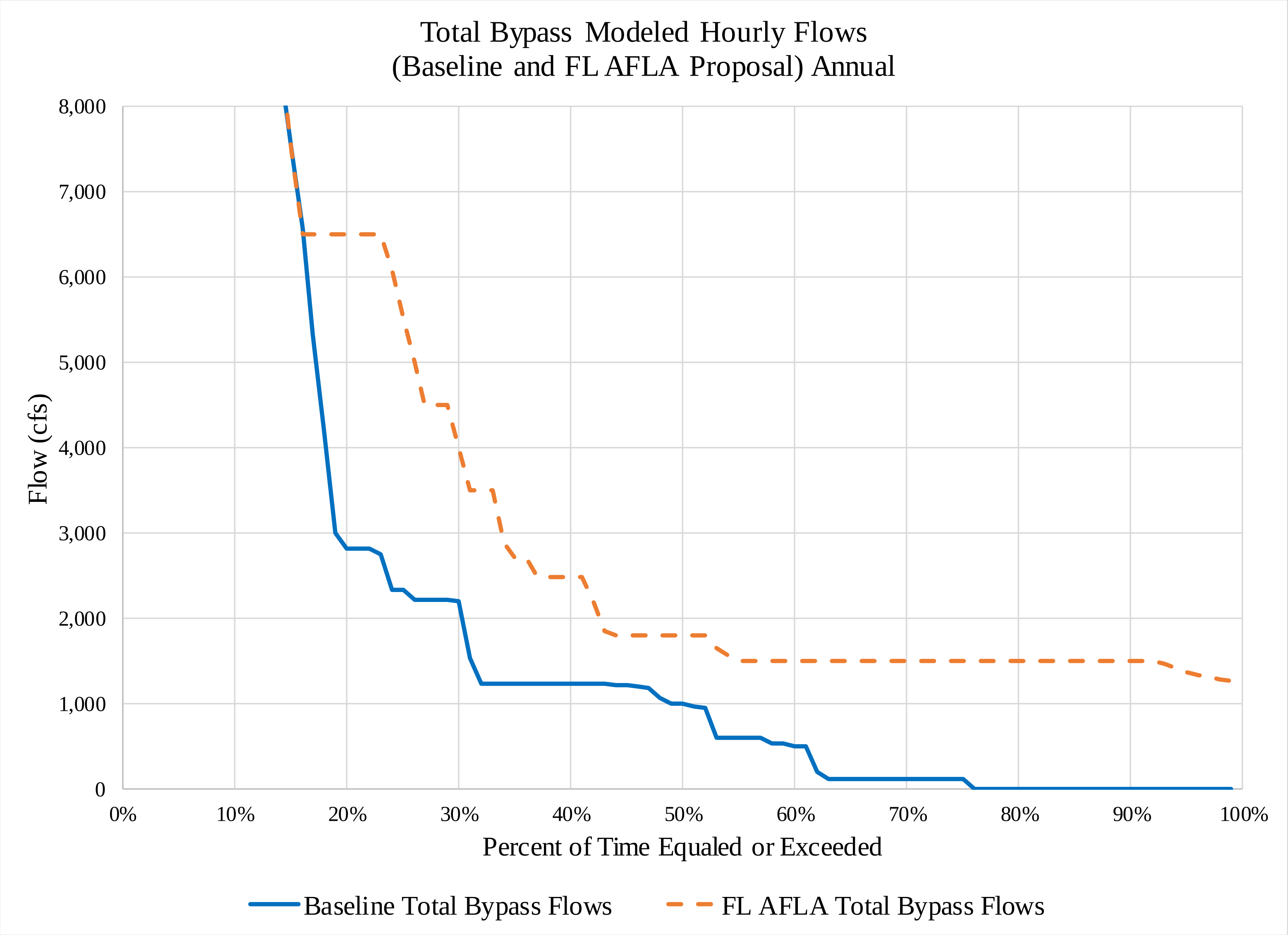


Figure 3.3.2.2.1-11: Annual Duration Curve for Total Bypass Flows below Station No. 1

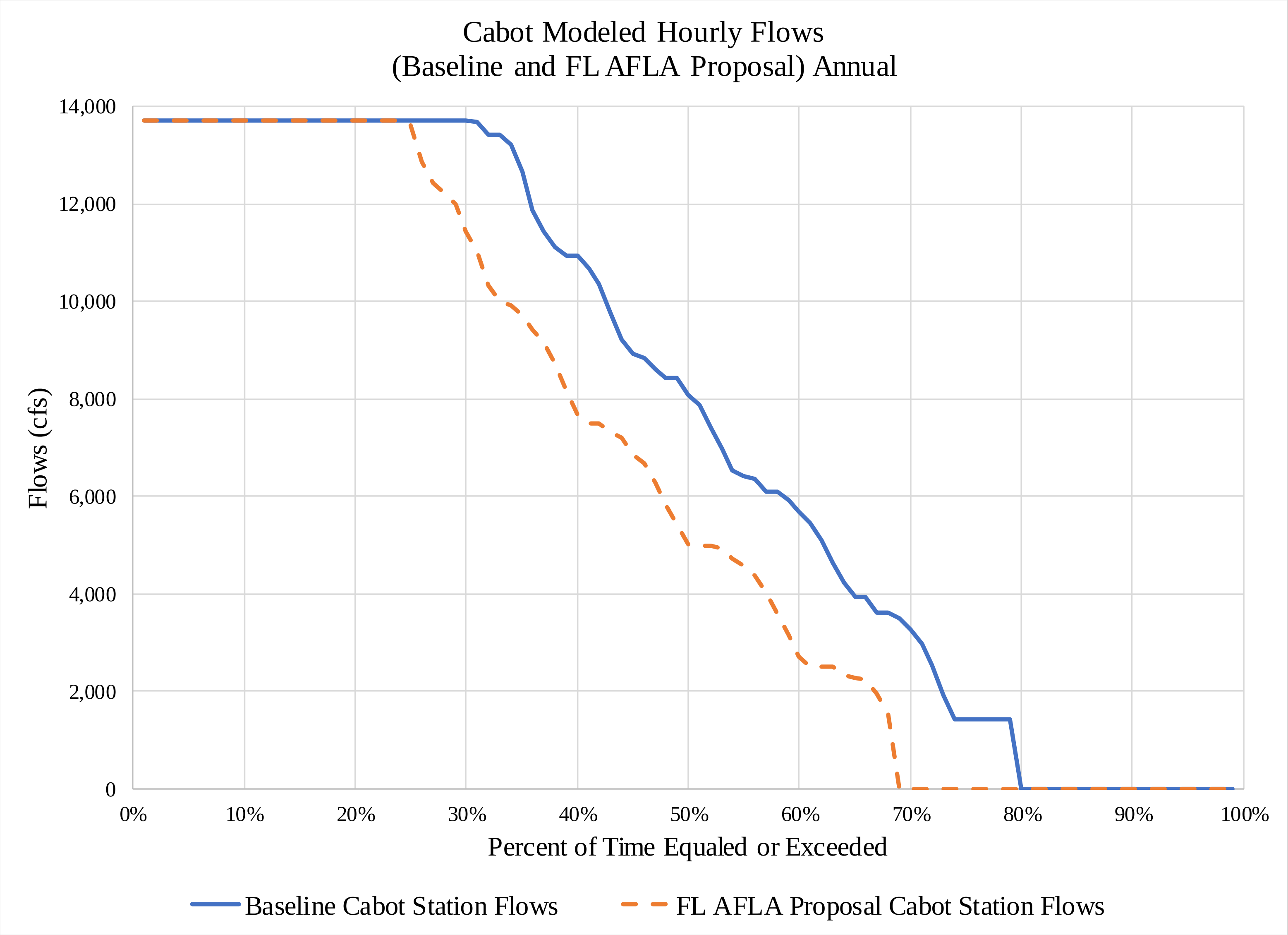


Figure 3.3.2.2.1-12: Annual Duration Curve for flow through Cabot Station

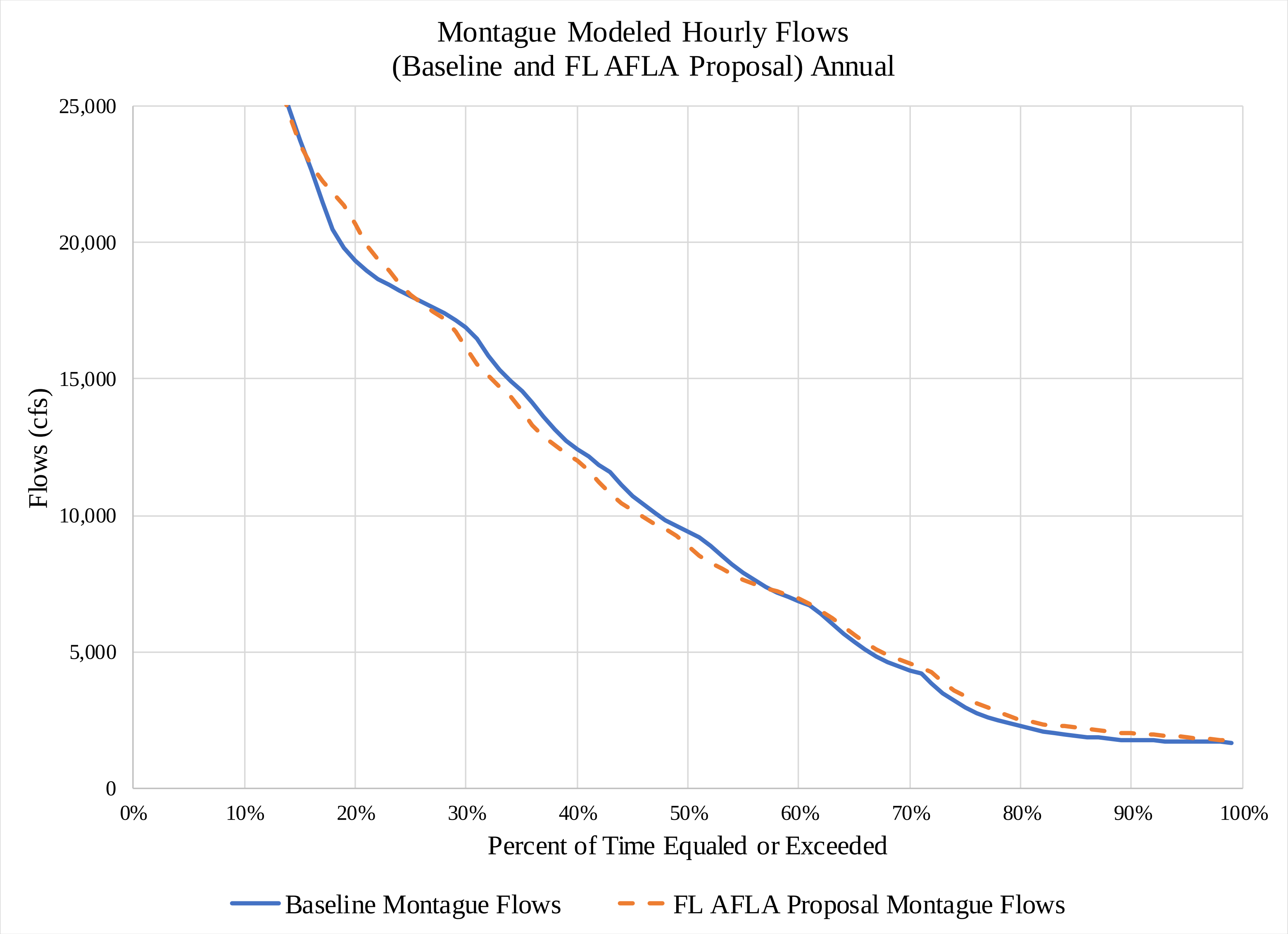
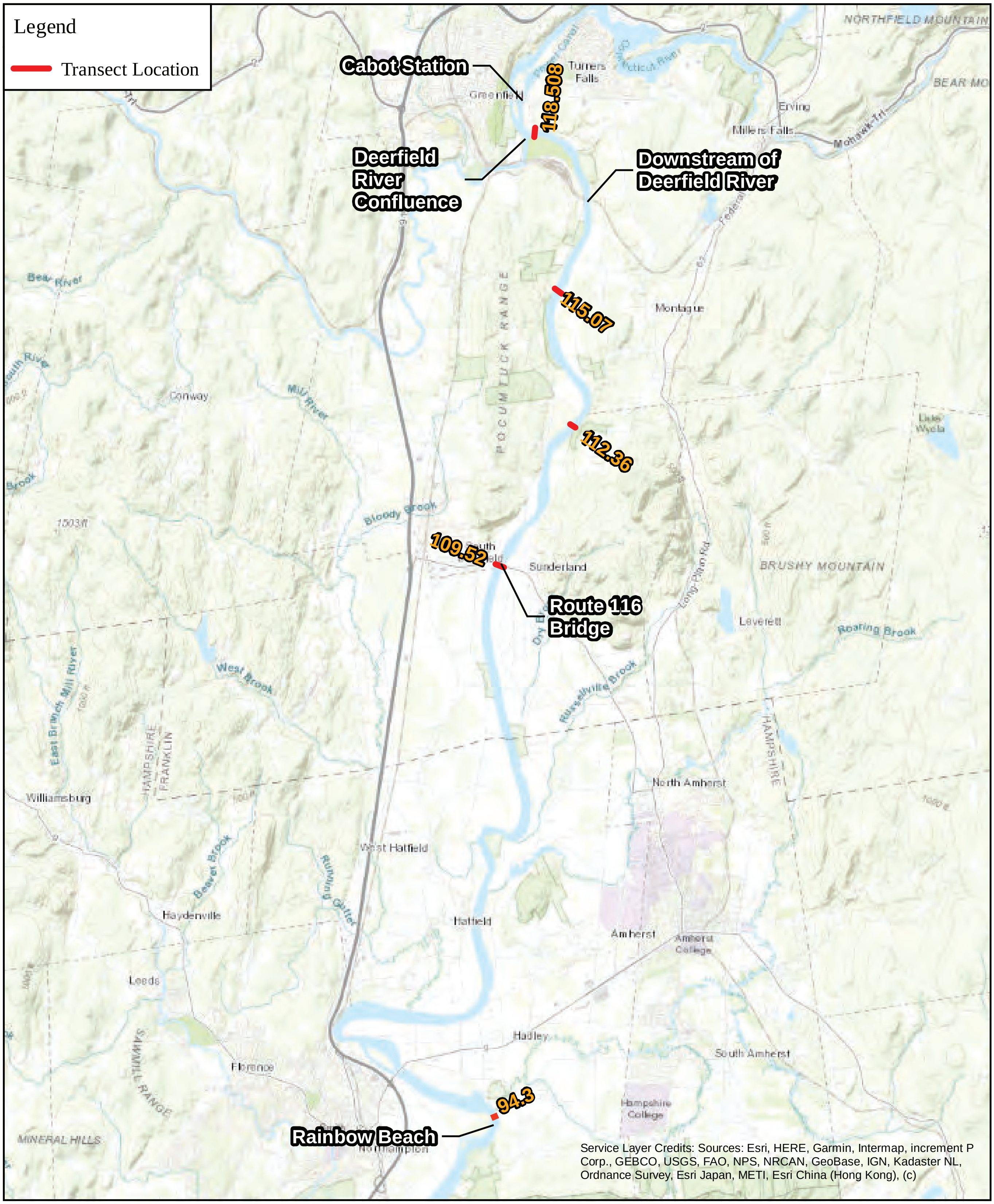


Figure 3.3.2.2.1-13: Annual Duration Curve for flows at Montague (includes Deerfield River)



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N

0 1.25 2.5 5
Miles

Figure 3.3.2.2.1-14:
Map Showing HEC-RAS Transects RM118.508, RM115.07, RM112.36, RM109.52 and RM94.298 (Rainbow Beach)

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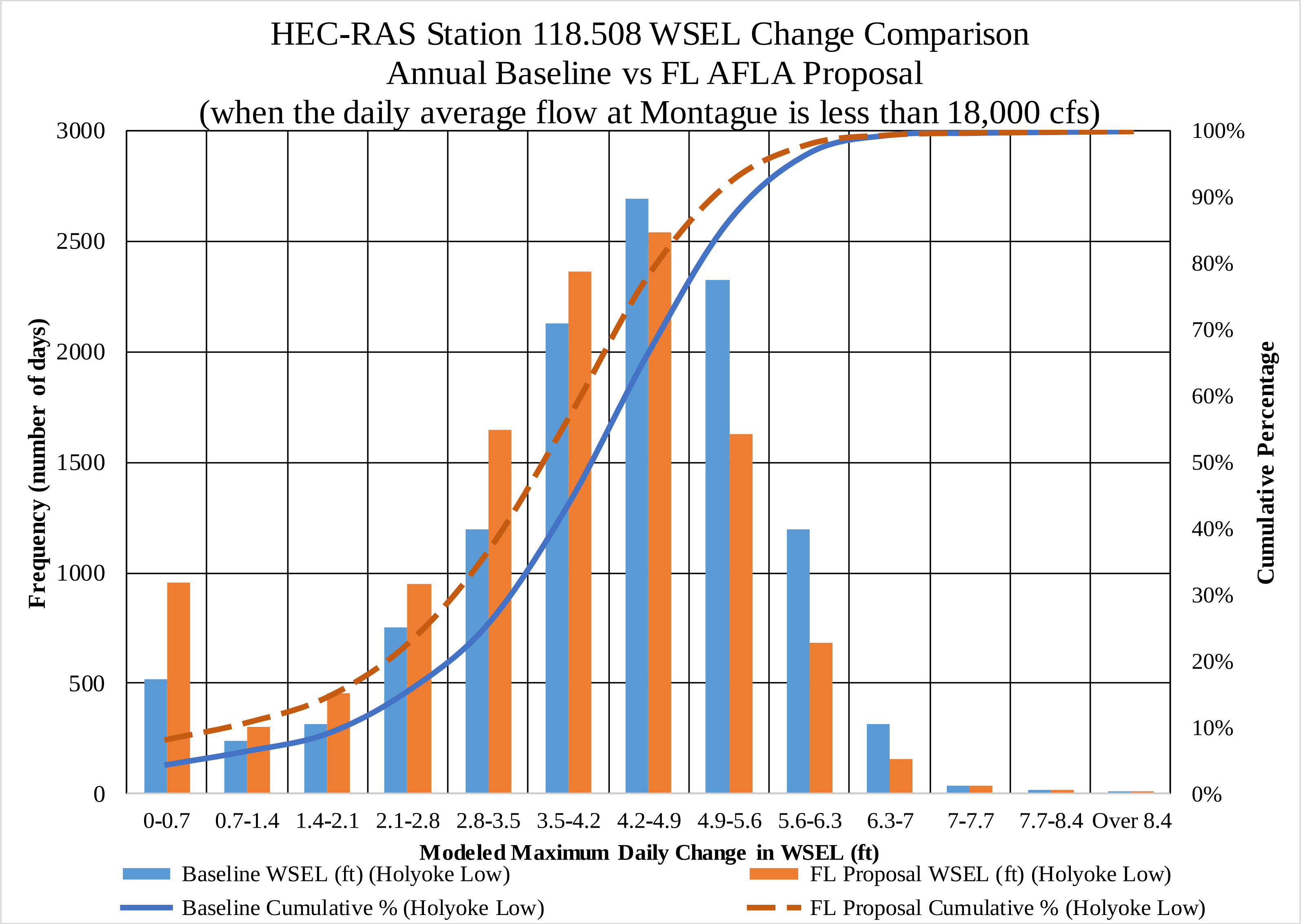

Figure 3.3.2.2.1-15: Annual WSEL Histograms and Duration Curves HEC-RAS Station 118.508

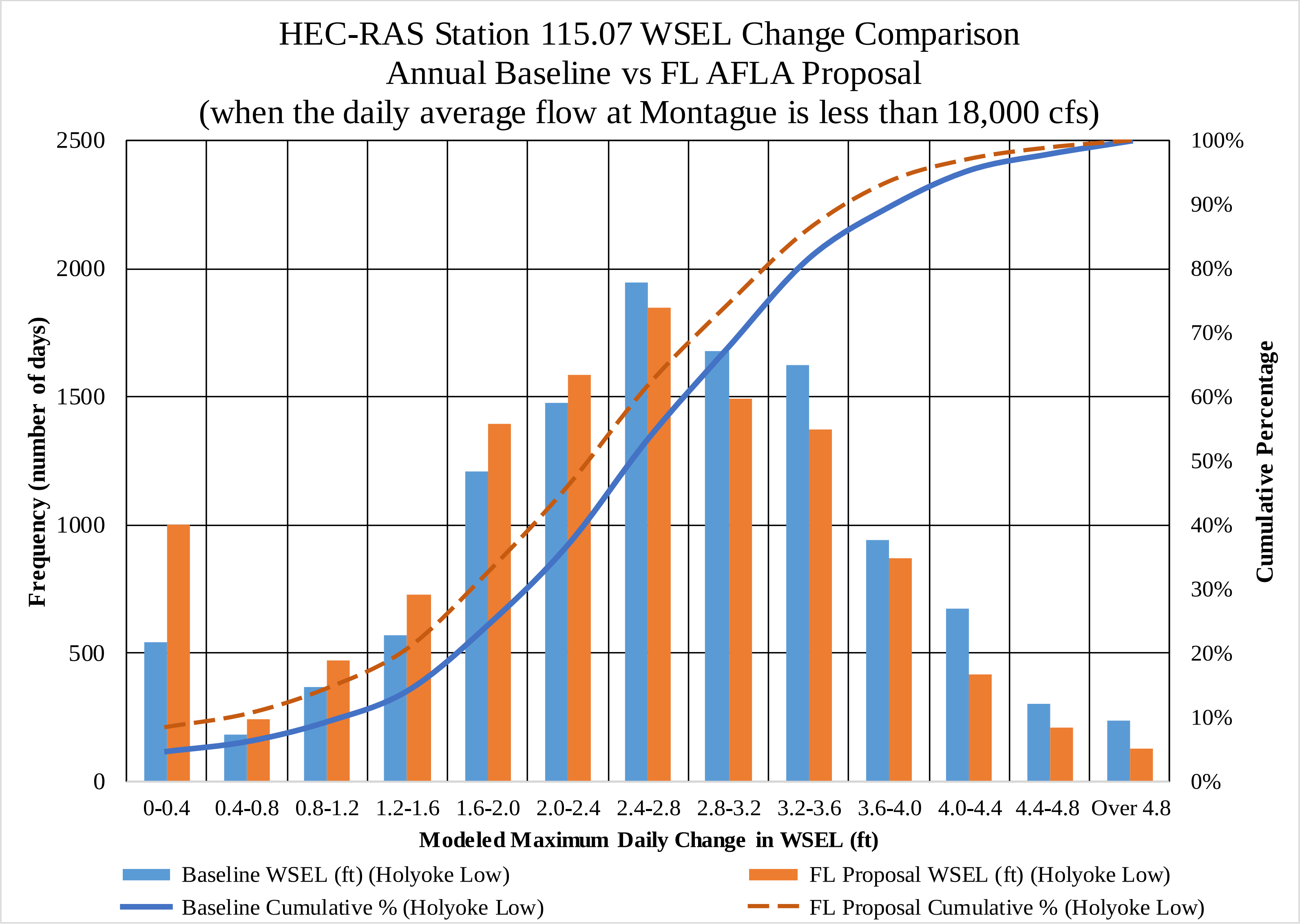

Figure 3.3.2.2.1-16: Annual WSEL Histograms and Duration Curves HEC-RAS Station 115.07

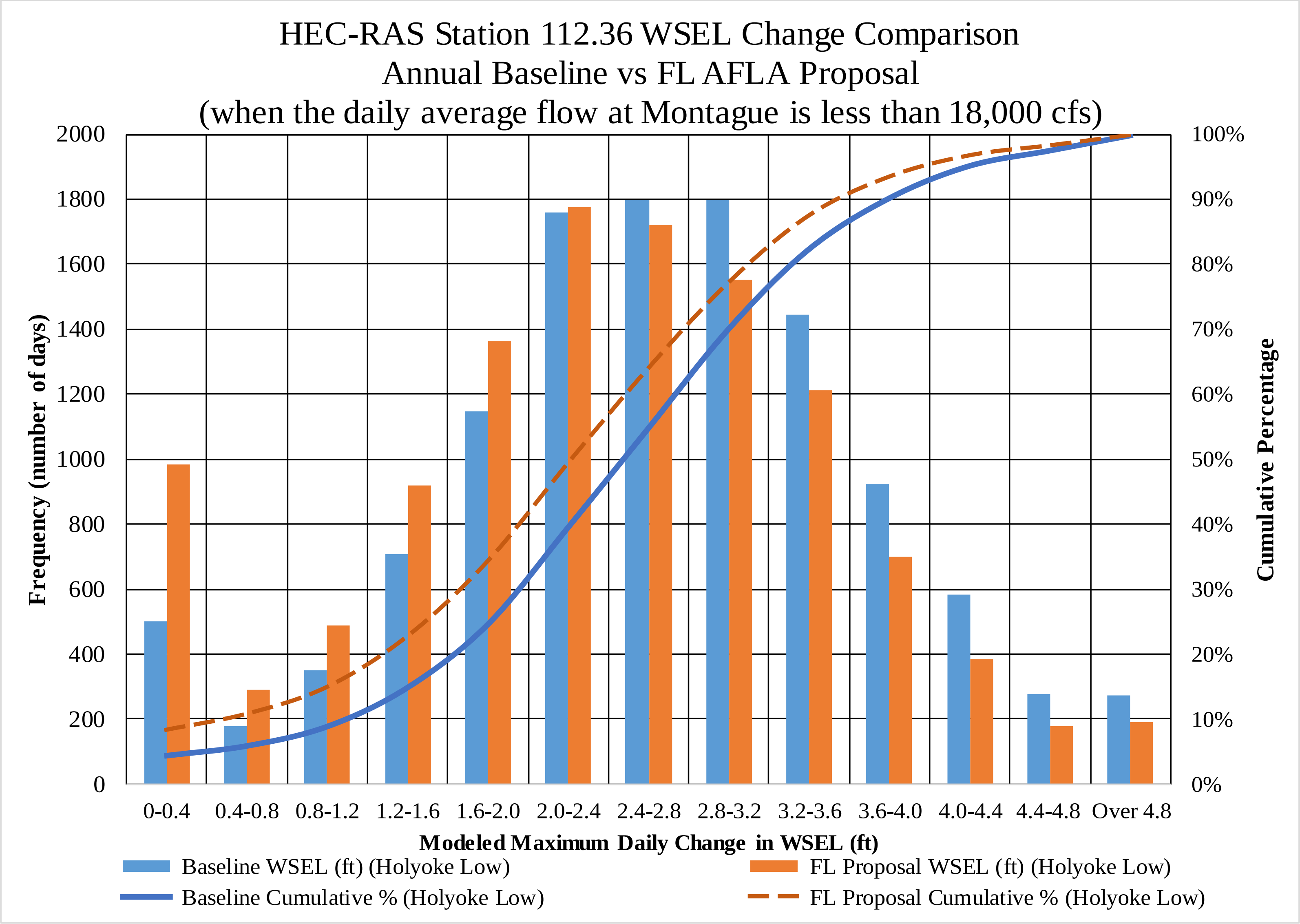

Figure 3.3.2.2.1-17: Annual WSEL Histograms and Duration Curves HEC-RAS Station 112.36

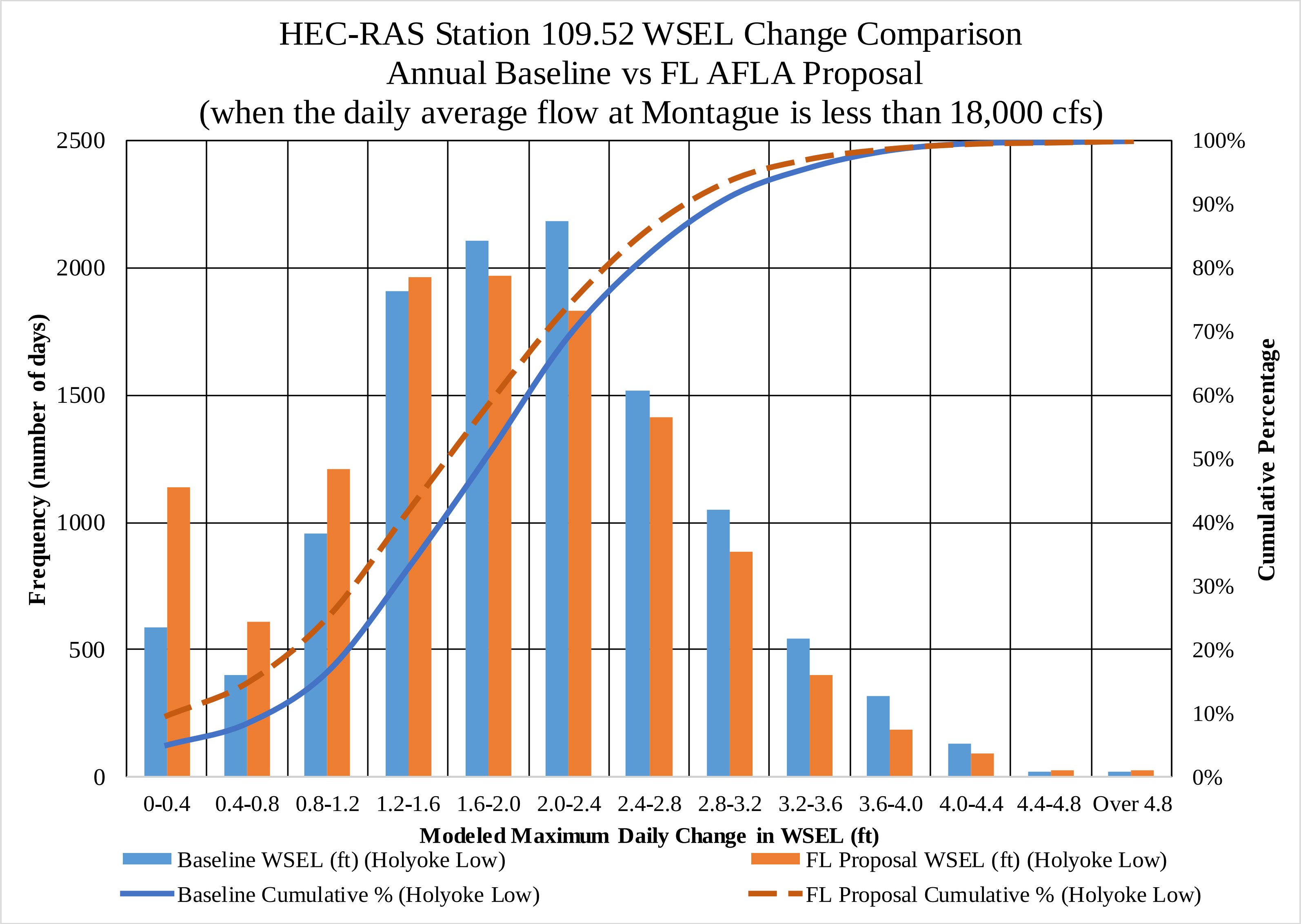

Figure 3.3.2.2.1-18: Annual WSEL Histograms and Duration Curves HEC-RAS Station 109.52

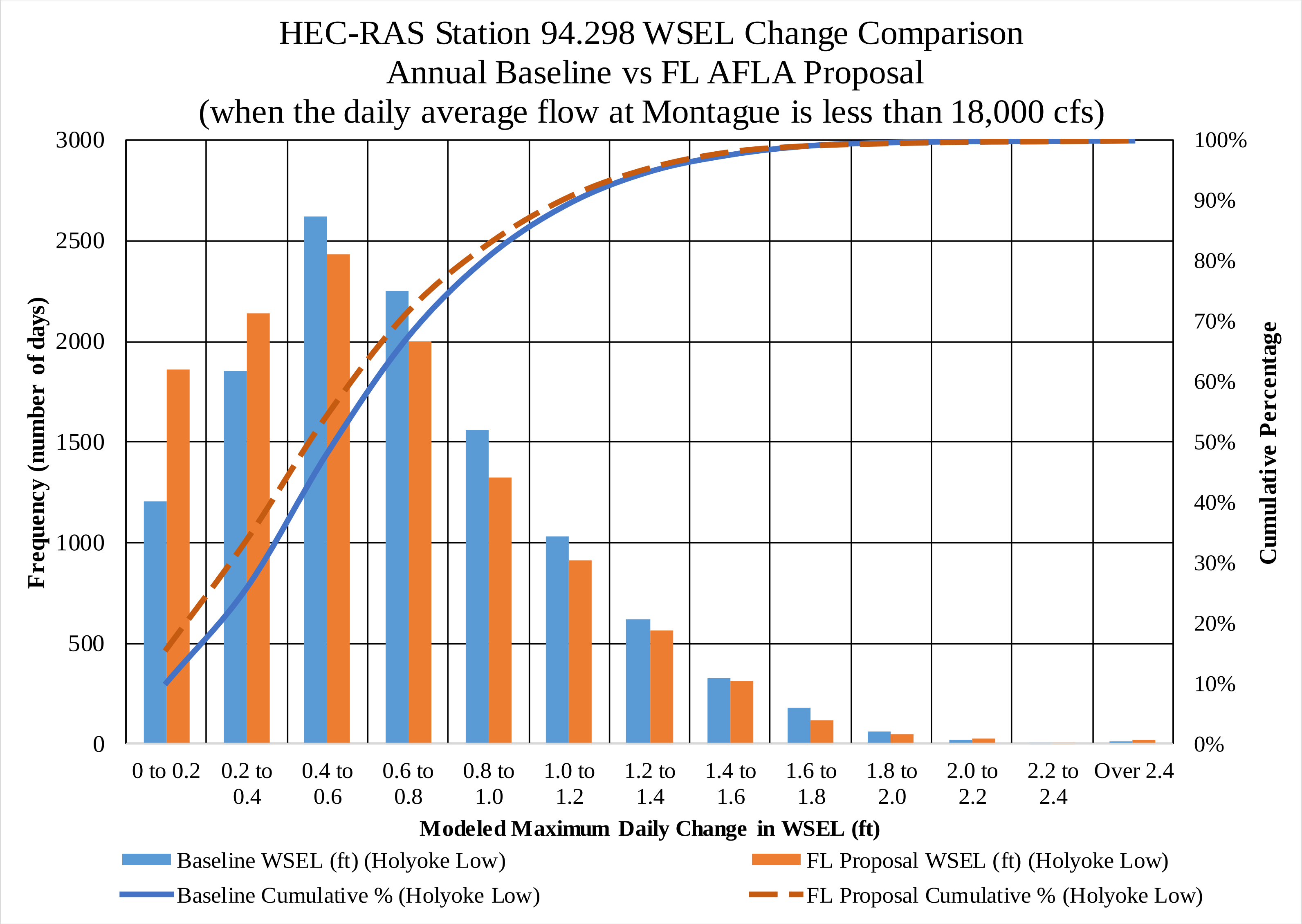

Figure 3.3.2.2.1-19: Annual WSEL Histograms and Duration Curves HEC-RAS Station 94.298 Rainbow Beach