RELICENSING STUDY 3.1.1

2013 FULL RIVER RECONNAISSANCE

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

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EXECUTIVE SUMMARY

Background

The Connecticut River as it flows in a southerly direction, through New England, and into Long Island Sound passes through a number of impoundments formed by dams, many of which are relatively low-head hydropower facilities. One such impoundment is the Turners Falls Impoundment (the Impoundment) which extends approximately 20 miles in length through Vermont, New Hampshire, and Massachusetts. The Impoundment begins in the north at the Vernon Dam in Vernon, VT and ends in the south at the Turners Falls Dam in Montague, MA.

The Connecticut River is primarily an alluvial river which formed after the end of the most recent ice age (approximately 15,000 years before present). At the end of the ice age, Lake Hitchcock formed and inundated much of the extent of the valley ultimately evolving into a river through erosional processes. During these processes the water in the lake broke through natural dams and incised through lake deposits which now form terraces along significant portions of the Connecticut River. The construction of a series of dams over time along the Connecticut River has raised the level of the river incrementally. Although the water level has been raised as a result of these dams it still remains below the terrace level (except in extreme flood events) through much of its length, including through the Turners Falls Impoundment.

The Impoundment provides a wide variety of uses including hydropower generation, agriculture, and recreation. Land-use adjacent to the Impoundment is primarily agriculture or forested with some development in select areas. Due to a variety of factors including the geomorphic and geologic composition of the Impoundment, hydrologic and hydraulic conditions, adjacent land-use, and various Impoundment uses erosion has been a concern of landowners, adjacent municipalities, and various stakeholder groups for decades.

In the late 1970s, the U.S. Army Corps of Engineers (USACE) commissioned a study of erosion along approximately 140 miles of the Connecticut River extending from Turners Falls Dam upstream through the Wilder Impoundment that documented erosion sites along the river and analyzed the causes of erosion (USACE, 1979). Experimental bank protection methods were employed and constructed in the 1970's by the USACE to stabilize riverbanks in the Impoundment along a short reach downstream of the Route 10 Bridge. Additionally during this time, other reaches of the Impoundment were lined with rip-rap using rock from the construction of the Northfield Mountain hydropower project to further protect riverbanks in the vicinity of the tailrace.

Additional studies of erosion were conducted in the 1990s culminating in the development of the Erosion Control Plan (ECP) in 1998 (Simons, 1999). As part of the ECP a reconnaissance survey of the length of the Impoundment riverbanks was conducted to identify and rank erosion sites. From this survey, a list of the 20 most severely eroded sites was developed. Following completion of this list the Northfield Mountain Project began to stabilize these sites using bio-engineering techniques. The 1998 list of sites has served as the basis for the construction of 18,150 linear feet of stabilization efforts from 1999 through 2014.

As of the 2013 FRR, 15 of the 20 sites identified in 1998 have been stabilized utilizing a range of bio-engineering techniques. In general, these projects have succeeded in meeting the objectives of the ECP by stabilizing eroding slopes, protecting adjacent property, and reducing sediment loading to the river. Of the 5 sites not stabilized, two are located in areas where extreme hydraulic conditions exist that are not Project related (just below Vernon Dam and just upstream of the Route 10 Bridge), one site is located on an island (island locations have typically not been as high a priority to repair as riverbank locations), and two other sites were not selected for stabilization based on feedback from stakeholders and landowners.

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

Over the past 15 years, Impoundment riverbank conditions with respect to erosion have improved. The 1998 FRR identified 3.4% of Impoundment riverbanks as being Severely eroded while the 2013 FRR found that only 0.6% of riverbanks were classified as having Extensive erosion.[1] The majority of the 20 most severely eroding sites identified in 1998 have successfully been treated, are now stable and supporting heavy vegetation, and have not experienced any significant erosion. Moreover, erosion sites in 1998 were quite large in magnitude and stark in appearance with very little vegetation and significant potential for ongoing erosion and sediment production. By contrast, in 2013 eroding sites were found to be generally smaller in magnitude with a greater degree of vegetation. In addition, based on the findings of the 2013 FRR it was observed that from 2008 to 2013 there has been an increase in riverbank stability, and therefore a corresponding decrease in eroding banks, of approximately 1.5%.

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

- *The segment of river with the greatest extent of eroding riverbanks is the un-impounded northern reach (Pittsburg, NH down to Gilman Dam). At the time of the available study (Field, 2004), 48.4% of the riverbanks were experiencing moderate or more significant erosion. Riverbanks that had been rip-rapped covered 17.1% of the length of the river.*[2]

- *Despite the fact that similar percentages of riverbank have been stabilized in the northern, free-flowing reach and in the Turners Falls Impoundment; the percentage of erosion in the Turners Falls Impoundment is only about one-third the extent of erosion that is occurring in the northern, un-impounded reach of the Connecticut River (16.7% compared to 48.4%).*

- *Several erosion sites were identified and photographed in the Bellows Falls, Vernon, Turners Falls, and Holyoke Impoundments in 1997. These erosion sites were photographed again in 2008. All of the erosion sites in 1997 in the Bellows Falls and Holyoke Impoundments, and all but one of the 1997 erosion sites in the Vernon Impoundment, remain in essentially the same state of erosion when photographed in 2008. Many of these sties are significant in both size and severity. In contrast, most of the erosion sites in the Turners Falls Impoundment in 1998 have been stabilized and are no longer eroding as of 2008 (when previously identified erosion sites were re-photographed in 3 impoundments and when the most recent FRR was conducted in the Turners Falls Impoundment), with several additional erosion sites scheduled to be stabilized as part of the*

[1] 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.
[2] The study reach along the Connecticut River from Pittsburg, NH to Gilman Dam is 85 miles.

"Erosion Control Plan for the Turners Falls Pool of the Connecticut River" (1998, Simons & Associates) by 2012.

- *In addition to the direct stabilization of many of the erosion sites in the Turners Falls Impoundment that were identified in the 1998 Erosion Control Plan (ECP), there is evidence of some natural stabilization processes including increased upper bank vegetation and areas of dense low bank aquatic vegetation that are helping provide a degree of additional stability in some areas.*

- *Based on the state of erosion in the northern un-impounded reach as well as the state of continued erosion in the Bellows Falls, Vernon and Holyoke impoundments it can be concluded that the riverbanks in the Turners Falls Impoundment are in the best condition (more stable and less eroding) than in any other part of the Connecticut River.*

2013 Full River Reconnaissance - Overview

FirstLight Hydro Generating Company (FirstLight), a subsidiary of GDF SUEZ North America, Inc., is required by the Federal Energy Regulatory Commission (FERC or the Commission) to conduct a Full River Reconnaissance (FRR) study every 3-5 years in accordance with the current license requirements of the Northfield Mountain Pumped Storage (Northfield Mountain) and Turners Falls Hydroelectric Projects (collectively referred to as the Project) as well as the ECP (Simons, 1999). Due to the impending Project relicensing effort, as well as the timing of the 2013 FRR, FERC contacted FirstLight and indicated that the 2013 FRR should be folded into the relicensing studies. In accordance with this request, FirstLight incorporated the 2013 FRR into its Revised Study Plan (RSP) as Study No. 3.1.1 *Full River Reconnaissance* (FirstLight, 2013). The methodology and scope defined in this study were approved with modifications by FERC in their Study Plan Determination Letter (SPDL)(FERC, 2013) issued September 13, 2013.[3] In addition, FirstLight consulted with, and sought approval from, the Massachusetts Department of Environmental Protection (MADEP) regarding the methodology and personnel conducting this study. The MADEP approved this study following a meeting at the Northfield Visitors Center on November 4, 2013.

The main field components of the FRR included: 1) land-use mapping; 2) sensitive receptor mapping; 3) evaluation of past bank stabilization projects; 4) land-based survey; and 5) boat-based survey. The goal of the land- and boat-based surveys was to identify and define riverbank features and characteristics as well as various erosion features throughout the Turners Falls Impoundment (the Impoundment) from the Vernon Hydroelectric Project in Vernon, VT to the Turners Falls Dam in Montague, MA. Field work for the 2013 FRR was conducted throughout the summer-early winter of 2013. Land-use and sensitive receptor mapping were conducted during the late summer and fall of 2013. Land- and boat-based surveys, including evaluation of past bank stabilization projects, were conducted November 11-19, 2013. Land-based survey work continued December 10-12, 2013 and in 2014 on May 7-9, June 4th and June 10th. An evaluation of the permanent, existing transects located throughout the Impoundment was also conducted as part of the land- and boat-based surveys.

Personnel who participated in FRR field efforts included a fluvial geomorphologist/hydraulic engineer and a geotechnical engineer as called for in the RSP (FirstLight, 2013). Additional personnel included a wildlife biologist and environmental scientist/bank restoration design and permitting specialist as well as various support staff. All personnel were approved by MADEP in advance of field efforts.

[3] FERC recommended that FirstLight include an analysis of operational changes through the period 1999 to 2013 to identify any correlation between operational changes and observed changes in erosion rates. However, FERC indicated that this analysis should be conducted as part of Study No. 3.1.2- *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability*.

Geo-referenced video and geo-tagged photographs were captured at each riverbank segment in order to document riverbank conditions as they were in November 2013. In addition riverbank features and characteristics, land-use, sensitive receptors, and stabilization projects observed during the 2013 FRR were developed into maps in ArcGIS. The maps are included in the report and accompanying appendices. Geo-referenced photos and videos are included in digital Appendix K.

Overall, field conditions were favorable throughout the 2013 FRR allowing field work to progress without issue. Flow conditions during the survey were generally less than the long-term median flows for these dates. Due to these low flows, the lower riverbanks were generally visible during the course of the survey. Hydropower operations throughout the Impoundment followed a typical peaking power generation mode resulting in fluctuating flows and water levels on an hourly basis. Additionally, the majority of the trees located along the riverbanks had lost their leaves by the time of the survey allowing for good visibility of riverbank conditions. Weather conditions were also favorable with essentially no precipitation during daylight hours.

The boat-based survey identified and recorded the coordinates of the start and end points of riverbank segments based on common riverbank features, characteristics, and erosion conditions as defined in the RSP (FirstLight, 2013). All riverbanks throughout the Impoundment, including islands, were assessed during the survey with the exception of the right-channel of the island just downstream of Vernon Dam which was inaccessible due to low flows. Although not accessible by boat, this area was surveyed by land. Due to the fact that the boat-based survey provided the best vantage point and perspective of the entire riverbank (i.e. upper and lower bank) the findings of the boat-based survey were used as the primary data source when establishing riverbank segments and developing summary statistics.

The 2013 boat-based survey resulted in delineation of 641 total riverbank segments including islands. Of the 641 segments, 596 segments totaling 228,009 feet (ft) were located on riverbanks with an additional 45 segments on islands. Segment lengths ranged from 13 ft to 3,330 ft with an average river segment length of 383 ft. The minimum and maximum segment lengths for previous FRRs ranged from 20 to over 4,000 ft with average segment lengths ranging from 480 to 1,267. The segment lengths for the 2013 FRR are shorter than all previous FRRs by a significant percentage in all statistical categories resulting in more detailed spatial data.

The land-based survey, conducted simultaneously with the boat-based survey as per MADEP request, identified and defined indicators of potential erosion and bank instability as well as erosion features that may not have been visible from a boat. Land-based segments were delineated and defined based on features and characteristics observed while traversing the top of the bank throughout the entire Impoundment, including islands. The land-based survey included all riverbanks and islands in the Impoundment except in areas where: 1) access was not possible or the area was deemed impassible; 2) access was unsafe; or 3) bank conditions did not warrant assessment (e.g. bedrock areas). Detailed geotechnical and geomorphic assessments, including field notes, sketches, and photographs, were also conducted at areas of interest as noted by the fluvial geomorphologist and geotechnical engineer. Overall a total of 38 detailed assessments were conducted. Observations made during the land-based survey were used to complement the findings of the boat-based survey and provide supplemental information and perspective to the overall assessment of Impoundment riverbanks.

Results

The results of the 2013 FRR indicated that the majority of the upper riverbanks in the Impoundment 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 Impoundment were found to be generally stable with None/Little current erosion occurring through much of this reach. As noted in the report, 84.8% of the total length of the Impoundment riverbanks were found to have None/Little erosion, 14.1% Some erosion, 0.5% Some to Extensive erosion, and 0.6% Extensive erosion. Furthermore, 5.5% of the total length of Impoundment 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.

The previous FRR conducted in 2008 showed that 83.3% of the riverbanks were experiencing little to no erosion, 16.1% of riverbanks experiencing some amount of erosion at that time, and an additional 0.6% classified as having extensive erosion. Based on the findings of the 2013 FRR it was observed that from 2008 to 2013 there has been an increase in riverbank stability and therefore a corresponding decrease in eroding banks of approximately 1.5%. The comparison of 2008 and 2013 FRR results illustrates that through natural processes of vegetation recruitment and growth and ongoing stabilization work as required by the ECP repair work is more than keeping pace with the rate of erosion.

Bank Stabilization/Preventative Maintenance Site Recommendations

The table found below presents the list of recommended sites for preventative maintenance or bank stabilization based on the results of the 2013 FRR. The sites recommended in this table represent projects that can be reasonably completed prior to the expiration of the current FERC license (set to expire April 2018) while still meeting the objectives and goals of the ECP. Recommended sites include the requested repair of the Shearer site which has experienced some undercutting of the bank above the rock toe and Camps 4E, 3E and 2W where structures are affected or potentially affected by erosion. The remaining sites were selected at eroded or eroding areas as observed during the 2013 FRR.

The recommended list of future bank stabilization/preventative maintenance sites (Phase IV projects) will undergo additional evaluation during the detailed environmental, historic, geotechnical, and engineering review required for permitting and construction. Pre-permitting discussions and consultation with regulatory agencies and stakeholders will be conducted to discuss permitting, design, and site specific issues before proceeding with permit applications for construction.

In addition to identifying sites which are recommended for future restoration, this report contains an analysis of past bank restoration and preventative maintenance efforts and recommendations for future stabilization techniques. Recommendations for future restoration techniques follow the trend of using "softer" soil bioengineering bank stabilization methods. These methods could include using large woody debris to trap sediment and/or planting native vegetation rather than heavy machinery for bank reshaping.

Recommended Bank Stabilization/Preventative Maintenance Sites

Year of Construction	Location/Name[4]	River Station (ft)	Length (ft)
2014	Shearer (89)	311+00 to 321+00	1060
2015	Camps 4E & 3E	108+00 & 88+00	100 &120: 220
2016	Camp 2W (387, 388)	132+00 to 137+00	500
2017	70, 75, 77 12-13 (Montague)	268+00, 270+00 & 273+00 67+00	105, 33 & 154 280, 580

[4] Location numbers represent boat-based segments identified during the 2013 FRR. Figures denoting the location of each boat-based segment can be found in Appendix G.

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LIST OF ABBREVIATIONS

µl/l	Microliters per liter
cfs	cubic feet per second
CRSEC	Connecticut River Streambank Erosion Committee
CRWC	Connecticut River Watershed Council
CT	Connecticut
DPW	Department of Public Works
ECP	Erosion Control Plan
ESRI	Environmental Systems Research Institute
°F	Degree Fahrenheit
ft	feet
FERC	Federal Energy Regulatory Commission
FGS	Field Geology Services
FirstLight	FirstLight Hydro Generating Company
FRCOG	Franklin Regional Council of Governments
FRR	Full River Reconnaissance
G&S	Gomez and Sullivan Engineers, D.P.C.
GB	Gigabyte
g/cm^3	Grams per cubic centimeter
GIS	Geographic Information Systems
GPS	Global Positioning System
HEC-RAS	Hydrologic Engineering Center River Analysis System
ILP	Integrated Licensing Process
MA	Massachusetts
MADCR	Massachusetts Department of Conservation and Recreation
MADEP	Massachusetts Department of Environmental Protection
MassGIS	Massachusetts Office of Geographic Information
MESA	Massachusetts Endangered Species Act
mg/l	Milligrams per liter
mi^2	Square mile
NEE	New England Environmental, Inc.
NH	New Hampshire
NHDES	New Hampshire Department of Environmental Science
NOI	Notice of Intent
Northfield Mountain	Northfield Mountain Pumped Storage Hydroelectric Project
NRCS	Natural Resources Conservation Service
O&M	Operation and Maintenance
PAD	Pre-Application Document
PE	Professional Engineer
PM	Preventative Maintenance
PSP	Proposed Study Plan
PWS	Professional Wetland Scientist
QAPP	Quality Assurance Project Plan
RSP	Revised Study Plan
Rt	Route
S&A	Simons & Associates
SD1	Scoping Document 1
SD2	Scoping Document 2
SPDL	Study Plan Determination Letter
SSC	Suspended Sediment Concentration

the Commission	Federal Energy Regulatory Commission
the Impoundment	Turners Falls Impoundment
the Project	Northfield Mountain Pumped Storage and Turners Falls Hydroelectric Projects
TRM	Turf Reinforcement Mat
USGS	United States Geological Survey
USACE	United States Army Corps of Engineers
VCGI	Vermont Center for Geographic Information
Vernon	Vernon Hydroelectric Project
VT	Vermont
VTDEC	Vermont Department of Environmental Conservation
VY	Vermont Yankee Nuclear Power Plant

1 INTRODUCTION

FirstLight Hydro Generating Company (FirstLight), a subsidiary of GDF SUEZ North America, Inc., is the current licensee of the Northfield Mountain Pumped Storage Project (FERC No. 2485) and the Turners Falls Hydroelectric Project (FERC No. 1889). FirstLight is required by FERC to conduct a Full River Reconnaissance (FRR) every 3-5 years in accordance with Project license requirements and the Northfield Mountain Erosion Control Plan (ECP)(Simons, 1999).

FirstLight has initiated with the Federal Energy Regulatory Commission (FERC, the Commission) the process of relicensing the two Projects using FERC's Integrated Licensing Process (ILP). The current licenses for the Northfield Mountain and Turners Falls Projects were issued on May 14, 1968 and May 5, 1980, respectively, with both set to expire on April 30, 2018. This report documents the results of the FRR, which was conducted in conjunction with the relicensing of the two projects.

As part of the ILP, FERC conducted a public scoping process during which various resource issues were identified. On October 31, 2012, FirstLight filed its Pre-Application Document (PAD) and Notice of Intent (NOI) with FERC. The PAD included FirstLight's preliminary list of proposed studies. On December 21, 2012, FERC issued Scoping Document 1 (SD1) and preliminarily identified resource issues and concerns. On January 30 and 31, 2013, FERC held scoping meetings for the two Projects. FERC issued Scoping Document 2 (SD2) on April 15, 2013.

FirstLight filed its Proposed Study Plan (PSP) on April 15, 2013 and, per the Commission regulations, held a PSP meeting at the Northfield Visitors Center on May 14, 2013. Thereafter, FirstLight held ten resource-specific study plan meetings to allow for more detailed discussions on each PSP and on studies not being proposed.[5] On June 28, 2013, FirstLight filed with the Commission an Updated PSP to reflect further changes to the PSP based on comments received at the meetings. On or before July 15, 2013, stakeholders filed written comments on the Updated PSP. FirstLight filed a Revised Study Plan (RSP) on August 14, 2013 with FERC addressing stakeholder comments. Included in the RSP was Study No. 3.1.1 *Full River Reconnaissance*. The methodology and scope for the 2013 FRR outlined in the RSP was approved with modification by the Commission in its September 13, 2013 SPDL (FERC, 2013).[6]

In addition, FirstLight consulted with, and sought approval from, the Massachusetts Department of Environmental Protection (MADEP) regarding the methodology and personnel conducting this study prior to field efforts commencing. The MADEP approved this study following a meeting at the Northfield Visitors Center on November 4, 2013. A consultation record of correspondence and meetings related to this study can be found in Appendix A.

The goal of the 2013 FRR was to identify and define, at a reconnaissance level, riverbank features and characteristics as well as the types, stages, indicators, and extent of erosion throughout the Turners Falls Impoundment (the Impoundment) without reference to the cause of erosion. Specific objectives of this survey included:

- Conducting a land-based investigation of the riverbanks and islands to document indicators of potential erosion and potential bank instability;

[5] The ten meetings were held on May 14, 15, 21, and 22, and June 4, 5, 11, 12, and 14 and August 8.
[6] FERC recommended that FirstLight include an analysis of operational changes through the period 1999 to 2013 to identify any correlation between operational changes and observed changes in erosion rates. However, FERC indicated that this analysis should be conducted as part of Study No. 3.1.2- *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability*.

- Identification of land-use practices within 200 feet of the riverbank and islands from Turners Falls Dam to Vernon Dam;

- Identification and definition of riverbank features and characteristics such as bank slope, height, sediment composition, and vegetation using clearly defined, and easily repeatable, classification techniques;

- Identification and definition of the type, stage, indicators, and extent of erosion in the Impoundment using clearly defined, and easily repeatable, classification techniques;

- Identification and mapping of the location(s) of sensitive receptors, including important wildlife habitat, along the riverbanks and islands of the impoundment;

- Spatially identifying, using a global positioning system (GPS), the transition points where riverbank features or characteristics change from one classification to another;

- Creation of geo-referenced video and photographic documentation of all riverbanks classified throughout the Impoundment. In addition, reproduction of the photo log used by Field Geology Services (FGS) as part of the report titled "*Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT*" (Field, 2007);

- Evaluation of past bank stabilization projects and recommendations for future projects based on the results of the FRR;

- Evaluation of the features identified in the field including, but not limited to: distribution and summary statistics, assessment of changes in riverbank conditions in context of the "*Erosion Control Plan for the Turners Falls Pool of the Connecticut River*" (ECP) (Simons, 1999), and evaluation of the changes in riverbank conditions since previous FRRs;

- Creation of various maps and geospatial datasets based on the information gathered in the field, including, but not limited to: riverbank features and characteristics, erosion type, erosion stage, extent of current erosion, potential bank instability, land-use, and riverbank stabilization site locations (current and recommended); and

- Development of a final report describing and summarizing the findings of the 2013 FRR including all data evaluation, mapping, and field documentation.

The 2013 FRR was a reconnaissance level riverbank survey which spanned the entire Impoundment from the Vernon Hydroelectric Project in Vernon, VT to the Turners Falls Dam in Montague, MA. The main field components of the FRR consisted of land- and boat-based surveys of riverbank features and characteristics, classification of land-uses adjacent to riverbanks, identification of sensitive receptor locations, and evaluation of existing bank stabilization efforts. Field work for the 2013 FRR was conducted during the summer-early winter of 2013 with supplemental data collection in 2014. Classification of adjacent riverbank land-use and mapping of sensitive receptor locations was conducted during the late summer and fall of 2013. Land- and boat-based surveys, including evaluation of past bank stabilization projects, were conducted on November 11-19 while land-based survey work continued December 10-12, 2013. Land-use classifications and sensitive receptor locations were validated and updated, if necessary, during the land-based survey. Several small segments of the land-based assessment were not completed before the onset of winter weather conditions. These locations were revisited on May 7-9, 2014, June 4, and June 10, 2014.

Personnel who participated in the survey included a fluvial geomorphologist/hydraulic engineer, geotechnical engineer, wildlife biologist, environmental scientist/bank restoration design and permitting specialist, and various support staff. Specific personnel who conducted the land- and boat-based surveys included:

- Robert Simons, PhD, PE (S&A, Project Director, Fluvial Geomorphologist and Hydraulic Engineer),
- Mickey Marcus, PWS (NEE, Project Manager, Senior Scientist),
- Kit Choi, PhD, PE (Geotechnical Engineer),
- Andrew Simon, PhD (Cardno ENTRIX, Fluvial Geomorphologist),
- Natasha Bankhead, PhD (Cardno ENTRIX),
- Christin McDonough (NEE, Wildlife Biologist),
- Gregg Simons (S&A, Hydraulic Engineer), and
- Sean Werle, PhD (NEE, Environmental Scientist).

All personnel listed above were approved by MADEP in advance of field efforts. Charles Momnie (FirstLight), John Howard (FirstLight), and Tim Sullivan (Gomez and Sullivan) were also present for portions of the field efforts.

Field conditions were favorable for the duration of the study allowing for field work to progress without issue. Flow conditions during the survey were generally less than the long-term median flows for these dates allowing for the lower riverbanks to be generally visible during the course of the survey. Hydropower operations throughout and just upstream of the Impoundment followed a typical peaking power generation mode resulting in fluctuating flows and water levels on an hourly basis. Additionally, the majority of the trees located along the riverbanks had lost their leaves by the time of the survey allowing for good visibility of riverbank conditions. Weather conditions were also favorable with essentially no precipitation during daylight hours.

Discussion pertaining to the specific methodology used, results and analysis, field collected data and maps, a summary of existing bank stabilization sites, and recommendations for future stabilization are found in the ensuing sections and appendices.

2 SUMMARY OF FIELD CONDITIONS

Although field work associated with the FRR was conducted throughout the late summer-winter of 2013 (with some follow up work in the spring 2014), the majority of the survey was conducted from November 11-19 and December 10-13, 2013. Weather conditions during this time ranged from temperatures in the teens to the 40's (°F) with generally no significant precipitation. The majority of the trees located along the riverbanks had lost their leaves by the time of the survey allowing for good visibility of riverbank conditions. Hydropower operations throughout and just upstream of the Impoundment followed a typical peaking power generation mode resulting in fluctuating flows and water levels on an hourly basis. Additional information on flow and water level conditions encountered during the survey is included below.

Flow Conditions in the Connecticut River

Flow conditions during the survey were generally less than the long term median flows for these dates. US Geological Survey (USGS) gages on the Connecticut River at North Walpole, NH and Montague, MA were referenced to provide flow and water level data for this period. The Walpole, NH gage (Gage No. 01154500) has a drainage area of 5,493 square miles (mi^2) and is located below the Bellows Falls Dam and upstream of the Vernon Hydroelectric Project (Vernon) Impoundment.[7] The Montague, MA gage (Gage No. 01170500) has a drainage area of 7,860 mi^2 and is located just below the Deerfield River confluence.

The mean flows as recorded at these two gages for the period November 11-19, 2013 and December 10-13, 2013 are compared to the full period of record in Table 2.1. As shown in the table, flows were below the average during the data collection period. Furthermore, the median daily flows for the dates when field work was conducted, based on 70 years of data at North Walpole, NH and 108 years of data at Montague, MA, are shown in Appendix B. The median daily flow values shown on the USGS flow hydrographs are found to be within the range of flows experienced during the 2013 FRR field work.

Flow and Water Elevation Conditions in the Impoundment

In addition to the USGS gages, TransCanada (owner and operator of Vernon) provides FirstLight with hourly discharge data from the Vernon Project. Discharge released from Vernon Dam for November 11-19, 2013 is presented in Figure 2.1 while discharge for December 10-12, 2013 is presented in Figure 2.2. For both time periods the discharge released from Vernon Dam fluctuated between approximately 2,000 and 12,000 cfs in the typical pattern of peaking power generation.

Water surface elevations as recorded at the Turners Falls Dam during the data collection period are shown in Figure 2.4 (November 11-19 period of data collection) and Figure 2.5 (December 10-12 period of data collection). As shown in these figures, Impoundment water surface elevations generally fluctuated between elevation 179 ft and 184 ft during the field data collection period. This range of fluctuation is representative of the range of fluctuations observed over the last 10 years. In general, flow and water levels encountered during the 2013 FRR field work were typical of the range of flows and water levels that occur when precipitation is relatively low during the fall.

[7] The Bellows Falls Dam and Hydroelectric Project is owned by TransCanada and is operated as a peaking facility, thus flows recorded at the Walpole gage will reflect hourly variability. Similarly, the Turners Falls Hydroelectric facility located just upstream of the Montague USGS gage operates as a peaking facility and thus flows recorded at the gage will reflect hourly variability. Also note the Deerfield River has several hydroelectric facilities that also operate as peaking facilities.

Table 2.1: Mean Flows at Connecticut River USGS Gages for period November 11-19 and December 10-13 for the full period of record and for 2013

Gage Name	Gage Period of Record	Drainage Area	Mean Flow During Data Collection Period (November 11-19 and December 10-13)		
			Full Period of Record	2013	Delta
Connecticut River at North Walpole, NH	1942-2013	5,493 mi^2	9,111 cfs	5,813 cfs	3,298 cfs
Connecticut River at Montague City, MA	1940-2013	7,860 mi^2	13,482 cfs	8,108 cfs	5,374 cfs

Figure 2.1 Vernon Dam Discharge, November 11-19, 2013

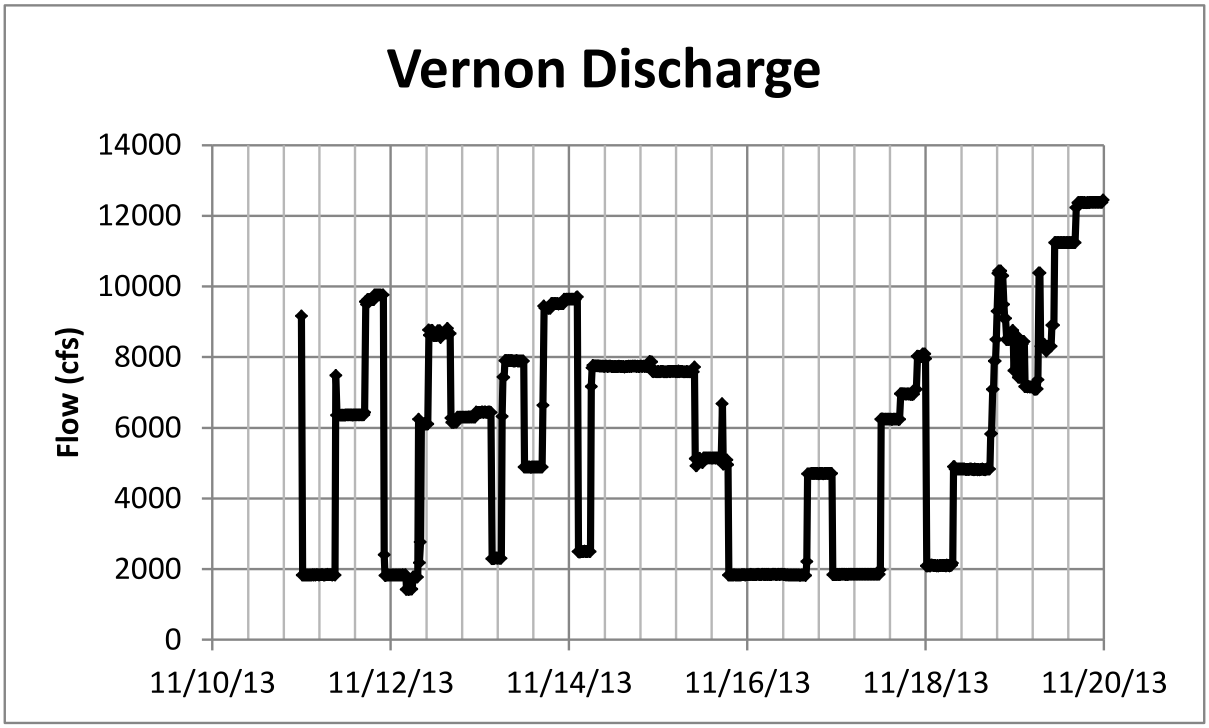


Figure 2.2 Vernon Dam Discharge, December 10-13, 2013

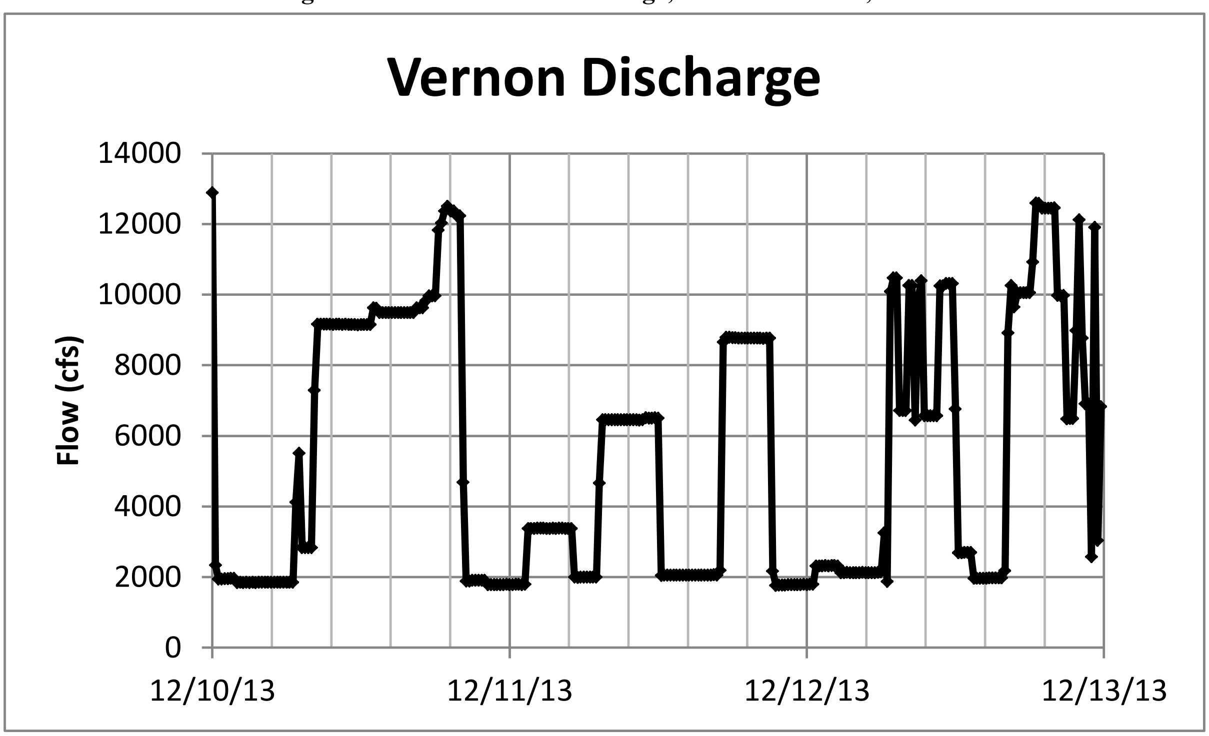


Figure 2.4 Water Surface Elevations, November 11-19, 2013[8]

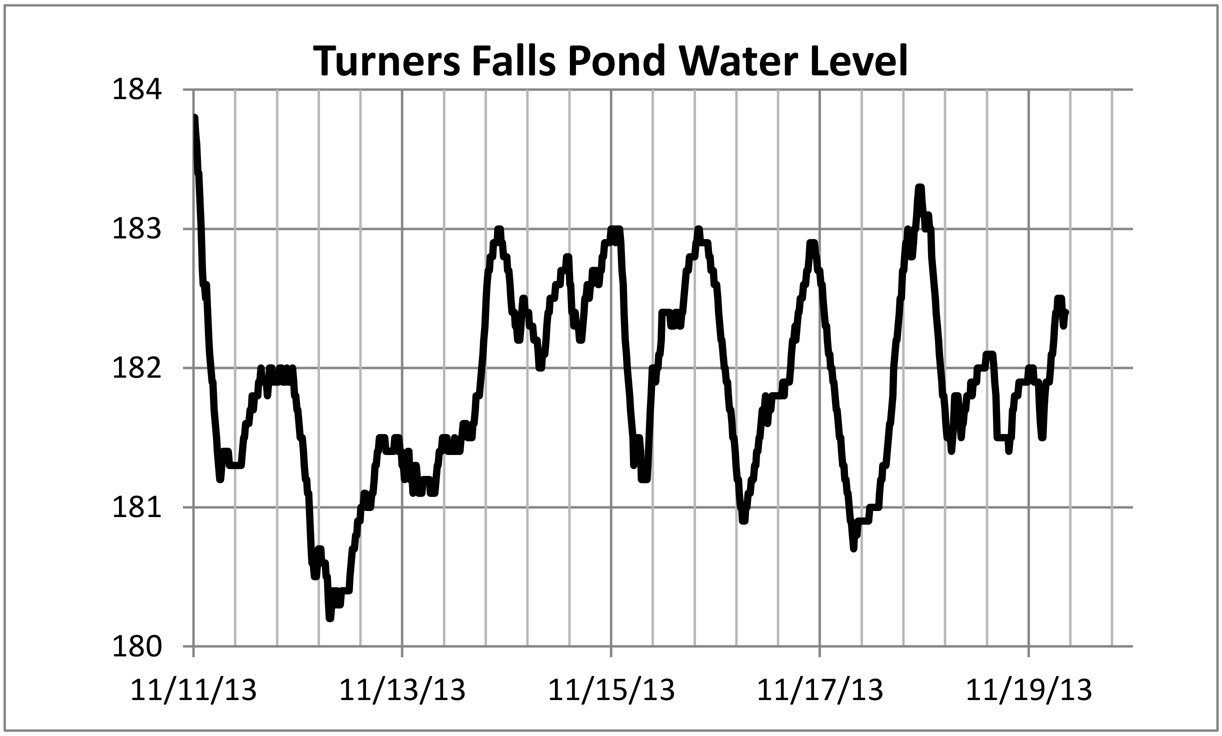
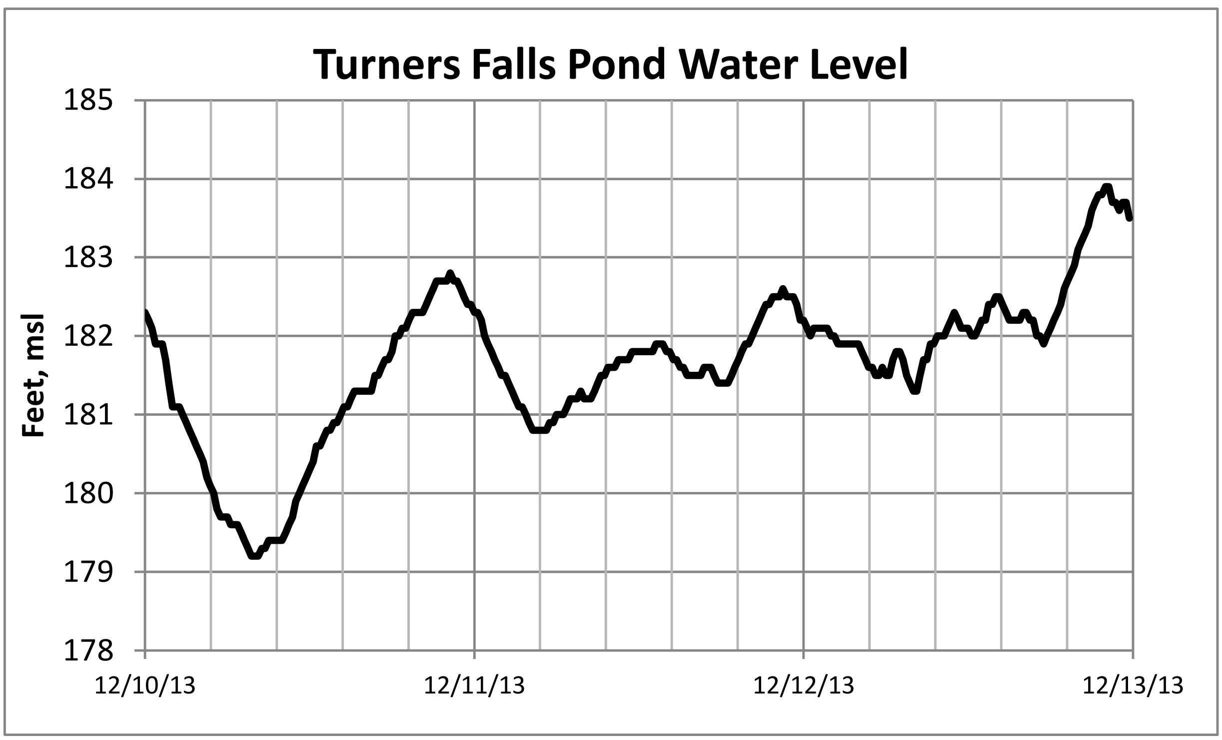


Figure 2.5 Water Surface Elevations, December 10-13, 2013[9]



[8] As measured at Turners Falls Dam
[9] As measured at Turners Falls Dam

3 SUPPORT DATA AND FIELD EQUIPMENT

Prior to initiation of field activities various resources and existing datasets were gathered to support FRR field efforts. Information gathered included: surficial geology maps, aerial photographs, land-use maps, sensitive receptor maps, riverbank classification reference guides, and detailed land- and boat-based data forms and data dictionaries. Digital and hardcopies of these datasets were present in the field throughout the survey. Descriptions of each support dataset can be found below.

In addition to the support datasets gathered, various field equipment were utilized to satisfy the objectives of the land- and boat-based surveys. Equipment utilized during these assessments included: a sub-meter GPS, data-logger, laser range-finder, GPS enabled Pentop field computer (loaded with field data forms), Red Hen Geo-referenced Videotaping System, and GPS enabled digital cameras. The combination of the various support datasets and field equipment allowed for accurate and efficient data collection by field personnel.

3.1 Support Data/Available Information

A summary of existing data used to support FRR field efforts is provided below.

Surficial Geology Maps

Surficial geology maps were obtained from the State of Vermont and from the USGS for the various quadrangles in New Hampshire and Massachusetts. These maps show a range of categories such as bedrock, glacial till, lake-bottom sediments, moraines, fluvial sands and gravels, recent alluvium, etc. GIS layers containing surficial geology information were also obtained for the study area. Examples of the surficial geology maps used during the course of this study are provided in Appendix C. Also included in Appendix C is an example of the USGS surficial geology legend (description of map units) using Hinsdale, NH as an example.

Aerial Photographs

Aerial photographs were obtained from Massachusetts, Vermont and New Hampshire GIS clearinghouses in advance of all field efforts. These photographs were loaded onto a Pentop computer to assist with the delineation of riverbank segments and identification of attributes during the land-based survey. In addition, aerial photographs of the study area are utilized as base layers for the various FRR maps contained in this report.

Land-use Maps

Maps of adjacent riverbank land-use located throughout the Impoundment were developed by NEE during the summer/fall of 2013 (Section 4). GIS based hard copy maps were developed from the information captured during the initial land-use inventory. These maps were kept with field personnel throughout the course of the land- and boat-based surveys as a reference when needed. Figures 4-1-4-5 provide examples of these maps. In addition, a GIS layer containing land-use classifications was loaded onto the Pentop computer for validation during the land-based survey.

Sensitive Receptors

The locations of sensitive receptors (i.e. important wildlife habitat located at or near the riverbank) were identified by NEE during the summer/fall of 2013 (Section 4). Maps depicting these locations were created in advance of the land- and boat-based survey. Hard copies of these maps were kept on hand by field personnel throughout the course of this study as a reference when needed. Figures 4-6-4-10 provide examples of these maps. In addition, a GIS layer containing the location of the previously collected sensitive receptors was loaded onto the Pentop computer for validation and updating, if needed, during the fall/winter 2013 field efforts.

Riverbank Classification Reference Guides

Hard copies of riverbank classification matrices, definition tables, and reference guides developed as part of the RSP (FirstLight, 2013) were kept on hand by field personnel throughout the duration of the study. Data dictionaries and field datasheets developed in advance of field efforts were also utilized in order to capture riverbank feature and characteristics attributes. Examples of these can be found in Section 5. In addition, riverbank classification photos contained in Appendix D of the 2013 Full River Reconnaissance Quality Assurance Project Plan (QAPP) (Simons, 2013) were referenced to assist in riverbank classification as needed. A copy of the QAPP can be found in Appendix D.

River Marker Stations

A river marker station GIS layer was developed to determine the general location of cross-sections, detailed study sites, or other areas of interest. Stations were developed for the length of the Impoundment based on distance in feet upstream from the Turners Falls Dam along a mid-channel path. Major stations were established every 1000 feet with minor stations established every 500 feet. The river marker stations follow the convention utilized in the available HEC-RAS hydraulic model where cross-sections were developed at 500 foot intervals throughout the length of the Impoundment. River marker stations are shown on the land-use, sensitive receptor, and other maps in following sections. Specific bank locations are referenced based on the adjacent river marker station and whether the location is on river Left or Right (as looking downstream).

4 LAND-USE AND SENSITIVE RECEPTOR MAPPING

Throughout the late summer and early fall of 2013 NEE developed a dataset containing land-use classifications adjacent to riverbanks and sensitive receptor locations throughout the Impoundment. The land-use and sensitive receptor datasets were then validated and updated, if needed, during the land- and boat-based surveys in November-December 2013.

4.1 Land-use mapping

Land-use practices within 200 ft of adjacent riverbanks throughout the Impoundment were identified and classified through a combination of desktop GIS analysis and field investigation/validation. In advance of field investigation, preliminary analysis of aerial photographs (2011) was conducted to: 1) determine the width of the riparian buffer; 2) develop a list of predetermined land-use categories that would be used during the field classification; and 3) identify other pertinent land-use information that would be useful during the field survey. Land-use GIS layers from the State of Massachusetts Geographic Information Systems Center (MassGIS) were also referenced to complement the preliminary analysis.

Following completion of preliminary analysis land-uses adjacent to Impoundment riverbanks were identified for an area of approximately 200 feet horizontally from the top of the slope. Land-use categories identified during this process included:

- Agriculture (intensive (e.g., row crops) and pasture/hay)
- Barren (little or no vegetation growth)
- Developed (houses or other impermeable land uses)
- Riparian Buffer Forest (statistics for different widths (0-25 ft, 25-50 ft, 50-100 ft, 100-200 ft, and >200 ft))
- Wetland (non-forested)
- Restored Banks
- Transportation (roads, bridges, railroad)

In addition, surficial geology and soils data were analyzed within the 200' buffer.

The preliminary land-use dataset was loaded onto the Pentop field computer and hard copy field maps were developed for field personnel to reference throughout the land-based survey. Land-use classifications were validated and updated during the land-based survey in November-December 2013. In addition, animal presence/activity and irrigation practices were noted at pertinent agricultural sites. Following completion of the land-based survey the land-use dataset was finalized.

The distribution of land-use categories identified throughout the Impoundment is found in Tables 4.1 through 4.4. Figures 4.1-4.5 provide examples of Impoundment land-use classification maps. Appendix E contains more detailed maps breaking down land-use classifications one step further (e.g., agricultural type, width of riparian buffer, surficial geology, etc.). Preliminary discussion pertaining to potential correlations between adjacent land-use and bank instability and erosion is discussed in Section 6. This topic will be investigated in greater detail during Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability.*

Table 4.1 Land-use distribution (200 ft horizontally from top of slope)[10]

Land-use	Acres	Percentage of Total
Cropland	275.1	26.3
Pasture	15.4	1.5
Barren	1.2	0.1
Developed	85.9	8.2
Transportation	21.7	2.1
Forest	631.0	60.3
Non-forested wetland	4.3	0.4
Restored	11.4	1.1

Table 4.2 Forested Riparian Buffer Widths (within 500 ft)

Width (ft)	Length (mi)	Percentage of Total
0-25	13.6	30.9
25-50	3.0	6.7
50-100	4.9	11.2
100-200	6.7	15.1
200-500	15.9	36.1

Table 4.3 Surficial Geology (within 200 ft)

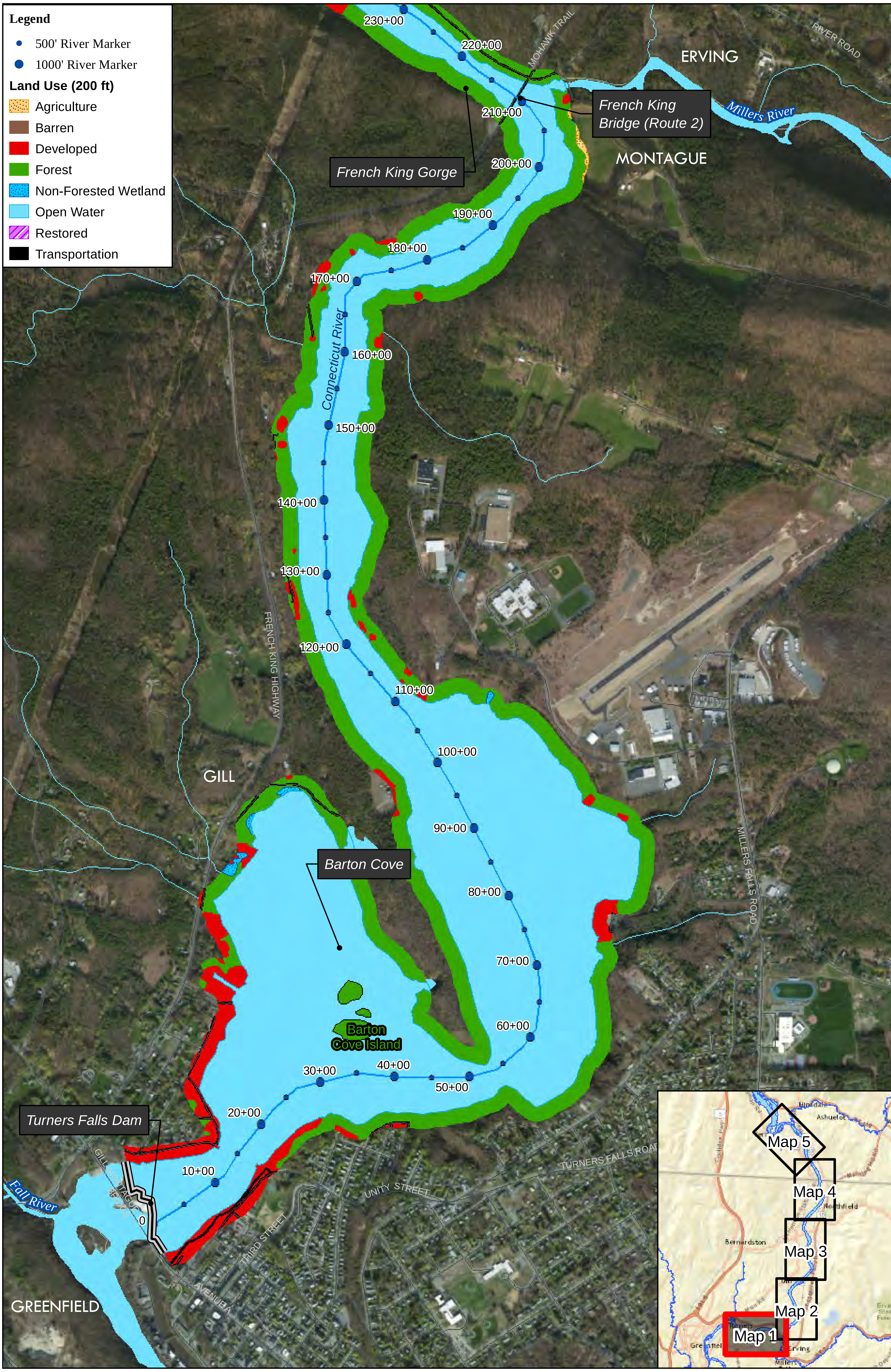
Width (ft)	Area (ac)	Percentage of Total
Postglacial Floodplain Alluvium Deposits	2,357	35.5
Glaciolacustrine Deposits (coarse, sand, pebbles)	2,103	31.7
Glaciolacustrine (well sorted, fine)	1,812	27.3
Swamp Deposits	5	0.1
Artificial Fill	31	0.5
Stream Terrace Deposits	105	1.6
Till or Bedrock	218	3.3

[10] Summary statistics do not take into account open water

Table 4.4 Soils (within 200 ft)[11]

Major Soil Type	Area (ac)	Percentage of Total
Agawam very fine sandy loam	44.51	1.4
Hadley very fine sandy loam	254	7.7
Hadley silt loam	94.07	2.9
Limerick silt loam	25.95	0.8
Occum fine sandy loam	42.78	1.3
Ondawa fine sandy loam	43.82	1.3
Poocham silt loam	86.24	2.6
Saco mucky silt loam	6	0.2
Scio silt loam	8	0.2
Suncook	30.26	0.9
Udorthents	119.85	3.7
Unadilla silt loam	36.31	1.1
Unadilla very fine sandy loam	25.52	0.8
Windsor and Merrimack	209	6.4
Windsor loamy fine sand	83.92	2.6
Winooski silt loam	22.67	0.7
Yalesville-Holyoke complex	56	1.7
Water	2,067.07	63.1
Other	22.31	0.7

[11] Soil classifications represent soils found in MA, VT, and NH. Summary statistics include islands, shallow portions of the river (including marshes or emergent shelves), and open water (MA and NH only).



FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Figure 4.1:
Land Use Classifications
within 200 ft of Connecticut River
Map 1

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan,

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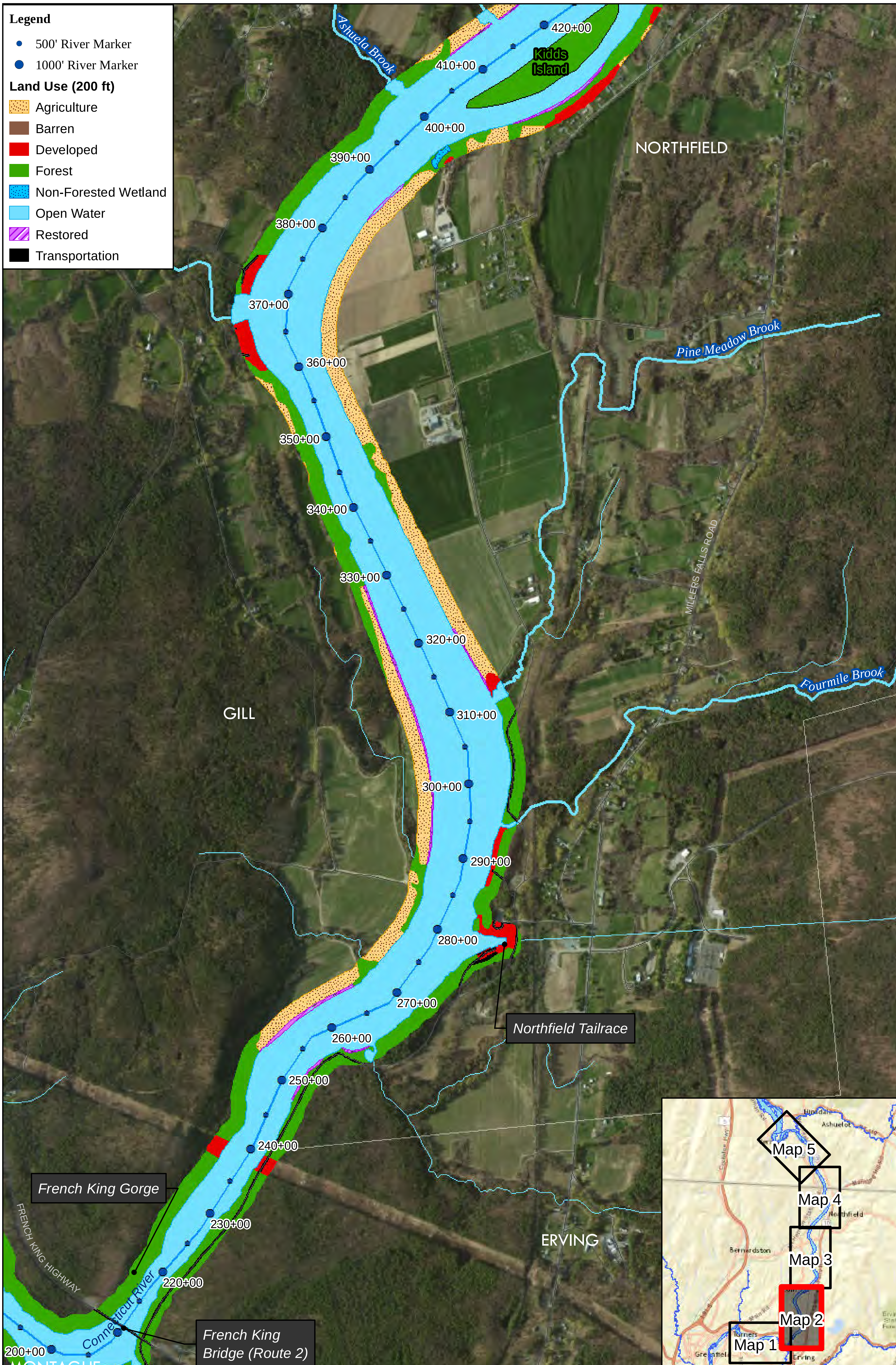

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 625 1,250 2,500
Feet

Figure 4.2:
Land Use Classifications
within 200 ft of Connecticut River
Map 2

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan,

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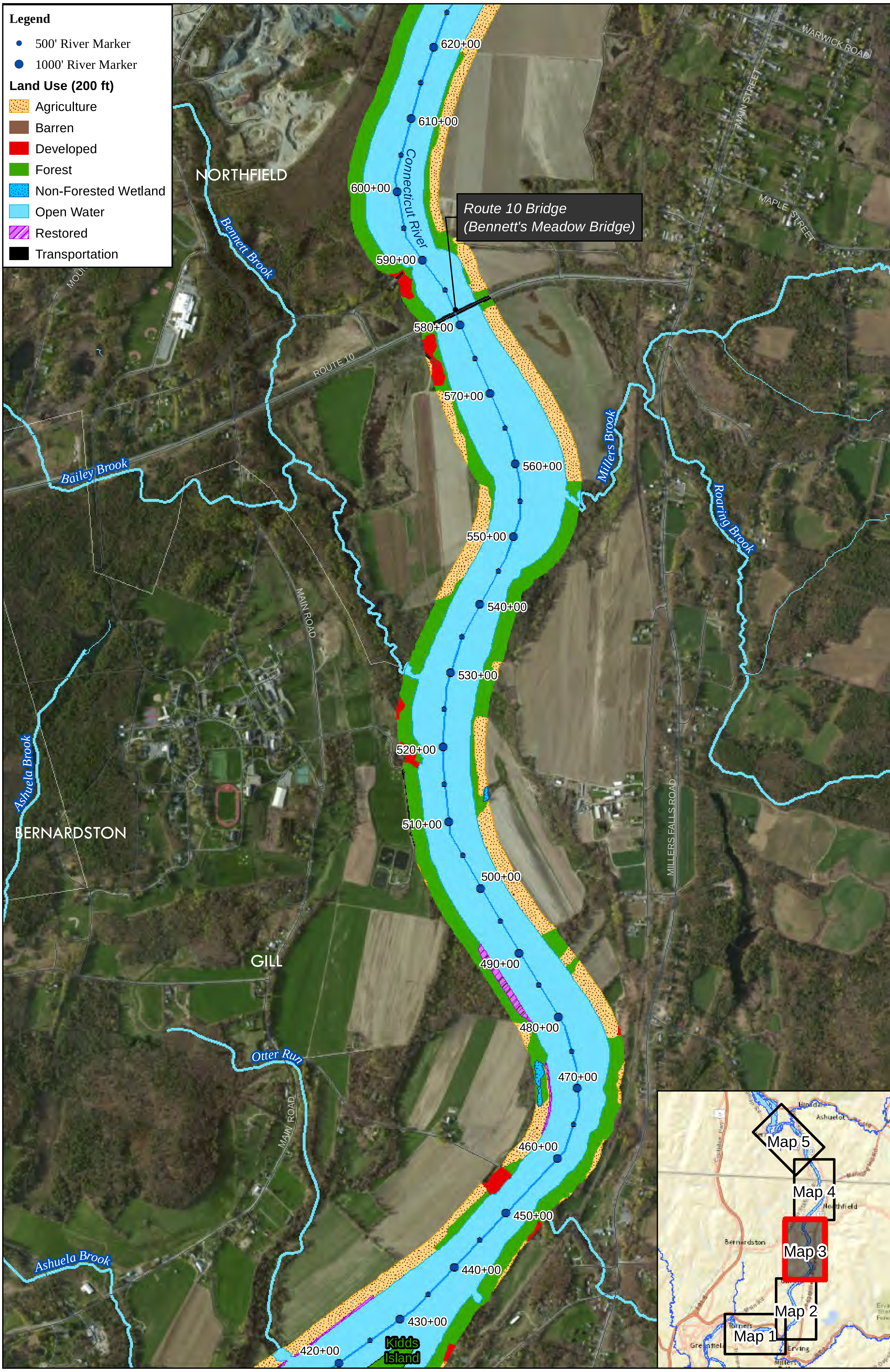

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

N

Figure 4.3:
Land Use Classifications
within 200 ft of Connecticut River
Map 3

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan,

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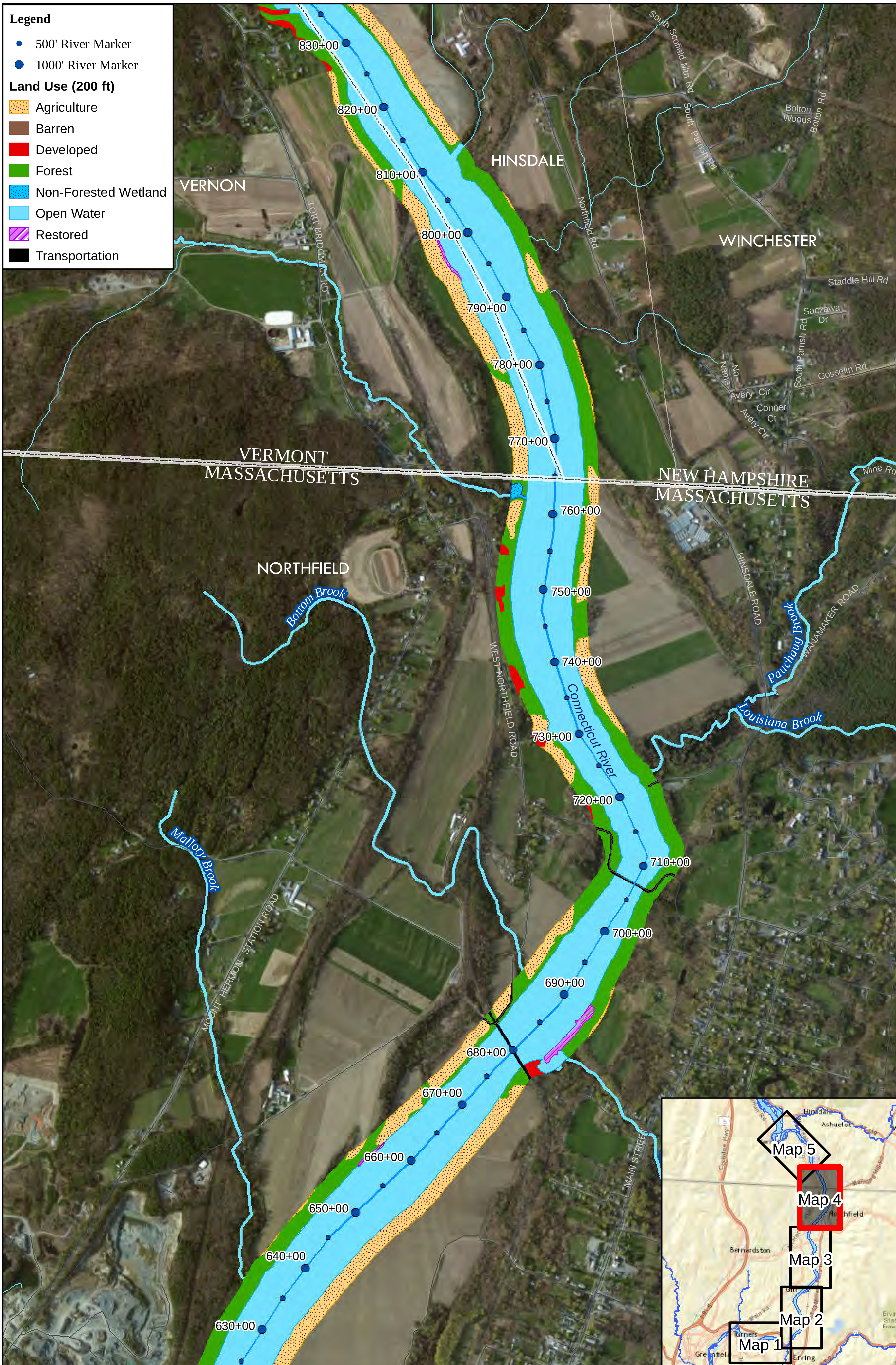

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500
Feet

Figure 4.4:
Land Use Classifications
within 200 ft of Connecticut River
Map 4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan,

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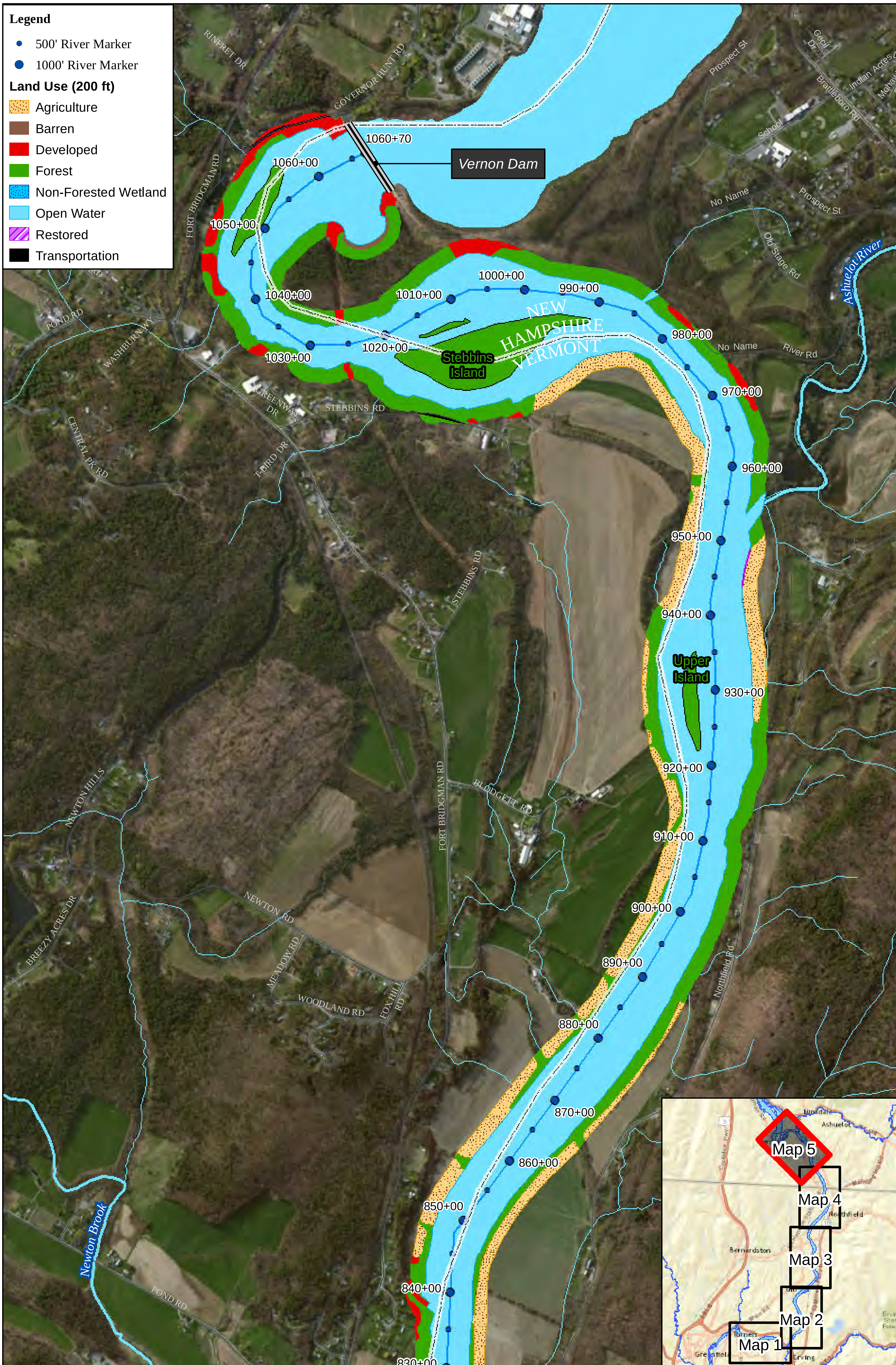

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Figure 4.5:
Land Use Classifications
within 200 ft of Connecticut River
Map 5

0 625 1,250 2,500 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan,

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4.2 Sensitive receptor mapping

During the summer/fall of 2013 NEE identified and mapped the locations of sensitive receptors found along or near the riverbanks of the Impoundment. The primary goal of this survey was to identify, quantify and/or rank potentially sensitive features that may be affected by changes in the environment (including bank restoration efforts). For the purpose of this study a sensitive receptor was defined as important wildlife habitat located at or near the riverbank. Many wildlife habitat features were observed during this survey including bank swallow and belted kingfisher nesting sites and bald eagle nest and perch sites.

The sensitive receptor field survey focused on documenting actual habitat and classified each site by function (e.g., nesting, mating, breeding, etc.). This classification is important as banks which are in transition, including steep or un-vegetated banks, may provide suitable nesting habitat for habitat specialist species such as belted kingfishers and bank swallows which are reliant on eroding banks. Belted kingfishers and bank swallows excavate cavities to use as nests in sheer banks lacking vegetation and containing appropriate soil conditions. As a result of this, bank restoration efforts in these areas may adversely affect these species.

Sensitive receptor mapping was conducted over 15 non-consecutive days from April to December 2013. Wildlife biologists conducted bank surveys from a motor boat by visually scanning banks for sensitive receptor sites and by walking all banks and islands during the land-based survey work. The coordinates of sensitive receptor locations were recorded with a Trimble GeoExplorer 6000 series XT with sub-meter accuracy GPS. When multiple bank nests were located communally, only one location point was collected. Spatial attribute data gathered included the number of cavities and the number of unique species in such cases as well as field notes, x and y coordinates, and endangered status.

Maps depicting the location of sensitive receptors were created in advance of the land- and boat-based surveys based on the preliminary investigation conducted during the summer and early fall of 2013. Hard copies of the maps were kept on hand by field personnel throughout the course of the surveys. A GIS layer containing sensitive receptor locations was loaded onto the Pentop computer for the land-based survey at which time the locations were validated and updated, if needed. At the conclusion of the land-based survey the sensitive receptor dataset was finalized and the GIS figures were updated.

Overall, 31 Sensitive Receptor locations were identified during 2013 field work. In 2014 an additional eagle nest was added (Kidd Island), bringing the number to 32 locations Figures 4.6-4.10 present sensitive receptor maps. Rare plant locations are currently being mapped as part of other studies, and these are not included in these figures.

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500
Feet

Figure 4.6:
Sensitive Receptors
Map 1

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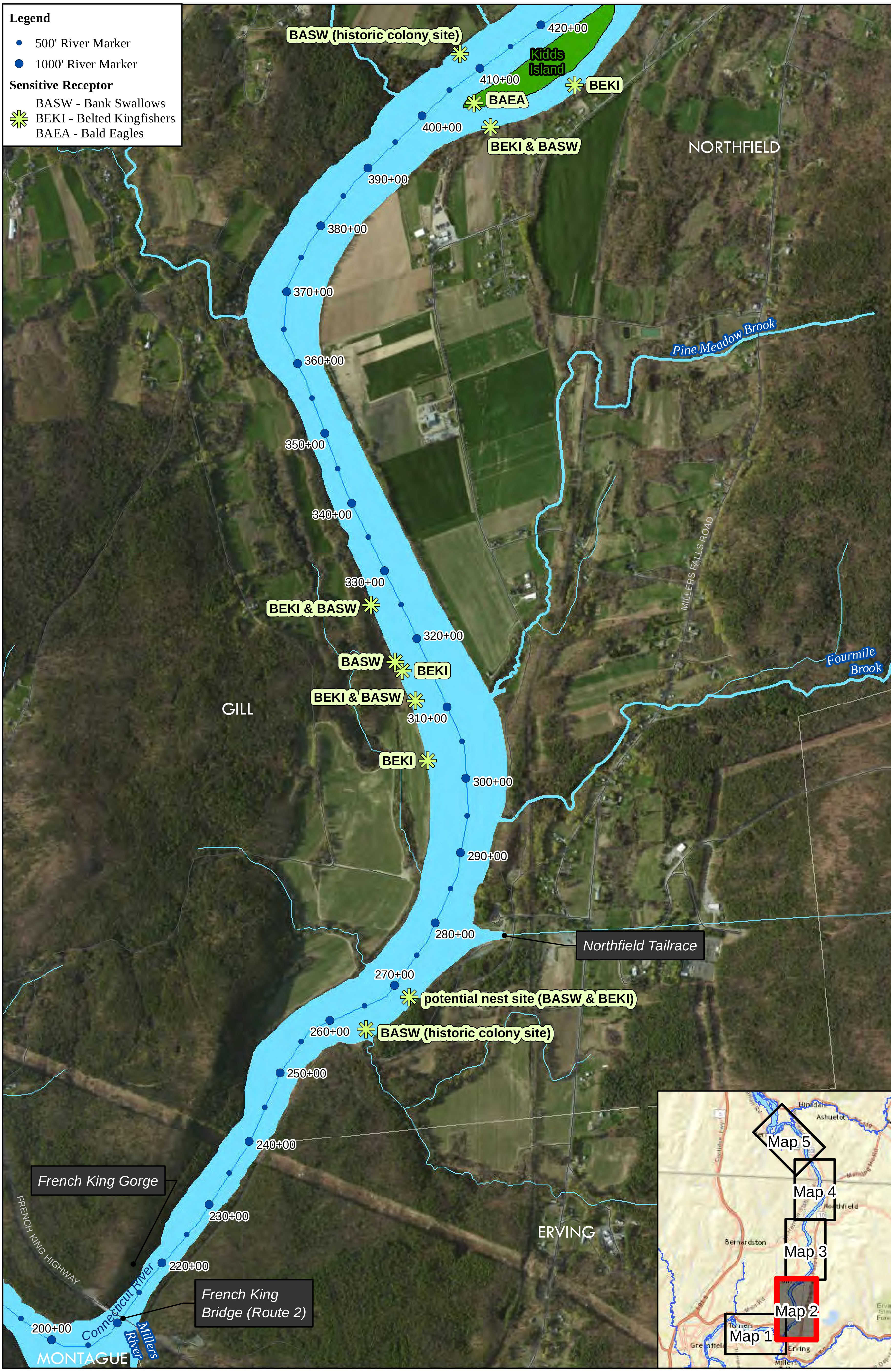

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

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Figure 4.7:
Sensitive Receptors
Map 2

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Figure 4.8:
Sensitive Receptors
Map 3

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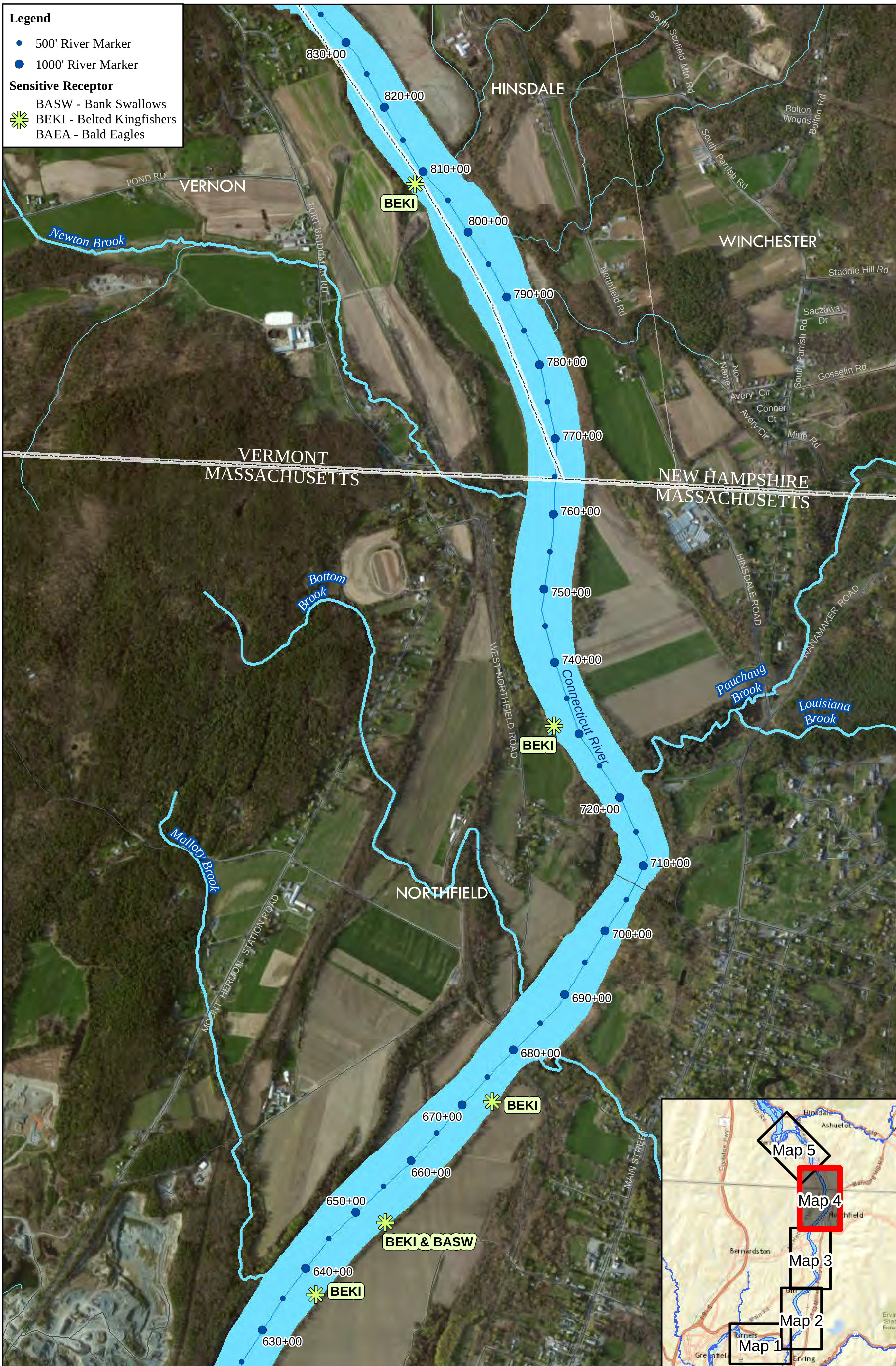

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Figure 4.9:
Sensitive Receptors
Map 4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Figure 4.10:
Sensitive Receptors
Map 5

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

The 2013 FRR provided the most complete and comprehensive methodology of any FRR since the inception of the ECP. When classifying a relatively long reach of river such as the Turners Falls Impoundment (~45 miles of riverbank) a reasonable perspective from which to view the riverbanks must first be established. One may argue that the best way to conduct such a survey is from a boat, moving at a slow speed, a reasonable distance from shore. Because of the scale and magnitude of the riverbanks and length of the Impoundment this approach provides the best perspective and view of the entire riverbank (i.e. upper and lower). Others may argue, however, that standing on the riverbanks and traversing the top of the banks is important in observing soil characteristics, geotechnical and/or geomorphic features of interest, and features that may not be readily visible from a boat (e.g., tension cracks). In order to develop a comprehensive understanding of the features, characteristics, and erosion conditions present throughout the Turners Falls Impoundment both a boat- and land-based survey were conducted as part of the 2013 FRR.

The goal of the 2013 FRR was to identify and define riverbank features, characteristics, and erosion conditions at a reconnaissance level without reference to the cause of erosion (FirstLight, 2013). As previously stated, the 2013 FRR had two major survey components: a land-based survey and a boat-based survey. The land-based survey was conducted simultaneously with the boat-based survey in accordance with recommendations received from MADEP. The boat-based survey was conducted November 11-19, 2013 while the land-based survey was conducted November 11-19 and December 10-13. Several small segments of the land-based survey were unable to be completed prior to the onset of winter weather conditions. These areas were revisited in the spring 2014 (May 7-9 and June 4). Maps depicting the longitudinal extent of each survey can be found in Appendix G.

The boat-based survey which consisted of identifying the start and end point of riverbank segments that exhibited common features, characteristics, and erosion conditions was conducted from a slow moving boat a relatively short distance from shore. Due to favorable flow, water level, and leaf-off conditions the boat-based survey provided an excellent vantage point of the upper and lower riverbank. The land-based survey consisted of making observations while traversing the top of bank throughout the entire Impoundment as well as conducting detailed site assessments at select locations identified by the fluvial geomorphologist and geotechnical engineer. Due to the fact that the generally steeper face of the riverbanks were not easily observed while traversing the top of the bank combined with the fact that the detailed site assessments focused only on very limited areas it was found that the boat-based survey provided the best vantage point of the entire riverbank. As a result of this finding the boat-based survey data was used as the primary data source when establishing riverbank segments and developing summary statistics. Observations made during the land-based survey were used to complement the findings of the boat-based survey and provide supplemental information and perspective to the overall assessment of Impoundment riverbanks.

Detailed descriptions of the boat- and land-based surveys are found in the sections below.

5.1 Boat-based Survey

A boat-based survey was conducted from November 11-19, 2013 to identify riverbank features and characteristics as well as the type(s), stage(s), and extent of erosion found throughout the Impoundment. Riverbank segments were identified and delineated based on common features and characteristics using the methodology and classification criteria outlined in the RSP (FirstLight, 2013) and QAPP (Simons, 2013). All riverbanks throughout the Impoundment, including islands, were assessed during the survey with the exception of the right-channel of the island just downstream of Vernon Dam which was inaccessible due to low flows. This location was not revisited in the spring of 2014 given that it was assessed during the land-based survey.

All field work associated with the boat-based survey was conducted from a slow moving boat located a relatively short distance from shore. Specific tasks completed during the boat-based survey included: 1) spatially defining riverbank transition points; 2) classification of riverbank features and characteristics; 3) identification of the type(s), stage(s), indicators, and extent of erosion; and 4) collection of geo-referenced video and photographic documentation. All classification of riverbank characteristics and erosion features were based on the criteria found in Tables 5.1 and 5.2, Figure 5.1, and the methodology contained in the RSP (FirstLight, 2013) and QAPP (Simons, 2013). As noted in Table 5.1, Impoundment riverbanks were subdivided into constituent parts of upper and lower riverbanks for certain classification purposes, however, if either the lower or (more typically) the upper riverbank exhibited erosion, the entire bank was classified as eroded or eroding. Thus the classification of the riverbank into upper or lower portions does not affect the overall calculations of eroded or eroding bank length. Discussion pertaining to the differentiation between the upper and lower riverbank is found in Appendix F.

Transition points where riverbank features and characteristics changed from one classification to another were identified and their locations were shot using a sub-meter GPS and laser rangefinder. Once the location of the transition point was shot with the laser rangefinder collection of a GPS point, corresponding offset distance, and angle were triggered on the boat. The combination of these measurements was used to automatically calculate the coordinates of the transition point. These coordinates were then automatically recorded on a datalogger. Once the location of each transition point was captured, observations of riverbank features and characteristics as well as pertinent erosion features were entered into the datalogger for each segment. This procedure was repeated along the entire length of the Impoundment during the field data collection period. Maps denoting the riverbank segments which were delineated during the boat-based survey can be found in Appendix G.

The boat-based survey identified a total of 641 riverbank segments covering both banks of the Impoundment and the islands (596 riverbank segments, 45 island segments). The 596 individual riverbank segments totaled 228,009 ft with segment lengths ranging from a minimum of 13 ft to a maximum of 3,330 ft. The average length of all riverbank segments (excluding islands) was 383 ft. To put this into perspective, previous FRRs have resulted in a range of segment lengths from 20 ft to over 4,000 ft, with average segment lengths from 480 ft to 1,267 ft. As such, the minimum, maximum, and average segment lengths for the 2013 FRR were smaller than all previous FRRs thereby resulting in a greater degree of detail when compared to previous FRR efforts. In addition, the 45 island segments covered a total length of 20,925 ft. Island segment lengths ranged from 62 ft to 2,247 ft in length with an average length of 465 ft. When combining the length of riverbank segments with the length of island segments the total length of Impoundment riverbanks was found to be 248,934 ft. Tables denoting the features and characteristics for each of the 641 segments are found in Appendix I.

Table 5.1 Connecticut River – Turners Falls Impoundment Riverbank Classifications for Boat-based Survey[12]

UPPER RIVERBANK CHARACTERISTICS[13]						
Upper Riverbank Slope	Overhanging *>90°*	Vertical *90°*	Steep *(>2:1)*	Moderate *(4:1-2:1)*	Flat *(<4:1)*	
Upper Riverbank Height *(total height above normal river level)*	Low *(<8 ft.)*	Medium *(8-12 ft.)*	High *(>12 ft.)*			
Upper Riverbank Sediment	Clay *(.001-.062mm)*	Silt/Sand *(.062-2 mm)*	Gravel *(2-64mm)*	Cobbles *(64-256mm)*	Boulders *(256-2048mm)*	Bedrock
Upper Riverbank Vegetation	None to Very Sparse *(<10%)*	Sparse *(10%-25%)*	Moderate *(25%-50%)*	Heavy *(>50%)*		
Sensitive Receptors	*Important wildlife habitat located at or near the riverbank*					
LOWER RIVERBANK CHARACTERISTICS						
Lower Riverbank Slope	Vertical *90°*	Steep *(>2:1)*	Moderate *(4:1-2:1)*	Flat / Beaches *(<4:1)*		
Lower Riverbank Sediment	Clay *(.001-.062mm)*	Silt/Sand *(.062-2 mm)*	Gravel *(2-64mm)*	Cobbles *(64-256mm)*	Boulders *(256-2048mm)*	Bedrock
Lower Riverbank Vegetation	None to Very Sparse *(<10%)*	Sparse *(10%-25%)*	Moderate *(25%-50%)*	Heavy *(>50%)*		
Sensitive Receptors	*Important wildlife habitat located at or near the riverbank*					
EROSION CLASSIFICATION						
Type(s) of Erosion	Falls – Undercut	Falls – Gullies	Topples	Slide or Flow	*Planar Slip* *Rotational Slump* *Flow*	
Indicators of Potential Erosion	Tension Cracks	Exposed Roots	Creep/ Leaning Trees	Overhanging bank	Notching	Other
Stage(s) of Erosion	Potential Future Erosion	Active Erosion	Eroded	Stable		
Extent of Current Erosion	None/Little *(<10%)*	Some *(10%-40%)*	Some to Extensive *(40%-70%)*	Extensive *(>70%)*		

[12] RSP Table 3.1.1-2 (FirstLight, 2013)
[13] 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 did not include quantitative field measurements of characteristics.

Table 5.2 Riverbank Classification Definitions[14]

RIVERBANK CHARACTERISTICS *(Upper and Lower)*[15]	
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[16]
Riverbank Height	**Low –** height less than 8 ft above normal river level[17]
	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[18]	**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 (Field, 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 (Field, 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.[19]

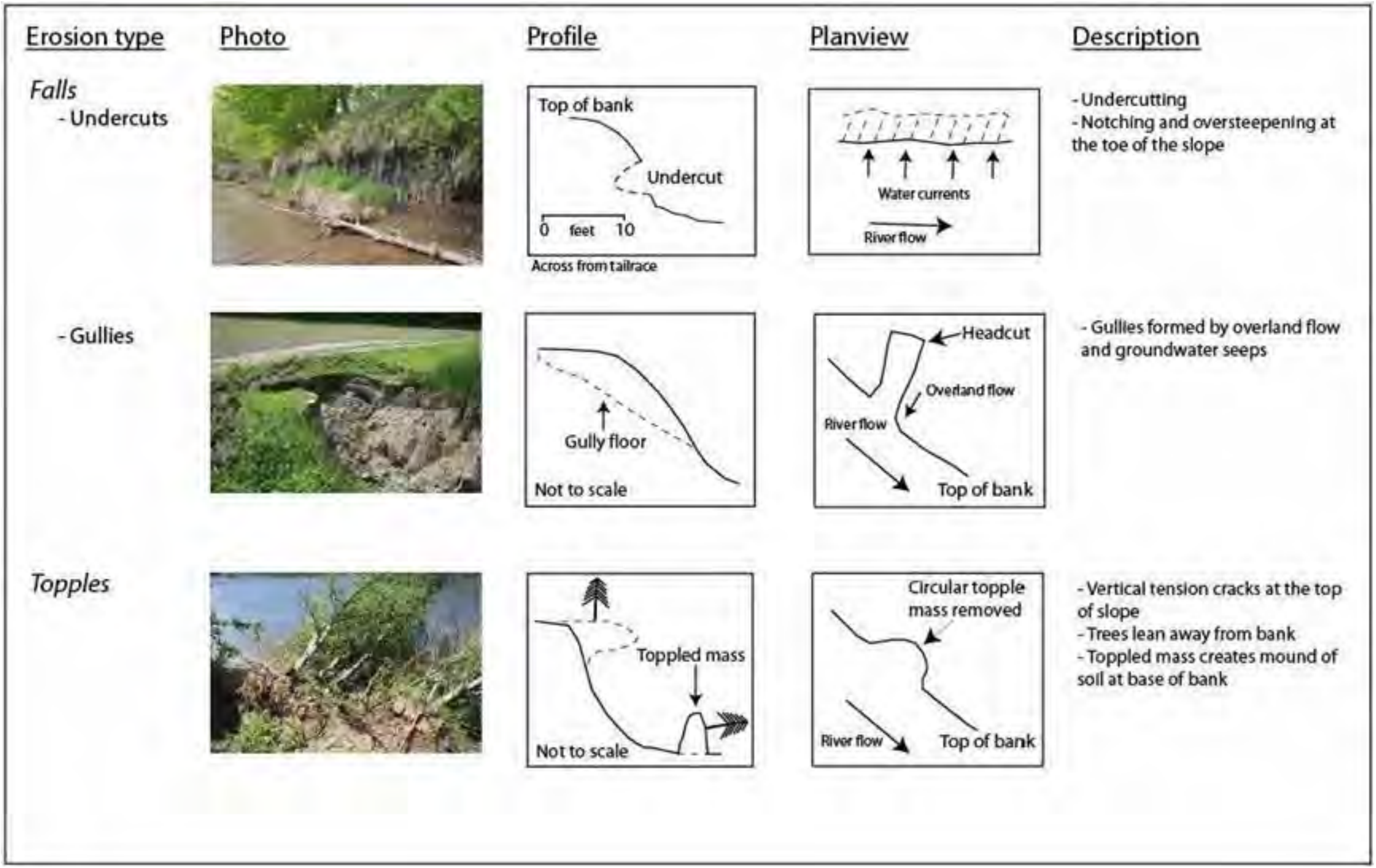
[14] RSP Table 3.1.1-3 (FirstLight, 2013)
[15] All quantitative classification criteria (e.g. slope, height, vegetation, extent, etc.) were based on approximate estimates made during field observations of riverbanks. The FRR is a reconnaissance level survey that does not include quantitative analysis.
[16] Beaches are defined as a lower riverbank segment with a flat slope
[17] For the purpose of this study, Normal Water Level will be defined as water levels within typical pool fluctuation levels, but below Ordinary High Water (186').
[18] Field, 2007

Stage(s) of Erosion	**Potential Future Erosion –** riverbank segment exhibits multiple or extensive indicators of potential erosion
	Active Erosion – riverbank segment exhibits one or more types of erosion as well as evidence of recent erosion activity
	Eroded – riverbank segment exhibits indicators that erosion has occurred (e.g. lack of vegetation, etc.), however, recent erosion activity is not observed. A segment classified as Eroded would typically be between Active Erosion and Stable on the temporal scale of erosion.
	Stable – riverbank segment does not exhibit types or indicators of erosion
Extent of Current Erosion	**None/Little[20] –** 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

[19] Segments with features classified as "Other" exhibited various erosion processes that did not fit in one of the existing classification categories. Maps denoting the location of features classified as "Other" can be found in Appendix J.

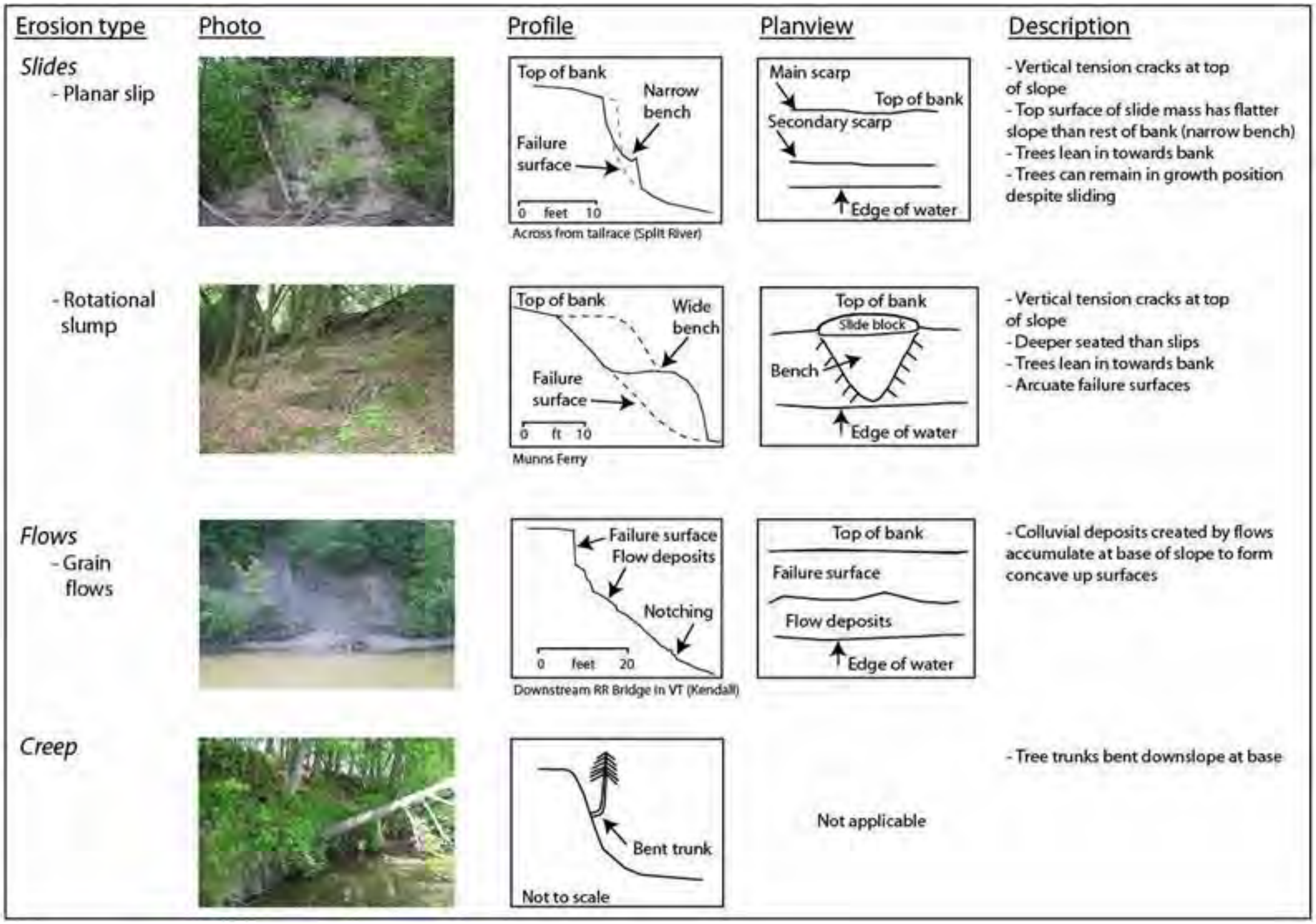
[20] Riverbanks consist of an irregular surface and include a range of natural materials (silt/sand, gravel, cobbles, boulders, rock, and clay), above ground vegetation (from grasses to trees), and below ground roots of different densities and sizes. Due to these characteristics, there are small areas 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.

Figure 5.1 Types of Erosion Occurring in the Turners Falls Impoundment and their Characteristics[21]



[21] RSP Table 3.1.1-4 (FirstLight, 2013)

Figure 5.1 Types of Erosion Occurring in the Turners Falls Impoundment and their Characteristics (continued)[22]



[22] RSP Table 3.1.1-4 (FirstLight, 2013)

5.2 Land-based Survey

The purpose of the land-based survey was to identify and define indicators of potential erosion and bank instability as well as erosion features that may not have been readily visible from a boat. In addition, land-use classifications and sensitive receptor locations identified during previous mapping efforts (summer-early fall 2013) were validated and updated as needed.

The land-based survey consisted of two components, the first of which included walking along the top of the riverbanks throughout the Impoundment, including islands, except in areas where: 1) access was not possible or the area was deemed impassible; 2) access was unsafe; or 3) bank conditions did not warrant assessment (e.g. bedrock areas). The second component of the land-based survey was to stop at a number of locations of interest, including areas of erosion as well as stable areas or areas that had been stabilized to cover a range of conditions and conduct detailed geotechnical and geomorphic site assessments. Observations made during the land-based survey were used to complement the findings of the boat-based survey and provide supplemental information and perspective to the overall assessment of Impoundment riverbanks.

Maps depicting the longitudinal extent of the areas that were covered during the land-based survey can be found in Appendix G. As noted in the Appendix, the light green lines depicted in the figures highlight the longitudinal extent of the riverbanks which were walked by field personnel. Upon review of these figures it will be observed that a few short segments of riverbank were not walked. These areas were not surveyed due to the reasons discussed above. Two islands were not assessed at the time of the original survey due to lack of boat access as hard winter weather prevailed starting in mid to late December. These islands were revisited in the spring (May 7-9, June 4, and June 10) once weather conditions improved and accessibility was no longer an issue.

Field efforts associated with the land-based survey consisted of four tasks: 1) delineation of riverbank segments based on common top of bank features and characteristics; 2) identification of pertinent attributes such as indicators of potential erosion and various geomorphic and geotechnical observations as observed from the top of the bank; 3) detailed geotechnical and geomorphic assessments in areas of interest as noted by the geotechnical engineer or fluvial geomorphologist (Section 5.3); and 4) validation of previously identified land-use classifications and sensitive receptor locations. Observations were made by field personnel while traversing the top of the riverbanks. Features and characteristics used for top of bank delineation included slope, vegetation, and adjacent land-use which were easily identifiable from the top of the bank. Erosion conditions associated with land-use and indicators of potential erosion that could be observed from the top of bank such as gullies and tension cracks were the focus of this aspect of the field survey.

Data was collected in a variety of ways including: hard copy datasheets, GPS enabled digital photographs, dataloggers, and a Pentop computer equipped with GPS and ArcGIS. The GPS enabled Pentop computer was preloaded with an ArcGIS application which was used to delineate top of bank segments and capture pertinent geomorphic or geotechnical observations. The ArcGIS application contained aerial imagery of the study area and various support datasets (e.g., land-use, sensitive receptors, surficial geology, etc.). Examples of the attributes captured using this application are shown in Table 5.3.

Riverbank observations were digitized in the field onscreen using ArcGIS, GPS, and aerial imagery. Pertinent attributes that could be readily observed from the top of the bank were captured for this component of the survey.

Table 5.3: Land-based Survey ArcGIS Application Attributes

Attribute Field	Description
ID	Riverbank segment ID number
Station Number	River marker station number
Photo Numbers	Description of all photos taken at segment including photo numbers
Riverbank	Drop-down list – Options: Right or Left
Personnel	Field personnel present for classification
Date	Date of classification
Previously Stabilized	Drop-down list – Options: Yes or No
Geotechnical Observations	Text field for geotechnical observations
Field Observations	Text field for general field observations
Erosion Type	Major and minor erosion types present along segment. Drop-down list – Options: Planar Slip / Flow / Falls – Undercut / Falls – Gullies / Topples / Slide or Flow / Rotational Slump
Indicators of Potential Erosion	Major and minor indicators of potential erosion present along segment. Drop-down list – Options: Tension Cracks / Exposed Roots / Creep or Leaning Trees / Overhanging Bank / Notching / Other
% Vegetative Cover – Top / Face / Toe	% of vegetative cover at the top, face, and toe of segment. Drop-down list – Options: None to Very Sparse (<10%) / Sparse (10-25%) / Moderate (25-50%) / Heavy (>50%)
Max Root Depth – Top / Face / Toe	Approximation of max root depth at the top, face, and toe of segment
Vegetative Type – Top / Face / Toe	Description of vegetative type present at the top, face, and toe of segment
Stratigraphy Material(s)	Description of the stratigraphy material present
Stratigraphy Color(s)	Description of the stratigraphy color
Stratigraphy Thickness	Approximation of the stratigraphy thickness
Stratigraphy Notes	General notes on stratigraphy present
Adjacent Land-Use	Description of adjacent land-use
Sensitive Receptors	Description of any sensitive receptors present
Notes	General notes
Segment Length	Length of riverbank segment in feet

5.3 Detailed Geotechnical/Geomorphic Site Assessments

Detailed geotechnical and geomorphic assessments were conducted at 38 locations throughout the Impoundment as part of the land-based survey. Sites where detailed assessments were conducted were selected by the geotechnical engineer or fluvial geomorphologist at select locations where features of particular geomorphic or geotechnical interest existed or, in some cases, where features and characteristics were representative of a given area.

Sites where detailed assessments were conducted exhibited a wide range of riverbank conditions from low, well vegetated or stabilized areas to areas of riverbank erosion or instability where vegetation was not as prevalent. Observed sites also included areas where recent stabilization occurred which employed newer techniques such as large woody debris and vegetation only. Maps depicting the locations where each detailed assessment was conducted can be found in Appendix G.

If an area of particular interest was observed by the fluvial geomorphologist or geotechnical engineer as the land-based survey crew walked along the top of the riverbank, a more detailed investigation of the entire riverbank was conducted. Once a site was selected for assessment, both the top and bottom of the bank was investigated in detail. Field datasheets were completed (including site sketches) and GPS enabled digital photographs were captured at each site. An example of a completed site assessment datasheet can be found in Figure 5.2. Copies of all completed, raw datasheets, including photos for each location, can be found in Appendix H.

The information contained on the datasheets represents the raw data as captured in the field. At the conclusion of field efforts the site assessments were reviewed and compared to data collected during the boat-based survey. The boat-based survey dataset was then updated as needed based on the supplemental data collected during the land-based assessment. The detailed site assessments, combined with observations made while traversing the top of bank, were used to complement the boat-based data and provide supplemental information and perspective to the overall assessment of Impoundment riverbanks.

It should be noted that the detailed site assessments contain a field labeled “Length of Representative Segment,” which is approximate. Due to the fact that the land-based assessment occurred from the top of the riverbank and the detailed site assessments were conducted from the toe of the bank at one specific location it was difficult to determine from the land the extent of how representative a given site was of the larger reach; perspective of the larger reach was observed by boat. Furthermore, although some detailed site assessments were conducted at locations representative of a larger reach the assessments were typically focused on specific areas/features of interest as observed by the geotechnical engineer or fluvial geomorphologist. In general, the observations made on the detailed site assessment datasheets should be considered site specific. Given that the sites where detailed assessments were conducted were dependent on the location of specific features/areas of interest they were not intended to be evenly distributed throughout the Impoundment or conducted at every land-based segment.

Figure 5.2 Detailed Land-Based Geotechnical/Geomorphic Assessment Datasheet

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land -Based Survey

Observation Point Number: *18* **Personnel:** *YKC, AS, MM, CM, TS*

Date: *November 15, 2013* **Time:** *10:00 am*

Station Number: *870+00* **Photo Reference Numbers:** *642 - 646*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *867+00* **To Station Number** *925+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

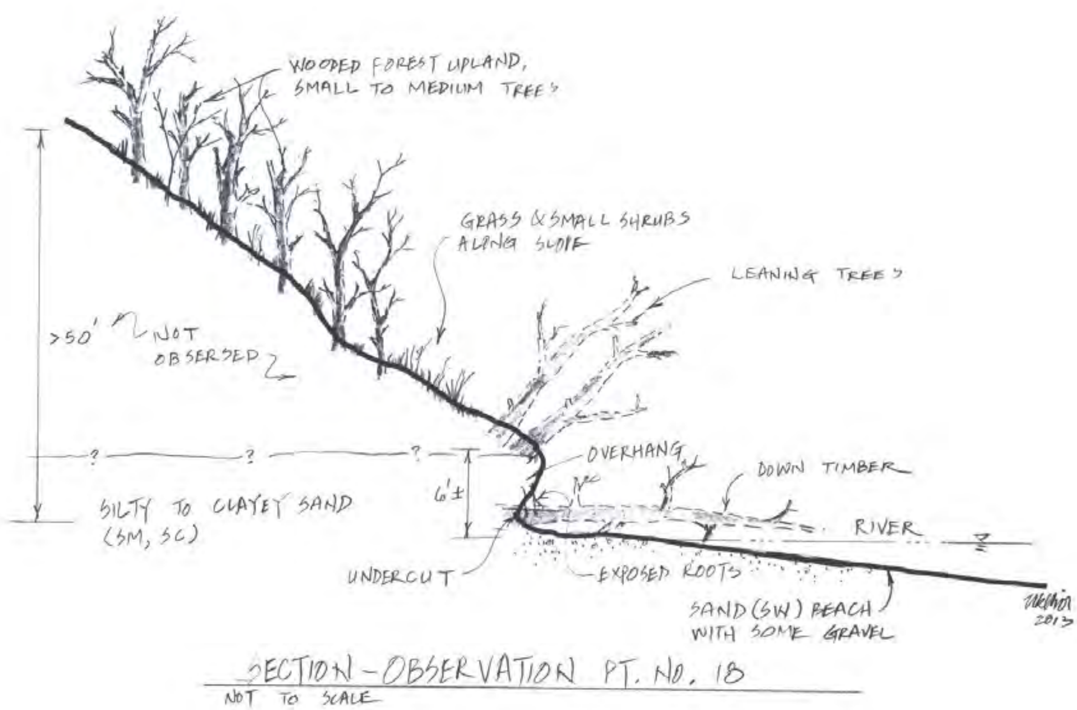
Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILTY SAND (SM) to CLAYEY SAND (SC) – Mostly fine sand, 20% to 30% low- to medium-plastic fines.

Observed Erosion Features:

- *Overhangs to near-vertical scarps near toe of bank.*
- *Exposed roots of leaning trees near toe of bank at river level, with undercuts behind roots.*
- *Down timber and leaning trees near river level.*

Site Sketch:



Observation Point Number: *18* **Personnel:** *YKC, AS, MM, CM, TS*

Date: *November 15, 2013* **Time:** *10:00 am*

Station Number: *870+00* **Photo Reference Numbers:** *642 - 646*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *867+00* **To Station Number** *925+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILTY SAND (SM) to CLAYEY SAND (SC) – Mostly fine sand, 20% to 30% low- to medium-plastic fines.

Observed Erosion Features:

- *Overhangs to near-vertical scarps near toe of bank.*
- *Exposed roots of leaning trees near toe of bank at river level, with undercuts behind roots.*
- *Down timber and leaning trees near river level.*

Figure 5.2 Detailed Land-Based Geotechnical/Geomorphic Assessment Datasheet (cont.)

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey
Observation Point Number: *18* **Date:** *November 15, 2013*

Station Number: *870+00*

Maximum Root Depth:

-

Erosion Classification:

Types of Erosion: *mass wasting*

Indicators of Potential Erosion: *Exposed roots*
Overhanging bank
Undercuts

Notes: *overhangs to near vertical scarps at the toe of the bank, exposed roots of leaning trees near toe of bank at river level with undercuts behind roots, downed trees and leaning trees near river level*

Bank Vegetation:

Top: *Heavy (>50%), Broad-leaved deciduous tree*
Red oak, black birch, shag bark hickory, green ash, Japanese barberry, Christmas fern*

Face: *Heavy (>50%), Broad-leaved deciduous tree*
Red oak, black birch, shag bark hickory, green ash, river rye, sedges, solidago*

Toe: *None-Very sparse (0-10%) emergent (nonpersistents)*
river rye, sedges

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural & forested

Sensitive Receptor:
Yes

Notes: *emergent shelf at toe from ~station 930+00 to 920+00*

High bank, low bench

Lots of herbaceous veg at top of bank

Invasive species present (barberry, bittersweet), although sparse

6 RESULTS AND ANALYSIS

Following completion of all field efforts, field data collected during the 2013 FRR were post processed, reviewed for quality assurance/quality control, and analyzed. The data analysis process included comparing observations made in the field with the geo-tagged digital images of riverbank segments, evaluation of land-based observations, and review of the geo-tagged video of Impoundment riverbanks. Summary statistics of pertinent riverbank features and characteristics were developed and analysis of changes found throughout the Impoundment since the 2008 FRR were conducted. In addition, comparisons were made to past FRRs, where appropriate, and correlations between riverbank features/characteristics, land-use, and bank instability or erosion were conducted as required by the RSP (FirstLight, 2013). The results of these analyses are presented below.

6.1 2013 FRR Results

The results and findings of the 2013 FRR represent a combination of observations made during the land- and boat-based surveys. The results of the boat-based survey, complemented with observations made during the land-based survey, were used to establish the riverbank segmentation from which summary statistics and analyses were conducted. Due to favorable flow, water level, and leaf-off conditions the boat-based survey provided a significantly better vantage point of Impoundment riverbanks than the land-based survey did. The land-based survey proved valuable, however, in noting upper slope and top of bank conditions or riverbank features that may not have been readily visible from the boat. The combination of data collected during the boat-based survey supplemented with land-based observations provided a complete and comprehensive view of riverbank features, characteristics, and erosion conditions found throughout the Impoundment.

Surficial Geology

Most of the surficial deposits in the general region of the Impoundment 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:

> *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.
>
> *Glacial stratified deposits* – During retreat of the last ice sheet, materials in the glacier were deposited in glacial streams, lakes and marine environments that occupied the valleys and lowlands. Because these materials were deposited in water, they tend to be stratified and well-sorted gravel, sand, silt and clay. Glacial stratified deposits are the predominant surficial materials in the Connecticut River Valley. These deposits generally overlie till; however in some places till is not present and the stratified deposits lie directly on bedrock. The largest glacial lake in the region was Lake Hitchcock which occupied the Connecticut Valley area. Lake Hitchcock was dammed behind a mass of earlier deltaic sediments in the Cromwell-Rock Hill area of central Connecticut. The lake lengthened northward into northern Vermont and New Hampshire as the ice sheet retreated. The principal bottom sediments of Lake Hitchcock are varved clay, silt, and

fine sand at least 300 feet in maximum thickness, which are overlain by a continuous blanket of sand 2 to 25 feet thick.

Post-glacial deposits – The two principal post-glacial deposits are floodplain alluvium and aeolian deposits. Floodplain alluvium consists of sand, gravel, and silt, stratified and well sorted to poorly sorted. The grain size distribution of alluvium generally varies over short distances, both vertically and laterally. Along smaller streams, alluvium is commonly less than 5 feet thick. The most extensive deposits of alluvium in the region are along the Connecticut River, where the materials are predominantly sand, fine gravel, and silt, with thickness up to about 25 feet. Alluvium typically overlies thicker glacial stratified deposits. The aeolian deposits in the region consist of windblown silt and sand that form a discontinuous but widespread blanket, about 5 feet in maximum thickness over bedrock and glacial deposits.

Summary of Detailed Site Assessments

The following features and characteristics of the riverbank were made at each location where detailed site assessments were conducted:

- Exposed geologic and geotechnical features, such as soil type(s), bedrock, stratigraphy, landslide (mass-wasting), depressions, tension cracks, etc.;

- Erosion features and classification, such as undercuts, overhangs, steep slopes, scarps, scour channels, exposed roots, leaning or fallen trees, etc.;

- Bank vegetation, such as type and percent cover.

Observations of exposed soil types (in Unified Soil Classification System) and erosion features found at these localized sites are summarized in Appendix H.

In general, geological and geotechnical observations from the detailed site assessments are consistent with published geology. Geology observed along the riverbanks included bedrock, flood-plain alluvium, glacial stratified deposits, and Lake Hitchcock deposits. Bedrock, consisting of sandstone and shale, was exposed primarily on both sides of the river bank at and south of the French King Gorge, extending all the way to Barton Cove. Bedrock was also observed at the north end of the Impoundment at Vernon Dam. Interbedded varved clay and silt deposits, with medium- to high-plasticity, were observed at the north side of the Impoundment in New Hampshire and Vermont. Relatively clean sands were encountered on the upper bank at two locations: one near Barton Cove and one near Vernon Dam. The dominant soil types at the river banks, observed at over 50% of the land-based observation points, are silt and sandy silt flood-plain alluvium, with little plasticity and 5 to 30% fine sand. Sandy and gravelly materials, consisting of silty sand, clean sands, and clean gravels, were observed primarily in the lower bank beaches in many of the observation points.

From an engineering standpoint, the bank materials observed generally can be characterized as follows:

- Clayey soils (varved clay, clays, clayey sands) – High resistance to hydraulic erosion, low to high cohesive strength, low permeability.

- Silty soils (silt, sandy silt) – Low resistance to hydraulic erosion, low to moderate cohesive strengths, and low to moderate permeability.

- Granular soils (gravels, sands, silty sands) – Low resistance to hydraulic erosion, a range of frictional strengths, high permeability.

Note that the actual engineering properties of the bank materials will be measured in-situ in field tests at detailed study sites in the summer and fall of 2014 as part of Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability* (a.k.a Causation Study).

The following is a list of key erosion observations and trends identified during the detailed site assessments conducted as part of the FRR land-based survey:

1. The erosion features observed where detailed site assessments were conducted consisted primarily of steep slopes and scarps, overhangs, undercuts, exposed roots, mass-wasting, and slumpings.

2. All of the erosion observed at the locations where detailed site assessments were conducted occurred in the steep Upper Bank, and not in the Lower Bank.

3. No tension cracks were observed while walking on top of the Upper Bank, however, the shoulder of the Upper Bank was overgrown with vegetation and fallen leaves, making detailed observation of the ground surface difficult.

4. Erosion at the locations where detailed site assessments were conducted was observed in the sandy and silty riverbank materials, and not in clays and clayey sands. This is consistent with the engineering behavior of these materials under hydraulic scouring loadings.

5. There were numerous locations where old steep scarps and overhangs near the top of the riverbank were observed. These features appeared to be caused by historical floods during periods of high flow and precipitation.

6. Several of the locations where detailed site assessments were conducted were previously restored and repaired. All of these sites indicated good performance (see detailed evaluation in Section 8).

7. Several of the locations where detailed site assessments were conducted showed little to no erosion and appeared to be naturally stabile, even in silty materials. All of these sites have flat to very flat Upper Bank slopes, with lower riverbank vegetation.

8. There are numerous sites where recent sediment deposition was observed at the toe of the Upper Bank most likely from Tropical Storm Irene. Emerging vegetation was observed in some of these recent sediments.

9. There are numerous old landslides on the Upper Bank, some in slopes that are over 50 to 75 feet high. Based on general size, age, and shape of trees (curved or straight) the age of such movement is likely to have been on the order of 50 years ago or possibly older and may be associated with the large flood event of 1936. It is possible that these old landslides may not be related to localized erosion at the river level, but may be caused by other natural mechanisms such as periods of high precipitation and associated elevated groundwater conditions.

10. In some of the old landslides, we observed some water-loving plants (e.g. horsetails) in the upland areas, suggesting possible high groundwater conditions or local drainage issues.

11. Damage to vegetation and riverbanks was observed (Site No. 25) due to cows grazing on the riverbanks, removing the beneficial effects of vegetation.

Riverbank Features and Characteristics

As shown in Table 5.1 observations of riverbank features and characteristics such as sediment, slope, and vegetation were noted separately for the lower and upper riverbanks at each riverbank segment. Erosion condition classifications, and summary statistics, such as the type(s), stage, extent, or potential indicators of erosion were based on the entire riverbank. This erosion classification approach is consistent with past FRR's. Although the entire bank was examined it was observed that erosion processes almost exclusively occurred at the transition point between the lower and upper riverbank or higher and not on the lower riverbank itself. Thus the classification of the riverbank into upper or lower portions does not affect the overall calculations of eroded or eroding bank length. A detailed discussion of the upper and lower riverbanks and the transition point between them can be found in Appendix F.

Once the comprehensive, post processed boat-based survey dataset was reviewed and finalized, an analysis of the longitudinal extent of each of the riverbank features, characteristics, and erosion conditions (as defined in Table 5.1) was conducted for each riverbank segment (including islands). Summary statistics were then developed for each riverbank feature and characteristic by calculating the sum of the length of all individual segments for a given feature or characteristic (e.g., lower riverbank sediment) and dividing it by the sum of the length of all riverbank segments in the Impoundment (including stabilized sites and islands) to determine a percentage. Summary statistics for erosion conditions were similarly developed by summing the length of all individual segments for a given erosion condition (e.g., extent of current erosion) and dividing it by the sum of the length of all riverbank segments in the Impoundment including stabilized sites and islands. The results of this analysis can be found in Table 6.1.

Based on review of Table 6.1, the following observations are noted, the majority of the upper riverbanks in the Impoundment 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 Impoundment were found to be generally stable with None/Little current erosion occurring. As noted in the table, 85.1% of the Impoundment riverbanks were found to have None/Little erosion, 13.7% Some erosion, 0.6% Some to Extensive erosion, and 0.6% Extensive erosion. Furthermore, 5.3% of the Impoundment riverbanks were found to have Potential Future Erosion, 0.6% Active Erosion, 9.0% Eroded, 83.6% Stable, and 1.5% in the Process of Stabilization.[23]

Table 5.2 contains definitions for each erosion condition classification. For example, as noted in the table a riverbank exhibiting None/Little erosion is a generally stable bank where the total surface area of the bank segment has approximately less than 10% active erosion present. 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 may be small areas of irregularities or disturbance which often occur at interfaces between materials, particularly in the vicinity of the water surface. 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 Current Erosion for generally stable riverbanks that include these relatively small disturbed areas is characterized as None/Little.

The percentages for the various erosion condition categories (e.g., Stage of Erosion, Extent of Current Erosion, etc.) represent the dominant classification present in a given segment. Multiple conditions may

[23] While originally not one of the RSP erosion condition classifications, one riverbank segment was classified as being "In the Process of Stabilization" due to the fact that riverbank stabilization work was being constructed at this 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 is then being planted to provide additional stabilization on the gravel beach as well as extending other vegetation onto portions of the upper riverbank.

be present within one riverbank segment but only one dominant classification can be made. For example, a given riverbank segment may have some small areas of Active erosion, Potential Future erosion, or Eroded conditions, however, if the dominant stage of erosion present at that segment is Stable then that segment would be classified as Stable. Similarly if a given riverbank segment has small areas that are Stable or have Potential Future Erosion but the dominant stage of erosion is Active then that segment would be classified as Active. The same is true of the Extent of Current Erosion category. A given segment may have Some erosion or Some to Extensive erosion in small areas, however, if the majority of the segment has None/Little erosion then that segment is classified as None/Little. This approach is appropriate and typical for a reconnaissance level survey such as the 2013 FRR.

In addition to summary statistics, maps denoting the location of each riverbank feature, characteristic, and erosion condition found throughout the Impoundment were developed in ArcGIS. Figures 6.1-6.5 denote the Extent of Current Erosion as identified during the 2013 FRR. Maps depicting all other riverbank features, characteristics, and erosion conditions are found in Appendix J.

When reviewing the figures found in Appendix J and the summary statistics found in Table 6.1 it is important to note that erosion features such as the Type of Erosion (e.g., Falls - Undercut) and Indicators of Potential Erosion (e.g., Creep/Leaning Trees) may still be present in a given riverbank segment even if that segment is classified as Stable with None/Little erosion. As discussed above, a riverbank that is considered Stable with None/Little erosion frequently includes a range of Potential Indicators of Erosion and even some Types of Erosion. This is especially true of the Connecticut River which was formed by erosional processes through incision of sediment deposited in the bed of Lake Hitchcock after the last ice age. In addition, there are numerous old erosional features which were observed that can be attributed to the large flood event of 1936 which was the most significant flow event of recorded history that caused significant damage and erosion.

Based on observations made during the FRR it was common to find some small degree of undercutting (even at the interface of bedrock and soil layers), exposed roots, and creep/leaning trees in many segments of the river even if those segments were classified as Stable with None/Little erosion. However, in many cases these features were not considered significant unless they reached beyond the previously defined classification thresholds or appeared in significant combinations to warrant elevating the classification of a segment from Stable or None/Little to another Stage or Extent of Current Erosion category. For this reason it is observed in the Appendix figures and summary statistics that along a considerable length of the river erosional features such as undercuts, notching, exposed roots, and creep/leaning trees were observed and noted but were not considered sufficient to elevate segments from one Stage or Extent classification to another. Such segments of river are well below any reasonable threshold of being considered for stabilization or preventative maintenance efforts.

Tables containing the specific riverbank features and characteristic classifications identified at each riverbank segment are found in Appendix I.

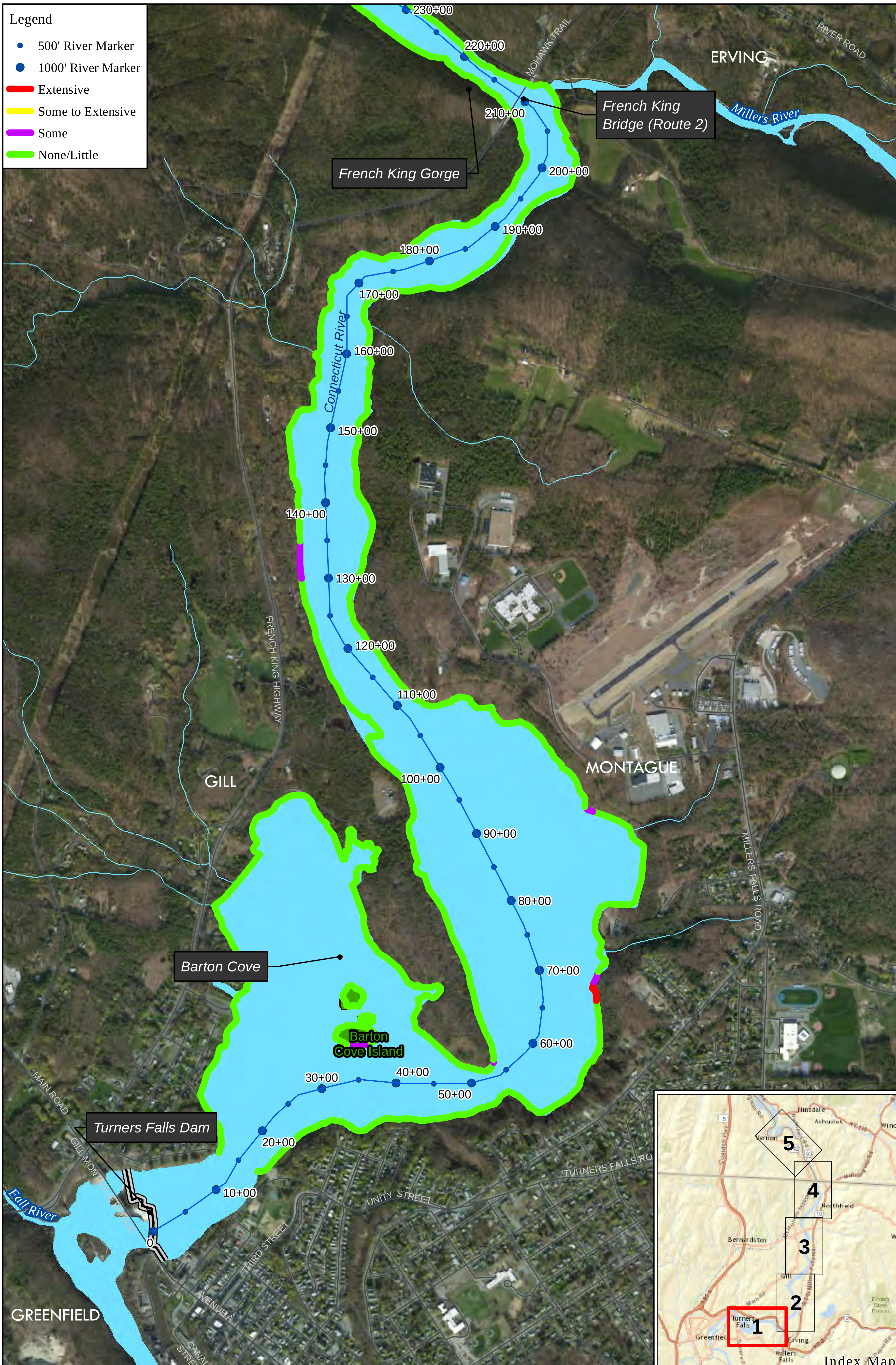
Table 6.1 Summary Statistics of Riverbank Features and Characteristics – Turners Falls Impoundment[24]

Riverbank Features	Characteristics[25]					
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%[26]	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[27]%	Exposed Roots 38.1%	Creep/Leaning Trees 62.7%	Overhanging Bank 12.7%	Notch 5.0%	Other 1.1%

[24] Summary statistics were developed for each riverbank feature and characteristic by calculating the sum of the length of all individual segments for a given feature or characteristic (e.g., lower riverbank sediment) and dividing it by the sum of the length of all riverbank segments in the Impoundment (including stabilized sites and islands) to determine a percentage. The results of the boat-based survey, complemented by land-based observations, were used to develop riverbank segmentation.
[25] Refer to Table 5.2 for definitions of each classification.
[26] 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.
[27] 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.

Riverbank Features	**Characteristics[25]**					
Stage of Erosion	Potential Future Erosion 5.5%	Active Erosion 0.6%	Eroded 9.1%	Stable 83.5%	In Process of Stabilization 1.3%[28]	
Extent of Current Erosion	None/Little 84.8%	Some 14.1%	Some to Extensive 0.5%	Extensive 0.6%		

[28] While originally not one of the RSP erosion condition classifications, one riverbank segment was classified as being "In the Process of Stabilization" due to the fact that riverbank stabilization work was being constructed at this 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 is then being planted to provide additional stabilization on the gravel beach as well as extending other vegetation onto portions of the upper riverbank.



FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

FirstLight GDF SUEZ

N

0 650 1,300 2,600 Feet

Figure 6.1:
Extent of Current Erosion
Map 1

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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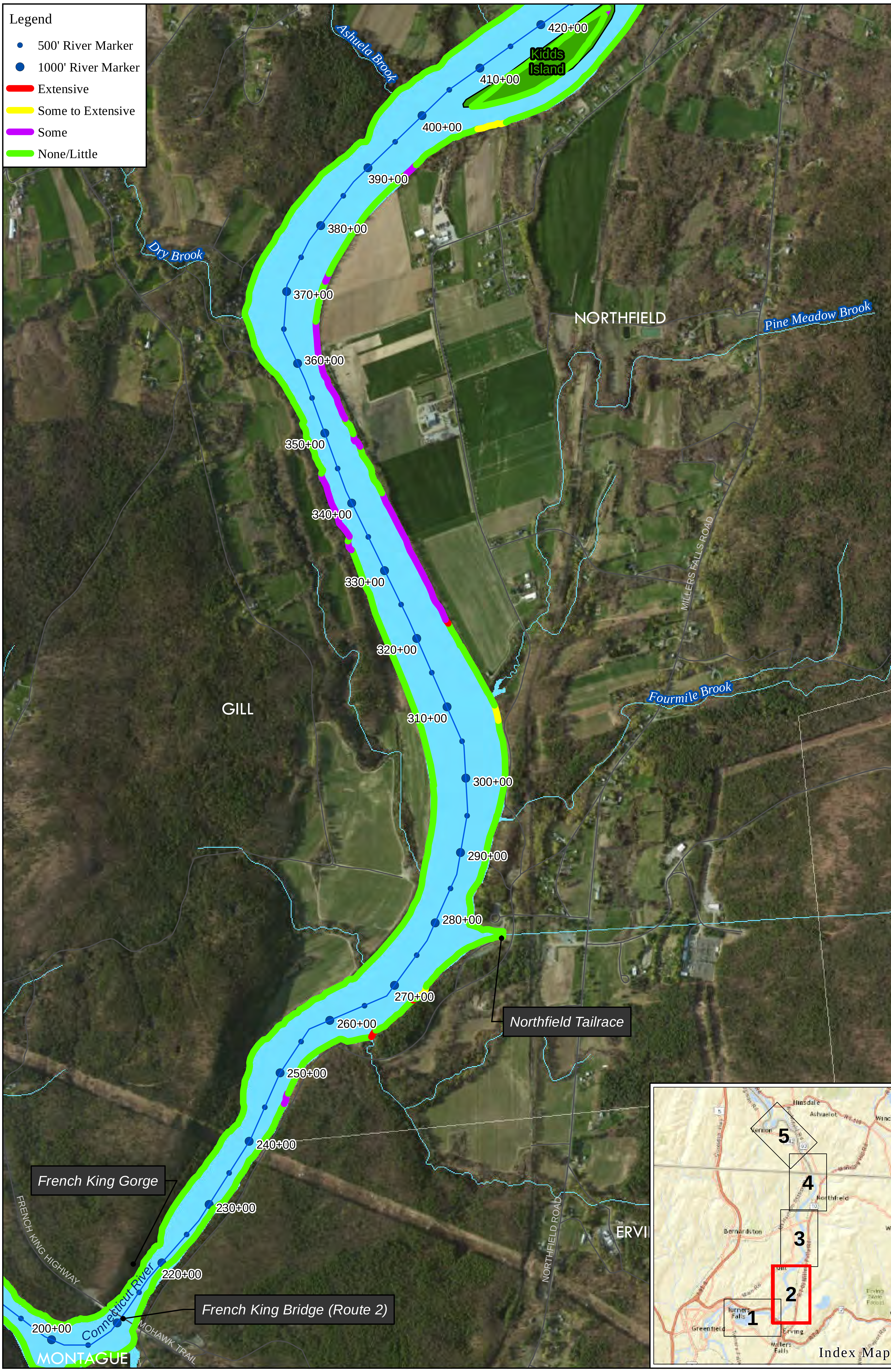

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NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

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0 650 1,300 2,600 Feet

Figure 6.2:
Extent of Current Erosion
Map 2

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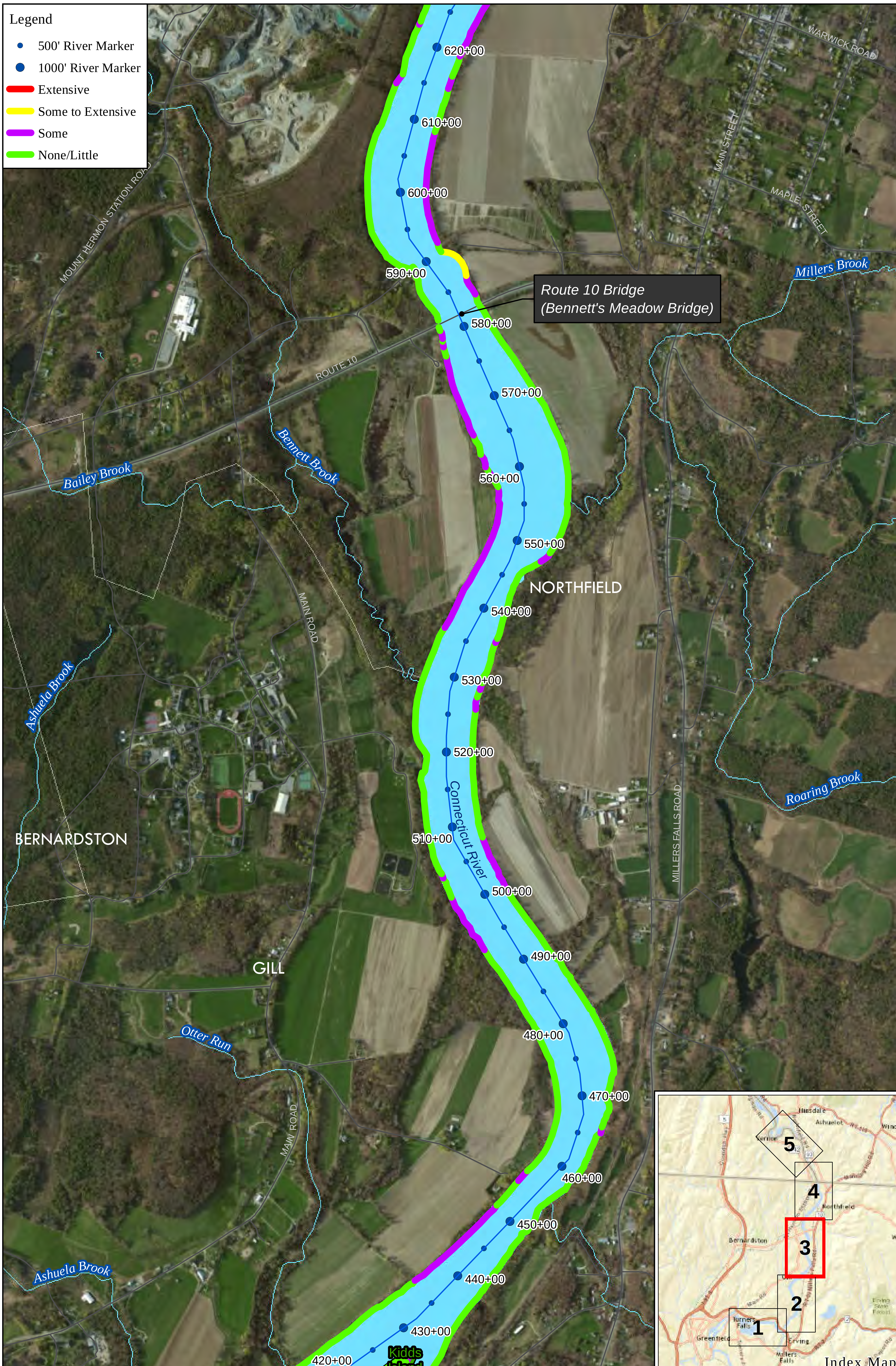

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Figure 6.3:
Extent of Current Erosion
Map 3

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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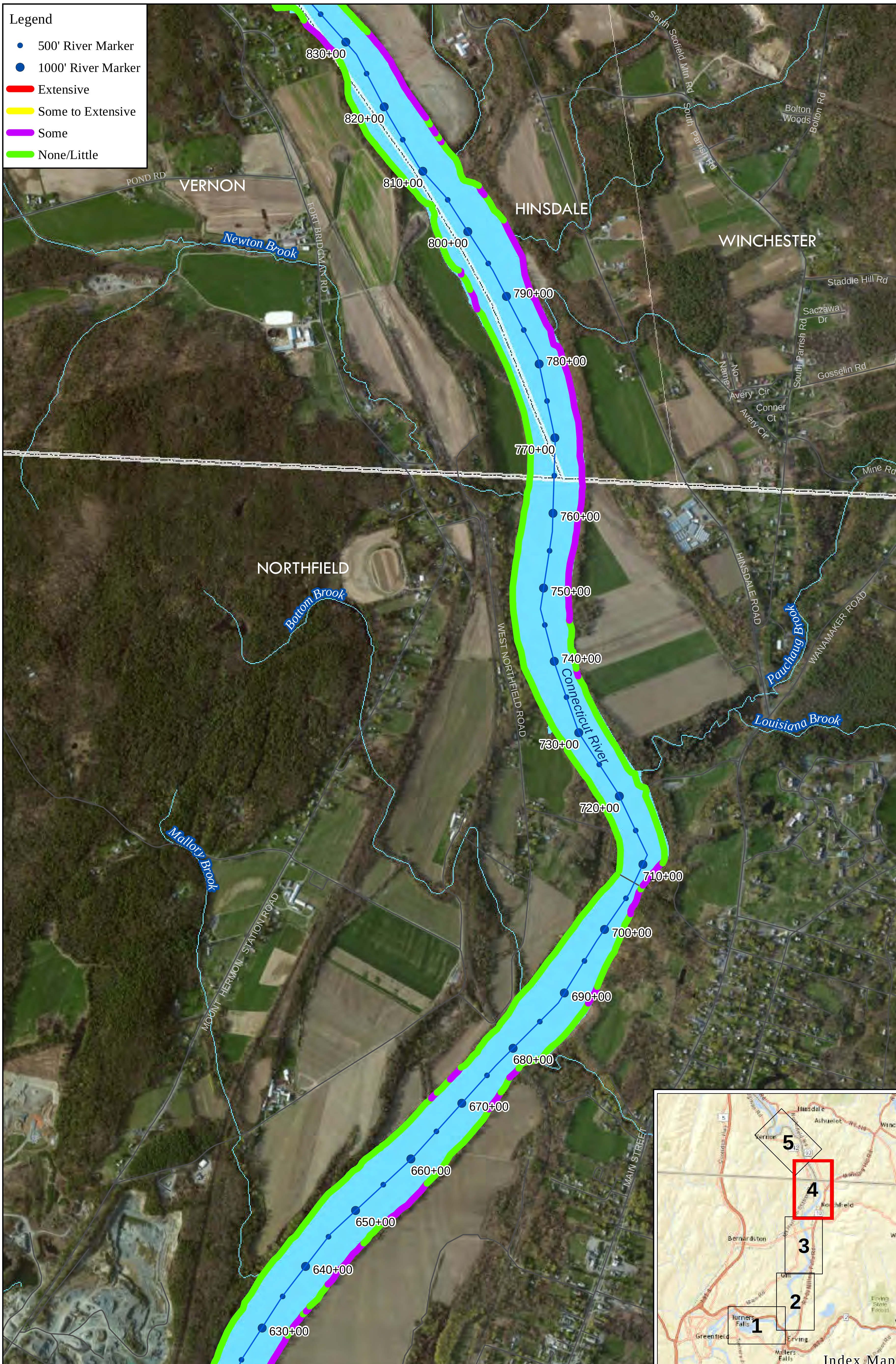

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Figure 6.4:
Extent of Current Erosion
Map 4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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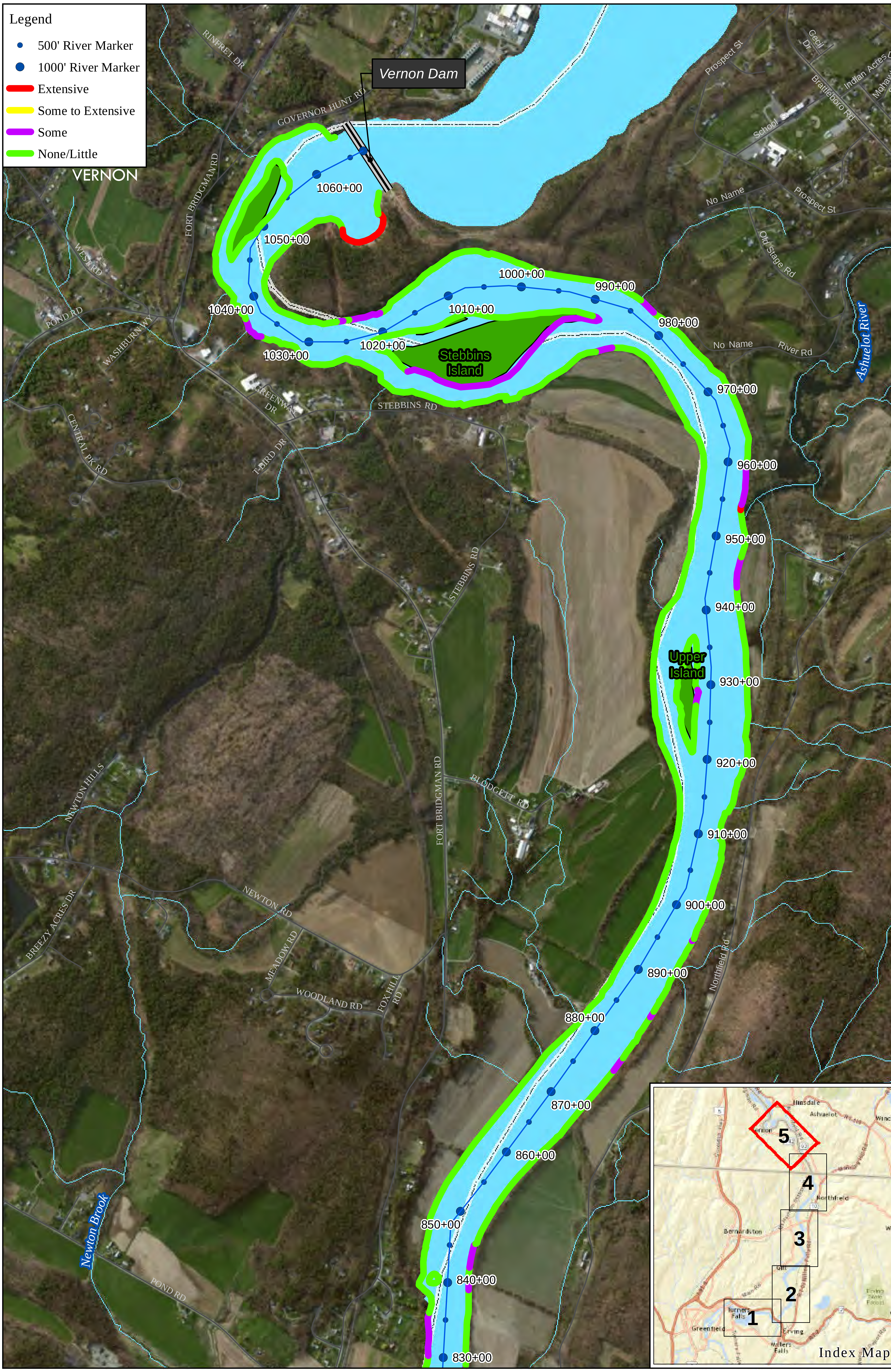

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0 650 1,300 2,600 Feet

Figure 6.5:
Extent of Current Erosion
Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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6.2 2008-2013 Analysis

The previous FRR conducted in 2008 found that the Impoundment was in generally good health with 83.3% of Impoundment riverbanks being classified as having little to no erosion. Observation of the Impoundment over the 5-year period since 2008 indicates that much of the Impoundment remains in a similar, but somewhat improved condition with 84.8% of the riverbanks classified as having None/Little erosion.

To determine changes in riverbank conditions from the 2008 to the 2013 FRR a comparison was made between key erosion results (Table 6.2). As shown in the table, there has been a net increase in stability and decrease in erosion of 1.5% over this 5-year period. Length of riverbank segments classified as None/Little increased by 1.5% from 83.3 to 84.8%. Extensive erosion remained the same at 0.6% while Some and Some to Extensive decreased from 16.1 to 14.6%.[29] A few segments of erosion were noted as either ongoing or new since the 2008 FRR. These sites were included as part of the detailed study sites for data collection and analysis associated with Study No. 3.1.2.

Primary events since 2008 that have occurred in the Impoundment include: 1) ongoing riverbank stabilization efforts implemented in accordance with the ECP and 2) Tropical Storm Irene (August 2011). Detailed descriptions of the stabilization work which has occurred since 2008 can be found in Section 8 while discussion of Tropical Storm Irene and other observed changes since 2008 are included below.

Tropical Storm Irene

Tropical Storm Irene (August 2011) was the flow event of record during the 5-year period between the 2008 and 2013 FRR's. The peak flow during this storm was 127,000 cfs as measured at the USGS maintained Montague, MA gage. Suspended sediment concentrations (SSC) measured following Tropical Storm Irene were found to be on the order of 1,000 - 2,000 mg/l.[30] By comparison, typical SSC values during mean annual flow conditions in the Impoundment (13,930 cfs) range from approximately 1.7 to 26.3 mg/l.[31] Figures 6.6 and 6.7 provide examples of the highly turbid water flowing through the Connecticut River during and following Tropical Storm Irene.

While the impacts of Tropical Storm Irene on riverbank instability and erosion will be assessed as part of Study No. 3.1.2, field observations following Irene found that significant localized areas of sediment deposition occurred at various locations throughout the Impoundment. Deposition was primarily observed on the lower riverbanks/beaches ranging from several inches to over a foot in some areas.[32]

[29] The 2008 FRR classified the extent of erosion as Extensive, Some, and Little to No Erosion. For comparison purposes, 2013 classifications of Extensive and None/Little were compared to the 2008 classifications of Extensive and Little to No Erosion, respectively. The 2013 classifications Some and Some were combined and compared to the 2008 classification of Some. Although different nomenclature was used during the 2008 FRR the classification terms and observation methods were commensurate to the 2013 terms and methods thus allowing valid comparisons to be made.

[30] Suspended sediment samples were collected shortly after the peak flow of Tropical Storm Irene (8/29 – 9/2/2011) from near the water surface at a number of locations throughout the Turners Falls Impoundment as well as from the Ashuelot and Millers Rivers, and a few locations in the Vernon Impoundment.

[31] As measured at the LISST StreamSide (2013) installed at the Route 10 Bridge in Northfield, MA as part of Study No. 3.1.3 *Northfield Mountain Project Sediment Management Plan.* These values were calculated as a daily average from days when the mean daily flow was between 12,000 and 16,000 cfs. Because the LISST StreamSide measures volume concentration in µl/l, measurements were converted to mass concentration in mg/l using a density conversion of 2.65g/cm^3 as normally used by the sampling equipment manufacturer. The density conversion may be revised after further study.

[32] Sediment deposition was observed during the recession limb of the flood hydrograph by Robert Simons and Charles Momnie at a number of locations throughout the Turners Falls Impoundment. Additional measurements of

Examples of lower riverbank deposition resulting from Irene can be found in Figures 6.9 - 6.11. While some of the sediment deposited as a result of Tropical Storm Irene was subsequently washed away, some of it remained and provided additional media for recruitment of aquatic or other low-lying riparian vegetation. This vegetation was found to have colonized and is growing on the layer of deposited sediment.

Although riverbank segments where lower riverbank vegetation currently exists remain a relatively small portion of the Impoundment, there has been a significant increase in lower riverbank vegetation. This increase in vegetation is a result of the sediment deposition due to Tropical Storm Irene combined with the frequency and magnitude of flows since Irene which have allowed the majority of the deposited sediment to remain in place and vegetation to establish. Examples of new lower riverbank vegetation at a number of locations throughout the Impoundment are shown in Figures 6.12 and 6.13.

Vegetation

From the 2008 to the 2013 FRR the extent of lower riverbank vegetation that is readily observable has increased significantly. In 2008 the longitudinal extent of lower riverbanks where vegetation was found was approximately 5.1% whereas in 2013 lower riverbank vegetation had increased to approximately 11.7%. This increase in lower riverbank vegetation corresponds to approximately 16,000 linear feet of additional lower riverbanks containing vegetation. This is a significant length considering that stabilization projects have typically been in the 1,000 to 2,000 feet per year range for the past several years.

Vegetation at this portion of the riverbank, which is primarily located at the transition between the lower and upper riverbank, provides significant erosion protection by damping or attenuating hydraulic forces from the current and boat waves, increasing resistance to erosion due to root density and strength, and encouraging additional sediment deposition. Sediment deposition and growth of vegetation at this key location on the riverbank provides support to the toe of the upper riverbank which increases stability and discourages erosion. The density of a patch of such vegetation in the summer is shown in Figure 6.14.

This notable and observable natural increase in lower riverbank vegetation is an encouraging trend that typically is a self-supporting and sustaining process. Lower riverbank vegetation slows the movement of water which encourages sediment deposition thereby building up this portion of the riverbank. Additionally, once the vegetation is established, it has a tendency to try to expand through reproductive or recruitment processes. This natural phenomenon has been successfully replicated in a number of recent riverbank stabilization projects that encourages sediment deposition and growth of vegetation on the lower riverbank as it transitions towards the upper riverbank.

Urgiel Linear Erosion Feature

A linear erosion feature was observed in 2013 extending longitudinally along the river through a portion of the Urgiel Upstream site and continuing upstream over a distance of several hundred feet (Figure 6.15). The manifestation of this feature is a vertical shift on the order of a foot to several feet in height where apparently the lower part of the bank has shifted downward exposing this vertical scarp. It does not appear that the lower bank is separating horizontally from the upper bank so it is not a tension crack but instead is a vertical shift. The fact that this feature extends through a variety of terrain from a stabilized segment to a natural segment and crosses perpendicular features such as a local drainage features suggests that the cause for this shift is the result of something deeper below the surface farther down the bank into the river itself. This area is part of a complex of detailed study sites (10L, 10R, and 26) where continued

sediment deposition were made by NEE after the flood had passed at previously established sediment monitoring locations found at stabilization sites on the right bank of the river across from the Northfield Mountain tailrace.

observation and detailed study will occur as part of Study No. 3.1.2. The findings of this detailed analysis will help to develop a better understanding of this particular feature.

Lower Riverbank Sediment

One factor in evaluating the stability of a riverbank is the resistance to erosion of the lower riverbank. If a lower riverbank consists of non- or less-erodible material it is less erodible and provides support to the upper riverbank. There has been an increase in lower riverbanks consisting of gravel from 2008 to 2013 and less in the silt/sand category. From 2008 to 2013 there has been a decrease in silt/sand of approximately 6% and a corresponding increase in gravel of approximately 5%. Much of this change is due to gravel placement on the lower riverbanks (along with anchored woody debris and vegetation) due to the construction of several stabilization projects during this time frame (Lower Split River Farm, Upper Split River Farm, Bathory/Gallagher). Placement of gravel on the lower riverbank along with anchored woody debris before planting of vegetation is shown in Figure 6.16.

Table 6.2 Comparison of Extent of Erosion 2008-2013

Extent of Current Erosion	2008[33]	2013
None/Little	83.3%	84.8%
Some	16.1%	14.1%
Some to Extensive	N/A	0.6%
Extensive	0.6%	0.6%

[33] The 2008 FRR classified the Extent of Current Erosion as Extensive, Some, and Little to No Erosion. For comparison purposes, 2013 classifications of Extensive and None/Little were compared to the 2008 classifications of Extensive and Little to No Erosion, respectively. Some and Some to Extensive 2013 classifications were combined and compared to the 2008 classification of Some.

Figure 6.6 Contrast of sediment laden water in the Impoundment due to Tropical Storm Irene with Millers River

HI photo 508

Figure 6.7 Turbid water from Connecticut River flowing into Long Island Sound during Tropical Storm Irene

Figure 6.8 Erosion during Tropical Storm Irene

HI photo 366

Figure 6.9 Sediment deposition due to Tropical Storm Irene

HI photo 239

Figure 6.10 Sediment deposition due to Tropical Storm Irene

Lower Split River restoration site – 60 cm deposition

Figure 6.11 Sediment deposition and vegetation including cottonwood seedlings

photo 6586

Figure 6.12 Sediment deposition and vegetation

Segment 303, FRR photo 1577

Figure 6.13 Sediment deposition and vegetation

FRR photo 1546

Figure 6.14 Lower riverbank vegetation, summer 2014

photo 6779

Figure 6.15 Linear erosion feature

photo 1056

Figure 6.16 Gravel placement

photo 567

6.3 Comparisons with Past FRR's

As required by the SPDL the results of the 2013 FRR were compared to previous FRR's using summary statistics and analysis in ArcGIS to the extent comparisons can be made considering differences in survey technology and accuracy from one survey to the next.

Comparisons among FRRs are complex. Any comparison must consider a range of issues including the type of equipment utilized, the spatial accuracy of the equipment, and the specific riverbank features and characteristics which are being classified in the field. In addition to these technical issues, the perspective of the observer in evaluating the range of riverbank features and characteristics can vary from one survey to the next. Finally, the time of year when the survey was conducted can affect riverbank visibility at the time of observation (e.g., leaf-off conditions vs. summer conditions). These factors must all be taken into account when conducting comparisons between FRR's. Although such comparisons are complex FirstLight worked to minimize the variability between surveys by taking into account the considerations previously mentioned allowing for high level comparisons to be performed. Given the fact that the 2013 core methodology and personnel were essentially the same as the 2008 FRR it was found that the results of these FRR's were especially comparable.

Table 6.3 provides a high level summary of each FRR from 1998-2013.

Field Equipment Utilized, 1998-2013

As noted in Table 6.3, the 1998, 2001, and 2004 FRR's utilized a GPS enabled video camera which recorded the position of the antenna (located on the boat in close proximity to the camera) while simultaneously collecting video images of the riverbank. While considered leading edge technology at the time the spatial accuracy of the field collected data could vary by tens or several tens of feet from the recorded position on the boat to the intended target on the riverbank. Factors such as the position of the boat, camera angle, and observer vantage point all could greatly influence the spatial accuracy of the data. Due to the accuracy limitations of the equipment if the same observer and boat operator covered the same river on the same day it is possible that there would be differences between one set of observations and another.

The available technology improved greatly for the 2008 and 2013 FRR's. These FRR's utilized a GPS enabled laser rangefinder which improved the accuracy of the riverbank segmentation. The laser rangefinder shoots a location on the bank at which time a distance and azimuth from the boat to the bank are recorded. The GPS unit collects the coordinate information of the boat at which time an offset is automatically conducted using the measured distance and angle. The end result is actual riverbank coordinates of the start and end points of each riverbank segment (as opposed to boat coordinates used in 1998, 2001, and 2004). The increased accuracy of the field equipment used from 2008-2013 as compared to 1998-2004is apparent when reviewing the total length of Impoundment riverbanks reported for each FRR. The 1998 FRR reported a total Impoundment riverbank length of 243,000 ft (including islands) while the 2008 FRR reported 246,282 ft. (including islands). These changes in riverbank lengths can be attributed, at least in part, to the increased accuracy of the field equipment used over time.

Appropriateness of Comparisons with past FRR's

In general, advances in mapping software such as ArcGIS have outpaced the field technology that can be reasonably applied to an FRR. Thus, while it is theoretically possible to conduct segment by segment comparisons between FRR's using programs such as ArcGIS these comparisons are not appropriate due to the varying type of equipment used, the spatial accuracy of the equipment, varying methods employed over time, the time of year the surveys were conducted (1998 & 2001 – July, 2004-2013 – November), and the fact that some FRR's took into account islands and others did not.

Further complicating in-depth comparisons between FRR's is the fact that riverbank feature and characteristic classification terminology and criteria have evolved over time, often changing from one FRR to the next. Any comparison between FRR's using ArcGIS must address equipment spatial accuracy issues and differences in technology as well as differences in classification categories and how these differences quantitatively affect mapping results. In sum, while it is possible to compare FRRs, any comparisons must be carefully developed and limitations considered in the process of making any conclusions.

Although in-depth, segment by segment comparisons with past FRR's are not appropriate, comparisons of summary statistics from one FRR to the next can be made with reasonable validity given that each set of FRR data collection and summary results have been consistent.

In comparing FRRs it is also important to evaluate basic observations of the condition of the Impoundment and constituent parts as well as significant events that occurred between one FRR and another to develop an assessment of trends and changes that occur over time.

Comparison of 2013 FRR Results with past FRRs

Since 1998, riverbanks in the Impoundment have improved in stability through three primary mechanisms: 1) stabilization/preventative maintenance projects, 2) increasing lower riverbank vegetation and 3) increasing vegetation on areas of the upper riverbank. Riverbank stabilization projects implemented as a result of the ECP have transformed almost 20,000 feet of eroded riverbank into stable, well-vegetated segments of the river that are no longer eroding.[34] Figures 6.17 and 6.18 contrast a site (Skalski) before and after stabilization. As observed in the figures, vegetation has been expanding and growing into areas where vegetation is sparse. In addition, there has been a noticeable increase in lower riverbank vegetation that dampens and attenuates river current and wave activity thereby increasing protection to the generally steeper upper riverbank areas. Details of riverbank stabilization work that has been conducted is discussed further in Section 8.1 while sediment deposition and lower riverbank vegetation was discussed previously. As a result of stabilization projects and natural processes of vegetation establishment and growth (on both the upper and lower riverbanks), Impoundment riverbanks have become more stable and erosion has decreased over the past 15 years.

In 1998, 20 sites were identified with the greatest severity of erosion. Since that time most of the previously identified sites have been stabilized. While some of these sites remain un-stabilized (i.e. downstream of Vernon Dam and at the Route 10 Bridge) most of the eroding sites that remain in 2013 are less severely eroding and of smaller lengths than the initial set of sites. Figures 6.19 and 6.20 compare examples of eroded areas in 1998 to 2013.

In the 2008 FRR, a few segments of lower riverbank vegetation were observed. From 2008 to 2013 there has been additional expansion of lower riverbank vegetation from 5.1% to 11.7%. As previously discussed, this represents approximately 16,000 feet of additional lower riverbank vegetation over this 5 year period. Recent riverbank stabilization projects have been designed to encourage deposition of sediment by including woody debris to slow the current and break up wave activity which further

[34] Prior to 1998, 27,900 feet of riverbank had been stabilized primarily by rip-rap (including 2,000 feet using hard techniques by the USACE). Also prior to 1998 an additional 2,640 feet of riverbank had been stabilized in the first phase of bio-engineering projects for a total of 30,540 feet. The following lengths of riverbank have been stabilized by additional phases of bio-engineering techniques: 2,500 ft (1998-2001), 2,680 ft (2001-2004), 4,635 ft (2004-2008), 8,335 ft (2008-2013), for a total from 1998 to 2013 of 18,150 ft. The total length of stabilization efforts extends over a length of 48,690 ft. This does not include preventative maintenance projects at a number of Camp locations ("Camp" properties are privately owned cabins located on Project Lands in the Towns of Gill and Montague, Massachusetts). These small projects utilize bio-engineering techniques and total approximately 290 feet. Total riverbank protection through 2013 extends along 48,980 feet of the Turners Falls Impoundment.

encourages the establishment of vegetation on the lower riverbank areas. In addition, lower riverbank vegetation has been planted and seeds distributed to increase the coverage and density of this important component of vegetation as an integral part of the riverbank stabilization process (Figures 6.21 and 6.22).

A comparison of key stability/erosion statistics has been made from 2008 to 2013. From 2008 to 2013 the extent of riverbank experiencing None/Little erosion increased from 83.3% to 84.8% (205,153 to 211,158 feet), representing a 1.5% increase in stabile length over this 5 year period. In 2008, 16.1% of the riverbanks were classified is the some erosion category and 0.6% in the extensive erosion category. In 2013, the categories were subdivided into some, some to extensive, and extensive erosion with the survey showing 0.6% in the extensive category (similar to 2008), with 0.5% and 14.1% in the some to extensive and some categories (representing 1.5% decrease in erosion in these categories from 2008).[35]

[35] In 2008 the total length of Impoundment riverbanks, including islands, was found to be 246,282 ft. In 2013 this length was 248,934 ft. These lengths were determined from coordinates collected during each FRR's boat-based GPS survey and the establishment of curvilinear segments of the bank line between segment start and end points. In 2008 the curvilinear segment lengths were determined from digital USGS maps while in 2013 these curvilinear segments were determined from aerial photography. Use of the aerial photography allowed for a more detailed definition of this land-water interface resulting in a greater length from 2013 compared to the smoother line segments from 2008. In addition, the island in Barton Cove was mapped in 2008 as a single island, whereas in 2013 it was mapped as three islands. This also resulted in a net increase of length from one survey to the next.

Table 6.3 Summary of FRR Methods, 1998-2013

	1998	2001	2004	2008	2013
Equipment/Method	Geo-referenced video shot from boat	Geo-referenced video shot from boat	Geo-referenced video shot from boat	Geo-referenced video from boat coupled with data-logged observations of riverbanks with position shot by laser rangefinder	Geo-referenced video from boat coupled with data-logged observations of riverbanks with position shot by laser rangefinder, geo-tagged photographs, land-based observations from top of bank along TFI and detailed observations at selected sites
Features & Characteristics	Bank material, bank geometry (slope, height, beach), vegetation, erosion/stability characteristics	Bank height, bank slope, bank material, degree of vegetation, erosion	Bank height, bank slope, bank material, degree of vegetation, erosion	Upper riverbank slope, Lower riverbank slope, Upper riverbank sediment, Lower riverbank sediment, Upper riverbank height, Upper riverbank vegetation, Mass wasting, Erosion type, Lower riverbank vegetation	Upper riverbank slope, Upper riverbank height, Upper riverbank sediment, Upper riverbank sediment, Lower riverbank slope, Lower riverbank sediment, Lower riverbank vegetation, Types of erosion, Indicators of potential erosion, Stages of erosion, Extent of erosion. Land based observations of soils, erosion characteristics, vegetation.
Time of year	July	July	November	November	November/December
Observer	Simons	Marcus	Marcus	Simons	Simons/Marcus/ Simon/Choi

Figure 6.17 Example of Erosion Site prior to stabilization (Skalski, Site 6 – 1998)

Figure 6.18 Example of Erosion Site after stabilization (Skalski, 2008)

Figure 6.19 Flagg Site in 1998

Figure 6.20 Eroded site (Segment 90), 2013

Figure 6.21 Vegetation planted on lower riverbank at stabilization site

Figure 6.22 Vegetation planted on lower riverbank at stabilization site

6.4 Correlations between Riverbank Features, Characteristics, Land-use, and Bank Instability and Erosion

Relationships exist between erosion and riverbank features, characteristics, and adjacent land-use. For example, riverbanks with steep slopes and less vegetation are more prone to either experience some type or degree of erosion or be more susceptible to erosion than a riverbank that is flatter and well-vegetated. Similarly, some types of land-use or development may cause disturbances which lead to the destabilization of riverbanks. An example of this is when riparian vegetation is reduced for development or agricultural purposes thus decreasing the stability of the riverbank and increasing its susceptibility to erosion with a given range of hydraulic forces.

This section provides a general review of potential correlations observed in the field between 1) riverbank features and characteristics and bank instability, and 2) adjacent riverbank land-use and bank instability. A more detailed investigation of this topic is currently being investigated as part of Study No. 3.1.2 the results of which will be included in the final report for that study.

Correlations between Riverbank Features, Characteristics, and Erosion

While multiple forces can influence erosion or the potential for erosion preliminary analysis of correlations between riverbank features and characteristics, based on observations made during the 2013 FRR, found that the potential for future erosion is relatively greater where riverbank slopes are steep to overhanging, protective vegetation is lacking, and sediment is comprised of silt/sand and inherently quite erodible. The correlations between these characteristics can be seen in Figures 6.23 -6.26. Summary statistics denoting the percentage of riverbanks with varying ranges of slope, vegetation, sediment, and erosion are documented in Table 6.1. Further investigation of these correlations is currently underway as part of Study No. 3.1.2.

Correlations between Adjacent Land Uses and Erosion

Various types and degrees of erosion found in the Impoundment can be observed at locations with a wide variety of adjacent land-uses. Two of the most severe areas of erosion that were identified in the 1998 FRR, and continue to be so in 2013, are located immediately downstream of Vernon Dam (Figure 6.27) and just upstream of the Route 10 Bridge (Figure 6.28). As discussed in the report titled *"Analysis of Erosion in the Vicinity of the Route 10 Bridge Spanning the Connecticut River,"* (Simons, 2012), severe erosion which has occurred at these locations are due to extreme hydraulic conditions and eddy formation. The associated developed land-use (i.e. a dam and a bridge) combined with the riverine and geomorphic features present at these locations have created the extreme hydraulic conditions which result in the observed extensive erosion.

Erosion has also been observed in areas where houses and other associated development are located in close proximity to the river. An example of erosion in close proximity to a house is shown in segment 388 (Figure 6.29). As shown in the figure undercutting, overhanging bank, and exposed roots were observed at this location in close proximity to the structure. In several instances where houses have been built close to the river, riparian vegetation has also been cleared which can adversely affect riverbank stability.

The strongest correlation between land-use and erosion has been observed in agricultural areas. Agriculture along the river typically is located on relatively flat floodplain terraces with only a narrow or virtually non-existent zone of riparian vegetation. Frequently the riverbanks in these areas are steep to overhanging and consist of silty/sandy soils that are easily erodible unless sufficient vegetation is present to reinforce the soil and provide some buffering of hydraulic forces. An example of erosion that has occurred where the agricultural land-use exists can be seen in Figure 6.30.

Further analysis and evaluation of correlations between various land-uses and erosion processes is being conducted as part of Study No. 3.1.2. Results of these analyses will be presented in the final report for that study.

Figure 6.23 Flat, vegetated bank

904

Figure 6.24 Moderate slope, vegetated bank

993

Figure 6.25 Steep-Overhanging bank lacking in vegetation

673

Figure 6.26 Steep-Overhanging bank with little vegetation

1403

Figure 6.27 Eddy-induced erosion at Vernon Dam

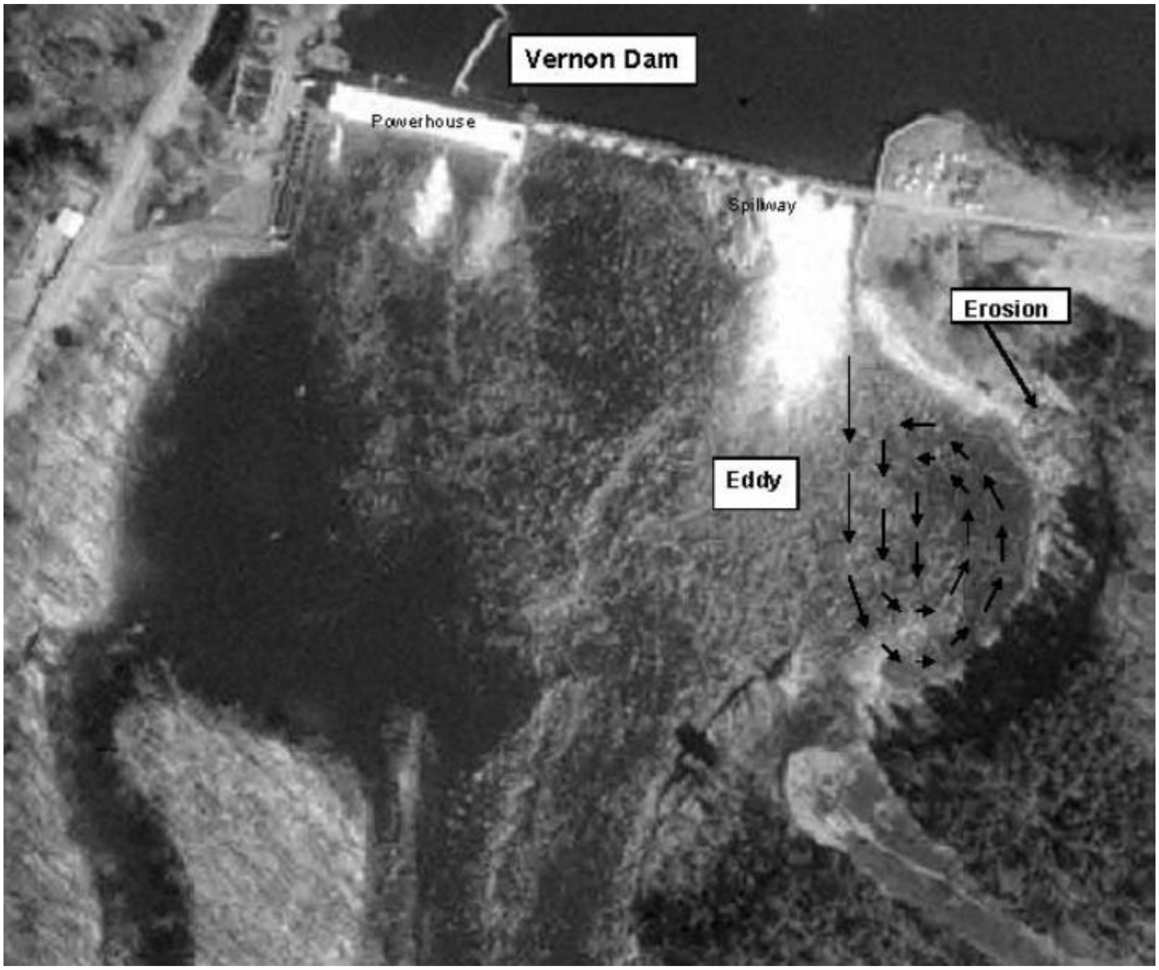


Figure 6.28 Eddy-induced erosion at Route 10 Bridge

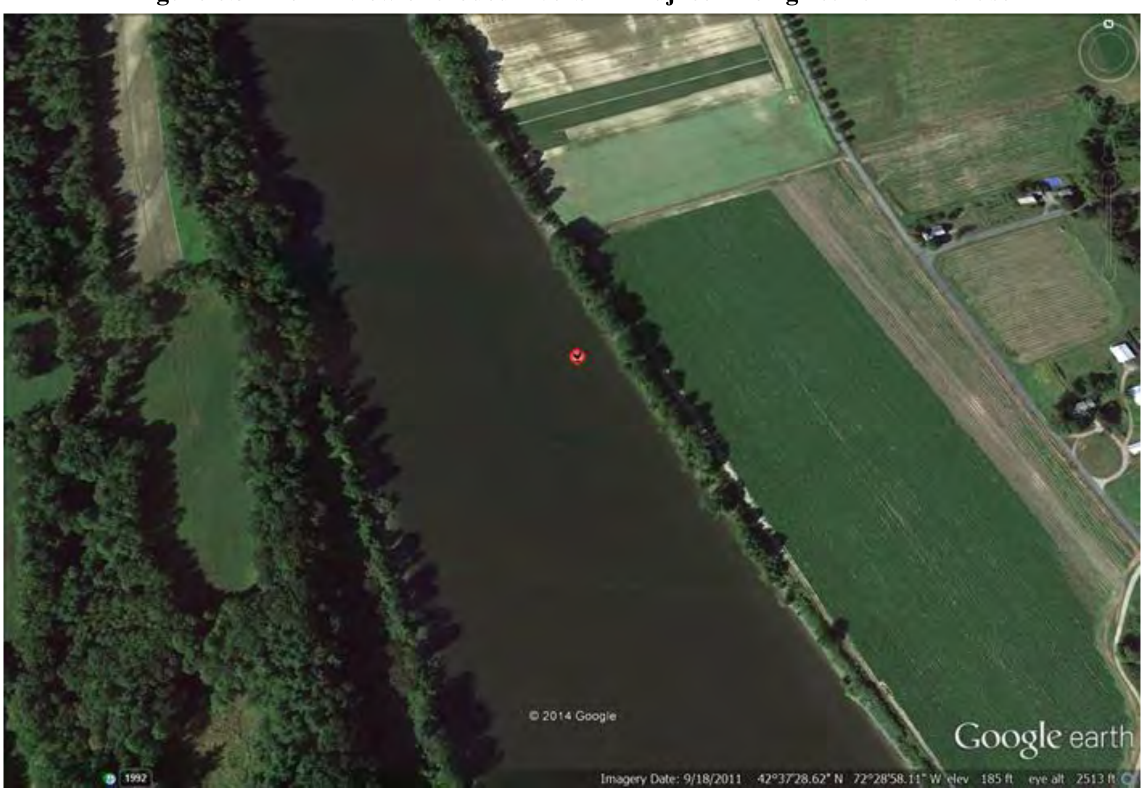
Figure 6.29 Erosion adjacent to seasonal Camp 2-W

439

Figure 6.30 Erosion adjacent to agricultural land-use

621

Figure 6.31 Aerial view of eroded riverbank adjacent to agricultural land-use



7 VIDEO AND PHOTOGRAPHIC DOCUMENTATION OF RIVERBANK CONDITIONS IN 2013

7.1 Geo-referenced Photos and Video

Two sets of images, geo-referenced digital photographs and geo-referenced videos, were collected during the boat-based survey to document riverbank conditions along the Impoundment as they existed in November 2013. The photographs and videos visually document riverbank conditions as observed at the time they were taken. The videos are geo-referenced and the photographs are geo-tagged so that the position where each photograph was taken is known as well as the position of the video camera as the boat travelled along the path of the Impoundment.

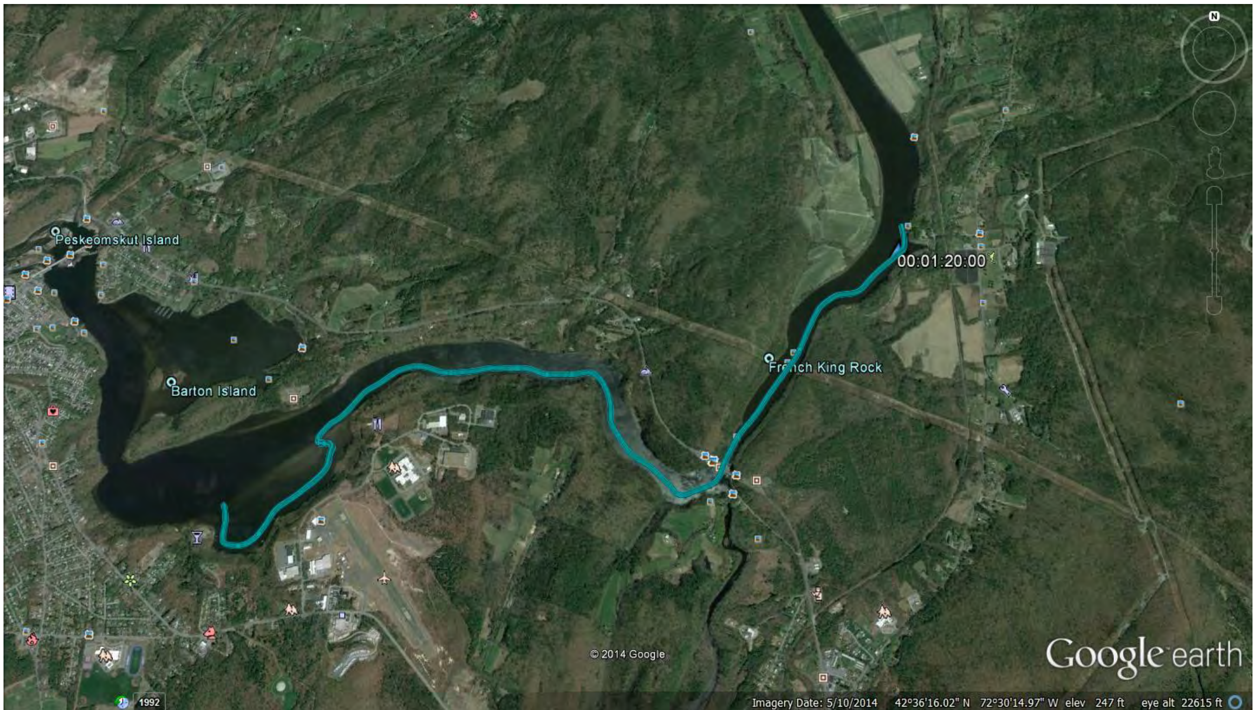
Approximately 1,600 geo-tagged digital photographs were taken of the Impoundment. By using software such as IsWhere from Red Hen Systems, Google Earth will automatically display the location of the photograph based on its geo-tagged coordinates. Figures 7.1 and 7.2 depict examples of this. Figure 7.1 shows the riverbank photograph while the red circle in the aerial image from Google Earth displayed in Figure 7.2 depicts the location where the photograph was taken. For any area of interest, a photograph can be referenced to see what the riverbank looked like during the 2013 FRR. The geo-tagged photographs are available in digital form and are included in digital Appendix K.

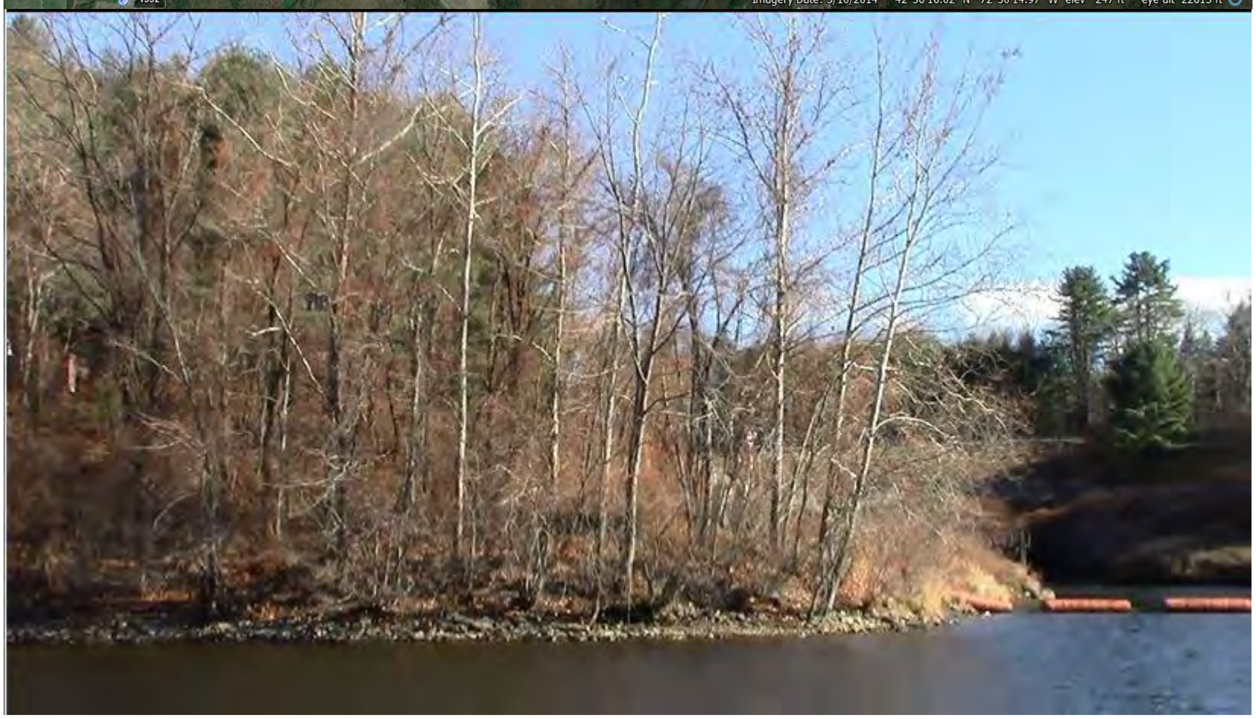
Complete geo-referenced video of the Impoundment (except for the back side, right-channel behind the island immediately downstream of Vernon Dam as discussed in Section 5) was also captured during the boat-based survey. Similarly to the geo-referenced digital photographs, video still shots or clips can be seen with their accompanying location using software such as IsWhereVideo from Red Hen Systems. Figure 7.3 provides a screen shot example of this capability. The left image from the screenshot is an image captured from the video. The image on the right is from Google Earth showing the range of the entire video segment shown in red with the yellow pin indicating the actual location where the clipped video image was taken. The complete geo-referenced video of the Impoundment is included in digital Appendix K.

Figure 7.1 Geo-tagged Photograph Downstream Vernon Dam

Figure 7.2 Location of Geo-tagged Photograph Downstream Vernon Dam

Figure 7.3 Example of Geo-referenced Video





7.2 Re-creation of 2007 Field Geology Services Photo log

A photo log documenting the condition of the riverbanks throughout the Impoundment was collected in June 2007 as part of the *Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT* (Field, 2007) conducted by FGS. During the study scoping process Stakeholders requested that FirstLight recollect the photo log as part of the 2013 FRR. In order to show riverbanks under similar conditions as the 2007 photos a set of comparable photographs were taken in June and July 2014. A digital set of geo-referenced photographs can be found in digital Appendix K.

8 RIVERBANK STABILIZATION PROJECTS

8.1 History of Stabilization in Turners Falls Impoundment

There is evidence throughout the Impoundment of historic measures used to stabilize eroding riverbanks including using old bulkheads, revetments, concrete retaining walls, stone rip-rap, and tires. Significant bank hardening was conducted after the 1934 flood and 1938 hurricane. During the construction of the Northfield Mountain project in the late 1960's and early 1970's stone rip rap was installed along the riverbanks near the Tailrace, within Barton Cove, and in front of camps and private properties. These latter measures were largely successful protecting the banks from erosion.

Bank stabilization in the Impoundment has occurred in various phases since construction of the Northfield Mountain Project. During the initial phase of stabilization, from the beginning stages of the Northfield Mountain Project (late 1960's-1972) until 1996, the following lengths of riverbank were stabilized:

- 23,300 ft – Rip-rap
- 2,600 ft – Rip-rap with vegetation
- 2,600 ft – Grade and plant

Approximately 2000 ft of experimental bank stabilization measures were constructed by the USACE in the 1970s consisting of three segments of tires placed in different configurations and another segment of geo-textile fabric with articulated concrete blocks.

Starting in 1996, several initial projects were constructed utilizing bioengineering which began a new phase of stabilization. In 1998, a FRR was conducted which classified riverbanks in the Impoundment and prioritized the 20 most severely eroded sites to be considered for stabilization through implementation of the ECP (Simons, 1999). Descriptions of these sites, including their status as of 2013, are denoted in Table 8.1while the locations of these sites are shown in Figure 8.1.

Soil bioengineering projects on large rivers was uncommon in the U.S. in the 1990's as such initial projects were designed with structural elements to ensure stability. As projects successfully weathered high flows and storms, the bank restoration designs were modified with fewer structural elements, smaller diameter stone, or in the most recent projects, logs in place of stone. Bank stabilization projects implemented since 1996 have utilized a bioengineering or "soft engineering" approach to restoration. A "hybrid" approach to bank stabilization (using a stone toe of slope and vegetated upper bank) was developed after a series of public meetings and discussions initiated by the Franklin Regional Council of Governments (FRCOG) and Connecticut River Streambank Erosion Committee (CRSEC).

Since the original FRR in 1998 there have been three phases of restoration work completed. Each phase of work has had an approximately 5 year implementation plan which included obtaining the associated local, state, and federal permits. With the exception of a permitting delay in 2002, at least one large construction project has been completed each year since 1996. Small scale bank restoration projects, which are part of the preventative maintenance plan, have been completed in addition to the larger bank restoration projects during this time.

Bank stabilization projects within the Turners Falls Impoundment have evolved since 1996. The different construction techniques and materials have demonstrated varying levels of success although all projects have been successful in stabilizing the sites and controlling erosion. Over the years, construction techniques and materials have changed in response to the performance of previously stabilized sites, improved understanding of stabilization techniques, and comments from regulators and stakeholders.

In 2001, the identification of several species of state-listed Odonates (dragonflies) led to scientific evaluations and the modification of the restored banks to enable upland use by emerging insects. The presence of cultural resources on or near bank restoration projects also led to design changes and modifications of construction techniques to avoid impact to significant sites. These two elements, rare species and cultural resources, have been the primary drivers for bank restoration design.

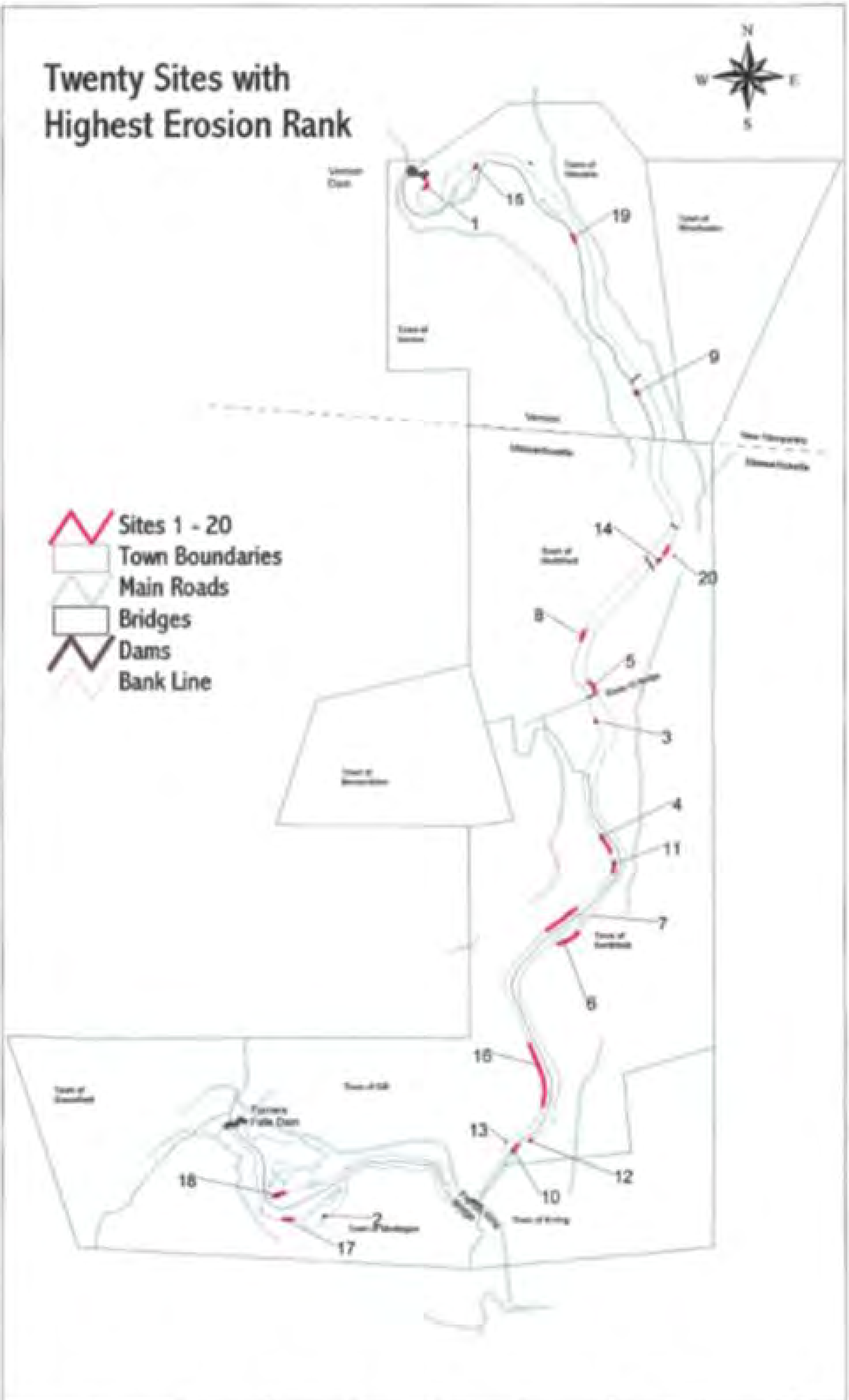
The flows recorded during Tropical Storm Irene (127,000 cfs at the Montague gage) in August, 2011 tested the past 15 years of bank stabilization efforts with no apparent significant damage to the stabilized project sites. This storm demonstrated that the bioengineering and preventative maintenance approach to bank restoration is effective in helping to control additional bank erosion as well as providing important wildlife habitat features. To date, all stabilized sites have successfully restored the eroding banks and have significantly reduced erosion in the Impoundment.

Since the 2008 FRR, seven different sites totaling 6,135 linear feet (5,335 linear feet of major riverbank restoration and 800 linear feet of preventative maintenance) have undergone some form of stabilization.

Table 8.1 Twenty Sites with Highest Erosion Rank from the Erosion Control Plan, 1998 and current status

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

(Simons, 1999)



Twenty Sites with Highest Erosion Rank
N
W
E
S
Sites 1 - 20
Town Boundaries
Main Roads
Bridges
Dams
Bank Line
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Vermont
Massachusetts
Turners Falls Dam
Town of Gill
1
0
1
2
3
4
5
6
7 Miles

Figure 1.2

8.2 Evaluation of Existing Bank Stabilization Projects

This section provides a critical review of the bank stabilization projects that have been conducted as of the 2013 FRR to determine if the primary and secondary goals of the ECP have been achieved. As outlined in the ECP, primary goals include infrastructure protection, erosion control, sediment retention, and bank stability have been achieved; while secondary goals include farmland protection, wildlife habitat protection, cultural resources protection, and the establishment of native vegetation.

The restoration projects have been largely successful to date in meeting the primary and secondary project goals of protecting property, controlling the rate of erosion and sediment deposition, and protecting habitat. The bioengineering approach has been found to be resilient in stabilizing the riverbanks during water level fluctuations, spring floods, and storms, including Tropical Storm Irene in August 2011. Since the inception of the ECP there has been an evolution of design and construction methods based on performance and specific recommendations by regulatory agencies. As part of that evolution construction designs have been gradually using “softer” engineering approaches which minimize or remove all hard structural elements. Construction techniques have been modified to reduce the active construction time and the construction companies retained have been selected due to their specific expertise in river construction and ecological restoration. The use of plant cultivars suggested by the Natural Resources Conservation Service (NRCS) for the revegetation of the first stabilization projects have been phased out in favor of using all native species from local sources and genotypes. Lastly, the employment of natural channel design features for the retention of sediment in the most recent bank stabilization projects has proven to be effective in preventing erosion to the adjacent bank.

The protection of cultural resources and wildlife habitat, particularly for rare Odonates has dictated the final design, construction access, types of machinery (if any), and the time of year for the bank stabilization construction. There are many local, state, and federal regulatory agencies that provide site specific review comments during the permitting process for each project which must be addressed prior to finalizing restoration designs.

Riverbank stabilization/restoration and preventative maintenance projects were constructed in three phases (1996-2000, 2001-2008, and 2009-2013). Over time the design and construction of these projects evolved from initial bio-engineering projects which utilized relatively larger and greater quantities of rock for the toe of the slope and vegetation on regarded upper slopes to recent projects with generally flatter beaches with gravel, woody debris, and vegetated upper slopes without reshaping or regarding the upper slopes. Maps denoting the locations of the existing bank stabilization projects are found in Figures 8.2 - 8.6.

All constructed sites are inspected at least once each year to review project stability and to conduct general maintenance. Permit compliance surveys are required for 2 to 5 years after construction depending on the specific permit requirements of local, state, and federal regulatory agencies. A Certificate of Compliance (State Wetlands closure) marks permitting completion of a project. This is requested by FirstLight approximately 2 years following the completion of a project or when all permit conditions have been satisfied.

Following construction of various stabilization projects it has been observed that a minor introduction of invasive plant species occurred. In general these invasive species have been controlled, however, following Tropical Storm Irene in August 2011, the 2012, 2013, and 2014 Operation and Maintenance (O&M) inspections have found significantly more invasive plant species along the riverbanks within the Impoundment, both on restored sites and elsewhere. The quantity of plants (e.g. purple loosestrife, dispersed via tiny seeds) has increased, and additional species (e.g. winged euonymus, Japanese Barberry, and Oriental Bittersweet) all spread by seeds, are appearing for the first time within restored sites. It is possible that the increased presence of invasive plant species was the result of the flood event associated with Tropical Storm Irene. An example of this are the fragments of Japanese Knotweed which were found on many of the riverbanks immediately following Tropical Storm Irene, and in locations (e.g. Split

River Farm) that did not previously support this invasive species. The most recent compliance inspections of restoration sites were conducted in July 2013 and August 2014.

The Phase III bank restoration projects constructed between 2009 and 2013 require monthly inspections between April and October for a period of 5 years. The monthly inspections evaluate bank stability, sediment deposition/erosion, and vegetation establishment at each site. Additionally, detailed cross section surveys of the bank and river bed are conducted at least once each year. A yearly report reflecting the overall project status and site conditions is submitted to the MADEP and to the Town of Gill Conservation Commission. Bank restoration projects were visited in November 2013 during the FRR land-based survey by geotechnical engineer Kit Choi whose comments are incorporated into this report section.

The ensuing pages contain a detailed evaluation of the restored sites found throughout the Impoundment dating back to 1996. Appendix L contains before and after photographs of each of the project sites.

Phase 1 (1996-2000) Constructed Sites

Wickey

Year Constructed: 1996

Location: Northfield, Massachusetts, at approximately River Marker 650+50, right bank

Length: Approximately 320 linear feet

Construction Technique: Stone Toe, bioengineering slope

Materials Used: 8”-12” stone rip rap on toe of slope. Three stacks of coir rolls above stone. 700 gm coir erosion control blanket on slope. Live willow stakes, seed.

Construction Access: Top of Bank from existing farm access road.

Plant Materials: Dormant willow stakes. Native seed mix.

Contractor: Maxymillian Technologies, Pittsfield, MA

Comments: This relatively small project site was chosen as the first bioengineering project to allow site contractors to become familiar with the construction techniques. Work was accomplished within one month in November 1996 with no complications. Immediately following construction there was a storm event with over 100,000 cfs flow which reached close to the top of the slope and completely flooded the project site. After the water receded, there was no observed damage to the slope, providing confidence that the design was appropriate for high storm flows. A deposition layer of fine sand along the entire slope and bank face was held by the rough coir fabric. The stone rip rap remained intact with no movement. This flood event and the site stability of the slope permitted the transition to smaller diameter stone which was used in subsequent restoration projects.

The dormant willow stakes performed well, growing to over 12 feet in height in the five years following construction. The lower bank, toe and shelf are successfully stabilized and vegetated with herbaceous vegetation. The willows, although successfully established, were removed by beaver, leaving the site with primarily herbaceous vegetation.

As a result of a land ownership change, a new water withdrawal system for crop irrigation was permitted and installed in 2010 which cut into a portion of the restored bank slope. This work was permitted and the slopes restored by the landowner.

O&M: Invasive species such as Purple loosestrife, Oriental bittersweet and multiflora rose were observed pioneering on the top of the slope. During annual site inspections the invasive species have been removed and these areas have been successfully seeded with New England Wildlife Conservation seed mix.

Shearer

Year Constructed: 1996

Location: Northfield, Massachusetts, at approximately River Marker 315+00, left bank

Length: Approximately 1,100 linear feet

Construction Technique: stone toe of slope, bioengineered bank and slope

Materials Used: 8" stone toe rip rap; 3 stacks of coir rolls above stone; sections of geo-lifts, tensar, and coir fabric, woody debris.

Construction Access: Top of slope using a long-reach excavator

Plant Materials: Native shrubs and native seed mix.

Contractor: Maxymillian Technologies, Pittsfield, MA

Comments: The contractor used an existing farm road/track at the top of the slope for construction staging and site access. The banks were heavily eroded but tree cutting, and stump removal was initially required before the slopes were graded back to a stable grade (1.5:1). A long reach excavator was used to place buckets of rip rap at the toe of the slope over a geotextile fabric.

There were several restoration techniques used in this demonstration project: The geolift construction provided a bank stabilization technique in steep sections of the slope, using native willow and dogwood species. Other sections of the bank slope were graded, loamed, and covered with an erosion control blanket. Tensar was installed at the toe of the slope, which appears to have provided some long-term lower bank support and stability. Three rows of coir rolls were installed at the transition area between the rip rap and bank slope. These were planted with woody vegetation (dormant willows) and herbaceous plant plugs which were intended to provide lower bank stability once the coir material decomposed (approximately 5 years). The construction took place in December. The willow live stakes were kept moist by placing them in tubs of water. Woody debris was added to the project by installing large logs along the riverbank in several locations at the edge of the river. These locations were frequented by fisherman until the logs decomposed approximately 10 years after construction.

Erosion has developed between the top of the stone rip rap and the bank slope, and has led to a narrow scoured area along most of the project length. Although the slope remains well vegetated and stable, these conditions are likely to change if additional stone is not added. Permits to make these repairs in the fall of 2014 have been submitted to local, state, and federal regulatory agencies.

Trees were not planted at the top of the slope at the request of the landowner due to his use of the adjacent fields as a private airstrip. The beaver trails and bank damage has been repaired several times as part of the O&M plan.

Prior to construction, a stand of invasive Japanese Knotweed was observed on this site, which remains in roughly the same location, and is proposed to be removed as part of the 2014 restoration plan.

Crooker

Year Constructed: 1997

Location: Gill, Massachusetts, at approximately River Marker 585+00, right bank

Length: Approximately 760 linear feet

Construction Technique: Stone Rip rap 6”-8”, with bioengineered slopes.

Materials Used: stone, wire gabion, tensar, coir rolls, erosion control blankets, rooted cuttings.

Construction Access: Through residential property, and along the length of the slope. The site contractor constructed the stone toe and cut a “road” along the length of the bank face to allow a backhoe to operate. Access was from the north (upstream). Bank reconstruction and geolift construction began at the downstream end of the project, working back upstream to the access point.

Plant Materials: Summer construction necessitated the use of rooted plants for the geolifts. Willow and dogwood cuttings were wrapped in soil and erosion control material and grown in a nursery for installation during the summer construction. Shrubs were containerized. Native seed mix was used on the bank slope.

Contractor: Petricca Industries, Pittsfield, MA

Comments: This site is immediately upstream of the Rt 10 Bridge, and adjacent to a residential home. There was significant erosion on both sides of the river but this location was restored to protect the house and infrastructure, including a septic leach field. Access via the residence yard permitted construction work to take place along the bank without the need for tree clearing of the adjacent upland forest. After clearing and grubbing the site, an access road was cut into the bank face allowing construction vehicles to begin the restoration work. A stone toe was installed along the length of the project and then the construction began from downstream working upstream. This project used several different bank construction techniques as part of the Phase I bioengineering demonstration. Summer construction necessitated the use of containerized or rooted plants for the geolift construction, A portion of the bank used gabion wire integrated into the lower bank in place of the Tensar used in the Shearer construction the previous year. The river currents and the protection of a residence necessitated the more structural restoration methods, while still using soil bioengineering techniques.

The site is stable and not significantly affected by invasive species. There is good herbaceous and shrub growth on the bank and slope. Minor amounts of purple loosestrife and oriental bittersweet have been observed and pulled during annual inspections.

L'Etoile

Year Constructed: 1998

Location: Northfield, Massachusetts, at approximately River Marker 385+50, left bank

Length: Approximately 460 linear feet

Construction Technique: Stone toe 4"-6" rip rap, bioengineering slope, and woody debris.

Materials Used: Stone, erosion control fabric, logs.

Construction Access: Through farm fields. Construction work from top of slope.

Plant Materials: Native shrubs and Native seed, no trees used.

Contractor: Petricca Industries, Pittsfield, MA (need to confirm)

Comments: This work was designed to stabilize an eroding section of bank adjacent to active agricultural fields. Stone was placed at the toe of slope, logs were anchored to the shoreline to provide habitat, and the bank was graded back to a 1.5:1 slope and stabilized with an erosion control blanket and planted with native shrubs.

The site is stable, well vegetated, and controlling erosion. Staghorn sumac (planted) is working very well in stabilizing the slope. The woody debris installed at the river's edge has decomposed and is no longer present.

O&M. The invasive species purple loosestrife, multiflora rose and oriental bittersweet have been managed at this site.

Flagg Farm

Year Constructed: 1999-2000

Location: Gill, Massachusetts, at approximately River Marker 420+00, right bank

Length: Approximately 2,500 linear feet

Construction Technique: work on this site was built over a two year period. The southern section, downstream of Otter Run Brook, was built in 1999, and area north of the brook built in 2000. The southern section left the near-vertical bank intact and worked only on the lower beach. The northern work included a section of re-graded bank slope and a second area where a roadway was cut to stabilize the lower bank. Each section is described below.

Materials Used: 4”-6” stone, coir rolls, brush fascines, large woody debris, erosion control blankets.

Construction Access: All construction access was through the Flagg Farm via existing farm roads. A temporary crossing was constructed across Otter Run Brook for access to the northern restoration sites. Work south of the Brook was along the lower exposed bank next to the river. Work north of the Brook was from the top of the slope. In one location a temporary access was cut to the river.

Plant Materials: Aquatic and emergent vegetation, native shrubs. Willow fascines, and native seed.

Contractor: Petricca Industries, Pittsfield, MA

Comments: South of Otter Run Brook (1999): The banks in this area were an un-vegetated vertical bluff. Cows were permitted to trample the banks for access to the river. This was one of the largest beach areas on the Connecticut River. Boaters camping on Kidd Island used this section as a bathing beach also trampling up and down the banks. A large colony of Bank Swallows used the vertical eroded banks as a nesting site. After consultations with Mass Fish and Wildlife ornithologist Brad Blodgett, a plan was developed to stabilize the toe of the slope but not to re-grade the upper slope. Brad was confident that if the bank became vegetated the swallows would abandon this site for other more suitable nesting locations along the river, which has proven to be correct. With permission of the landowner, the restoration plan included the addition of a new barbed-wire fence at the top of the slope to prevent cows from gaining access down the bank.

The restoration plan constructed a stone toe “breakwater” at the edge of the beach, planting the beach with emergent wetland plants, and adding a fascine bundle of willows at the toe of the bank. Additionally, large logs were cabled to the beach to provide habitat diversity. All of these techniques were successful in re-vegetating the lower bank and allowing the vertical bank face to become re-vegetated within approximately three years after construction. The stone breakwater and re-vegetated bank discouraged boaters from using this area and the fencing kept the cows off of the slope. By 2011 the fencing broke, and the cows gained access to the river. This breach was repaired during FirstLight O&M inspections. A fence across the beach north of Otter Run Brook prevents the cows from gaining access to the northern restoration sections which remains intact and well-vegetated.

Comments: North of Otter Run Brook (middle section) 2000.

Access to the section of riverbank north of Otter Run Brook was via a temporary swamp mat timber bridge. Once across the brook, construction machinery worked primarily from the top of the slope and agricultural fields to grade back the bank (1.5:1 slope) and stabilize the surface with loam, erosion control blankets and native seed. Stone rip rap was installed at the edge of the existing beach and willow brush fascines were installed at the toe of the slope. No other shrubs were installed. This section has remained stable and well-vegetated.

Comments: North of Otter Run Brook (upper section) 2000

Access to the riverbank used an eroded gully to bring construction equipment to the river edge where the beach area was re-established and planted with native emergent and aquatic wetland vegetation. The gully was in-filled, repaired and stabilized with native vegetation. It is fully vegetated at this time and the lower beach area is fully vegetated and stable with native vegetation.

O&M: During O&M inspections in 2010, a small (500 square foot) area of Phragmites (common reed) was observed. This is an undesirable invasive wetland plant which, if left un-checked, can rapidly spread. An herbicide application (Rodeo) was applied. Annual inspections since 2010 have detected individual stems of Phragmites which are pulled or which have Rodeo wiped on the stems. Additional invasive plants including: Purple loosestrife; Oriental bittersweet; Japanese barberry; multiflora rose, and autumn olive began to appear on this site since 2012. These have been controlled by hand-pulling the newly established plants.

Comments: The Flagg site has been a successful example of re-establishing native emergent plants at the lower bank (beach) and using this technique to help stabilize the upper bank/slope. The presence of cattle gaining access to the river over the bank has led to some degradation of the upper slope. The middle and northern restoration sections, which are protected from cattle grazing, are stable and well vegetated.

Phase 2 (2001-2008) Constructed Sites

Urgiel Upstream

Year Constructed: 2001

Location: Gill, Massachusetts, at approximately River Marker 490+00, right bank

Length: Approximately 1,200 linear feet

Construction Technique: Grade bank slope to 1.5:1, stone toe, native plants

Materials Used: 4" stone rip rap over a geotextile fabric at the toe of slope. Banks graded back and covered with a biodegradable erosion control blanket. Two stone swales were installed at either end of the project to accommodate overland runoff.

Construction Access: Farm roads through the Urgiel Farm were used for River access. The top of the bank was cleared, and used for construction staging and site access. An eroded section of the bank was excavated and used for access by construction equipment to the river edge. Equipment worked from a flattened work road along the lower bank and from the top of the slope. After construction, the access road was in-filled and replanted. Farm fields used for site access were tilled and restored.

Plant Materials: native shrubs, trees at the top of the slope, rooted willow cuttings at the lower bank and within the stone rip rap. Seed on the slope.

Contractor: Davenport Construction. Greenfield, MA

Comments: This was the first project under the Phase II construction projects and the first project to come under the jurisdiction of the Massachusetts Endangered Species Act (MESA). This site was identified as the location for a rare species of dragonfly (Cobra Clubtail Dragonfly *Gomphus vastus*) and Tule Bluet (*Enallagma carunculatum*). Subsequent pre-construction surveys of this species delayed construction from 2000 to 2001 to allow for an evaluation of the site and the use of rare dragonfly species within the proposed bank restoration area. This pre-construction survey found approximately 400 individual dragonflies (15 species) using this 1200 foot section of riverbank during their emergence during May-July. Post construction surveys found an increase of dragonfly use of the restored riverbank to over 12,000 individuals. It appears that the dragonflies benefit from emergence sites that have structure (woody debris, logs, vegetation). The restoration sites have provided these attributes. The site is well-vegetated, continues to support a large emerging population of dragonflies, and has met the restoration goals of re-vegetation and erosion control.

The construction technique used by Davenport Construction to bring an excavator down the slope to near the edge of the river proved efficient and allowed for more careful placement of the stone rip rap (as opposed to placement using a long-reach excavator

There was extensive plantings of native shrubs on the slope and planting of larger tree specimens at the top of the bank (requested under MESA to provide future Bald Eagle perch sites).

O&M: Several purple loosestrife plants were observed and pulled, as were black locust seedlings. Slope slippage at the upper slope was recently observed on the northern end of this restoration site. The cause of this slippage is currently being evaluated by the geomorphology and geotechnical engineering team.

Durkee Point

Year Constructed: 2003

Location: Northfield, Massachusetts, at approximately River Marker 260+50, left bank

Length: Approximately 500 linear feet

Construction Technique: Re-grade bank to 1.5:1 slope. Stone breakwater. Bioengineering slope, and emergent shelf.

Materials Used: 2”-4” stone toe, Turf Reinforcement Mat (TRM), erosion control blanket.

Construction Access: eroded gully provided access to the lower bank for construction of emergent shelf. Work also from the top of the slope. Additional work on small stream from top of slope.

Plant Materials: Native shrubs, seed, and emergent and aquatic wetland plants

Contractor: Davenport Construction. Greenfield, MA

Comments: This section of riverbank experienced significant erosion between the 1998 FRR and construction in the late fall of 2003. This was, and continues to be, a popular location for shore fishing. Cars were able to park at the top of the bank and fishermen used or created a gully path from the top of the slope to the edge of the water.

This restoration site is bordered to the north (upstream) by a small unnamed stream which has a severely eroded left bank with an avulsion (cut through) likely in the near future. This eroded bank and slope was stabilized using erosion control material and native plants. Large boulders were placed in the stream to help divert high flows away from this bank. This work has been successful to date in stabilizing this location.

A beach/emergent shelf was created at the lower bank and was planted with native emergent aquatic vegetation. A low stone breakwater supports this shelf. Aquatic plants (primarily pond weed and water celery) were planted in the shallow water of the river. As an experiment to reduce the use of stone, a single width (7.5 feet) of a turf reinforcement mat (TRM) called Pyramat was installed along the entire length of the project instead of using stone at the toe of the slope. This non-biodegradable erosion blanket was covered with a layer of soil and planted over. This material has performed very well at this site (outside bend), has provided structural stability to the lower bank, and supported herbaceous and shrub plant growth. Willow fascines were installed at the top of the slope to promote shrub growth and to intercept the overland sheet flow of water. Native shrubs were planted on the slope, lower bank, and riparian buffer area. Native seed was spread throughout the site.

Construction was in the late fall of 2003 and the erosion control blanket was modified to a heavy coir fabric. During the following winter high water flows deposited whole trees on the restored slope, however, there was no bank erosion and the vegetation was quickly established. This site was visited during Tropical Storm Irene in late August 2011 and although the water levels were at the top of the slope the near-bank velocity was less than 5 feet per second. Other than depositing trash and sediment there was no damage to the bank from this storm event. This site has been successfully restored, with no construction or post-construction problems to date.

O&M: Purple loosestrife, multiflora rose and Oriental bittersweet are pulled and controlled. Fishermen continue to use this site, parking on River Road. Several small paths down the slope and bank to the edge of the water have developed from their use but no problem erosion has been observed to date and no additional effort has been made to limit the use of this site for recreation.

River Road

Year Constructed: 2003

Location: Northfield, Massachusetts, at approximately River Marker 250+00, left bank

Length: Approximately 980 linear feet

Construction Technique: In-fill, stone toe, bioengineering slope.

Materials Used: loam, 2”-4” stone rip rap, coir rolls, and erosion control blankets.

Construction Access: Access via two eroded drainage gullies

Plant Materials: native trees, shrubs, and seed mix

Contractor: Davenport Construction. Greenfield, MA

Comments: Prior to construction this site was characterized by eroding vertical, un-vegetated banks and fallen trees. An initial archeological evaluation found this location to have significant cultural resources which required protection as directed by the Massachusetts Historical Commission. The final bank restoration plan incorporated the use of two eroded gullies for access to the lower bank as these locations had no artifacts. Instead of grading back the near-vertical eroded riverbank fill material was added to build up the slope to 1.5:1. Using this technique the riparian forest at the top of the slope remained entirely intact and avoided the disturbance of potential cultural resource artifacts. A new stone rip rap toe of slope, with two layers of coir rolls, supported the new slope and bank. Loam was spread, seeded, and covered with a biodegradable erosion control blanket. Native trees and shrubs were planted on the lower bank and slope in the Spring of 2004.

The two existing drainage gullies were used for construction access and were fully re-graded and restored following the completion of construction. With approval from the Town of Northfield DPW, new drainage (drop inlets and drainage pipes) was installed on River Road to bring overland runoff closer to the edge of the river and discharge on stone instead of continued erosion of the earth riverbank. The gullies were replanted with trees to restore the riparian buffer.

This site, with easy access to the river from River Road, continues to be a popular fishing location. There are several worn trails through the site but no significant erosion or problems caused by pedestrian access. This location is occasionally used as a river access point for canoeists and kayakers who carry their craft a short distance from the road to the river. The site is stable and has preserved cultural resources and the riparian buffer.

O&M: Several invasive species such as autumn olive, multiflora rose, purple loosestrife, Oriental bittersweet, and black locust have been pulled or controlled at this site. A small area of the slope (approximately 100 square feet) at the northern end of the site was eroded due to overland sheet flow during a rain storm event in 2005. The slope erosion was repaired by infilling with soil, covering with new erosion control blankets, and seeding/planting. Shrubs were also planted in the upland forest to intercept sheet flow which has resolved this problem.

Rod & Gun Club (Camp 2E)

Year Constructed: 2004

Location: Montague, Massachusetts, at approximately River Marker 90+00, left bank

Length: Approximately 240 linear feet

Construction Technique: No machinery permitted on this site by the Town of Montague Conservation Commission. Work was accomplished manually.

Materials Used: Toe of Slope stabilization using logs and coir rolls. Slope stabilization using erosion control blankets and shrubs.

Construction Access: This site, called the rod and gun club site, is also known as Camp 2E. There is a steep paved driveway to this camp and a dirt path to the downstream camp. All work was accomplished manually.

Plant materials: Native shrubs, native seed mix.

Contractor: Davenport Construction. Greenfield, MA

Comments: The lack of machine access to the riverbank restricted restoration work to manual preventative maintenance activities. Logs were moved into place to shore-up the toe of slope and coir rolls were installed where logs were not available. The slope below a path between two camps was stabilized and re-constructed by hand to provide a wider access path. The slope was planted with native shrubs, primarily shade-tolerant Mountain Laurel. The unvegetated slopes have significantly in-filled with vegetation. FirstLight is in the process of having the wood bulkhead on this property removed (it is in poor condition) and to restore and stabilize the banks. This work is anticipated to be completed in 2015, depending on final design plans and permitting.

O&M: No invasive species have been observed. In 2014 an evaluation and design plan has commenced to remove the wood bulkhead and restore the banks. This work will improve the most erosion-prone section at this camp.

Skalski

Year Constructed: 2004

Location: Northfield, Massachusetts, at approximately River Marker 415+00, left bank

Length: Approximately 1,600 linear feet

Construction Technique: Stone toe, bioengineering lower slope treatment. Upper slope left undisturbed. Access Road in-filled, stabilized, and re-vegetated.

Materials Used: 2”-4” stone, coir rolls, biodegradable erosion control blanket.

Construction Access: Site access and staging in farm field at top of the high slope. An existing eroded gully was used to cut a machine access road from the high slope to the edge of the river.

Plant Materials: Native shrubs, willows, and native seed mix

Contractor: Maxymillian Technologies, Pittsfield, MA

Comments: Significant bank and slope erosion developed on this section of the river at the outside bend of Kidd Island. Prior to construction the banks were near vertical with very little vegetation. There is a high slope (approximately 60 feet) from the property plateau to the river. This is the site of a private residence; Mr. Fred Skalski is deceased. The farm fields at the top of the bank have been leased for row crops and contain cultural artifacts.

An eroded gully down the slope provided an opportunity to gain access to the river without disturbing cultural resources. A steep roadway was cut for construction equipment and the soils stockpiled in a location approved by the Massachusetts Historical Commission. A stone toe of slope was established over geotextile material and the lower bank and slope adjacent to the river was re-graded approximately half way up the steep slope. Coir rolls were installed between the stone and the slope. In several locations during construction groundwater seepage was encountered which were backfilled with stone. Loam was spread on the re-graded slopes and covered each day with native seed and a biodegradable erosion control blanket. The access road was filled with the soil stockpiles and stabilized. The farm fields used for construction staging were plowed and re-seeded. The bank and lower slope treatment has worked very well to date in stabilizing this steep and difficult site. Although grading or planting was not conducted on the upper half of the slope these areas have naturally re-vegetated in the ten years following construction. This steep site with unconsolidated soils has responded very well to the restoration plan and has become re-vegetated with no obvious signs of erosion.

O&M: Purple loosestrife, Japanese knotweed and oriental bittersweet have been found and pulled along the bank. A new property owner has cut a path from the top of the slope to the edge of the river.

Bennett Meadow

Year Constructed: 2005

Location: Northfield, Massachusetts, at approximately River Marker 570+50, right bank

Length: Approximately 100 linear feet

Construction Technique: Preventative Maintenance

Materials Used: Coir rolls, willow stakes, native seed mix.

Construction Access: Overland from Bennett Meadow Wildlife Area. Manual work.

Plant Materials: Willow cuttings from Bennett Meadow Cutting Block

Contractor: NEE, Inc. Amherst, MA

Comments: This site, located downstream of the Rt 10 Bridge, is composed of three separate eroded areas with a total length of 100 linear feet. This area was identified for erosion control in the 1998 FRR. Using no machinery, coir rolls were installed at the toe of the slope and willow fascines and stakes were installed along the lower bank and beach.

The construction in this location improved site conditions on the lower bank. The coir rolls have degraded and the majority of the willow plantings have been naturally replaced with other plants (such as Box Elder). The preventative maintenance work was successful in helping to stabilize and slow down the rate of erosion.

O&M: There have been several purple loosestrife plants along this reach which have been hand pulled.

Urgiel Downstream

Year Constructed: 2005

Location: Northfield, Massachusetts, at approximately River Marker 470+00, right bank

Length: Approximately 980 linear feet

Construction Technique: flat stone toe, graded bank, vegetated bioengineering slope

Materials Used: 2” stone above geotextile, erosion control blanket.

Construction Access: From top of slope and bottom of slope.

Plant Materials: Native trees, shrubs, and seed.

Contractor: Davenport Construction, Greenfield, MA

Comments: This eroded bank location had significant past land disturbance; possibly gravel excavation, and few trees or riparian buffer at the top of the slope. Due to known dragonfly emergence preferences, a reduced diameter of stone was placed at the toe of the slope. The slope was graded in a gentle slope into the river to allow easier access for the emerging dragonflies with no large obstructions. Construction access to the site was via existing farm roads. The slopes were suitable for machinery to work from both the top of the slope to the edge of the river.

Rooted willows were planted at the lower bank. Shrubs were planted on the upper bank and slope. Trees were planted at the top of the slope to re-establish a riparian buffer. There were no construction issues with this site.

This eroded bank location has been successfully stabilized with no post-construction issues. It is well vegetated and has supported a diverse dragonfly population.

O&M: This site has remained stable with no O&M issues. Several invasive species, including purple loosestrife and Japanese Knotweed, have been observed and removed.

Country Road

Year Constructed: 2006

Location: Northfield, Massachusetts, at approximately River Marker 685+00, left bank

Length: Approximately 850 linear feet

Construction Technique: emergent shelf (partial), graded slope, stone toe, avulsion protection from Mill Brook

Materials Used: 2"-4" stone, coir rolls, pyramat (TRM); erosion control blankets, root wads

Construction Access: Access to the project was via a small farm road ("Country Road") off Mill Street to an open hay field which was used for construction staging. There was an overgrown cart road from the field to the top of the riverbank. All staging and access roads on the riverbank were restored and replanted.

Plant Materials: native trees, shrubs, and seed mix. Emergent wetland plants and aquatic plants were installed along the river's edge. Root wads were placed on the banks of Mill Brook to prevent erosion. Shrubs were planted on the slope between Mill Brook and the Connecticut River.

Contractor: Davenport Construction. Greenfield, MA

Comments: This location had evidence of previous land uses which may have contributed to the heavy erosion observed, including an abandoned sewer outfall pipe, an old farm dump site, and a cart road at the top of the bank slope. Debris (old appliances, metal) within the project area was removed during construction. The near-vertical slopes were graded back to 1.5H:1V for site stability. There was no riparian buffer at the top of the slope and no cultural resources within the proposed work area. After grading back the slope, stone was installed along the edge of the Connecticut River. Several narrow areas were created for the establishment of emergent vegetation and a narrow beach was created using coir rolls. Coir rolls and Pyramat were installed directly above the stone toe of slope to provide additional protection of the bank. The old sewer pipe created a small point and the project worked around this abandoned structure. The site is well vegetated and becoming established as a new riparian buffer.

The bank restoration project includes a peninsula between the Connecticut River and Mill Brook. During the project survey and engineering design process, the slope between a bend of Mill Brook and the project site failed and was significantly eroded. The stabilization of Mill Brook was included in the project work to prevent a significant avulsion of the Brook and additional sedimentation into the Connecticut River. A design was developed using tree root wads at the edge of the brook and stabilizing the eroded slope with a biodegradable erosion control blanket and dense shrub plantings. To date, the stabilization of the Mill Brook slopes has been effective with no new erosion and with dense vegetation cover.

O&M: Invasive plant species were well-established on this site prior to construction and continue to be found. Autumn olive, black locust, oriental bittersweet, purple loosestrife, Japanese knotweed, and multiflora rose have been controlled.

Campground Point

Year Constructed: 2008

Location: Gill, Massachusetts, at approximately River Marker 60+00, right bank

Length: Approximately 1,000 linear feet

Construction Technique: Preventative Maintenance

Materials Used: Logs, coir rolls, native shrubs and seed

Construction Access: by boat from CT River

Plant Materials: native willows, native shrubs, and seed

Contractor: NEE, Inc. Amherst, MA

Comments: This location is on the north side of the public campground run by FirstLight in an area known as “the narrows” immediately upstream of Barton Cove. The steep slopes in this area have been noted as severely eroded since at least the 1970’s. A preventative maintenance (PM) plan was developed in accordance with the 1998 Erosion Control Plan to slow down the rate of erosion. There is a well established upland forest on the upper slopes and at the top of the slope. Machine access from the top of the bank would have required significant forest clearing to access the river. To stabilize the toe of the slope existing fallen logs from the site and coir rolls were anchored to the toe of the slope in eroding areas along approximately 1000 linear feet of shoreline. Bare soil on the bank and slope were planted with shade tolerant native shrubs, and seeded with a native seed mix. This PM plan used vegetation to stabilize the eroding slopes. Work was conducted manually. The site has responded well to the stabilization measures and has become almost 100% vegetated. Several small areas of upper bank erosion are present.

There has been minor erosion caused by tent campers who walk down to the Connecticut River from the campground. This section of the river is also a popular bathing beach for boaters who also tend to walk up and down the bank and slopes. Preventative maintenance measures have served to slow down the rate of bank erosion as evidenced by the permanent survey transect through this site.

O&M: No invasive species were noted at this site until 2010 and then only few bittersweet seedlings were reported. By 2013 more extensive bittersweet, purple loosestrife, multiflora rose, and coltsfoot were observed and removed.

Montague (Rod & Gun Club Point)

Year Constructed: 2008

Location: Gill, Massachusetts, at approximately River Marker 65+00, left bank

Length: Approximately 1,000 linear feet

Construction Technique: Preventative Maintenance

Materials Used: Logs, coir rolls, erosion control blankets, coir silt fencing, native shrubs and seed

Construction Access: By boat from CT River

Plant Materials: native willows, native shrubs, and seed

Contractor: NEE, Inc. Amherst, MA

Comments: This area of steep, high, and eroded bank is located across the river from the Campground Point restoration site. There is a historic concrete retaining wall at this site, and photographs from the 1970's show this slope as severely eroded. Access via land is not practical, and a Preventative Maintenance approach to erosion control in accordance with the 1998 Erosion Control Plan was implemented with access by boat and using manual labor. To stabilize the toe of the slope, existing fallen logs from the site and coir rolls were anchored to the toe of the slope in eroding areas along approximately 1000 linear feet of shoreline. Bare soil on the bank and slope were planted with native shrubs and seeded with a native seed mix. To help stabilize the steep sandy slope, biodegradable erosion control materials and temporary silt fencing was installed across the face of the slope to help stabilize the soils and to permit vegetation to become established.

The preventative maintenance approach has been partly successful in helping to stabilize and prevent erosion on this highly eroded site; however, one steep sandy slope approximately 300 feet long continues to erode, and has sparse vegetation.

O&M: Additional shrubs and seed were added in 2013 and 2014.

Kendall Farm

Year Constructed: 2008

Location: Vernon, Vermont, at approximately River Marker 800+00, right bank

Length: Approximately 915 feet

Construction Technique: Stone Toe of Slope, bioengineering on slope.

Materials Used: 2”-4” stone, biodegradable erosion control fabrics, native trees, shrubs, seed mix, logs

Construction Access: Farm roads provided access to the top of the bank. Work was conducted from the top of the slope. A temporary access road to the edge of the river was created by excavating through an eroded gully.

Plant Materials: Native Trees, Shrubs, and native seed mix

Contractor: Davenport Construction. Greenfield, MA

Comments: This site is located directly downstream of a former railroad bridge. One of the large stone pier bridge supports has fallen in the Connecticut River and unusual river currents are thought to be at least partially responsible for the bank erosion along this section of the river. There is a permanent river cross section through this location where bank erosion of up to 7 feet in one year was recorded. Mr. Sam Kendall (deceased) raised corn in the fields adjacent to the riverbank. Overland sheet flow from the farm fields in roughly the center of the restoration site created a deep gully down the slope to the river and head-cut back into his fields creating a potential safety hazard to farm workers. The proposed restoration plan, developed with Mr. Kendall and the Vermont ANR, graded back the slope and incorporated a row of trees and narrow buffer at the top of the slope to create a riparian buffer. The gully provided the start of an access route to the edge of the river which was used during construction then restored. Several drainage channels were incorporated into the bank restoration design to accommodate the overland sheet flow without causing bank erosion. There are several additional locations on this property downstream of the restoration site where overland sheet flow from fields is contributing to bank erosion.

There is deep water adjacent to this restoration site with no habitat to create an aquatic shelf or emergent bench at the edge of the river. The stone toe is steeper than at other locations due to the existing grades and steep drop off of the lower bank. Large logs were incorporated into lower bank and edge of the Connecticut River to provide additional habitat and structure. This remains a popular fishing location.

The site is nearly 100% vegetated and has been stable with no evidence of new erosion. The riparian buffer at the top of the slope is becoming established and densely vegetated. The farm fields have been offset to accommodate this buffer.

O&M: Additional trees were planted in 2013 including sycamore, cottonwood, silver maple and sugar maple. There are small colonies of oriental bittersweet, Japanese knotweed, coltsfoot, and purple loosestrife at the site which have been controlled. Naturally occurring *Galerucella* beetles which feed exclusively on purple loosestrife were observed on this site.

Phase 3 (2009-2013) Constructed Sites

A 6,335 foot long section of the river has been stabilized over a 5 year period using similar construction techniques; engineered logs to trap sediment, a constructed emergent beach, and no stone rip rap. There is also no grading back of the riverbank, except for the two access routes described below. There are five distinct projects with three separate adjacent landowners. The two downstream locations are adjacent to the Split River Farm (Donald Patterson, owner). North of the Split River Farm the adjacent landowner is Michael Bathory and Mary Anne Gallagher. The adjacent landowner on the northern section is Alan Wallace and Barbara Watson. There is an untreated bank area between the Lower Split River and the Upper Split River restoration sites which has stone rip rap banks. This area is directly across the river from the Northfield Mountain tailrace which has been stable with no erosion issues.

The construction concepts used on this site are innovative and unique. The concepts were developed jointly by FirstLight and their consultants, CRSEC and the individual members, and a consulting contract for design plans issued by FRCOG.

Sediment deposition along the banks of the Connecticut River occurs following the annual spring freshet and during large storm events yet the majority of this sediment is eventually eroded away. The concept for the Phase III bank restoration projects was to create engineered log piles which would help to retain sediment, protect the adjacent banks, and create a lower bank with emergent and aquatic vegetation. Observations during previous FRR investigations reported stable bank segments adjacent to well-vegetated lower banks. Additionally, previous FRR investigations and mapping found bank aggradation and retention of sediment in areas which had emergent vegetation and “rough” surfaces. An additional desirable element of the bank restoration design was to determine if bank restoration projects could be successfully constructed without including a stone toe of slope in an effort to improve wildlife habitat and aesthetics. Fill material was brought onto the site to help build up the emergent shelf. This was integrated with cross members of logs which helped to support the construction machinery but which also provided habitat and structure by leaving the exposed tree roots at the edge of the River.

These projects required extensive regulatory review and local, state and federal permits including the issuance of a Water Quality Certificate. The permits require 5 years of detailed post-construction monitoring for each of the constructed segments including cross sectional surveys, vegetation assessments, measurements of bank erosion, aggradation, scour, vegetation surveys, and wildlife habitat assessments in an annual report. Site specific data are collected from April through October providing the opportunity to detail the progress of the successful restoration on each of these sites up to the present time. All of the projects are successfully providing bank protection and have reduced the rate of erosion while also providing new wildlife habitat.

Prior to construction, the project engineers and consultants reviewed specific site conditions and established locations for each of the structures. The local conservation commission and adjacent landowners have participated in these pre-construction assessments. In locations where there was recent erosion in the time between engineering, permitting, and construction, the structure locations were modified to provide the most bank protection. Engineering evaluations were conducted during construction including pull tests of the earth-anchors to comply with the project specifications. These projects required a full time environmental monitor (State and Local Permit Conditions) and a high level of scrutiny during construction. Construction compliance reports were produced weekly and sent to all regulatory agencies. There is an annual monitoring report which is required for five years after construction of each project segment.

Lower Split River Farm

Year Constructed: 2009

Location: Gill, Massachusetts, at approximately River Marker 260+00, right bank

Length: Approximately 1,725 linear feet

Construction Technique: Engineered logs, Bioengineering, woody debris, constructed emergent shelf

Materials Used: logs, large piles of coarse woody debris (logs), root wads, native vegetation

Construction Access: Existing farm roads provided access to the riverbank. A small stream was forded using timber construction mats, which were removed following the project work. A small construction staging area was established at the north end of the fields. A construction access road was established to the edge of the river via an eroded section of the bank devoid of trees and cultural artifacts. A second construction access road was designed and permitted at the southern end of the project site but was not used. Following construction, the access ramp to the river was re-graded, stabilized and re-vegetated. The staging area was restored and the stream ford removed and restored.

Plant Materials: Native shrubs, emergent vegetation, and native seed.

Contractor: Davenport Construction. Greenfield, MA

Comments: There were several construction treatments and methods used to stabilize this riverbank segment. The downstream end of the site was characterized by "scalloped" and cut banks. Logs and tree roots were used to fill in the eroded bank segments and to protect the bank from erosion. Log piles were established at regular intervals or in locations where additional bank protection was needed. The substrate used for the emergent plant shelf was placed on a geotextile fabric but there was depression at the southern end of the site where the soils at the lower bank were unconsolidated. This caused the emergent plants to be at a slightly lower elevation than the upstream portion. The log piles were built and cabled in place working from downstream, to upstream, backing out of the site at the one entry point.

Following construction in the late fall a decision was made to cover the surface of the emergent shelf with biodegradable coir matting to protect the land surface during the winter. Following the deposition of new sediment in the spring of 2010 the emergent shelf was planted by the site contractor with aquatic and emergent vegetation. During the summer of 2010, before the vegetation became established, several sections of the coir fabric became exposed and loose which dislodged many of the newly installed plants. The coir material was removed over the next two years and the vegetation replanted. This use of protective matting was determined to be unnecessary and was not used on subsequent Phase III restoration projects.

Within two years of construction the emergent plant shelf was fully vegetated and retaining a portion of the sediment deposited. During Tropical Storm Irene this location retained up to 60 cm of new sediment.

O&M: Several small patches of invasive plant species have been observed including: purple loosestrife, oriental bittersweet, multiflora rose, Japanese barberry, and black locust. Following Tropical Storm Irene in August 2011 many small pieces of Japanese Knotweed were found and removed.

Upper Split River Farm I

Year Constructed: 2010

Location: Gill, Massachusetts, at approximately River Marker 290+00, right bank

Length: Approximately 1,360 linear feet

Construction Technique: Bioengineering, woody debris, constructed emergent shelf

Materials Used: logs, large piles of coarse woody debris (logs), root wads, native vegetation,

Construction Access: Existing farm roads provided access to the riverbank, which included a roadway to the edge of the water from an historic ferry landing.

Plant Materials: Native shrubs, emergent vegetation, and native seed.

Contractor: SumCo, Hamilton, MA

Comments: A construction staging area was located in a Town-owned parcel between the Split River Farm fields and the River. This staging area was used for storing materials and equipment for restoration work in 2010-2013 thereby minimizing impacts to farmland or cultural resource sites. SumCo developed efficient construction techniques and were able to complete the work more quickly than other contractors, often restoring more than 100 linear feet in one day. A single site access to the riverbank was on the southern (downstream) end of the project site. The wood log piles were installed from north to south. The construction work was conducted in late fall. Planting vegetation was conducted during the 2011 growing season following the spring freshet. There were no construction-related issues and the new site contractor was successful in implementing the design work.

O&M: This site has been successfully retaining river sediment following the spring freshet providing a foundation for the planted vegetation. The sediment has also provided substrate for volunteer tree seedlings such as maples and cottonwoods to colonize. Several invasive species: Oriental bittersweet, multiflora rose, Japanese knotweed, and purple loosestrife have been observed and removed. There were many small pieces of rooted Japanese knotweed deposited on this site following Tropical Storm Irene in 2011.

Upper Split River Farm II

Year Constructed: 2011

Location: Gill, Massachusetts, at approximately River Marker 300+50, right bank

Length: Approximately 1,000 linear feet

Construction Technique: Engineered logs, Bioengineering, woody debris, constructed emergent shelf

Materials Used: logs, large piles of coarse woody debris (logs), root wads, native vegetation,

Construction Access: Existing farm roads provided access to the riverbank. A small stream at the north end of the farm was forded using timber construction mats which were removed following the project work. A small construction staging area was established at the north end of the fields. A construction access road was established to the edge of the river via an eroded section of the bank devoid of trees. Extensive archeological assessment and recovery was required prior to site grading and construction.

Plant Materials: Native shrubs, emergent vegetation, and native seed

Contractor: SumCo, Hamilton, MA

Comments: The newly created access road from the farm fields to the edge of the river provides good construction access for maintenance and site work. Work was conducted from the access road approximately 1000 feet downstream to join with the upstream end of the Upper Split River Farm I restoration site. Brush, tree-tops, and excess woody material were inserted between the engineered log piles to better retain sediment. Work was accomplished quickly with no construction problems in the late fall 2011. The planting of herbaceous vegetation was delayed due to a lack of river sediment deposition. Woody plants (mostly willows) were installed during the 2013 growing season. Despite the lack of planted herbaceous materials over 70 species of volunteer plant species have naturally become established including many tree seedlings. The restoration design depends on normal sediment deposition as a substrate for planting.

The restoration work has been successful in stabilizing the adjacent banks and farm fields from additional erosion.

O&M: Several invasive species seedlings, particularly oriental bittersweet, have been pulled from this site.

Bathory/Gallagher & Wallace/Watson (2 sites)

Years Constructed: 2012-2013

Location: Gill, Massachusetts, at approximately River Marker 310+00 to 330+50, right bank

Length: Approximately 2,250 linear feet

Construction Technique: Engineered Logs, bioengineering, coarse woody debris, constructed bench

Materials Used: engineered logs, large piles of coarse woody debris (logs), root wads, native vegetation

Construction Access: Construction access road built in 2011 for previous project.

Plant Materials: Native shrubs, emergent vegetation, and native seed

Contractor: SumCo, Hamilton, MA

Comments: To avoid construction work on the adjacent landowner properties, the construction access road built in 2011 at the northern end of the Split River Farm property (310+00) was used for this project. The long project length, combined with only one access route, necessitated a modified construction schedule. In 2012 the lower bank (bench) was built from south to north on the entire length of the project in the late fall. During this process the adjacent vertical bank was stabilized using trees, root wads and soil. Several design techniques were used depending on the erosion on the adjacent slopes. Trees which were leaning, or likely to fall, were cut and integrated into the toe of slope protection. Otherwise, the trees and bank slopes were left undisturbed. The contractor left the site using the same access route. During the winter/spring of 2013 there was a very modest spring freshet with minimal deposition of new sediment. Volunteer herbaceous and tree seedlings began to germinate especially at the higher elevations. The site remained stable during 2013 and provided additional erosion protection of the banks. The contractors returned to the project site in the fall of 2013 and completed the construction work starting at the upstream end of the project and working south to the access road. Additional material and bank stabilization was done at the request of the adjacent landowners and the Gill Conservation Commission. Following construction, the entire project site was seeded with seeds collected from the Lower Split River restoration site (dark green bulrush and common cattail). Herbaceous vegetation was planted in 2014.

The vertical bank faces on these restoration banks have continued to provide nesting sites for belted kingfisher and bank swallow during the 2013 and 2014 nesting season.

O&M: Oriental bittersweet, multiflora rose, Japanese knotweed, and purple loosestrife seedlings have been observed and pulled.

Camps

"Camp" properties are privately owned cabins located on Project Lands in the Towns of Gill and Montague, Massachusetts. In 2010 and 2011 FirstLight initiated a review of the camps and Project Lands to evaluate riverbank stability/erosion and cultural land-uses which may contribute sediment to the Connecticut River. Erosion caused by cultural land-use (e.g. parking lots, driveways, roof drainage) were the responsibility of the camp owners while riverbank erosion was the responsibility of FirstLight. Six camps were identified as having eroded riverbanks. Meetings with the individual camp owners, FirstLight, and their consultants were held in 2011 and 2012 to review the steps required by the camp owners to stabilize or repair the property.

In 2011 FirstLight initiated design, permitting, and construction on the six camps with eroded bank sections. Two upland camps in Montague were also included in the permitting as demolition work was proposed within 200 feet of the Connecticut River. Construction work was conducted in the fall of 2011 and the spring of 2012. The two abandoned camps in Montague were demolished in 2011 and the Project Lands restored. The bank restoration work was conducted manually with access to sites by boat. Debris used for site stabilization (tires, appliances, wood, etc.) was removed from the river and properly disposed. Each site is relatively small (20-70 linear feet) and the methods used for bank reconstruction are similar. For this reason these sites have been consolidated. Most camp owners had previously cleared vegetation in front of the buildings. Part of the restoration was to re-establish a vegetated buffer along the river, as such the camp owners may prune this vegetation, but it must be maintained and not be removed.

Camp 2W

Year Constructed: 2011

Location: Gill, Massachusetts, at approximately River Marker 133+00, right bank

Length: Approximately 70 linear feet

Construction Technique: Bioengineering.

Materials Used: Coir Rolls, erosion control blanket

Construction Access: Boat

Plant Materials: Native shrubs, seed.

Contractor: NEE, Inc. Amherst, MA

Camp 2E

Year Constructed: 2011

Location: Montague, Massachusetts, at approximately River Marker 80+00, left bank

Length: Approximately 20 linear feet

Construction Technique: Bioengineering.

Materials Used: Coir Rolls, erosion control blanket

Construction Access: boat

Plant Materials: Native shrubs, seed

Contractor: NEE, Inc. Amherst, MA

Camp 6E

Year Constructed: 2011

Location: Montague, Massachusetts, at approximately River Marker 111+00, left bank

Length: Approximately 40 linear feet

Construction Technique: Bioengineering.

Materials Used: Coir Rolls, erosion control blanket

Construction Access: boat

Plant Materials: Native shrubs, seed

Contractor: NEE, Inc. Amherst, MA

Camp 7E

Year Constructed: 2011

Location: Montague, Massachusetts, at approximately River Marker 114+00, left bank

Length: Approximately 40 linear feet

Construction Technique: Bioengineering.

Materials Used: Coir Rolls, erosion control blanket

Construction Access: boat

Plant Materials: Native shrubs, seed

Contractor: NEE, Inc. Amherst, MA

Camp 8E

Year Constructed: 2011

Location: Montague, Massachusetts, at approximately River Marker 120+00, left bank

Length: Approximately 60 linear feet

Construction Technique: Bioengineering.

Materials Used: Coir Rolls, erosion control blanket

Construction Access: boat

Plant Materials: Native shrubs, seed

Contractor: NEE, Inc. Amherst, MA

Camp 10W

Year Constructed: 2011

Location: Gill, Massachusetts, at approximately River Marker 155+00, right bank

Length: Approximately 60 linear feet

Construction Technique: Bioengineering.

Materials Used: Coir Rolls, erosion control blanket

Construction Access: boat

Plant Materials: Native shrubs, seed

Contractor: NEE, Inc. Amherst, MA

Camp Comments: All of the camp sites had evidence of bank restoration efforts by previous camp owners. This included adding stone, wood, tires, metal, appliances, and other hard material to protect the banks from erosion. All debris was removed from the restored banks but existing stone walls and native stone was left in place. There was a lack of trees and riparian vegetation in front of the camps. Once a bank was cleaned of debris, several different soil bioengineering techniques were used to stabilize the banks. This included stacked rolls of coir; geo-lifts, and biodegradable erosion control blankets. The newly restored banks were planted with native shrubs and seed and the camp owners were directed not to remove the vegetation (although cutting back the height of the shrubs was permitted).

The success of these small bank restoration efforts will depend on the willingness of the camp owners to maintain the vegetation and to help keep the banks stable.

O&M: In 2013 and 2014 additional shrubs were planted and invasive species pulled.

Bonnette Farm

Year Constructed: 2012

Location: Hinsdale, New Hampshire, at approximately River Marker 945+00, left bank

Length: Approximately 500 linear feet

Construction Technique: Preventative Maintenance

Materials Used: Plants only

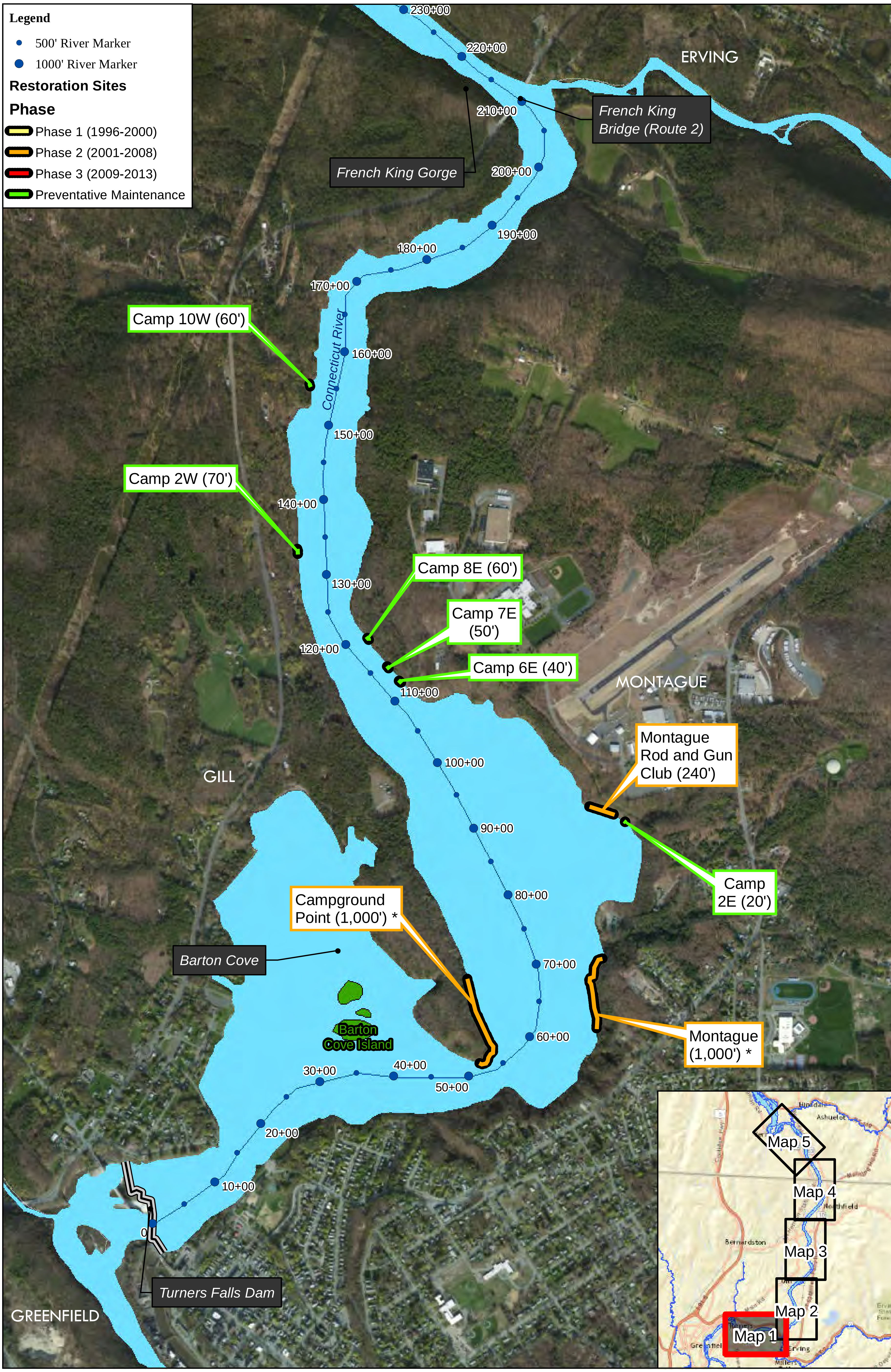
Construction Access: overland with permission of land-owner

Plant Materials: Native trees, shrubs, seed.

Contractor: NEE, Inc. Amherst, MA

Comments: In the fall of 2012 the riverbank at this location was observed to be actively eroding and lacking vegetation. In the late fall 2012 native shrubs were planted on the un-vegetated sections of bank and trees were planted at the top of the bank in an unmown buffer adjacent to the farm fields. This Preventative Maintenance work was allowed by the New Hampshire Department of Environmental Services (NHDES) without a permit.

O&M: The planting work done in 2012 was intended to provide initial bank stabilization on a near vertical and actively eroding section of bank. There has been significant improvement in site stabilization, although several areas of sparse vegetation remain.



FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Figure 8.2
Bank Restoration Sites
in the Turners Falls Impoundment
Map 1

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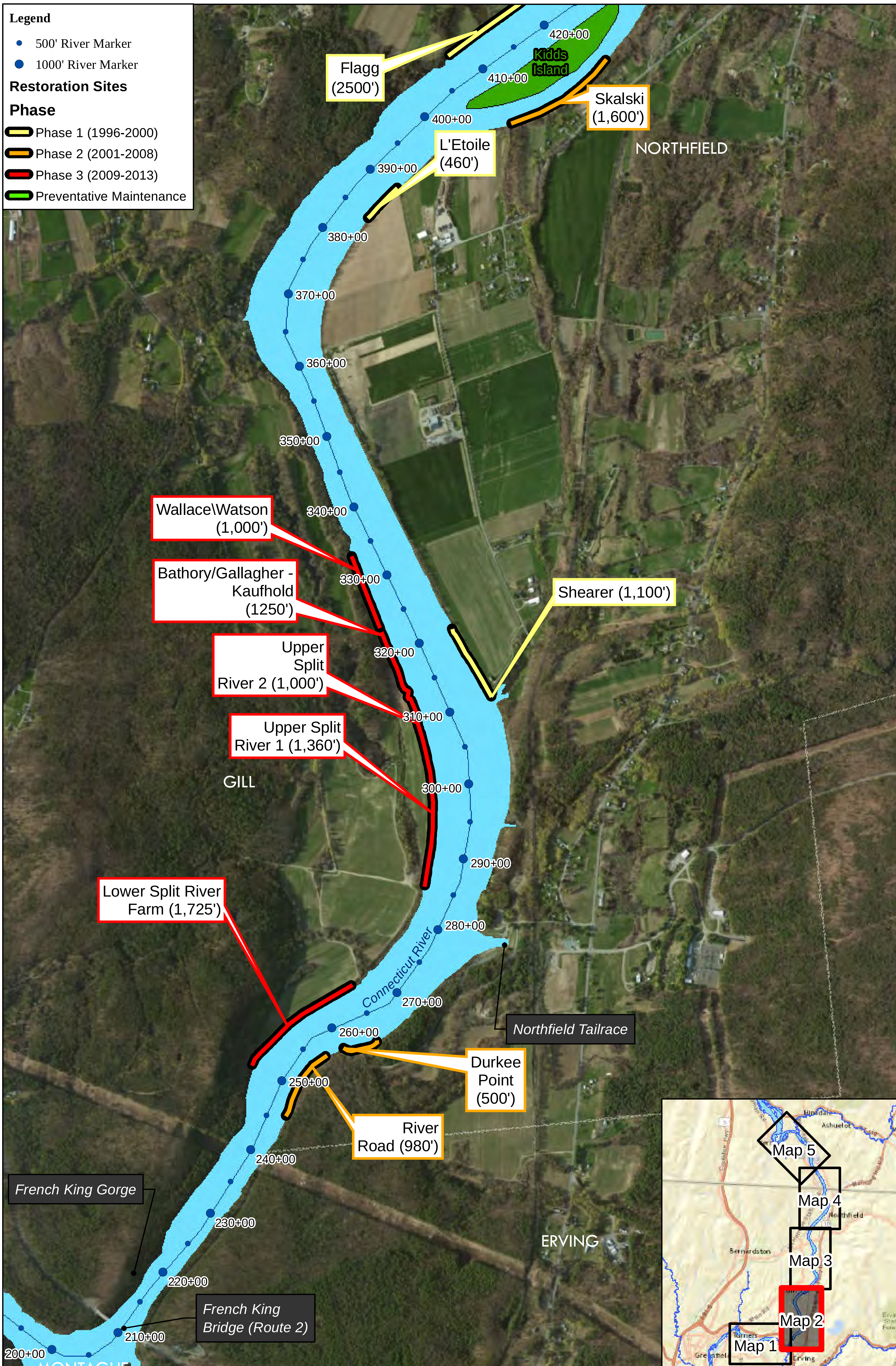

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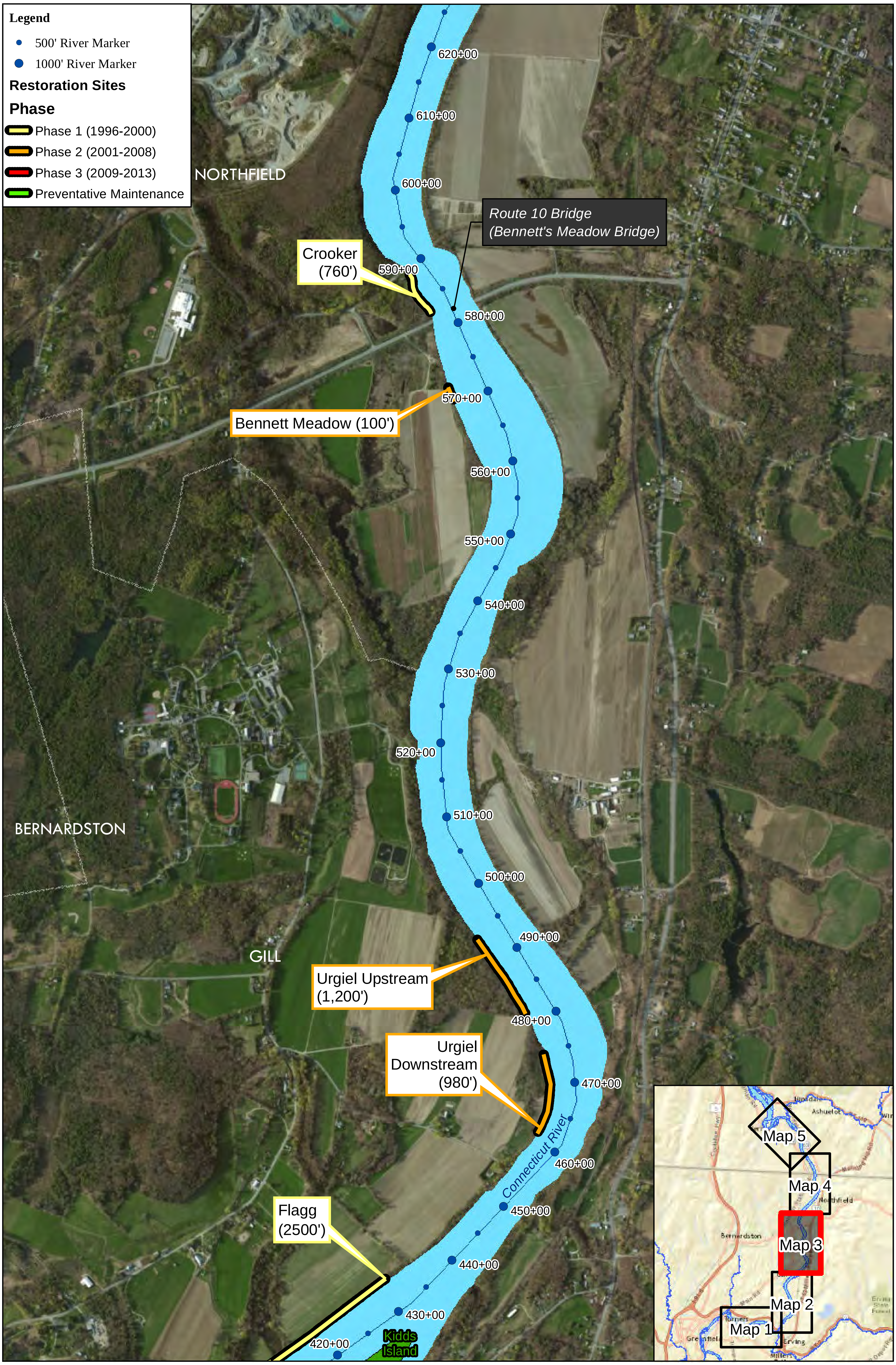
FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Figure 8.3
Bank Restoration Sites
in the Turners Falls Impoundment
Map 2



FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Figure 8.4
Bank Restoration Sites
in the Turners Falls Impoundment
Map 3

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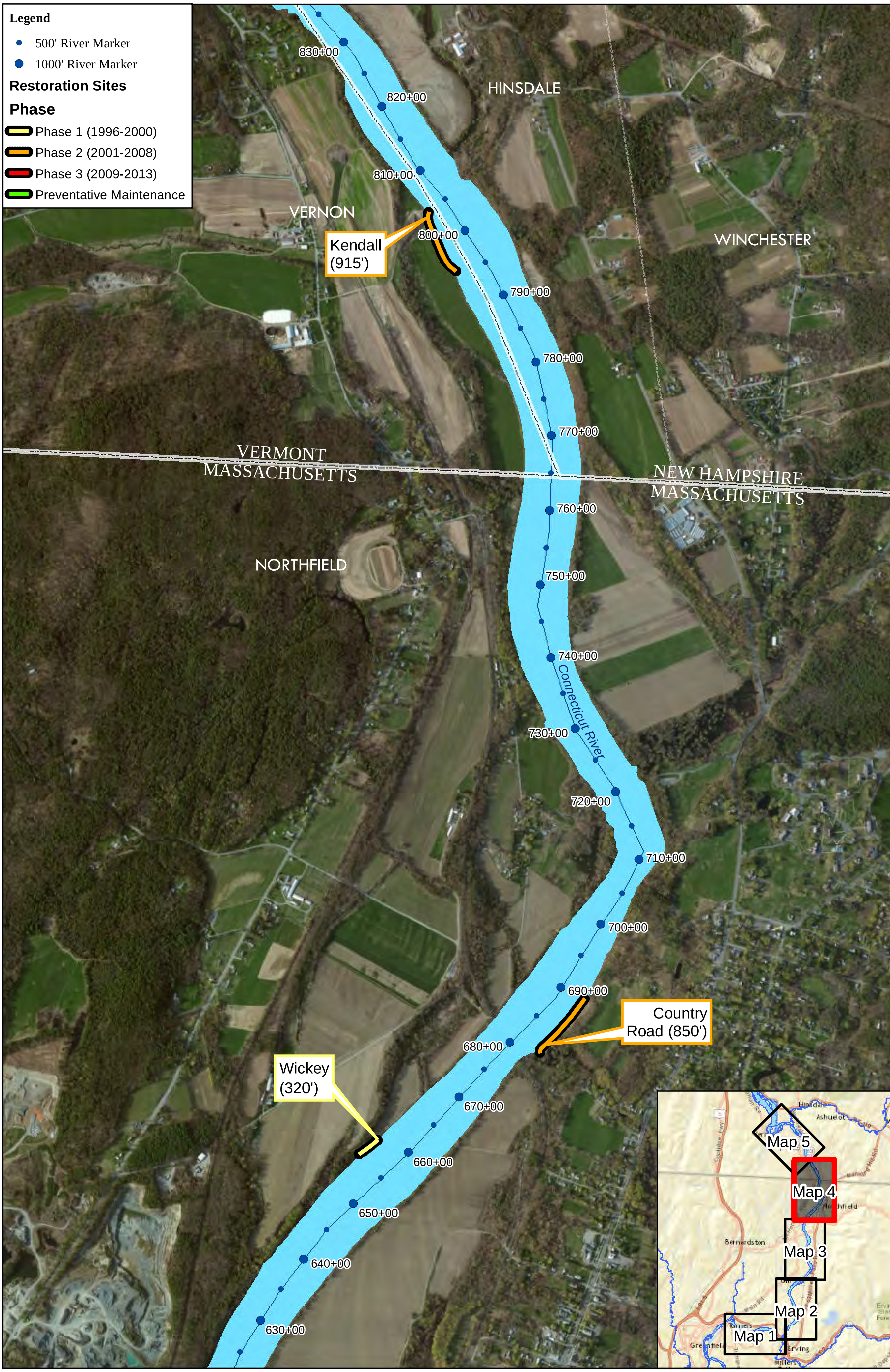

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 625 1,250 2,500 Feet

Figure 8.5
Bank Restoration Sites
in the Turners Falls Impoundment
Map 4

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Figure 8.6
Bank Restoration Sites
in the Turners Falls Impoundment
Map 5

8.3 General Considerations for Preventative Maintenance and Bank Stabilization Projects

Table 8.3 presents the list of recommended bank stabilization/preventative maintenance projects for implementing Phase IV of the ECP. The sites recommended in this table represent projects that can be reasonably completed prior to the expiration of the current FERC license (set to expire April 2018) while still meeting the objectives and goals of the ECP. Included in Table 8.3 are the FRR boat-based segment number (which can be viewed on the figures in Appendix G), the river station (representing the distance upstream of the Turners Falls Dam in feet), the proposed year of construction, length of segment, and erosion conditions as noted during the 2013 FRR. Figures 8.7-8.12 depict the location of each recommended site while Appendix M presents photographs and feature and characteristic tables of each recommended site.

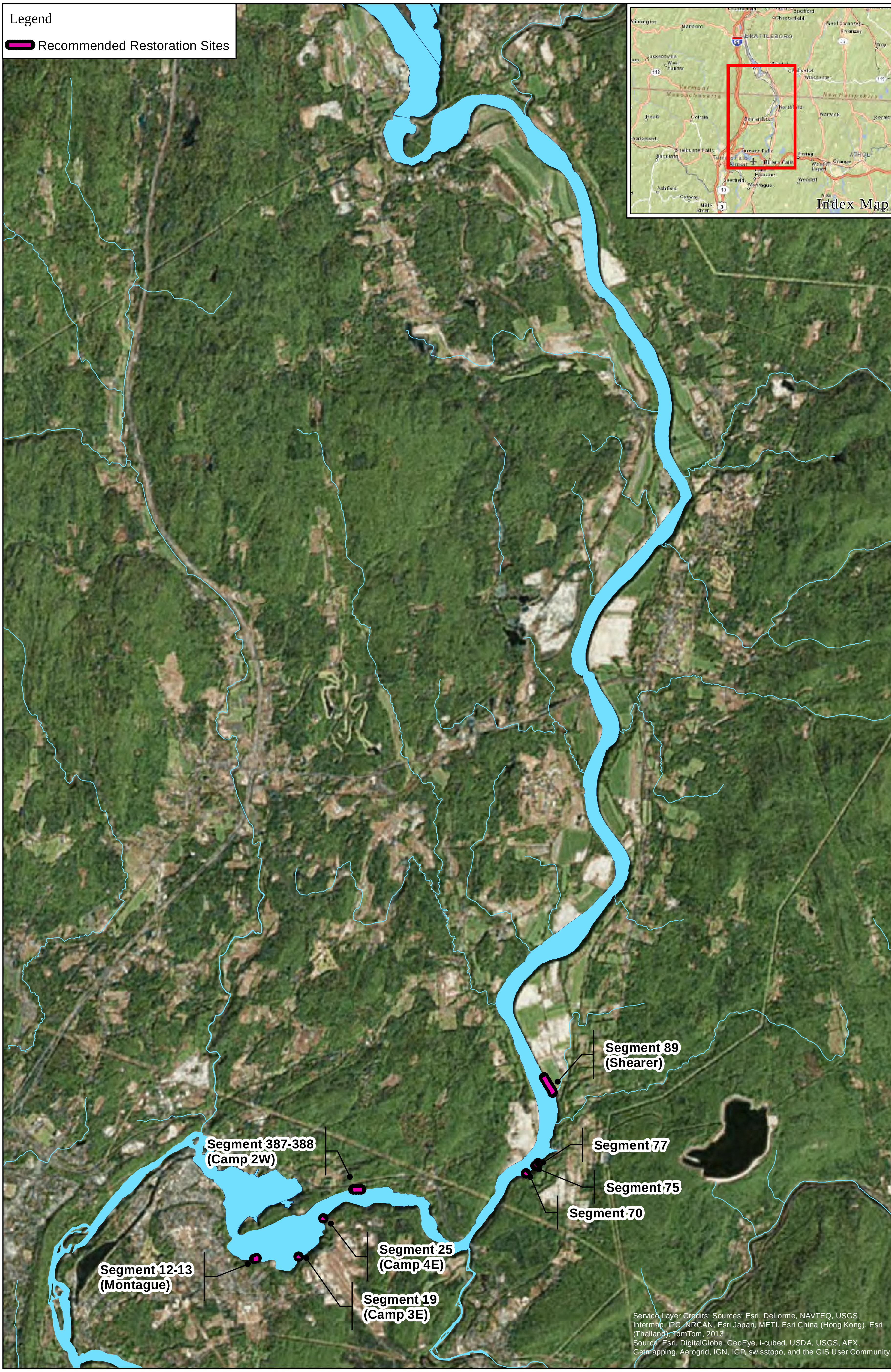
Riverbank segments recommended for future stabilization were identified based on the results of the annual riverbank site inspections, the land-based detailed site assessments and geotechnical observations, and the 2013 FRR boat-based survey. The objectives of the recommended preventative maintenance and bank stabilization projects are to protect property from erosion damage and to reduce sediment loading to the river in accordance with the ECP (Simons, 1999). The recommended sites meet the primary and secondary goals of the 1998 ECP plan priority list and may be reasonably engineered, designed, permitted, and constructed within the timeframe of the current FERC license.

Pre-permitting discussions and consultation with regulatory agencies and stakeholders will be conducted to discuss permitting, design, and site specific issues before proceeding with permit applications for construction.

Table 8.3 Proposed locations for bank stabilization/preventative maintenance projects

Year of Construction	Segment #	River Station (ft)	Length (ft)	Stage of Erosion	Extent of Erosion	Type of Erosion	Potential Indicators of Erosion
2014	89 (Shearer)	311+00 to 321+00	1056	Stable[36]	None/little	Undercut	Exposed Roots
2015	25 Camp 4E	108+00	95	Eroded	Some	Slide	Creep/Leaning Trees
2015	19 Camp 3E	88+00	118	Eroded	Some	Slide	Other
2016	387-388 Camp 2W	132+00 to 137+00	500	Eroded & Potential Future Erosion	Some	Slide, Undercut	Overhanging Bank, Exposed Roots
2017	12-13 (Montague)	67+00	280	Active Erosion	Extensive	Planar Slip, Overhanging Bank	Overhanging Bank, Exposed Roots, Creep/Leaning trees, Other
2017	70	268+00	105	Active Erosion	Extensive	Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots
2017	75	270+00	33	Active Erosion	Extensive	Topple	Creep/Leaning Trees, Overhanging Bank, Exposed Roots
2017	77	273+00	154	Eroded	Some to Extensive	Slide	Creep/Leaning Trees

[36] While this site is stable with a rock toe and heavily vegetated upper riverbank from previous stabilization work, there is an undercut extending along the length of this segment just above the top of rock. The landowner has requested this work be done and FirstLight has agreed to modify the existing stabilization project to eliminate the undercut.



FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 0.5 1 2 Miles

Figure 8.7
Recommended Preventative Maintenance/Bank Stabilization Sites

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 145 290 580 Feet

Figure 8.8:
Recommended Preventative Maintenance/Bank Stabilization Sites
Map 1

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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FirstLight
GDF SUEZ

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 150 300 600 Feet

Figure 8.9:
Recommended Preventative Maintenance/Bank Stabilization Sites
Map 2

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Figure 8.10:
Recommended Preventative
Maintenance/Bank Stabilization Sites
Map 3

N

0 150 300 600 Feet

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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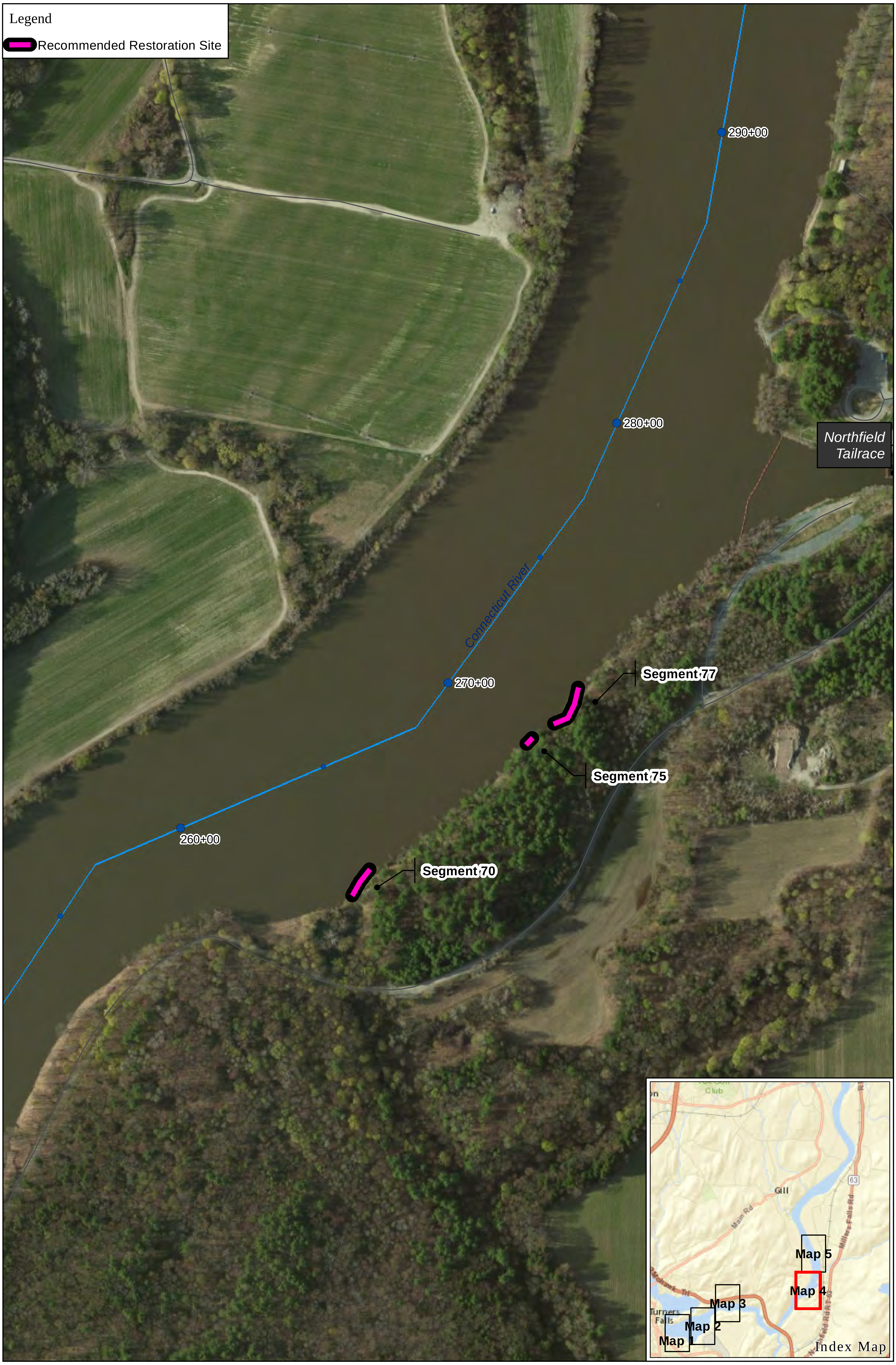

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Figure 8.11:
Recommended Preventative Maintenance/Bank Stabilization Sites
Map 4

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 150 300 600 Feet

Figure 8.12:
Recommended Preventative Maintenance/Bank Stabilization Sites
Map 5

Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

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9 GLOSSARY OF TERMS

Table 5.3 and Figure 5.7 provide definitions for the majority of the terms of importance found throughout this report. In addition, Appendix F provides a detailed discussion on the differentiation between the lower and upper riverbank. Other terms of interest used throughout this report are listed below.

Lower Riverbank: is that part of the riverbank that is frequently below water, typically lies at a relatively flat slope, and is mostly barren of vegetation other than some scattered aquatic vegetation. Refer to Appendix F for more detailed discussion.

Upper Riverbank: is that part of the riverbank that is frequently above water but can be inundated for short durations during high flow events and supports various types of terrestrial vegetation. Refer to Appendix F for more detailed discussion.

The above definition will be further defined during Study No. 3.1.2 through statistical analysis of hydrologic data and calibrated hydraulic modeling to determine a range of elevations of water surface along the Impoundment.

10 REFERENCES

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APPENDIX A – CONSULTATION RECORD

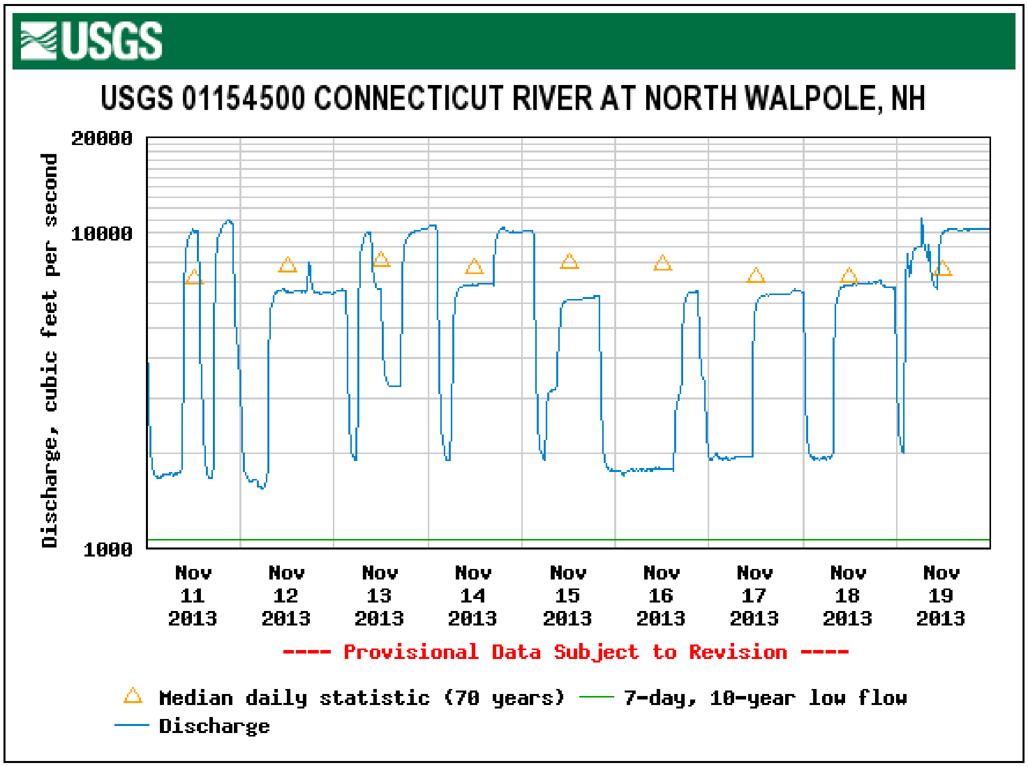
Appendix A: Consultation Record

In advance of the 2013 Full River Reconnaissance, FirstLight met and consulted with various Stakeholder and Agency groups on several occasions to review and update the methodology that was to be employed during the 2013 FRR survey. A summary of these meetings are found in the table below:

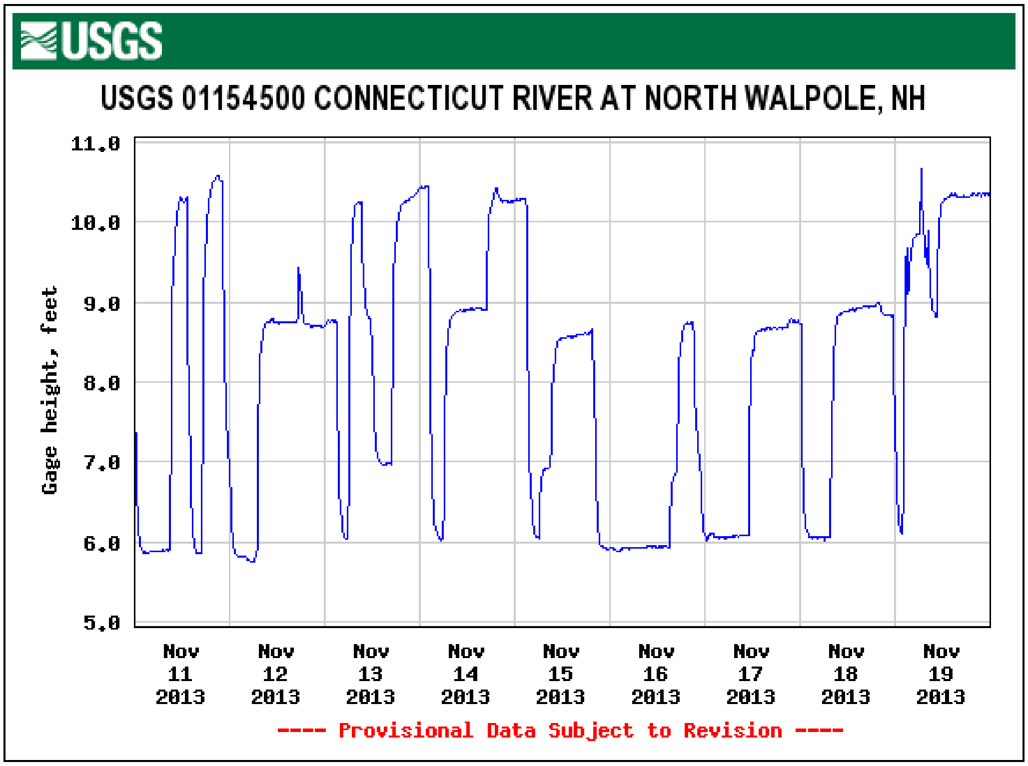
DATE	ATTENDEES	LOCATION
5/15/2013	Connecticut River Streambank Erosion Committee (CRSEC), Franklin Regional Council of Governments (FRCOG), Franklin Conservation District (FCD), Connecticut River Watershed Council (CRWC), Landowners and Concerned Citizens for License Compliance (LCCLC), FERC, Massachusetts Department of Environmental Protection (MADEP), FirstLight	Northfield Mountain Visitors Center
6/14/2013	CRSEC, FRCOG, FCD, CRWC, LCCLC, FERC, MADEP, FirstLight	Northfield Mountain Visitors Center
8/26/2013	MADEP, FirstLight	MADEP Offices - Springfield, MA
10/30/2013	CRSEC, FirstLight	J.W. Olver Transit Center, Greenfield, MA
11/5/2013	MADEP, FirstLight	Northfield Mountain Visitors Center

APPENDIX B – USGS FLOW & STAGE HYDROGRAPHS

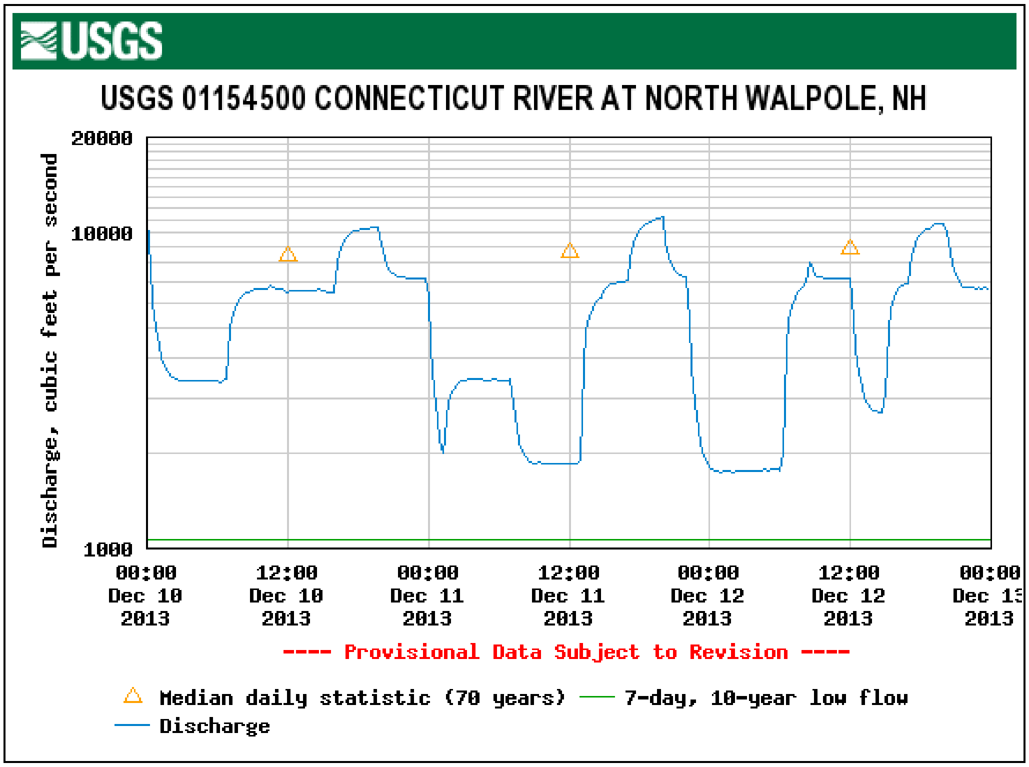
Connecticut River at North Walpole, NH – November 11-19, 2013, Flow Hydrograph



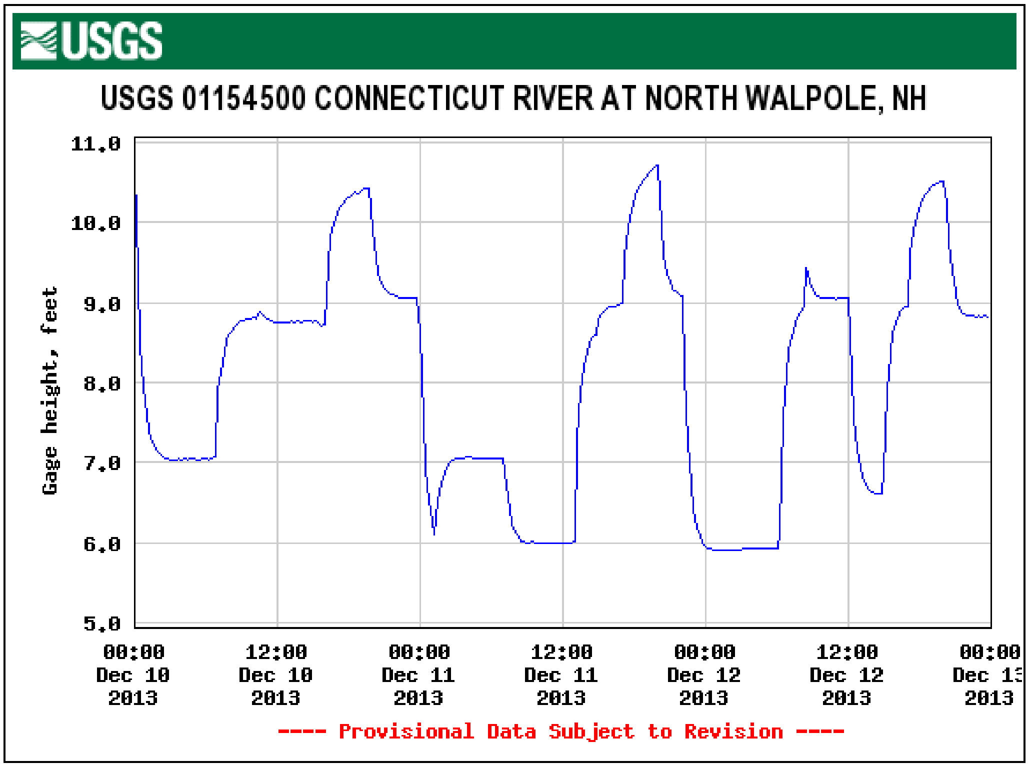
Connecticut River at North Walpole, NH – November 11-19, 2013, Stage Hydrograph



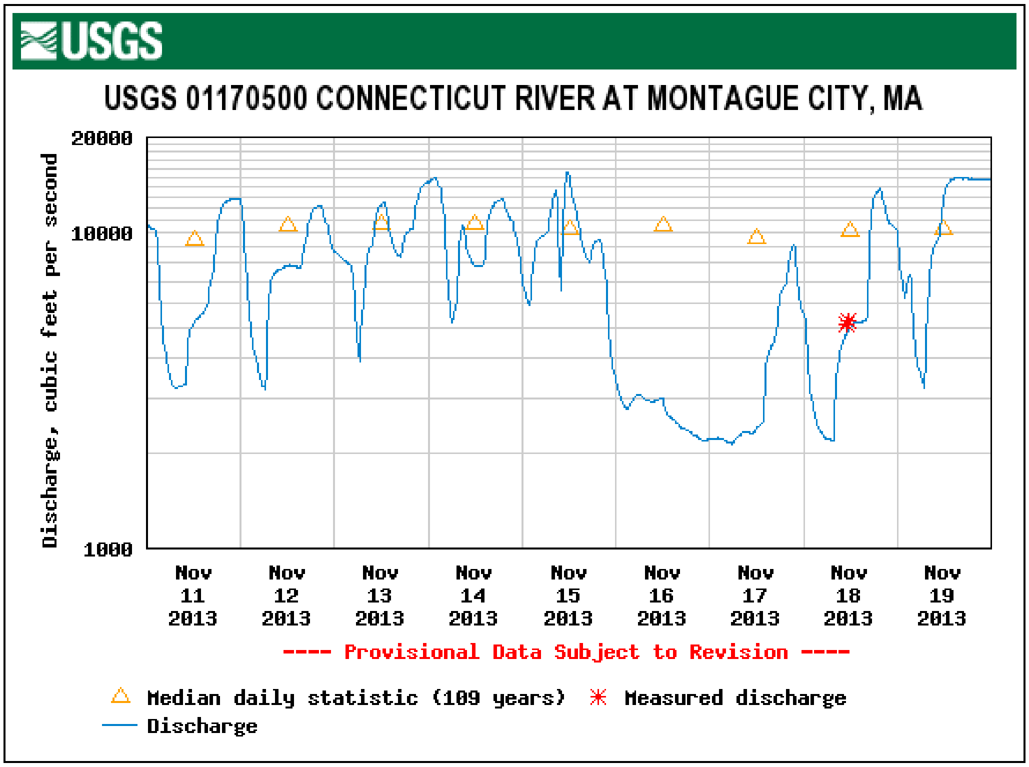
Connecticut River at North Walpole, NH – December 10-12, 2013, Flow Hydrograph



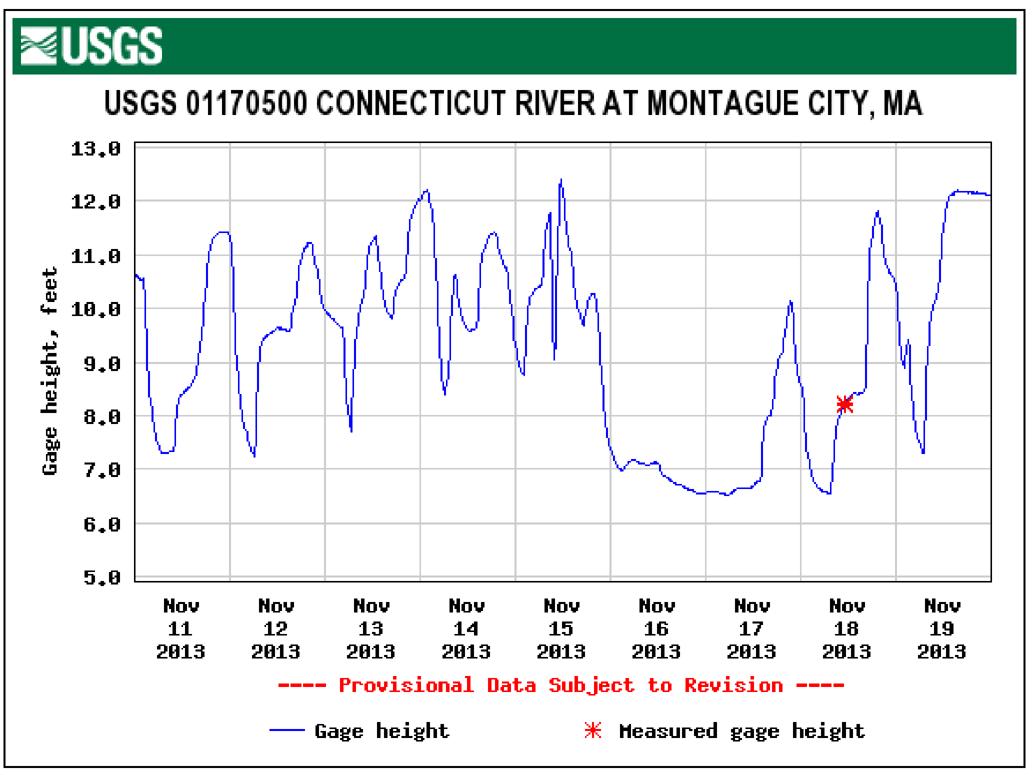
Connecticut River at North Walpole, NH – December 10-12, 2013, Stage Hydrograph



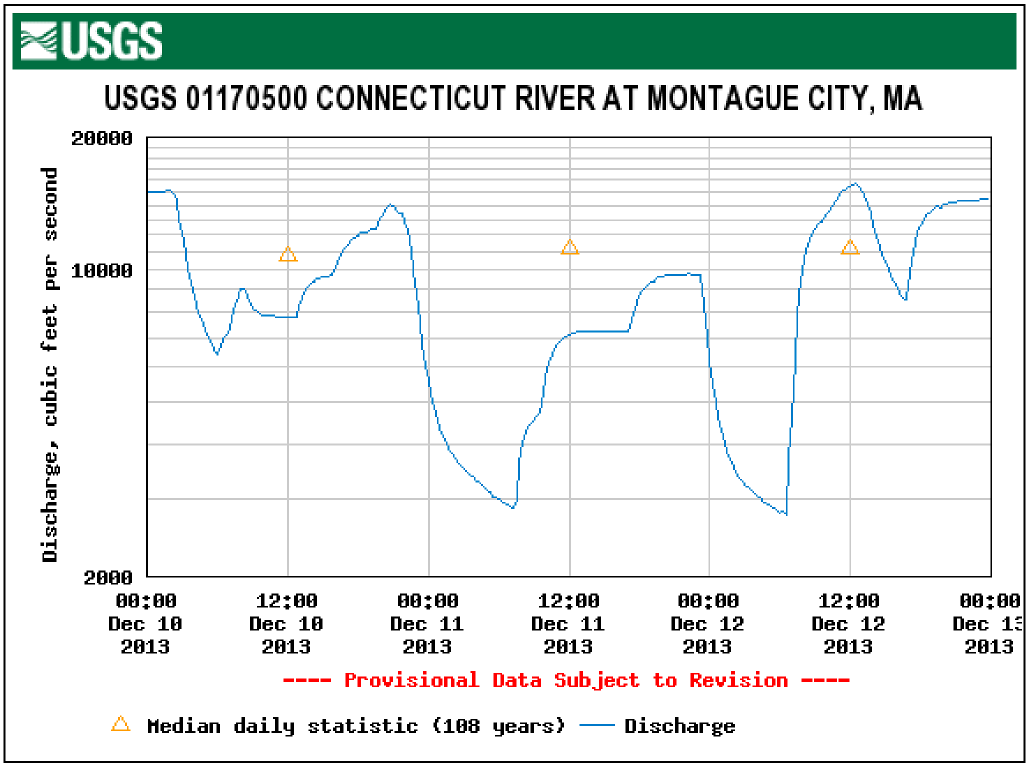
Connecticut River at Montague, MA – November 11-19, 2013, Flow Hydrograph



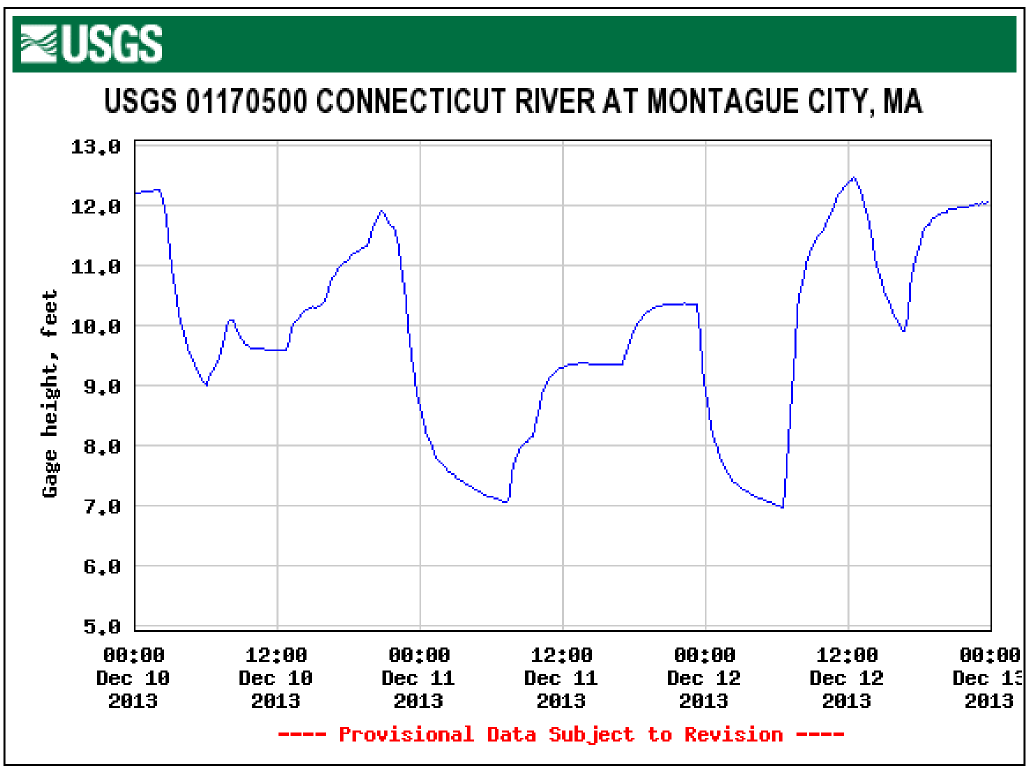
Connecticut River at Montague, MA – November 11-19, 2013, Stage Hydrograph



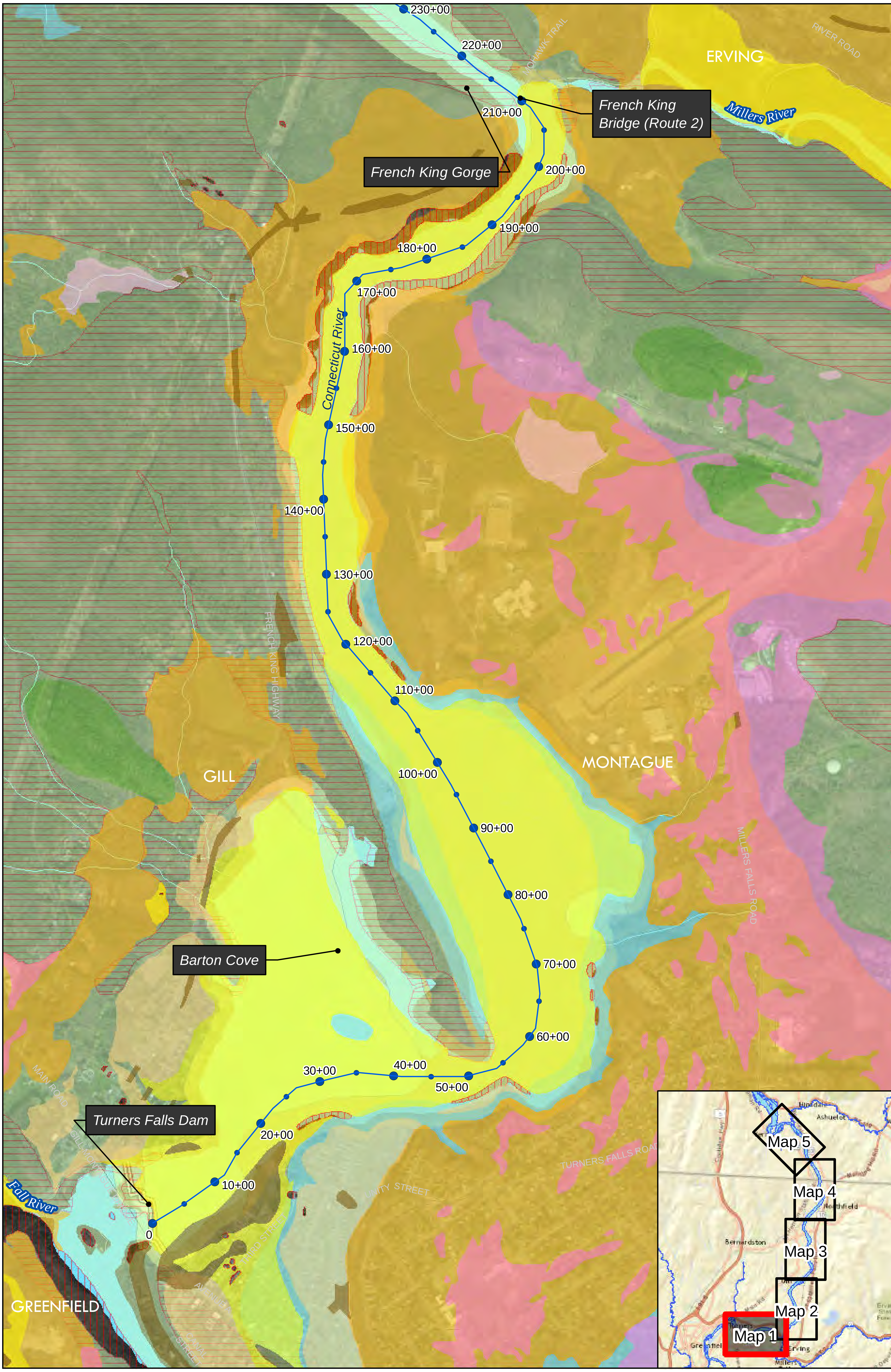
Connecticut River at Montague, MA – December 10-12, 2013, Flow Hydrograph



Connecticut River at Montague, MA – December 10-12, 2013, Stage Hydrograph



APPENDIX C – SURFICIAL GEOLOGY MAPS



FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Surficial Geology
Map 1

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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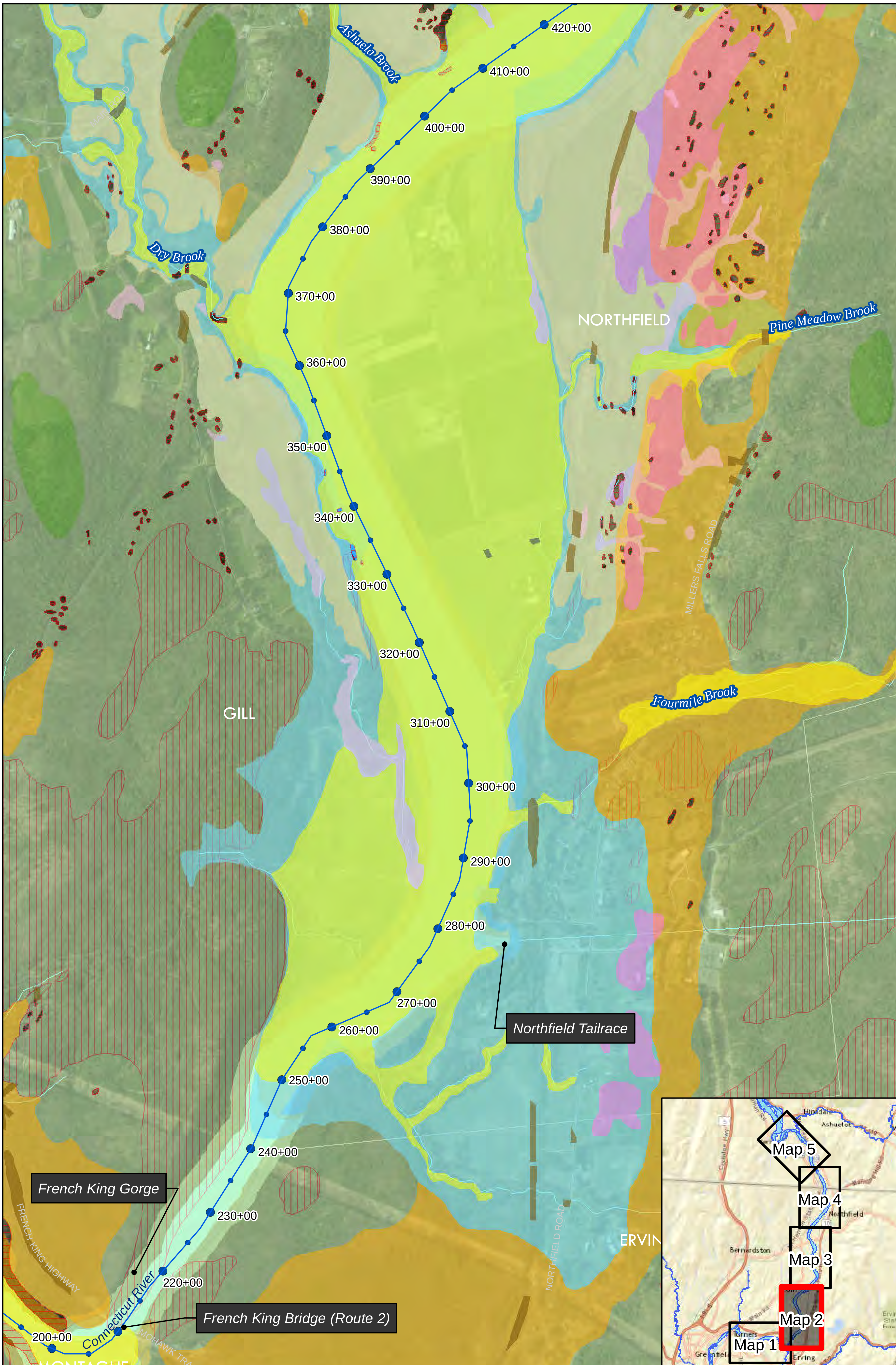

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Surficial Geology
Map 2

N

0 625 1,250 2,500 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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FirstLight GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Surficial Geology
Map 3

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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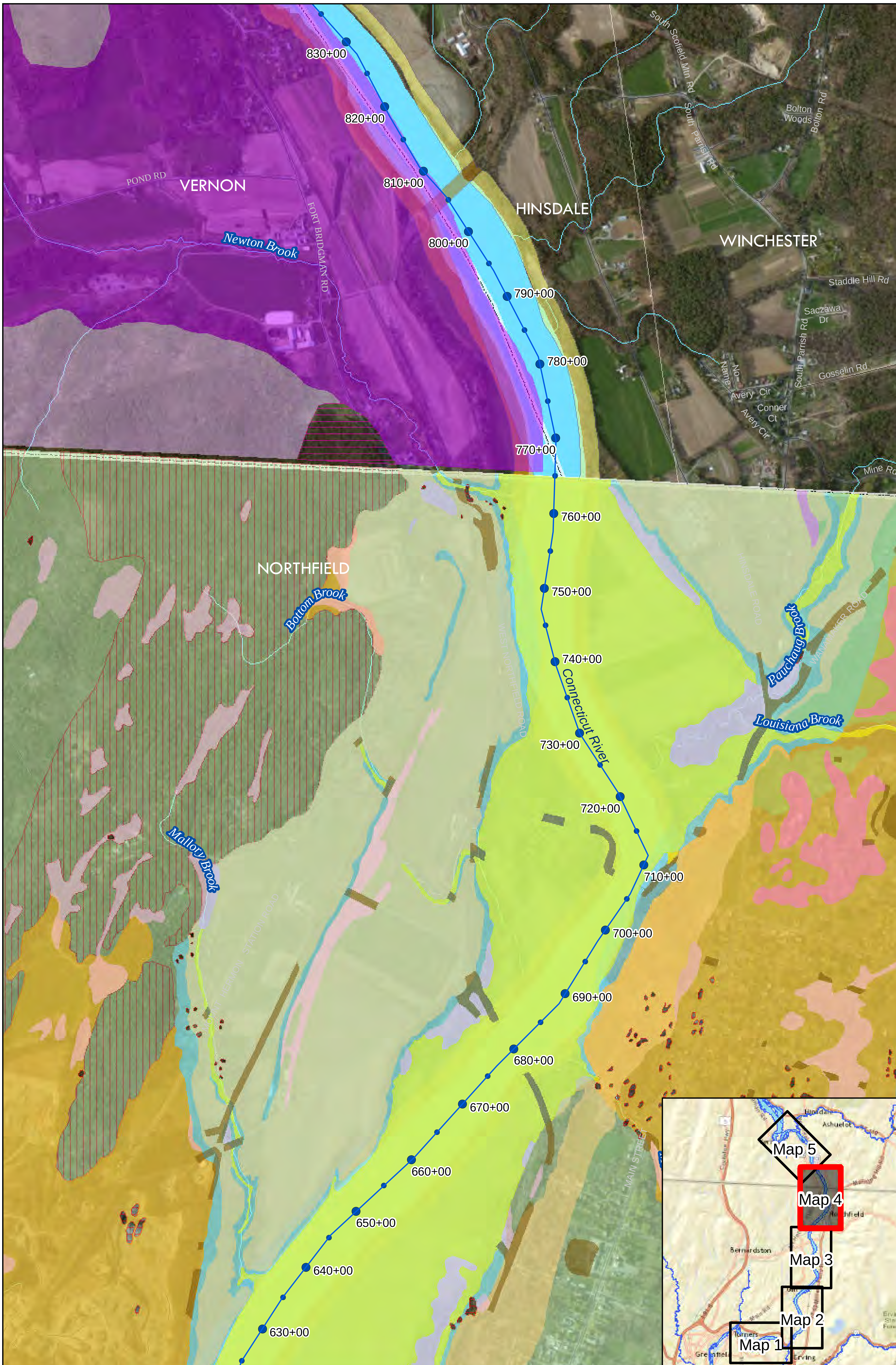

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Surficial Geology
Map 4

N

0 625 1,250 2,500 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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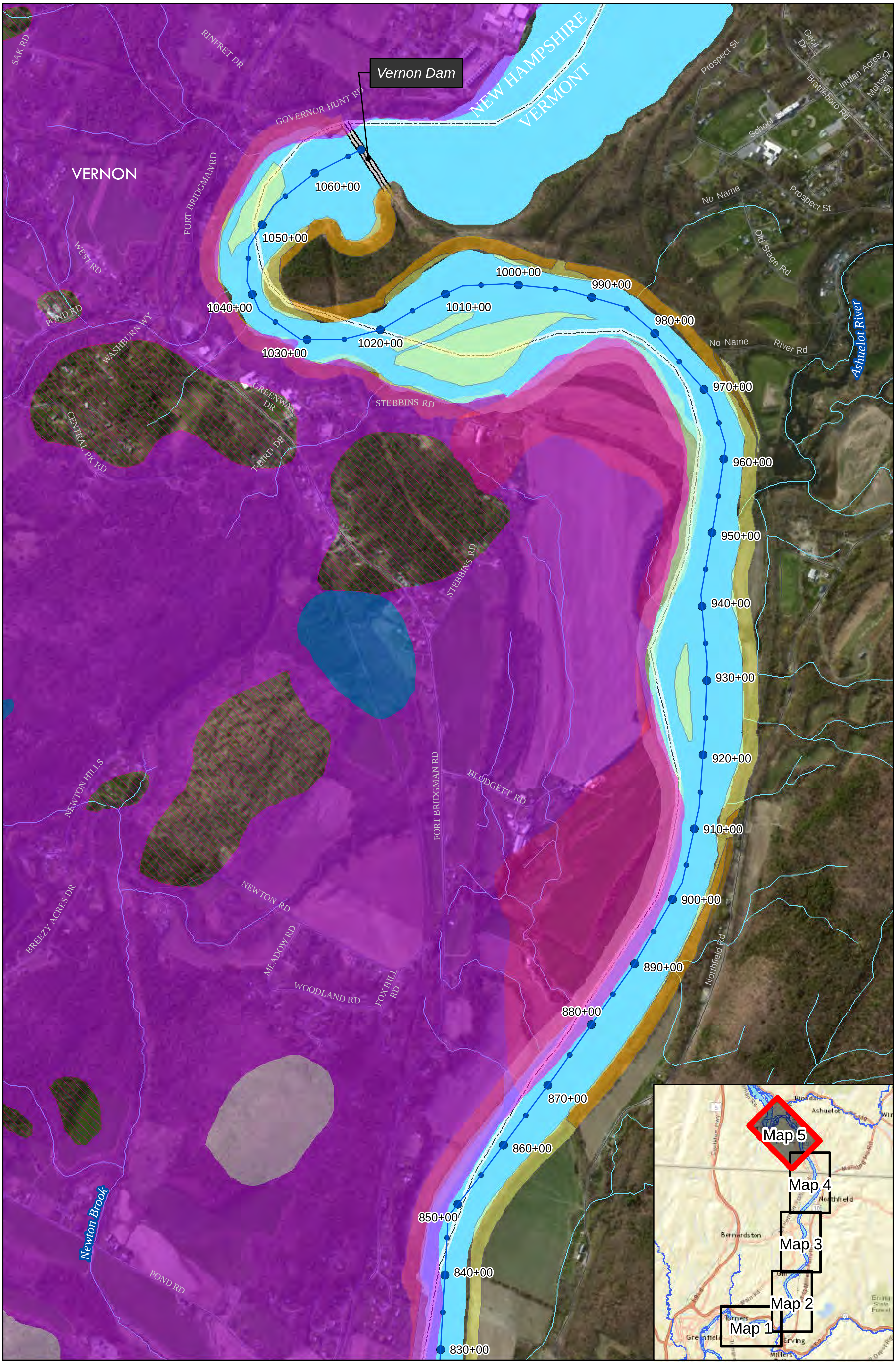

FirstLight
GDF SUEZ

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Surficial Geology
Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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Legend

VT Surficial Geology

- Bedrock exposure
- Eolian deposit
- Glacial deposit
- Glaciofluvial deposit
- Glaciolacustrine deposit
- Pluvial deposit
- Postglacial fluvial deposit
- Surface Water

MA Surficial Geology

Postglacial Deposits

- Artificial Fill
- Floodplain Alluvium
- Swamp Deposit

Early Postglacial Deposits

- Alluvial-Fan Deposit
- Inland-Dune Deposit
- Stream-Terrace Deposit
- Talus Deposit

Glacially Stratified Deposits

- Coarse Deposit
- Fine Deposit

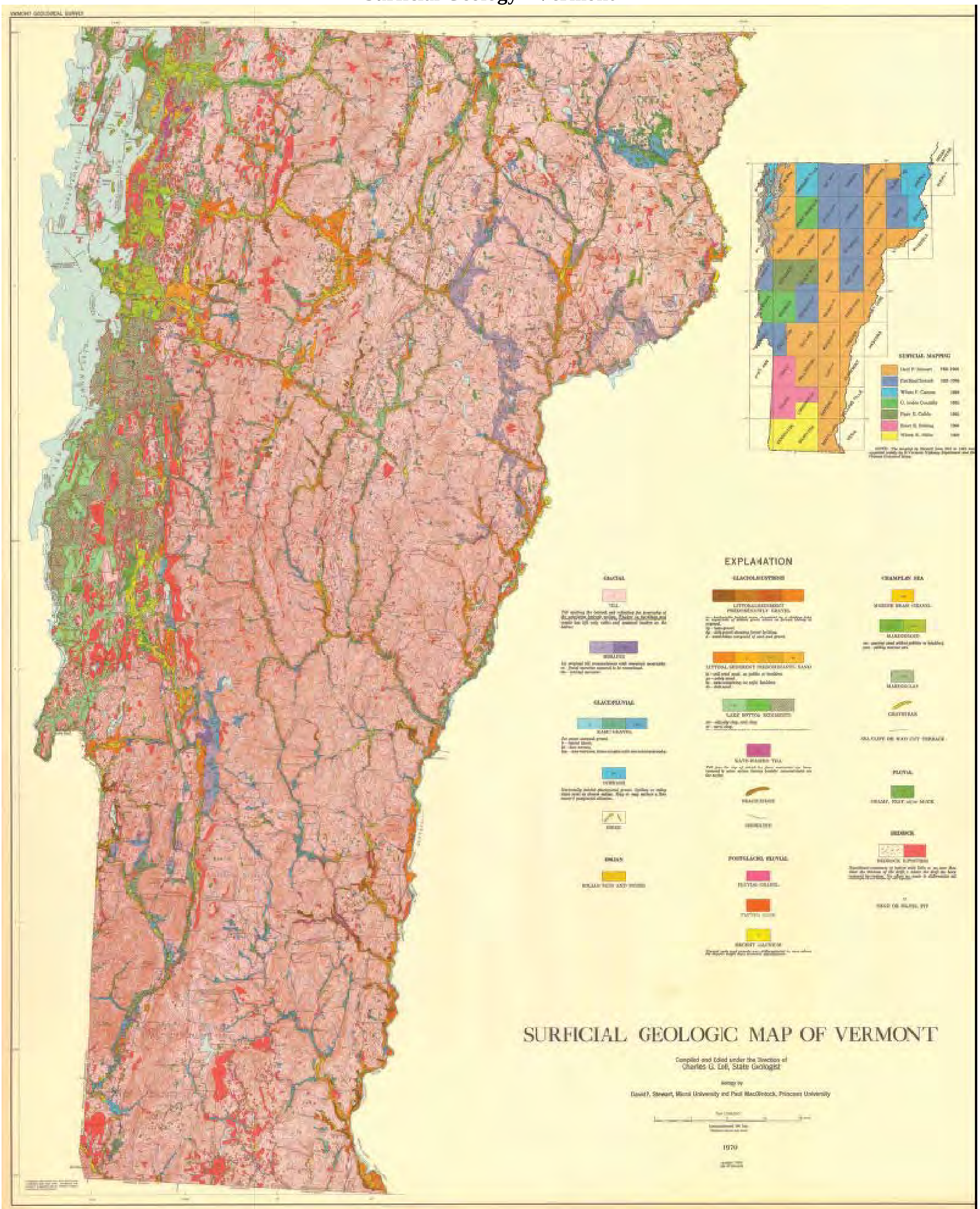
Till and Bedrock

- Abundant Outcrop or Shallow Bedrock
- Bedrock Outcrop
- Thick Till
- Thin Till
- Waterbody (Soil not classified)

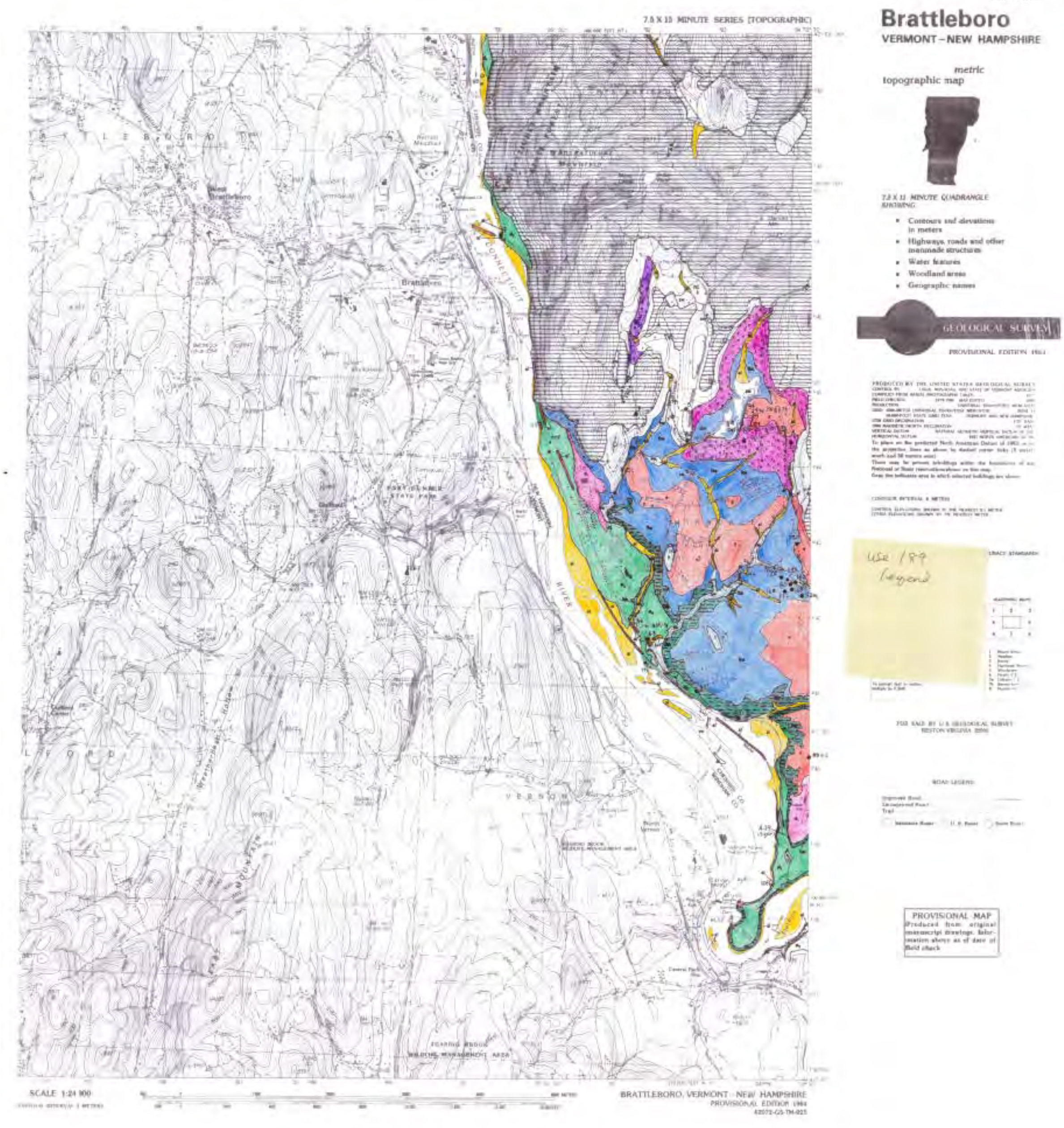
New Hampshire Surficial Geology

- Glacial lake deposits, fine and well sorted deposits
- Glacial lake deposits, sand and gravel
- Till or bedrock
- Floodplain alluvium
- Artificial fill

Surficial Geology - Vermont



Surficial Geology – Brattleboro (East), New Hampshire



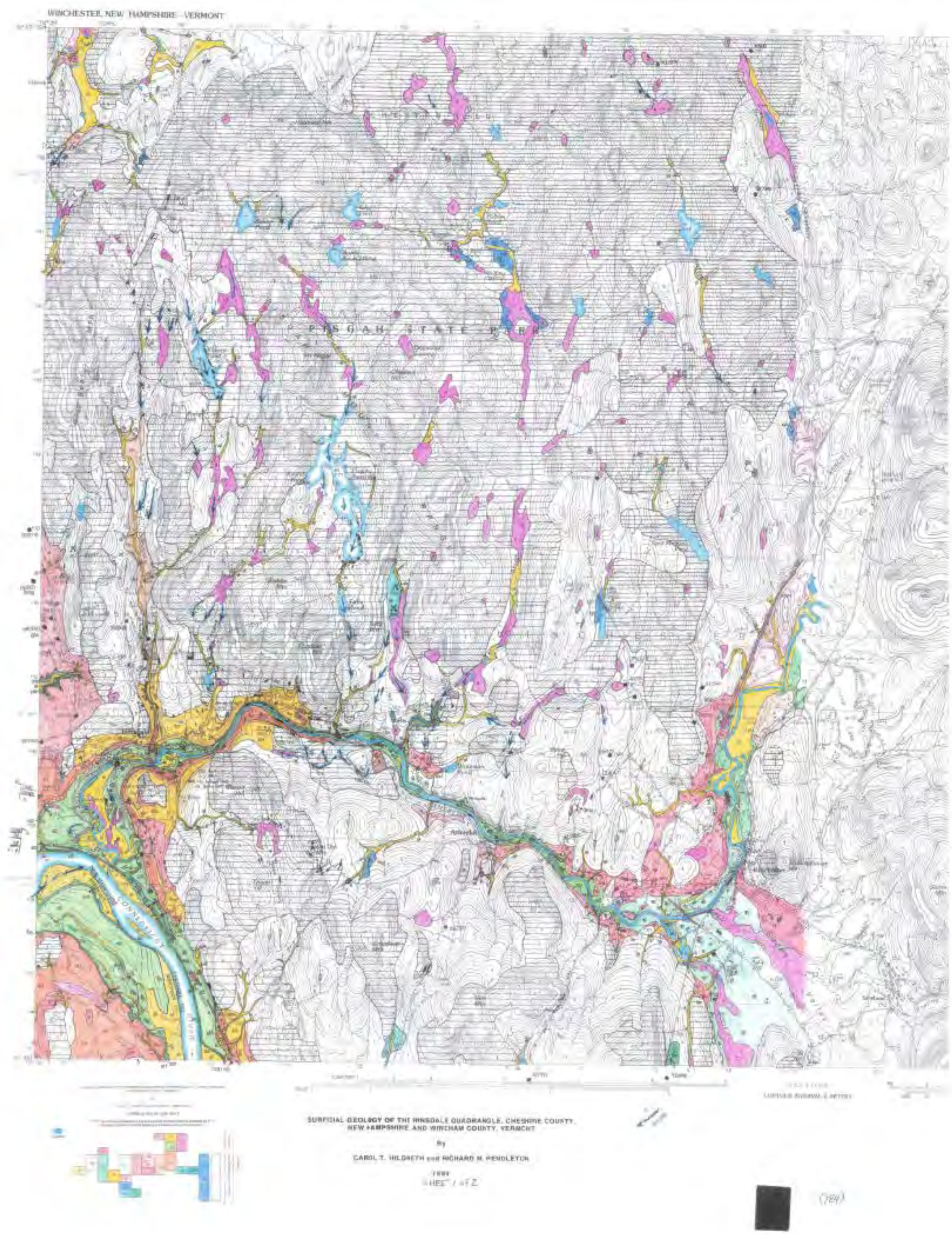
SCALE 1:24,000
CONTOUR INTERVAL 6 METERS
DATUM IS MEAN SEA LEVEL

SURFICIAL GEOLOGIC MAP OF THE NEW HAMPSHIRE PORTION OF THE BRATTLEBORO (EAST), QUADRANGLE, CHESHIRE COUNTY, NEW HAMPSHIRE

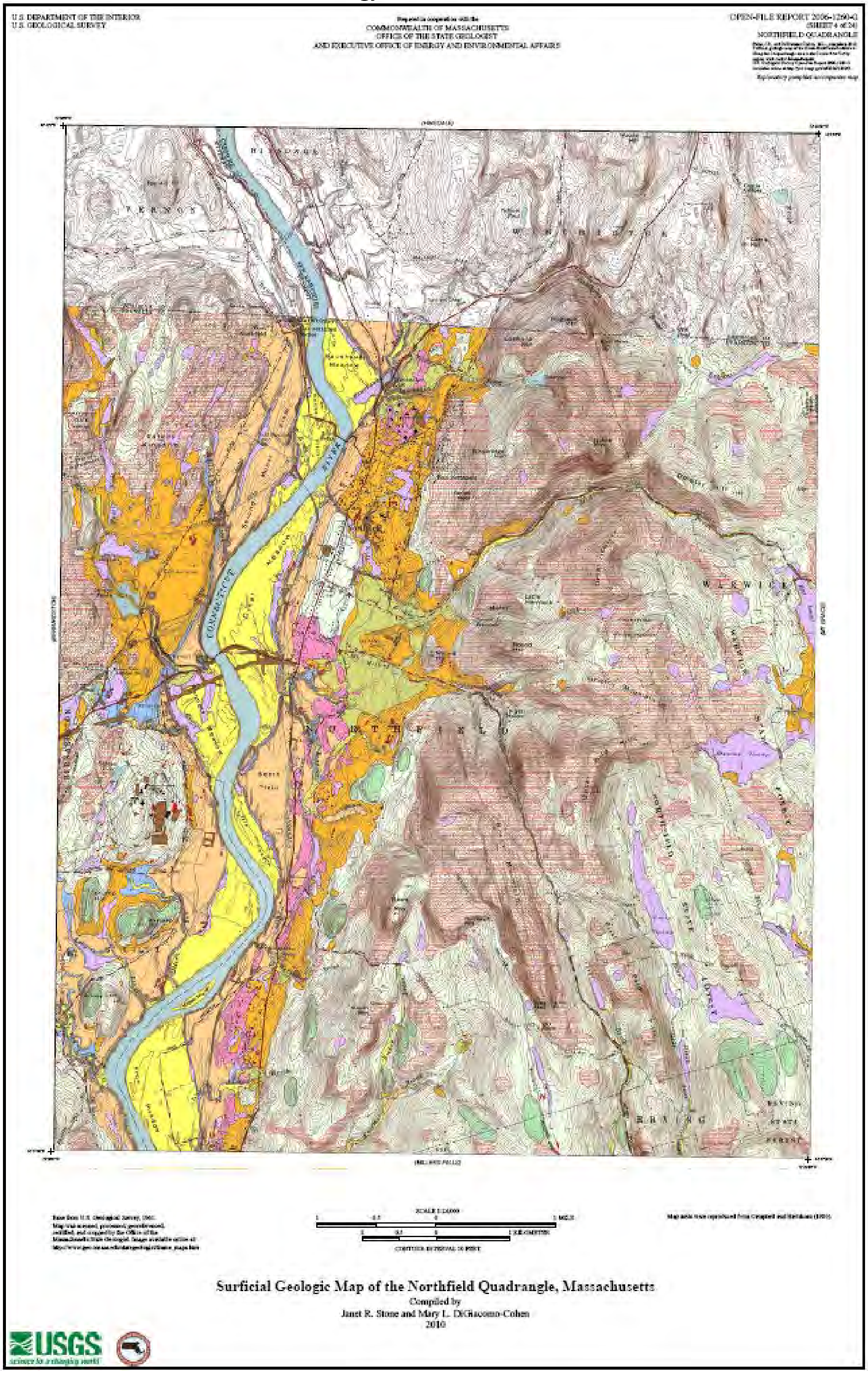
By
Richard M. Pendleton
200X
(Mapped in 200X)

Brattlebo
1:24,00

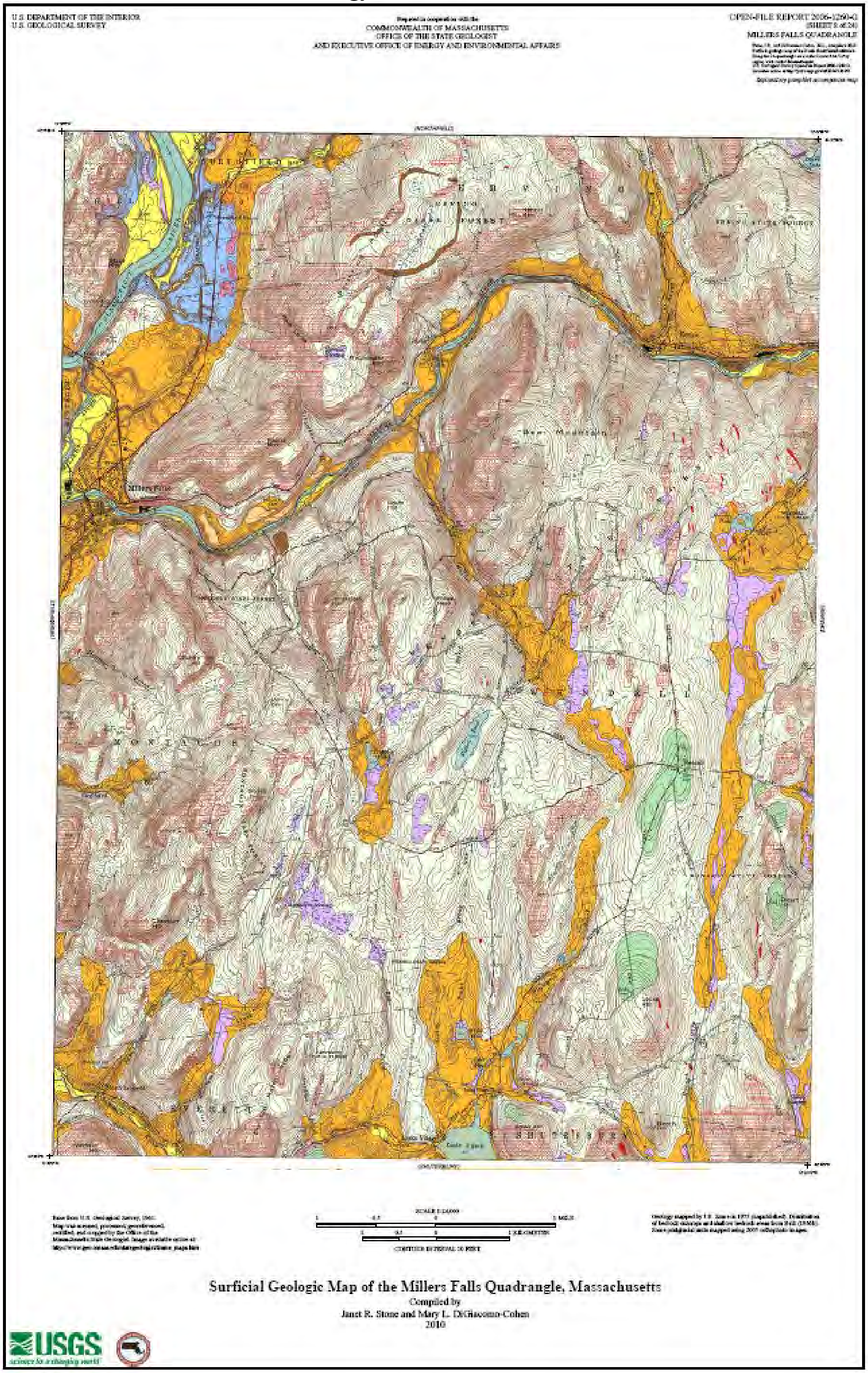
Surficial Geology – Hinsdale, New Hampshire



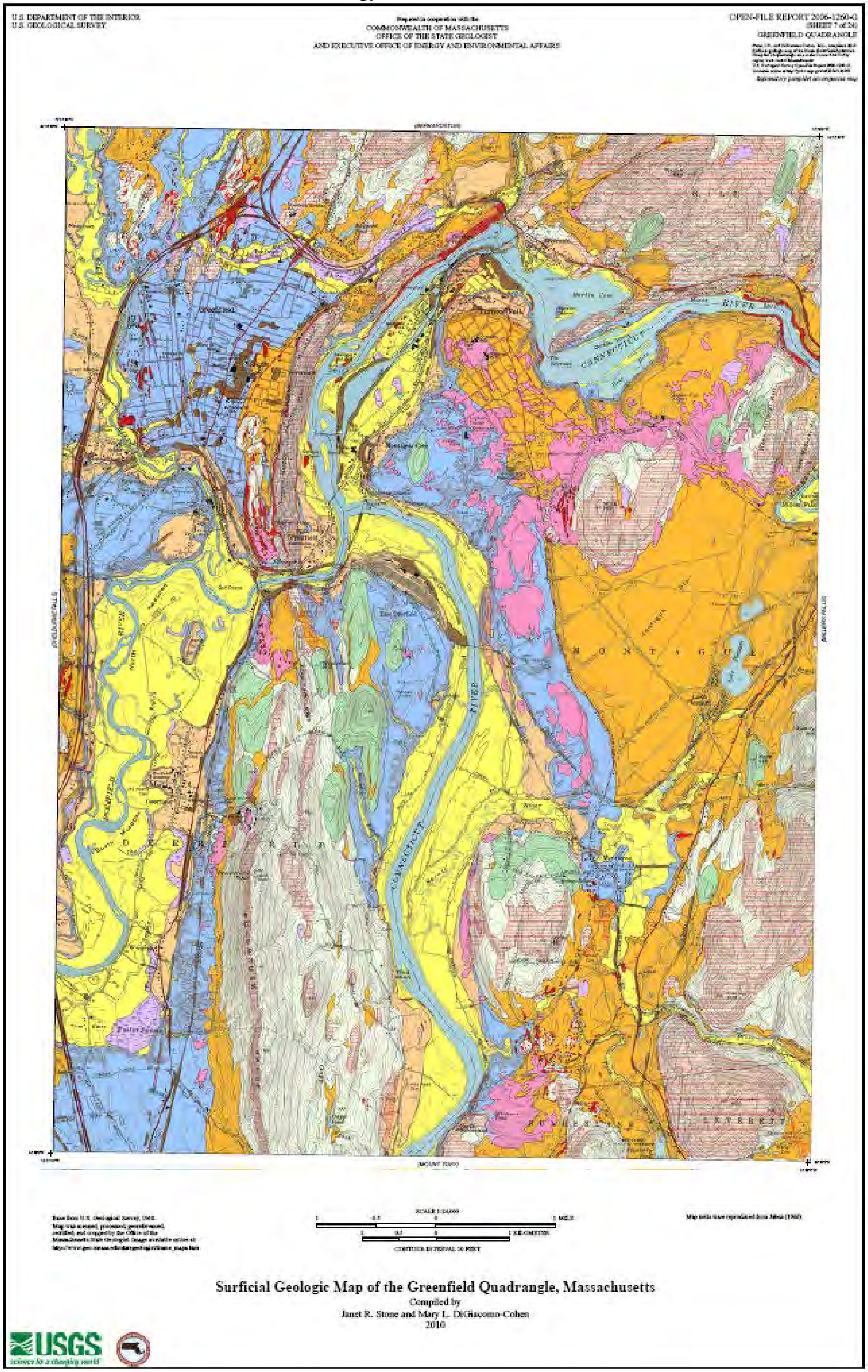
Surficial Geology – Northfield, Massachusetts



Surficial Geology – Millers Falls, Massachusetts



Surficial Geology – Greenfield, Massachusetts



Surficial Geology Map Legends

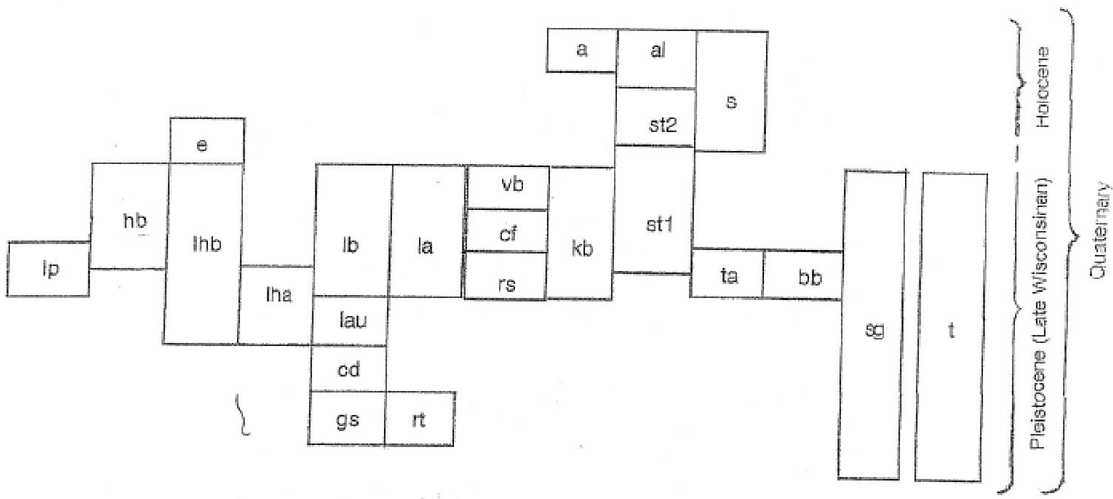
SURFICIAL GEOLOGY OF THE HINSDALE QUADRANGLE, CHESHIRE COUNTY, NEW HAMPSHIRE AND WINDHAM COUNTY, VERMONT

By

CAROL T. HILDRETH and RICHARD M. PENDLETON

CORRELATION OF MAP UNITS

NOTE: All units are Quaternary in age and symbols normally would be preceded by a "Q." Correlation between isolated deposits and between map units is tentative.



SURFICIAL GEOLOGY OF THE HINSDALE QUADRANGLE, CHESHIRE COUNTY, NEW HAMPSHIRE AND WINDHAM COUNTY, VERMONT

DESCRIPTION OF MAP UNITS

By

Carol T. Hildreth and Richard M. Pendleton

(NOTE: All units are Quaternary in age and symbols normally would be preceded by a "Q")

(Mapped in 1998 and 1999--Scale 1:24,000)

A layer of windblown sand and silt, generally mixed with underlying glacial deposits, is present over much of the map are but is not shown.

NOTE: Correlation between isolated deposits and between map units is tentative.

a ARTIFICIAL CUT AND FILL--Manmade. Material of fill varies from natural sand and gravel to quarry wastes to sanitary landfill. Depth of cuts and thickness of fill variable. Not extensively mapped in urbanized areas.

al ALLUVIUM (HOLOCENE)--Sand, silt, gravel and minor muck in flood plains along present rivers and streams. As much as 3 meters (10 feet) thick. Extent of alluvium indicates most areas flooded in the past which may be subject to future flooding. In areas upstream from dams, the al unit may be a drowned stream terrace. In places, indistinguishable from swamp deposits (s) or lake-bottom deposits (lb, lhb). Areas mapped as al based in part on evidence indicating they are flooded every few years.

s SWAMP DEPOSITS (HOLOCENE)--Muck, peat, silt, and sand. Generally 1/2 meter to 3 meters (1 foot to 10 feet) thick, but may be as much as 9 meters (30 feet) thick. In places, indistinguishable from alluvium (al).

e EOLIAN DEPOSITS (HOLOCENE AND PLEISTOCENE)--Sand, fine- to medium-grained, and silt, well-sorted. Found as a thin blanket to small dunes on a variety of older glacial deposits. Thickest deposits, most of which do not have a distinct morphology in this quadrangle, occur on high ground east of the Connecticut River, indicating deposition by prevailing west to northwest winds shortly after glacial Lake Hitchcock drained, exposing its bottom sediments to wind erosion. "These dunes cannot readily be distinguished from low sandy kames by their moundlike form; but where the interior is revealed as in roadcuts, the uniform coarseness of the sand and the utter absence of pebbles and stones will identify them as windblown" Goldthwaite and others, 1951, p. 51). As much as 6 meters (20 feet) thick.

STREAM-TERRACE DEPOSITS (HOLOCENE AND LATE PLEISTOCENE)--Sand, gravel, silt, and minor muck, generally on terraces cut by the late-glacial and post-glacial Connecticut and Ashuelot Rivers and their tributaries, as they cut down their channels when base levels dropped due to failure of glacial drift dams within their watersheds. Deposits in the Connecticut River drainage were deposited on the floodplain of the Early Holocene-Late Pleistocene Connecticut River, as it cut down through lake-bottom and deltaic deposits of former glacial-Lake Hitchcock; and most of these terrace deposits disconformably overie varved clay. Deposits near the top of a scarp may be as much as 12 meters (40 feet) thick, while those near the base of the next highest scarp commonly form discontinuous patches that overlie varved clay (Campbell and Hartshorn, 1980). Several terrace levels were identified, but were combined into two units. The higher, older unit was probably graded to the Lily Pond bedrock barrier near Turners Falls in the Greenfield quadrangle, Massachusetts (Campbell and Hartshorn, 1980; Jahns and Willard, 1942). The lower unit consists of several terrace levels that were graded to stages of the Connecticut River intermediate between the older terrace and modern levels. More detailed study of these terraces could potentially lead to identification of two or more units, similar to those identified for the Cold River area by Ridge (1988). Stream terrace units identified in the Hinsdale quadrangle also include erosional terraces discontinuously veneered with stream-terrace deposits.

st_2 Higher stream-terrace deposits. From 1/2 to 12 meters (1 to 40 feet) thick.

st_1 Lower stream-terrace deposits. From 1/2 to 6 meters (1 to 20 feet) thick.

hb GLACIAL-LAKE AND GLACIAL-STREAM DEPOSITS IN THE HUBBARD BROOK--LILY POND AREA (PLEISTOCENE)-- Sand, gravel, silt, an minor clay and flowtill deposited in contact with or beyond adjacent ice as kame-terrace, ice-channel, and/or esker materials laid down by south-flowing meltwaters graded to the drainage divide between Hubbard Brook and Lily Pond Brook through the col at 216-222 meters (709-728 feet) altitude along the dirt road near the northwest edge of the quadrangle. Contemporaneous in part with units lp, lhb, lb, la, kb, st1, ta, and bb. As much as 9 meters (30 feet) thick .

lp GLACIAL-STREAM DEPOSITS IN THE LILY POND BROOK AREA (PLEISTOCENE)-- Sand, gravel, silt, and minor clay deposited in contact with or beyond adjacent ice as kame-terrace and outwash deposits by meltwaters flowing south down the Lily Pond drainage. Contemporaneous in part with units lhb, lha, lb, la, kb, st1, ta, and bb. As much as 3 meters (10 feet) thick.

sg UNCORRELATED GLACIAL-LAKE AND GLACIAL-STREAM DEPOSITS IN THE HUBBARD BROOK, BROAD BROOK, AND WHEELOCK BROOK DRAINAGES (PLEISTOCENE)-- Small deposits, uncorrelated with any outlet, of sand, gravel, silt, deposited in contact with or byeond adjacent ice as kame-terrace, ice-channel, and/or esker materials. As much as 3 meters (10 feet) thick.

GLACIAL-LAKE HITCHCOCK DEPOSITS (PLEISTOCENE)--Sand, gravel, silt, and clay deposited by glacial meltwaters in contact with or beyond adjacent ice as kame-delta, shore, nearshore, outwash and bottom-set beds of glacial Lake Hitchcock, whose level was controlled by a glacial drift dam at Rocky Hill, Connecticut, and a spillway at New Britain, CT. Glacial-lake Hitchcock occupied the Connecticut valley for several thousands of years between around15,000-16,000 years ago to perhaps about 12,000 -11,000 years ago. The front of the Late-Wisconsinan Ice sheet may have still been in contact with the lake near its northern end when the Rocky Hill drift dam failed and the lake drained. Unit lhb consists of bottomset beds, mostly silt and clay varves as much as 50 meters (150 feet) thick. Unit lha consist of kame-delta and outwash deposits laid down by meltwaters draining the Ashuelot River valley, mostly sand and gravel grading west and south to finer grained sand where the meltwaters entered glacial Lake Hitchcock at aroundt 120 + meters (394 + feet) altitude. Due to post-glacial uplift in the area, the water plane is tilted at 0.9 meters/ km (4.74 feet per mile in a N21.5°W direction, so that shore deposits and deltas built into the lake north of the area are found at respectively higher elevations (Koteff and Larsen, 1989; Larsen, 1992).

lhb Lake-bottom and nearshore deposits, as much as 50 meters (150 feet) thick.

lha Kame-delta, shore, nearshore, and outwash deposits, as much as 30 meters (100 feet) thick

kb GLACIAL-STREAM DEPOSITS OF KILBURN BROOK AREA (PLEISTOCENE)--Sand, gravel, and minor silt, clay, and muck deposited in contact with and beyond adjacent ice as kame-terrace, outwash and alluvial fan deposits by meltwaters flowing south down the valley of Kilburn Brook and its tributaries. Contemporaneous with parts of units lp, hb, lha, lb, la, st1, ta, and bb. As much as 3 meters (10 feet) thick.

GLACIAL-LAKE ASHUELOT DEPOSITS (PLEISTOCENE)--Sand, gravel, silt, and clay deposited by meltwaters in contact with or beyond adjacent ice as kame-delta, delta, shore and nearshore and bottom-set beds of glacial Lake Ashuelot, whose level was controlled by a glacial drift dam that clogged the Ashuelot River valley between the confluence of the Ashuelot with Tufts and Broad Brooks. The spillway for glacial Lake Ashuelot was a channel at altitude 138-144 meters (453-472 feet) in the hills just south of the modern river in the same area. Some varved clay deposits in the Keene area were deposited in glacial Lake Ashuelot approximately 12,600 to 12,700 years B.P.(Before Present) and there are more than 30 feet of silt and clay below that particular varved section (Larsen, 1992, p. 386).

lb Lake-bottom and nearshore deposits--Clay, silt, and fine to coarse sands overlain in places by dominantly deltaic sand and pebble gravel deposits (larsen and Kotefff, 1997). As much as 40 meters (130 feet) thick.

la Kame-delta, delta, shore, and nearshore deposits consisting of predominantly sand and pebble grave. One potential beach deposit was noted under the power lines south of Spot Meadow Brook in the east-central part of the quadrangle. As much as 18 meters (60 feet) thick.

vb Very Brook Deposit--Sand and gravel deposited adjacent to abeyond ice as kame deposits. As much as 30 m (100 ft) thick. Originally mapped in the adjacent West Swanzey quadrangle (Pendleton, 1998)

cf Camp Forest Lake Deposits--Proximal deltaic and kame sands and gravels deposited in contact with and downgradient of glacial ice. As much as 30 m (100 ft) thick. Originally mapped in the adjacent West Swanzey quadrangle (Pendleton, 1998)

rs Richmond Street Deposits--Deltaic and glaciolacustrine sands and gravels deposited into the northern portion of Sunny Valley in Winchester into Glacial Lake Ashuelot. As much as 25 m (80 ft) thick. Originally mapped in the adjacent West Swanzey quadrangle (Pendleton, 1998)

ta GLACIAL-STREAM DEPOSITS IN THE TUFTS BROOK AREA (PLEISTOCENE)-- Sand, gravel, silt, and minor clay deposited in contact with and beyond adjacent ice as kame-terrace, outwash, ice-channel filling, and/or esker deposits by south-flowing meltwaters down the Tufts Brook drainage valley. As much as 3 meters (10 feet) thick.

bb GLACIAL-STREAM DEPOSITS IN THE BROAD BROOK AREA (PLEISTOCENE)-- Sand, gravel, silt, and minor clay deposited in contact with and beyond adjacent ice as kame-terrace, outwash, ice-channel filling, and/or esker deposits by south-flowing meltwaters down the Broad Brook drainage valley. A large pot-hole scar over 2 meters (8 feet) high that was scoured out by glacial meltwaters was observed on the west side of the trail, about 1,067 meters (3,500 feet) north of where the trail crosses under the power lines. As much as 3 meters (10 feet) thick.

lau UPPER GLACIAL-LAKE ASHUELOT DEPOSITS (PLEISTOCENE)--Sand, gravel and minor silt and clay deposited in contact with and beyond adjacent ice as kame-terrace deposits graded to a higher level than the main glacial Lake Ashuelot channel (about 162-168 meters [531-551 feet] altitude) . As much as 9 meters (30 feet) thick.

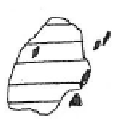
cd GLACIAL-STREAM DEPOSITS EAST OF CAT DEN MOUNTAIN (PLEISTOCENE)-- Sand, gravel, flowtill, silt, and minor clay deposited in contact with and beyond adjacent ice as kame-terrace deposits laid down by meltwaters flowing westward between the mountains on the south and the ice margin on the north. As much as 3 meters (10 feet) thick.

gs GLACIAL-LAKE AND GLACIAL-STREAM DEPOSITS EAST AND SOUTH OF GUN AND SCHOFIELD MOUNTAINS (PLEISTOCENE)-- Sand, gravel, flowtill, silt, and minor clay deposited in contact with and beyond adjacent ice as kame-terrace deposits laid down by meltwaters flowing southward between the mountains on the north and east and the ice margin on the south and west. As much as 3 meters (10 feet) thick.

rt GLACIAL-STREAM DEPOSITS ALONG ROUTE 10 SOUTH (PLEISTOCENE)-- Sand, gravel, flowtill, silt, and minor clay deposited in contact with and beyond adjacent ice as kame-terrace deposits laid down by meltwaters flowing southward over a divide at 222-228 meters (728-748 feet) altitude about 0.75 km (1/2 mile) south of the quadrangle border. As much as 3 meters (10 feet) thick.

t TILL (PLEISTOCENE)--Light- to dark-gray, nonsorted to poorly sorted mixture of clay, silt, and, pebbles,cobbles and boulders; contains some gravel. Thickness varies and generally is less than 6 meters (20 feet), but is commonly more than 24 meters (80 feet) under the crest of most drumlins.

BEDROCK EXPOSURES--Individual outcrops not shown completely. Solid is individual outcrop; ruled pattern indicates areas of abundant exposures and areas where surficial deposits are generally less than 10 feet thick. Mapped in part from aerial photos and Soil Surveys (Simmons and others, 1949, and Rosenberg, 1985).



MATERIALS OBSERVATIONS--Surficial materials in exposures, well holes and test holes. Letters indicate texture in decreasing order of abundance. Number indicates thickness in feet.

g gravel
b boulder
c cobble
p pebble
s sand (as separate beds; not including sand in matrix of gravel)
F fine sand
$\not{s}$ silt
$\not{c}$ clay
t till
R rottenstone
G grüss (a granular form of rottenstone derived from weathering of granitic rocks)

WELL-HOLE AND TEST-HOLE DATA--Materials for some holes described. Approximately located from New Hampshire Department of Environmental Services, Water Resources Division, Concord, N.H., and Moore and others (1994, pl. 2) .

Well or test hole reported as ending in bedrock or refusal. Where only a number is given, it represents depth to bedrock in feet. Where surficial materials were identified by driller, said materials and their thickness in feet are given (add thickness of all materials in each hole to find depth to bedrock). Altitude to bedrock suface in feet above mean sea level given in parentheses where known.

Well or test hole that did not reach bedrock or refusal. Depth reached indicated (in feet).

Koteff, Carl, Stone, J.R., Larsen, F.D., Ashley, G.M., Boothroyd, J.C., and Dincauze, D.F., 1988, Glacial Lake Hitchcock, postgracial upift, and post-lake archaeology, *in* Brigham-Grette, Julie, ed., Fieldtrip Guidebook of 1988 AMQUA meeting, University of Massachusetts Department of Geology and Geography Contribution No. 63, p. 169-208.

______ and Larsen, F.D., 1989. Postglacial uplift in western New England: Geologic evidence for delayed rebound, *in* Gerersen, S., and Basham, P.W., eds., Earthquakes at North Atlantic passive margins: Neotetonics and postgacial rebound: Norwell, Massachusetts, Kluwer Academic Publishers, p. 105-123.

Larsen, F.D., 1992, Glacial landforms and morphosequences in the Ashuelot River valley, Winchester to Keene, New Hampshire, Trip B-7 *in* Robinson, Peter, and Brady, J.B., eds., Guidebook for fieldtrips in the Connecticut Valley region of Massachusetts and adjacent states, volume 2: New England Intercollegiate Geol. Conf. 84th Ann. Mtg. Guidebook, Univ. Massachusetts Dept. Geology and Geography Contr. No. 66, p. 380-397.

______ and Koteff, Carl, 1988, Deglaciation of the Connecticut Valley--Vernon, Vermont, to Westmoreland, New Hampshire, Field Trip A-6 *in* Bothner, W.A., Guidebook for field trips in southwestern New Hampshire, souheastern Vermont, and north-central Massachusetts: New England Intercollegiate Conf. 80th Ann. Mtg. Guidebook, Univ. New Hampshire, Durham, Dept. Earth Sciences Pub., p. 103-125.

______ and Koteff, Carl, 1997, Surficial geology of the Keene 7.5-minute metric quadrangle, Cheshire County, New Hampshire, scale, 1:24,000

Moore, Richard Bridge, Johnson, C.D., and Douglas, E.M., 1994, Geohydrolgy and Water quality of stratified-drift aquifers in the Lower Connecticut River basin, southwestern New Hampshire: U.S. Geol. Survey Water-Resources Inv. Rept. 92-4013, 68 p. Appendices A-C, map scale 1:48,000.

Pendleton, R.M., 1998, Surficial geologic map of the West Swanzey 7.5-minute quadrangle(East Half of the Winchester 7.5 x 15- minute quadrange), Cheshire County, New Hampshire, scale 1:24,000

Ridge, J.C., 1988, The Quaternary geology of the Upper Ashuelot River, Lower Cold River, and Warren Brook valleys of southwestern New Hampshire, Trip B-4 *in* Bothner, W.A., Guidebook for field trips in southwestern New Hampshire, souheastern Vermont, and north-central Massachusetts: New England Intercollegiate Conf. 80th Ann. Mtg. Guidebook, Univ. New Hampshire, Durham, Dept. Earth Sciences Pub., p. 176-208.

Rosenberg, G.L., 1985, Soil Survey of Cheshire County, New Hampshire: U.S. Dept. Agriculture Soil Conservation Pub., 262 p. 48 plates.

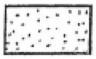
Simmons, C.S., Latimer, W.J., Layton, M.H., Coates, W.H., Lyford, W.H., and Scripture, P.N., 1949, Soil Survey of Cheshire and Sullivan Counties, New Hampshire: U.S. Soil Conservation Service Series 1937, No. 23, 82 p., map scale 1:62,500.

Note: Mapped in cooperation with the National Geologic Map Program; STATEMAP program

TEXTURE OF STRATIFIED DEPOSITS--Indicated to a depth of at least l/2 meter (1.5 feet)

 Pebble to boulder gravel

 Mixed sand and gravel

 Sand

 Sand, fine sand, silt and clay

 Borrow pit, small

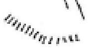
 Borrow pit, small-abandoned

 Borrow pit, large, or cut bank

 Approximate extent of glacial Lake Ashuelot, projected N21.5W, 0.9 meters/mile from the spillway at an altitude of 138-144 meters (453-472 feet) (Larsen, 1992) (see discussion above). Shown as a solid line where corresponds with a unit contact.

 Abandoned glacial meltwater and modern stream channels. Direction of flow shown by arrow

 Shallow scour channels on stream terraces and modern alluvial plains.

 Scarp

Glacial striations. Point of observation is at southern end of line.

 Drumlin form. Some are classic drumlin shape and others are just sreamlined hills, inferred to Indicate general direction of glacial ice movement

Threshold (outlet) to which designated glacial deposits are graded. Number gives approximate elevation in meters. Symbol(s) is (are) unit(s) graded to the threshold.

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APPENDIX D – 2013 FRR QUALITY ASSURANCE PROJECT PLAN (QAPP)

Quality Assurance Project Plan
FirstLight 2013 Full River Reconnaissance Turners Falls Impoundment of the Connecticut River

Prepared by:
Simons & Associates
New England Environmental

Prepared for:
FirstLight Power Resources Services, LLC
c/o FirstLight Hydro Generating Company
99 Millers Falls Road
Northfield, MA 01360

Date: August 14, 2013

1 Title and Approval Page

John Howard — Date
FirstLight, Director – FERC Hydro Compliance, Northfield Mountain Station

Charles Momnie — Date
FirstLight – Project QA/QC Engineer

Dr. Robert Simons — Date
Simons & Associates – Project Director, Fluvial Geomorphologist

Michael Marcus — Date
New England Environmental, Inc. – Project Manager

2 Table of Contents

List of Tables and Figures

3 Distribution List

The following individuals will receive a copy of this Quality Assurance Project Plan (QAPP) upon approval.

Table 1: QAPP Distribution List

QAPP Recipient Name	Project Role	Organization	Telephone Number and Email Address
John Howard	Director, FERC Hydro Compliance, Project Director for FirstLight	FirstLight Power Resources Services, LLC	413-659-4489 John.howard@gdfsuezna.com
Charles Momnie	Senior Engineer, Project Coordinator /Project Review for FirstLight	FirstLight Power Resources Services, LLC	413-659-4472 Charles.momnie@gdfsuezna.com
Robert Simons	Project Director/Fluvial Geomorphologist	Simons & Associates	970-988-2880 rksimons@rksimons.com
Michael Marcus	Senior Scientist/Project Manager	New England Environmental, Inc.	413-658-2050 mmarcus@neeinc.com
Gregg Simons	Hydraulic Engineer, data collection, ArcGIS map preparation and analysis	Simons & Associates	970-988-2880 greggrsimons@gmail.com
Christin McDonough	Staff Scientist, data collection, preparation of ArcGIS maps, documentation	New England Environmental, Inc.	413-658-2063 cmcdonough@neeinc.com
Sean Werle	Staff Scientist, equipment maintenance	New England Environmental, Inc.	413-658-2051 swerle@neeinc.com
Mark Wamser	FERC Relicensing Project Manager	Gomez and Sullivan Engineers, P.C.	603-428-4960 mwamser@gomezandsullivan.com

4 Project and Task Organization

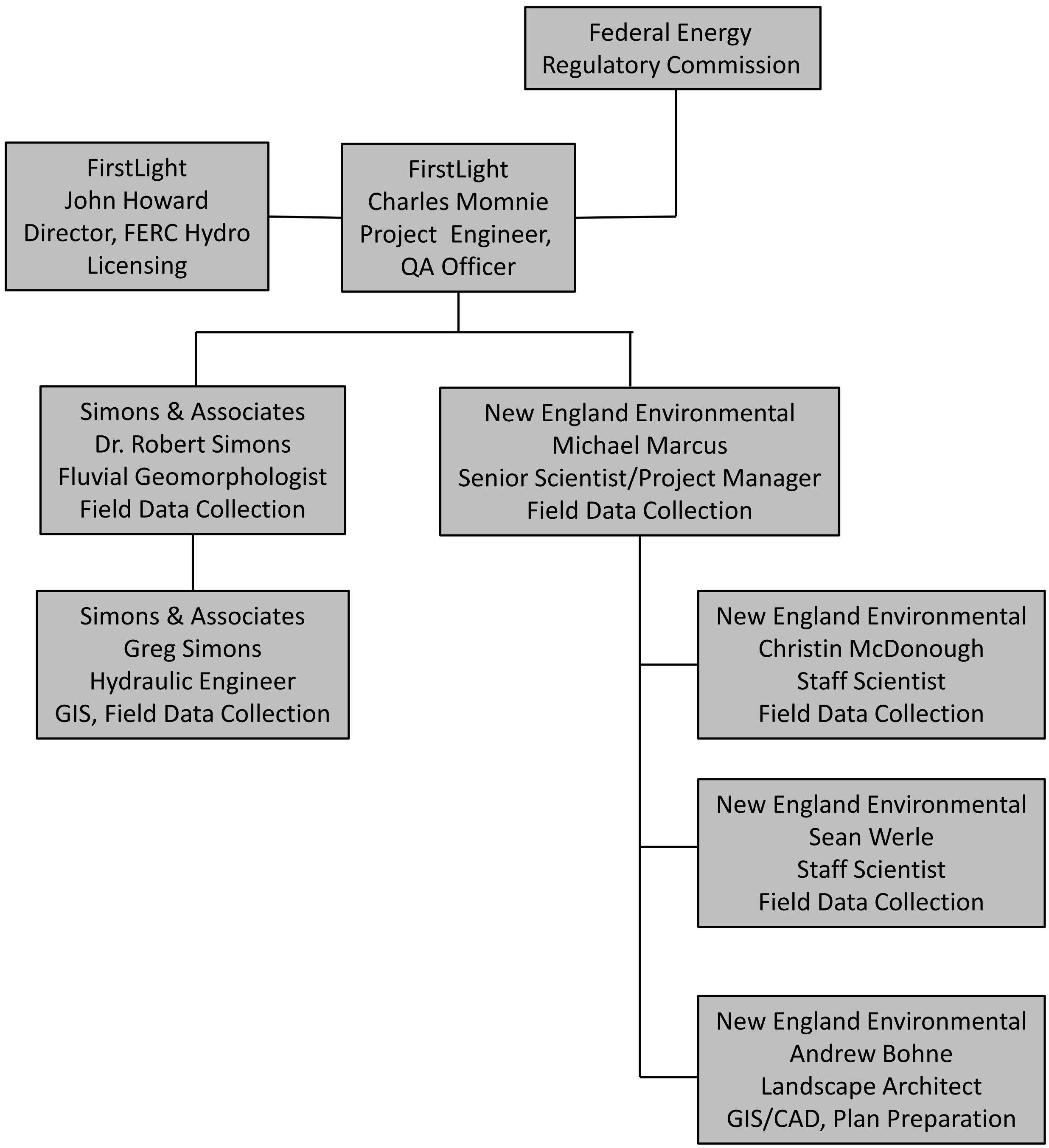
The 2013 Full River Reconnaissance (FRR) Quality Assurance Project Plan (QAPP) was prepared by Simons & Associates (S&A) and New England Environmental, Inc. (NEE) for FirstLight Power Resources Services, LLC c/o FirstLight Hydro Generating Company (FirstLight). FirstLight is required by the Federal Energy Regulatory Commission (FERC) to conduct FRRs every 3-5 years in accordance with the Northfield Mountain Project's Erosion Control Plan (ECP)(Simons, 1999) and to satisfy compliance requirements associated with the Turners Falls Project (FERC No. 1889) and Northfield Mountain Project (FERC No. 2485) licenses.

This study is a combined effort of FirstLight, Simons and Associates (S&A), and New England Environmental, Inc. (NEE). The following is a list of individuals and organizations involved with this project, showing their respective roles and responsibilities. Figure 1 displays the organization flow chart for this study. See Table 1 for contact information.

Table 2: Names, Organizations and Responsibilities Associated with 2013 FRR

Name	Organization	Responsibility
John Howard	FirstLight	QAPP Review, draft and final document review
Charles Momnie	FirstLight, Project Engineer /Quality Assurance Officer	QAPP Review, draft and final document review Responsible for overall project management and completion
Project Director		
Dr. Robert Simons	Simons & Associates (S&A)	Responsible for overall project design and completion. Data collection, data management and analysis, documentation of results and report
Project Manager		
Michael J. Marcus	New England Environmental (NEE)	Supervision of scientific staff, supervision of data collection, staff training, data management
Field Assistant/Hydraulic Engineer		
Gregg Simons	S&A	Field work, data logging, ArcGIS mapping and analysis
Field Assistant/Staff Scientist		
Christin McDonough	NEE	Field work, data entry develop ArcGIS maps
Field Assistant/Staff Scientist		
Sean Werle	NEE	Boat Operator, maintenance of instruments
Andrew Bohn	NEE	Landscape Architect/Planner

Figure 1: Project Organization Chart



5 Problem Definition / Background

FirstLight owns and operates the Northfield Mountain Pumped Storage Project (Northfield Mountain Project), a 1,119 -MW pumped storage hydroelectric project constructed in 1972 along the Connecticut River near Northfield, MA. The Northfield Mountain Project consists of an Upper Reservoir, an underground pressure shaft and four unit penstocks, an underground powerhouse, four reversible pump-turbine generators, and a mile-long tailrace tunnel connecting the powerhouse to a 20-mile-long reach of the Connecticut River known as the Turners Falls Impoundment, which functions as a Lower Reservoir. The manmade Upper Reservoir was formed with four earth-core rock fill embankment structures and a concrete gravity dam.

FirstLight also owns and operates the Turners Falls Project, a 67.709 MW hydroelectric project located in Montague MA, in the village of Turners Falls. The Turners Falls Dam forms the Turners Falls Impoundment, shown in Figure 2.

The Turners Falls Project and Northfield Mountain Project are licensed by FERC. In compliance with relevant articles of the FERC licenses for both projects, a reconnaissance survey of the Turners Falls Impoundment was conducted in 1998 to map riverbank characteristics and to prioritize erosion sites to be considered for stabilization. As a result of this work, an "*Erosion Control Plan for the Turners Falls Pool of the Connecticut River*," (Simons, 1999) – commonly referred to as the Erosion Control Plan (ECP) was developed. The ECP provides for FirstLight to conduct FRR studies to document existing riverbank conditions within the Turners Falls Impoundment every 3 to 5 years. Since the development of the initial ECP, four FRRs (1998, 2001, 2004, and 2008) have been conducted to date. The next FRR is scheduled for 2013.

Although not germane to this QAPP, the FERC licenses for both projects expire on April 30, 2018. FirstLight has initiated the process of relicensing the Turners Falls and Northfield Mountain Projects, using FERC's Integrated Licensing Process (ILP), with the filing of their Pre-Application Document (PAD) and Notice of Intent (NOI). These documents were filed with FERC on October 31, 2012. Although the 2013 FRR is being conducted to comply with the ECP, FERC has requested that it be included as part of the relicensing studies for the Projects as well. Due to this request, FirstLight developed a study plan based on FERC's study plan criteria which was included in the Revised Study Plan (RSP) for the Project. Readers should reference Study No. 3.1.1- *Full River Reconnaissance* in the RSP for additional details. Further details relative to the FERC relicensing schedule are provided later in this document (Table 2).

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

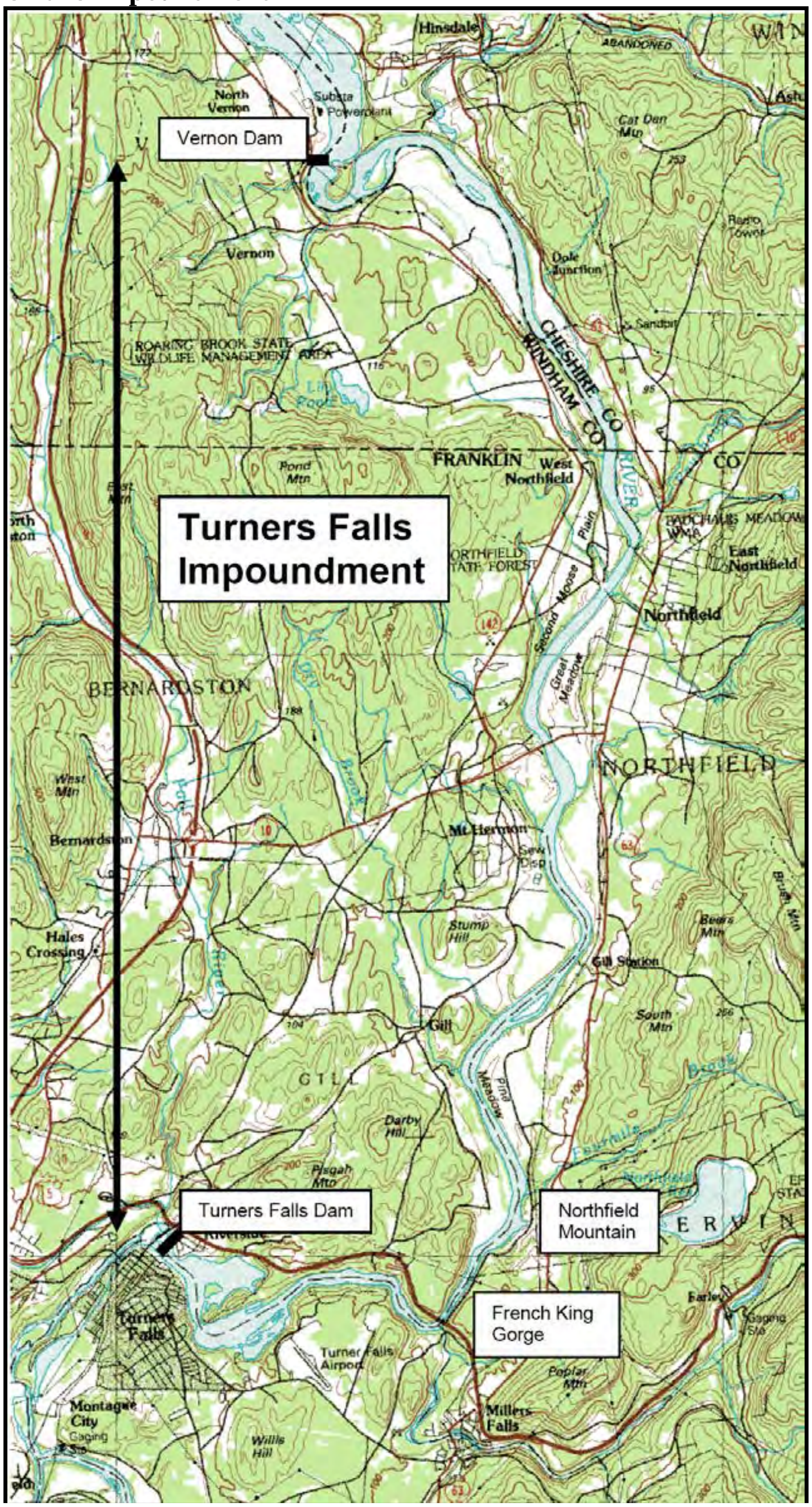
The objective of the 2013 FRR is to utilize a predetermined classification of riverbank features and characteristics, including the type, stage, extent, and indicators of erosion[1], which will document current

[1] For the purpose of this study, the type of erosion is defined as the specific active erosion process or processes occurring at a given location (i.e. falls, topples, slides, etc.). The stage of erosion is defined as the point on the temporal scale of erosion that a given bank is currently at (i.e. active erosion, eroded, stable, etc.). Indicators of

riverbank conditions in the Turners Falls Impoundment. Data collected as part of this process will be used to identify and evaluate changes in riverbank conditions over time (going back to the original FRR conducted as part of the ECP) and determining the location(s) of, and planning for, potential future restoration work. The 2013 FRR will include boat and land based surveys during leaf off conditions. The location of transition points, or end points, where riverbank conditions change from one category to another will be captured via sub-meter GPS as part of the boat survey. Summary statistics based on the data collected will be developed and maps denoting the locations of various riverbank features and conditions will be generated.

potential erosion (i.e. leaning trees, tension cracks, etc.) are processes or characteristics of a riverbank that contribute to the instability of the bank; these are used to determine locations where future erosion may occur.

Figure 2: Turners Falls Impoundment



6 Project / Task Description

The goal of the 2013 FRR is to conduct a reconnaissance level survey (boat and land based) of riverbank conditions throughout the Turners Falls Impoundment from Turners Falls Dam to Vernon Dam (Figure 2). Islands within the Turners Falls Impoundment will also be included in this survey. Field activities associated with this effort will occur in early fall (land-based survey) and late fall (boat-based survey, mid-November during leaf off conditions). Specific objectives of the 2013 FRR include:

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

In order to effectively and efficiently accomplish the goals and objectives of the FRR, the study methodology has been divided into several tasks and subtasks. As such, study methods will consist of the following tasks:

- Task 1: Land-Based Observations

- Task 2: Classify Riverbank Features, Characteristics, and Erosion (Boat-Based)
- Task 3: Spatially Define Riverbank Transition Points
- Task 4: Video and Photographic Documentation
- Task 5: Riverbank Stabilization Projects

These tasks are described in greater detail in Section 10 – Survey Methods.

Once all field efforts and post-processing are completed, data review and map generation of the 2013 FRR field data will be conducted and a final report will be generated. Data review will include, but not be limited to, the development of summary statistics of riverbank classifications based on Table 4 and Table 7, assessment of trends or correlations between adjacent riverbank characteristics, land-use and erosion, and comparisons of riverbank conditions with past FRRs. Mapping developed as part of this task will include, but not be limited to, maps depicting riverbank characteristics, types, stages, and extents of current erosion, indicators of potential erosion, adjacent land-use, and the location of bank stabilization projects. Figure 4 depicts an example of riverbank characteristic maps that have been included in past FRR reports. 2013 FRR mapping will follow previous FRR mapping styles so that data are comparable. A list of maps that may be included with the final report can be found at the end of this section. All maps will be developed in ArcGIS. A detailed list of deliverables that will be included in the final report can be found in Section 20 – Reports to Management.

Conceptual Schedule

Table 3 includes the project schedule. Given that FERC has requested the 2013 FRR be folded into the FERC relicensing process, review and approval of this document is subject to the timelines dictated by the ILP. The milestones highlighted in green are dictated by the ILP (the FERC regulation is cited in the table).

As part of the relicensing process, stakeholders submitted study requests by March 1, 2013. Study requests were addressed by FirstLight in the form of a Proposed Study Plan (PSP) on April 15, 2013. Stakeholder meetings were held with on May 15 and June 14, 2013 to discuss the PSP. FirstLight filed an Updated Proposed Study Plan based on these meetings June 28. Stakeholders filed comments with FERC on the Updated PSP on or before July 15, 2013. In accordance with the ILP schedule, FirstLight will be filing its RSP on August 14, 2013. This QAPP will be incorporated into FirstLight's RSP as an Appendix to the aforementioned study plan and thus will be subject to review and comment from stakeholders based on the schedule below.

FirstLight is proposing to initiate land-based studies (Task 1, Section 10) in the early fall of 2013. Boat based, full river mapping (Tasks 2, 3, and 4, Section 10) will be conducted in the late fall (mid-November 2013) during leaf-off conditions. In addition, FirstLight is proposing to reproduce the 2007 photo log created as part of Field, 2007 as part of the FRR field efforts. Due to the fact that the 2007 photo log was captured during summer conditions, FirstLight is proposing to reproduce the 2007 photo log during the summer 2014 in order to allow for direct comparisons of the 2007 and 2014 photo logs. Based on the ILP schedule, and assuming there is no dispute with this particular study, FERC would issue its study plan determination letter by September 13, 2013 which would allow sufficient time to conduct the November 2013 FRR. If an agency with mandatory conditioning authority disputes this particular study, FERC would not issue its study plan determination letter until December 12, 2013. Thus, FirstLight would have to delay conducting the 2013 FRR until 2014.

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

Table 3: Project Schedule/Timeline

Milestone	Schedule
Conduct full river boat tour and discussion with CRSEC and FERC Staff	November 9, 2012
Develop technical approach for field data collection (river based and ground based observation, survey, data collection)	November 2012
Develop Quality Assurance Project Plan; distribute to CRSEC	
Meet with CRSEC to discuss proposed technical approach and QAPP	December 5, 2012
Draft Review of QAPP by Ct. River Streambank Erosion Committee and landowners	February 4, 2013
QAPP Preparation	March 2013
Stakeholders submit study requests (§5.9)	March 1, 2013
FirstLight files its PSP, which includes the FRR and QAPP (§5.11a)	April 15, 2013
Stakeholder Meetings to Discuss PSP (§5.11e)- specifically geology and soils	May 14-15, 2013
Stakeholders file written comments on PSP (§5.12)	July 14, 2013
FirstLight files its Revised Study Plan (RSP) (§5.13a)	August 14, 2013
Stakeholders file comments on RSP, if necessary (§5.13b)	August 28, 2013
FERC Issues their Study Plan Determination Letter (§5.13b)	September 12, 2013
[2]Notice of Formal Study Dispute (if necessary) (§5.14a)	October 2, 2013
Study Dispute Determination (§5.14 (1))	December 2, 2013
Conduct FRR Land-based Survey	Early Fall 2013
Conduct FRR Boat-based Survey	Mid-November 2013
Reproduce Field, 2007 Photo Log	Summer 2014
File FRR Report with FERC	September 2014

Data Quality Objectives

The data collected during this effort will be used to assess riverbank conditions in the Turners Falls Impoundment from the Turners Falls Dam to the Vernon Dam. Field data will be used to develop summary statistics and maps in order to better understand riverbank conditions in the study area. Results of field efforts, data review, and map generation will be used to determine the locations of potential future stabilization projects.

Field personnel will be equipped with field data sheets containing a description, photo, profile, and plan view of each type of erosion. Field datasheets used will be similar to Table 5, 6, and 7 and will also contain the reference photographs found in Appendix D. When classifying a riverbank segment during the boat-based survey, field personnel can quickly reference the field data sheet to ensure accurate classification of the features present. Field data sheets will also contain descriptions regarding the classification criteria for riverbank features and the stage, indicators, and extent of erosion based on Tables 5 and 7 as well as the reference photographs found in Appendix D. In addition, the 2013 FRR has been expanded to include a land-based assessment of the riverbanks. The land-based assessment will provide a means of identifying and mapping features that may not be visible during the boat-based survey (i.e. tension cracks).

Quality control following field data collection will be provided by comparing the data logging files, or field data sheets, of riverbank features and characteristics collected in the field with the geo-referenced

[2] Note that only agencies with mandatory conditioning authority can file for dispute resolution.

digital video showing the riverbanks at the time of the FRR (Task 4, Section 10). Given that the entire riverbank of the Turners Falls Impoundment will be surveyed and digitally videoed, if a question arises concerning the classification of any segment information in the data logging file(s) can be compared to an image or video of any such segment.

An appendix to the FRR report will include a comparison of the specific riverbank features and characteristics from the data logging files, or field data sheets, collected during the field surveys to a photograph of that same segment of riverbank captured from the digital geo-referenced video. A discussion will be presented in the FRR report based on this comparison. The process of comparing the data logging files to video/still images of a selected percentage of segments, or any segment of particular interest, provides a high level of quality assurance and control on the field data collected. This approach also provides a method for reference checking any subsequent interpretation of the field survey data after the survey has been completed.

Equipment Specifications & Accuracy

Equipment used during 2013 FRR field data collection will include: 1) sub-meter GPS; 2) laser range finder; 3) data-logger; and 4) geo-reference video equipment. The Trimble GeoXT Sub-Meter GPS and the Laser Technology, Inc. TruPulse 360B laser range finder will be used as the sub-meter GPS, data-logger, and laser range finder for this survey. Additional details and equipment specifications on this equipment can be found in Appendix A, B, and C.

The accuracy of a sub-meter GPS is assumed to be within one meter; however, the accuracy of any GPS depends on the availability of a sufficient number of satellites and the differential correction that is applied during data post processing. In order to ensure the most accurate data collection possible the location/time of day of the satellites will be determined for optimal GPS readings prior to initiation of GPS mapping. The GPS unit will collect the coordinates of the boat at the location where the riverbank classification is recorded. The laser range finder then calculates the azimuth and distance from the boat to the riverbank feature(s). The coordinates of the riverbank feature(s) will be calculated by combining these three measurements (boat location, distance, azimuth) to conduct an offset.

The position of the riverbank point will be shot from the boat using the laser range finder. The accuracy of a mapping grade laser rangefinder is +/- 1 foot for distance and +/- 1 degree for azimuth. Assuming the length of the shots from the laser range finder is 100 feet, an accuracy of one degree translates into approximately +/- 1.7 feet distance when projected along the length of the bank (100 times sine of 1 degree). Therefore, the combination of the accuracy of the sub-meter GPS and the laser range finder would be approximately +/-6 feet, with an estimated accuracy of within 10 feet for 90% of the measurements made.

Representativeness

All riverbanks and islands within the Turners Falls Impoundment from the Turners Falls Dam to the Vernon Dam will be included in this assessment. The comprehensive nature of the study area will allow for a representative dataset depicting the current riverbank features and conditions in the impoundment.

In order to ensure that GPS data collected in the field is representative of the actual riverbank features present a field test will be conducted using the GPS unit and laser range finder prior to the initiation of FRR mapping. The field test will consist of identifying a fixed, known point on the bank from a slow moving boat. The GPS unit and laser range finder will then be used to collect the position of the known point. The known point will be surveyed multiple times and the difference in location will be determined.

This approach will ensure representative riverbank transition points are captured in the field via GPS within the accuracy limits of the equipment.

In addition to field testing the GPS and laser range finder system, geo-referenced video will be taken of all riverbanks at the time of classification as a form of reference checking and quality control. Field datasheets containing descriptions, photos, profiles, and plan views of each type of erosion (Table 7) as well as descriptive information about the stage, extent, and indicators of erosion will be utilized and referenced by field personnel. This approach was described in more detail earlier in this section.

Comparability

Field collected data will be preliminarily reviewed and compared at the end of each day to ensure consistency in data collection methods and to identify any potential data collecting errors or anomalies. Any data that is found to be questionable will be flagged and reviewed in greater detail by the Project Manager. If data collection errors are present the data will be discarded and recollected.

An appendix to the FRR report will include a comparison of the specific riverbank features and characteristics from the data logging files, or field data sheets, collected during the field surveys to a photograph of that same segment of riverbank captured from the digital geo-referenced video. A discussion will be presented in the FRR report based on this comparison. The process of comparing the data logging files to video/still images of a selected percentage of segments, or any segment of particular interest, provides a high level of quality assurance and control on the field data collected. This approach also provides a method for reference checking any subsequent interpretation of the field survey data after the survey has been completed.

Following all field data collection efforts and post processing a comparison of the 2013 FRR will be made to the previous FRRs using summary statistics in ArcGIS. Comparison efforts will include evaluating changes in the length of riverbank shoreline experiencing erosion, severity of erosion, length of riverbank stabilization, success of erosion remediation efforts, identification of new erosion areas, etc. The purpose of these comparisons is to evaluate the temporal trends in riverbank erosion and to determine if an equilibrium of erosion and stabilization is developing.

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

Completeness

The methodology proposed in this QAPP, combined with the extent of the study area, will provide a complete and representative dataset of riverbank conditions in the Turners Falls Impoundment. When it is found that data do not meet the quality objectives outlined from this section the Project Manager or QA

Officer will determine what corrective action(s) must be taken. Incomplete data, as determined by the Project Manager or QA Officer, may lead to the need for re-assessment of a particular area if it is found that the available data are insufficient to meet project goals.

7 Training Requirements

The Project Manager and QA Officer will ensure that all field technicians have current training in the operation of all field data collection equipment (Section 6 – Equipment Specifications). In addition, the Project Manager will provide oversight and support to the field technicians when needed. There are no other specialized training or certification requirements needed to perform the tasks outlined within this QAPP.

8 Documents and Records

The Project Manager will be responsible for ensuring project staff review the QAPP, understand the data forms, and are fully trained in operating project equipment. All field data will be obtained in digital form as recorded on the data-logger and digital video/still photography. This information will be stored on various computer systems and servers at S&A and NEE offices.

To ensure that digital data files are secure, data logging files will be downloaded onto two computers at the end of each field day. At the end of the field data collection process, all digital files will be stored on computers/servers at S&A and NEE. Digital files from the data-logger and the geo-referenced video files will also be provided to FirstLight.

Field mapping equipment that will be used includes a sub-meter GPS, data-logger, and laser range-finder. Equipment maintenance schedule records will be maintained by the Project Manager at NEE in Amherst, MA. Copies of all maintenance records will be maintained by the Project Director at his office.

9 Sampling Process Design (Experimental Design)

The purpose of the FRR is to conduct a reconnaissance level survey that will provide an overview of riverbank conditions throughout the Turners Falls Impoundment. Study methods will include identifying and defining riverbank features and characteristics and the types, stages, indicators, and extent of erosion. This methodology was designed such that the classification criteria for riverbank characteristics and types, stages, and indicators of erosion are clearly defined and can be easily reproduced. The overall design of the survey is a census of all riverbanks within the Turners Falls Impoundment as opposed to sampling which would assume that only a portion of the area would be surveyed.

10 Survey Methods

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

- Task 1: Land-Based Observations
- Task 2: Classify Riverbank Features, Characteristics, and Erosion
- Task 3: Spatially Define Riverbank Transition Points
- Task 4: Video and Photographic Documentation

- Task 5: Riverbank Stabilization Projects

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

Task 1: Land-Based Observations

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

Task 1a: Identify and Define Indicators of Potential Erosion

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

Field observations will be based on the criteria found in Table 4 and will include: 1) gathering basic positional attribute information of the features identified; 2) identifying the locations of sensitive receptors; and 3) identifying and investigating indicators of potential erosion or bank instability that would not be readily visible from a boat. Indicators of potential erosion (excluding tension cracks) such as exposed roots, creep, overhanging banks, and notching are anticipated to be more easily identifiable from a boat than from walking along the riverbanks. As a result, these features will not be investigated in-depth as part of this task but will instead be included in the boat-based survey discussed in Task 2b. The primary focus of the land-based assessment will be to identify the location of and investigate tension cracks or other indicators of potential erosion that will not be clearly identifiable from a boat. For the purpose of this study tension cracks are defined as a cracks formed at the top edge of a bank that potentially could lead to topples or slides (Field, 2007). Figure 3 depicts an example of a tension crack.

Classification of the type(s), stage(s), and extent of erosion will not be included in this task as they will be more easily identified from a boat and therefore are included in Task 2b. However, if during the field investigation any types of erosion are observed that may not be easily identifiable from a boat those features will be documented. Classifications of the type of erosion that may be conducted as part of this task will follow the same methodology identified in Task 2b. Detailed discussion regarding the type(s), stage(s), indicators, and extent of erosion can be found in Task 2b, Table 5, 6, and 7.

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

When conducting the land-based assessment, the field crew will walk along the top of the banks to identify and note the location of tension cracks, sensitive receptors, or other features that may not be visible from a boat. The locations of these features will be captured via sub-meter GPS where satellite coverage will allow[3]. If GPS data collection is not possible, the location of the features will be approximated on field maps using aerial imagery. All field observations will be entered into a data-logger or recorded on field datasheets similar to Table 4. Geo-referenced digital photographs will be taken to document the features identified in the field and as a means of data control and reference checking.

Task 1b: Land-use Mapping

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

Prior to field investigation, existing aerial imagery will be used to: 1) determine the width of riparian buffers; 2) develop a list of predetermined land-use categories that will be used during field classification; and 3) identify other pertinent land use information that may be useful during the field survey. MassGIS land-use layers may also complement preliminary analysis of the land-uses within the study area. As part of the land-based assessment, land-uses will be mapped for an area of approximately 200 feet horizontally from the top of the slope. The assessment will also determine the specific agricultural land-use in 2013 such as row or crop cover, measurement of riparian areas, and other land-use data not apparent from the aerial imagery or MassGIS layer(s). All observations will be stored on a data-logger or recorded on field datasheets similar to Table 4. The start and end points of land-use segments will be captured via sub-meter GPS where satellite coverage will allow. If GPS data collection is not possible, the location of the features will be approximated on field maps using aerial imagery.

The results of the land-use mapping combined with aerial imagery, MassGIS layers, and property ownership information obtained from the Town Assessor's in VT, NH, and MA will be combined to develop a geospatial dataset from which a series of land-use maps and land-use analyses will be generated. Areas that are observed to have a direct correlation between adjacent land-use and erosion will be documented.

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

Table 4: Connecticut River – Turners Falls Impoundment Riverbank Classifications for Land-based Survey

RIVERBANK FEATURE POSITIONAL ATTRIBUTES						
Right or Left Bank[4]						
Coordinates *(Start-End)*						
Distance from River						
Height above River						
Sensitive Receptors	*Descriptions of important wildlife habitat use on or near the riverbanks such as bank swallow colonies, kingfisher nests, eagle nests, prime odonate and mussel habitat, etc.*					
Adjacent Land Use						
EROSION CLASSIFICATION[5]						
Type(s) of Erosion	Falls – Undercut	Falls – Gullies	Topples	Slide or Flow	*Planar Slip* *Rotational Slump* *Flow*	
Indicators of Potential Erosion	Tension Cracks	Exposed Roots	Creep/ Leaning Trees	Overhanging bank	Notching	Other
Notes						

[4] As looking downstream
[5] Refer to Task 2 (Tables 6 and 7) for a complete list of classification definitions. Erosion types and indicators of erosion (excluding tension cracks) will be more easily identified by boat and therefore will not be a primary focus of the land-based survey. The primary objective of the land-based survey is to identify the locations of tension cracks, adjacent land-use, and other features that would not be easily identifiable from a boat. The methodology defined in Task 2 will not be duplicated as part of this task.

Figure 3: Example of Tension Cracks

(Field, 2007)

Task 2: Classify Riverbank Features, Characteristics, and Erosion

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

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

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

Task 2a: Identify and Define Riverbank Features and Characteristics

A boat survey will be conducted to identify and define features and characteristics of the riverbanks in the Turners Falls Impoundment. Classification will be based on the criteria found in Table 5 which contains pre-determined classification categories based on observations made during past FRRs. Classification categories found in Table 5 include bank slope, height, sediment composition, and vegetative cover. Each riverbank will be classified based on one attribute per characteristic. For example, riverbank X has a Slope of "Vertical", Height of "High", Sediment composition of "Boulders", and degree of vegetative cover of "Sparse". Table 6 provides definitions and descriptions of each classification.

Based on past FRRs it has been observed that riverbanks in the Turners Falls Impoundment generally consist of an upper and lower bank. Upper banks are often above water except during high flows, while lower banks are frequently or partially submerged. In order to accurately capture the characteristics of the entire riverbank, classification will be completed for both upper and lower bank characteristics. Table 5 includes classification categories for the upper and lower banks.

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

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

Observations made as part of this task will occur from a boat approximately 50-100 ft from shore, or closer if possible. In order to ensure consistent identification during this assessment a field datasheet will be developed based on Table 5 and Table 7 as well as reference photographs found in Appendix D. The field datasheet will be carried with the field crew and referenced when classifying riverbank characteristics. Field observations will be entered into a data-logger or recorded on field datasheets. Geo-referenced video will be taken to document the features identified in the field and as a means of data control and reference checking (Task 4).

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

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

While conducting Task 2a, an erosion classification will be conducted of each riverbank segment. A typical sequence of assessment would generally entail: 1) classifying the characteristics of a given riverbank segment based on the criteria found in Table 5; 2) collecting the transition points of the bank segment via sub-meter GPS; 3) conducting an erosion classification of the bank segment; and 4) moving on to the next riverbank segment and repeating steps 1-3.

The erosion classification will be based on the criteria found in Table 5 and will include identification of the type(s), stage(s), indicators, and extent of erosion. Indicators of potential erosion such as exposed roots, creep, overhanging banks, and notching will be identified as part of this task. Indicators of potential erosion, such as tension cracks, that are not clearly visible from the boat will be investigated and identified in greater detail as part of the land-based assessment discussed in Task 1. Table 6 and 7 contain detailed descriptions, photos, profiles, and plan views of the criteria that will be used for the erosion classification.

Types of erosion identified in the field are based on the recommendations made by Field, 2007 and will consist of: 1) Falls (which can be classified as Undercuts or Gullies); 2) Topples; and 3) Slides or Flows. Slides can be further subdivided into subcategories Planar slip and Rotational slump. It should be noted that Field lists Slides and Flows as two separate types of erosion, however, given the fact that the FRR is a reconnaissance level survey, it may be difficult for field personnel to make the differentiation between a slide, planar slip, rotational slump, or flow in the field. As such, for the purpose of this study, Slides and Flows have been combined into one category. If field personnel can easily identify and make the differentiation between the specific type of Slide or Flow (e.g. planar slip, rotational slump, etc.) those observations will be noted on the data-logger or field data sheet. Definitions of each type of erosion can be found in Table 6 while photos, profiles, plan views, and descriptions can be found in Table 7. Each type of erosion present in a given riverbank segment will be identified and noted.

Based on the recommendation of Field, 2007 the 2013 FRR will incorporate an assessment of the indicators of potential erosion or bank instability that are present in a given riverbank segment. Indicators of potential erosion that will be identified include: 1) tension cracks (Task 1b); 2) exposed roots; 3) creep; 4) overhanging bank; 5) notching; and 6) other indicators. Definitions and descriptions of these features can be found in Table 6 and Table 7.

Indicators of potential erosion included in this study are based on the classifications proposed in Field, 2007 with some additions. It should be noted that Field classifies creep as a type of erosion and leaning trees as an indicator of erosion, however, based on the definition provided by Field in Table 7 creep is typically defined by the presence of tree trunks that are bent downslope at the base. Based on this definition, creep has been classified as an indicator of potential erosion for the purpose of this study. The classification of “other” as an indicator of potential erosion (Table 5) will be utilized if the field crew observes potential erosion features that do not fit into one of the predefined classifications. Any features noted as “other” will be described in detail on field data sheets or in the data-logger. All indicators of potential erosion in a given riverbank segment will be documented and noted.

The 2013 FRR will also include classifying the temporal or process stage(s) of erosion of each riverbank segment based on the recommendations of Field, 2007. While Field did recommend a template for erosion stage classifications, the template was based on a hypothetical sequence of erosion composed of various types of erosion. Field’s sequence described the process of a riverbank eroding and then eventually becoming more stable after the riverbank slope has decreased in steepness and a beach has formed to protect the slope. This process occurs through an ongoing temporal riverbank transition process during stages of stability and erosion or instability. What Field had labeled as stages of erosion were actually types of erosion through the processes of riverbank evolution. These various types of erosion are already included in the erosion classification and, as such, Field’s recommended stages of erosion will not be adopted for this study. Temporal or process stages of erosion that will be included in the 2013 FRR will include: 1) Potential Future Erosion; 2) Active Erosion; 3) Eroded; and 4) Stable. Definitions and descriptions of each stage of erosion can be found in Table 6. A temporal or process stage of erosion will be assigned to each bank segment identified in Task 2a based on the type(s) of erosion and indicators of potential erosion present in that segment.

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

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

All erosion classifications conducted as part of this task will occur from a boat approximately 50-100 ft from shore, or closer if possible. In order to ensure consistent identification during this assessment a field datasheet will be developed based on Table 5, 6, 7, as well as the representative photographs included in Appendix D. The field datasheet will be carried with the field crew and referenced when conducting the erosion classification. Field observations will be entered into a data-logger or recorded on field datasheets. Geo-referenced video will be taken to document the features identified in the field and as a means of data control and reference checking (Task 4).

Table 5: Connecticut River – Turners Falls Impoundment Riverbank Classifications for Boat-based Survey

UPPER RIVERBANK CHARACTERISTICS[6]						
Upper Riverbank Slope	Overhanging *>90°*	Vertical *90°*	Steep *(>2:1)*	Moderate *(4:1-2:1)*	Flat *(<4:1)*	
Upper Riverbank Height *(total height above normal river level)*	Low *(<8 ft.)*	Medium *(8-12 ft.)*	High *(>12 ft.)*			
Upper Riverbank Sediment	Clay *(.001-.062mm)*	Silt/Sand *(.062-2 mm)*	Gravel *(2-64mm)*	Cobbles *(64-256mm)*	Boulders *(256-2048mm)*	Bedrock
Upper Riverbank Vegetation	None to Very Sparse *(<10%)*	Sparse *(10%-25%)*	Moderate *(25%-50%)*	Heavy *(>50%)*		
Sensitive Receptors	*Descriptions of important wildlife habitat use on or near the riverbanks such as bank swallow colonies, kingfisher nests, eagle nests, prime odonate and mussel habitat, etc.*					
LOWER RIVERBANK CHARACTERISTICS						
Lower Riverbank Slope	Vertical *90°*	Steep *(>2:1)*	Moderate *(4:1-2:1)*	Flat / Beaches *(<4:1)*		
Lower Riverbank Sediment	Clay *(.001-.062mm)*	Silt/Sand *(.062-2 mm)*	Gravel *(2-64mm)*	Cobbles *(64-256mm)*	Boulders *(256-2048mm)*	Bedrock
Lower Riverbank Vegetation	None to Very Sparse *(<10%)*	Sparse *(10%-25%)*	Moderate *(25%-50%)*	Heavy *(>50%)*		
Sensitive Receptors	*Descriptions of important wildlife habitat use on or near the riverbanks such as bank swallow colonies, kingfisher nests, eagle nests, prime odonate and mussel habitat, etc.*					
EROSION CLASSIFICATION						
Type(s) of Erosion	Falls – Undercut	Falls – Gullies	Topples	Slide or Flow	*Planar Slip* *Rotational Slump* *Flow*	
Indicators of Potential Erosion	Tension Cracks	Exposed Roots	Creep/ Leaning Trees	Overhanging bank	Notching	Other
Stage(s) of Erosion	Potential Future Erosion	Active Erosion	Eroded	Stable		
Extent of Current Erosion	None/Little *(<10%)*	Some *(10%-40%)*	Some to Extensive *(40%-70%)*	Extensive *(>70%)*		

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

Table 6: Riverbank Classification Definitions

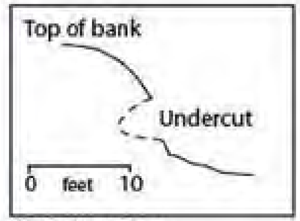
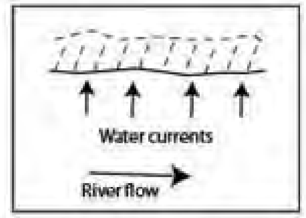
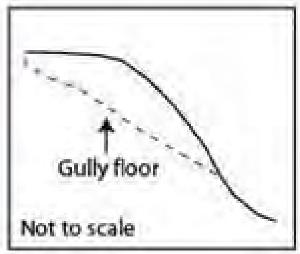
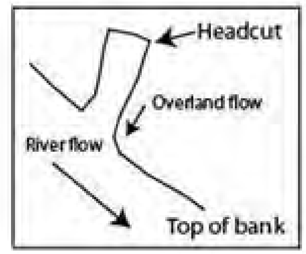
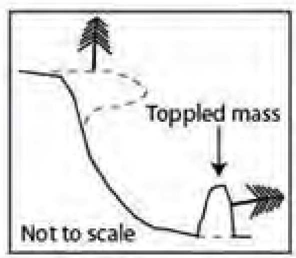
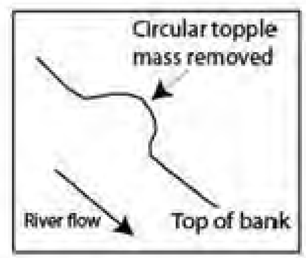
RIVERBANK CHARACTERISTICS *(Upper and Lower)*[7]	
Riverbank Slope	**Overhanging** – any slope greater than 90º
	Vertical – slopes that are approximately 90º
	Steep – exhibiting a slope ratio greater than 2 to 1
	Moderate – ranging between a slope ratio of 4 to 1 and 2 to 1
	Flat – exhibiting a slope ratio less than 4 to 1[8]
Riverbank Height	**Low –** height less than 8 ft above normal river level[9]
	Medium – height between 8 and 12 ft above normal river level
	High – height greater than 12 ft above normal river level
Riverbank Sediment	**Clay –** any sediment with a diameter between .001 mm and 2 mm
	Silt / Sand – any sediment with a diameter between .062 mm and 2 mm
	Gravel – any sediment with a diameter between 2 mm and 64 mm
	Cobbles – any sediment with a diameter between 64 mm and 256 mm
	Boulders – any sediment with a diameter between 256 mm and 2048 mm
	Bedrock – unbroken, solid rock
Riverbank Vegetation	**None to Very Sparse –** less than 10% of the total riverbank segment is composed of vegetative cover
	Sparse – 10-25% of the total riverbank segment is composed of vegetative cover
	Moderate – 25-50% of the total riverbank segment is composed of vegetative cover
	Heavy – 50 % or greater of the total riverbank segment is composed of vegetative cover
Sensitive Receptors	Descriptions of important wildlife habitat use on or near the riverbank such as bank swallow colonies, kingfisher nests, eagle nests, prime odonate and mussel habitat, etc.
EROSION CLASSIFICATIONS	
Type(s) of Erosion[10]	**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 (Field, 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 (Field, 2007)
	Overhanging Bank – any slope greater than 90º
	Notching – similar to an undercut, defined as an area which leaves a vertical stepped face presumably after small undercut areas have failed.
	Other – Indicators of potential erosion that do not fit into one of the four categories listed above will be noted by the field crew.
Stage(s) of Erosion	**Potential Future Erosion –** riverbank segment exhibits multiple or extensive indicators of potential erosion

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

	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[11] –** 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

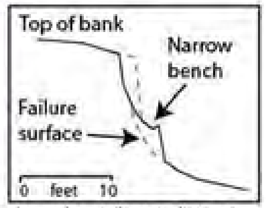
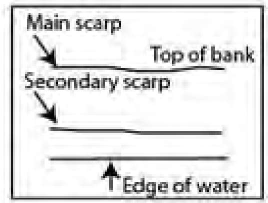
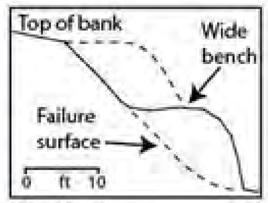
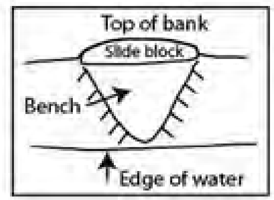
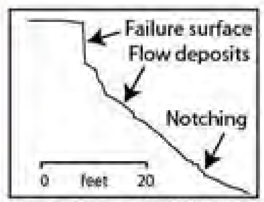
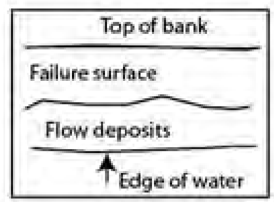
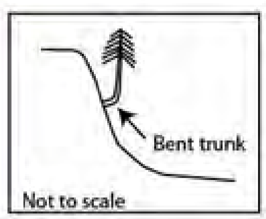
[11] Riverbanks consist of an irregular surface and include a range of natural materials (silt/sand, gravel, cobbles, boulders, rock, and clay), above ground vegetation (from grasses to trees), and below ground roots of different densities and sizes. Due to these characteristics, there are small areas 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 7: Types of Erosion Occurring in the Turners Falls Impoundment and their Characteristics

Erosion type	Photo	Profile	Planview	Description
Falls - Undercuts		 Across from tailrace		- Undercutting - Notching and oversteepening at the toe of the slope
- Gullies				- Gullies formed by overland flow and groundwater seeps
Topples				- Vertical tension cracks at the top of slope - Trees lean away from bank - Toppled mass creates mound of soil at base of bank

(Field, 2007)

Table 7: Types of Erosion Occurring in the Turners Falls Impoundment and their Characteristics (continued)

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

(Field, 2007)

Task 3: Spatially Define Riverbank Transition Points

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

The individual conducting the classification (Task 2, Table 5) will select a point of transition from one riverbank segment to another and "shoot" this point with the laser range-finder to determine the distance and azimuth to the riverbank from the boat. At the same time, the sub-meter GPS unit will collect the position of the boat. The distance and azimuth from the laser range-finder is automatically entered into the data-logger. The data-logger will then conduct an offset using the combination of these three measurements (boat GPS location, distance, and azimuth) to calculate the coordinates of the transition point. Once the offset has been conducted the data-logger will alert the user that the coordinates of the transition point were stored successfully. This process will be repeated at each transition point. Appendix A and B provide specifications for the sub-meter GPS and laser range-finder models that have been selected for this survey.

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

The number of riverbank segments identified will depend on the frequency of transitions between various features and classifications observed in the field. There is no set distance of segmentation along the river[12]; however, segments shorter than 20 ft will not be captured due to accuracy limitations of the equipment.

The location of sensitive receptors, such as important wildlife habitat, will also be mapped via sub-meter GPS.

Task 4: Video and Photographic Documentation

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

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

survey (Task 1). Additionally, the photo log created as part of Field, 2007 will be reproduced, to the best extent possible, during summer 2014. Given that the 2007 photo log was collected in the summer, reproduction of the photo log in the summer of 2014, as opposed to the fall 2013, will allow for direct comparison between the photo logs.

Task 4a: Geo-referenced Video

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

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

Task 4b: Re-collection of 2007 Photo Log

The riverbank photo log completed by Field Geology Services as part of the report titled *"Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT"* (Field, 2007) will be repeated as part of the 2013 FRR. The replication of the 2007 photo log will be done as closely as possible to the original photos within the context of FRR field activities.

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

Task 5: Riverbank Stabilization Projects

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

Task 5a: Evaluation of Past Bank Stabilization Projects

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

Task 5b: Recommendations for Future Bank Stabilization Projects

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

11 Sample Handling and Custody

No samples will be collected during the FRR.

12 Analytical Methods

Once all field efforts and post-processing are completed, data review and map generation of the 2013 FRR field data will be conducted. Data review will include, but not be limited to, the development of summary statistics of riverbank classifications based on Table 4 and Table 5, assessment of trends or correlations between adjacent riverbank characteristics, land-use and erosion, and comparisons of riverbanks conditions with past FRRs.

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

Transition points collected via GPS as part of Task 3 will be used to develop a GIS layer containing the spatial segmentation of the riverbanks in the Turners Falls Impoundment. The attribute table(s) of this GIS layer(s) will be populated with the information gathered from Tables 4 and 5. Summary statistics and maps for each category found in these tables will be developed. In areas where erosion phenomena exist, riverbank characteristics identified in Table 5 will be documented to determine if a correlation or trend exists between specific riverbank characteristics and erosion. Land-use data compiled as part of Task 1 will also be evaluated for correlations or trends with erosion features present.

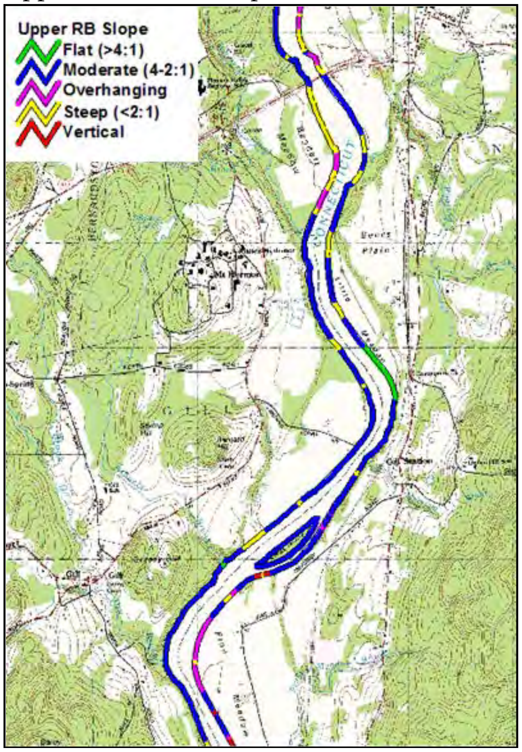
A comparison of the 2013 FRR will be made to the previous FRRs using summary statistics and analysis in ArcGIS. Comparison efforts will include evaluating changes in the length of riverbank shoreline experiencing erosion, severity of erosion, length of riverbank stabilization, success of erosion remediation efforts, identification of new erosion areas, etc. The purpose of these comparisons is to evaluate the temporal trends in riverbank erosion and to determine if an equilibrium of erosion and stabilization is developing.

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

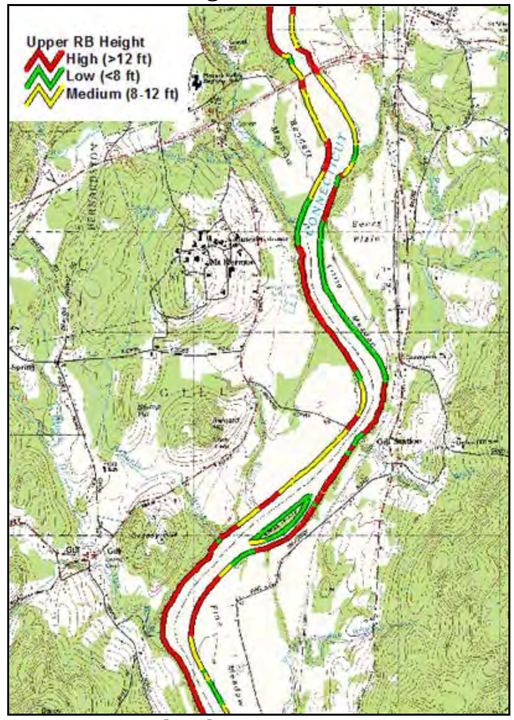
Mapping developed as part of this task will include, but not be limited to, maps depicting riverbank characteristics, types, stages, and extents of current erosion, indicators of potential erosion, adjacent land-use, and the location of bank stabilization projects. Figure 4 depicts an example of riverbank characteristic maps that have been included in past FRR reports. 2013 FRR mapping will follow previous FRR mapping styles so that data are comparable. A list of maps that may be included with the final report can be found at the end of this section. All maps will be developed in ArcGIS.

Figure 4: 2001 FRR maps for Height, Slope, Vegetation, and Material

Upper Riverbank Slope – Section 3

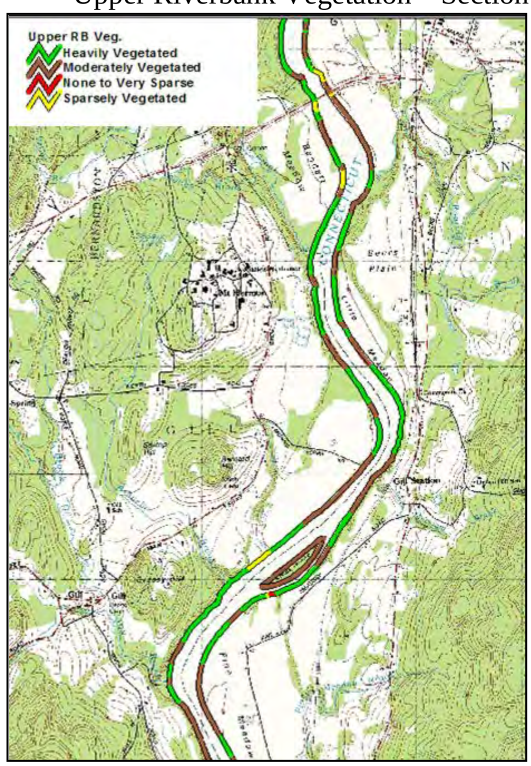


Upper Riverbank Height – Section 3



Lower Riverbank Sediment – Section 2

Upper Riverbank Vegetation – Section 3



13 Quality Control

To improve bank visibility the 2013 FRR will be conducted in November 2013 during leaf-off. A land-based bank survey and evaluation will be conducted prior to the FRR to serve as a control, and to provide additional site specific data. Pre-survey field trials were conducted in November, 2012 by S&A and NEE to calibrate sampling techniques and methods with all field staff.

The mapping and identification of erosion features has a degree of subjectivity which may lead to reduced accuracy or quantification errors. The protocols, data collection methods, and verification of data highlighted in this QAPP are intended to reduce the level of error and subjectivity as much as possible. All photographs, data collected, field forms, video, and survey information is to be maintained in its original format for future referencing if needed. Collected field data will be reviewed to document any inconsistencies in the data. All discrepancies need to be researched, and if the error is not determined, the necessary data will be measured again. If error results from improper use of equipment, or operator error, then retraining must occur before new data collection may proceed.

Field data will be checked at the end of each day by the Project Manager to ensure data are properly collected. All data entered on the data forms will then be checked by the QA/QC Manager. Any problems identified will be discussed with the staff and corrected in the field the following day.

Quality control following field efforts will be provided by comparing the data logging files, or field data sheets, of riverbank features and characteristics collected in the field with the geo-referenced digital video showing the riverbanks at the time of the FRR (Task 4, Section 10). Given that the entire riverbank of the Turners Falls Impoundment will be surveyed and digitally videoed, if a question arises concerning the classification of any segment information in the data logging file(s) can be compared to an image or video of any such segment.

An appendix to the FRR report will include a comparison of the specific riverbank features and characteristics from the data logging files, or field data sheets, collected during the field surveys to a photograph of that same segment of riverbank captured from the digital geo-referenced video. A discussion will be presented in the FRR report based on this comparison. The process of comparing the data logging files to video/still images of a selected percentage of segments, or any segment of particular interest, provides a high level of quality assurance and control on the field data collection. This approach also provides a method for reference checking any subsequent interpretation of the field survey data after the survey has been completed.

14 Instrument and Equipment Testing, Inspection, and Maintenance

Field equipment used by the field personnel will include a sub-meter GPS, a data-logger, a laser range-finder, and a geo-referenced videotaping system. Regular maintenance procedures will be conducted in accordance with the instrument manufacturer and a log of the regular maintenance will be kept. All mechanical and electronic equipment will be cleaned and dried each day if necessary. Spare parts and batteries will be readily available so there will be no interference with data collection in the case of mechanical breakdown. Records will be maintained for all instruments used to ensure conformance to the specified requirements. The instruments are to be evaluated before use to confirm proper working function to the degree of accuracy necessary to accomplish the task for which it has been assigned.

GPS units must be turned on for a minimum of 15 minutes before data collection begins to ensure the current satellite almanac has been transmitted and received by the unit. The GPS unit will be benchmarked with a position of known geographic location at the beginning and at the end of the collection period, and average precision/error can be calculated for points collected. If the error is > 49 feet, then satellite coverage was insufficient at that time, and the data will need to be recollected.

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

At the beginning of each day the geo-referenced video equipment will be tested by taking video of a bank prior to the start of actual data collection. The test video will be played back to ensure that the video equipment is in proper working order. If the video equipment is not working, the field crew will take necessary action(s) in accordance with the equipment manual.

15 Instrument and Equipment Calibration and Frequency

Equipment and instruments used for this effort do not require calibration.

16 Inspection and Acceptance of Supplies and Consumables

General supplies will be purchased from different suppliers. These supplies will be purchased as needed by field staff and should not require special inspection.

17 Non-direct Measurements

The non-direct methods that will be used as part of the 2013 FRR include: 1) USGS topographic maps for locations in VT, NH and MA, 2) ortho-photographs for these same states and 3) historical data, previously published and prepared in ArcGIS. All non-direct methods and materials will be used to support the field work.

18 Data Management

Data collected in the field will mostly be digital. This will include the data-logger files of riverbank features and characteristics, the geo-referenced digital video, digital photos and date-logger files of the land-based field work. These files will be downloaded to computers at the end of each field day. After verification and validation is completed, the reviewed and finalized data files will be downloaded to computers/servers at both S&A and NEE.

All field data sheets will be checked for completeness after each survey, and at the end of each day. The team leader will inspect all field records before leaving the site, and field data sheets will be reviewed by the Project Manager each day. Any omissions or discrepancies will be addressed immediately. Original field data sheets will remain in the possession of the field team member, and a copy will be placed in the electronic project file along with any other pertinent site information. Any secondary data will be stored in the project file, in either hardcopy, or electronic format.

All computer generated documents will be inspected for validity, completeness and accuracy by the QC Manager and Project Manager. All project files and drawings will have a unique file name including the project number and name. Every drawing will have a backup copy. Paper files will be maintained in a secure filing cabinet. Electronic files will be password protected and will not be modified without proper authorization. Electronic files will be backed up every night and stored off site. Inactive files are archived, and once archived they are changed to read-only status.

19 Assessments and Response Actions

Attention to quality is a primary consideration of the project. The Project Manager will formally review the performance of the field technicians at times during the sampling season to ensure proper data collection. All personnel associated with the project will ensure that the standard operating procedures be followed closely. Training and maintenance records will be filled out in a timely manner. Refresher courses for the field technicians will be conducted for each new season and as needed if it is determined that the field technicians are not sampling correctly.

To ensure data quality, the QA Officer will accompany the field crew at least once during the sampling period.

Equipment errors may occur and must be accounted for by reporting them to the Project Manager. If the error is identified before sampling takes place, the equipment will be labeled as broken and repaired or replaced by properly working equipment, if available. If malfunctioning equipment affects the data, the equipment will be recorded as such on the field data sheet and immediately reported to the Project Manager.

The Project Manager is ultimately responsible for oversight of all activities of the data collection process. The QA Officer will ensure that field technicians are performing all data collection as prescribed by the QAPP.

20 Reports to Management

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

Deliverables in the final report will include:

Task 1 – Land-Based Observations

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

- Data logging and field forms

Task 2 – Classify Riverbank Features, Characteristics, and Erosion

- Riverbank characteristic maps including: slope, surficial sediment/substrate, height, and vegetation;
- Riverbank segments map;
- Riverbank erosion classification maps including: erosion types, erosion stages, indicators of potential erosion, and extent of current erosion;
- Sensitive receptors map (wildlife habitat);
- Summary statistics of riverbank characteristics and erosion features;
- Documentation of correlations between specific riverbank characteristics and erosion; and
- Data logging and field forms

Task 3 – Spatially Define Riverbank Transition Points

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

Task 4 – Video and Photographic Documentation

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

Task 5 – Riverbank Stabilization Projects

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

21 Data Review, Verification, and Validation

The project QA Officer will review all data collected as well as subsequent calculations to evaluate whether QC requirements have been met and whether data are usable to obtain the stated objectives of the project based on criteria contained in the QAPP. Subsequent final review and approval will be made by the Project Manager.

22 Verification and Validation Methods

Validation and verification of field data will be conducted on a daily basis by reviewing the data-logger files to ensure that all riverbank segments observed are fully completed, covering all features and characteristics in the classification matrix. GPS location data will be checked comparing the segment of riverbank observed each day with the locations plotted on the computer.

Field observations of riverbank features and characteristics will be compared with images captured from the geo-referenced digital video files. Since geo-referenced video will be available for the entire Turners Falls Impoundment, the classification of any riverbank segment can be verified by comparing the observations in the data-logger to the geo-referenced video.

When it is found that data do not meet the quality objectives of the QAPP, or do not adhere to the QC measures, the Project Manager may determine what corrective action must be taken:

- Incomplete data may lead to re-surveying of river bank segments if the available data are insufficient to meet project goals

- When data quality is poor, the Project Manager will apply one of the following actions:
    1. Systems audit for measurements in questions;
    2. Immediate re-survey of the river bank segments in question;
    3. Revise riverbank segment classification based on geo-referenced video;
    4. Rejection of identified data with a written explanation; or
    5. Rejection of survey segments from the assessment with recommendation for re-survey.

23 Reconciliation with User Requirements

The classification of any particular segment can be compared against the photographs referenced during classification by utilizing images from the corresponding geo-referenced video images taken during the field survey. If the project objectives are met, the user requirements have been met. If the project objectives have not been met, the corrective actions will be established by the Project Manager.

24 References

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

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

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

APPENDIX A - TRIMBLE GEOXT SUB-METER GPS SPECIFICATIONS

Trimble GeoXT Sub-Meter GPS - Rugged and reliable data collection

The Trimble® GeoXT™ handheld from the GeoExplorer® 3000 series is the essential tool for maintaining your GIS. A high performance GPS receiver combined with a rugged handheld computer, the GeoXT handheld is optimized to provide reliable location data, when and where you need it.

It's ideal for use by utility companies, local government organizations, federal agencies, or anyone managing assets or mapping critical infrastructure who needs accurate data to do the job right—the first time. With EVEREST™ multipath rejection technology onboard, the GeoXT handheld records quality GPS positions even under canopy, in urban canyons, and in all the everyday environments you work in, so you know your GIS has the information that others can depend on.

And if you need that extra edge in precision, you can collect data with Trimble TerraSync™ software, Trimble GPScorrect™ extension for Esri ArcPad software, or Trimble Positions™ Mobile extension and then postprocess it back in the office with Trimble GPS Pathfinder® Office software, Trimble GPS Analyst™ extension for Esri ArcGIS Desktop software, or Trimble Positions Desktop add-in. These office processing suites use the new Trimble DeltaPhase™ technology to achieve 50 cm accuracy for GPS code measurements after postprocessing, and even higher levels of postprocessed accuracy are possible when you log GPS carrier data for extended periods.

With a powerful 520 MHz processor, 128 MB RAM, and 1 GB of on board storage, the GeoXT handheld is a high performance device designed to work as hard as you do. The handheld gives you all the power you need to work with maps and large data sets in the field, and its high resolution VGA display allows for crisp and clear viewing of your data.

With the GeoXT handheld you have the flexibility to work exactly the way you want to. The handheld is powered by the industry-standard Windows Mobile® version 6.1 operating system, so you can choose a software solution designed for your field requirements, whether off-the-shelf or purpose-built. And you can use the built-in wireless LAN connection to access your organization's secure network and get the most up-to-date information. You can also wirelessly connect to other devices such as Bluetooth-enabled laser rangefinders and barcode scanners for convenient cable-free solutions that keep you productive in the field.

Rugged design and powerful functionality are the hallmarks of the GeoExplorer® series. When accuracy is critical, the GeoXT handheld delivers with unprecedented efficiency and reliability, when and where you need it.

Key features:

- Real-time submeter GPS with integrated SBAS and EVEREST multipath rejection technology
- 50 cm accuracy after postprocessing with Trimble DeltaPhase technology
- High-resolution VGA display for crisp and clear map viewing
- Bluetooth and wireless LAN connectivity options
- 1 GB on board storage plus SD slot for removable cards
- Windows Mobile version 6.1 operating system

Rugged handheld with all-day battery

APPENDIX B – LASER RANGE FINDER EQUIPMENT SPECIFICATIONS

LTI TruPulse 360B

Laser Technology, Inc. http://www.quantumgear.com/trupulse-360b/

LTI TruPulse 360B

Now with TruVector Compass Technology™ and BlueTooth™ wireless transfer of data!

$1,695.00

enlarge

Quantity: 1

Detailed Description

The TruPulse 360B includes all of the features of the 360 plus BlueTooth™ wireless data transfer

This model is the only all-in-one compass/laser that produces the best possible azimuth accuracy regardless of what angle you shoot from. So, whether you need accurate distance and height measurements or you want to expand your capabilities with a compass, there is a TruPulse model designed just for you. Nothing on the market offers this kind of functionality, with such a compact design and low price point. Start mapping more and moving less today.

Industries: Forestry, Natural Resources, GIS/GPS, Construction, Mining, Utilities, Telecom

Quick Links:
TruPulse Series Specs

By embedding TruVector compass technology™ into the TruPulse 360, this unit is transformed into an integrated compass, distance and height laser range finder that delivers mapping-grade accuracy without inclination limitations. With the TruPulse 360 rangefinder you can acquire multiple targets from a single location, without ever having to worry about compromising your data.

The TruPulse 360B offers increased productivity

Tilt the TruPulse 360 89 degrees, turn it on its side, or even hold it upside down, and the TruPulse 360 will give you accurate azimuth in any direction it's aimed. It even has a built in system that will alert you if you need to recalibrate the unit.The TruPulse 360 is small enough to fit in your pocket, yet powerful enough to deliver professional, mapping-grade accuracy in a hand-held, point-and-shoot package. Find a safe convenient point of view and start collecting field data.

(All specifications are subject to change without notice.)
Dimensions: 5 inches x 2inches x 3.5 inches (12 cm x 5 cm x 9 cm)
Weight: 8 ounces (220 g)
Data Communication: Serial, via wired RS232 (standard) or wireless Bluetooth (optional)
Power: 3.0 volts DC nominal
Battery Type: (1) CRV3 or (2) AA
Battery Duration: CRV3 - Approx. 15,000 measurements (12,000 w/Bluetooth enabled);
AA - Approx. 7,500 measurements (6,000 w/Bluetooth enabled)
Display: In-scope LCD displays menu options and data values
Units: Feet, Yards, Meters, and Degrees
Monopod/tripod Mount: 1/4inches - 20 female thread
Eye Safety: FDA Class 1 (CFR 21)
Environmental: Impact, water and dust resistant. NEMA 3, IP 54
Temperature: -4 F to +140 F (-20 C to +60 C)
Optics: 7x magnification (field of view: 330 ft @ 1,000 yds)
Measurement Solutions:
Distance (Horizontal, Vertical, Slope)
Inclination (Degrees and Percent Slope)
Height (Flexible three-shot routine)
Azimuth (Compass bearing for single-shot positioning)
Missing Line (Distance, Inclination and Azimuth between any two remote points)
Measurement Range:
Distance: 0 to 3,280 ft (1,000 m); typical,
6,560 ft (2,000 m); max to reflective target
Inclination: ±90 degrees
Azimuth: 0 to 359.9 degrees
Accuracy:
Distance: ±1 ft (±30 cm); typical± yd (±1 m); max
Inclination: ±0.25 degrees
Azimuth: ±1 degree; typical
Targeting Modes:
Standard, Closest, Farthest, Continuous, and Filter (requires reflector and foliage filter)
TruTargeting:
Automatically provides best possible accuracy and acquisition distance to a given target
TruVector Compass Technology™:
Provides the best possible compass accuracy regardless of the laser’s inclination. It even warns you when the compass needs calibrating.

APPENDIX C – RED HEN SYSTEMS GEO-REFERENCED VIDEO MAPPING

Red Hen Systems Geo-Referenced Video Mapping

VMS-HD Complete System Bundle Includes:

- Red Hen VMS Hardware
- Convergent Design nanoFlash HD/SD Digital Video Recorder/Player
- Desktop GIS Software: MediaMapper 5.3*
- GPS Antenna/Receiver
- Feature Trigger (on board)
- 4" Microphone Jack Cable
- Power Adapter with International Plugs
- Hirose Power Cable
- Flash Card Reader/USB Cable
- Pelican Case
- Manuals

Convergent Design nanoFlash HD/SD Digital Video Recorder/Player

Introducing the World's smallest high quality HD/SD-SDI / HDMI Recorder/Player. The nanoFlash by Convergent Design is the most versatile Recorder/Player in the World in terms of bit-rates, recording options and formats. By adding the nanoFlash , one can meet the acquisition requirements, 50 Mbps, for many networks. The nanoFlash is a state-of-the-art miniature CompactFlash HD/SD SDI and HDMI Recorder/Player. Red Hen Systems is pleased to have been selected as the premier Spatial Multimedia Reseller and GIS Integration partner for the nanoFlash by Convergent Design.

- Improves the image quality of most cameras as the HD/SD-SDI and HDMI outputs are before the compression stages.
- Many cameras only record highly compressed 4:2:0 while outputting 4:2:2 over HD-SDI or HDMI.
- The nanoFlash uses these high-quality uncompressed 4:2:2 images to produce higher quality recordings.

The nanoFlash offers a dramatically better image, free from motion artifacts and other image problems, such as mosquito noise. Typically the nanoFlash offers a better image, even from many high-end cameras.

Wide Range of Bit-Rates
- 4:2:2 Long-GOP from 50 to 180 Mbps Long-GOP
- 4:2:2 I-Frame Only from 100 to 280 Mbps
- 4:2:0 Long-GOP from 18 to 35 Mbps
- SD 5/6/7/8/9 Mbps

Wide Range of Frame Rates

- Supports HD-SDI, SD-SDI and HDMI inputs
- Works with most any camera with HD/SD-SDI or HDMI outputs HD/SD-SDI and HDMI outputs active simultaneously
- Long, Uninterrupted Recording Times

Records in:
- Native Quicktime for Final Cut Pro
- Native MXF for Avid, Sony Vegas, Edius, others
- MPG Format in SD for quick same day creation of DVD's
- MPG Format in HD - Realtime Rendering of Blu-Ray disks
- No Mandatory Transcoding - Drag and Drop Editing

- All Solid-State - No Moving Parts - No Fans - No Noise - Field Proven Rugged - Withstands Extreme Temperatures - High Humidity - High Altitudes - High Vibration - High G-Forces
- Camera Mountable - 0.85 Pounds - 1/4" x 20 Tripod Thread
- Very Low Power - 5.6 Watts maximum, 0.2 watts standby Wide Voltage Range - 6.5 to 19.5 Volts DC - Uses most any battery type - International AC Power Supply included

- Supports Timecode and Audio embedded in HD/SD-SDI
- Supports Audio embedded in HDMI
- Supports Analog Audio, 24-Bit/48K, with up to 44 dB of gain via 3.5 mm audio input, compatible with tape-out signals
- One Channel balanced audio consumer line level / mic, orT
- Two Channel unbalanced audio consumer line level / mic

All audio recorded at 24-Bit/48K Uncompressed
Headphone / Consumer line-level outputs

2 CompactFlash card slots - Records seamlessly from one card to the next
The image quality produced by the nanoFlash is exactly the same as the Flash XDR.

VMS-HDII

Our easy-to-use digital camera accessories and GPS video digital recorders let you collect video imagery - along with essential location information. Our GIS software lets you process the imagery and generate multimedia maps that bring vital information to the eyes and fingertips of decision-makers. With the click of a button you know where something is, as well as what it looks like. And you can share the maps with others over the Internet.

This system combines Red Hen's VMS-333 with the nanoFlash recorder from Convergent. Completely customizable, now add up to 4 channels of recording for UltraViolet, Infrared, Standard Definition, and/or High Definition. Expand the information in your data collect for more comprehensive results. In our most portable, light-weight size yet, the HDII is especially suited to collect geo-tagged “path” HD video from all mobile platforms, such as aircraft, ground vehicles and marine vessels.

Features:

• Format: Record in High-Definition or standard definition
• Recording: All video and GPS data encapsulated in a single file on compact flash card, seamlessly switches recording from card 1 to card 2
• GPS: WAAS-enabled for greater location accuracy in the US; supports international SBAS (Satellite Based Augmentation System) in Europe and Asia
• Feature Trigger: Allows you to “mark” points of interest for quick analysis
• Photo Capture: Automatically capture geo-referenced still photos from High-Definition video
• Analysis: MediaMapper 5.3 software allows for subject matter experts to create electronic work products

Benefits:

• Competitive price, with unprecedented High-Def and multimedia mapping functionality
• Light weight, portable — easily switch between aircraft and vehicles, or carry on foot
• Removable compact flash cards allow for archiving of original recording — ideal for law enforcement
• All Solid-State design - Ideal for Extreme Environments

Supported Video Input Formats:

· 1920x1080i @ 60, 59.94, 50 Hz
· 1920x1080p @ 30, 29.97, 25, 24, 23.98 Hz
· 1920x1080psf, @ 30, 29.97, 25, 24, 23.98 Hz
· 1280x720p @ 60, 59.94, 50 Hz
· 720x486 @ 29.97 Hz
· 720x576 @ 25 Hz

.mts & .m2ts file types may not work correctly and therefore are not supported.

APPENDIX D – RIVERBANK CLASSIFICATION REFERENCE PHOTOGRAPHS

Upper Riverbank Slope


Flat (<4:1)


Moderate (4:1-2:1)

Steep (>2:1)

Vertical (90º)

Overhanging (>90º)

Lower Riverbank Slope:

Flat/Beach (<4:1)

Moderate (4:1-2:1)

Steep (>2:1)

Vertical (90º)

Upper Riverbank Sediment:

Silt/Sand (.062-2 mm)

Bedrock

Lower Riverbank Sediment:

Silt/Sand (.062-2 mm)

Gravel (2-64 mm)

Cobbles (64-256 mm)

Boulders (256-2048 mm)

Bedrock

Clay (.001-.062 mm)

Upper Riverbank Height:

Low (<8 ft)

Medium (8-12 ft)

High (>12 ft)

Upper Riverbank Vegetation:

Heavy (>50%)

Moderate (25-50%)

Sparse (10-25%)

None to very sparse (<10%)

Lower Riverbank Vegetation:

Heavy (>50%)

Moderate (25-50%)

Sparse (10-25%)

None to Very Sparse (<10%)

Extent of Current Erosion:

None/Little (<10%)

None/Little (<10%)

None/Little (<10%)

Some (10%-40%)

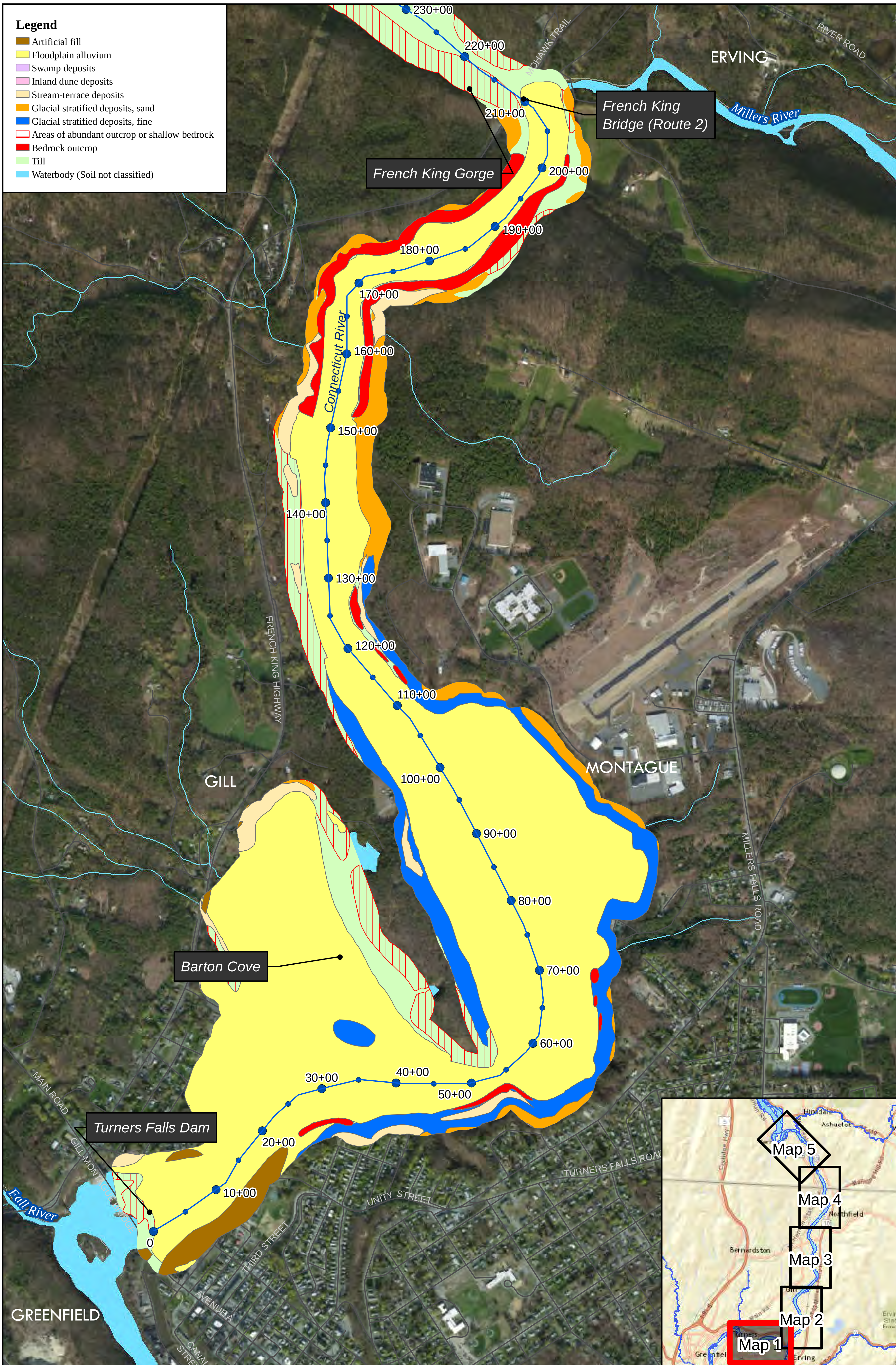
Some to Extensive (40%-70%)

Extensive (>70%)

Extensive (>70%)

NOTE: All quantitative classification criteria (e.g. slope, height, vegetation, extent, etc.) will be based on approximate qualitative estimates made during field observations of riverbanks. The FRR is a reconnaissance level survey that will not include quantitative field measurements of characteristics. Photographs contained in this appendix will be used for reference checking in the field to ensure for consistent and accurate data classification.

APPENDIX E – LAND-USE MAPS



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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Surficial Geology within 200' Buffer of River
Map 1

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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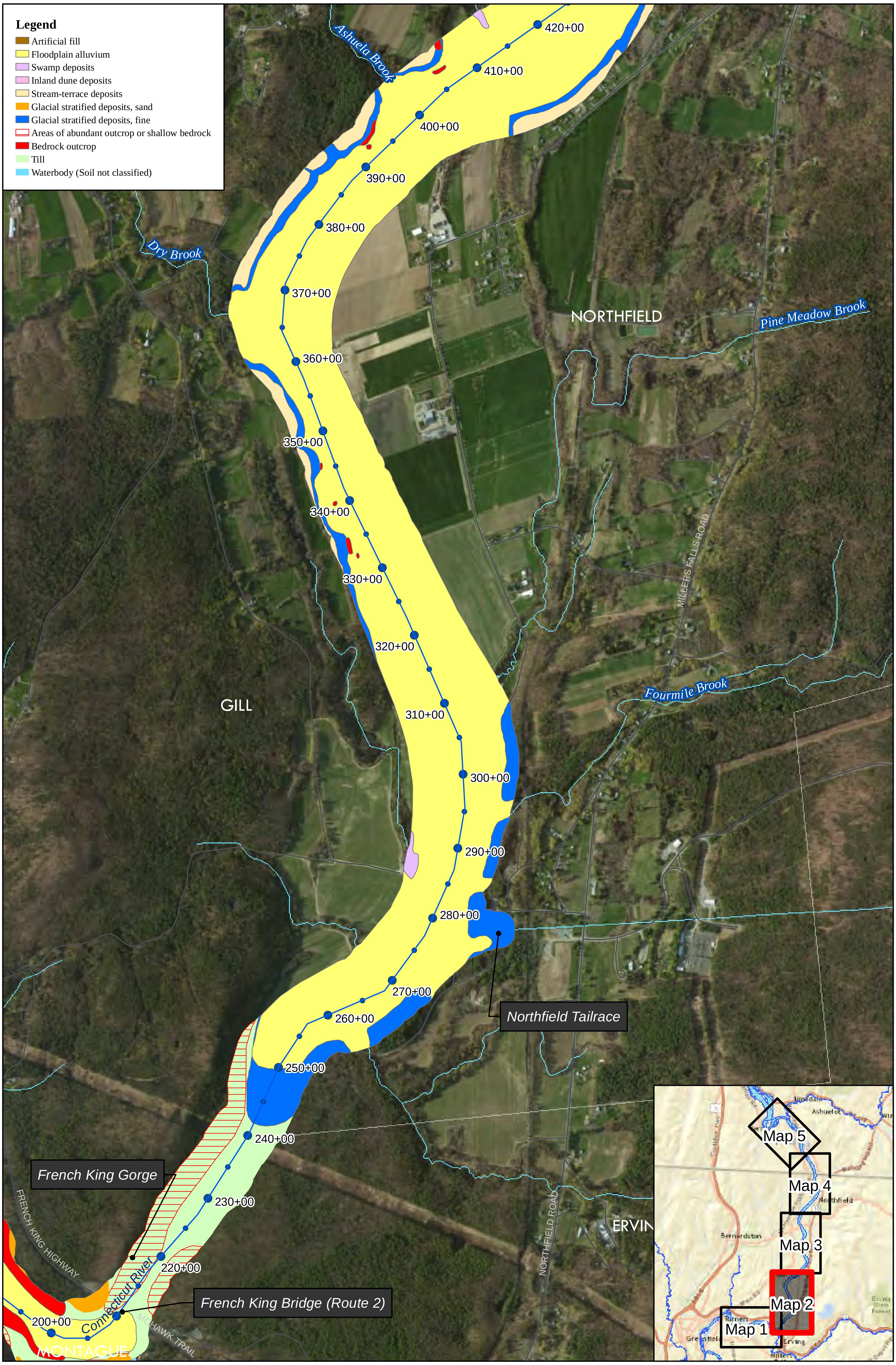

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Surficial Geology within 200' Buffer of River
Map 2

N

0 625 1,250 2,500 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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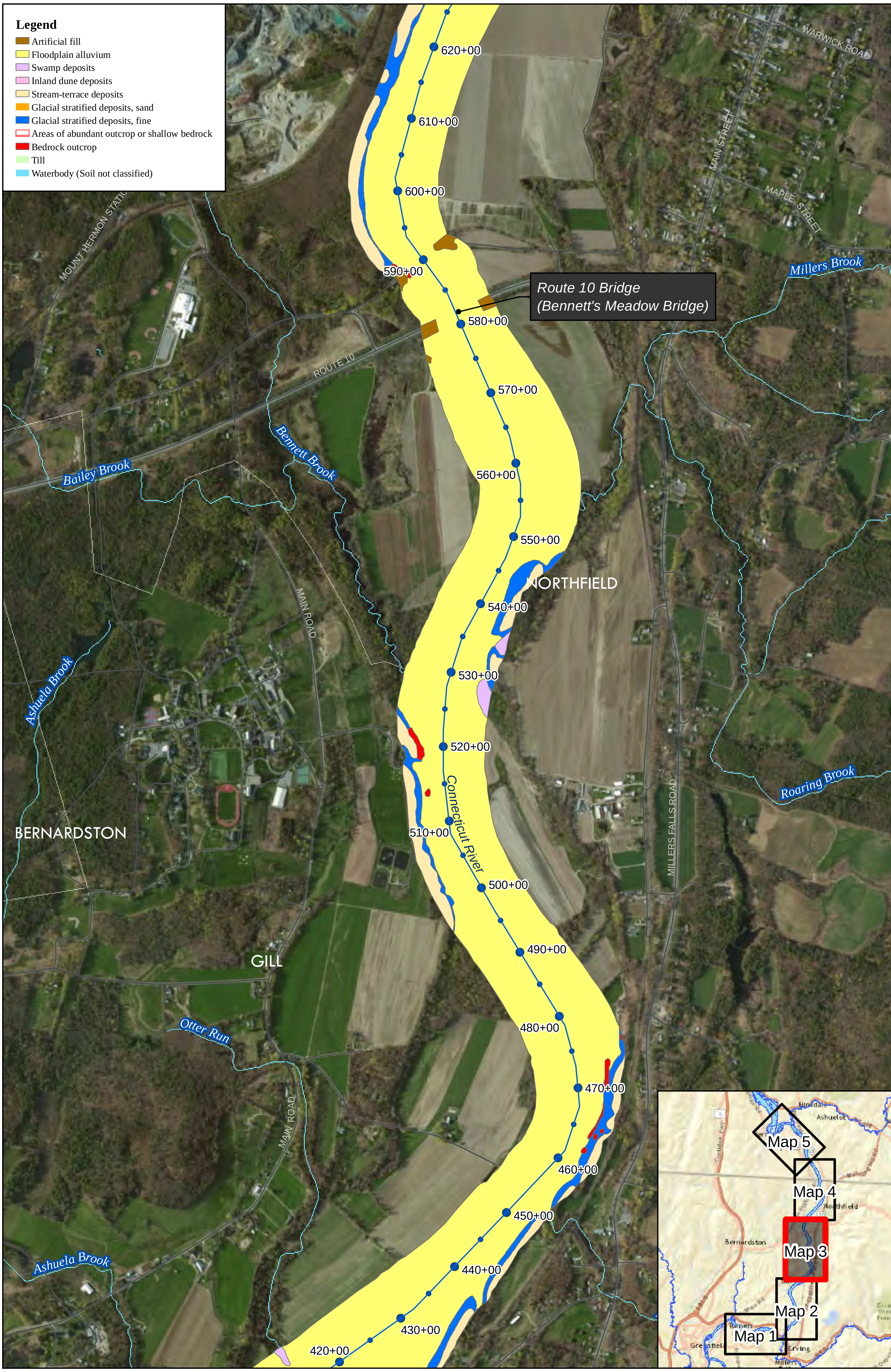

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Surficial Geology within 200' Buffer of River
Map 3

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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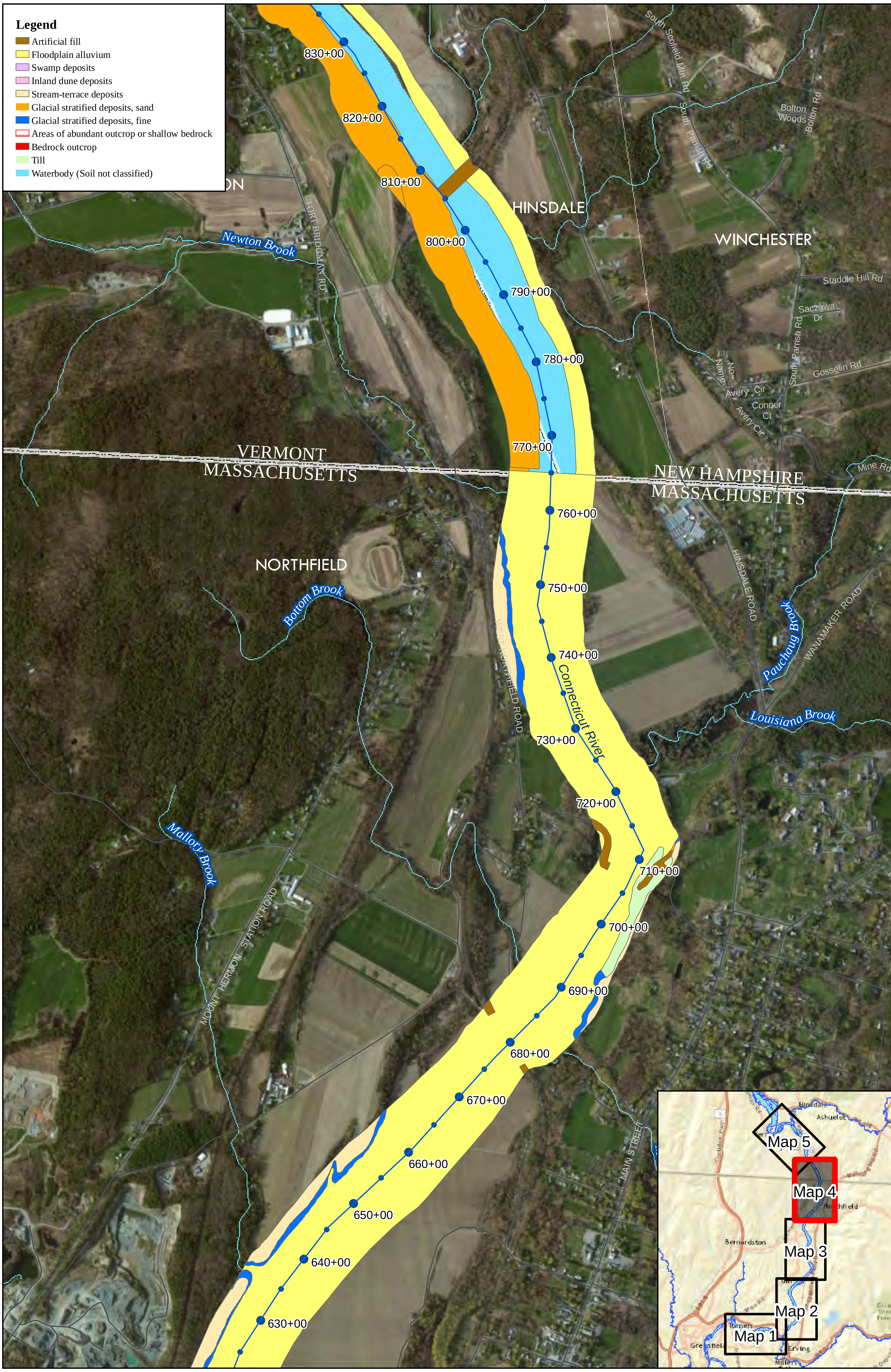

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Surficial Geology within 200' Buffer of River
Map 4

0 625 1,250 2,500 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Surficial Geology within 200' Buffer of River
Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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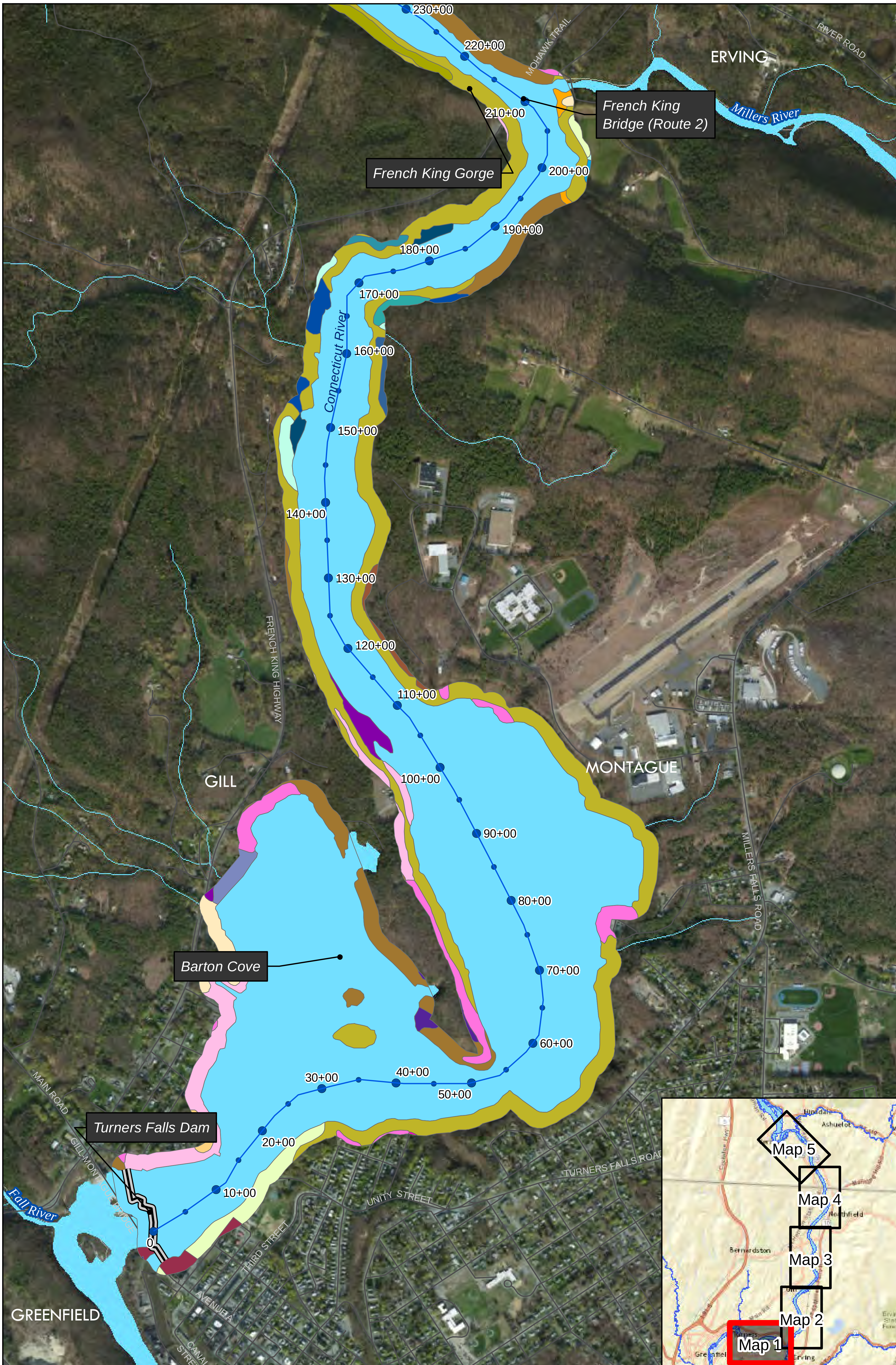

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Soil Classifications within 200' Buffer of River
Map 1

0 625 1,250 2,500 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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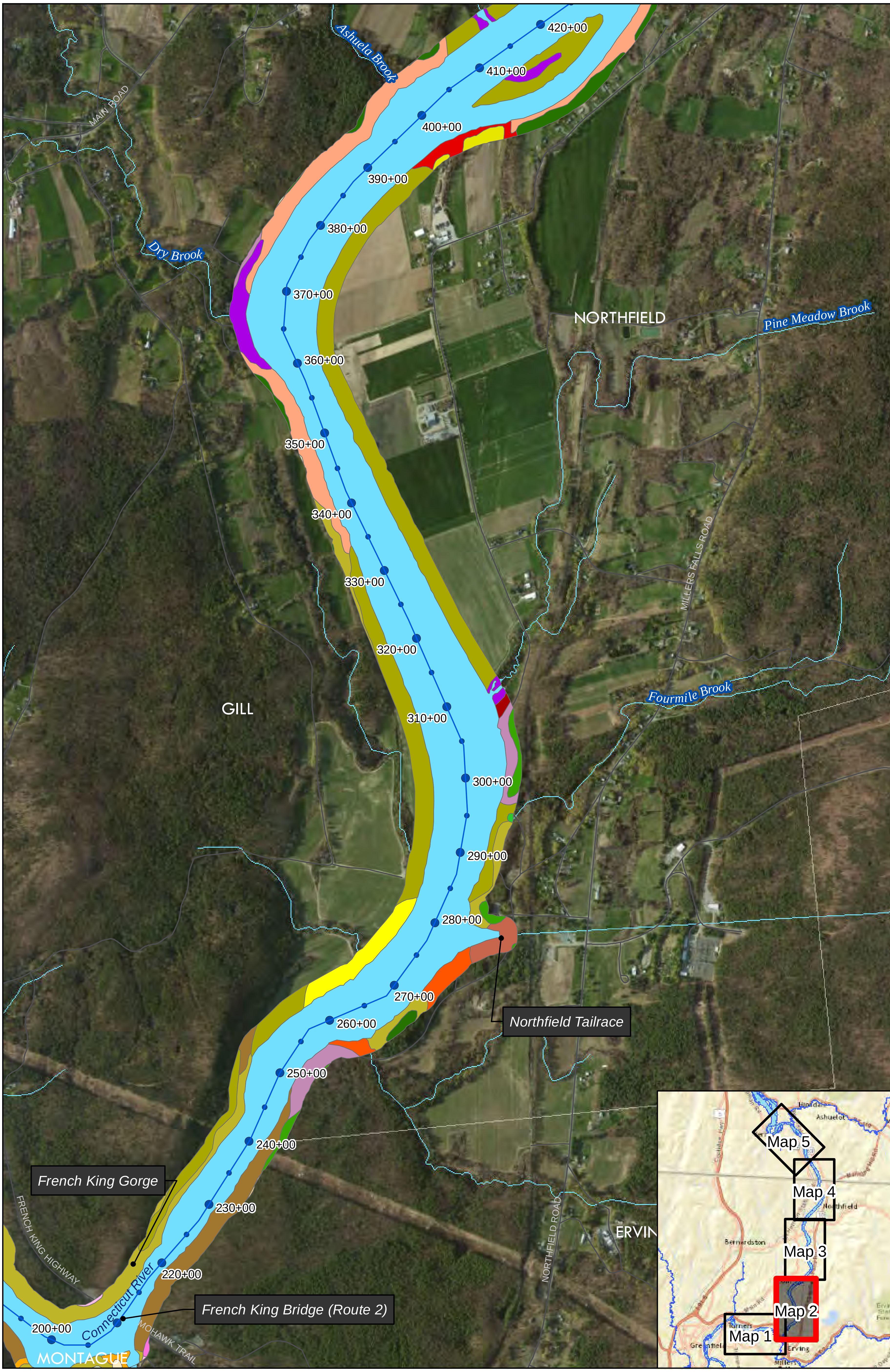

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

N

Soil Classifications within 200' Buffer of River
Map 2

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Soil Classifications within 200' Buffer of River
Map 3

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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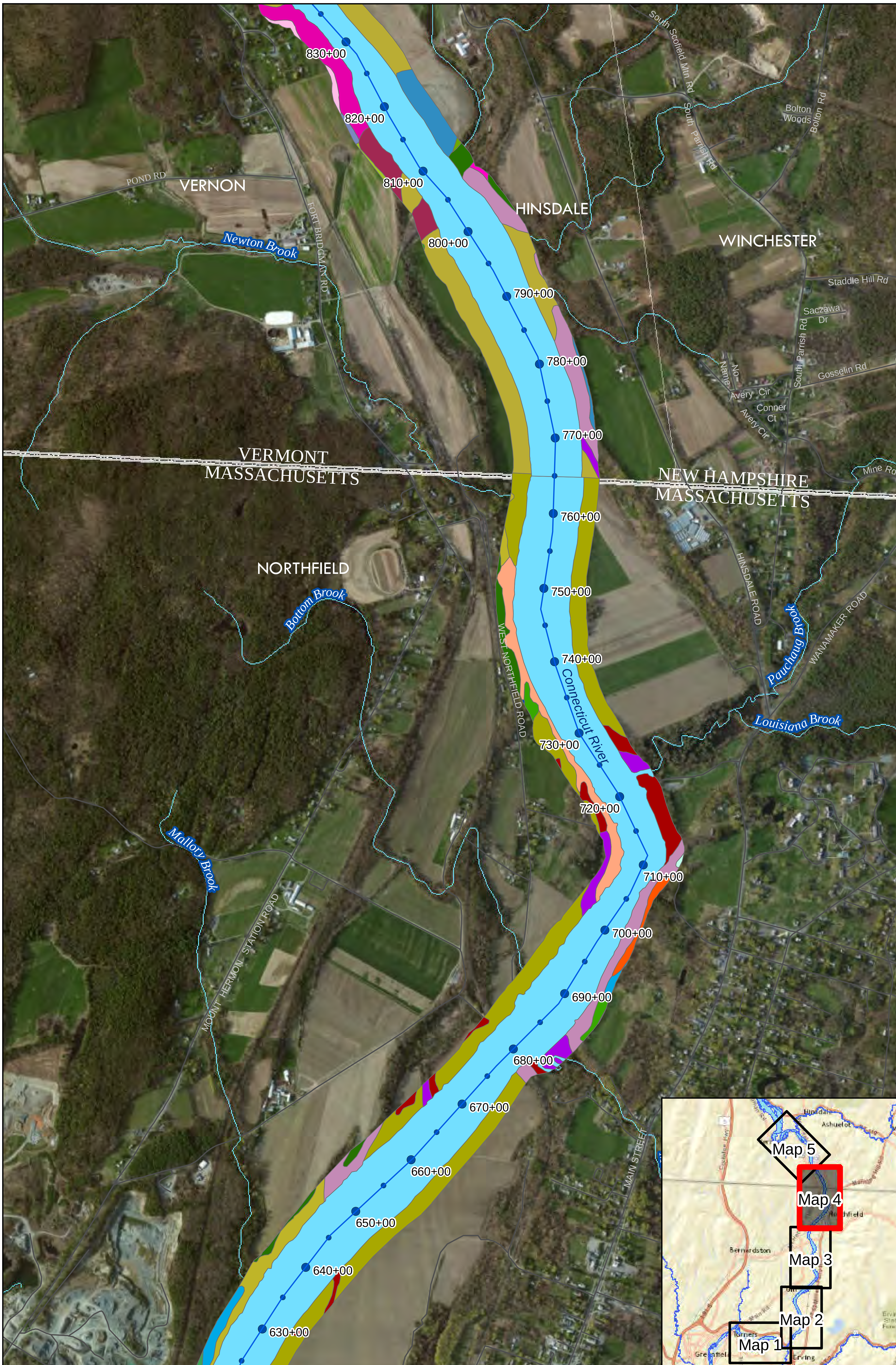

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500
Feet

Soil Classifications within 200' Buffer of River
Map 4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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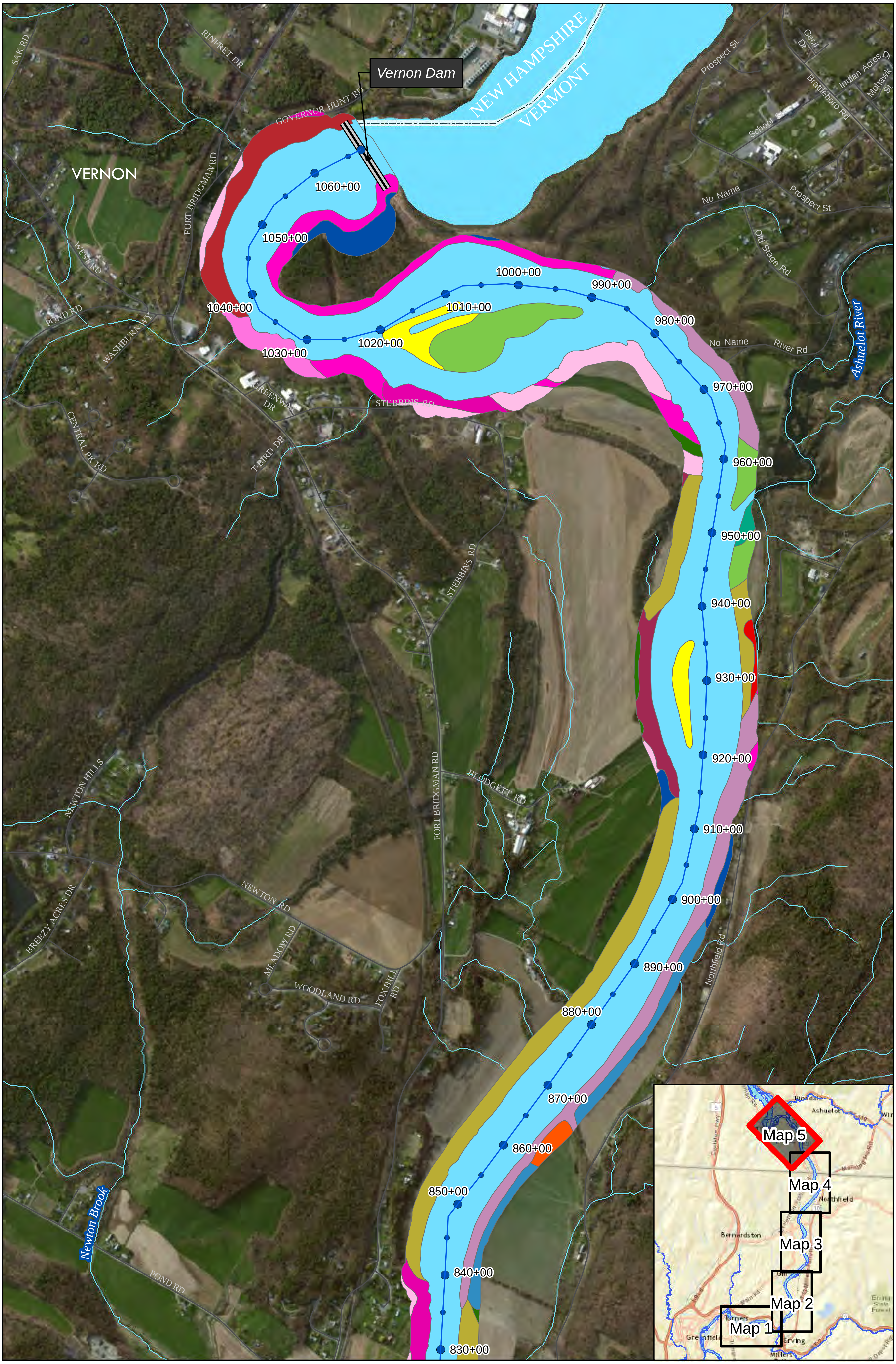

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Soil Classifications within 200' Buffer of River
Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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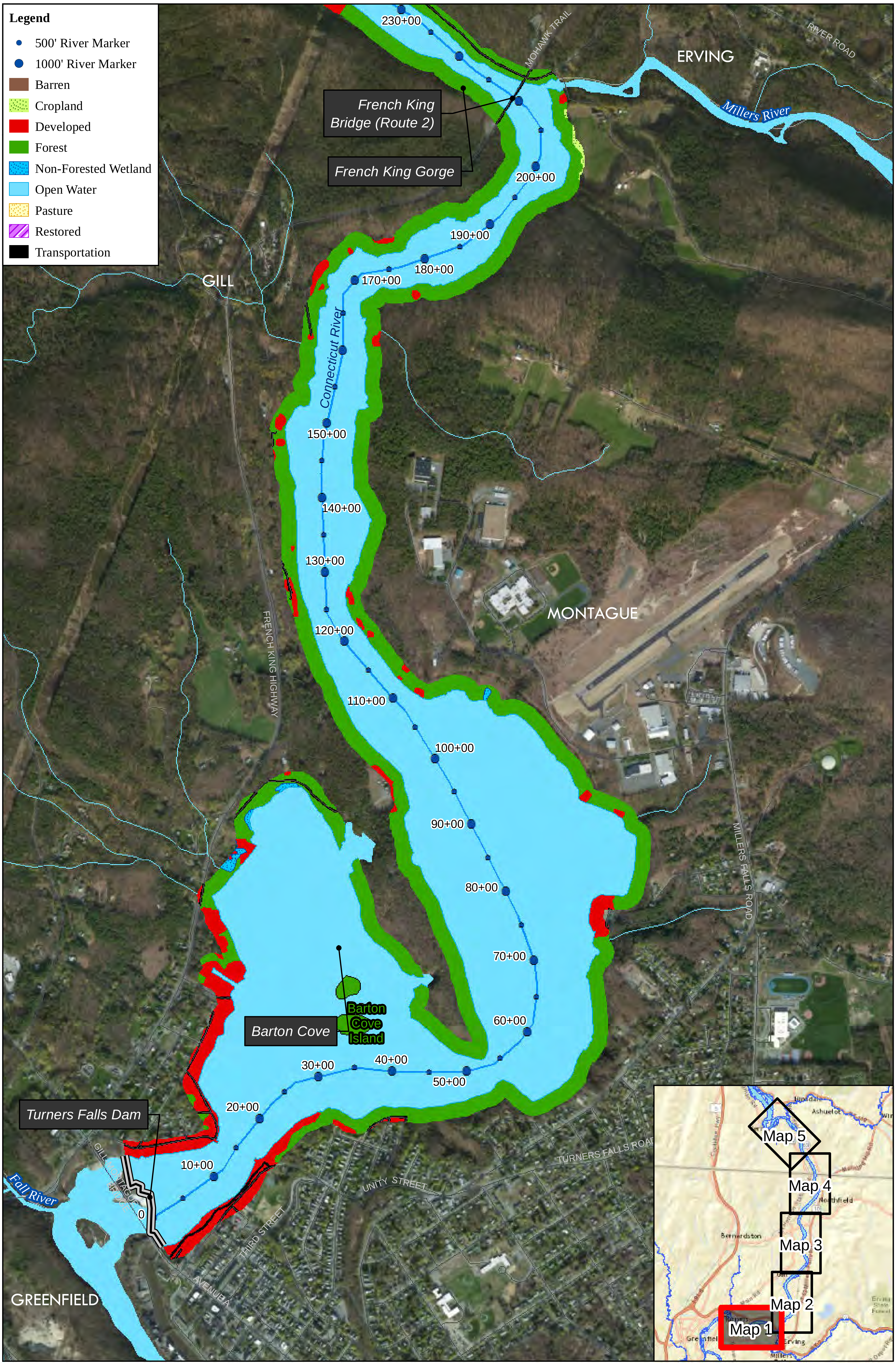
Legend

- Agawam fine sandy loam, 0-3% slopes
- Agawam fine sandy loam, 3-8% slopes
- Agawam fine sandy loam, 8-15% slopes
- Agawam fine sandy loam, 15-25% slopes
- Birdsall mucky silt loam, 0-2% slopes
- Hadley very fine sandy loam, 0-3% slopes, occasionally flooded
- Hadley very fine sandy loam, 0-3% slopes, protected
- Hinckley sandy laom, 3-8% slopes
- Holyoke-Yalesville complex, 8-15% slopes, rocky
- Limerick silt loam, 0-2% slopes, frequently flooded
- Merrimac fine sand loam, 0-3% slopes
- Merrimac fine sandy loam, 3-8% slopes
- Ninigret very fine sandy loam, 3-8% slopes
- Occum fine sandy loam, 0-3% slopes, occasionally flooded
- Poocham silt loam, 25-60% slopes
- Pootatuck very fine sandy loam, 0-3% slopes, occasionaly flooded
- Raynham silt loam, 0-3% slopes
- Saco mucky silt loam, 0-2% slopes, frequently flooded
- Scio silt loam, 3-8% slopes
- Suncook loamy sand, 0-3% slopes, occasionally flooded
- Udifluvents, frequently flooded
- Udorthents, 25-60% slopes, frequently flooded
- Udorthents, smoothed
- Udorthents-Urban land complex
- Unadilla silt loam, 0-3% slopes
- Unadilla silt loam, 3-8% slopes
- Undadilla silt loam, 3-8% slopes
- Warwick channery fine sandy loam, 15-25% slopes
- Windsor and Merrimac soils, 25-60% slopes
- Windsor loamy sand, 0-3% slopes
- Windsor loamy sand, 3-8% slopes
- Windsor loamy sand, 8-15% slopes
- Winoosi silt loam, 0-3% slopes, protected
- Winooski silt loam, 0-3% slopes, occasionally flooded
- Yalesville-Holyoke complex, 3-8% slopes, rocky
- Yalesville-Holyoke complex, 8-15% slopes, rocky
- Yalesville-Holyoke complex, 15-25% slopes, rocky
- Yalesville-Holyoke complex, 25-50% slopes, rocky
- Water



FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Detailed Land Use Classifications within 200 ft of Connecticut River
Map 1

0 625 1,250 2,500 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan,

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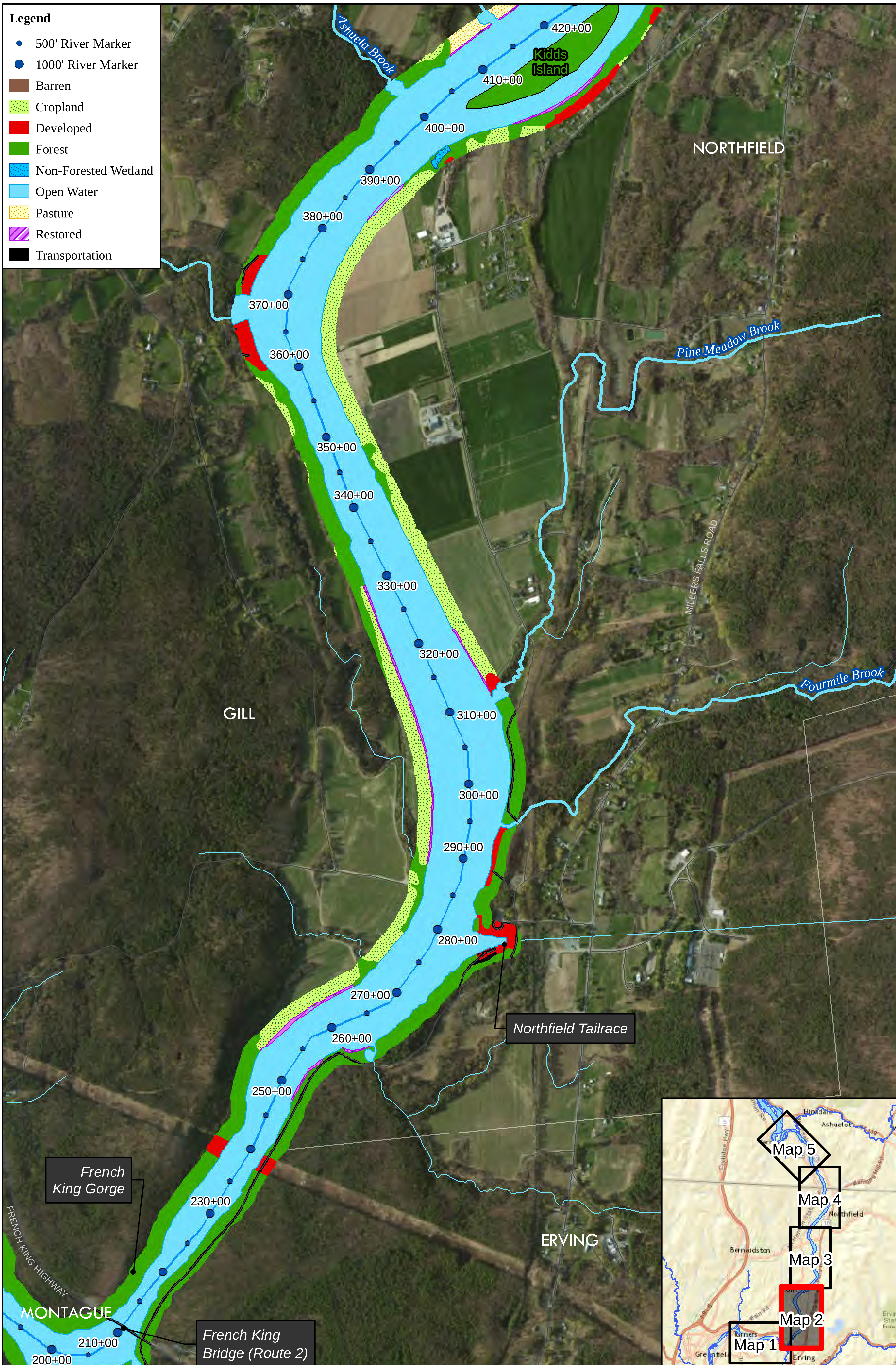

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Detailed Land Use Classifications within 200 ft of Connecticut River
Map 2

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Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan,

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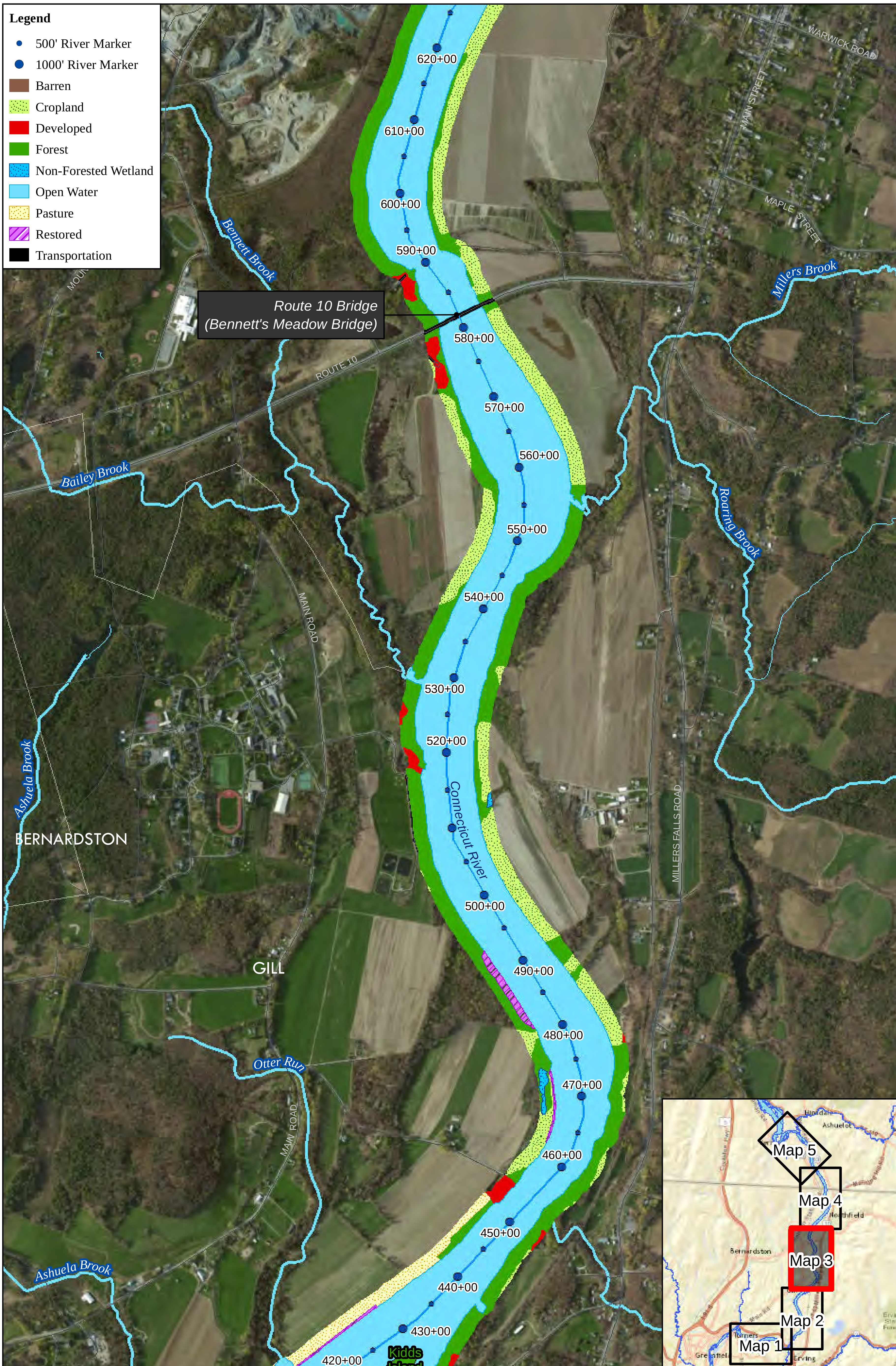

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Detailed Land Use Classifications
within 200 ft of Connecticut River
Map 3

N

0 625 1,250 2,500 Feet

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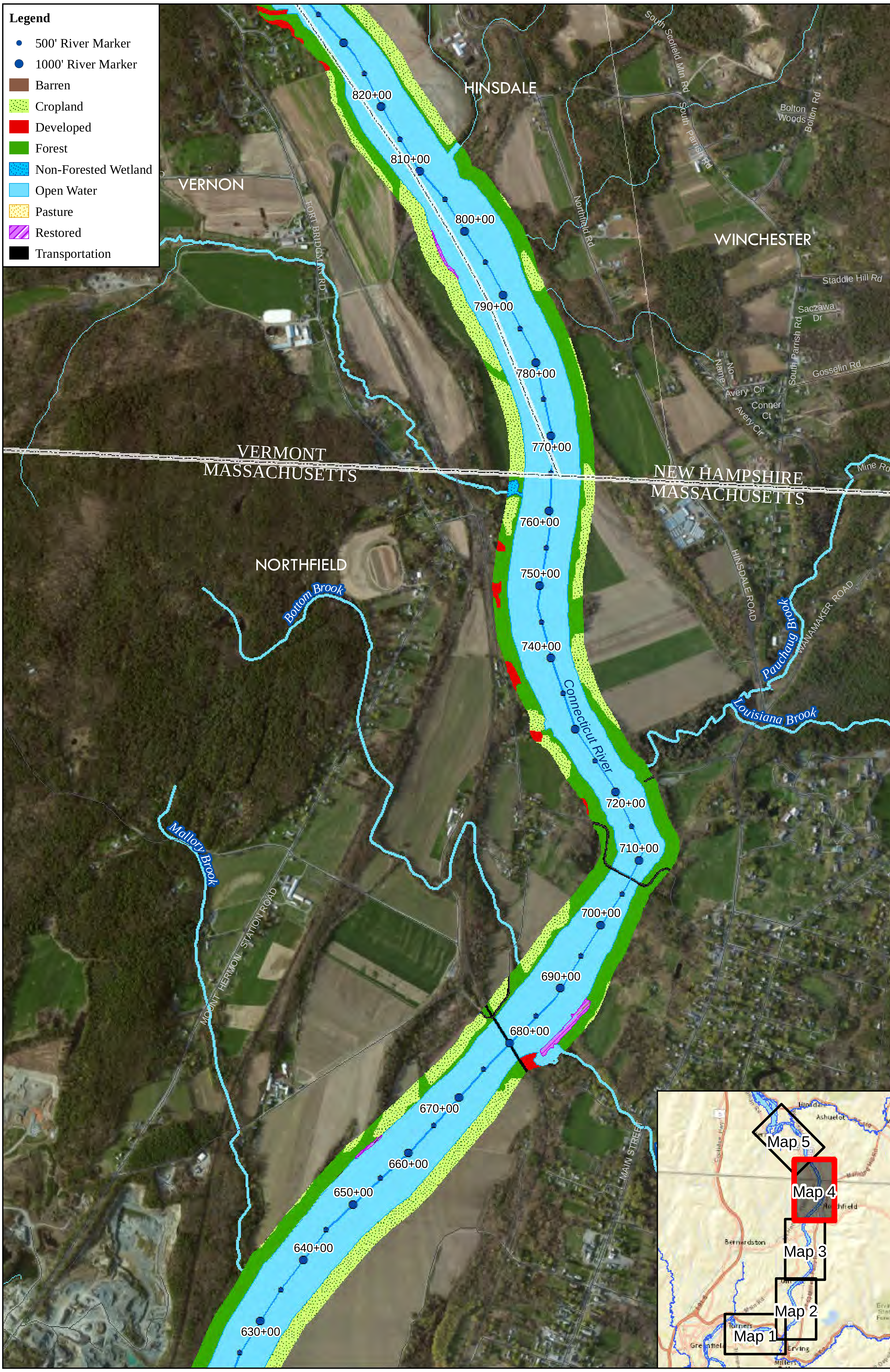

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Detailed Land Use Classifications within 200 ft of Connecticut River
Map 4

N

0 625 1,250 2,500 Feet

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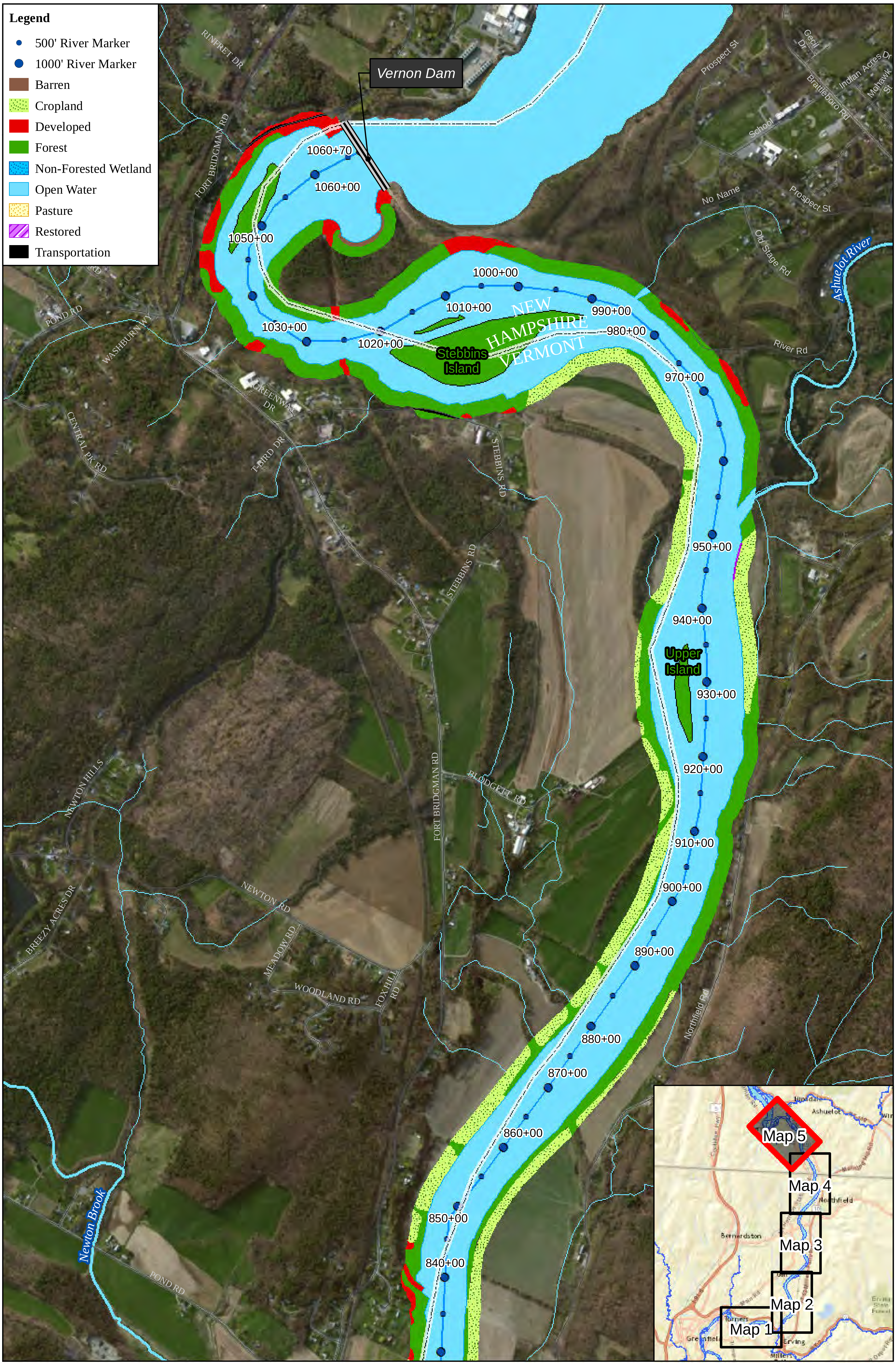

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Detailed Land Use Classifications within 200 ft of Connecticut River
Map 5

0 625 1,250 2,500 Feet

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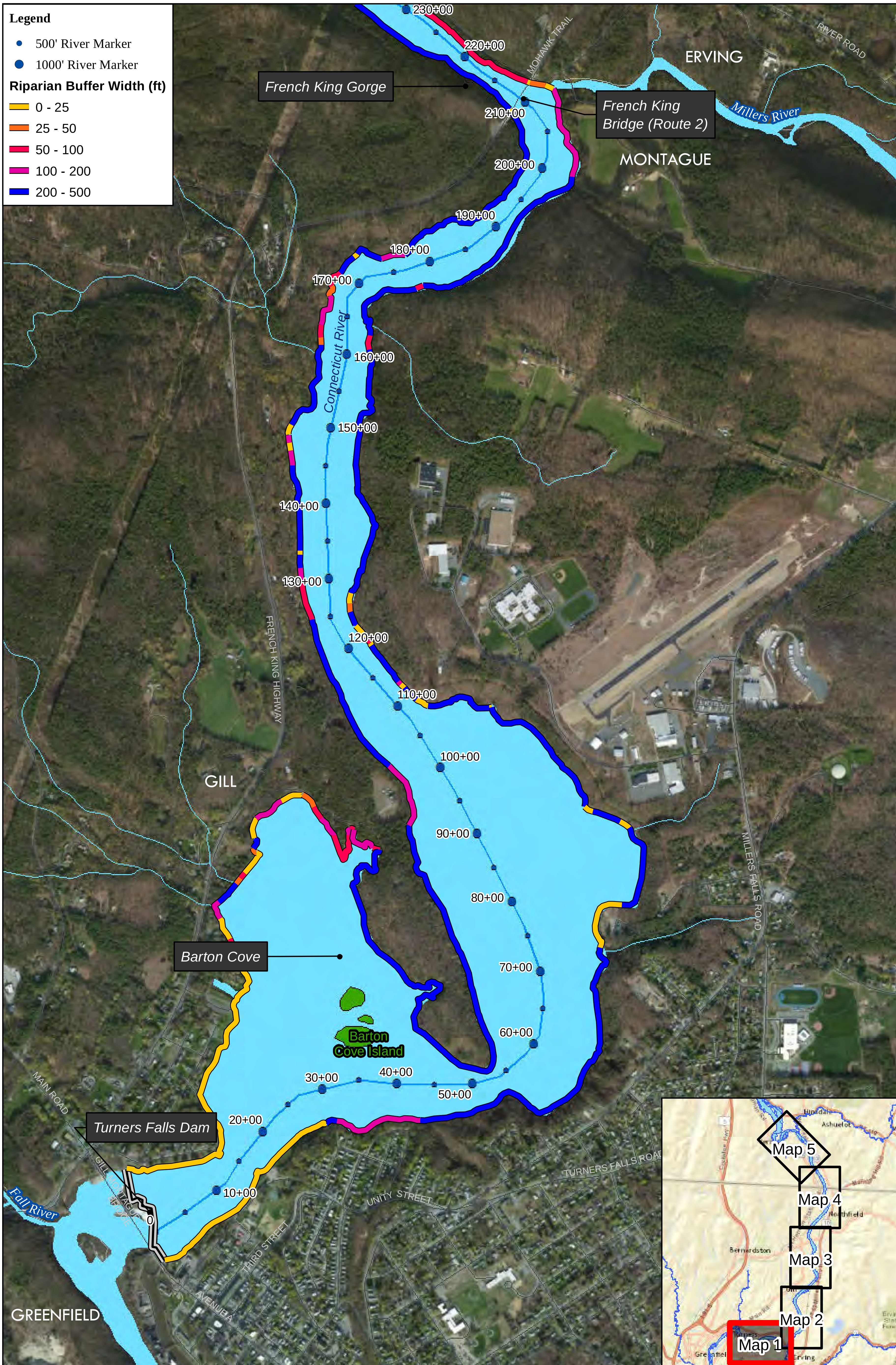

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Riparian Buffer Widths
within 200 ft of Connecticut River
Map 1

0 625 1,250 2,500 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan,

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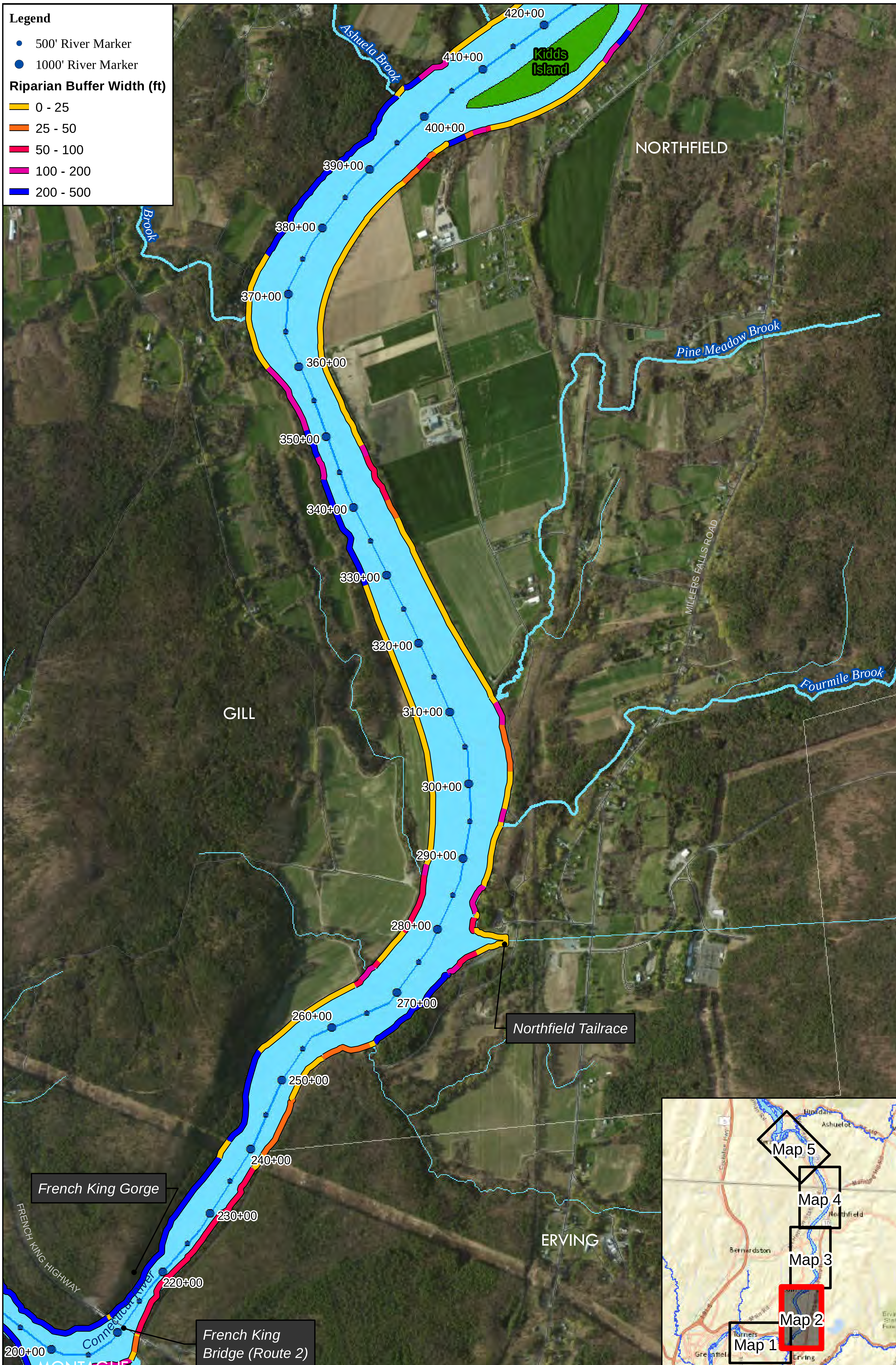

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1

NORTHFIELD MOUNTAIN/TURNERS FALLS

FULL RIVER RECONNAISSANCE

Riparian Buffer Widths
within 200 ft of Connecticut River
Map 2

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N

0 625 1,250 2,500 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan,

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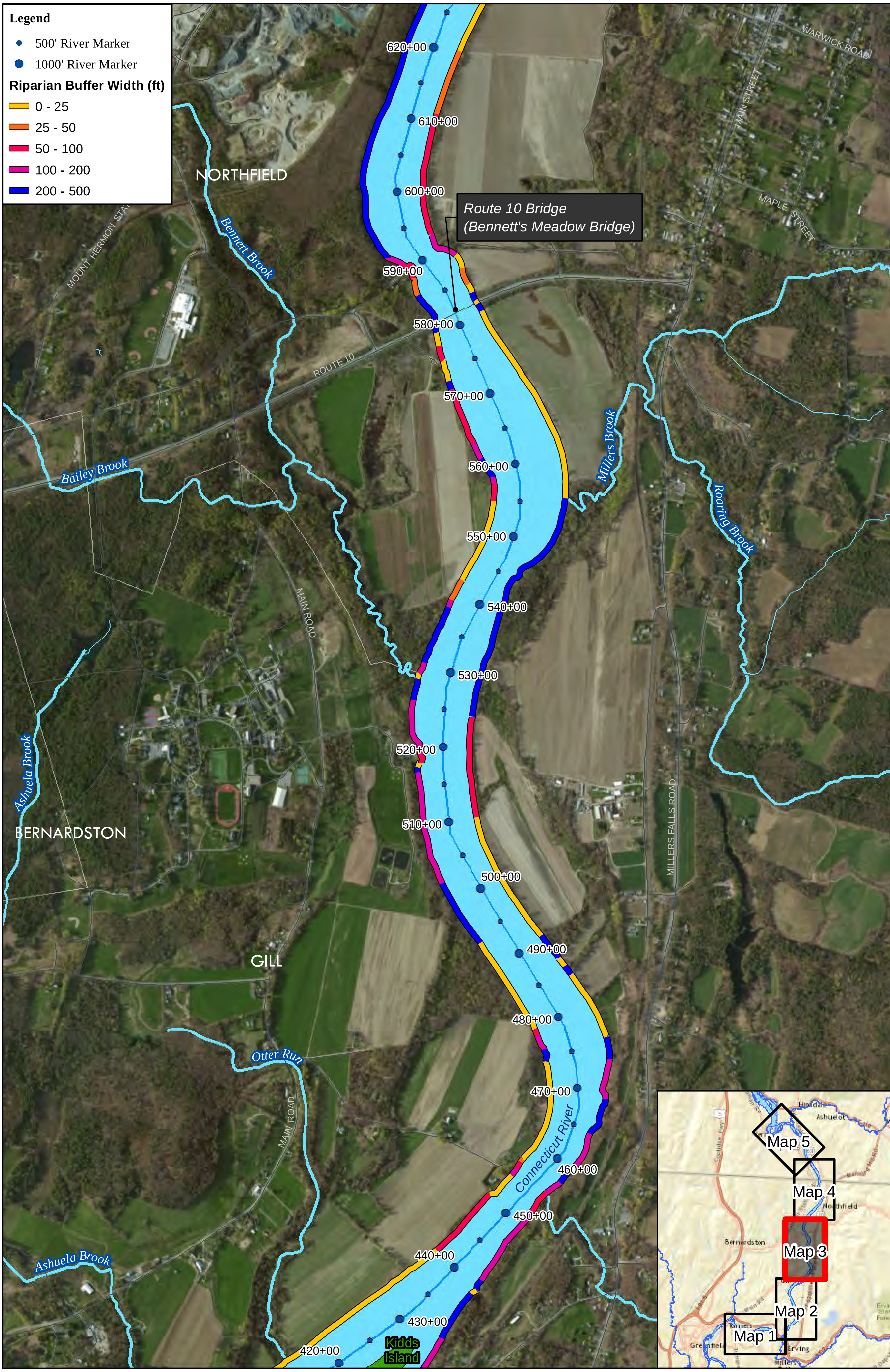

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Riparian Buffer Widths
within 200 ft of Connecticut River
Map 3

N

0 625 1,250 2,500 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan,

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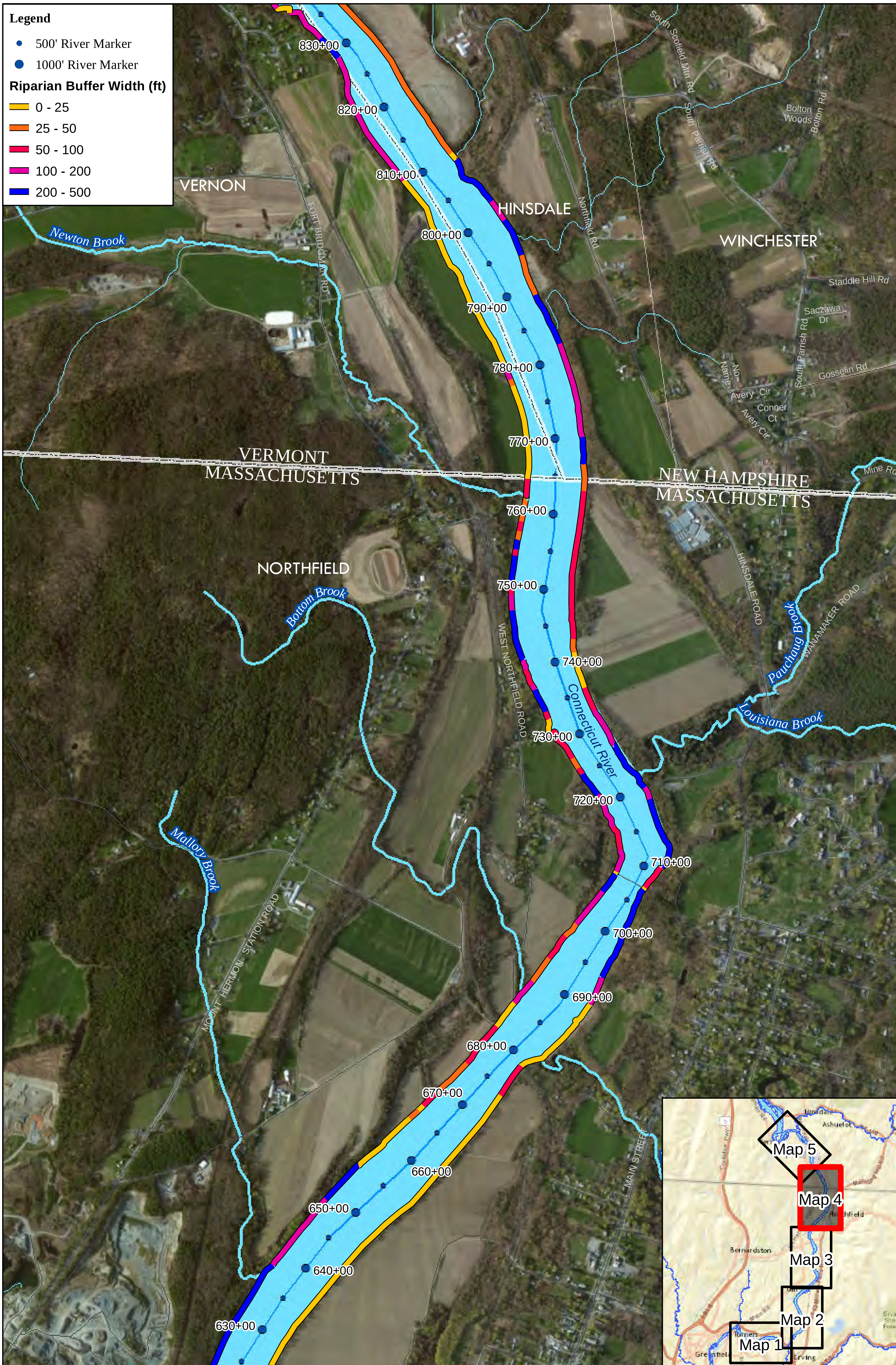

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Riparian Buffer Widths
within 200 ft of Connecticut River
Map 4

N

0 625 1,250 2,500 Feet

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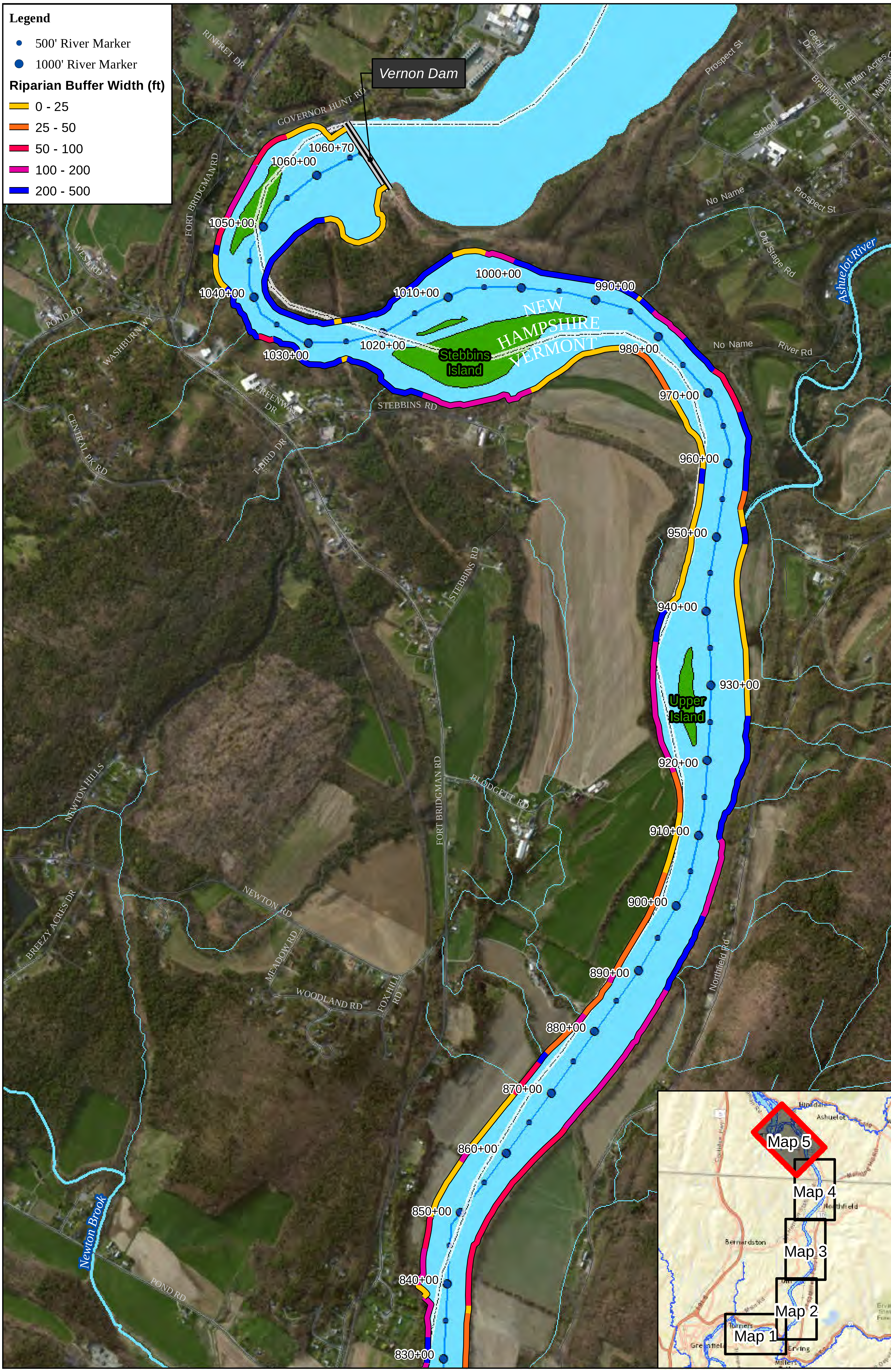

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Riparian Buffer Widths
within 200 ft of Connecticut River
Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan,

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APPENDIX F – UPPER/LOWER RIVERBANK DEFINITION

APPENDIX F – Upper/Lower Riverbank Definition

Introduction

As agreed upon at the Stakeholder consultation meeting held on June 24, 2014 at the Northfield Mountain Visitor Center, FirstLight is providing clarification on the working definitions of the Turners Falls Impoundment upper and lower riverbanks as used in Study No. 3.1.1 *Full River Reconnaissance* and Study No. 3.1.2 *Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability*.

The definitions outlined below are the working definitions. These definitions were developed based on observations made in the field combined with the professional experience of FirstLight's team of experts on various rivers across the country. It is anticipated that these definitions will continue to evolve and be refined during the field work associated with Study No. 3.1.2 (i.e. determination of actual elevations in the field).

The definitions do not necessarily correspond to regulatory definitions used in state and federal environmental regulations. For example, the definition of "bank" used in this document may be broader than the regulatory definitions of bank used in the Massachusetts wetlands protection act rules at 310 CMR 10. FirstLight believes using non-regulatory definitions is appropriate at this stage because the intent of Study No. 3.1.2 is not to assess erosion solely on "banks" as defined in the regulations but rather to take a more holistic view of the river system. FirstLight agrees that the regulatory definitions will ultimately be important during relicensing and will work with state and federal regulatory agencies and affected stakeholders in that regard.

Lower Riverbank

The lower riverbank in the Turners Falls Impoundment is defined as that portion of the bank that is frequently below water, typically lies at a relatively flat slope, and is mostly barren of vegetation other than some scattered aquatic vegetation. The lower riverbank may be completely inundated, partially inundated, or mostly exposed at a given time depending on Impoundment water levels. Riverbank features and characteristics (e.g. slope, sediment, and vegetation) are often found to be more uniform along the lower riverbank than the upper riverbank although sediment can vary depending on location along the river (e.g. silt/sand, bedrock, riprap, etc.). Figures 1-6 provide examples of typical lower riverbanks found in the Impoundment.

Upper Riverbank

The upper riverbank in the Turners Falls Impoundment is defined as that portion of the bank that is frequently above water but can be inundated during high flows. The upper riverbank supports various types of terrestrial vegetation and can exhibit a wide range of riverbank features and characteristics (e.g. slope, height, vegetation, and erosion conditions). Slopes often range from Moderate to Overhanging with vegetation ranging from Sparse to Heavy. Silt/Sand is typically the dominant sediment type found along the upper riverbanks. Figures 1-6 provide examples of typical upper riverbanks found in the Impoundment.

Lower to Upper Riverbank Transition

The transition point from the lower to upper riverbank is often pronounced, easily identifiable in the field, and easily captured via standard mapping techniques. The lower riverbank is typically flat with little to no vegetation while the upper riverbank has moderate to overhanging slopes with sparse to heavy vegetation. The sharp contrast in features and characteristics often found between the upper and lower riverbanks typically, but not always, make the transition point easily identifiable. Figures 1-6 provide examples of this transition.

Figure 1. Riverbank Cross-Section – Example 1

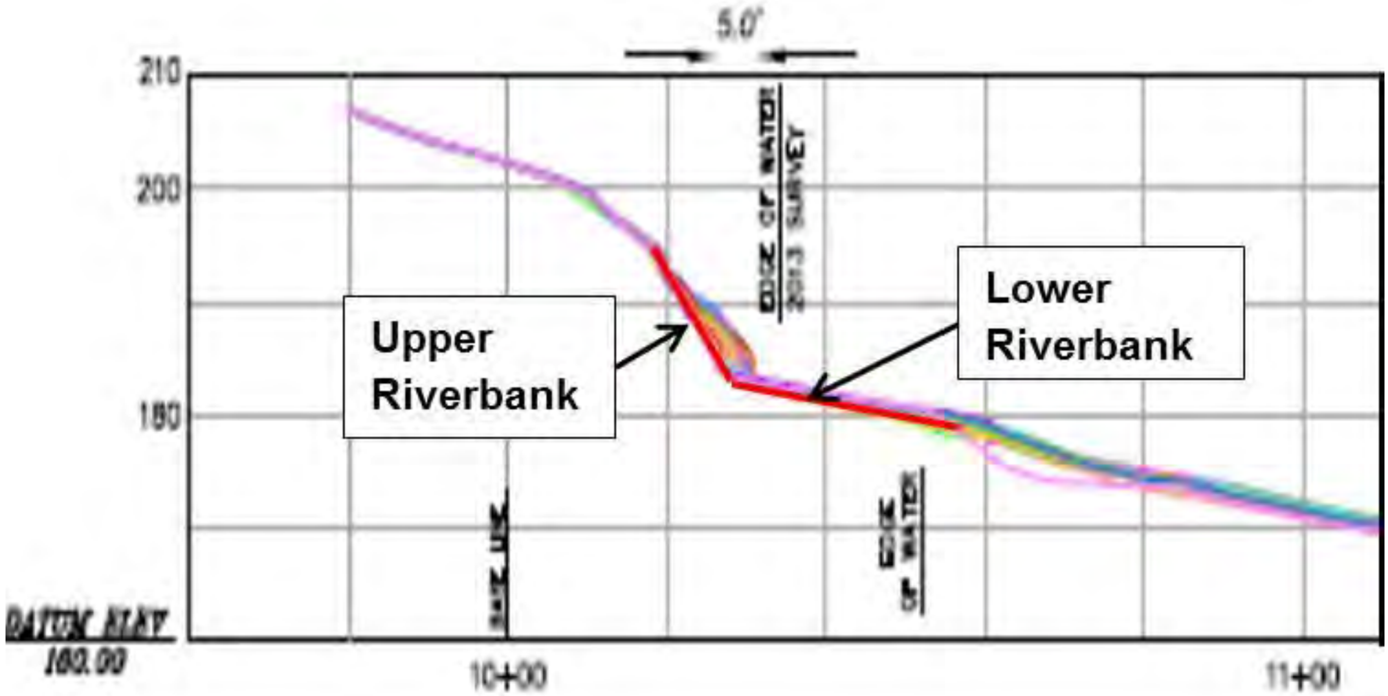


Figure 2. Riverbank Cross-Section – Example 2

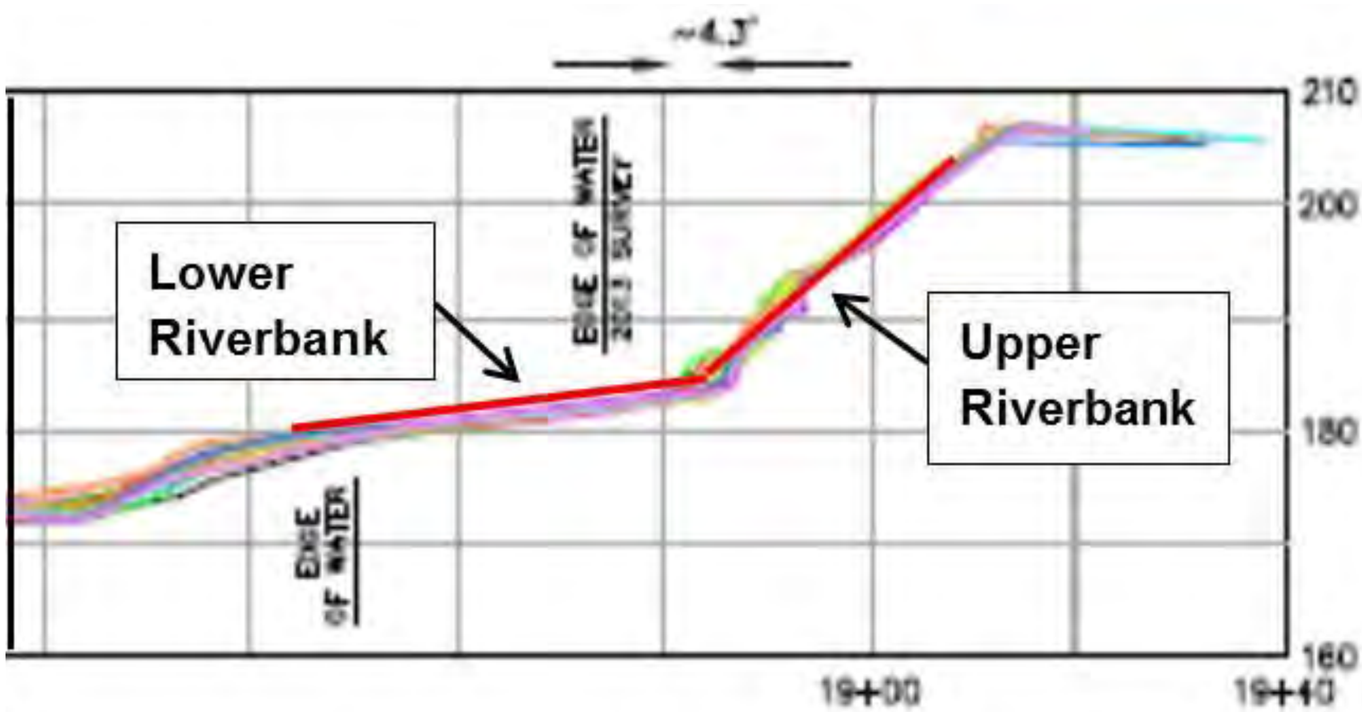


Figure 3. Upper vs. Lower Riverbank – Example 1

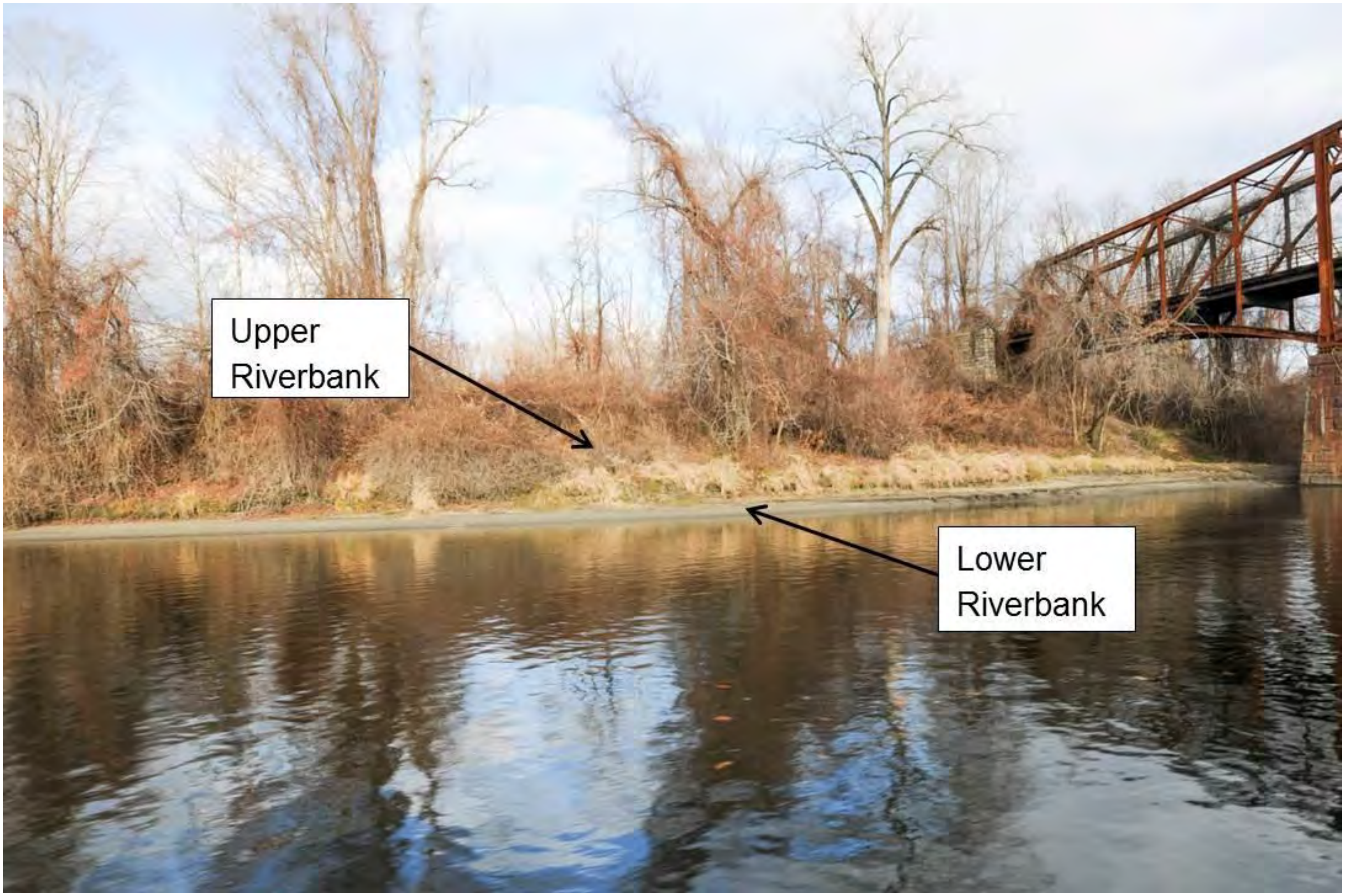


Figure 4. Upper vs. Lower Riverbank – Example 2

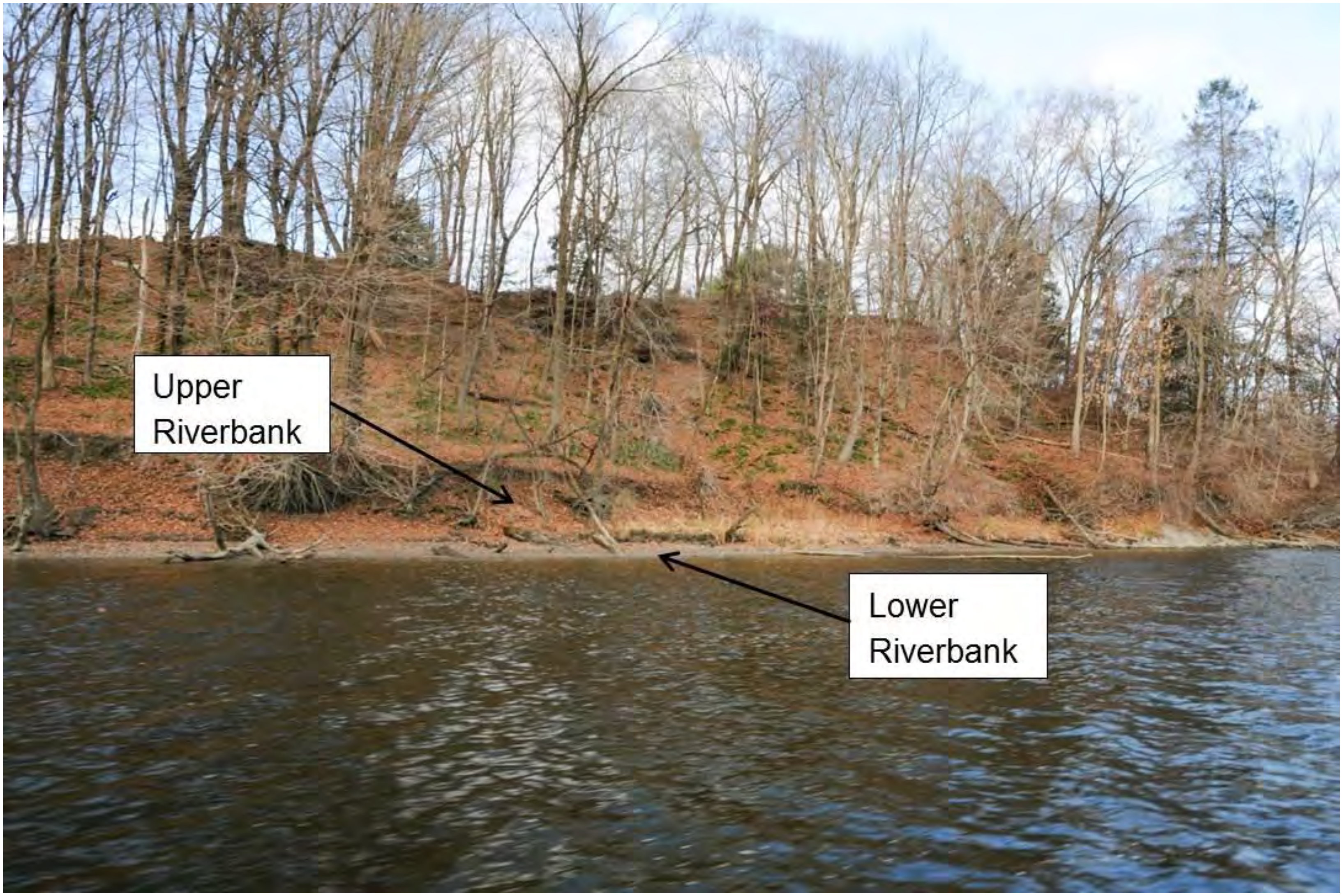


Figure 5. Upper vs. Lower Riverbank – Example 3

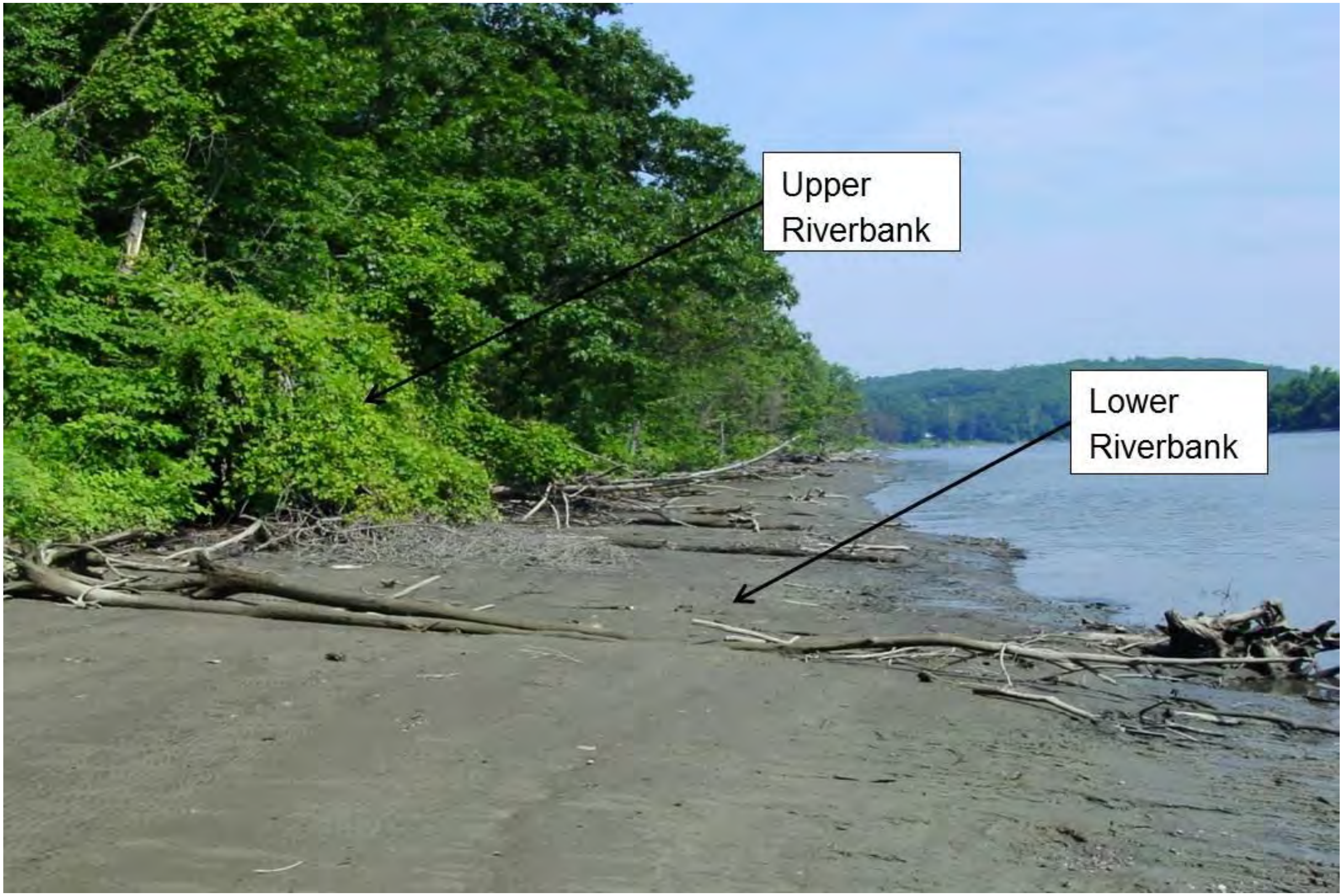
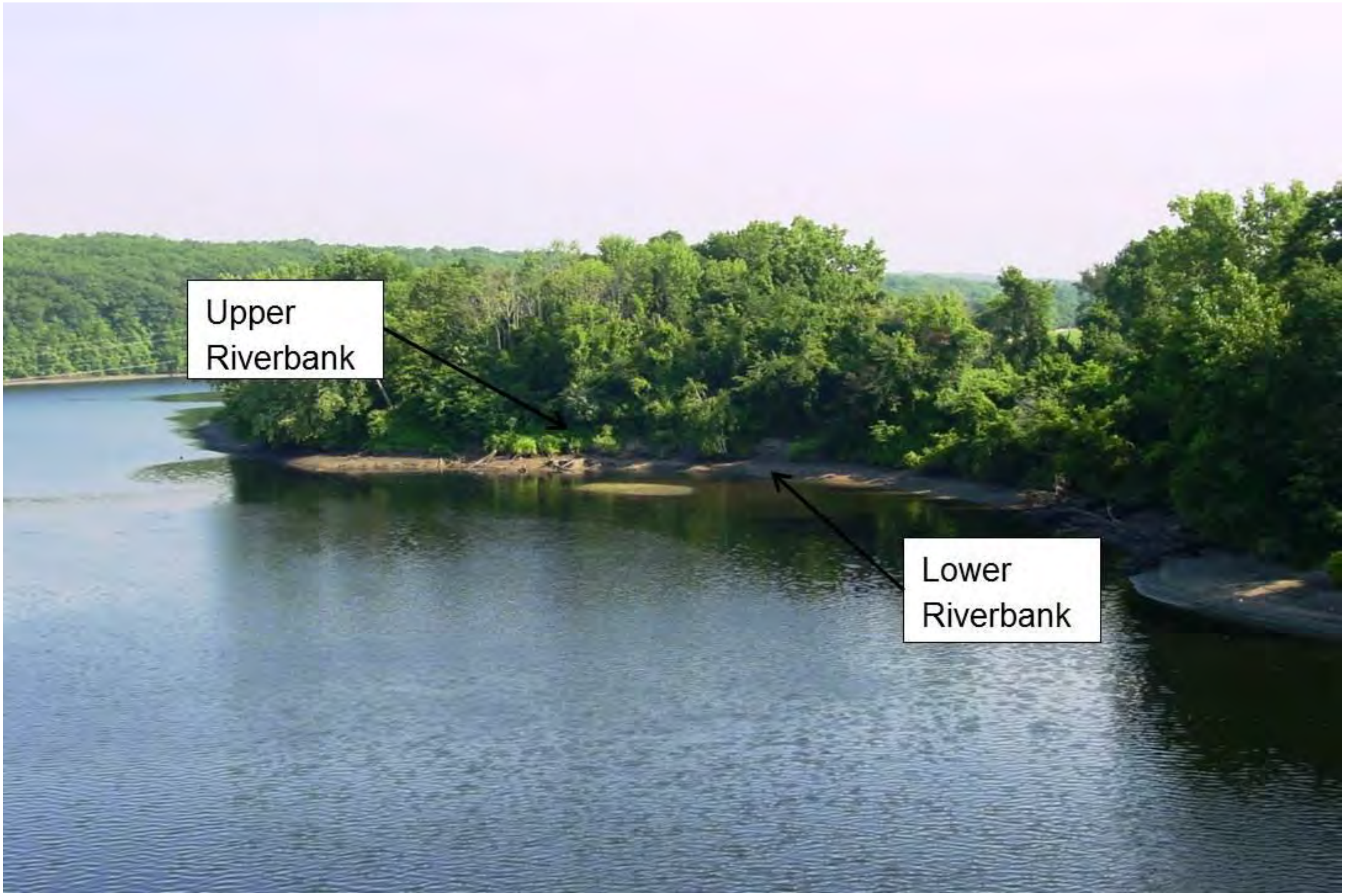
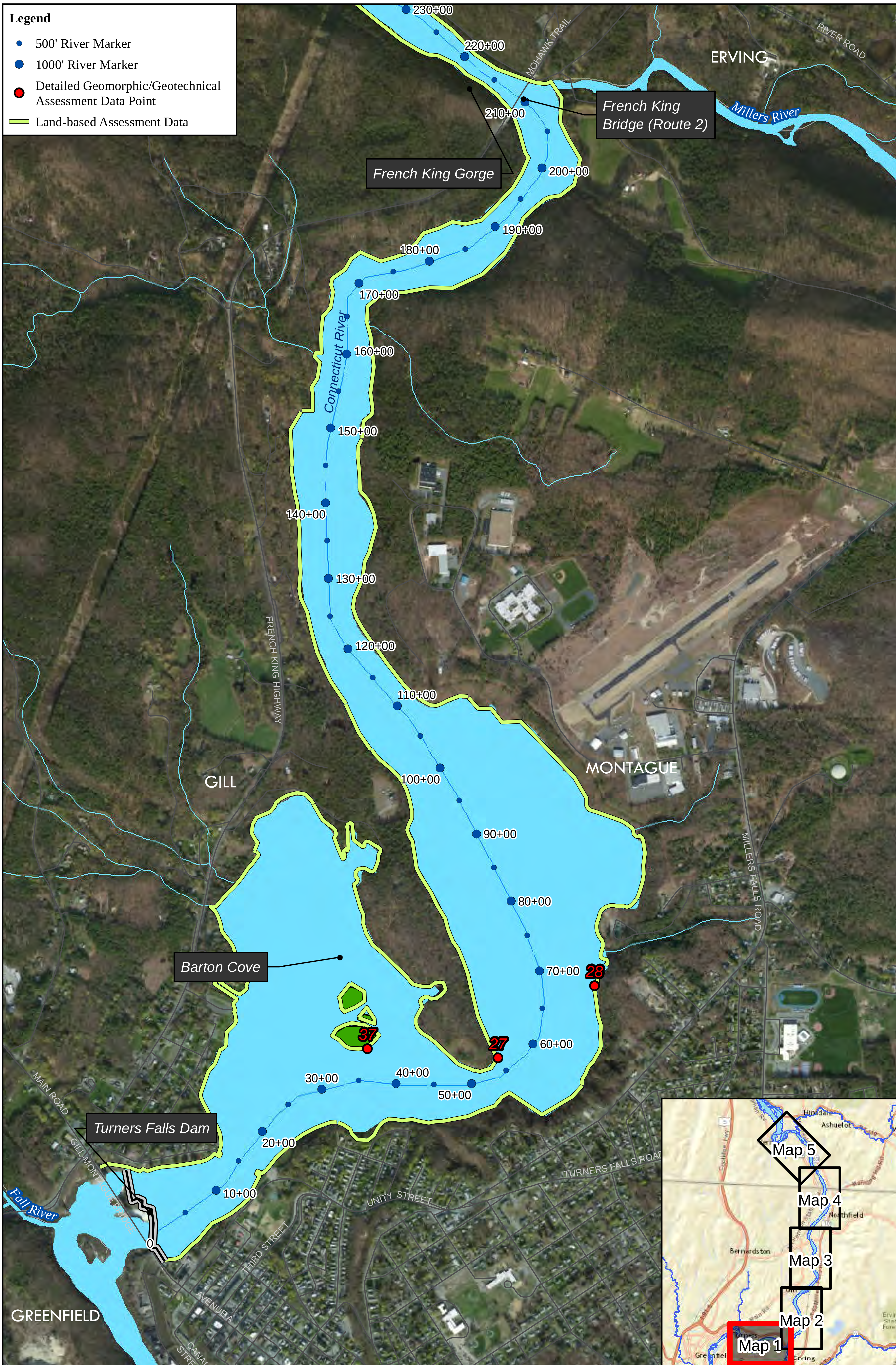


Figure 6. Upper vs. Lower Riverbank – Example 4



APPENDIX G – LAND AND BOAT-BASED SURVEY RIVERBANK SEGMENT MAPS



FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1

NORTHFIELD MOUNTAIN/TURNERS FALLS

FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Land Based Survey

Map 1

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Land Based Survey
Map 2

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Land Based Survey
Map 3

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500
Feet

Land Based Survey
Map 4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 625 1,250 2,500 Feet

Land Based Survey
Map 5

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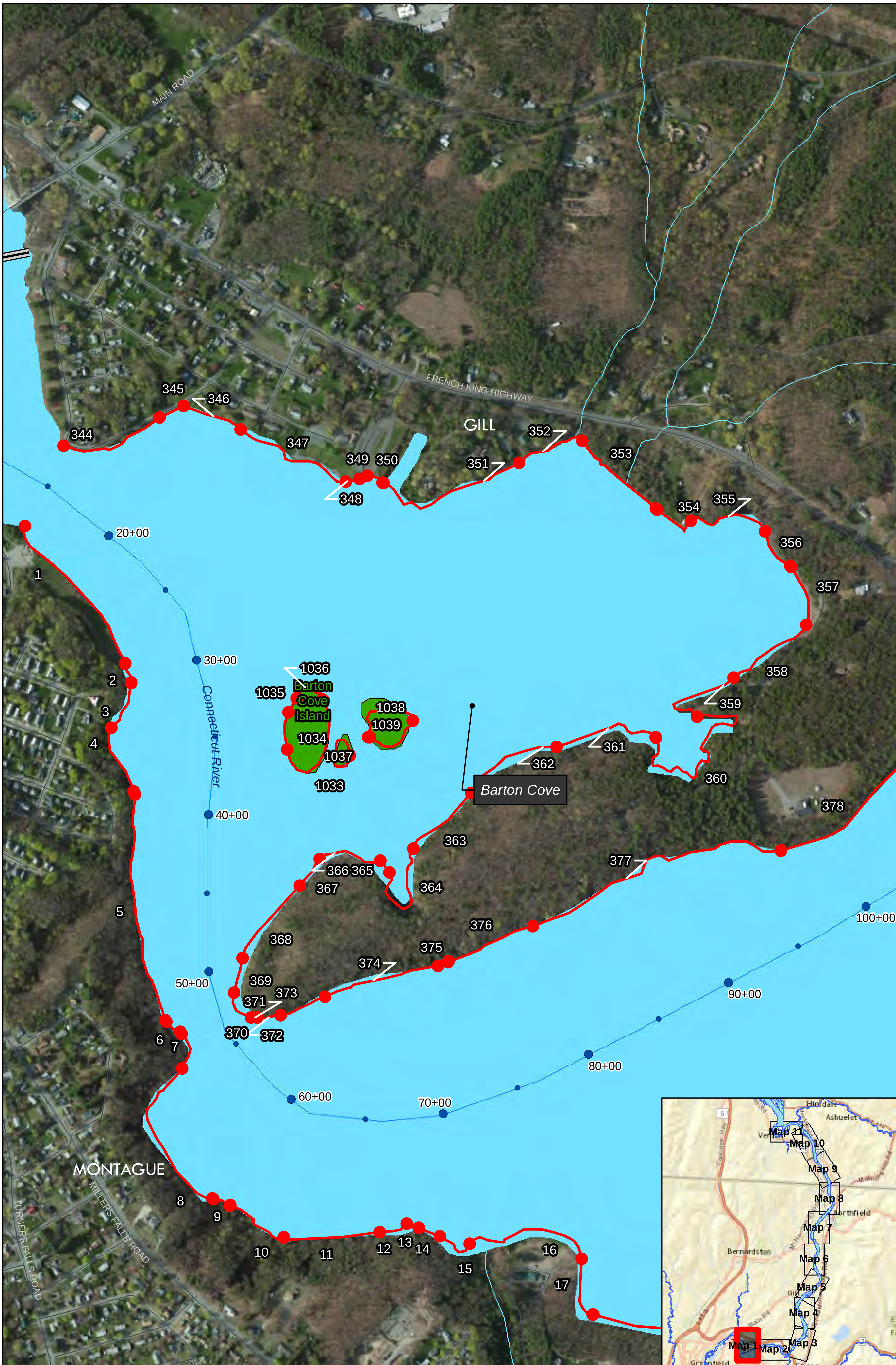

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 300 600 1,200 Feet

Boat Based Survey
Map 1

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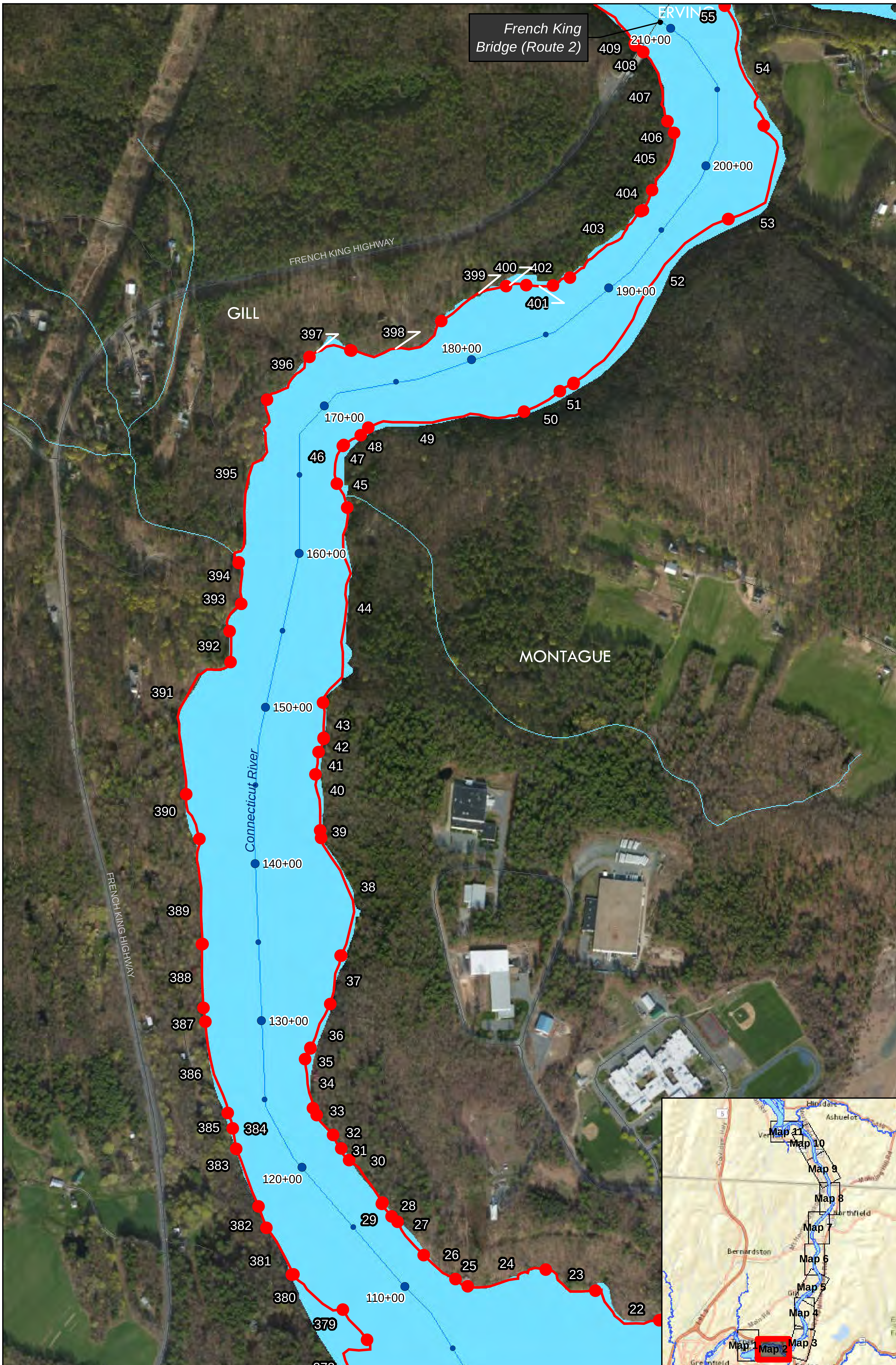

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Boat Based Survey
Map 2

0 300 600 1,200 Feet

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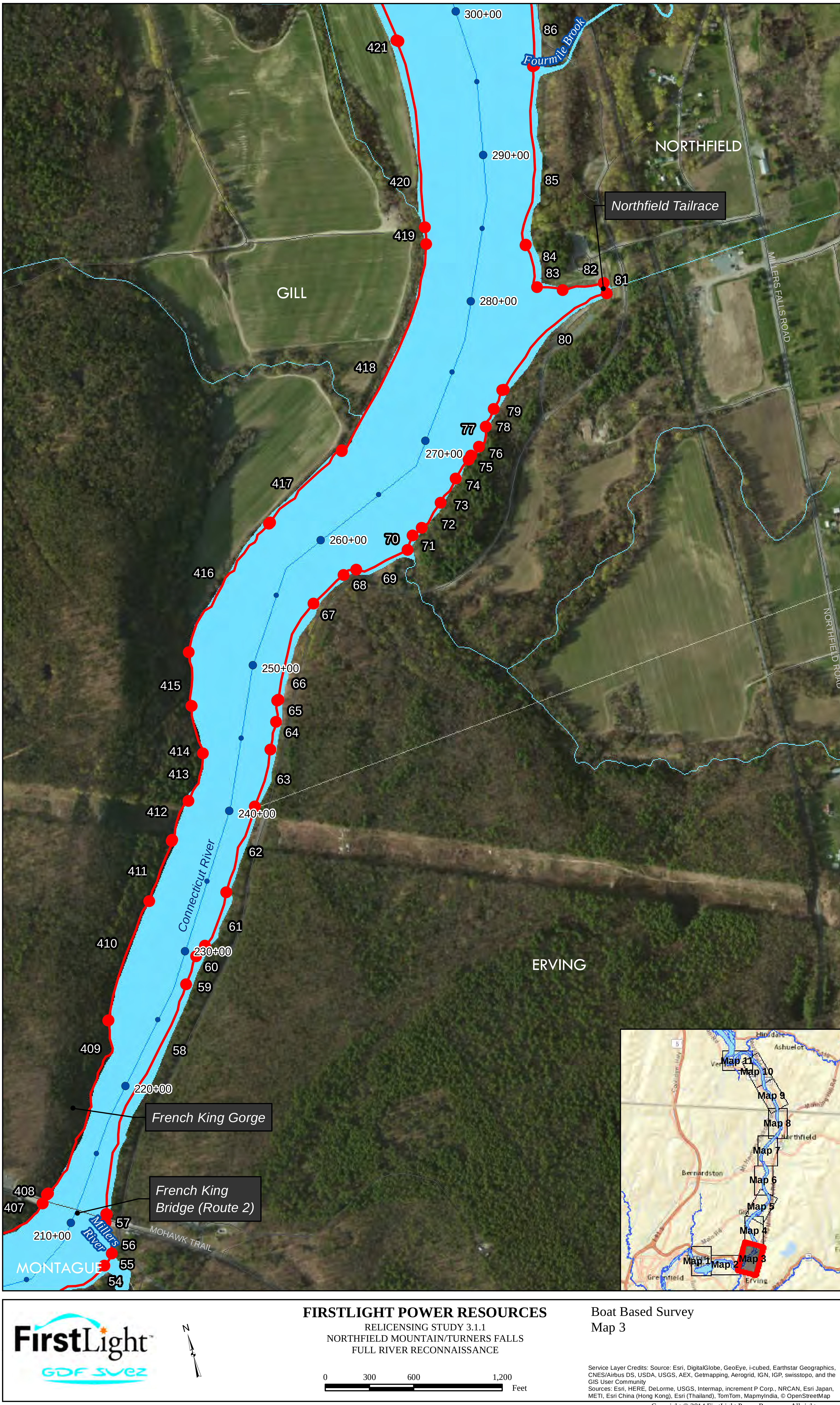

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Boat Based Survey
Map 3

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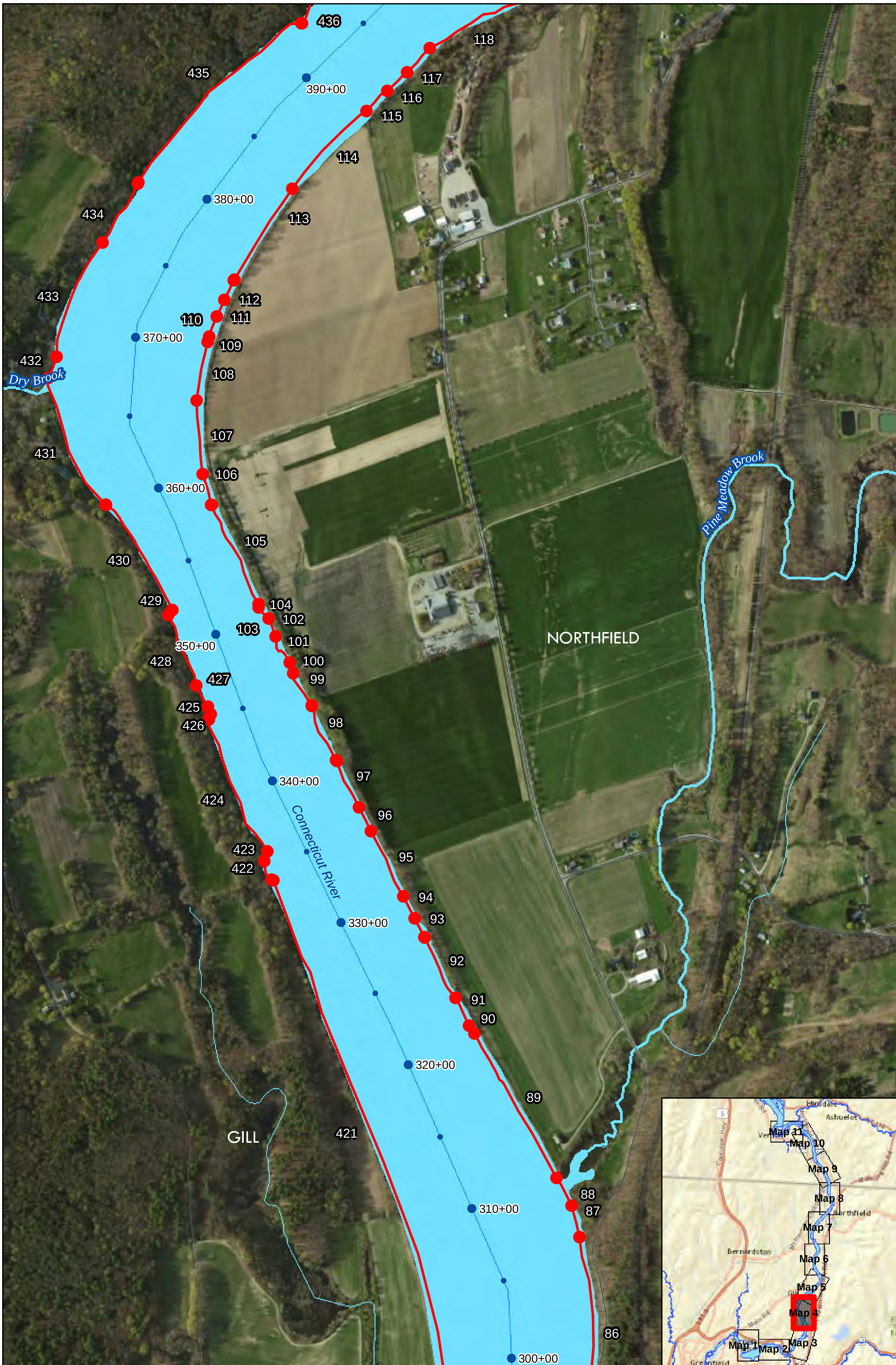

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 300 600 1,200
Feet

Boat Based Survey
Map 4

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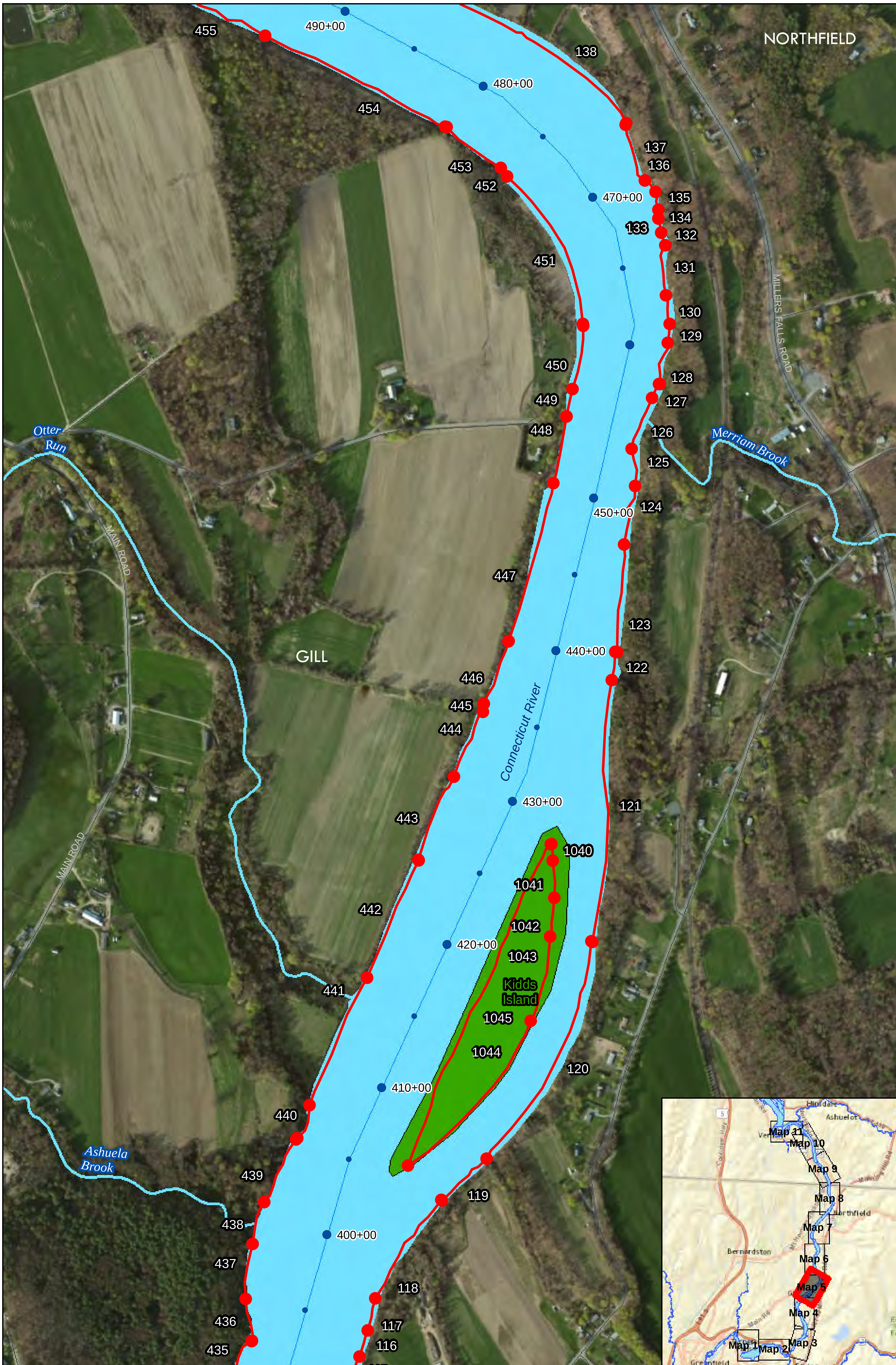

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 300 600 1,200 Feet

Boat Based Survey
Map 5

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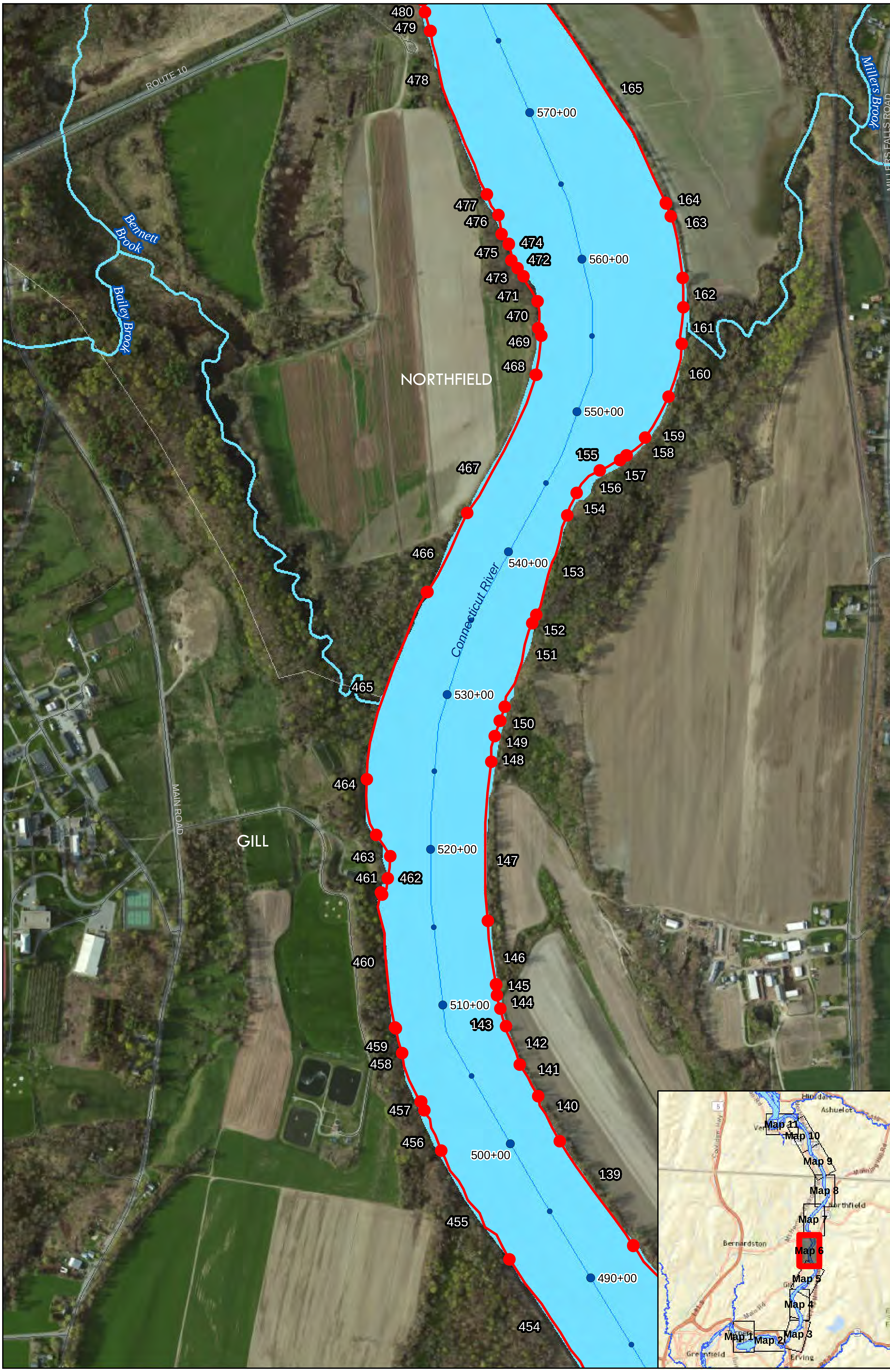

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Boat Based Survey
Map 6

N

0 300 600 1,200 Feet

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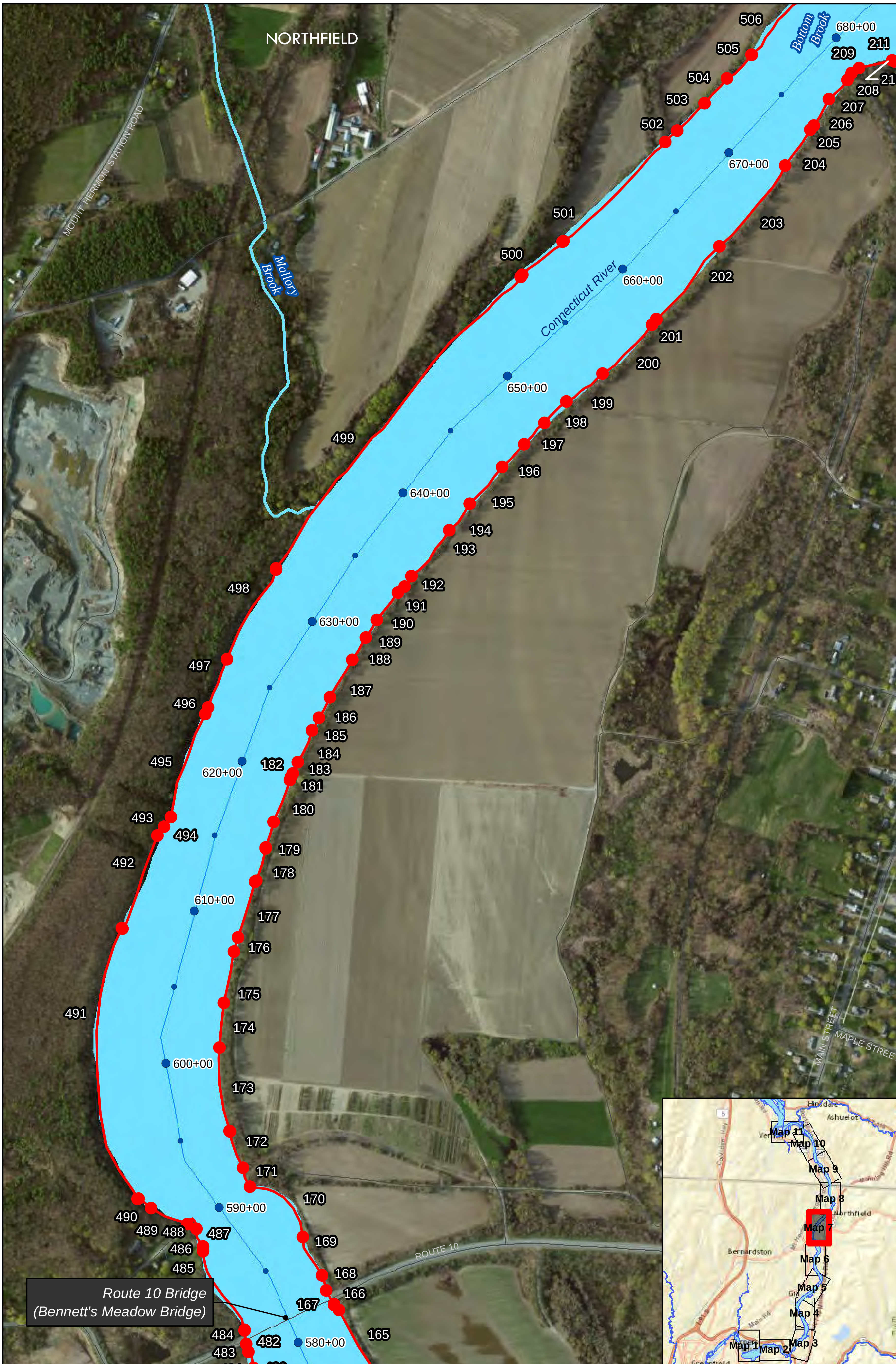

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 300 600 1,200 Feet

Boat Based Survey
Map 7

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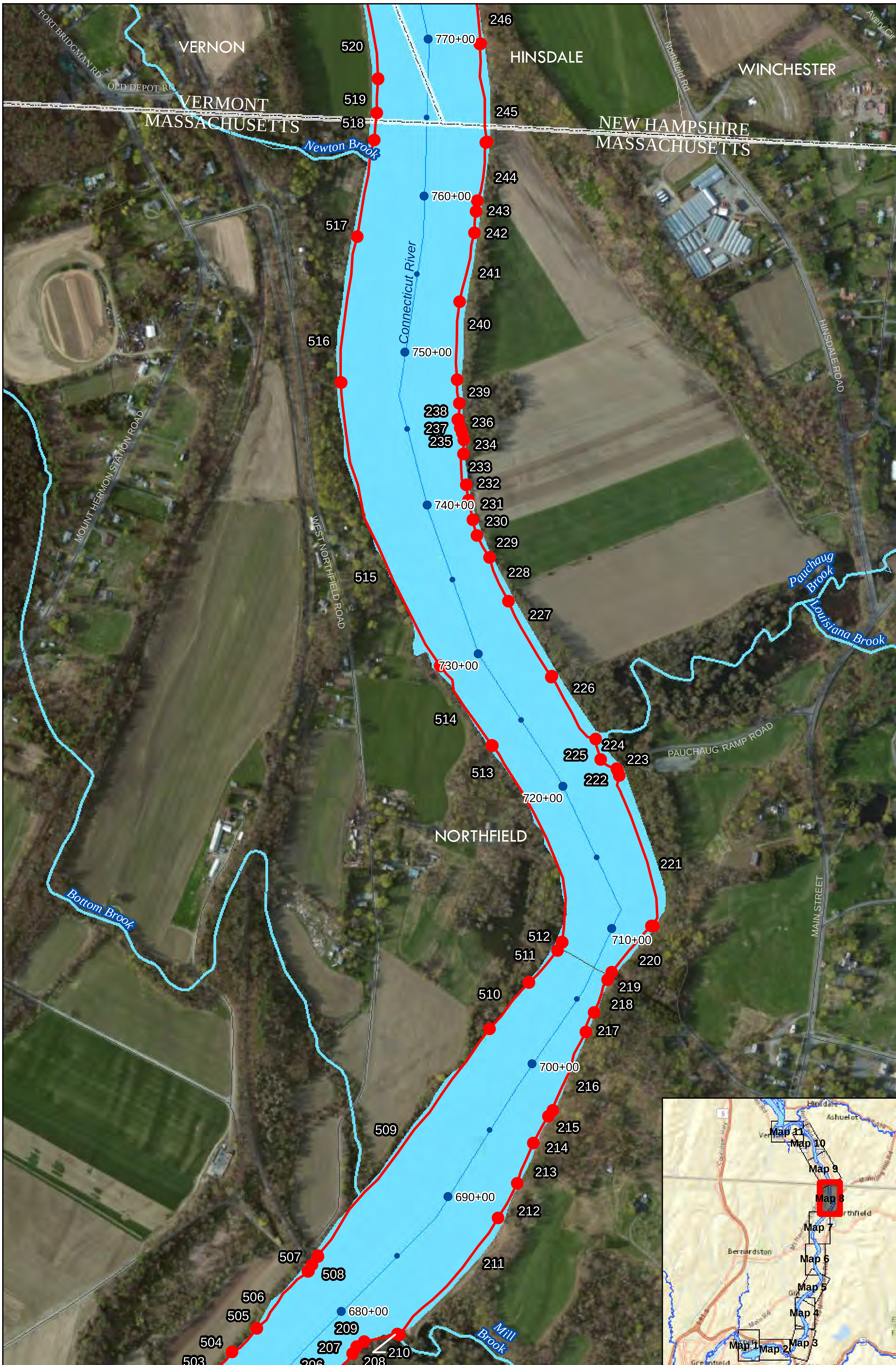

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Boat Based Survey
Map 8

N

0 300 600 1,200 Feet

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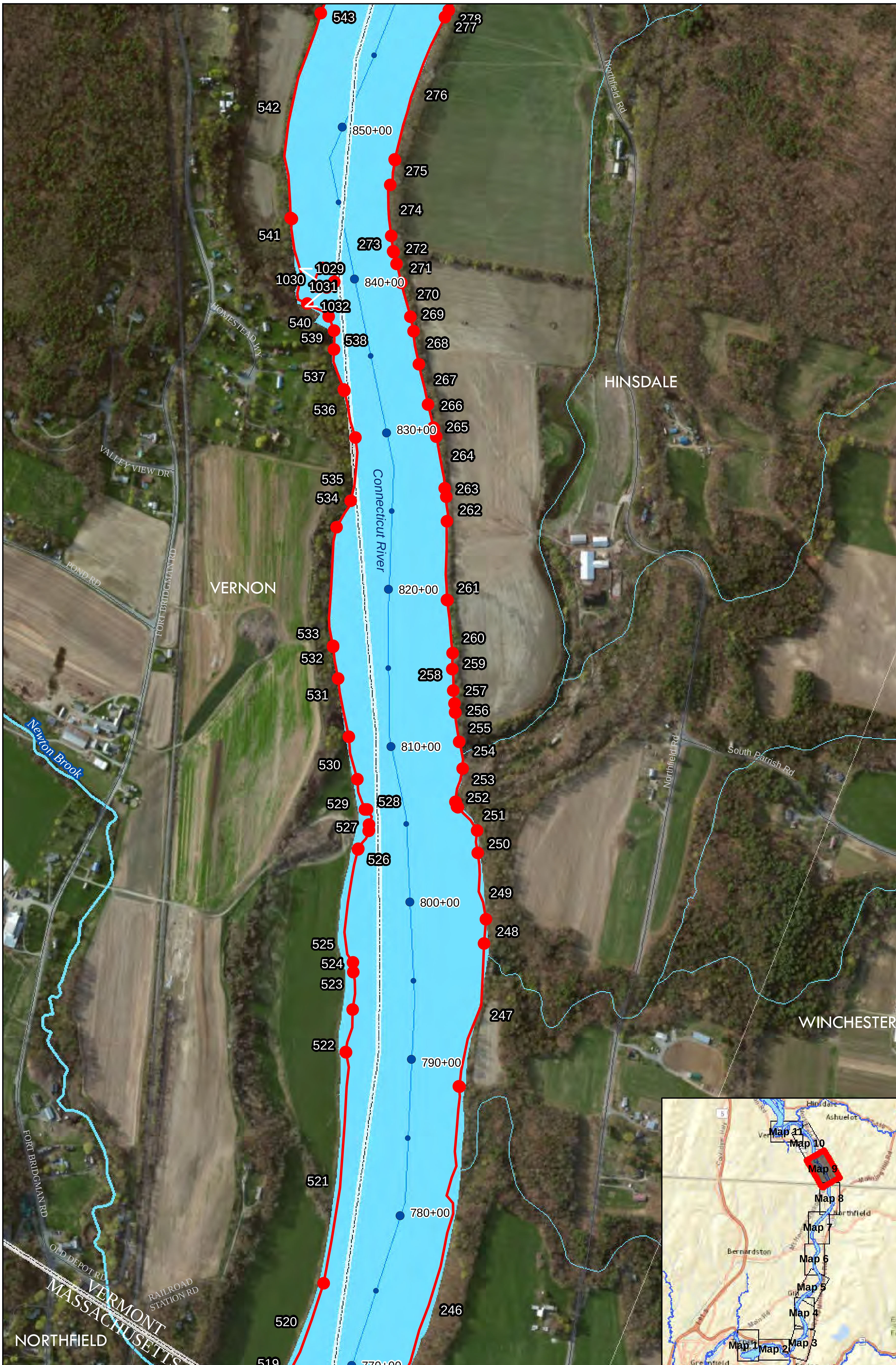

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 300 600 1,200 Feet

Boat Based Survey
Map 9

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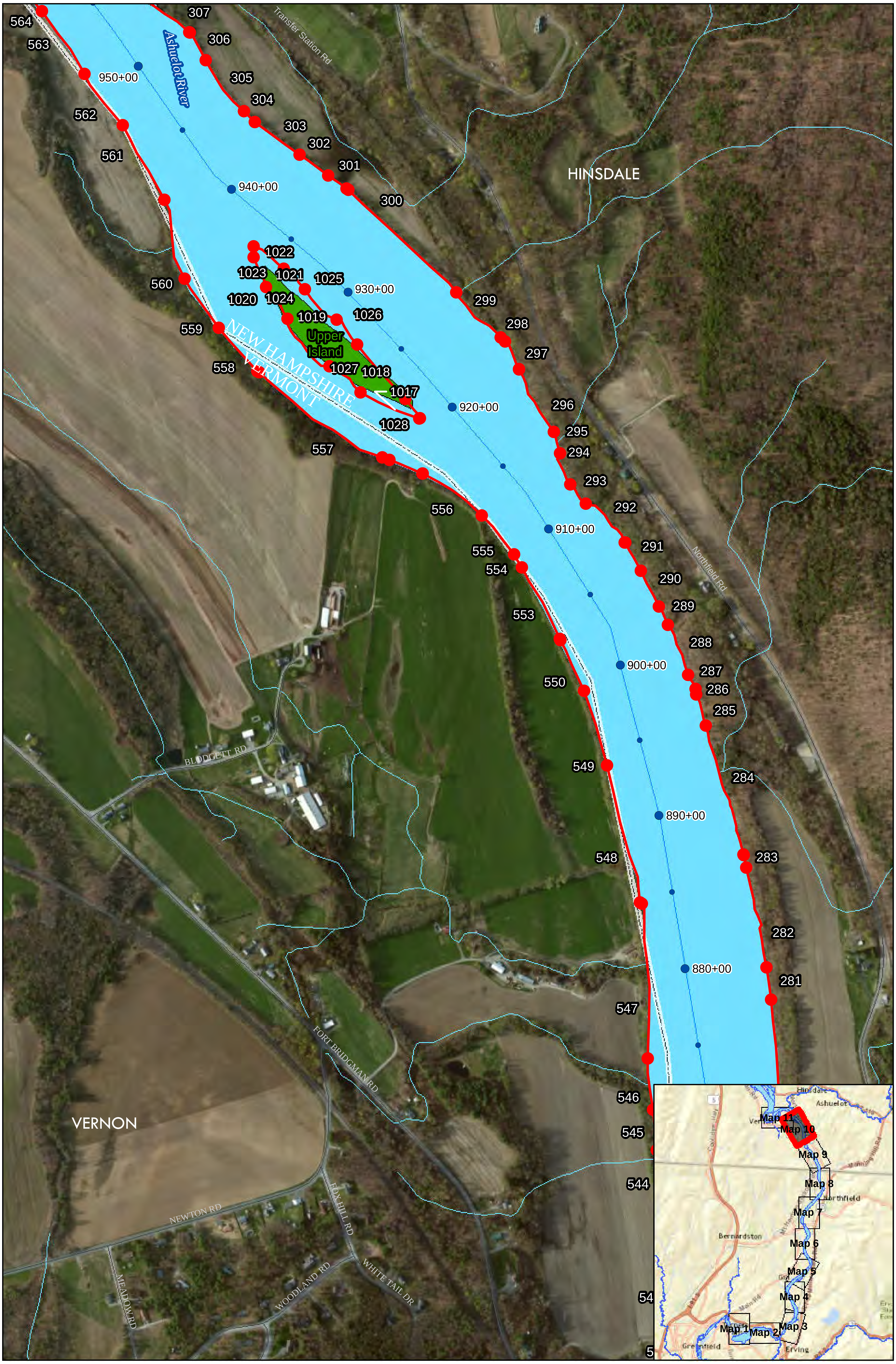

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 300 600 1,200 Feet

Boat Based Survey
Map 10

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 300 600 1,200 Feet

Boat Based Survey
Map 11

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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APPENDIX H – DETAILED GEOTECHNICAL/GEOMORPHIC SITE ASSESSMENT DATASHEETS & PHOTOS

Synopsis of Land-Based Observations
2013 Connecticut River Full River Reconnaissance

Observation Point No. (Note 3)	Date	Station (Note 1)	Photo Reference No.	Left or Right Bank (Note 2)	Previously Stabilized?	Representative Segment Length, Station Range
1	11/12/13	960+00	521 – 525 (YKC)	Left	No	955+00 to 970+00
2	11/12/13	989+00	526 – 531 (YKC)	Left	No	986+00 to 1015+00
3	11/12/13	1060+00	536 - 543 (YKC)	Left	No	1058+00 to 1060+70
4	11/12/13	1028+00	545 - 548 (YKC)	Left	No	See Note 4
5	11/13/13	295+00	549 - 551 (YKC)	Left	Yes	310+00 to 330+00
6	11/13/13	350+00	552 - 559 (YKC)	Left	No	334+00 to 385+00
7	11/13/13	385+00	560 - 562 (YKC)	Left	Yes	385+00 to 390+00
9	11/13/13	435+00	568 - 575 (YKC)	Left	No	420+00 to 475+00
10	11/13/13	484+00	576 - 580 (YKC)	Left	No	480+00 to 490+00
11	11/13/13	505+00	581 - 588 (YKC)	Left	No	490+00 to 555+00
12	11/14/13	589+00	603 - 608 (YKC)	Left	No	581+00 to 590+00
13	11/14/13	604+00	609 - 614 (YKC)	Left	No	590+00 to 680+00
14	11/14/13	726+00	622 - 625 (YKC)	Left	No	710+00 to 730+00
15	11/14/13	765+00	626 - 630 (YKC)	Left	No	740+00 to 770+00
16	11/15/13	830+00	634 - 637 (YKC)	Left	No	810+00 to 865+00
17	11/15/13	835+00	638 - 641 (YKC)	Left	No	810+00 to 865+00
18	11/15/13	870+00	642 - 646 (YKC)	Left	No	867+00 to 925+00
19	11/15/13	947+50	647 - 651 (YKC)	Left	Yes	930+00 to 950+00
20	11/15/13	937+00	652 - 656 (YKC)	Right	No	See Note 5
21	11/15/13	792+50	664 - 668 (YKC)	Right	No	765+00 to 795+00
22	11/16/13	260+00	674 - 683 (YKC)	Right	Yes	250+00 to 285+00
23	11/16/13	321+00	684 – 690, 698 (YKC)	Right	Yes	310+00 to 360+00
24	11/16/13	336+00	691 – 696, 698 - 699 (YKC)	Right	No	336+00 to 351+00
25	11/16/13	410+00	705 - 710 (YKC)	Right	Yes	408+00 to 415+00
26	11/16/13	485+00	712 - 716 (YKC)	Right	No	475+00 to 518+00
27	11/17/13	62+00	717 - 725 (YKC)	Right	Yes	57+00 to 90+00
28	11/17/13	65+00	727 - 734 (YKC)	Left	Yes	59+00 to 70+00
29	11/19/13	659+00	740 - 744 (YKC)	Right	No	640+00 to 680+00
30	11/19/13	1052+00	745 - 748 (YKC)	Right	No	1042+00 to 1059+00
31	11/19/13	982+00	749 - 751 (YKC)	Right	No	982+00 to 960+00
32	12/10/13	1053+00	56-60 (CM)	Island	No	1052+00 to 1057+00
33	12/10/13	1046+50	61-62 (CM)	Island	No	1045+00 to 1050+00
34	12/10/13	1000+00	72-74 (CM)	Island	No	989+00 to 1015+00
35	12/12/13	271+00	75-78 (CM)	Left	No	265+00 to 274+00
36	12/12/13	685+00	88-90 (CM)	Right	No	680+00 to 710+00
37	6/4/2014	37+50	125-126 (CM)	Island	No	35+00 to 40+00
38	6/10/2014	415+00	1010054-1010066 (CM)	Island	No	410+00 to 420+00

Notes: (1) Station is measured in feet, with Station 0+00 at Turners Fall Dam, increasing upstream.

(2) Left and right bank is referenced facing downstream.

(3) No land-based observation form was completed for Point No. 8.

(4) Observation point represents 100-foot-wide corridor within power transmission line.

(5) Observation point was selected just upstream of Upper Island where river has wider cross section.

Table H.2
Erosion Features & Exposed Soils at Detailed Site Assessment Locations

Observation Point No. (Note 3)	Station (Note 1)	Left or Right Bank (Note 2)	Previously Stabilized?	Observed Erosion Features	Geotechnical Observations
1	960+00	Left	No	• Near-vertical erosion scarps at bottom of Upper Bank, 5' to 10' high (typical) • Some erosion gullies, 3' to 5' deep at mid-slope of Upper Bank. • Some down timber and leaning trees at river level, with exposed roots. • Slumping and mass-wasting	SANDY SILT (ML), SILTY FINE SAND (SM)
2	989+00	Left	No	• Steep slopes on Upper Bank • Overhangs and undercuts near bottom of Upper Bank at river level • Exposed roots under overhangs • Down timber and/or leaning trees near river level.	SILTY FINE SAND (SM), VARVED CLAY (CL, ML), SAND (SW) & GRAVEL (GW) bar
3	1060+00	Left	No	• Steep slopes with sparse vegetation along entire slope. • Step-like benches on lower 10' of slope. • Some down timber and small leaning trees at lower portion of slope.	SAND (SP), SAND WITH SILT (SP-SM), CLAY (CL-CH), SAND (SP) and GRAVEL (GP) beach
4	1028+00	Left	No	• Minor localized bank erosion near river level. • Ground surface was hummocky at shoreline, but no vertical scarps. • Near vertical erosion scarp near the top of slope, just below power line.	SAND (SP), CLAY (CL, CH)
5	295+00	Left	Yes	• Shallow erosion just above riprap where roots from vegetation were lacking.	SILT (ML), SAND (SP), sound riprap with little displacement or deterioration
6	350+00	Left	No	• Near-vertical scarps, with several intermediate benches from mass-wasting and slumping. • Some down timber and leaning trees. • Little grass, but some shrubs between trees • Some exposed tree roots on upper scarps near top of bank.	SILT (ML)

Observation Point No. (Note 3)	Station (Note 1)	Left or Right Bank (Note 2)	Previously Stabilized?	Observed Erosion Features	Geotechnical Observations
7	385+00	Left	Yes	• Little to no erosion. Stabilization appeared to be performing well.	Upper bank soils not observed. Some recent sediments (ML) along shoreline. Riprap toe in good conditions.
9	435+00	Left	No	• Near-vertical scarps up to about 8' high from river level, with undercuts. • Leaning trees to down timber, with exposed tree roots along erosion scarps. • A relatively flat bench at about mid-slope, may be from mass-wasting and slumping.	SILT (ML), SAND (SP)
10	484+00	Left	No	• Little to no erosion. Flat bench just above river completely covered with cattails and native grass.	SILT (ML)
11	505+00	Left	No	• Erosion scarps just below top of bank, very steep. • Exposed roots. • Some trees with bent trunks, may be indication of land creep. • Down timber	SILT (ML), some recent sediments (ML)
12	589+00	Left	No	• Overhangs near top of bank. • Tension cracks near toe of bank in slumped materials • Slumping and falls of materials • Near vertical scarps near bottom of Upper Bank. • Down timber and small live trees with bent trunks.	SANDY SILT (ML). Apparent bank barb at right bank.
13	604+00	Left	No	• Terraced with near-vertical scarps entire slope. • Numerous exposed roots, especially near toe of Upper Bank, with undercuts under root zones & root wads. • Leaning trees and down timber. • Some slumping of materials near toe of Upper Bank	SILT (ML), SAND (SP) beach
14	726+00	Left	No	• Little to no erosion • Well-established native grass and trees in recent sediment terrace	SILT (ML). Recent sediment near shoreline.

Observation Point No. (Note 3)	Station (Note 1)	Left or Right Bank (Note 2)	Previously Stabilized?	Observed Erosion Features	Geotechnical Observations
15	765+00	Left	No	• Mass-wasting and slumping along entire bank. • Near-vertical scarps near top of bank, and slumped materials at lower half of bank. • Exposed roots, down timber • Some steep but shallow scarps near river level.	SILT (ML), SANDSTONE bedrock.
16	830+00	Left	No	• Minor erosion gullies up to about 12" deep on slope. • Small scarps (<1' high) near toe of bank. • Leaning trees and down timber near toe of bank. • Small exposed roots.	SANDY SILT (ML) to SILTY SAND (SM)
17	835+00	Left	No	• Minor erosion of recent sediments deposited during Hurricane Irene • Steep older scarps above recent sediments, with exposed roots	SANDY SILT (ML) to SILTY SAND (SM), recent sediments (ML)
18	870+00	Left	No	• Overhangs to near-vertical scarps near toe of bank. • Exposed roots of leaning trees near toe of bank at river level, with undercuts behind roots. • Down timber and leaning trees near river level.	SILTY SAND (SM) to CLAYEY SAND (SC)
19	947+50	Left	Yes	• Overhangs and near-vertical scarps at top of bank, with sparse vegetation. • Mass-wasting and slumping at mid-slope.	SILT (ML)
20	937+00	Right	No	• Little to no erosion. Bank was very flat and appeared stable.	Upper bank soils not observed.
21	792+50	Right	No	• Significant erosion, with steep scarps and slumpings. • Very steep banks, entire slope, with overhangs and undercuts near river level. • Some slumpings. • Exposed roots along scarps.	SANDY SILT (ML), GRAVEL (GP) and SILTY SAND (SM) beach
22	260+00	Right	Yes	• Little to no recent erosion. Repair appeared to be effective in controlling erosion along this segment.	SANDY SILT (ML) to SILTY SAND (SM), recent sediments along shoreline.

Observation Point No. (Note 3)	Station (Note 1)	Left or Right Bank (Note 2)	Previously Stabilized?	Observed Erosion Features	Geotechnical Observations
23	321+00	Right	Yes	• Old erosion scarps all along top half of bank, very steep (near vertical to overhangs), now protected with timber log buttress structures.	Native soils not observed behind backfill materials.
24	336+00	Right	No	• Only at the top of the slope near river level, with steep scarps and undercuts. • Some down timber at river level.	SANDY SILT (ML), entire slope appears to be in old landslide
25	410+00	Right	Yes	• Steep, near-vertical scarps at top half of bank, appeared to predate repair. • Portion of the flat lower bank material was eroded, reportedly after cows grazed and removed all planted vegetation.	SANDY SILT (ML)
26	485+00	Right	No	• Mass-wasting and slumping. • Near-vertical scarp and overhang along top portion of upper bank. • Undercuts at toe of bank at river level, especially under fell trees. • Down timber, leaning and curved tree trunks indicated past ground movements.	SAND (SP) to SILTY SAND (SM), GRAVELLY SAND (SP) beach
27	62+00	Right	Yes	• Some erosion scarps and undercuts along bank where there were no logs protection (est. <50% along stabilized area) • Mass-wasting process along entire hillside, with slumpings, bend trees, down timber. • Slide scarps near top and mid-slope of bank.	SANDY SILT (ML), SAND (SP) beach
28	65+00	Left	Yes	• Little to no erosion at the toe of bank. Stabilization repair appeared to be effective. • Some mass-wasting along sandy mid-slope, with a few tilting trees.	SAND (SP), slope appeared to be near angle of repose of sand
29	659+00	Right	No	• Mass-wasting along entire slope, with near-vertical slide scarps exposed. • Slumpings of materials, with some leaning trees. • Undercuts at river level below near-vertical scarps.	SANDY SILT (ML)

Observation Point No. (Note 3)	Station (Note 1)	Left or Right Bank (Note 2)	Previously Stabilized?	Observed Erosion Features	Geotechnical Observations
30	1052+00	Right	No	• Steep scarps along bank of wooded terrace at river level, with exposed roots. • Some leaning trees and trees with curved trunks, indicated past ground movements. • Minor slumpings at toe of bank at river level.	SANDY SILT (ML)
31	982+00	Right	No	• Steep scarps with little to no vegetation, but mossy. • Leaning trees and exposed roots near river level at toe of bank.	SAND with SILT (SP-SM)
32	1053+00	Mid-Island	No	• Fluvial erosion <2' deep scours, from fluvial force, extending from upstream end of island around both sides approximately 1/3 down length of island • Dead snags present, stunted and crushed sycamores from fluvial force	SAND (SP, SP-SM)
33	1046+50	Island Right	No	• Steeper bank on right bank than left (island left is a gradual graded slope with floodplain forest and few-no invasive veg; island right is steep, eroding, densely colonized with invasive plants. Both fluvial and mass wasting on island right) • Minor fluvial erosion at toe; pockets of mass wasting	SANDY SILT (ML)
34	1000+00	Mid-Island	No	• Historical slumps, some creep/leaning trees • The downstream (northern) end of the island appears to be transitional between depositional (upstream island left bank) and erosional zones (downstream tip of island and island right bank). • Island right bank is higher (elevational), nearly 20' high and extremely steep and steeper than island left bank (island left is a lower grade & depositional; see "Characterization" line for additional island left bank details).	SANDY SILT (ML)

Observation Point No. (Note 3)	Station (Note 1)	Left or Right Bank (Note 2)	Previously Stabilized?	Observed Erosion Features	Geotechnical Observations
35	271+00	Left	No	• Eroding bank face, active mass wasting, very sandy soil • Woody debris at toe • Coniferous forest community • Very steep, high hillside back from bank, and there is erosion at the top of the hill with overhanging hemlock roots just as at the top of the bank	SILTY SAND (SM) to SANDY SILT (ML)
36	685+00	Right	No	• Nearly vertical bank with active failures, bank shape is almost convex it is so steep and falling into river • Treefalls • Sandy, silty soils • Lots of invasive vegetation along this reach (mostly shrub and vine layer) under deciduous canopy cover	SILTY SAND (SP-SM, SM)
37	37+50	Island Left	No	• Recent slide • High, sandy bank with silty, unvegetated bench • Flat bench with native material • Scattered fragments of shale throughout bench (typical for this reach)	SANDY SILT (ML)
38	415+00	Island Right	No	• Minor fluvial erosion at toe of slope • Historic slides • Areas of exposed, vertical bank face • Wide silty bench with lots of large coarse woody debris	SILTY SAND (SM)

Notes: (1) Station is measured in feet, with Station 0+00 at Turners Fall Dam, increasing upstream.

(2) Left and right bank is referenced facing downstream.

(3) No land-based observation form was completed for Point No. 8.

Table H.3
Exposed Soil Types at Detailed Site Assessment Locations

Soil Classification (Unified Soil Classification System)	Descriptions	Locations of Observation Points
CLAY (CL, CH)	Medium to high plasticity, <10% sand, gray	3L, 4L
VARVED CLAY: CLAY (CL), SILT (ML)	Alternating layers of medium-plastic clay and low-plastic silt, brown	2L
SILT (ML)	Low to no plasticity, 5% - 30% fine sand, dark brown, light to dark gray, tan	5L, 6L, 9L, 10L, 11L, 13L, 14L, 15L, 19L
SANDY SILT (ML)	Slight plasticity to no plasticity, 10% - 30% mostly fine sand, brown, gray, tan	1L, 12L, 21R, 24R, 25R, 27R, 29R, 30R, 33I, 34I
SILTY SAND (SM)	Mostly fine sand, 10% - 50% nonplastic fines, brown	1L (beach), 2L, 21R (beach), 36R
SANDY SILT (ML) to SILTY SAND (SM)	Nonplastic, approx. 40% to 60% fine sand, gray, brown	16L, 17L, 35L
SILTY SAND (SM) to CLAY SAND (SC)	Mostly fine sand, 20% to 30% low- to medium-plastic fines	18L
SAND (SP) to SILTY SAND (SM)	Mostly medium sand, approx. 5% - 20% nonplastic fines	26R
SAND (SP) to SAND WITH SILT (SP-SM)	Mostly fine to medium sand, 0% - 10% nonplastic fines, gray	3L, 31R, 32I
SAND (SW)	Coarse to fine sand, <5% nonplastic fines, brown	2L (beach)
SAND (SP) to GRAVELLY SAND (SP)	Fine to coarse sand, <5% nonplastic fines, 10% - 20% fine to coarse gravel, 5% - 10% cobbles, brown	4L, 5L (beach), 9L (beach), 13L (beach), 26R (beach), 27R (beach), 28L
GRAVEL (GW)	Fine to coarse gravel, 1”-3” sizes, <5% nonplastic fines	2L (beach), 3L, 21R (beach)
Bedrock	Highly weathered sandstone, soft, orange	15L

Notes:

1. Nomenclature of land-based observation points:

   Suffix L – Left Bank (looking downstream)
   Suffix R – Right Bank (looking downstream)
   Suffix I – Island
   Beach – Lower Bank

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *1* **Personnel:** *YKC, AS, MM, CM, PW, TS*

Date: *November 12, 2013* **Time:** *10:00 am*

Station Number: *960+00* **Photo Reference Numbers:** *521 - 525*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *955+00* **To Station Number** *970+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

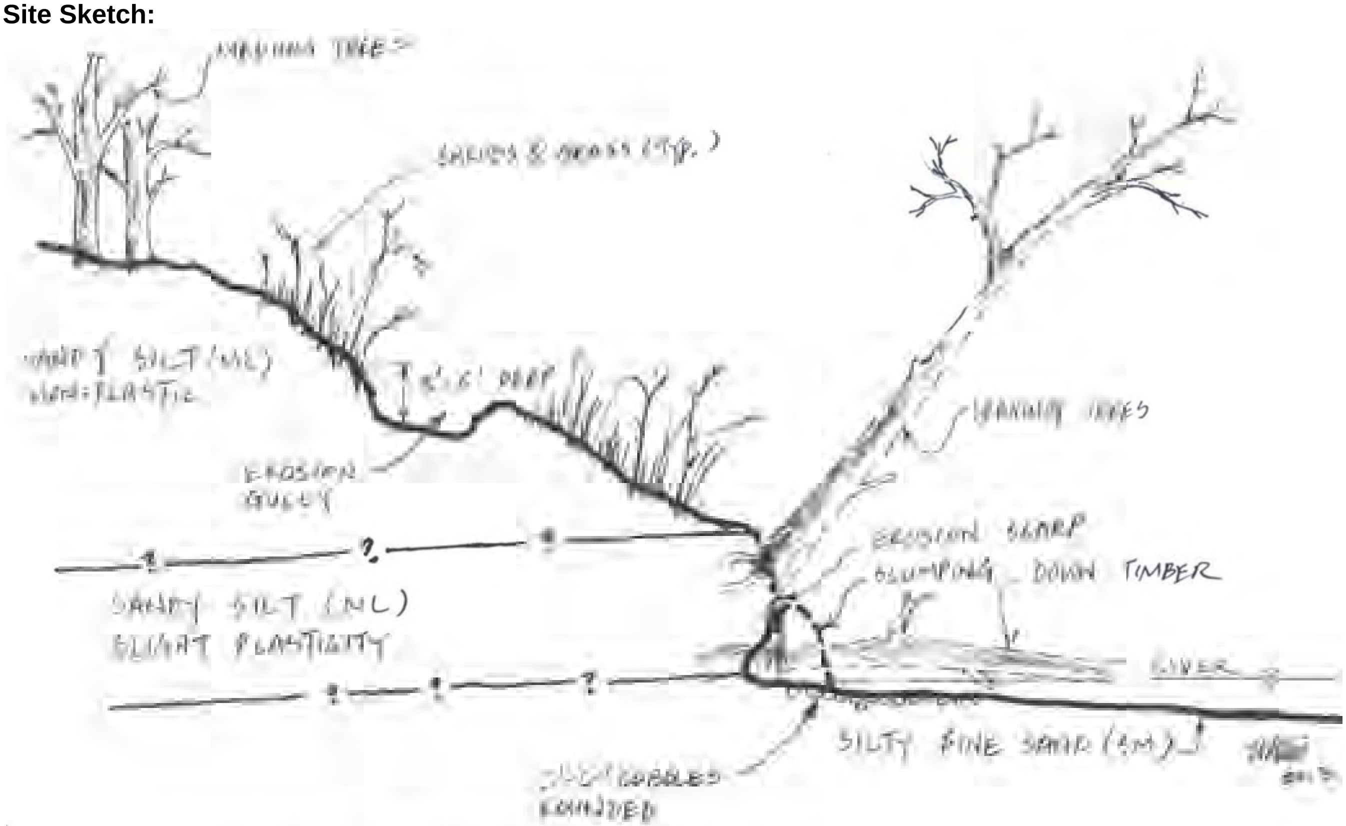
SANDY SILT (ML) – Upper layer: Little to no plasticity, 20% - 30% of mostly fine sand. Lower layer: slight plasticity, 20% to 30% mostly fine sand.

SILTY FINE SAND (SM) – Mostly fine sand, 10% to 20% nonplastic fines.

Observed Erosion Features:

- *Near-vertical erosion scarps at bottom of Upper Bank, 5' to 10' high (typical)*
- *Some erosion gullies, 3' to 5' deep at mid-slope of Upper Bank.*
- Some down timber and leaning trees at river level, with exposed roots.
- Slumping and mass-wasting

Site Sketch:



SECTION - OBSERVATION PT. NO. 1
NOT TO SCALE

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *1* **Date:** *November 12, 2013*

Station Number: *960+00*

Erosion Classification:

Types of Erosion: Topples

Indicators of Potential Erosion: Exposed roots
Overhanging bank
Creep/leaning trees

Notes:

Bank Vegetation:

Top:
Heavy (>50%) cover - Floodplain forest, dense herbaceous cover

Face:
Sparse (10-25%) cover – herbaceous

Toe:
None

Adjacent Land Use:
Forested & Agricultural

Sensitive Receptor:
No

Notes:
Near vertical erosion scarps at bottom of upper bank, 5-10' high. Slumping, mass wasting, erosion gullies, leaning/downed trees at river level.

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 521 – 525
Observation Point No. 1 - November 12, 2013

Photo No. 521

Photo No. 522

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 521 – 525
Observation Point No. 1 - November 12, 2013

Photo No. 523

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 521 – 525
Observation Point No. 1 - November 12, 2013

Photo No. 524

Photo No. 525

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *2* **Personnel:** *YKC, AS, MM, CM, TS*

Date: *November 12, 2013* **Time:** *11:20 am*

Station Number: *989+00* **Photo Reference Numbers:** *526 - 531*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *986+00* **To Station Number** *101+50*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:

(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILTY FINE SAND (SM) – Mostly fine sand, approx. 40 – 50% nonplastic fines, brown

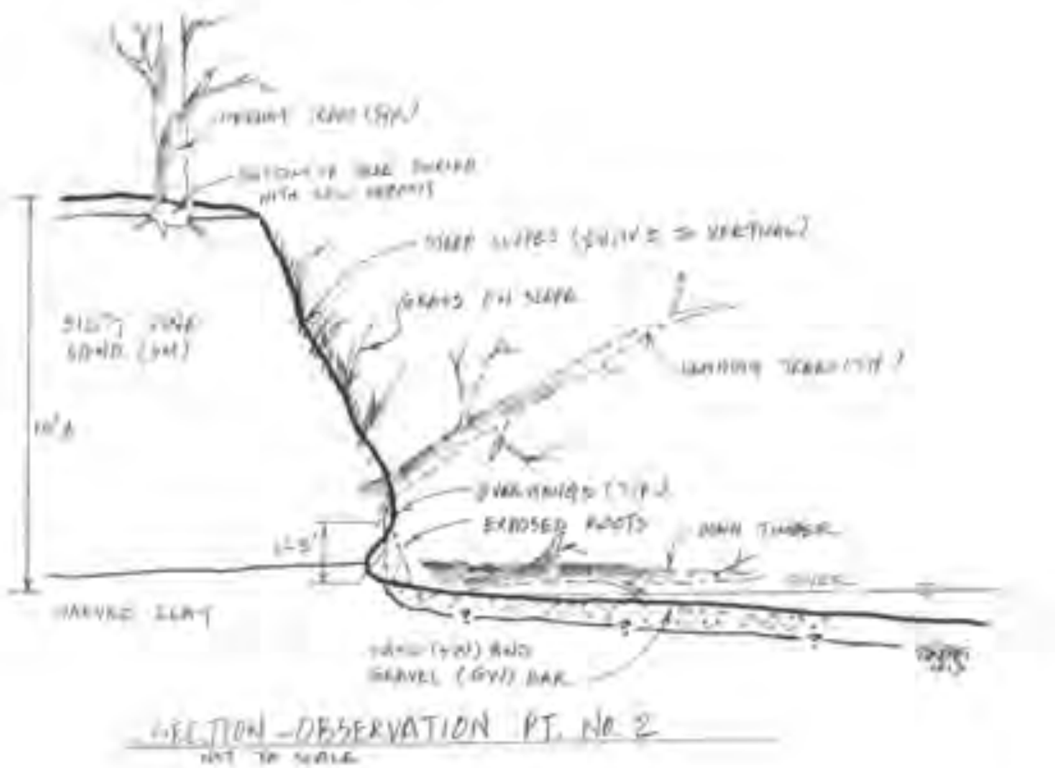
VARVED CLAY – Alternating CLAY (CL) and SILT (ML) layers, medium plasticity, brown

SAND & GRAVEL BAR – Approx. 50% SAND (SW), coarse to fine sand, <5% nonplastic fines, 50% GRAVEL (GW), fine to coarse gravel, 1" – 3", <5% nonplastic fines

Observed Erosion Features:

- *Overhangs and undercuts near bottom of Upper Bank*
- *Exposed roots under overhangs*
- *Down timber and/or leaning trees near bottom of Upper Bank and top of Lower Bank*
- *Steep slopes on Upper Bank*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *2* **Date:** *November 12, 2013*

Station Number: *989+00*

Maximum Root Depth:

1.1 m

Erosion Classification:

Types of Erosion: Topples

Indicators of Potential Erosion: Overhanging bank
Exposed roots
Creep/leaning trees

Notes: Steep slopes on upper bank with overhangs and undercuts, exposed roots, downed/leaning trees.

Indicators of Potential Erosion:

Overhanging bank
Exposed Roots
Creep/Leaning Trees

Bank Vegetation:

Top:
Heavy (>50%) cover, broad-leaved deciduous tree
red oak, hemlock, gray birch, bittersweet, equisetum*

Face:
Sparse (10-25%) cover, herbaceous
River rye, solidago, equisetum, barberry*

Toe:
None

NOTE: The dominant plant is noted with an *

Adjacent Land Use:

Forest, powerlines and historic (capped) landfill

Sensitive Receptor:

Yes – Kingfisher, bank swallows & eagle nest

Notes:

High terrace with some slides, capped landfill here.
Lots of invasive plants here.

Eagle nest site.

Upland forest, gravel toe.

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 526 - 531
Observation Point No. 2 - November 12, 2013

Photo No. 526

Photo No. 527

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 526 - 531
Observation Point No. 2 - November 12, 2013

Photo No. 528

Photo No. 529

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 526 - 531
Observation Point No. 2 - November 12, 2013

Photo No. 530

Photo No. 531

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *3* **Personnel:** *YKC, AS, MM, CM, TS, PW*

Date: *November 12, 2013* **Time:** *2:00 pm*

Station Number: *1060+00* **Photo Reference Numbers:** *536 - 543*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *1058+00* **To Station Number** *1060+70*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

<u>Stratigraphy:</u>
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SAND (SP) to SAND WITH SILT (SP-SM) – Mostly fine to medium sand, 0% to 10% nonplastic fines.
CLAY (CL, CH) – medium to high plasticity, <10% sand, gray.
SAND (SP) and GRAVEL (GP) – Along beach area in Lower Bank. Likely just a veneer.

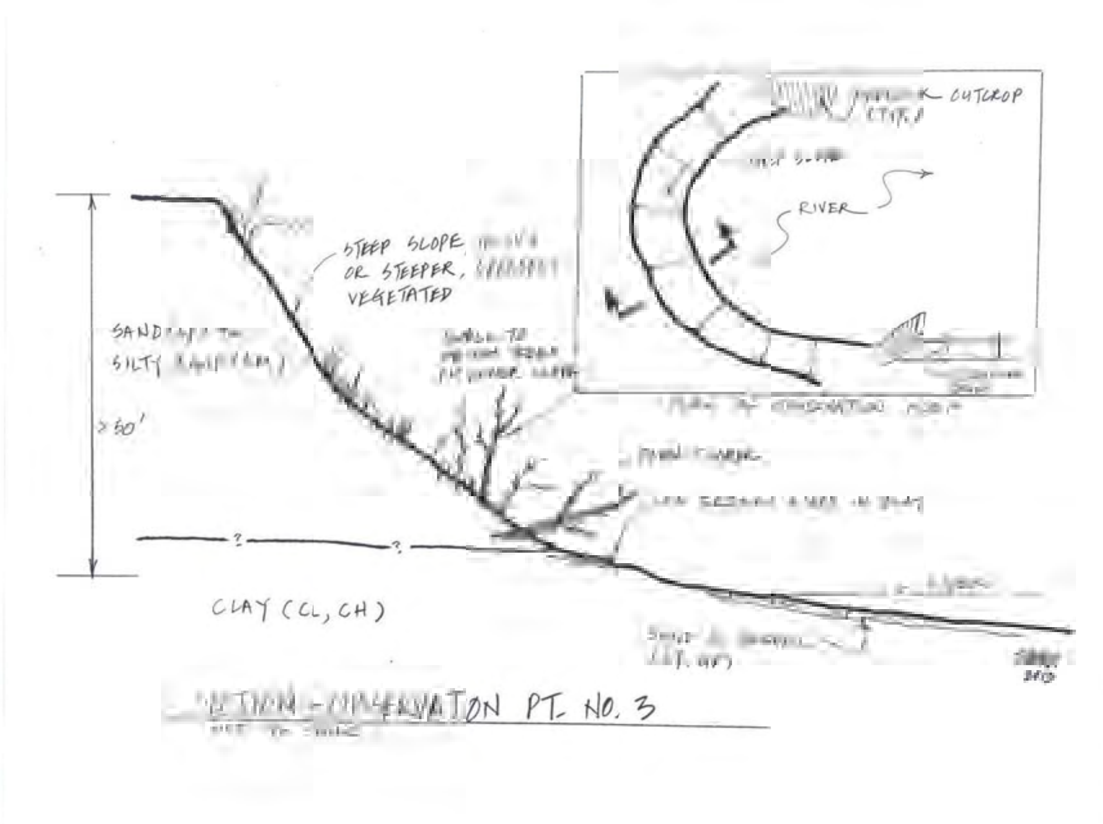
<u>Other observations:</u>

- *Clay layer "pumped" when walking on the surface, indicating presence of hydrostatic uplift pressure under clay.*
- *Bedrock outcrops are exposed at each end of the "cove".*

Observed Erosion Features:

- *Steep slopes with sparse vegetation along entire slope.*
- *Step-like benches on lower 10' of slope.*
- *Some down timber and small leaning trees at lower portion of slope.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *3* **Date:** *November 12, 2013*

Station Number: *1060+00*

Maximum Root Depth:
1 m

Erosion Classification:

<u>Types of Erosion</u>: Topples

<u>Indicators of Potential Erosion</u>: Overhanging bank
Exposed roots

<u>Notes</u>: Steep slopes with sparse vegetation along entire slope
Step-like benches on lower 10' of slope
Leaning trees at top of slope, many treefalls

Bank Vegetation:

<u>Top:</u> Heavy (>50%) cover, needle-leaved coniferous tree
*Eastern white pine**

<u>Face</u>: Sparse (10-25%) cover, needle-leaved coniferous shrub/sapling
Eastern white pine saplings*

<u>Toe</u>: None

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Dam, impoundment, forest

Sensitive Receptor:
Yes – many bank swallow nest cavities (~40) and kingfisher nest cavities near top of bank face

Notes: *Approximately 45 bank swallow cavities & ~ 12 kingfisher cavities*

Erosion wall ~100' high with a near-vertical face, sandy material

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 536 – 543
Observation Point No. 3 - November 12, 2013

Photo No. 536

Photo No. 537

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 536 – 543
Observation Point No. 3 - November 12, 2013

Photo No. 538

Photo No. 539

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 536 – 543
Observation Point No. 3 - November 12, 2013

Photo No. 540

Photo No. 541

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 536 – 543
Observation Point No. 3 - November 12, 2013

Photo No. 542

Photo No. 543

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *4* **Personnel:** *YKC, AS, MM, CM, TS, PW*

Date: *November 12, 2013* **Time:** *3:30 pm*

Station Number: *1028+00* **Photo Reference Numbers:** *545 - 548*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *see Note 1* **To Station Number** *see Note 1*

Note 1 – Observation point represents 100-foot- wide corridor within power transmission line

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:

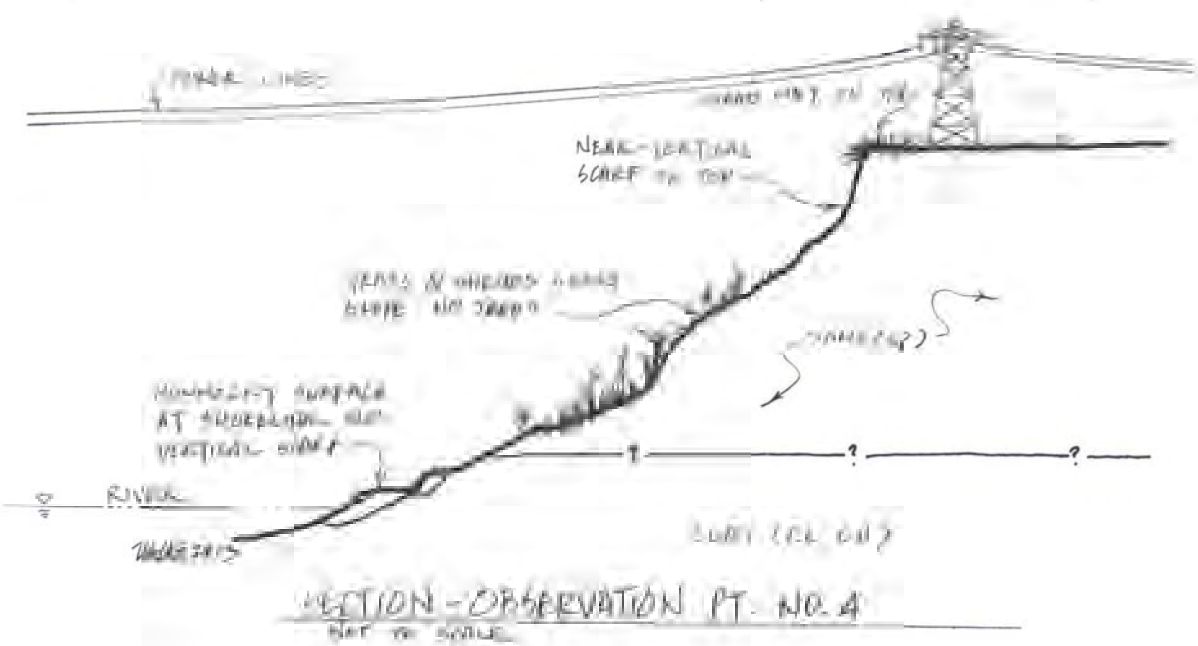
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SAND (SP) – Medium to coarse sand, <5% nonplastic fines.
CLAY (CL, CH) – Medium to high plasticity, <10% sand, gray.

Observed Erosion Features:

- *Minor localized bank erosion near river level.*
- *Ground surface was hummocky at shoreline, but no vertical scarps.*
- *Near vertical erosion scarp near the top of slope, just below power line.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *4* **Date:** *November 12, 2013*

Station Number: *1028+00*

Maximum Root Depth:

1 m

Erosion Classification:

Types of Erosion: Topples

Indicators of Potential Erosion: Overhanging bank
Exposed roots

Notes: Minor localized bank erosion near river level.

Bank Vegetation:

Top: Heavy (>50%) cover, herbaceous
*Eastern white pine**

Face: Moderate (25-50%) cover, herbaceous
Eastern white pine saplings*

Toe: Moderate (25-50%) cover,herbaceous

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Powerlines

Sensitive Receptor:
Yes

Notes: *Near vertical erosion scarp near top of slope, just below powerline – sensitive receptor locaiton*

Ground surface was hummocky at shore.

No trees

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 545 - 548
Observation Point No. 4 - November 12, 2013

Photo No. 545

Photo No. 546

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 545 - 548
Observation Point No. 4 - November 12, 2013

Photo No. 547

Photo No. 548

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *5* **Personnel:** *YKC, AS, MM, CM, PW*

Date: *November 13, 2013* **Time:** *9:00 am*

Station Number: *295+00* **Photo Reference Numbers:** *549 - 551*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *310+00* **To Station Number** *330+00*

Previously Stabilized? *Yes (Transact No. 8A, previously designated Shearer Site, constructed in Dec. 1996)*

Geologic / Geotechnical Observations:

Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILT (ML) – Low plasticity, <10% fine sand, dark brown.
SAND (SP) – Clean fine sand along beach. Likely just veneer.

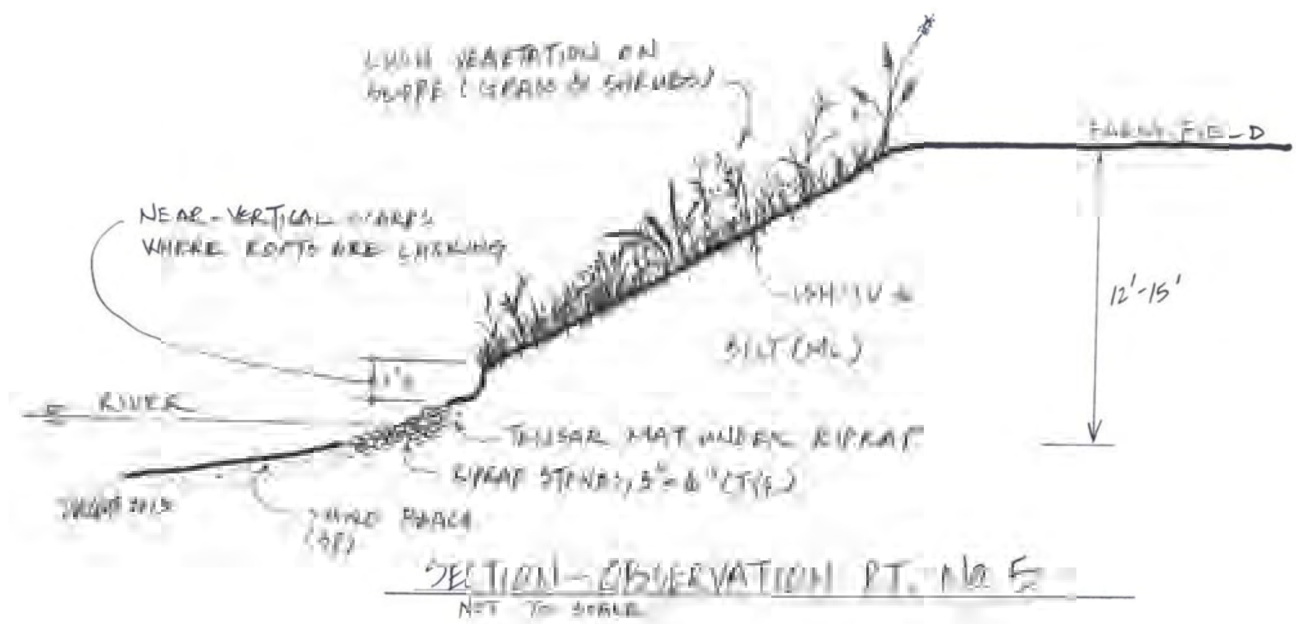
Other Observations:

- *Riprap armoring appeared to be adequate, with little displacement or settlement and gap in coverage.*
- *Riprap stones are angular and sound rock, with little to no deterioration.*

Observed Erosion Features:

- *Shallow erosion just above riprap where roots from vegetation were lacking.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *5* **Date:** *November 13, 2013*

Station Number: *295+00*

Maximum Root Depth:
<1 m

Erosion Classification:

Types of Erosion: none

Indicators of Potential Erosion: none

Notes: Previously stabilized site (Shearer), no erosion

Bank Vegetation:

Top: Moderate (25-50%), Broad-leaved deciduous shrub/sapling
Staghorn sumac, Japanese knotweed, oriental bittersweet*

Face: Moderate (25-50%), Broad-leaved deciduous shrub
Staghorn sumac, mixed grasses*

Toe: Rock, no veg

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural

Sensitive Receptor:
No

Notes: *Shearer farm site*

Vegetation is all shrub, there is no canopy permitted to establish itself (property owner prefers this)

Many non-native aggressively invasive species present, mostly Japanese knotweed

Cross section #8A

Riprap toe

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 549 - 551
Observation Point No. 5 - November 13, 2013

Photo No. 549

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 549 - 551
Observation Point No. 5 - November 13, 2013

Photo No. 550

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 549 - 551
Observation Point No. 5 - November 13, 2013

Photo No. 551

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *6* **Personnel:** *YKC, AS, MM, CM, PW*

Date: *November 13, 2013* **Time:** *10:00 am*

Station Number: *350+00* **Photo Reference Numbers:** *552 - 559*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *334+00* **To Station Number** *385+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILT (ML) – Low to no plasticity, <10% fine sand, dark gray.

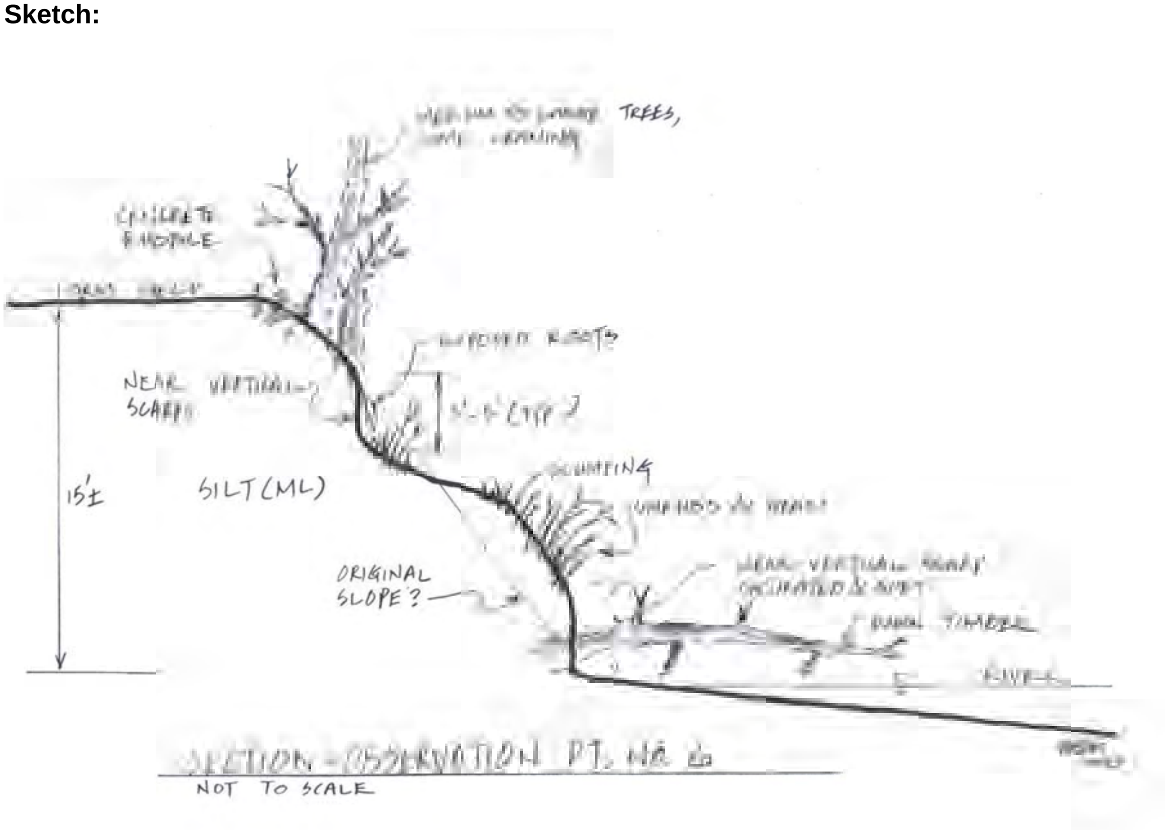
Other observations:

- *Concrete rubble on top of bank did not appear to be for erosion stabilization purpose.*

Observed Erosion Features:

- *Near-vertical scarps, with several intermediate benches from mass-wasting and slumping.*
- *Some down timber and leaning trees.*
- *Little grass, but some shrubs between trees*
- *Some exposed tree roots on upper scarps near top of bank.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *6* **Date:** *November 13, 2013*

Station Number: *350+00*

Maximum Root Depth:

<1 m

Erosion Classification:

Types of Erosion: mass-wasting (historical)

Indicators of Potential Erosion: Creep/leaning trees
Exposed roots
Overhanging bank

Notes:

Bank Vegetation:

Top: *Heavy (>50%), Broad-leaved deciduous tree*
Sugar maple, red maple, mix birches, black oak*

Face: *Heavy (>50%), Broad-leaved deciduous tree/sapling*
Sugar maple, red maple, black oak (leaning live trees and saplings)*

Toe: sand bench, no veg

NOTE: The dominant plant is noted with an *

Adjacent Land Use:

Agricultural

Sensitive Receptor:

No

Notes: *Historical mass-wasting, estimated ~12 years old (sigafouse) at L'etoile farm*

Eroded, vertical bank at Shearer Farm

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 552 - 559
Observation Point No. 6 - November 13, 2013

Photo No. 552

Photo No. 553

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 552 - 559
Observation Point No. 6 - November 13, 2013

Photo No. 554

Photo No. 555

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 552 - 559
Observation Point No. 6 - November 13, 2013

Photo No. 556

Photo No. 557

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 552 - 559
Observation Point No. 6 - November 13, 2013

Photo No. 558

Photo No. 559

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *7* **Personnel:** *YKC, AS, MM, CM, PW*

Date: *November 13, 2013* **Time:** *10:30 am*

Station Number: *385+00* **Photo Reference Numbers:** *560 - 562*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *385+00* **To Station Number** *390+00*

Previously Stabilized? *Yes (previously designated L'Etoile Restoration Site, constructed in 1998)*

Geologic / Geotechnical Observations:

Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

Soil layers were not exposed along slope, and no excavation was performed.

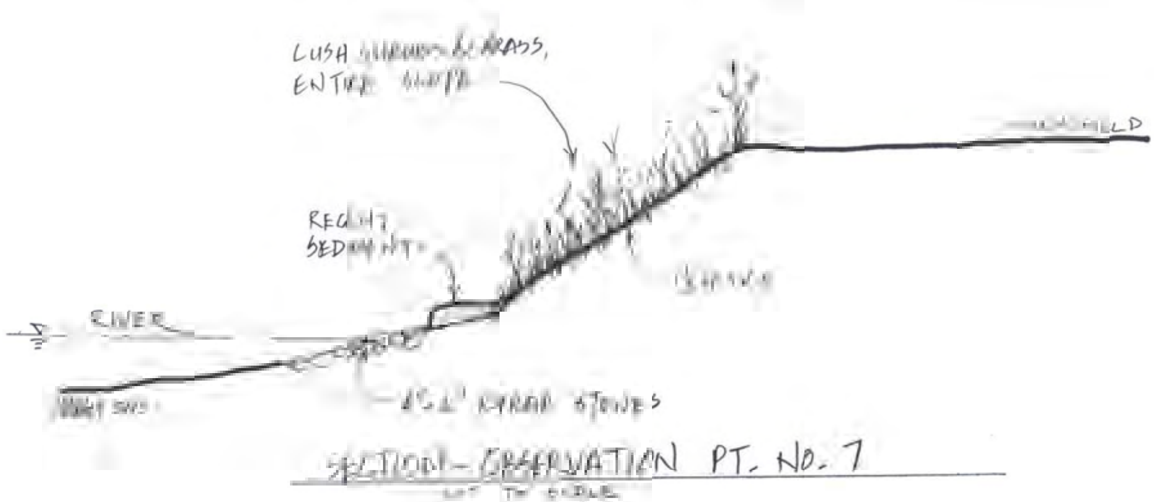
Other observations:

- *Riprap toe performing well, with no signs of displacements or settlements.*
- *Riprap stones were 4" to 6" size angular sound rock, with no deterioration.*
- *Some recent sediments just above riprap from recent Hurricane Irene.*

Observed Erosion Features:

- *Little to no erosion. Stabilization appeared to be performing well.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *7* **Date:** *November 13, 2013*

Station Number: *385+00*

Maximum Root Depth:

Erosion Classification:

Types of Erosion:

Indicators of Potential Erosion:

Notes:

Bank Vegetation:

Top: *Moderate (25-50%), Broad-leaved deciduous shrub*
Staghorn sumac, dogwoods, willows, mixed grasses*

Face: *Moderate (25-50%), Broad-leaved deciduous shrub*
Staghorn sumac, dogwoods, willows, mixed grasses/solidago*

Toe: rock toe (anthro)

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural

Sensitive Receptor:
No (but beaver slide present)

Notes: *L'etoile farm*

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 560 - 562
Observation Point No. 7 - November 13, 2013

Photo No. 560

Photo No. 561

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 560 - 562
Observation Point No. 7 - November 13, 2013

Photo No. 562

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *9* **Personnel:** *YKC, AS, MM, CM, PW*

Date: *November 13, 2013* **Time:**

Station Number: *415+00* **Photo Reference Numbers:** *CM 92-93*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *407+00* **To Station Number** *420+00*

Previously Stabilized? *Yes*

Geologic / Geotechnical Observations:

Stratigraphy:

Observed Erosion Features:

- *Top of bank erosional gullies (6), creep evidence, exposed soils, dumping*

Site Sketch:

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *8* **Date:** *November 13, 2013*

Station Number: *415+00*

Maximum Root Depth:

Erosion Classification:

Types of Erosion:

Indicators of Potential Erosion: creep
Exposed roots
Overhanging bank

Notes:

Bank Vegetation:

Top: *Sparse (10-25%) Broad-leaved deciduous tree*
Oaks, maples & hemlock

Face: *Moderate (25-50%), Broad-leaved deciduous shrub*
Dogwoods, willow, pine saplings, fescue

Toe: rock toe (anthro)

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Residential

Sensitive Receptor:
No (but beaver slide present)

Notes: *Skalaski farm restoration site (2004) ~1,600 lf & bank ~60' high (very steep)*

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *9* **Personnel:** *YKC, AS, MM, CM, PW*

Date: *November 13, 2013* **Time:** *12:30 pm*

Station Number: *435+00* **Photo Reference Numbers:** *568 - 575*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *420+00* **To Station Number** *475+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:

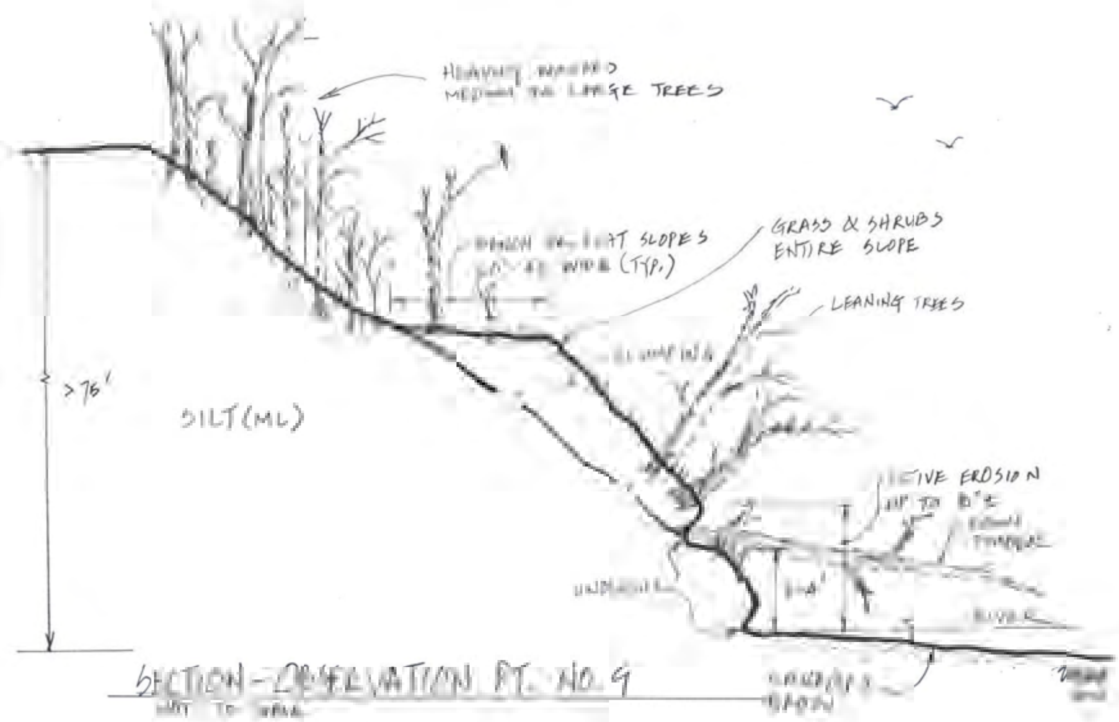
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILT (ML) – Nonplastic, little to no sand, gray.
SAND (SP) – Mostly clean fine sand on beach. Likely just veneer.

Observed Erosion Features:

- *Near-vertical scarps up to about 8' high from river level, with undercuts.*
- *Leaning trees to down timber, with exposed tree roots along erosion scarps.*
- *A relatively flat bench at about mid-slope, may be from mass-wasting and slumping.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *9* **Date:** *November 13, 2013*

Station Number: *435+00*

Maximum Root Depth:
1.5 m

Erosion Classification:

Types of Erosion: Mass wasting & fluvial

Indicators of Potential Erosion: Creep/leaning trees
Exposed roots
Overhanging bank

Notes: near vertical scarps up to ~8' high, with undercuts

Leaning trees to down timber, with exposed tree roots along erosion scarps

A relatively flat bench at ~mid-slope, may be from mass wasting & slumping

Bank Vegetation:

Top: Heavy (>50%), needle-leaved coniferous tree
Hemlock, mixed birches, black cherry, mix of silver/red maples, mixed oaks*

Face: Moderate (25-50%), needle-leaved coniferous tree/sapling
Hemlock, mix maples/oaks*

Toe: sand/silt bench – no veg

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
forested

Sensitive Receptor:
No

Notes: *Beautiful riverfront with a wide forested riparian buffer of well-established forest buffer, including dense hemlock stands*

Forested riparian buffer at top, pockets of eroded bank, many gullies especially at stream/tributary inlset where there is a very deep gorge ~100'deep

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 568 - 575
Observation Point No. 9 - November 13, 2013

Photo No. 568

Photo No. 569

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 568 - 575
Observation Point No. 9 - November 13, 2013

Photo No. 570

Photo No. 571

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 568 - 575
Observation Point No. 9 - November 13, 2013

Photo No. 572

Photo No. 573

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 568 - 575
Observation Point No. 9 - November 13, 2013


Photo No. 574


Photo No. 575

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *10* **Personnel:** *YKC, AS, MM, CM, PW*

Date: *November 13, 2013* **Time:** *2:00 pm*

Station Number: *484+00* **Photo Reference Numbers:** *576 - 580*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *480+00* **To Station Number** *490+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

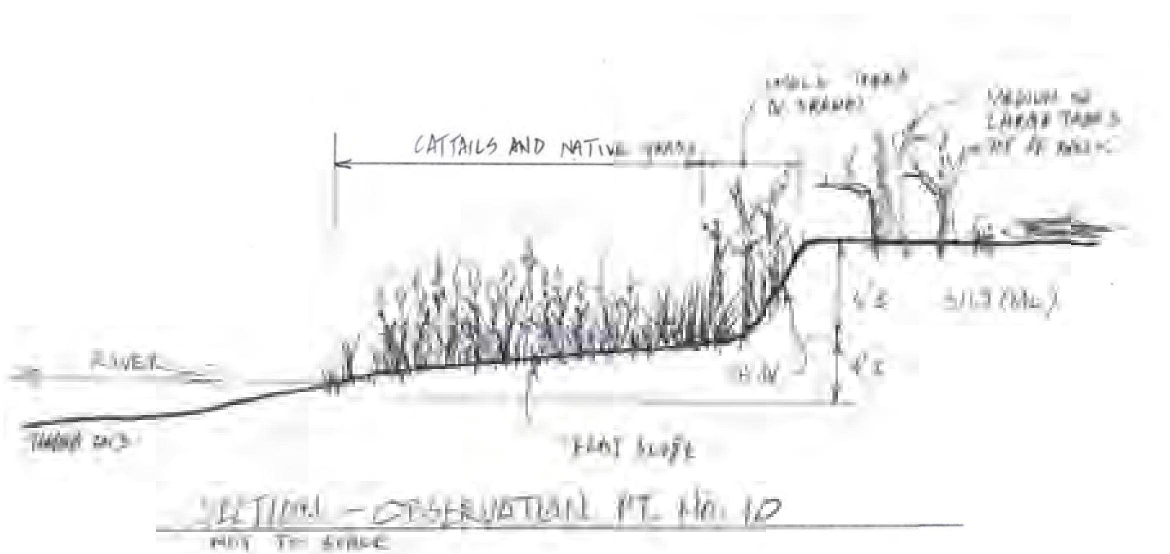
<u>Stratigraphy:</u>
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILT (ML) – Nonplastic, 10% - 20% fine sand, brown.

Observed Erosion Features:

- *Little to no erosion. Flat bench just above river completely covered with cattails and native grass.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *10* **Date:** *November 13, 2013*

Station Number: *484+00*

Maximum Root Depth:
1.2 m

Erosion Classification:

Types of Erosion: none

Indicators of Potential Erosion:

Notes:

Bank Vegetation:

Top: *Moderate (25-50%), Broad-leaved deciduous tree*
*Silver maple**

Face: *Moderate (25-50%), broad leaved deciduous sapling/vine*
Silver maple, grape & bittersweet*

Toe: Moderate (24-50%) Persistent emergent
Typha latifolia, woolgrass, mixed rushes & sedges, river rye*

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
agricultural

Sensitive Receptor:
Emergent shelf (Odonate hab)

Notes: *Depositional zone with thin forested riparian buffer but excellent persistent emergent shelf leads to stable bank, retention of land and retention of soils*

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 576 - 580
Observation Point No. 10 - November 13, 2013

Photo No. 576

Photo No. 577

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 576 - 580
Observation Point No. 10 - November 13, 2013

Photo No. 578

Photo No. 579

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 576 - 580
Observation Point No. 10 - November 13, 2013

Photo No. 580

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *11* **Personnel:** *YKC, AS, MM, CM, PW*

Date: *November 13, 2013* **Time:** *2:30 pm*

Station Number: *505+00* **Photo Reference Numbers:** *581-588*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *490+00* **To Station Number** *555+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

Upper Bank: SILT (ML) – Nonplastic,<10% sand, dark gray.
Lower Bank: SILT (ML) – Slightly plastic, <10% sand, gray.
Recent sediment from Hurricane Irene: SILT (ML) – Low plasticity, gray.

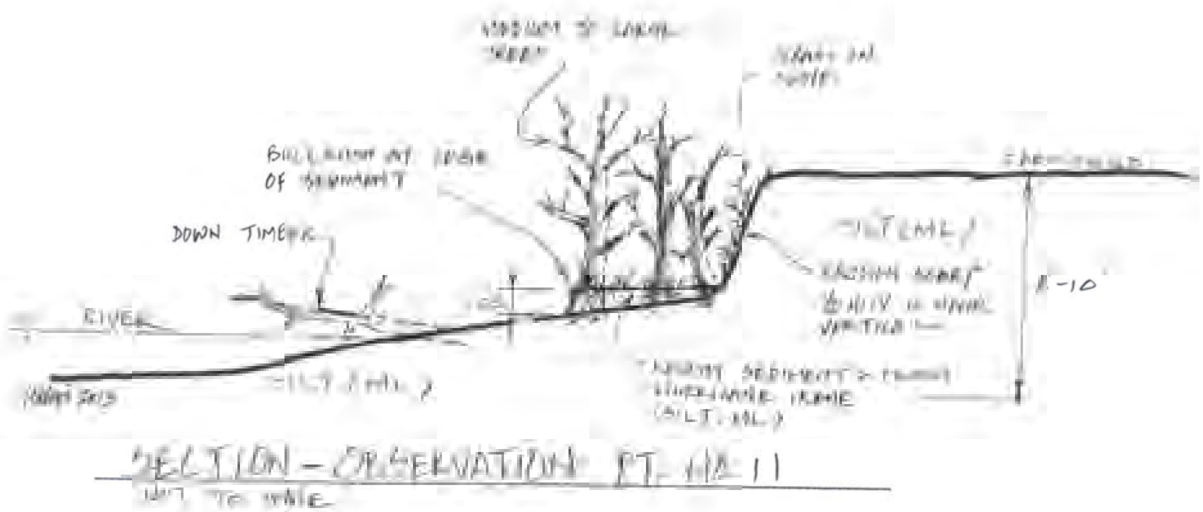
Other observations:

- *Bottom of some trees near river level covered with recent sediments, with bull rush growing.*

Observed Erosion Features:

- *Erosion scarps just below top of bank, very steep.*
- *Exposed roots.*
- *Some trees with bent trunks, may be indication of land creep.*
- *Down timber*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *11* **Date:** *November 13, 2013*

Station Number: *505+00*

Maximum Root Depth:
1.2 m

Erosion Classification:

<u>*Types of Erosion*</u>*: Little to no erosion*

<u>*Indicators of Potential Erosion*</u>*: Creep/leaning trees*
Exposed roots
Downed trees

<u>*Notes*</u>*:* *Erosion scarps just below the top of the bank (TOB), very steep*

No invasive veg at this site

Transitional zone

Bank Vegetation:

<u>*Top:*</u> *Moderate (25-50%), Broad-leaved deciduous tree*
Silver maple, red maple*

<u>*Face*</u>*:* *Moderate (25-50%), broad leaved deciduous sapling/vine*
Silver maple, red maple, grape & bittersweet*

<u>*Toe*</u>*:* None to Very Sparse (0-10%) Non-Persistent emergent
mixed rushes & sedges but primarily silt

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
agricultural

Sensitive Receptor:
No

Notes: *Transitional zone with emergent vegetation growing on recent deposition of sediments from Hurricane Irene*

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 581 - 588
Observation Point No. 11 - November 13, 2013

Photo No. 581

Photo No. 582

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 581 - 588
Observation Point No. 11 - November 13, 2013

Photo No. 583

Photo No. 584

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 581 - 588
Observation Point No. 11 - November 13, 2013

Photo No. 585

Photo No. 586

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 581 - 588
Observation Point No. 11 - November 13, 2013

Photo No. 587

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 581 - 588
Observation Point No. 11 - November 13, 2013

Photo No. 588

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *12* **Personnel:** *YKC, AS, MM, CM*

Date: *November 14, 2013* **Time:** *9:15 am*

Station Number: *589+00* **Photo Reference Numbers:** *603 - 608*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *581+00* **To Station Number** *590+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) – Nonplastic, 10% - 30% fine sand, light brown.

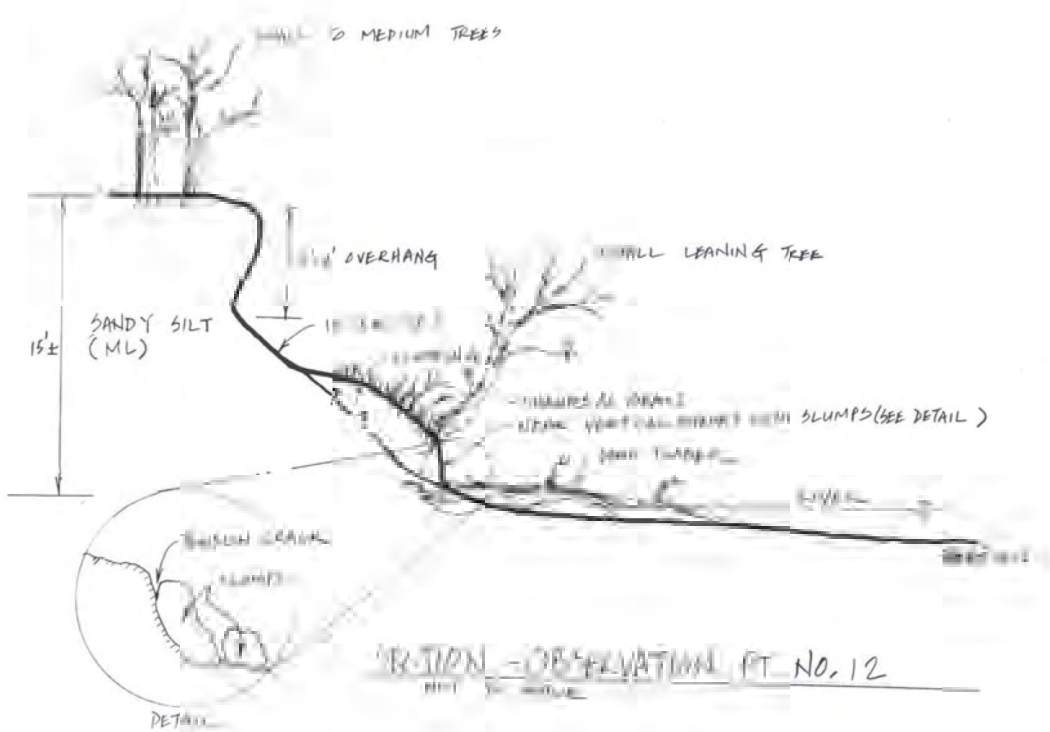
Other observations:

- *Section is directly across the river from a pile of rock in the right bank that may act as a bank barb to deflect flow toward the left bank.*

Observed Erosion Features:

- *Overhangs near top of bank.*
- *Tension cracks near toe of bank in slumped materials*
- *Slumping and falls of materials*
- *Near vertical scarps near bottom of Upper Bank.*
- *Down timber and small live trees with bent trunks.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *12* **Date:** *November 14, 2013*

Station Number: *589+00*

Maximum Root Depth:
1.3 m

Erosion Classification:

Types of Erosion: mass-wasting & fluvial

Indicators of Potential Erosion: Overhanging bank
Downed trees

Notes: Section is directly across the river from a pile of rock in the right bank that may act as a bank "barb" to deflect flow towards the left bank

Bank Vegetation:

Top: Heavy (>50%), Broad-leaved deciduous tree
Red maple, birches, grape/bittersweet, honeysuckle, black locust*

Face: Moderate (25-50%), broad leaved deciduous sapling/vine
Sumac, black locust saplings, autumn olive, honeysuckle, rye*

Toe: None (0%) unvegetated
Primarily sand/silt toe

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
agricultural

Sensitive Receptor:
No

Notes: *Bedrock point across river is pushing flow over to left bank, creating a carved "bowl"*

Eroded cliff

Old bridge abutment here and pile of concrete blocks

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 603 - 608
Observation Point No. 12 - November 14, 2013

Photo No. 603

Photo No. 604

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 603 - 608
Observation Point No. 12 - November 14, 2013

Photo No. 605

Photo No. 606

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 603 - 608
Observation Point No. 12 - November 14, 2013

Photo No. 607

Photo No. 608

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *13*   **Personnel:** *YKC, AS, MM, CM*

Date: *November 14, 2013*   **Time:** *10:00 am*

Station Number: *604+00*   **Photo Reference Numbers:** *609 - 614*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *590+00*   **To Station Number** *680+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

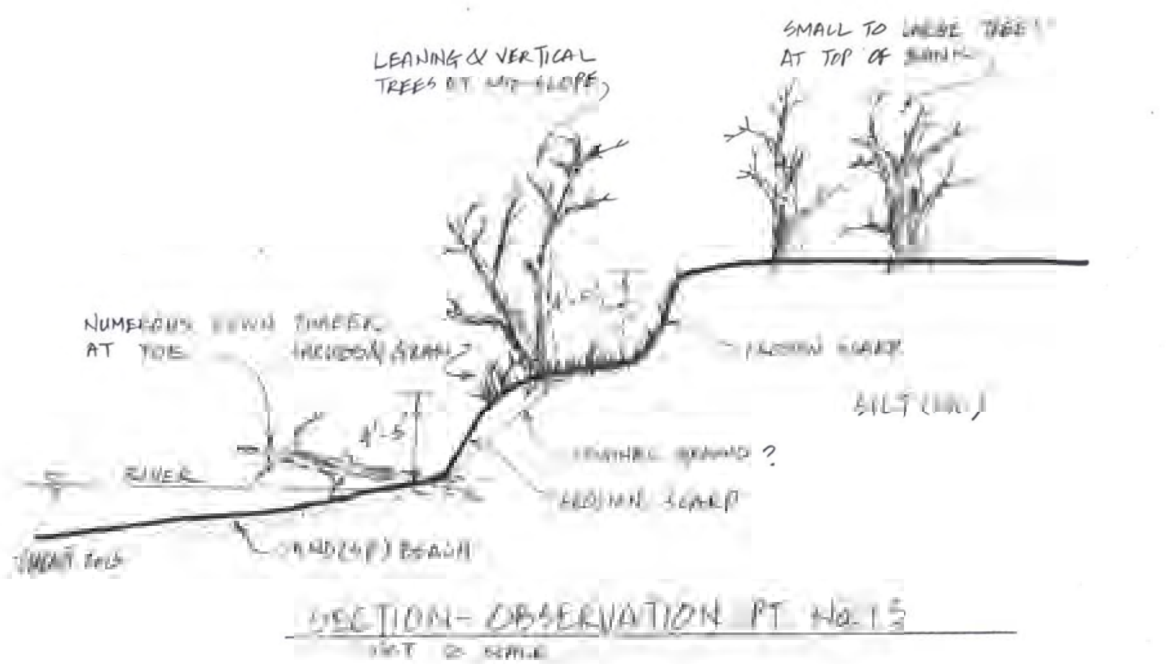
Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILT (ML) – Nonplastic, <10% fine sand, light gray.
SAND (SP) – Mostly fine sand, <5% nonplastic fines.

Observed Erosion Features:

- *Terraced with near-vertical scarps entire slope.*
- *Numerous exposed roots, especially near toe of Upper Bank, with undercuts under root zones & root wads.*
- *Leaning trees and down timber.*
- *Some slumping of materials near toe of Upper Bank*

ite Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *13* **Date:** *November 14, 2013*

Station Number: *604+00*

Maximum Root Depth:
1.2 m

Erosion Classification:

Types of Erosion: minor

Indicators of Potential Erosion: Creep/leaning trees
Downed trees

Notes: Terraced with near vertical scarps throughout the entire slope.

Numerous exposed roots, especially near the toe of the Upper Bank, with undercuts under root zones & root wads

Some slumps

Bank Vegetation:

Top: Heavy (>50%), Broad-leaved deciduous tree
Silver maple, box elder, red maple, winged euonymus, Japanese barberry, grape/bittersweet vines*

Face: Heavy (>50%), broad leaved deciduous sapling/vine
Leaning red maples, grape/bittersweet*

Toe: None to Very Sparse (0-10%)
Primarily sand/silt toe

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
agricultural

Sensitive Receptor:
No – too much woody veg

Notes: *There are lots of invasives here in the riparian zone, including winged euonymus, Japanese barberry, autumn olive, honeysuckle and bittersweet. Some silver maples in the riparian zone are exceptionally large and spectacular.*

Ag field planted with row corn

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 609 - 614
Observation Point No. 13 - November 14, 2013

Photo No. 609

Photo No. 610

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 609 - 614
Observation Point No. 13 - November 14, 2013

Photo No. 611

Photo No. 612

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 609 - 614
Observation Point No. 13 - November 14, 2013

Photo 613

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 609 - 614
Observation Point No. 13 - November 14, 2013

Photo No. 614

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *14* **Personnel:** *YKC, AS, MM, CM*

Date: *November 14, 2013* **Time:** *1:00 pm*

Station Number: *726+00* **Photo Reference Numbers:** *622 - 625*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *710+00* **To Station Number** *730+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

<u>*Stratigraphy:*</u>

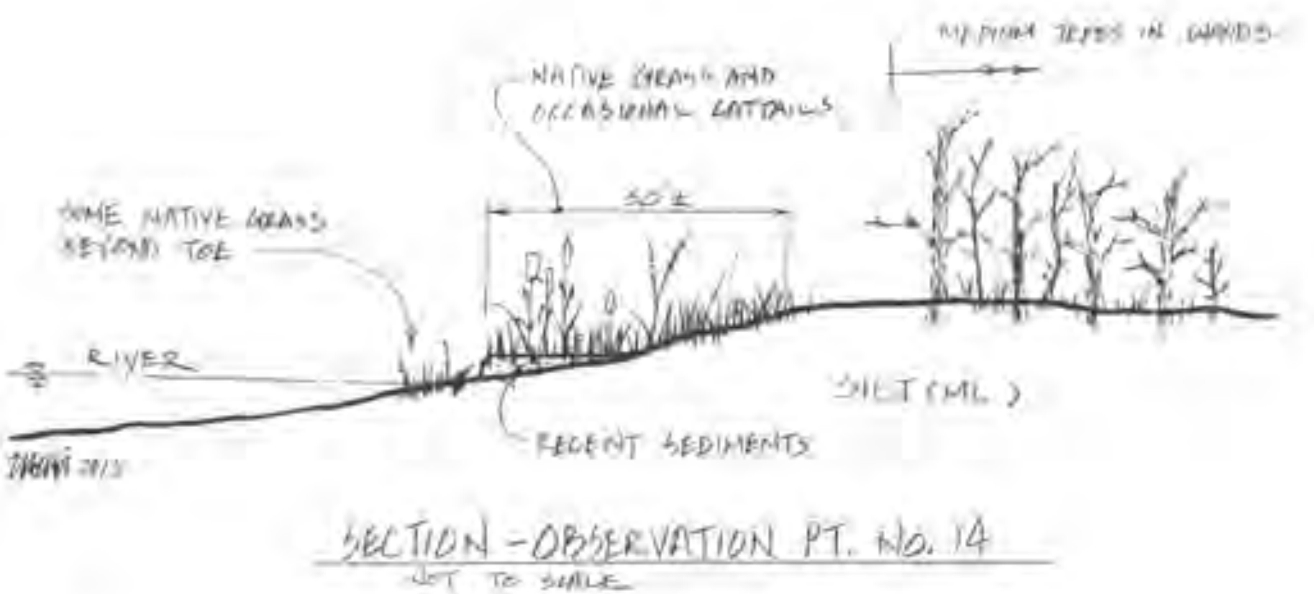
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILT (ML) - <10% fine sand, nonplastic, dark gray

Observed Erosion Features:

- *Little to no erosion*
- *Well-established native grass and trees in recent sediment terrace*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *14* **Date:** *November 14, 2013*

Station Number: *726+00*

Maximum Root Depth:

Erosion Classification:

Types of Erosion: none

Indicators of Potential Erosion:

Notes: depositional zone

Bank Vegetation:

Top: Heavy (>50%), Broad-leaved deciduous tree
Red maple, silver maple, sycamore, cottonwood*

Face: Moderate (25-50%), Persistent & non-persistent emergent
Typha, mixed sedges/grasses/rushes

Toe: Moderate (25-50%), Persistent & non-persistent emergent
Typha, mixed sedges/grasses/rushes

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
agricultural

Sensitive Receptor:
Emergent shelf (Odonate hab)

Notes: *Depositional zone with thin forested riparian buffer but excellent persistent emergent shelf leads to stable bank, retention of l and retention of soils*

Emergent bench at toe

Little to no erosion

Well-establised native grass and trees in recent sediment terrace. Phragmites patch present here (non-native)

Upstream from Pachaug Meadow

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No.622 - 625
Observation Point No. 14 - November 14, 2013

Photo No. 622

Photo No. 623

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No.622 - 625
Observation Point No. 14 - November 14, 2013

Photo No. 624

Photo No. 625

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *15* **Personnel:** *YKC, AS, MM, CM*

Date: *November 14, 2013* **Time:** *2:00 pm*

Station Number: *765+00* **Photo Reference Numbers:** *626 - 630*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *740+00* **To Station Number** *770+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

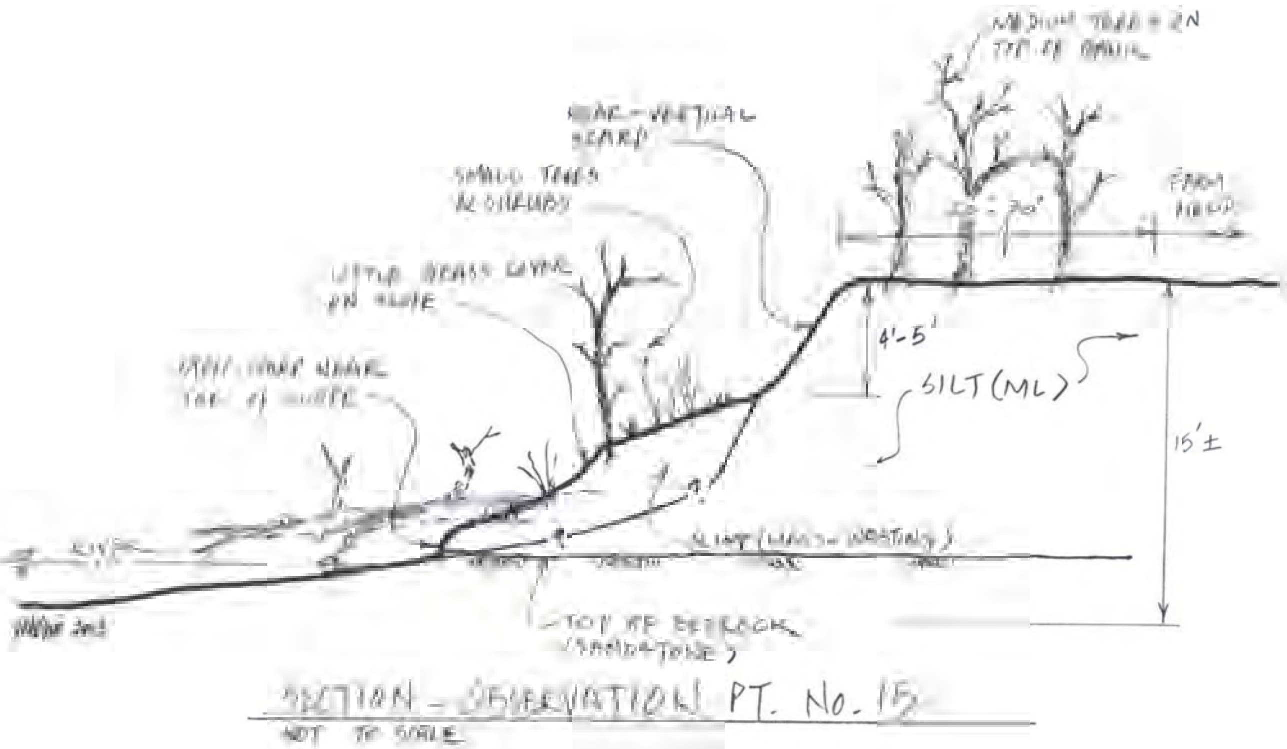
<u>Stratigraphy:</u>
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILT (ML) – Nonplastic, <10% fine sand, dark gray
BEDROCK – Sandstone, highly weathered to near soil-like consistency, iron-stained, soft, orange.

Observed Erosion Features:

- *Mass-wasting and slumping along entire bank.*
- *Near-vertical scarps near top of bank, and slumped materials at lower half of bank.*
- *Exposed roots, down timber*
- *Some steep but shallow scarps near river level.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *15* **Date:** *November 14, 2013*

Station Number: *765+00*

Maximum Root Depth:

1.2 m

Erosion Classification:

Types of Erosion: Mass wasting and slumping along the entire bank

Indicators of Potential Erosion: Exposed roots
Leaning trees
Downed trees

Notes: near vertical scarps near the TOB and slumped materials at lower half of bank

exposed roots

downed trees

some steep but shallow scarps near river level

Bank Vegetation:

Top: Heavy (>50%), Broad-leaved deciduous tree
Silver maple, red maple, black cherry, invasive shrubs*

Face: Heavy (>50%), Broad-leaved deciduous tree
Silver maple, bittersweet*

Toe: None to Very sparse (0-10%), Herbaceous/forbs
Mixed grasses, but mostly downed coarse woody debris

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
agricultural

Sensitive Receptor:
No

Notes: *High bank*

Lots of invasive veg, including Japanese barberry, bittersweet, etc.

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 626 - 630
Observation Point No. 15 - November 14, 2013

Photo No. 626

Photo No. 627

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 626 - 630
Observation Point No. 15 - November 14, 2013

Photo No. 628

Photo No. 629

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 626 - 630
Observation Point No. 15 - November 14, 2013

Photo No. 630

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *16* **Personnel:** *YKC, AS, MM, CM, TS*

Date: *November 15, 2013* **Time:** *8:40 am*

Station Number: *830+00* **Photo Reference Numbers:** *634 - 637*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *810+00* **To Station Number** *865+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

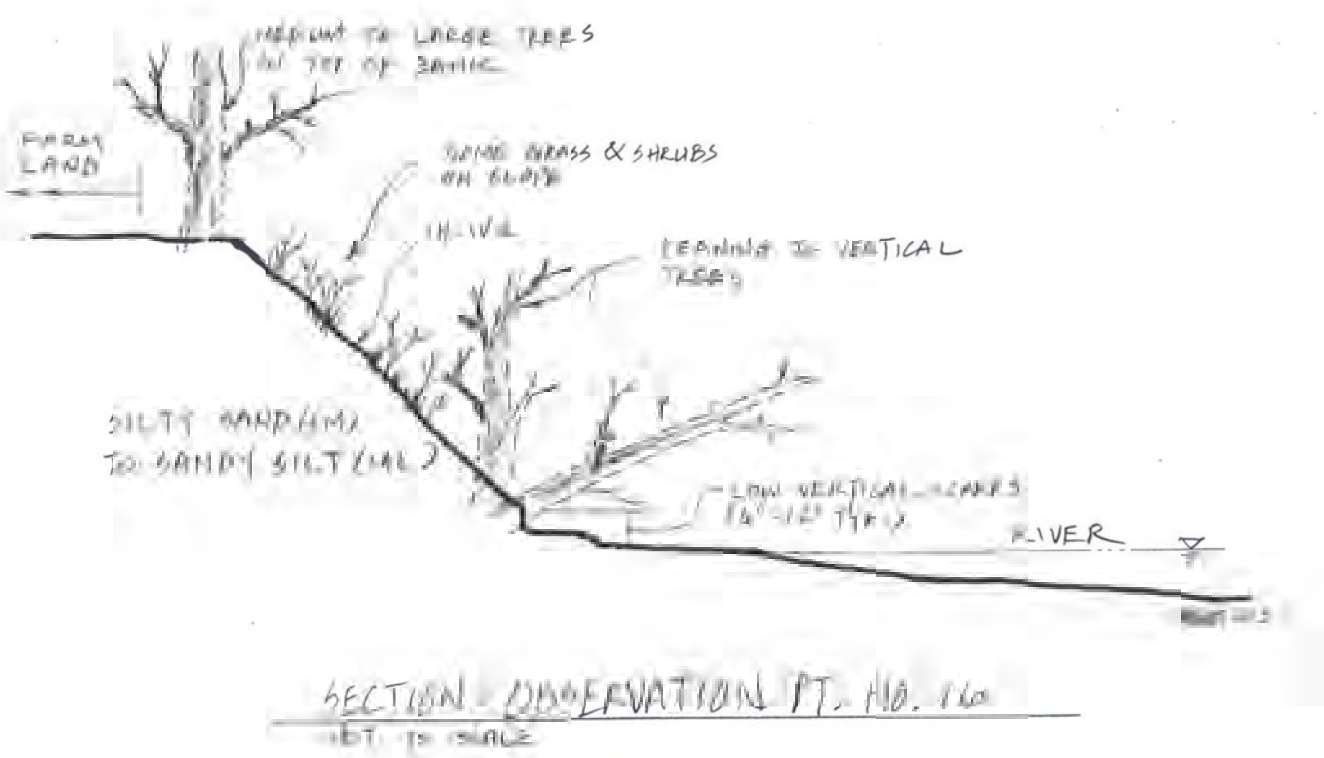
<u>Stratigraphy:</u>
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) to SILTY SAND (SM) – Nonplastic, approx. 50% fine sand, gray.

Observed Erosion Features:

- *Minor erosion gullies up to about 12" deep on slope.*
- *Small scarps (<1' high) near toe of bank.*
- *Leaning trees and down timber near toe of bank.*
- *Small exposed roots.*

ite Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *16* **Date:** *November 15, 2013*

Station Number: *830+00*

Maximum Root Depth:

>4'

Erosion Classification:

Types of Erosion:

Indicators of Potential Erosion: Exposed roots
Leaning trees
Downed trees

Notes: exposed roots

downed trees

Bank Vegetation:

Top: Heavy (>50%), Broad-leaved deciduous tree
Silver maple, box elder, red maple, Japanese barberry, multiflora rose, winged euonymus, bittersweet, agricultural*

Face: Heavy (>50%), Broad-leaved deciduous tree
Silver maple, red maple, wild rye, bulrush, bittersweet*

Toe: None to Very sparse (0-10%)
none

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
agricultural

Sensitive Receptor:
No

Notes: *agricultural field with think riparian buffer*

Lots of invasive veg, including Japanese barberry, bittersweet, etc.

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 634 - 637
Observation Point No. 16 - November 15, 2013

Photo No. 634

Photo No. 635

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 634 - 637
Observation Point No. 16 - November 15, 2013

Photo No. 636

Photo No. 637

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *17* **Personnel:** *YKC, AS, MM, CM, TS*

Date: *November 15, 2013* **Time:** *9:15 am*

Station Number: *835+00* **Photo Reference Numbers:** *638 - 641*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *810+00* **To Station Number** *865+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

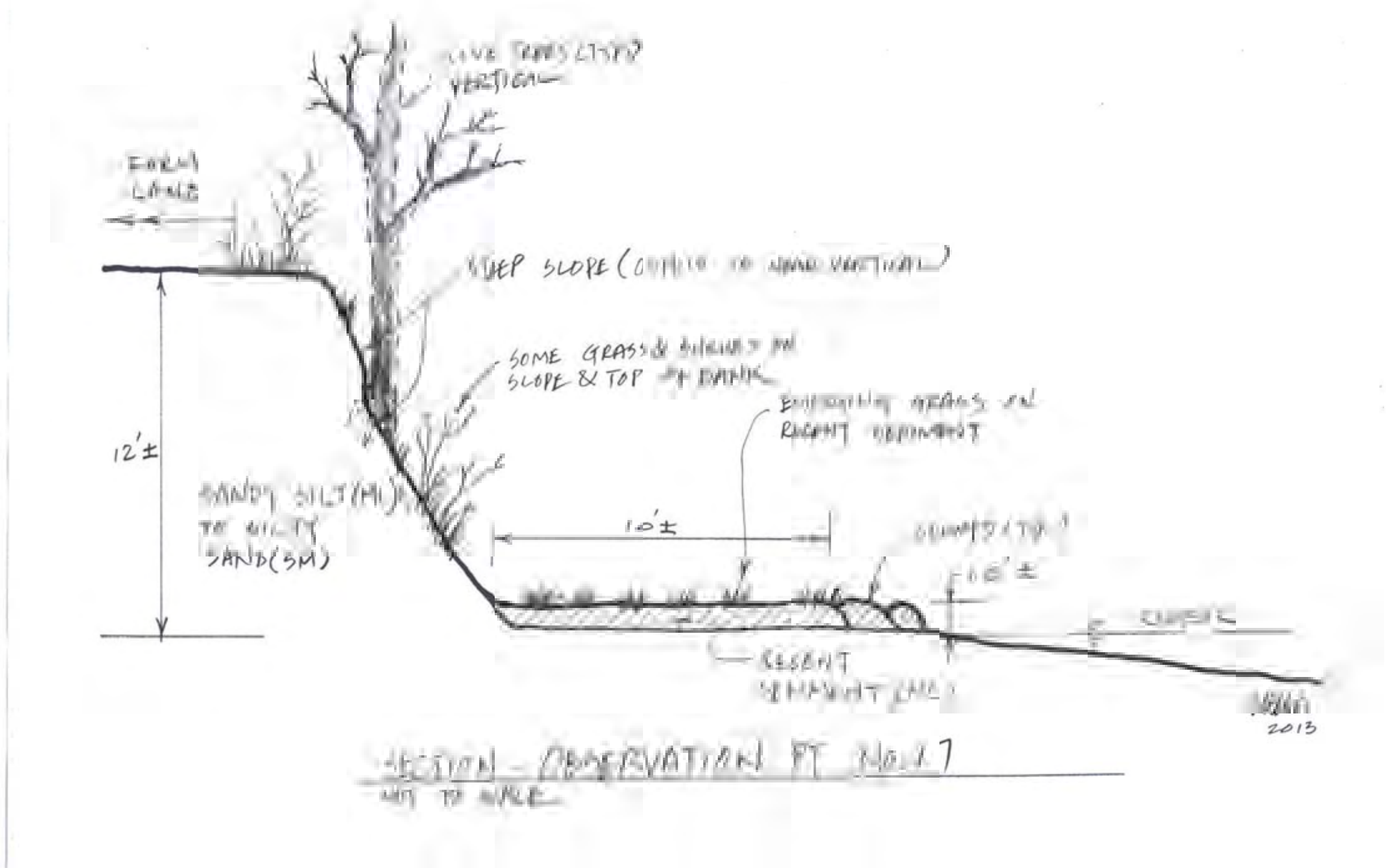
Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) to SILTY SAND (SM) – Nonplastic, approx. 50% fine sand, gray.

Observed Erosion Features:

- *Minor erosion of recent sediments deposited during Hurricane Irene*
- *Steep older scarps above recent sediments, with exposed roots*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *17* **Date:** *November 15, 2013*

Station Number: *835+00*

Maximum Root Depth:

-

Erosion Classification:

Types of Erosion:

Indicators of Potential Erosion: Exposed roots

Notes: Minor erosion of recently deposited sediments (from Irene). Vegetation has become established on the sediment shelf, holding soils in place from fluvial force

Bank Vegetation:

Top: *Moderate (25-50%), Broad-leaved deciduous tree*
Silver maple, box elder, red maple, Japanese barberry, multiflora rose, winged euonymus, bittersweet, agricultural*

Face: *Moderate (25-50%), Broad-leaved deciduous tree*
Silver maple, red maple, wild rye, bulrush, bittersweet*

Toe: *Sparse (10-25%) emergent (nonpersistents)*
Woolgrass, soft rush, bull rush, cardinal flower

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
agricultural

Sensitive Receptor:
No

Notes: *agricultural field with thin riparian buffer*

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 638 - 641
Observation Point No. 17 - November 15, 2013

Photo No. 638

Photo No. 639

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 638 - 641
Observation Point No. 17 - November 15, 2013

Photo No. 640

Photo No. 641

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *18* **Personnel:** *YKC, AS, MM, CM, TS*

Date: *November 15, 2013* **Time:** *10:00 am*

Station Number: *870+00* **Photo Reference Numbers:** *642 - 646*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *867+00* **To Station Number** *925+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

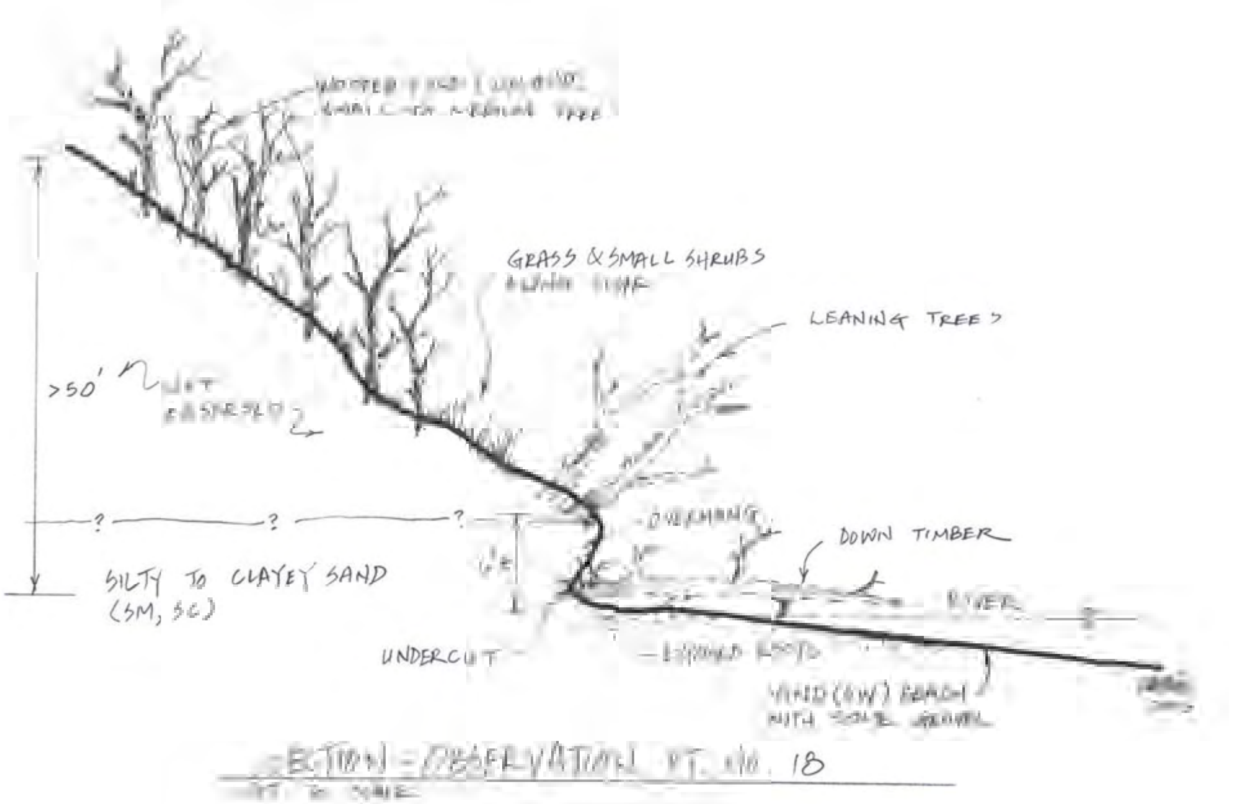
Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILTY SAND (SM) to CLAYEY SAND (SC) – Mostly fine sand, 20% to 30% low- to medium-plastic fines.

Observed Erosion Features:

- *Overhangs to near-vertical scarps near toe of bank.*
- *Exposed roots of leaning trees near toe of bank at river level, with undercuts behind roots.*
- *Down timber and leaning trees near river level.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *18* **Date:** *November 15, 2013*

Station Number: *870+00*

Maximum Root Depth:

-

Erosion Classification:

Types of Erosion: mass wasting

Indicators of Potential Erosion: Exposed roots
Overhanging bank
Undercuts

Notes: overhangs to near vertical scarps at the toe of the bank, exposed roots of leaning trees near toe of bank at river level with undercuts behind roots, downed trees and leaning trees near river level

Bank Vegetation:

Top: Heavy (>50%), Broad-leaved deciduous tree
Red oak, black birch, shag bark hickory, green ash, Japanese barberry, Christmas fern*

Face: Heavy (>50%), Broad-leaved deciduous tree
Red oak, black birch, shag bark hickory, green ash, river rye, sedges, solidago*

Toe: None-Very sparse (0-10%) emergent (nonpersistents)
river rye, sedges

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural & forested

Sensitive Receptor:
Yes

Notes: *emergent shelf at toe from ~station 930+00 to 920+00*

High bank, low bench

Lots of herbaceous veg at top of bank

Invasive species present (barberry, bittersweet), although sparse

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 642 - 646
Observation Point No. 18 - November 15, 2013

Photo No. 642

Photo No. 643

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 642 - 646
Observation Point No. 18 - November 15, 2013

Photo No. 644

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 642 - 646
Observation Point No. 18 - November 15, 2013

Photo No. 645

Photo No. 646

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *19* **Personnel:** *YKC, AS, MM, CM, TS*

Date: *November 15, 2013* **Time:** *11:00 am*

Station Number: *947+50* **Photo Reference Numbers:** *647 - 651*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *930+00* **To Station Number** *950+00*

Previously Stabilized? *Yes (previously designated Bonnett Site)*

Geologic / Geotechnical Observations:

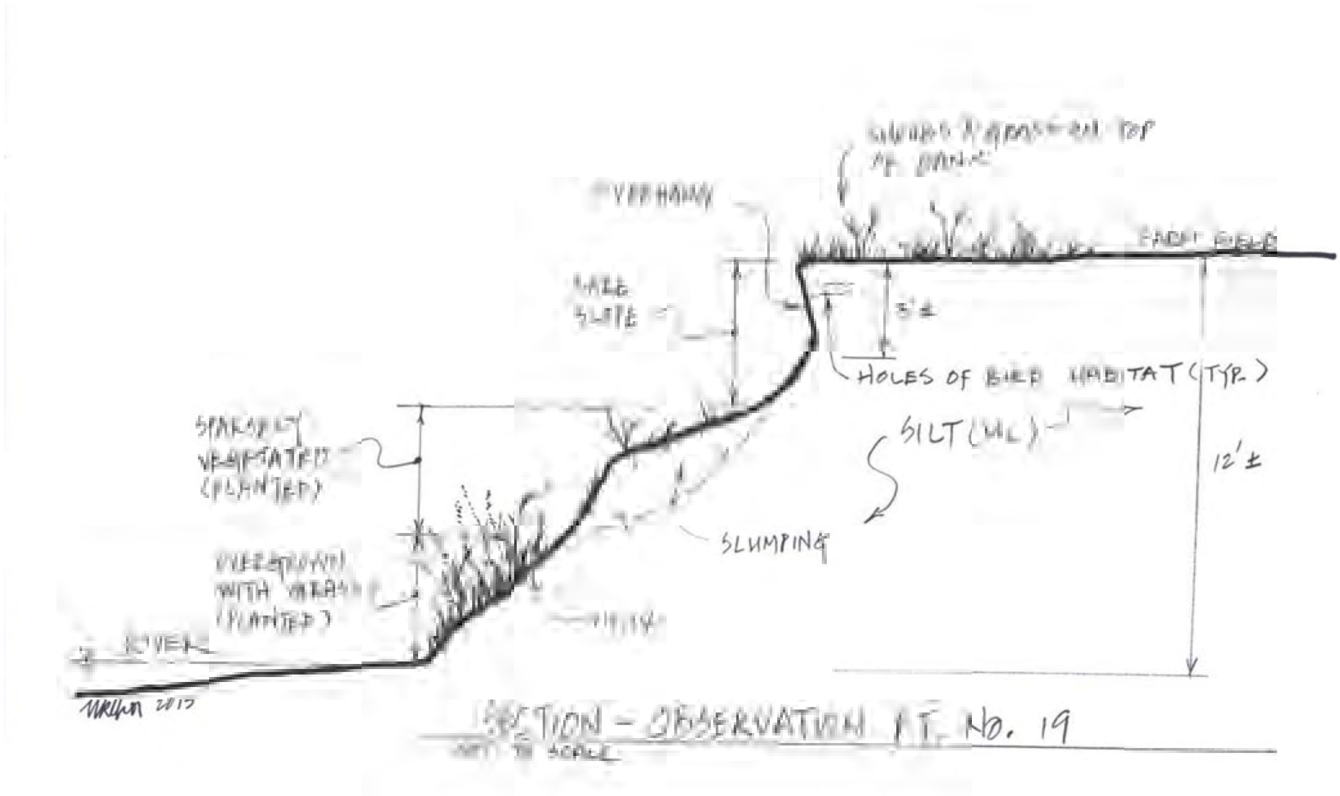
Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILT (ML) – Nonplastic, 20% to 30% fine sand, tan.

Observed Erosion Features:

- *Overhangs and near-vertical scarps at top of bank, with sparse vegetation.*
- *Mass-wasting and slumping at mid-slope.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *19* **Date:** *November 15, 2013*

Station Number: *947+50*

Maximum Root Depth:

-

Erosion Classification:

Types of Erosion: mass wasting

Indicators of Potential Erosion: Exposed roots
Overhanging bank
Undercuts

Notes: overhangs to near vertical scarps at the top of the bank, with sparse vegegation
Mass wasting & slumping at mid-slope

Bank Vegetation:

Top: Moderate (25-50%), Broad-leaved deciduous sapling
Red oak, black birch, shag bark hickory, green ash, Japanese barberry, Christmas fern*

Face: Moderate (25-50%), herbaceous
Red oak, black birch, shag bark hickory, green ash, river rye, sedges, solidago*

Toe: None (0-10%)
none

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural

Sensitive Receptor:
Yes

Notes: *Bonnette Farm site, recently partially restored*

Kingfisher nest cavity

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 646 - 651
Observation Point No. 19 - November 15, 2013

Photo No. 647

Photo No. 648

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 646 - 651
Observation Point No. 19 - November 15, 2013

Photo No. 649

Photo No. 650

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 646 - 651
Observation Point No. 19 - November 15, 2013

Photo No. 651

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *20* **Personnel:** *YKC, AS, MM, CM, TS*

Date: *November 15, 2013* **Time:** *11:40 am*

Station Number: *937+00* **Photo Reference Numbers:** *652 - 656*

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *Not Applicable (Note 1)* **To Station Number** *Not Applicable*

Note 1 – Observation point selected just upstream of Upper Island where river has wider cross section)

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:

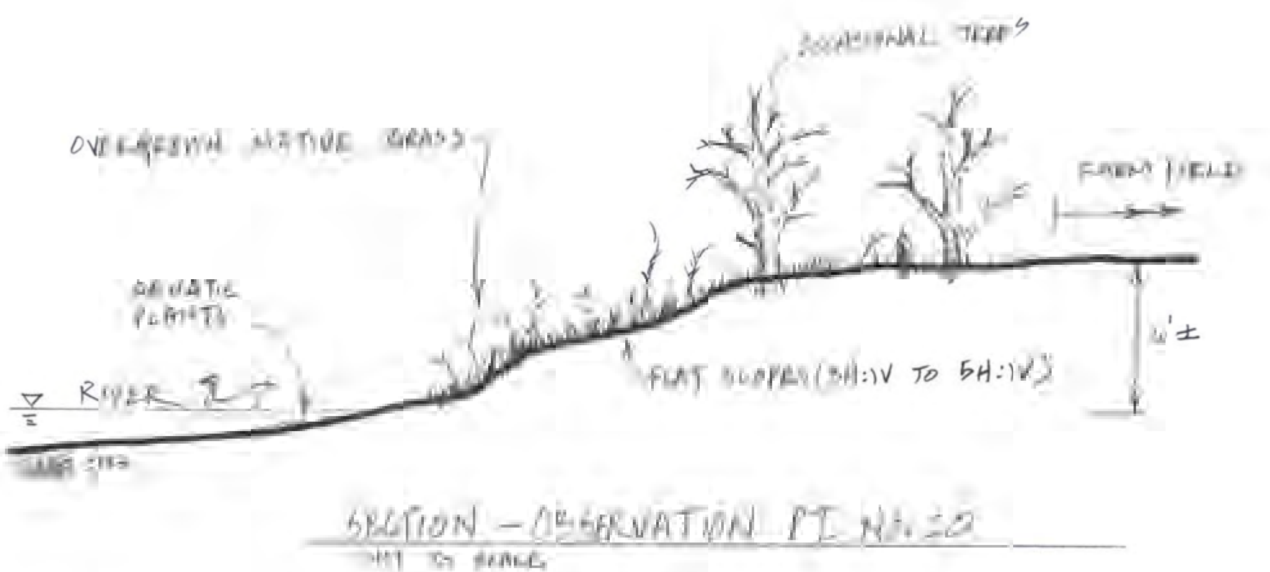
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

Soil not exposed. Entire bank overgrown with vegetation, and no excavation performed.

Observed Erosion Features:

- *Little to no erosion. Bank was very flat and appeared stable.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *20* **Date:** *November 15, 2013*

Station Number: *937+00*

Maximum Root Depth:

-

Erosion Classification:

Types of Erosion: little-no erosion

Indicators of Potential Erosion:

Notes: geotechnical form location point
Little to no erosion here
Bank level and stable
No exposed soils, dense vegetation

Bank Vegetation:

not recorded at this point

Adjacent Land Use:
Agricultural

Sensitive Receptor:
No

Notes: *Bank stable and level*

Upstream from Upper Island & ~20' downstream from this loc is a small creek discharging into the river

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 652 - 656
Observation Point No. 20 - November 15, 2013

Photo No. 652

Photo No. 653

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 652 - 656
Observation Point No. 20 - November 15, 2013

Photo No. 654

Photo No. 655

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 652 - 656
Observation Point No. 20 - November 15, 2013

Photo No. 656

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *21* **Personnel:** *YKC, AS, MM, CM, TS*

Date: *November 15, 2013* **Time:** *1:50 pm*

Station Number: *792+50* **Photo Reference Numbers:** *664 - 668*

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *765+00* **To Station Number** *795+00*

Previously Stabilized? *No (Just downstream of Kendle Restoration Site)*

Geologic / Geotechnical Observations:

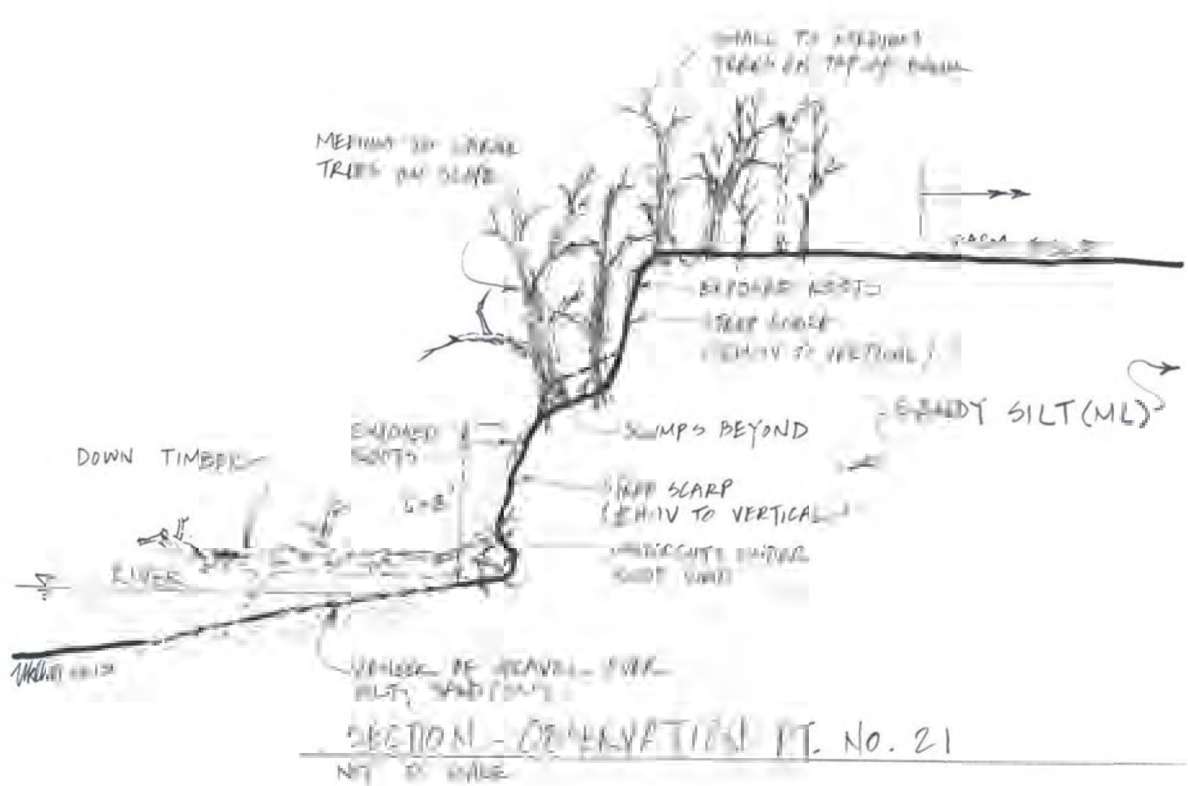
Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) – Nonplastic, 10% - 20% fine sand, gray.
Beach: GRAVEL (GP) to SILTY SAND (SM). Likely thin veneer.

Observed Erosion Features:

- *Significant erosion, with steep scarps and slumpings.*
- *Very steep banks, entire slope, with overhangs and undercuts near river level.*
- *Some slumpings.*
- *Exposed roots along scarps.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *21* **Date:** *November 15, 2013*

Station Number: *792+50*

Maximum Root Depth:

-

Erosion Classification:

Types of Erosion: mass wasting

Indicators of Potential Erosion: Exposed roots
Overhanging bank
Undercuts

Notes: overhangs to near vertical scarps at the top of the bank, with sparse vegegation
Mass wasting & slumping at mid-slope
Sandy/silty soils on bank face, gravelly beach

Bank Vegetation:

Top: Heavy (>50%), Broad-leaved deciduous sapling/shrub
Staghorn sumac, winged euonymus, barberry, bittersweet, ag fields*

Face: None to Very sparse (0-10%), broad-leaved deciduous shrub
Winged euonymus, barberry, bittersweet, rye, solidago

Toe: None to Very sparse (0-10%), herbaceous
Gravel beach

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural

Sensitive Receptor:
No

Notes: *Eroding banks*

Agricultural gullies

Significant invasive plant colonization (euonymus, barberry, bittersweet, autumn olive, honeysuckle)

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 664 - 668
Observation Point No. 21 - November 15, 2013

Photo No. 664

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 664 - 668
Observation Point No. 21 - November 15, 2013

Photo No. 665

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 664 - 668
Observation Point No. 21 - November 15, 2013

Photo No. 666

Photo No. 667

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 664 - 668
Observation Point No. 21 - November 15, 2013


Photo No. 668

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *22* **Personnel:** *YKC, MM, CM*

Date: *November 16, 2013* **Time:** *10:00 am*

Station Number: *260+00* **Photo Reference Numbers:** *674 - 683*

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *250+00* **To Station Number** *285+00*

Previously Stabilized? *Yes (previously designated Lower Split River Farm Restoration Site, constructed in 2009)*

Geologic / Geotechnical Observations:

Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) to SILTY SAND (SM) – Nonplastic, approx. 40% to 60% fine sand, light gray.

Other observations:

- *Vegetation and lower root wads effective to retain sediments.*
- *Upper root wads appeared too widely spaced to retain sediments.*
- *Installed movement pins near top of bank indicated no recent erosion on upper bank.*
- *Installed staff gage showed about 15 cm. of recent sediments from Hurricane Irene*
- *Coconut mats not effective to retain sediments on lower bench.*

Observed Erosion Features:

- *Little to no recent erosion. Repair appeared to be effective in controlling erosion along this segment.*

Site Sketch:

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *22* **Date:** *November 15, 2013*

Station Number: *260+00*

Maximum Root Depth:

>1m (cont below ground)

Erosion Classification:

Types of Erosion: restoration site/none

Indicators of Potential Erosion:

Notes:

Bank Vegetation:

Top: *Moderate (25-50%), Broad-leaved deciduous tree*
Silver maple, red oak, red maple, elm, barberry, bittersweet*

Face: *Moderate (25-50%), broad-leaved deciduous sapling/shrub*
Silver maple, red maple, bittersweet, grape, aster, mix grasses*

Toe: *Sparse (10-25%), herbaceous/emergents*
Juncus, woolgrass, silver maple pioneers (seedlings)

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural

Sensitive Receptor:
No

Notes: *Restoration site: vegetation and lower root wads appear to be successful in retaining sediments during freshet events*
Little to no erosion after restoration

Lower Split River Farm site

Restoration site w/o hard armor such as riprap, but bioengineering techniques (CWD)

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 674 - 683
Observation Point No. 22 - November 16, 2013

Photo No. 674

Photo No. 675

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 674 - 683
Observation Point No. 22 - November 16, 2013

Photo No. 676

Photo No. 677

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 674 - 683
Observation Point No. 22 - November 16, 2013

Photo No. 678

Photo No. 679

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 674 - 683
Observation Point No. 22 - November 16, 2013

Photo No. 680

Photo No. 681

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 674 - 683
Observation Point No. 22 - November 16, 2013

Photo No. 682

Photo No. 683

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *23* **Personnel:** *YKC, MM, CM*

Date: *November 16, 2013* **Time:** *11:30 am*

Station Number: *321+00* **Photo Reference Numbers:** *684 – 690, 698*

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *310+00* **To Station Number** *360+00*

Previously Stabilized? *Yes (Constructed 2012 – 2013, anticipated completion by end of 2013)*

Geologic / Geotechnical Observations:

<u>Stratigraphy:</u>
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

Native soil types not observed. Backfill materials for restoration in log structures and flat bench were sand and gravel.

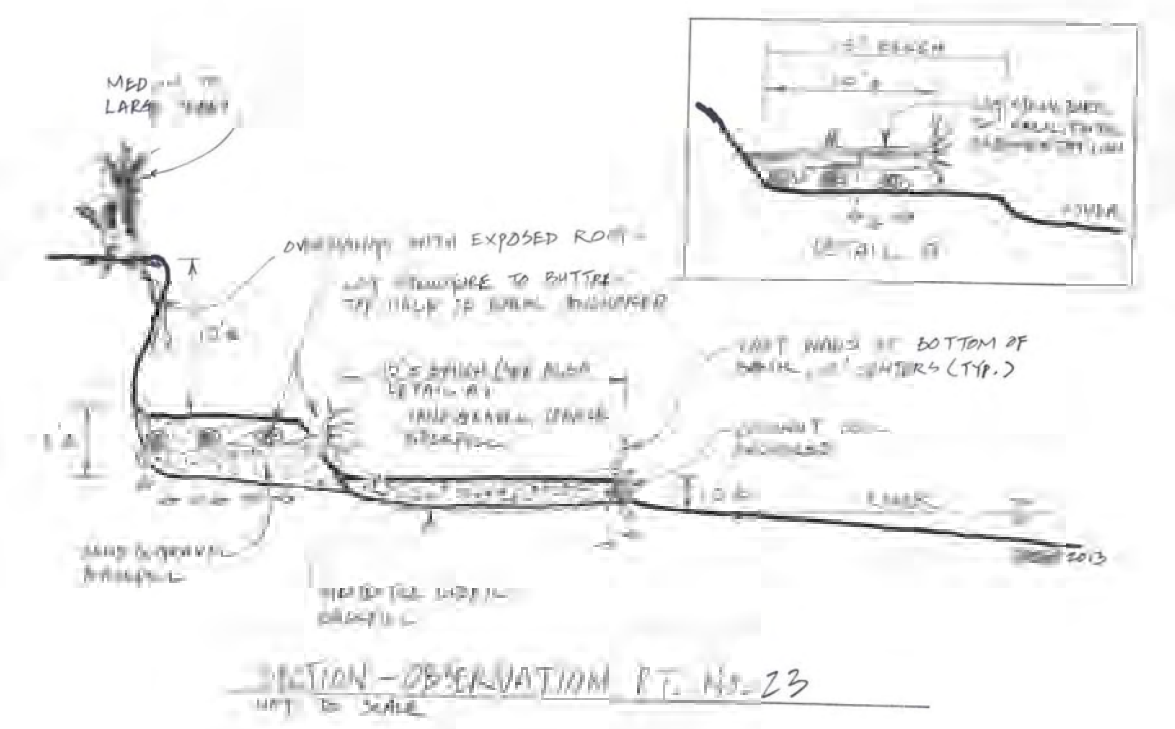
Other observations:

- *No seeding in restoration program. During stop for site observations, Mickey Marcus was broad-casting seeds of native grass and cattails along the flat bench (construction access road).*

Observed Erosion Features:

- *Old erosion scarps all along top half of bank, very steep (near vertical to overhangs), now protected with timber log buttress structures.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *23* **Date:** *November 16, 2013*

Station Number: *321+00*

Maximum Root Depth:

>2m (cont. below ground)

Erosion Classification:

Types of Erosion: mass wasting

Indicators of Potential Erosion: overhanging bank
exposed roots

Notes: Restoration site (bioengineering techniques where the existing eroding bank is left as-is and the toe/bench is built out). Log buttress structures and root wads.
Lots of exposed bank with old erosion scarps along the TOB

Very steep near vertical overhangs

Bank Vegetation:

Top: Moderate (25-50%), Broad-leaved deciduous tree
Silver maple, red oak, red maple, elm, bittersweet*

Face: Sparse (10-25%), broad-leaved deciduous sapling/shrub
Silver maple, red maple, bittersweet, grape, aster, mix grasses*

Toe: None to Very sparse (0-10%), herbaceous/emergents
Juncus, woolgrass, silver maple pioneers (seedlings), equisetum

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural

Sensitive Receptor:
Yes – kingfisher cavities

Notes: *Restoration site: vegetation and lower root wads appear to be successful in retaining sediments during freshet events*
Little to no erosion after restoration

Upper Split River Farm site

Restoration site w/o hard armor such as riprap, but bioengineering techniques (CWD)

Area of high terrace, slips and drainage gullies, lots of coarse woody debris

Upstream from gorge (constriction zone?)

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 684 – 690, 698
Observation Point No. 23 - November 16, 2013

Photo No. 684

Photo No. 685

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 684 – 690, 698
Observation Point No. 23 - November 16, 2013

Photo No. 686

Photo No. 687

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 684 – 690, 698
Observation Point No. 23 - November 16, 2013

Photo No. 688

Photo No. 689

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 684 – 690, 698
Observation Point No. 23 - November 16, 2013

Photo No. 690

Photo No. 698

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *24* **Personnel:** *YKC, MM, CM*

Date: *November 16, 2013* **Time:** *1:15 pm*

Station Number: *336+00* **Photo Reference Numbers:** *691 – 696, 698 - 699*

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *336+00* **To Station Number** *351+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

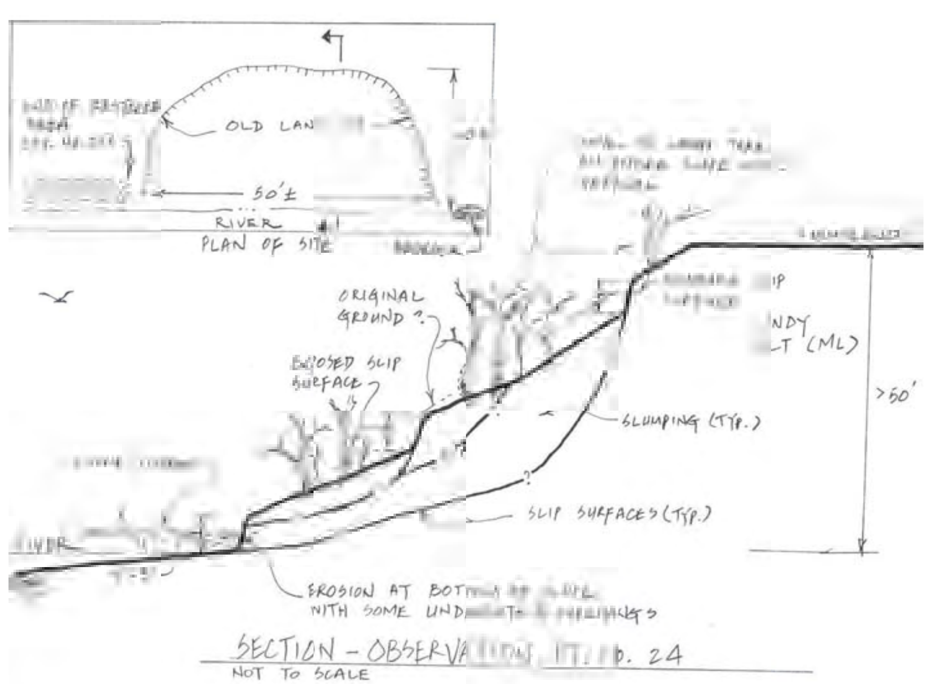
Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) – Nonplastic, 10% - 20% fine to medium sand, brown.

Other observations:
- *Bedrock outcrop at river level just upstream of old landslide.*
- *Observation area is a high terraced hill, heavily wooded.*
- *Evidences of old landslide (mass wasting), characterized by classical rotational slip surface extending from near the top of the hillside down to the river.*
- *Water-loving plants (horsetails) observed high on the hillside, suggesting possible high groundwater conditions.*
- *Trees (some very large) had mostly straight trunks, with few trees with curved trunks. Straight tree trunks indicate landslide movement probably predated the age of trees. Curved tree trunks may indicate on-going or past creep.*

Observed Erosion Features:
- *Only at the top of the slope near river level, with steep scarps and undercuts.*
- *Some down timber at river level.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *24* **Date:** *November 16, 2013*

Station Number: *336+00*

Maximum Root Depth:

Erosion Classification:

Types of Erosion: mass wasting

Indicators of Potential Erosion: overhanging bank
exposed roots
Creep/leaning trees

Notes: bedrock outcrop at river level
High terraced hillside

Bank Vegetation:

Top: Heavy (>50%), Broad-leaved deciduous tree
Red oak, gray birch, alder, ironwood*

Face: Moderate (25-50%), broad-leaved deciduous sapling
Red oak, ironwood, birches, alder*

Toe: None to Very sparse (0-10%), herbaceous/emergents
*Equisetum**

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural (hay field)

Sensitive Receptor:
No

Notes: *Some areas of bedrock*

No invasive plants here

Slow land movement, old creep

High terrace and evidence of landslides characterized by rotational slip from top of hillside down to river

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 691 – 696, 698 - 699
Observation Point No. 24 - November 16, 2013

Photo No. 691

Photo No. 692

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 691 – 696, 698 - 699
Observation Point No. 24 - November 16, 2013

Photo No. 693

Photo No. 694

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 691 – 696, 698 - 699
Observation Point No. 24 - November 16, 2013

Photo No. 695

Photo No. 696

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 691 – 696, 698 - 699
Observation Point No. 24 - November 16, 2013


Photo No. 698


Photo No. 699

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *25* **Personnel:** *YKC, MM, CM*

Date: *November 16, 2013* **Time:** *2:30 pm*

Station Number: *410+00 (Note 1)* **Photo Reference Numbers:** *705 – 710*

Note 1 – Area observed was between the wooded area and the creek (Otter Run), and represented the reach damaged by cows only. Conditions observed are not representative of entire restored site.

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *408+00* **To Station Number** *415+00*

Previously Stabilized? *Yes (previously designated Flagg Restoration Site)*

Geologic / Geotechnical Observations:

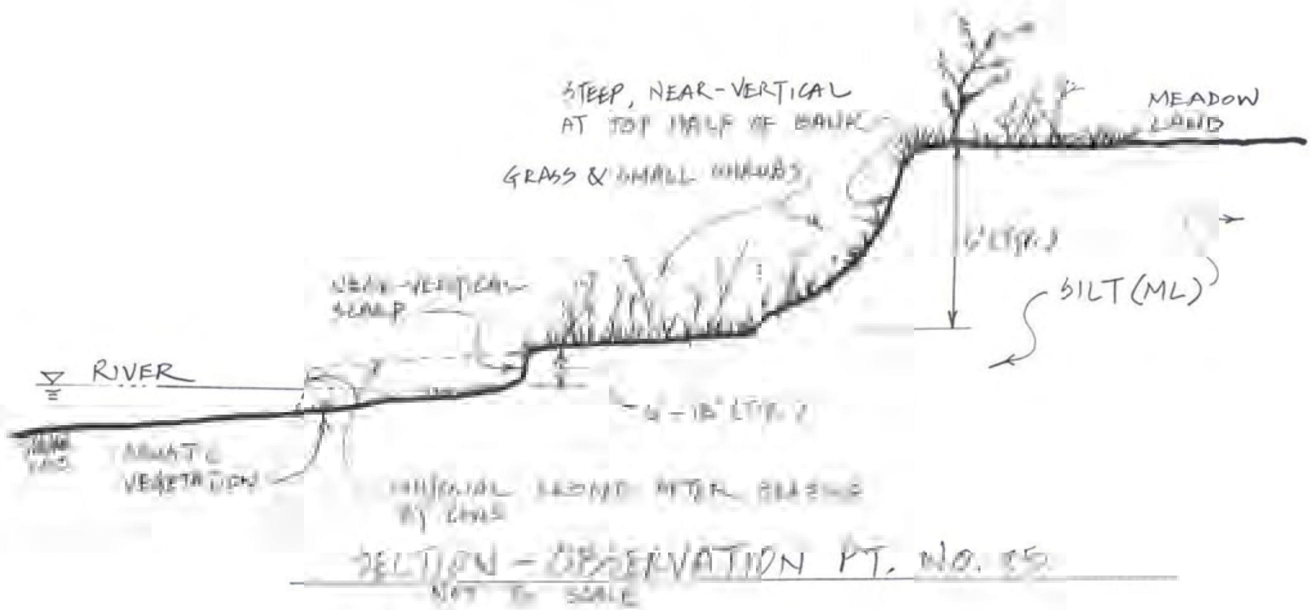
<u>Stratigraphy:</u>
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) – Nonplastic, 15% - 30% fine sand, tan.

Observed Erosion Features:

- *Steep, near-vertical scarps at top half of bank, appeared to predate repair.*
- *Portion of the flat lower bank material was eroded, reportedly after cows grazed and removed all planted vegetation.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *25* **Date:** *November 16, 2013*

Station Number: *410+00*

Maximum Root Depth:

>2m (cont. below ground)

Erosion Classification:

Types of Erosion: mass wasting

Indicators of Potential Erosion: overhanging bank
exposed roots

Notes: Steep, vertical, actively eroding bank

Bank Vegetation:

Top: None to Very sparse (0-10%), Broad-leaved deciduous shrub
Autumn olive, barberry, solidago*

Face: Sparse (10-25%), herbaceous
Solidago, various mixed grasses, barberry*

Toe: None to Very sparse (0-10%), herbaceous/emergents
Eleocharis (growing along bench)*

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural

Sensitive Receptor:
No

Notes: *Flagg restoration site, previously restored but ruined by cow grazing*

This bank was formerly the location of the largest bank swallow colony nest site on the CT River in western MA. However, due to excessive vegetation growth along the face of the bank there are no cavities currently.

Steep, vertical, actively failing sandy bank face with steep, vertical scarps at top half of bank (appear to predate restoration)

Portion o fthe lower bank material was eroded after grazing

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 705 - 710
Observation Point No. 25 - November 16, 2013

Photo No. 705

Photo No. 706

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 705 - 710
Observation Point No. 25 - November 16, 2013

Photo No. 707

Photo No. 708

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 705 - 710
Observation Point No. 25 - November 16, 2013

Photo No. 709

Photo No. 710

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *25* **Date:** *November 16, 2013*

Station Number: *485+00*

Maximum Root Depth:

19"

Erosion Classification:

Types of Erosion: mass wasting

Indicators of Potential Erosion: overhanging bank
exposed roots
downed trees
creep/leaning trees

Notes: recent failure, mostly mass wasting. Some minor fluvial erosion but mostly geomorphological bank failure (Irene, ~2 yrs)

Mass wasting and slumping, near vertical scarps and overhangs along TOB

Undercuts at toe

Bank Vegetation:

Top: Heavy (>50%), Broad-leaved deciduous tree
Mixed oaks and maples, winged euonymus, bittersweet, barberry

Face: Moderate (25-50%), Broad-leaved deciduous tree/sapling
Mixed oaks and maples, birches, bittersweet

Toe: None to Very sparse (0-10%), herbaceous/emergents
Juncus (patchy)*

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Forested & Agricultural

Sensitive Receptor:
No

Notes: *Urgiel Upstream restoration site (partial restoration)*

Significant invasives vegetation colonization (barberry, euonymus, bittersweet, some honeysuckle)

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *26* **Personnel:** *YKC, MM, CM*

Date: *November 16, 2013* **Time:** *3:30 pm*

Station Number: *485+00* **Photo Reference Numbers:** *712 - 716*

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *475+00* **To Station Number** *518+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SAND (SP) to SILTY SAND (SM) – Mostly medium sand, approx. 5% - 20% nonplastic fines.
GRAVELLY SAND (SP) – Mostly medium sand, <5% nonplastic fines, 10% - 20% fine to coarse gravel, 5% - 10% cobbles

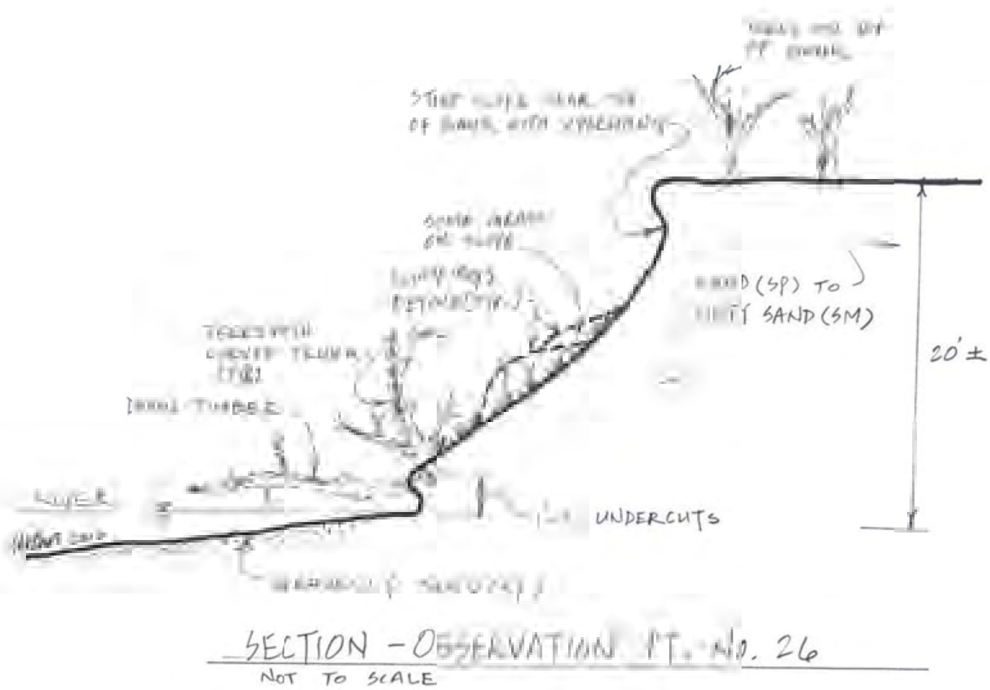
Other observations:

- *Minor recent sediments from Hurricane Irene.*

Observed Erosion Features:

- *Mass-wasting and slumping.*
- *Near-vertical scarp and overhang along top portion of upper bank.*
- *Undercuts at toe of bank at river level, especially under fell trees.*
- *Down timber, leaning and curved tree trunks indicated past ground movements.*

Site Sketch:



2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 712 - 716
Observation Point No. 26 - November 16, 2013

Photo No. 712

Photo No. 713

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 712 - 716
Observation Point No. 26 - November 16, 2013

Photo No. 714

Photo No. 715

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 712 - 716
Observation Point No. 26 - November 16, 2013


Photo No. 716

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *27* **Personnel:** *YKC, MM, CM*

Date: *November 17, 2013* **Time:** *10:30 am*

Station Number: *62+00* **Photo Reference Numbers:** *717 - 725*

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *57+00* **To Station Number** *90+00*

Previously Stabilized? *Yes (previously designated Camp Ground Point Restoration Site)*

Geologic / Geotechnical Observations:

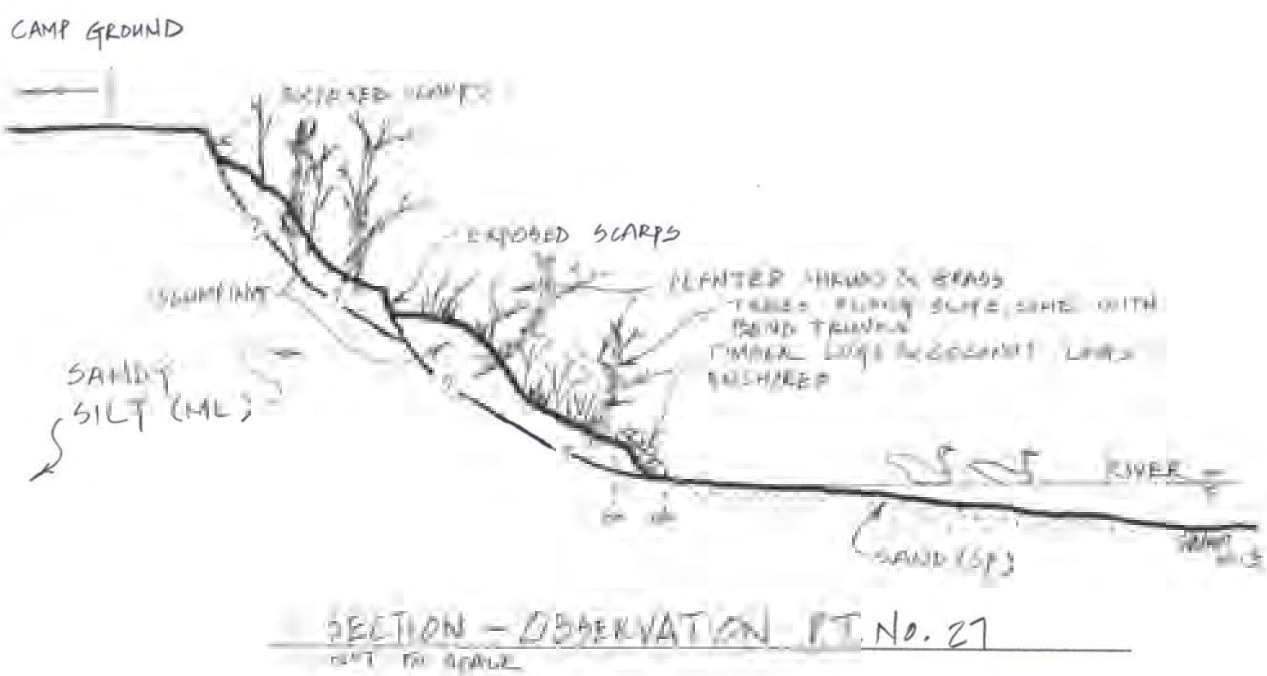
<u>Stratigraphy:</u>
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) – Nonplastic, 10% - 20% fine sand, tan.
SAND (SP) – Medium to coarse sand, <5% nonplastic fines, brown.

Observed Erosion Features:

- *Some erosion scarps and undercuts along bank where there were no logs protection (est. <50% along stabilized area)*
- *Mass-wasting process along entire hillside, with slumpings, bend trees, down timber.*
- *Slide scarps near top and mid-slope of bank.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *27* **Date:** *November 17, 2013*

Station Number: *62+00*

Maximum Root Depth:

24"

Erosion Classification:

Types of Erosion: mass wasting

Indicators of Potential Erosion: overhanging bank
exposed roots
downed trees
creep/leaning trees

Notes: Part of bank is failing (~30' high)
Campground Point
Bank is very steep and sandy
Erosioin scarps and undercuts along bank

Bank Vegetation:

Top: Heavy (>50%), Broad-leaved deciduous tree
Red oak, hemlock, eastern white pine, mixed birches, alder, mountain laurel*

Face: Moderate (25-50%), Broad-leaved deciduous tree/sapling
Red oak, hemlock, eastern white pine, alder and laurel*

Toe: None to Very sparse (0-10%), herbaceous/emergents
None (coconut coir along some toe, or sand)

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Forested & Agricultural

Sensitive Receptor:
No

Notes: "*Campground Point"*

Some sandy beach at toe, severe erosion on opposite side of river here as well, just downstream from Turners Falls Rod & Gun Club

Very deep channel in this section of the river (~140' deep)

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 717 - 725
Observation Point No. 27 - November 17, 2013

Photo No. 717

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 717 - 725
Observation Point No. 27 - November 17, 2013

Photo No. 718

Photo No. 719

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 717 - 725
Observation Point No. 27 - November 17, 2013

Photo No. 720

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Photo No. 721

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 717 - 725
Observation Point No. 27 - November 17, 2013

Photo No. 722

Photo No. 723

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 717 - 725
Observation Point No. 27 - November 17, 2013

Photo No. 724

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Photo No. 725

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *28* **Personnel:** *YKC, MM, CM*

Date: *November 17, 2013* **Time:** *1:00 pm*

Station Number: *65+00* **Photo Reference Numbers:** *727 - 734*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *59+00* **To Station Number** *70+00*

Previously Stabilized? *Yes (previously designated Rod and Gun Club Point Site)*

Geologic / Geotechnical Observations:

<u>*Stratigraphy:*</u>
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SAND (SP) – Mostly fine sand, <5% nonplastic fines, brown.

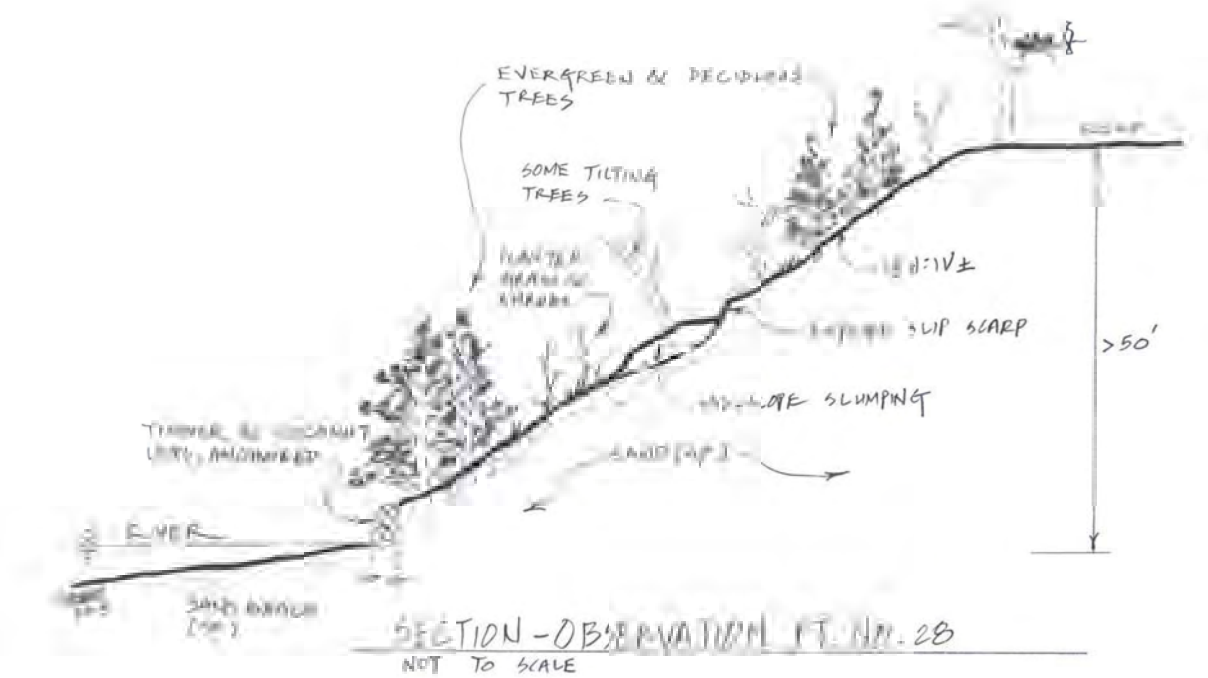
<u>*Other observations:*</u>

- *Sandy slopes appear to be at angle of repose.*
- *A bare slope, about 50' – 75' wide, with little vegetation, but no slumping.*

Observed Erosion Features:

- *Little to no erosion at the toe of bank. Stabilization repair appeared to be effective.*
- *Some mass-wasting along sandy mid-slope, with a few tilting trees.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *28* **Date:** *November 17, 2013*

Station Number: *65+00*

Maximum Root Depth:

-

Erosion Classification:

Types of Erosion: mass wasting

Indicators of Potential Erosion: overhanging bank
exposed roots
creep/leaning trees

Notes:

Bank Vegetation:

Top: *Heavy (>50%), Broad-leaved deciduous tree*
Mixed oaks, maples, hemlock, eastern white pine, laurel

Face: *Moderate (25-50%), Broad-leaved deciduous tree/sapling*
Hemlock, eastern white pine, alder, laurel, Sphagnum moss*

Toe: *None to Very sparse (0-10%), unvegetated*
Sand

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Rod & Gun Club

Sensitive Receptor:
No

Notes: Turners Falls Rod & Gun Club location

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 727 - 734
Observation Point No. 28 - November 17, 2013

Photo No. 727

Photo No. 728

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 727 - 734
Observation Point No. 28 - November 17, 2013

Photo No. 729

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 727 - 734
Observation Point No. 28 - November 17, 2013

Photo No. 730

Photo No. 731

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 727 - 734
Observation Point No. 28 - November 17, 2013


Photo No. 732


Photo No. 733

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 727 - 734
Observation Point No. 28 - November 17, 2013

Photo No. 734

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *29* **Personnel:** *YKC, MM, CM*

Date: *November 19, 2013* **Time:** *9:30 am*

Station Number: *659+00 (Note 1)* **Photo Reference Numbers:** *740 – 744*

Note 1 – Observed area is just upstream of Wicky Site. River was high, and beach area was submerged.

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *640+00* **To Station Number** *680+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:

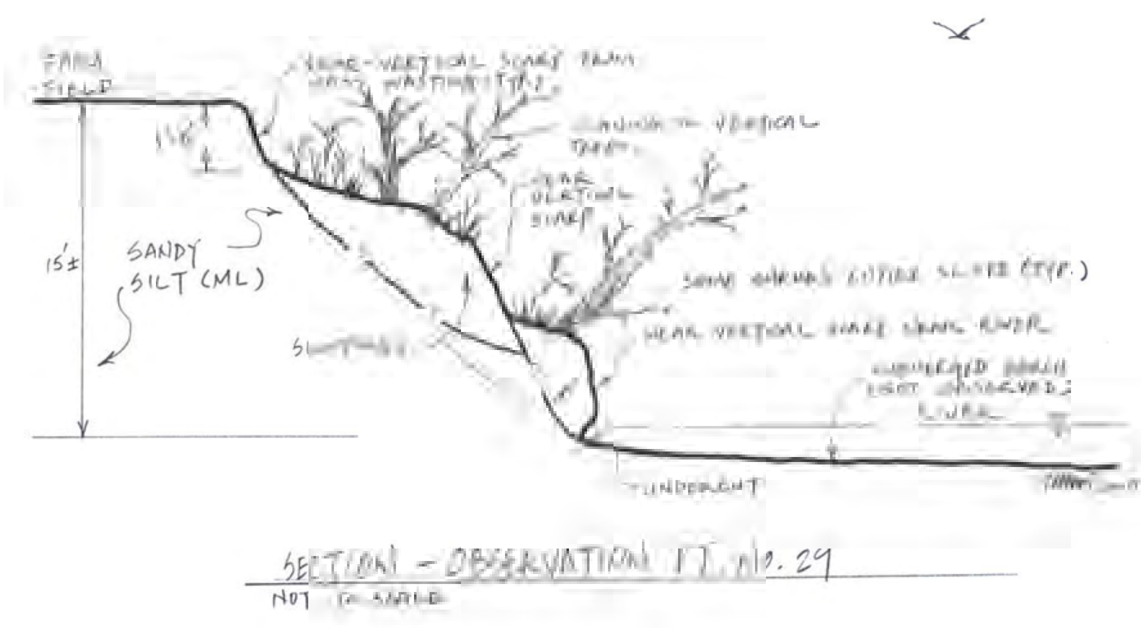
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) – Nonplastic, 10% - 20% fine sand, gray.

Observed Erosion Features:

- *Mass-wasting along entire slope, with near-vertical slide scarps exposed.*
- *Slumpings of materials, with some leaning trees.*
- *Undercuts at river level below near-vertical scarps.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *29* **Date:** *November 19, 2013*

Station Number: *659+00*

Maximum Root Depth:

>1.2 m (cont. below ground)

Erosion Classification:

Types of Erosion: mass wasting

Indicators of Potential Erosion: overhanging bank
exposed roots
creep/leaning trees

Notes: Mass wasting along entire slope, near vertical slide scarps

Bank Vegetation:

Top: Moderate (25-50%), Broad-leaved deciduous tree
Silver maple, sugar maple, staghorn sumac, multiflora rose, bittersweet*

Face: Moderate (25-50%), Broad-leaved deciduous vine
Bittersweet, grape*

Toe: None to Very sparse (0-10%), unvegetated

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural

Sensitive Receptor:
No

Notes: *Wickey site*

Lots of invasives here (multiflora rose, bittersweet, etc)

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 740 - 744
Observation Point No. 29 - November 19, 2013

Photo No. 740

Photo No. 741

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 740 - 744
Observation Point No. 29 - November 19, 2013

Photo No. 742

Photo No. 743

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 740 - 744
Observation Point No. 29 - November 19, 2013

Photo No. 744

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *30* **Personnel:** *YKC, CM*

Date: *November 19, 2013* **Time:** *10:40 am*

Station Number: *1052+00 (Note 1)* **Photo Reference Numbers:** *745 - 748*

Note 1 – Unnamed island at middle of river. River was high, and beach area was submerged.

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *1042+00* **To Station Number** *1059+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:

(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) – Nonplastic, 10% - 20% fine sand, gray.

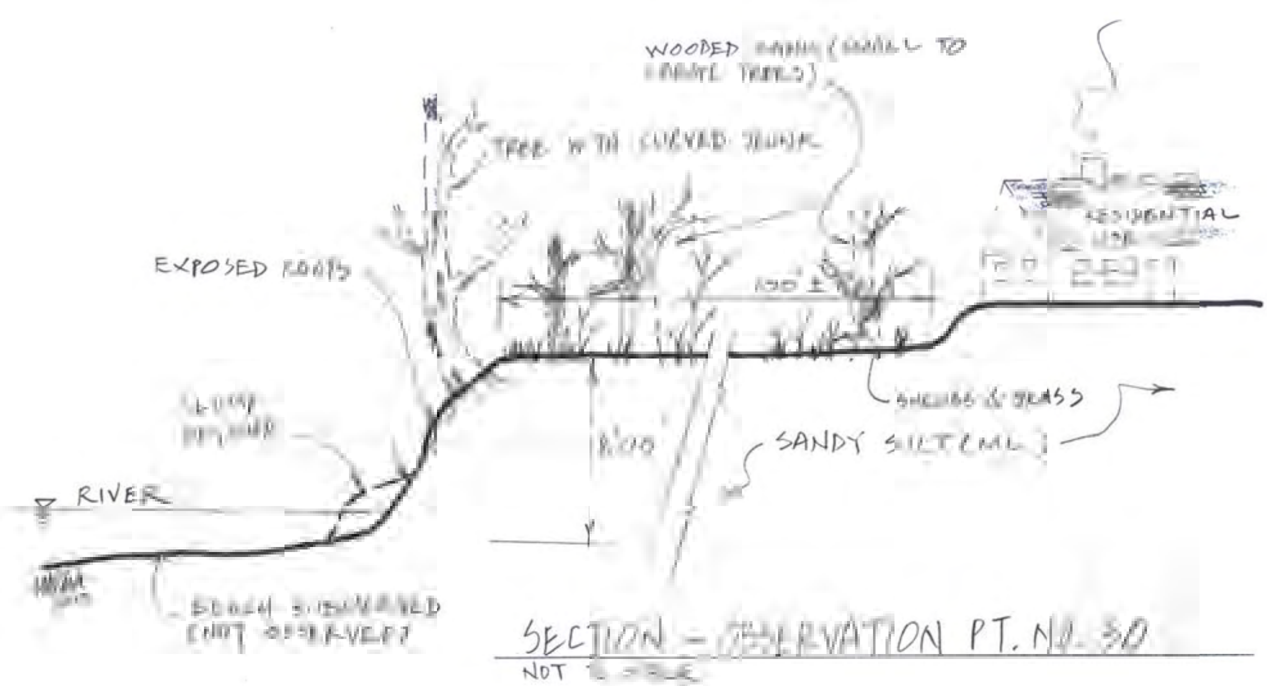
Other observations:

- *Water-loving vegetation (cottonwood, horsetails) observed on terrace, indicating high groundwater conditions.*

Observed Erosion Features:

- *Steep scarps along bank of wooded terrace at river level, with exposed roots.*
- *Some leaning trees and trees with curved trunks, indicated past ground movements.*
- *Minor slumpings at toe of bank at river level.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *30* **Date:** *November 19, 2013*

Station Number: *1052+00*

Maximum Root Depth:

-

Erosion Classification:

Types of Erosion:

Indicators of Potential Erosion: Overhanging bank
exposed roots
Leaning trees

Notes: low, stable bank with little fluvial erosion at toe

Bank Vegetation:

Top: Heavy (>50%), Broad-leaved deciduous tree
Cottonwood, sycamore, silver maple*

Face: Heavy (>50%), Persistent & non-persistent emergent
Equisetum, Solidago, mixed grasses/sedges/rushes*

Toe: Sparse (10-25%), Persistent & non-persistent emergent
*Equisetum**

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Residential, recreational (trail)

Sensitive Receptor:
No

Notes: *Steep scarps along bank of wooded terrace at river level, with exposed roots*

Some leaning trees (curved trunk)

Minor slumpings at toe

Minor evidence of fluvial erosion

Banks ~3-4' high with exposed roots near top where bank overhangs

No invasive non-native veg here – lovely floodplain forest

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 745 - 748
Observation Point No. 30 - November 19, 2013

Photo No. 745

Photo No. 746

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 745 - 748
Observation Point No. 30 - November 19, 2013

Photo No. 747

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 745 - 748
Observation Point No. 30 - November 19, 2013


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Photo No. 748

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *31* **Personnel:** *YKC, CM*

Date: *November 19, 2013* **Time:** *11:45 am*

Station Number: *982+00 (Note 1)* **Photo Reference Numbers:** *749 - 751*

Note 1 – River was high, but some beach area was still exposed.

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *982+00* **To Station Number** *960+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

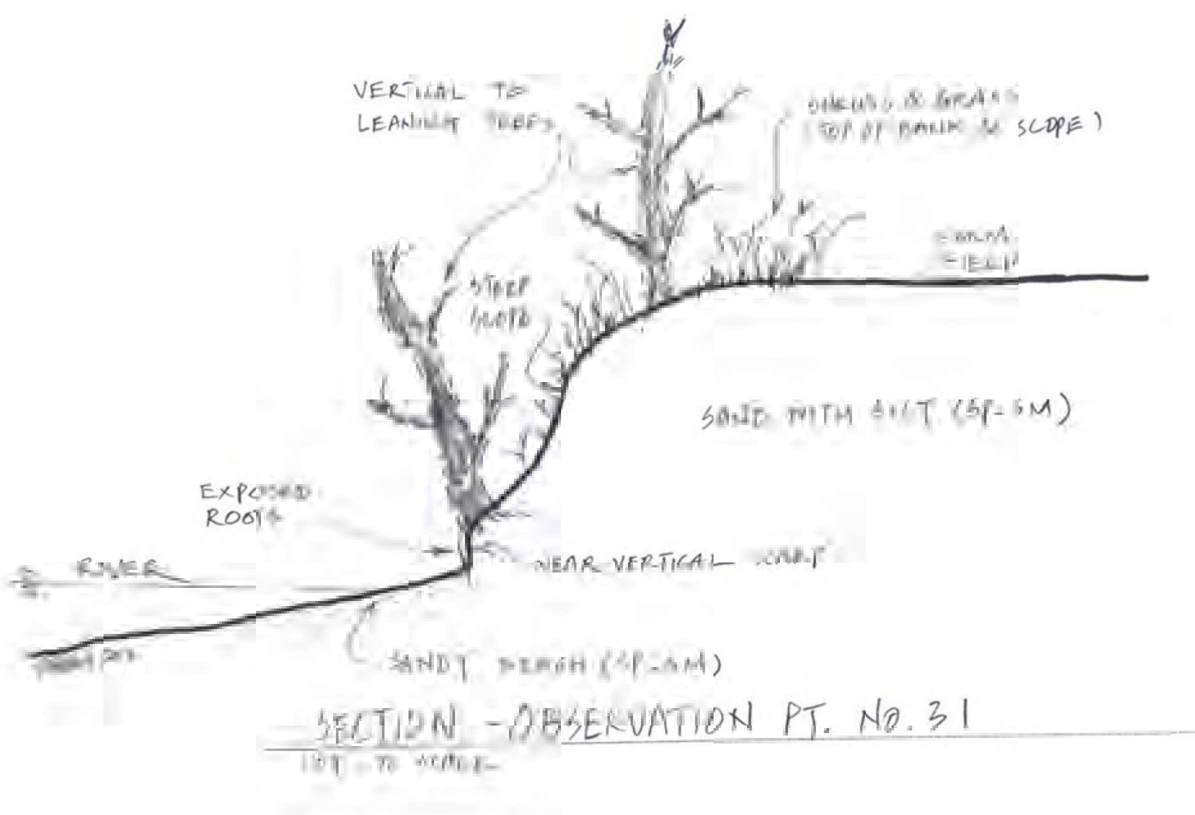
<u>Stratigraphy:</u>
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SAND WITH SILT (SP-SM) – Mostly very fine sand, 5% - 10% nonplastic fines, gray.

Observed Erosion Features:

- *Steep scarps with little to no vegetation, but mossy.*
- *Leaning trees and exposed roots near river level at toe of bank.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *31* **Date:** *November 19, 2013*

Station Number: *982+00*

Maximum Root Depth:

22"

Erosion Classification:

Types of Erosion:

Indicators of Potential Erosion: Creep/leaning trees
Exposed roots

Notes: Steep scarps with little to no vegetation other than moss

Leaning trees and exposed roots near river level at toe of bank

Bank Vegetation:

Top: Moderate (25-50%), Broad-leaved deciduous shrub
Staghorn sumac, sugar maple, birches, bittersweet, grape (trees = ~20% cover and shrub/vine = ~50% cover and therefore dominate)*

Face: Moderate (25-50%), vine
Bittersweet, grape, sumac*

Toe: None-Very Sparse (0-10%),
Some mixed grasses but primarily unvegetated beach

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural

Sensitive Receptor:
Yes

Notes: *As the land begins to curve there is increasing erosion: there is little to no erosion along the right bank upstream from farm to beyond the outcropping along the right bank*

Row crop adjacent land use with limited riparian buffer (<25' wide), which is dominated by non-native invasive plants

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 749 - 751
Observation Point No. 31 - November 19, 2013

Photo No. 749

Photo No. 750

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 749 - 751
Observation Point No. 31 - November 19, 2013

Photo No. 751

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *32* **Personnel:** *CM, LJ*

Date: *December 10, 2013* **Time:** *10:45 am*

Station Number: *1053+00* **Photo Reference Numbers:** *CM 56-60*

Left or Right Bank (Looking Downstream): *Island top, left & right (upstream third of island nose/end)*

Length of Representative Segment, From Station Number *1052+00* **To Station Number** *1057+00*

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

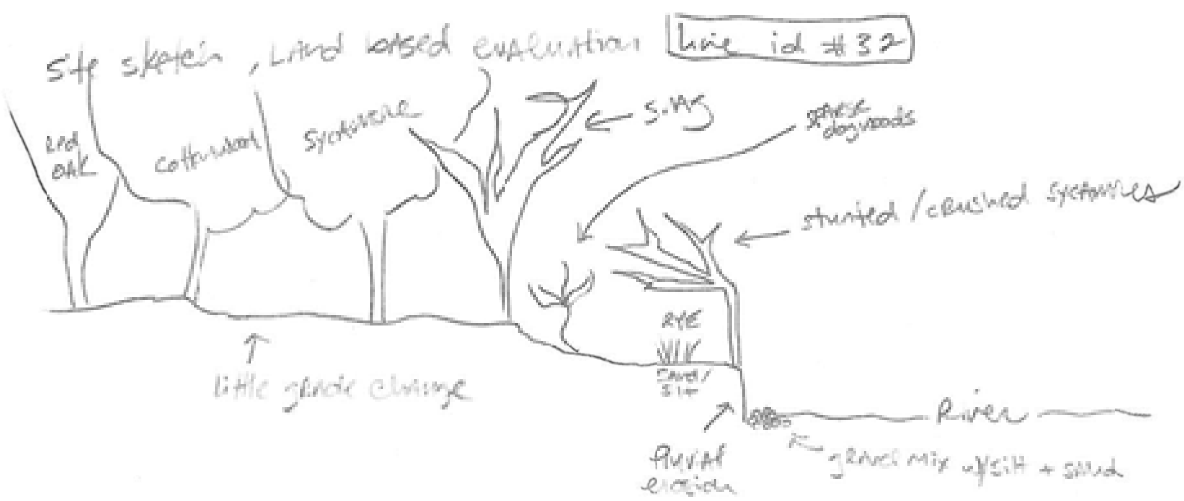
Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SAND (SP, SP-SM) – Mostly fine sand, 5% - 10% nonplastic fines, gray.

Observed Erosion Features:

- *Fluvial erosion <2' deep scours, from fluvial force, extending from upstream end of island around both sides approximately 1/3 down length of island*
- *Dead snags present, stunted and crushed sycamores from fluvial force*
- *Riparian forest community along island left bank and upstream "nose" of island consists of floodplain forest: cottonwood, sycamore, dead snags, red oak, with no shrub layer and some river rye in forbs layer.*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *32* **Date:** *December 10, 2013*

Station Number: *1053+00*

Maximum Root Depth:

Erosion Classification:

Types of Erosion: fluvial

Indicators of Potential Erosion: Exposed roots

Notes:

Bank Vegetation:

Top: *Heavy (>50%), Broad-leaved deciduous tree*
Cottonwood, sycamore, red oak, silver maple*

Face: *Moderate (25-50%), broad-leaved deciduous sapling/shrub*
Sycamore, dogwoods*

Toe: *Sparse (10-25%), herbaceous*
Primarily sand with some rye & solidago

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Forested, residential, dam

Sensitive Receptor:
No

Notes: *floodplain forest with low bank, little understory in forested areas, lots of dead snags from fluctuating hydroperiod (dam)*

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 56 through 60 (CM)
Observation Point No. 32 – December 10, 2013

Photo No. 58 (*Island left bank, note stunted crushed sycamores*)

Photo No. 59 (*Island left bank, note stunted crushed sycamores along bench and floodplain forest at top*)

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 56 through 60 (CM)
Observation Point No. 32 – December 10, 2013

Photo No. 56 (*fluvial scouring along upstream end of island*)

Photo No. 57 (*mature floodplain forest along island left bank*)

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *33* **Personnel:** *CM, LJ*

Date: *December 10, 2013* **Time:** *11:15 am*

Station Number: *1046+50* **Photo Reference Numbers:** *CM 61 & 62*

Left or Right Bank (Looking Downstream): *Island right*

Length of Representative Segment, From Station Number *1045+00* **To Station Number** *1050+00*
~595 feet

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

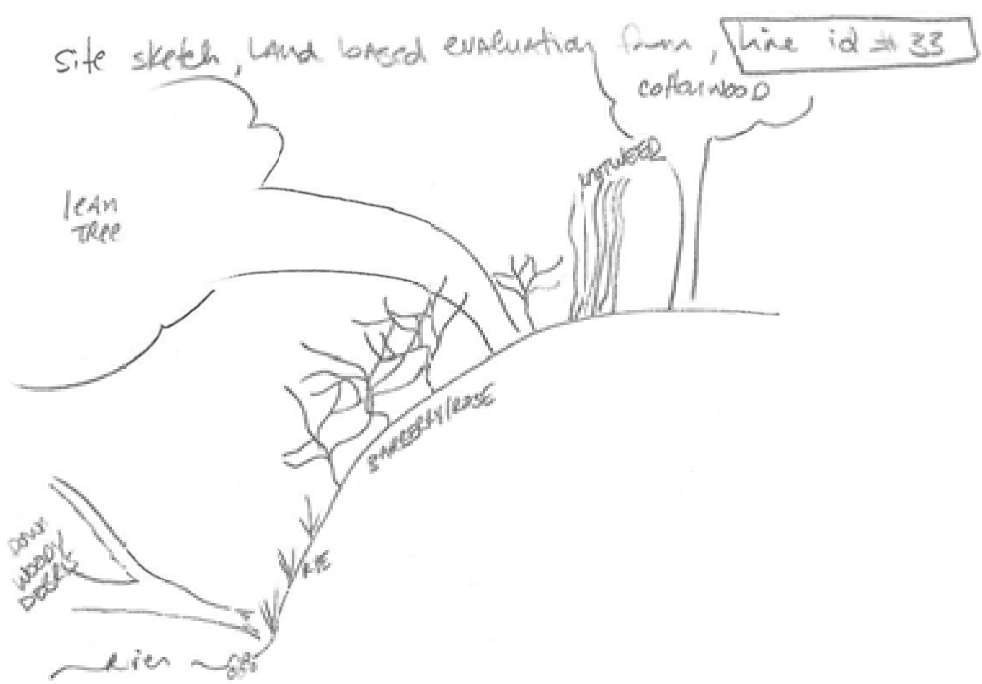
<u>Stratigraphy:</u>
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) – Slightly plastic, approx. 10% - 20% fine sand, dark gray.

Observed Erosion & other Features:

- *Steeper bank on right bank than left (island left is a gradual graded slope with floodplain forest and few-no invasive veg; island right is steep, eroding, densely colonized with invasive plants. Both fluvial and mass wasting on island right)*
- *Bank approximately 12' high and densely colonized with barberry, multiflora rose, knotweed and bittersweet in understory. Canopy is mix of cottonwood and red oak with few sycamores.*
- *Minor fluvial erosion at toe; pockets of mass wasting*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *33* **Date:** *December 10, 2013*

Station Number: *1046+50*

Maximum Root Depth:

Erosion Classification:

Types of Erosion: fluvial, some mass-wasting

Indicators of Potential Erosion: Overhanging bank
Creep/leaning trees

Additional Notes: Steeper sloped bank on the right side of the island than the left, which has a floodplain forest. More invasive non-native veg on this bank than the other side of island

Bank Vegetation:

Top: *Heavy (>50%), Broad-leaved deciduous tree*
Cottonwood, sycamore, silver maple, red oak*

Face: *Heavy (>50%), broad-leaved deciduous sapling/shrub*
Red osier dogwood, Japanese knotweed, Japanese barberry, multiflora rose, bittersweet*

Toe: *None to Very Sparse (0-10%), herbaceous*
*Rye**

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Forested, residential, dam

Sensitive Receptor:
No

Notes: *Steep slope with pockets of fluvial and mass-wasting erosion, some falls, some undercutting*

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 61 & 62 (CM)
Observation Point No. 33 – December 10, 2013

Photo No. 61 (*Vernon Island right bank, steeper and higher bank than island left*)

Photo No. 62 (*Vernon Island right bank, steeper and higher bank than left, and more invasive veg*)

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *34* **Personnel:** *CM, LJ*

Date: *December 10, 2013* **Time:** *11:45 am*

Station Number: *1000+00* **Photo Reference Numbers:** *CM 72, 73 & 74*

Left or Right Bank (Looking Downstream): *Island right & left (downstream tip and 2/3 of island right)*

Length of Representative Segment, From Station Number *989+00* **To Station Number** *1015+00*
~3478 feet (curves around downstream "nose" of island)

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

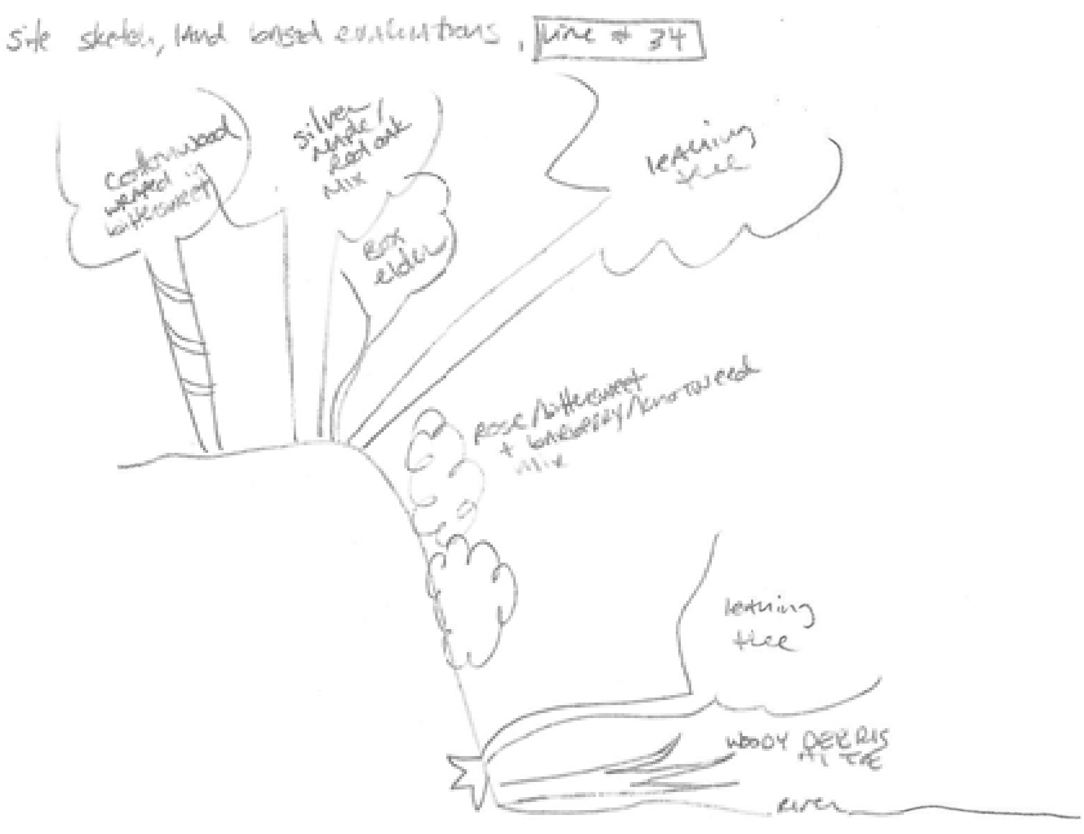
Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) – Slightly plastic, approx. 10% - 20% fine sand, dark gray.

Observed Erosion & other Features:

- *Historical slumps, some creep/leaning trees*
- *Significant invasive vegetation colonization (shrub layer is 90%+ dominated by Japanese barberry, in addition to other invasive plants present such as Japanese knotweed, oriental bittersweet, multiflora rose, et al) Canopy consists of red oak, silver maple, cottonwood and sycamore. Large presence of white tailed deer (sleeping forms easily observed throughout the island, tracks, scat, browse evidence and observed adults)*
- *The downstream (northern) end of the island appears to be transitional between depositional (upstream island left bank) and erosional zones (downstream tip of island and island right bank).*
- *Bald eagle perch (dead snag) and former nest site at downstream of island. Adult eagle observed utilizing this perch site.*
- *Island right bank is higher (elevational), nearly 20' high and extremely steep and steeper than island left bank (island left is a lower grade & depositional; see "Characterization" line for additional island left bank details).*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *34* **Date:** *December 10, 2013*

Station Number: *1000+00*

Maximum Root Depth:

Erosion Classification:

Types of Erosion: historical slumps

Indicators of Potential Erosion: Creep/leaning trees

Additional Notes: lots of invasive non-native veg

Bank Vegetation:

Top: *Heavy (>50%), Broad-leaved deciduous tree*
Red oak, silver maple, cottonwood, sycamore*

Face: *Moderate (25-50%), broad-leaved deciduous shrub*
Japanese barberry, multiflora rose, bittersweet*

Toe: *None to Very Sparse (0-10%), herbaceous*
*Rye**

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Agricultural, forested

Sensitive Receptor:
Yes – previous location of the eagle nest (blew down recently though) and is currently used as an eagle perch site

Notes: *there is a very high deer presence on this island*

Massive colonization of non-native plants. The shrub layer is nearly 100% dominated by Japanese barberry (monoculture) and there are several other invasives present as well, including multiflora rose, oriental bittersweet, Japanese knotweed, and a few unknown species (garden escapees)

The opposite side of the island has a low bank with a floodplain forest and this side has a higher, steeper bank populated with non-native shrubs/vines

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 72 through 74 (CM)
Observation Point No. 34 – December 10, 2013

Photo No. 72 (*Stebbins Island right bank*)

Photo No. 73 (*Stebbins Island right bank*)

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 72 through 74 (CM)
Observation Point No. 34 – December 10, 2013

Photo No. 74 (*Stebbins Island right bank, location of soil sample*)

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *35* **Personnel:** *CM, LJ*

Date: *December 12, 2013* **Time:** *11:45 am*

Station Number: *271+00* **Photo Reference Numbers:** *CM 75, 76, 77, & 78 (shows top of hill, back from bank)*

Left or Right Bank (Looking Downstream): *Left*

Length of Representative Segment, From Station Number *265+00* **To Station Number** *274+00*
~1135 feet

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

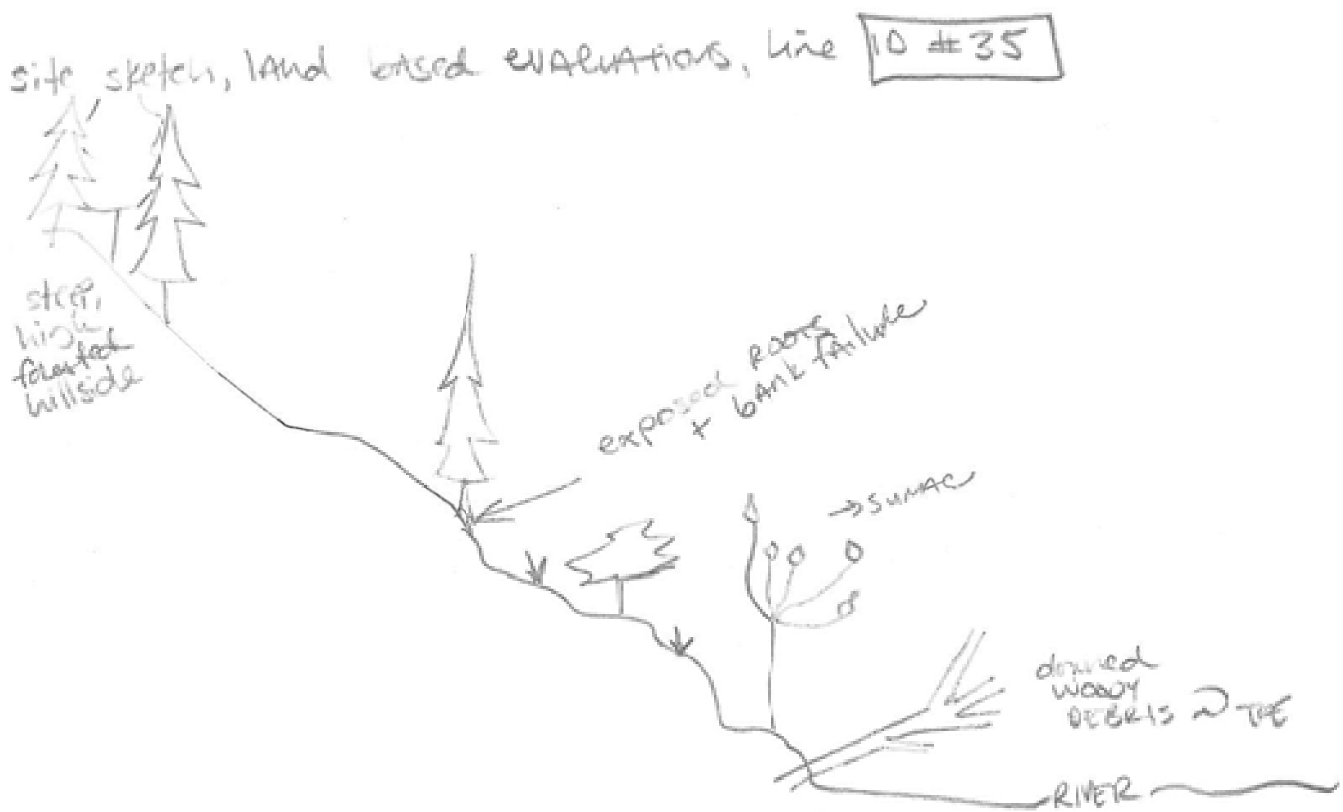
Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILT SAND (SM) to SANDY SILT (ML) – Nonplastic, approx. 40% - 60% mostly fine sand, brown.

Observed Erosion & other Features:

- *Eroding bank face, active mass wasting, very sandy soil*
- *Woody debris at toe*
- *Coniferous forest community*
- *Very steep, high hillside back from bank, and there is erosion at the top of the hill with overhanging hemlock roots just as at the top of the bank*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *35* **Date:** *December 12, 2013*

Station Number: *271+00*

Maximum Root Depth:

>1m (cont. below ground)

Erosion Classification:

Types of Erosion: new patches of mass wasting

Indicators of Potential Erosion: Exposed roots
Overhanging bank
Creep/leaning trees

Additional Notes: high, steep, sandy bank

Bank Vegetation:

Top: Heavy (>50%), Needle-leaved coniferous tree
Hemlock, eastern white pine, black birch, black cherry, red oak, red maple*

Face: Moderate (25-50%), broad-leaved deciduous shrub
Sumac, eastern white pine, honeysuckle, barberry, box elder, rose, birches*

Toe: None to Very Sparse (0-10%), herbaceous
Mostly downed woody debris

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Forested, agricultural

Sensitive Receptor:
Not yet, but this is new erosion and the soil type is appropriate for swallows/kingfisher nest cavities

Notes: *Slides, failed bank, very high steep hillside behind the bank (potential tension crack? – snow cover makes this not possible to investigate)*

Sandy soils and coniferous canopy

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 75 through 78 (CM)
Observation Point No. 35 – December 12, 2013

Photo No. 75 (*left bank, downstream from Riverview near station 272+00*)

Photo No. 76

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 75 through 78 (CM)
Observation Point No. 35 – December 12, 2013

Photo No. 77

Photo No. 78 (*top of the hillside back from river edge*)

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *36* **Personnel:** *CM, LJ*

Date: *December 12, 2013* **Time:** *10:30 am*

Station Number: *685+00* **Photo Reference Numbers:** *CM 88, 89, & 90*

Left or Right Bank (Looking Downstream): *Right*

Length of Representative Segment, From Station Number *680+00* **To Station Number** *710+00*
~1928 feet

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILT SAND (SP-SM, SP) – Mostly fine sand, approx. 10% - 20% nonplastic fines, brown.

Observed Erosion & other Features:

- *Nearly vertical bank with active failures, bank shape is almost convex it is so steep and falling into river*
- *Treefalls*
- *Sandy, silty soils*
- *Lots of invasive vegetation along this reach (mostly shrub and vine layer) under deciduous canopy cover*

Site Sketch:

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *36* **Date:** *December 12, 2013*

Station Number: *685+00*

Maximum Root Depth:

Erosion Classification:

Types of Erosion: new patches of mass wasting

Indicators of Potential Erosion: Creep/leaning trees
Overhanging bank
Exposed roots

Additional Notes: steep (nearly 1:1) alomost convex and in the process of falling into the river through active failures and throughout the reach

Trefalls

Sandy/silty soils

Bank Vegetation:

Top: *Heavy (>50%), Broad-leaved deciduous tree*
Red maple, red oak, bittersweet, rose, grape*

Face: *Heavy (>50%), broad-leaved deciduous shrub*
Multiflora rose, oriental bittersweet, honeysuckle, grape*

Toe: *None to Very Sparse (0-10%), herbaceous*
Mostly downed woody debris

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
agricultural

Sensitive Receptor:
No

Notes: *Active erosion and bank is almost convex as it slumps into the river.*

Many downed trees

Significant invasive veg colonization

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 88 through 90 (CM)
Observation Point No. 36 – December 12, 2013

Photo No. 88

Photo No. 89

2013 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 88 through 90 (CM)
Observation Point No. 36 – December 12, 2013

Photo No. 90

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *37* **Personnel:** *CM, SW & NV*

Date: *June 4, 2014* **Time:** *10:30 am*

Station Number: *37+50* **Photo Reference Numbers:** *CM 125-126*

Left or Right Bank (Looking Downstream): *Island Left*

Length of Representative Segment, From Station Number *35+00* **To Station Number** *40+00*
565 ft

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

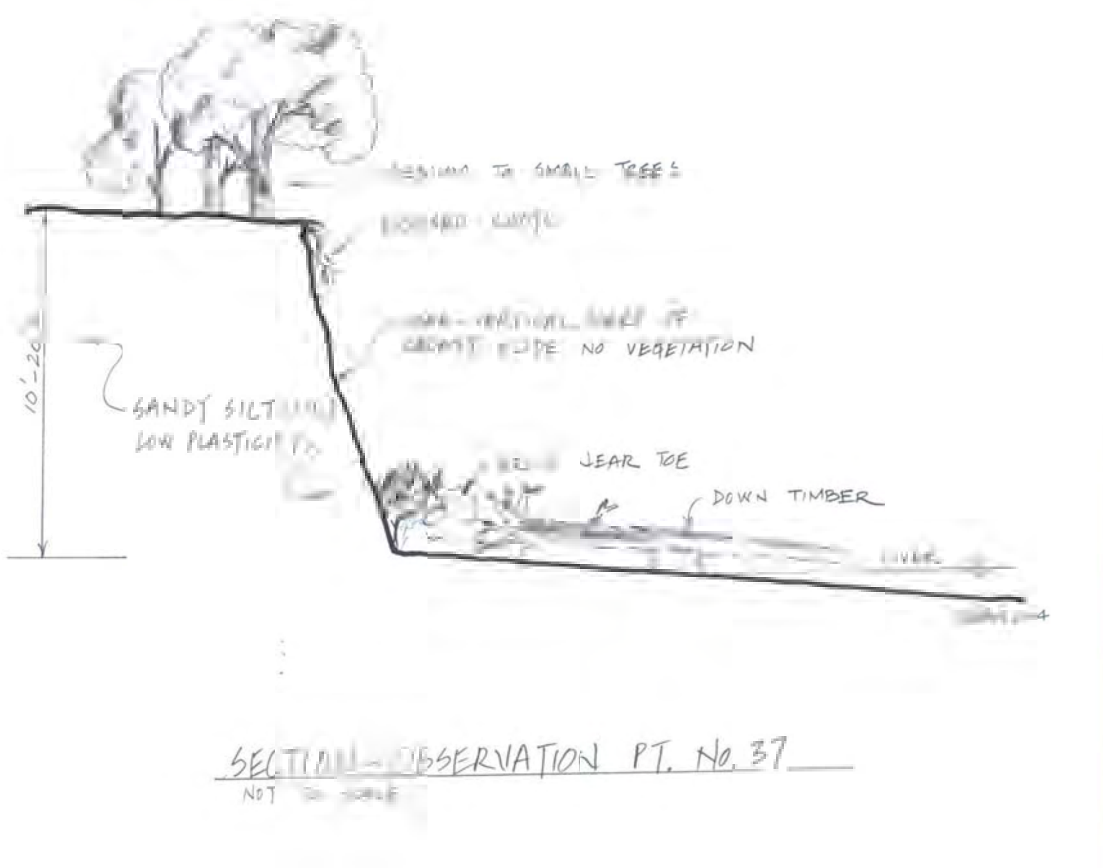
<u>*Stratigraphy:*</u>
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SANDY SILT (ML) – Low plasticity, approx. 30% - 40% mostly fine sand, light brown.

Observed Erosion & other Features:

- *Recent slide*
- *High, sandy bank with silty, unvegetated bench*
- *Flat bench with native material*
- *Scattered fragments of shale throughout bench (typical for this reach)*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *37* **Date:** *June 4, 2014*

Station Number: *37+50*

Maximum Root Depth:
~20"

Erosion Classification:

Types of Erosion: new slide

Indicators of Potential Erosion: Exposed roots
Overhanging bank
Active erosion/slide

Bank Vegetation:

Top: *Heavy (>75%), Broad-leaved deciduous tree*
*Mixed oak * (red/white), red maple, beech, eastern white pine in the tree canopy, with alder*, beech, red maple, azalea, highbush blueberry, ash, chokecherry and shadblow in the shrub layer (75% cover), and Eqisetum fluvialtale, mixed mosses and princess pine in the herbaceous layer (~15%)*

Face: *Heavy (>75%), broad-leaved deciduous shrub/sapling*
Black birch, willow, quaking aspen, eastern white pine, red oak, a large snag, alder, multiflora rose, and a fallen oak. Bidens, sensitive fern, and Equisetum fluvialtale are present on the bank face in the herbaceous layer, and comprise approximately 5% cover.*

Toe: *None to Very Sparse (0-10%), herbaceous*
Mostly downed woody debris

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Island, forested. On shore the dominant land use is residential and recreational.

Sensitive Receptor:
No (but see notes, this is a recent active swallow nest site)

Notes: *The assessment continues from the upstream end of the island to nearly the downstream end, about where rip-rap was historically placed at the toe/bench*

There was a bank swallow colony nesting site observed here in November/December 2013. However, a recent slide has collapsed the nest sites and the cavities cannot be observed today.

2013/2014 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 125 & 126 (CM)
Observation Point No. 37 – June 4, 2014

Photo No. 125

Photo No. 126

Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *38* **Personnel:** *CM, SW & NV*

Date: *June 4 & June 10, 2014* **Time:** *2:30 pm & 11:30 am*

Station Number: *415+00* **Photo Reference Numbers:** *CM 1010054-1010066*

Left or Right Bank (Looking Downstream): *Island right*

Length of Representative Segment, From Station Number *410+00* **To Station Number** *420+00*
975 ft

Previously Stabilized? *No*

Geologic / Geotechnical Observations:

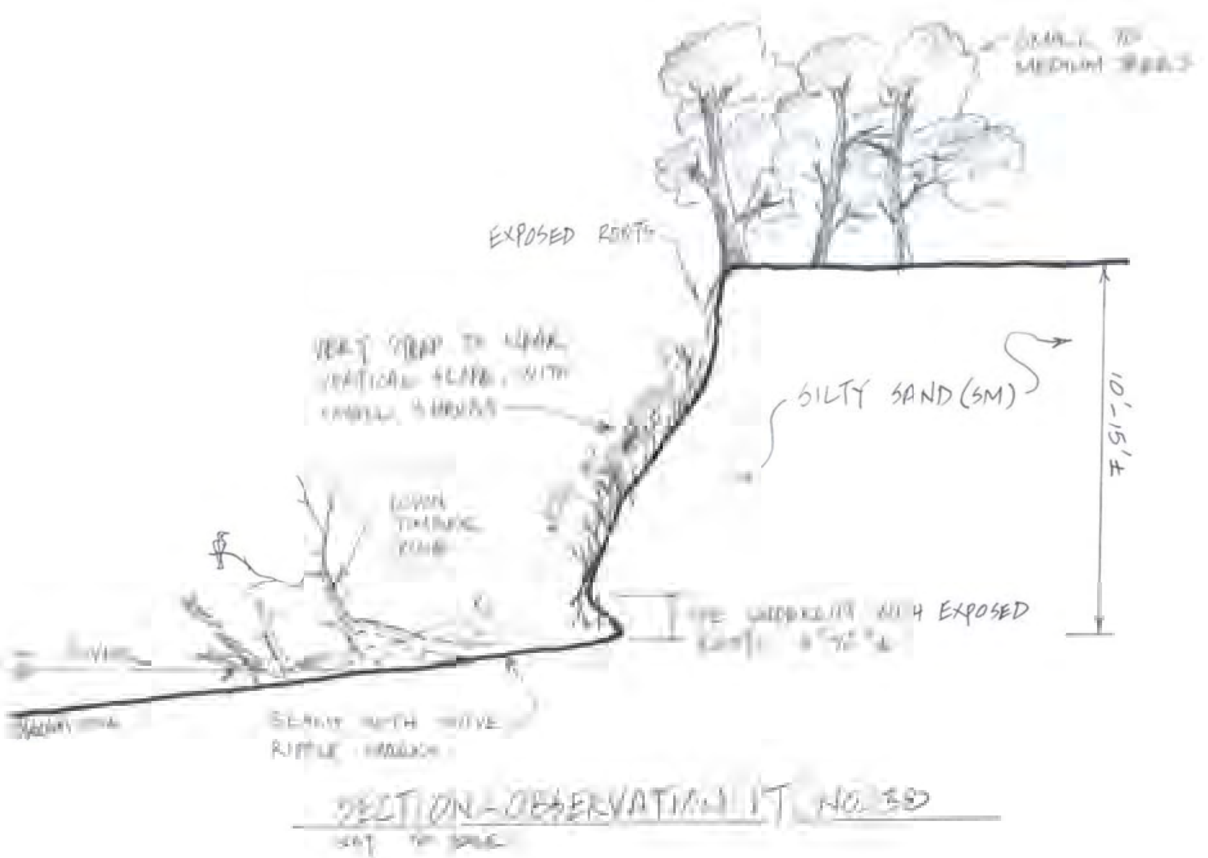
Stratigraphy:
(Refer to Site Sketch below for locations of soil/rock layers
Notations in parentheses are based on Unified Soil Classification System)

SILTY SAND (SM) – Fine sand, approx. 20% to 30% nonplastic fines, dark brown.

Observed Erosion & other Features:

- *Minor fluvial erosion at toe of slope*
- *Historic slides*
- *Areas of exposed, vertical bank face*
- *Wide silty bench with lots of large coarse woody debris*

Site Sketch:



Connecticut River – Turners Falls Impoundment Riverbank Classification for Land Based Survey

Observation Point Number: *38* **Date:** *June 10, 2014*

Station Number: *415+00*

Maximum Root Depth:
~3'

Erosion Classification:

<u>Types of Erosion</u>: old slides

<u>Indicators of Potential Erosion</u>: Exposed roots
Overhanging bank
Slides
Fluvial erosion at toe

Bank Vegetation:

<u>Top:</u> *Heavy (>75%), Broad-leaved deciduous tree*
Ash & basswood equi-dominant

<u>Face</u>: *Heavy (>75%), broad-leaved deciduous shrub/sapling*
Virginia creeper, O. bittersweet, staghorn sumac, ash, Equisetum fluviatile, Trifolium pratense, multiflora rose, Solidago, autumn olive, raspberry, poison ivy, great Solomon's seal, ostrich fern, Carex carina, jack-in-the-pulpit, sensitive fern

<u>Toe</u>: *None to Very Sparse (0-10%), herbaceous*
downed woody debris

NOTE: The dominant plant is noted with an *

Adjacent Land Use:
Island, forested.

Sensitive Receptor:
Yes – this is a hotspot:
Bald eagle nest (new)
American toad (with special golden color morph) breeding on shoreline
Gomphus eclosing all along shoreline, particularly where large coarse woody debris meets the waters edge

Notes:

2013/2014 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 57-66 (CM)
Observation Point No. 38 June 10, 2014

Photo No. P1010057

Photo No. P1010060

2013/2014 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 57-66 (CM)
Observation Point No. 38 June 10, 2014

Photo No. P1010061

Photo No. P1010064

2013/2014 Connecticut River Full River Reconnaissance
Land-Based Observations Photographs Reference No. 57-66 (CM)
Observation Point No. 38 June 10, 2014

Photo No. P1010065

Photo No. P1010066

APPENDIX I – BOAT-BASED SURVEY RIVERBANK SEGMENTS - FEATURES AND CHARACTERISTICS

2013 Riverbank Features and Characteristics

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
1	340	1115	Moderate	Low	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
2	41	135	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	None	Stable	None/Little
3	99	325	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
4	137	449	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
5	450	1476	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
6	33	108	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
7	76	249	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
8	331	1086	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
9	35	115	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		None	Stable	None/Little
10	132	433	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
11	187	614	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
12	58	190	Steep	High	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse	Planar Slip, Overhanging Bank	Overhanging Bank, Creep/Leaning Trees, Exposed Roots, Other	Active Erosion	Extensive
13	25	82	Moderate	High	Silt/Sand	Moderate	Steep	Bedrock	None-Very Sparse	Planar Slip, Overhanging Bank	Overhanging Bank, Creep/Leaning Trees, Exposed Roots	Active Erosion	Extensive
14	44	144	Steep	High	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Exposed Roots, Other	Eroded	Some

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
15	79	259	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
16	259	850	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		None	Stable	None/Little
17	121	397	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
18	476	1562	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
19	36	118	Moderate	Medium	Silt/Sand	Heavy	Vertical	Bedrock	None-Very Sparse	Slide	Other	Eroded	Some
20	55	180	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	None	Stable	None/Little
21	396	1299	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
22	162	531	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		None	Stable	None/Little
23	117	384	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
24	167	548	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
25	29	95	Moderate	High	Silt/Sand	Moderate	Moderate	Boulders	None-Very Sparse	Slide	Other, Creep/Leaning Trees	Eroded	Some
26	78	256	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
27	83	272	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
28	16	52	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
29	31	102	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Boulders	None-Very Sparse		None	Stable	None/Little
30	106	348	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
31	29	95	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse		None	Stable	None/Little
32	31	102	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	None	Stable	None/Little
33	50	164	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
34	97	318	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
35	24	79	Flat	Low	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	None	Stable	None/Little
36	94	308	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Boulders	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
37	97	318	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
38	248	814	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
39	15	49	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Bedrock	None-Very Sparse	Undercut	None	Stable	None/Little
40	110	361	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	None	Stable	None/Little
41	44	144	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	None	Stable	None/Little
42	27	89	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
43	68	223	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
44	399	1309	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
45	51	167	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
46	77	253	Moderate	Medium	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
47	38	125	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
48	21	69	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Boulders	None-Very Sparse		None	Stable	None/Little
49	310	1017	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
50	80	262	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	None	Stable	None/Little
51	30	98	Steep	High	Bedrock	Moderate	Steep	Bedrock	None-Very Sparse		None	Stable	None/Little
52	447	1467	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
53	241	791	Steep	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
54	258	846	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
55	30	98	Moderate	Low	Bedrock	Sparse	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
56	69	226	Moderate	High	Silt/Sand	Moderate	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
57	18	59	Vertical	High	Bedrock	None-Very Sparse	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
58	513	1683	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
59	62	203	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
60	29	95	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
61	122	400	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	None	Stable	None/Little
62	188	617	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	None	Stable	None/Little
63	122	400	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
64	59	194	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
65	45	148	Overhanging	High	Silt/Sand	Moderate	Moderate	Cobbles	None-Very Sparse	Slide	Creep/Leaning Trees	Eroded	Some
66	216	709	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		None	Stable	None/Little
67	85	279	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
68	30	98	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
69	117	384	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
70	32	105	Steep	High	Silt/Sand	Sparse	Flat/Beach	Gravel	None-Very Sparse	Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Active Erosion	Extensive
71	25	82	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
72	66	217	Steep	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse		None	Stable	None/Little
73	59	194	Steep	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
74	48	157	Steep	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
75	10	33	Vertical	High	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse	Topple	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Active Erosion	Extensive
76	26	85	Steep	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
77	47	154	Steep	High	Silt/Sand	Sparse	Flat/Beach	Gravel	None-Very Sparse	Slide	Creep/Leaning Trees	Eroded	Some to Extensive
78	41	135	Steep	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
79	43	141	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
80	300	984	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
81	22	72	Vertical	High	Bedrock	None-Very Sparse	Vertical	Bedrock	None-Very Sparse		None	Stable	None/Little
84	93	305	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Boulders	None-Very Sparse		None	Stable	None/Little
85	375	1230	Moderate	Low	Boulders	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
86	392	1286	Moderate	Low	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
87	63	207	Overhanging	High	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Rotational Slump	Creep/Leaning Trees, Overhanging, Exposed Roots	Eroded	Some to Extensive
88	61	200	Steep	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		Notch, exposed roots, creep/leaning trees	Stable	None/Little
89	322	1056	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse	Undercut	None	Stable	None/Little
90	19	62	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Rotational Slump, Undercut	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Extensive

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
91	60	197	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Rotational Slump	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
92	133	436	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Rotational Slump, Undercut	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
93	42	138	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
94	48	157	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Exposed Roots, Creep/Leaning Trees, Overhanging Bank	Eroded	Some
95	142	466	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Gravel	None-Very Sparse	Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
96	51	167	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
97	100	328	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
98	117	384	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Topples	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
99	75	246	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
100	22	72	Moderate	Low	Boulders	Moderate	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
101	64	210	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Eroded	Some
102	38	125	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Notching	Stable	None/Little
103	29	95	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
104	7	23	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse	Undercut	Notching, Creep/Leaning Trees, Exposed Roots	Stable	None/Little
105	214	702	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut, Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
106	62	203	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
107	144	472	Steep	High	Silt/Sand	None-Very Sparse	Flat/Beach	Silt/Sand	None-Very Sparse	Rotational Slump, Slide, Undercut	Overhanging Bank, Creep/Leaning Trees, Other	Eroded	Some
108	115	377	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
109	11	36	Overhanging	High	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut, Slide	Overhanging Bank, Creep/Leaning Trees, Exposed Roots	Eroded	Some

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
110	42	138	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
111	35	115	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Other, Creep/Leaning Trees, Exposed Roots	Eroded	Some
112	42	138	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
113	209	686	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
114	210	689	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		None	Stable	None/Little
115	56	184	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
116	53	174	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Other	Eroded	Some
117	64	210	Steep	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
118	233	764	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
119	121	397	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some to Extensive
120	478	1568	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		None	Stable	None/Little
121	511	1677	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
122	55	180	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
123	209	686	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
124	120	394	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
125	74	243	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
126	107	351	Moderate	Low	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Other	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
127	30	98	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Exposed Roots	Stable	None/Little
128	85	279	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
129	37	121	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
130	56	184	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Boulders	None-Very Sparse	Undercut	Exposed Roots, Creep/Leaning Trees	Stable	None/Little
131	100	328	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
132	26	85	Steep	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Rotational Slump, Undercut	Creep/Leaning Trees	Eroded	Some
133	28	92	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
134	17	56	Steep	High	Silt/Sand	Heavy	Flat/Beach	Bedrock	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
135	36	118	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
136	31	102	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Bedrock	None-Very Sparse	Undercut	Exposed Roots, Creep/Leaning Trees	Stable	None/Little
137	118	387	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
138	613	2011	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
139	250	820	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
140	98	322	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Exposed Roots, Creep/Leaning Trees, Overhanging Bank, Notch	Eroded	Some

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
141	71	233	Vertical	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Eroded	Some
142	80	262	Vertical	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Undercut	Creep/Leaning Trees, Exposed Roots	Eroded	Some
143	36	118	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		None	Stable	None/Little
144	27	89	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		None	Stable	None/Little
145	20	66	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Exposed Roots, Creep/Leaning Trees	Stable	None/Little
146	125	410	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		None	Stable	None/Little
147	311	1020	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
148	51	167	Steep	High	Silt/Sand	Moderate	Flat/Beach	Gravel	None-Very Sparse	Slide, Undercut	Creep/Leaning Trees, Exposed Roots	Eroded	Some
149	32	105	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
150	29	95	Steep	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Topples, Undercut	Creep/Leaning Trees, Exposed Roots	Eroded	Some
151	173	568	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand		Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
152	18	59	Steep	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Planar Slip, Undercut	Creep/Leaning Trees, Exposed Roots	Eroded	Some

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
153	204	669	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
154	48	157	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
155	65	213	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
156	45	148	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
157	15	49	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
158	52	171	Vertical	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Undercut	Other, Exposed Roots	Eroded	Some
159	92	302	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
160	107	351	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Exposed Roots, Creep/Leaning Trees	Stable	None/Little
161	72	236	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
162	57	187	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand		Slide	Creep/Leaning Trees, Exposed Roots	Eroded	None/Little
163	122	400	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		Notch	Stable	None/Little
164	28	92	Steep	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		None	Stable	None/Little
165	606	1988	Steep	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
166	15	49	Moderate	High	Silt/Sand	Heavy	Moderate	Silt/Sand	None-Very Sparse		None	Stable	None/Little
167	32	105	Moderate	High	Boulders	Moderate	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
168	30	98	Steep	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
169	85	279	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
170	157	515	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Creep/Leaning Trees, Exposed Roots	Eroded	Some to Extensive
171	40	131	Steep	High	Silt/Sand	Moderate	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
172	76	249	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut, Slide	Creep/Leaning Trees, Exposed Roots	Eroded	Some
173	165	541	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Potential Future Erosion	Some
174	87	285	Vertical	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
175	101	331	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
176	28	92	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Other, Overhanging Bank, Exposed Roots	Eroded	Some
177	113	371	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Exposed Roots, Creep/Leaning Trees	Stable	None/Little
178	65	213	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
179	52	171	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Eroded	Some
180	87	285	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
181	6	20	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Overhanging Bank, Exposed Roots	Eroded	Some
182	8	26	Steep	Low	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse	Gulley	Exposed Roots	Eroded	Some
183	25	82	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Exposed Roots, Overhanging Bank	Eroded	Some
184	67	220	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Other, Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
185	28	92	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Undercut	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Potential Future Erosion	Some
186	45	148	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
187	84	276	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Exposed Roots	Eroded	Some
188	51	167	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
189	40	131	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand		Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
190	67	220	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Undercut	Exposed Roots, Overhanging Bank, Creep/Leaning Trees	Eroded	Some
191	17	56	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
192	25	82	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots	Eroded	Some
193	116	381	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
194	66	217	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Undercut	Overhanging Bank, Creep/Leaning Trees, Exposed Roots	Eroded	Some
195	95	312	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
196	61	200	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Undercut	Overhanging Bank, Exposed Roots	Eroded	Some
197	58	190	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
198	59	194	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
199	90	295	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Undercut	Overhanging Bank, Creep/Leaning Trees, Exposed Roots	Eroded	Some

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
200	135	443	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Eroded	Some
201	14	46	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Undercut	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
202	188	617	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
203	203	666	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
204	85	279	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Other, Overhanging Bank, Exposed Roots	Eroded	Some
205	10	33	Moderate	Medium	Boulders	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Gulley	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
206	59	194	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
207	52	171	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Eroded	Some
208	16	52	Moderate	Medium	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
209	18	59	Vertical	High	Bedrock	None-Very Sparse	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
210	66	217	Moderate	Low	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
211	298	978	Moderate	High	Silt/Sand	Heavy	Moderate	Gravel	None-Very Sparse		None	Stable	None/Little
212	77	253	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Other	Potential Future Erosion	Some
213	84	276	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
214	59	194	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
215	15	49	Moderate	High	Silt/Sand	Heavy	Moderate	Silt/Sand	None-Very Sparse	Undercut	None	Stable	None/Little
216	166	545	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
217	42	138	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse	Undercut	Overhanging Bank, Exposed Roots	Potential Future Erosion	Some
218	69	226	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
219	17	56	Vertical	High	Bedrock	None-Very Sparse	Vertical	Bedrock	None-Very Sparse		None	Stable	None/Little
220	118	387	Steep	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
221	307	1007	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
222	10	33	Flat	Low	Bedrock	None-Very Sparse	Flat/Beach	Bedrock	None-Very Sparse		None	Stable	None/Little
223	4	13	Flat	Low	Bedrock	None-Very Sparse	Flat/Beach	Bedrock	None-Very Sparse		None	Stable	None/Little
224	37	121	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
225	41	135	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
226	153	502	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
227	169	554	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
228	93	305	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
229	49	161	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		Exposed Roots	Stable	None/Little
230	31	102	Overhanging	Medium	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Potential Future Erosion	Some

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
231	39	128	Steep	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
232	30	98	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Notch	Stable	None/Little
233	64	210	Steep	Medium	Silt/Sand	Moderate	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
234	27	89	Steep	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		Creep/Leaning Trees	Stable	None/Little
235	14	46	Moderate	Medium	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
236	10	33	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Notch, Exposed Roots	Stable	None/Little
237	16	52	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		None	Stable	None/Little
238	31	102	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Notching, Exposed Roots, Creep/Leaning Trees	Potential Future Erosion	Some
239	46	151	Vertical	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots, Notch, Overhanging Bank	Stable	Some
240	151	495	Vertical	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Stable	Some
241	137	449	Steep	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Exposed Roots, Overhanging Bank, Creep/Leaning Trees	Eroded	Some
242	42	138	Steep	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Potential Future Erosion	Some

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
243	21	69	Vertical	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Topples	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
244	115	377	Steep	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Potential Future Erosion	Some
245	191	627	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Potential Future Erosion	Some
246	627	2057	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
247	284	932	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
248	47	154	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Rotational Slump	Overhanging Bank, Exposed Roots	Eroded	Some
249	131	430	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
250	44	144	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Rotational Slump	Overhanging Bank, Creep/Leaning Trees, Exposed Roots	Eroded	Some
251	59	194	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
252	10	33	Vertical	High	Bedrock	None-Very Sparse	Vertical	Bedrock	None-Very Sparse		None	Stable	None/Little
253	66	217	Steep	High	Silt/Sand	Moderate	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
254	53	174	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		None	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
255	57	187	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Notching, Creep/Leaning Trees	Stable	None/Little
256	18	59	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	Sparse	Slide	Notching	Eroded	Some
257	25	82	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
258	42	138	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees	Eroded	Some
259	31	102	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
260	103	338	Steep	High	Silt/Sand	Moderate	Flat/Beach	Boulders	None-Very Sparse	Rotational Slump, Undercut	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
261	153	502	Steep	High	Silt/Sand	Moderate	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
262	48	157	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
263	16	52	Vertical	High	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Other, Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Eroded	Some
264	101	331	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
265	16	52	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		None	Stable	None/Little
266	46	151	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
267	80	262	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	Sparse		Notching	Stable	None/Little
268	65	213	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
269	29	95	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		None	Stable	None/Little
270	68	223	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
271	38	125	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
272	23	75	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
273	30	98	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
274	101	331	Vertical	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Topples	Overhanging Bank, Creep/Leaning Trees, Exposed Roots	Eroded	Some
275	50	164	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
276	294	965	Steep	High	Silt/Sand	Moderate	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
277	15	49	Steep	High	Silt/Sand	Moderate	Flat/Beach	Gravel	Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
278	157	515	Steep	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
279	34	112	Steep	High	Silt/Sand	Heavy	Flat/Beach	Gravel	Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
280	356	1168	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand		Undercut	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Stable	None/Little
281	64	210	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Eroded	Some
282	202	663	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
283	25	82	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Rotational Slump	Creep/Leaning Trees	Eroded	Some
284	265	869	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
285	64	210	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
286	11	36	Steep	High	Silt/Sand	Moderate	Flat/Beach	Gravel	None-Very Sparse	Topples, Rotational Slump	Creep/Leaning Trees, Exposed Roots	Eroded	Some
287	31	102	Steep	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
288	107	351	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
289	40	131	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
290	78	256	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
291	63	207	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
292	113	371	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
293	49	161	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
294	69	226	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
295	44	144	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
296	142	466	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
297	62	203	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
298	11	36	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		None	Stable	None/Little
299	127	417	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
300	292	958	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		None	Stable	None/Little
301	44	144	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
302	69	226	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
303	109	358	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
304	30	98	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
305	126	413	Vertical	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Rotational Slump, Undercut	Creep/Leaning Trees	Eroded	Some
306	63	207	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
307	131	430	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
308	23	75	Vertical	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Creep/Leaning Trees, Exposed Roots	Active Erosion	Extensive
309	80	262	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Eroded	Some
310	91	299	Steep	Medium	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Other, Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Eroded	Some
311	94	308	Moderate	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
312	74	243	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
313	199	653	Moderate	High	Silt/Sand	Moderate	Moderate	Boulders	None-Very Sparse	Undercut	Exposed Roots	Stable	None/Little
314	124	407	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
315	112	367	Steep	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		None	Stable	None/Little
316	153	502	Steep	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
317	72	236	Vertical	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Topples	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
318	256	840	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
319	156	512	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
320	77	253	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
321	37	121	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	None	Stable	None/Little
322	107	351	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
323	56	184	Steep	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
324	86	282	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
325	74	243	Moderate	Medium	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
326	53	174	Moderate	High	Silt/Sand	Heavy	Moderate	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
327	113	371	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
328	120	394	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		None	Stable	None/Little
329	48	157	Moderate	High	Silt/Sand	Heavy	Moderate	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Notch	Stable	None/Little
330	129	423	Moderate	High	Silt/Sand	Heavy	Moderate	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
331	24	79	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse	Slide	Overhanging Bank	Stable	None/Little
332	27	89	Moderate	High	Silt/Sand	Moderate	Moderate	Clay	None-Very Sparse	Slide	Overhanging, Exposed Roots	Potential Future Erosion	Some
333	128	420	Moderate	High	Silt/Sand	Heavy	Moderate	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
334	70	230	Moderate	Low	Silt/Sand	Moderate	Moderate	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
335	56	184	Moderate	Low	Silt/Sand	Moderate	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
336	82	269	Moderate	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
337	117	384	Flat	Low	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
338	120	394	Flat	Low	Silt/Sand	Moderate	Flat/Beach	Gravel	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
339	45	148	Flat	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
340	190	623	Moderate	High	Bedrock	None-Very Sparse	Steep	Bedrock	None-Very Sparse		None	Stable	None/Little
341	38	125	Moderate	High	Boulders	None-Very Sparse	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
342	276	906	Steep	High	Silt/Sand	None-Very Sparse	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Active Erosion	Extensive
343	88	289	Moderate	High	Boulders	None-Very Sparse	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
82	87	285	Vertical	High	Bedrock	None-Very Sparse	Vertical	Bedrock	None-Very Sparse		None	Stable	None/Little
83	54	177	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
344	208	682.4147	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		None	Stable	None/Little
345	52	170.6037	Moderate	Low	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
346	121	396.9816	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		None	Stable	None/Little
347	243	797.2441	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse		None	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
348	28	91.86352	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
349	16	52.49344						Bedrock					
350	36	118.1102	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
351	312	1023.622	Flat	Low	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
352	141	462.5984	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
353	197	646.3255	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse		None	Stable	None/Little
354	90	295.2756	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
355	170	557.7428	Flat	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
356	86	282.1522	Flat	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse		None	Stable	None/Little
357	122	400.2625	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
358	179	587.2704	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	None	Stable	None/Little
359	192	629.9213	Flat	Low	Silt/Sand	Moderate	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
360	427	1400.919	Steep	High	Bedrock	Moderate	Steep	Bedrock	None-Very Sparse		None	Stable	None/Little
361	214	702.0998	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	None	Stable	None/Little
362	199	652.8872	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Undercut	None	Stable	None/Little
363	158	518.3727	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	None	Stable	None/Little
364	226	741.4698	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
365	33	108.2677	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
366	129	423.2284	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
367	65	213.2546	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
368	180	590.5512	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
369	69	226.378	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
370	68	223.0971	Steep	High	Bedrock	Moderate	Steep	Bedrock	None-Very Sparse		None	Stable	None/Little
371	11	36.08924	Overhanging	High	Silt/Sand	Sparse	Steep	Bedrock	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
372	46	150.9186	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
373	94	308.399	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Stable	None/Little
374	229	751.3124	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
375	23	75.45932	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
376	180	590.5512	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
377	541	1774.934	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
378	425	1394.357	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
379	76	249.3438	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
380	126	413.3858	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
381	104	341.2074	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
382	44	144.357	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
383	120	393.7008	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
384	41	134.5144	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
385	31	101.706	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
386	184	603.6746	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
387	27	88.58268	Steep	High	Silt/Sand	Moderate	Moderate	Boulders	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots	Eroded	Some

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
388	123	403.5433	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Overhanging Bank, Exposed Roots	Potential Future Erosion	Some
389	206	675.853	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
390	92	301.8373	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	None	Stable	None/Little
391	315	1033.465	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
392	60	196.8504	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
393	65	213.2546	Flat	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		None	Stable	None/Little
394	82	269.0289	Flat	High	Silt/Sand	Heavy	Flat/Beach	Bedrock	None-Very Sparse		None	Stable	None/Little
395	353	1158.137	Moderate	High	Silt/Sand	Moderate	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
396	126	413.3858	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	None	Stable	None/Little
397	87	285.4331	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	None	Stable	None/Little
398	207	679.1339	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
399	145	475.7218	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
400	40	131.2336	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
401	52	170.6037	Steep	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
402	38	124.6719	Steep	High	Silt/Sand	Heavy	Steep	Bedrock	None-Very Sparse		None	Stable	None/Little
403	194	636.483	Steep	High	Bedrock	Moderate	Vertical	Bedrock	None-Very Sparse		None	Stable	None/Little
404	43	141.0761	Steep	High	Silt/Sand	Heavy	Steep	Bedrock	None-Very Sparse		None	Stable	None/Little
405	124	406.8242	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
406	27	88.58268	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
407	148	485.5643	Steep	High	Bedrock	Moderate	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
408	20	65.6168						Bedrock					

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
409	399	1309.055	Steep	High	Bedrock	Sparse	Steep	Bedrock	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
410	262	859.5801	Steep	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
411	133	436.3517	Steep	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
412	90	295.2756	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	None	Stable	None/Little
413	105	344.4882	Moderate	High	Silt/Sand	Heavy	Steep	Bedrock	None-Very Sparse	Undercut	None	Stable	None/Little
414	102	334.6457	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
415	113	370.7349	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
416	324	1062.992	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
417	215	705.3806	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Gravel	Heavy		Exposed Roots	Stable	None/Little
418	468	1535.433	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
419	35	114.8294	Moderate	High	Silt/Sand	Sparse	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
420	393	1289.37	Steep	High	Silt/Sand	Heavy	Flat/Beach	Gravel	Moderate		Overhanging Bank, Exposed Roots	Stable	None/Little
421	1015	3330.053	Steep	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		Overhanging Bank, Exposed Roots, Creep/Leaning Trees	In process of stabilization	None/Little
422	40	131.2336	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut, Topple	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
423	20	65.6168	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
424	284	931.7586	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut, Topple	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
425	9	29.52756	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
426	17	55.77428	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Bedrock	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
427	47	154.1995	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
428	150	492.126	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
429	12	39.37008	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
430	242	793.9633	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
431	276	905.5118	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
432	44	144.357	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
433	242	793.9633	Moderate	Low	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
434	134	439.6326	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
435	450	1476.378	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
436	83	272.3097	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
437	108	354.3307	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
438	86	282.1522	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
439	138	452.7559	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
440	71	232.9396	Moderate	High	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
441	271	889.1076	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	Sparse		None	Stable	None/Little
442	249	816.9292	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
443	177	580.7087	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		None	Stable	None/Little
444	140	459.3176	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
445	15	49.2126	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
446	130	426.5092	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
447	319	1046.588	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
448	132	433.0709	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
449	54	177.1654	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Rotational Slump, Undercut	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Eroded	Some
450	125	410.105	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
451	331	1085.958	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
452	21	68.89764	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
453	132	433.0709	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
454	392	1286.089	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	Sparse	Planar Slip	None	Stable	None/Little
455	255	836.6142	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Planar Slip	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
456	86	282.1522	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
457	18	59.05512	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Potential Future Erosion	Some
458	102	334.6457	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
459	50	164.042	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	None	Stable	None/Little
460	267	875.9843	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
461	34	111.5486	Moderate	Low	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	None	Stable	None/Little
462	44	144.357	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
463	49	160.7612	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Bedrock	None-Very Sparse		None	Stable	None/Little
464	112	367.4541	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
465	387	1269.685	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		Creep/Leaning Trees	Stable	None/Little
466	173	567.5853	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		Creep/Leaning Trees, Exposed Roots, Notch, Overhanging Bank	Potential Future Erosion	Some
467	302	990.8137	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Potential Future Erosion	Some
468	77	252.6247	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
469	16	52.49344	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Topples	Creep/Leaning Trees, Exposed Roots, Creep/Leaning Trees	Eroded	Some
470	53	173.8845	Overhanging	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
471	56	183.727	Steep	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
472	20	65.6168	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
473	19	62.33596	Steep	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
474	32	104.9869	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Potential Future Erosion	Some
475	23	75.45932	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Eroded	Some
476	38	124.6719	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Potential Future Erosion	None/Little
477	46	150.9186	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Overhanging Bank, Exposed Roots	Potential Future Erosion	None/Little
478	339	1112.205	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
479	38	124.6719	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
480	23	75.45932	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Exposed Roots, Overhanging Bank, Creep/Leaning Trees	Eroded	Some
481	12	39.37008	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
482	33	108.2677	Overhanging	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
483	16	52.49344	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
484	26	85.30184						Bedrock					
485	176	577.4278	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		None	Stable	None/Little
486	9	29.52756	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Bedrock	None-Very Sparse		None	Stable	None/Little
487	38	124.6719	Moderate	Low	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		None	Stable	None/Little
488	37	121.3911	Moderate	Low	Silt/Sand	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
489	77	252.6247	Moderate	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little
490	30	98.4252	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
491	550	1804.462	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
492	193	633.2021	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
493	22	72.17848	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Topples	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Eroded	Some
494	23	75.45932	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Potential Future Erosion	Some
495	212	695.5381	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
496	14	45.93176	Steep	High	Silt/Sand	Heavy	Flat/Beach	Cobbles	None-Very Sparse	Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
497	101	331.3648	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
498	200	656.168	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
499	742	2434.383	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
500	102	334.6457	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		None	Stable	None/Little
501	276	905.5118	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
502	32	104.9869	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
503	75	246.063	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
504	65	213.2546	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide, Undercut	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
505	67	219.8163	Steep	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
506	151	495.4068	Steep	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		None	Stable	None/Little
507	14	45.93176						Bedrock					
508	20	65.6168	Steep	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
509	553	1814.305	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
510	118	387.1391	Steep	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
511	84	275.5906	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
512	18	59.05512						Bedrock					

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
513	416	1364.829	Steep	Low	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
514	185	606.9554	Steep	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
515	589	1932.415	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
516	285	935.0394	Moderate	Medium	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	Sparse		Notching	Stable	None/Little
517	190	623.3596	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		Creep/Leaning Trees	Stable	None/Little
518	53	173.8845	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
519	66	216.5354	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		None	Stable	None/Little
520	190	623.3596	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
521	451	1479.659	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
522	84	275.5906	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
523	73	239.5013	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
524	21	68.89764	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Topples	Creep/Leaning Trees, Exposed Roots	Eroded	Some
525	225	738.189	Moderate	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse		None	Stable	None/Little
526	41	134.5144	Steep	High	Silt/Sand	Heavy	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
527	11	36.08924						Bedrock					
528	33	108.2677	Moderate	High	Silt/Sand	Moderate	Moderate	Boulders	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
529	61	200.1312	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
530	84	275.5906	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
531	115	377.2966	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
532	64	209.9738	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
533	234	767.7166	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Notch	Stable	None/Little
534	58	190.2887	Moderate	High	Silt/Sand	Heavy	Moderate	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
535	124	406.8242	Moderate	High	Silt/Sand	Moderate	Moderate	Bedrock	None-Very Sparse		Overhanging, Exposed Roots, Creep/Leaning Trees	Stable	None/Little
536	96	314.9606	Steep	Medium	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
537	83	272.3097	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Overhanging Bank, Exposed Roots	Eroded	Some
538	37	121.3911	Moderate	High	Silt/Sand	Moderate	Moderate	Bedrock	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
539	29	95.14436	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
540	49	160.7612	Steep	High	Bedrock	Moderate	Steep	Bedrock	None-Very Sparse		None	Stable	None/Little
541	179	587.2704	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
542	408	1338.583	Flat	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Notch	Stable	None/Little
543	258	846.4567	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Notch	Stable	None/Little
544	123	403.5433	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
545	80	262.4672	Moderate	Medium	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Notching	Stable	None/Little
546	101	331.3648	Moderate	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Notch	Stable	None/Little
547	305	1000.656	Moderate	Medium	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Notch	Stable	None/Little
548	277	908.7927	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Notch	Stable	None/Little
549	153	501.9685	Flat	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		Creep/Leaning Trees	Stable	None/Little
550	109	357.6116	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Notch	Stable	None/Little
553	159	521.6536	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Notch	Stable	None/Little
554	30	98.4252	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		Creep/Leaning Trees, Notch	Stable	None/Little
555	99	324.8032	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
556	143	469.1601	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
557	70	229.6588	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
557	15	49.2126	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
557	296	971.1286	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
558	114	374.0158	Moderate	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
559	117	383.8583	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Notch	Stable	None/Little
560	163	534.7769	Flat	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	Moderate		None	Stable	None/Little
561	168	551.1811	Steep	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
562	126	413.3858	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
563	149	488.8452	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
564	70	229.6588	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
565	153	501.9685	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
566	96	314.9606	Moderate	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Notching	Stable	None/Little
567	210	688.9764	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Notching	Stable	None/Little
568	70	229.6588	Moderate	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Exposed Roots	Stable	None/Little
569	37	121.3911	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
570	91	298.5564	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
571	71	232.9396	Steep	High	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Rotational Slump	Other	Eroded	None/Little
572	181	593.832	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
573	118	387.1391	Moderate	Medium	Silt/Sand	Heavy	Moderate	Silt/Sand	None-Very Sparse		None	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
574	56	183.727	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
575	71	232.9396	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	None	Stable	None/Little
576	229	751.3124	Moderate	High	Bedrock	Heavy	Steep	Bedrock	None-Very Sparse	Undercut	Exposed Roots	Stable	None/Little
577	131	429.79	Steep	High	Silt/Sand	Heavy	Moderate	Cobbles	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
578	98	321.5223	Steep	High	Bedrock	Moderate	Vertical	Bedrock	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
579	212	695.5381	Moderate	High	Silt/Sand	Heavy	Moderate	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
580	149	488.8452	Moderate	High	Bedrock	Moderate	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
581	106	347.769	Moderate	High	Silt/Sand	Moderate	Moderate	Boulders	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
582	100	328.084	Moderate	Medium	Bedrock	Moderate	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
583	39	127.9528	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
584	16	52.49344	Moderate	Medium	Bedrock	Heavy	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
585	48	157.4803	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Boulders	None-Very Sparse	Undercut	None	Stable	None/Little
586	105	344.4882	Moderate	High	Silt/Sand	Heavy	Moderate	Silt/Sand	None-Very Sparse	Rotational Slump	Overhanging Bank, Creep/Leaning Trees, Exposed Roots	Eroded	Some
587	152	498.6877	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
588	109	357.6116	Moderate	Medium	Silt/Sand	Moderate	Moderate	Silt/Sand	None-Very Sparse		None	Stable	None/Little
589	199	652.8872	Moderate	High	Silt/Sand	Moderate	Moderate	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
590	38	124.6719	Moderate	Medium	Bedrock	Moderate	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
591	121	396.9816	Moderate	Medium	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
592	30	98.4252	Moderate	Medium	Silt/Sand	Moderate	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
593	30	98.4252	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate	Undercut	Creep/Leaning Trees	Stable	None/Little
594	131	429.79	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
595	257	843.1759	Flat	Medium	Silt/Sand	None-Very Sparse	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
596	52	170.6037	Moderate	High	Boulders	None-Very Sparse	Moderate	Boulders	None-Very Sparse		None	Stable	None/Little

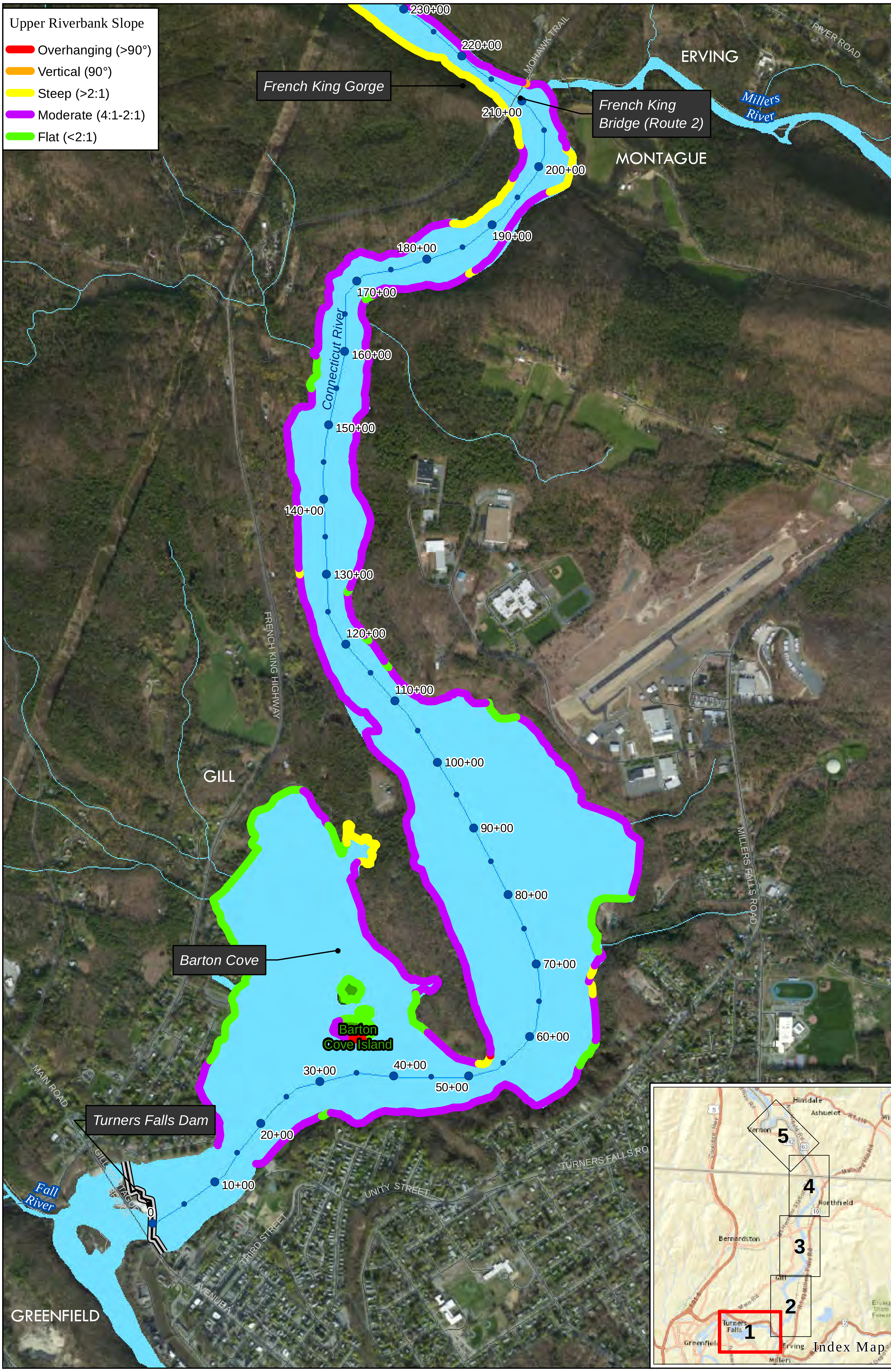
2013 Island Bank Features and Characteristics

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
1001	88	289	Flat	Low	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
1002	112	367	Moderate	Low	Silt/Sand	Sparse	Moderate	Silt/Sand	None-Very Sparse		None	Stable	None/Little
1003	93	305	Moderate	Medium	Silt/Sand	Moderate	Flat/Beach	Gravel	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
1004	236	774	Moderate	Medium	Silt/Sand	Moderate	Moderate	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Stable	None/Little
1005	63	207	Flat	Low	Silt/Sand	Moderate	Moderate	Silt/Sand	None-Very Sparse		None	Stable	None/Little
1006	251	823	Flat	Low	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
1007	129	423	Flat	Low	Silt/Sand	Moderate	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
1008	50	164	Flat	Low	Silt/Sand	Moderate	Flat/Beach	Gravel	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
1009	149	489	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
1010	127	417	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Eroded	Some
1011	492	1614	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Potential Future Erosion	Some
1012	254	833	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Exposed Roots, Overhanging Bank	Eroded	Some
1013	64	210	Steep	Low	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees	Eroded	Some

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
1014	246	807	Steep	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
1015	466	1529	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees	Stable	None/Little
1016	223	732	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
1017	127	417	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
1018	82	269	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Notching	Stable	None/Little
1019	133	436	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
1020	77	253	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
1021	64	210	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	None	Stable	None/Little
1022	22	72	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
1023	75	246	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse	Undercut	None	Stable	None/Little
1024	60	197	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
1025	88	289	Steep	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees	Stable	None/Little
1026	66	217	Steep	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Creep/Leaning Trees, Overhanging Banks, Exposed Roots	Eroded	Some
1027	143	469	Moderate	Medium	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Notching	Stable	None/Little
1028	48	157	Moderate	Low	Silt/Sand	Moderate	Flat/Beach	Silt/Sand	None-Very Sparse		Notching	Stable	None/Little
1029	21	69	Steep	Medium	Silt/Sand	Moderate	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
1030	42	138	Moderate	Medium	Silt/Sand	Moderate	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
1031	43	141	Flat	Medium	Silt/Sand	Moderate	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little
1032	19	62	Moderate	Medium	Silt/Sand	Moderate	Moderate	Bedrock	None-Very Sparse		None	Stable	None/Little

ID	Length (m)	Length (ft)	URB Slope	URB Height	URB Sediment	URB Vegetation	LRB Slope	LRB Sediment	LRB Vegetation	All Types of Erosion	All Potential Indicators of Erosion	Stages of Erosion	Extent of Erosion
1033	225	738	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little
1034	73	240	Overhanging	High	Silt/Sand	Sparse	Flat/Beach	Silt/Sand	None-Very Sparse	Slide	Overhanging Bank, Exposed Roots, Creep/Leaning Trees	Eroded	Some
1035	32	105	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	None	Stable	None/Little
1036	77	253	Moderate	High	Silt/Sand	Heavy	Flat/Beach	Gravel	None-Very Sparse		None	Stable	None/Little
1037	137	449	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse		None	Stable	None/Little
1038	155	509	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		None	Stable	None/Little
1039	117	384	Flat	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Heavy		None	Stable	None/Little
1040	33	108	Flat	Low	Silt/Sand	None-Very Sparse	Flat/Beach	Silt/Sand	None-Very Sparse		Creep/Leaning Trees, Exposed Roots	Eroded	Some
1041	72	236	Steep	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		Creep/Leaning Trees	Stable	None/Little
1042	76	249	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		Creep/Leaning Trees	Stable	None/Little
1043	170	558	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Sparse		Creep/Leaning Trees	Stable	None/Little
1044	373	1224	Moderate	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	Moderate		Creep/Leaning Trees	Stable	None/Little
1045	685	2247	Steep	Low	Silt/Sand	Heavy	Flat/Beach	Silt/Sand	None-Very Sparse	Undercut	Creep/Leaning Trees, Exposed Roots	Stable	None/Little

APPENDIX J –RIVERBANK FEATURE AND CHARACTERISTIC MAPS



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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Upper Riverbank Slope

Map 1

0 650 1,300 2,600 Feet

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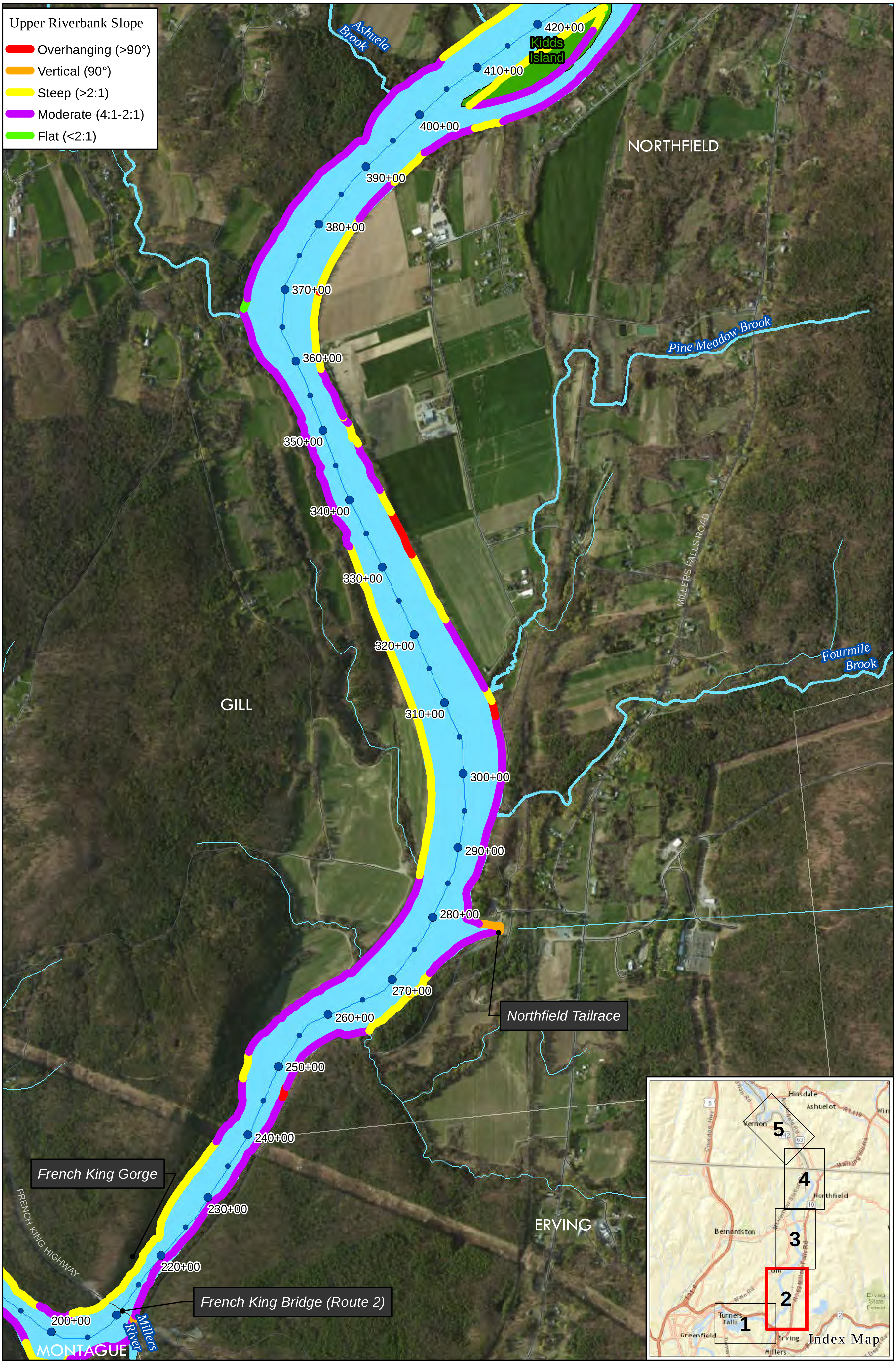

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Upper Riverbank Slope

Map 2

N

0 650 1,300 2,600 Feet

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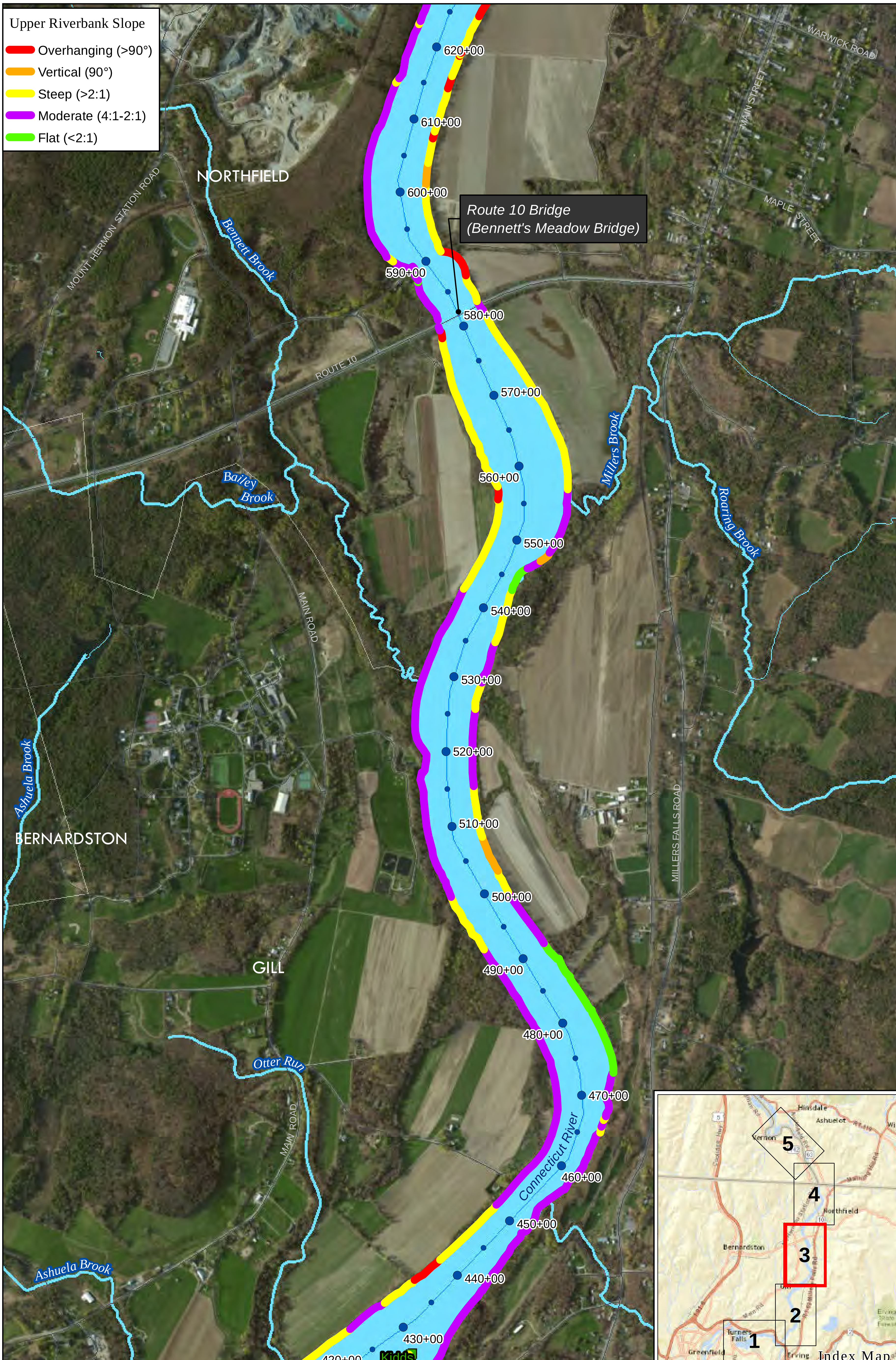

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Upper Riverbank Slope

Map 3

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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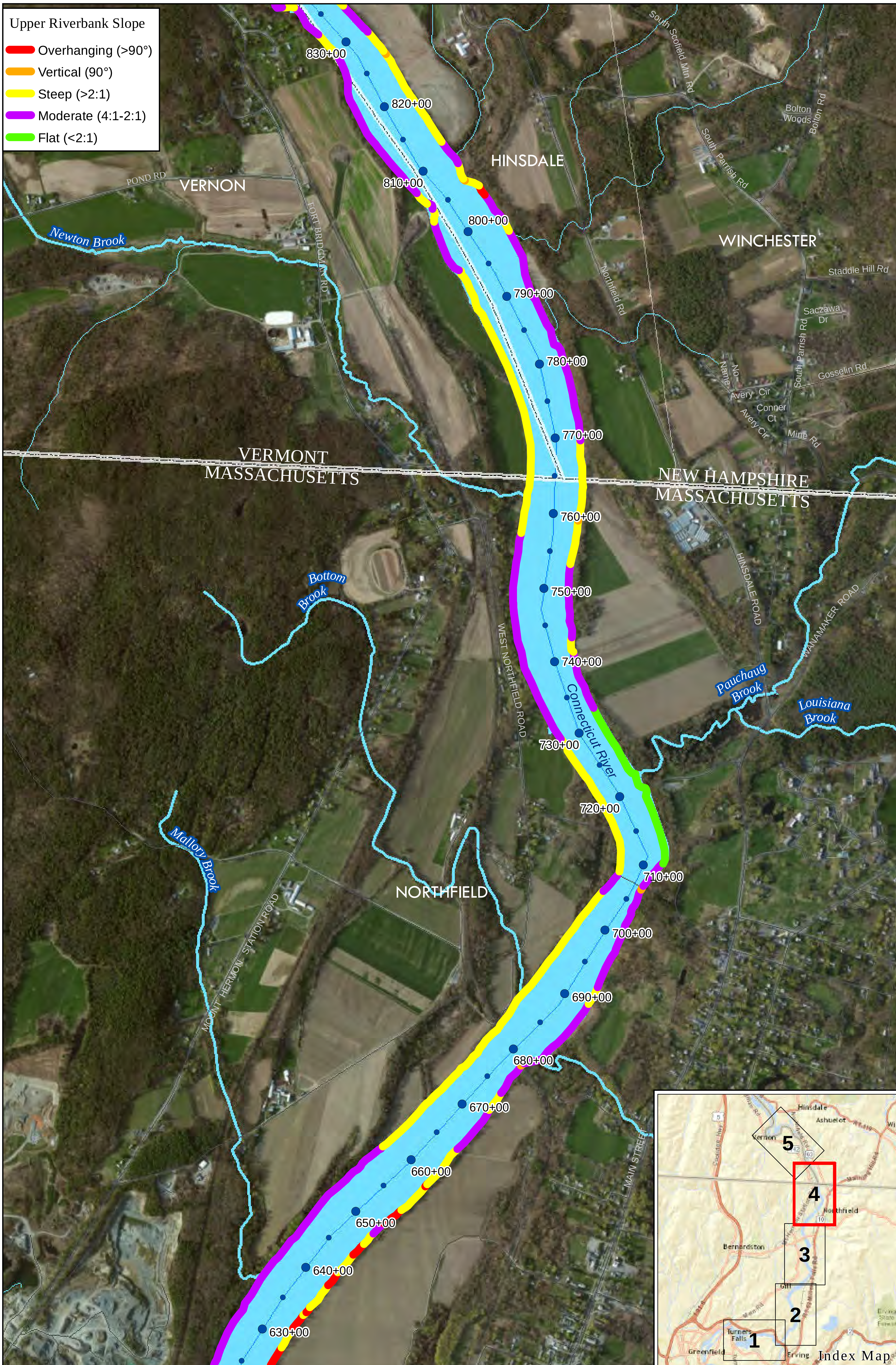

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Upper Riverbank Slope

Map 4

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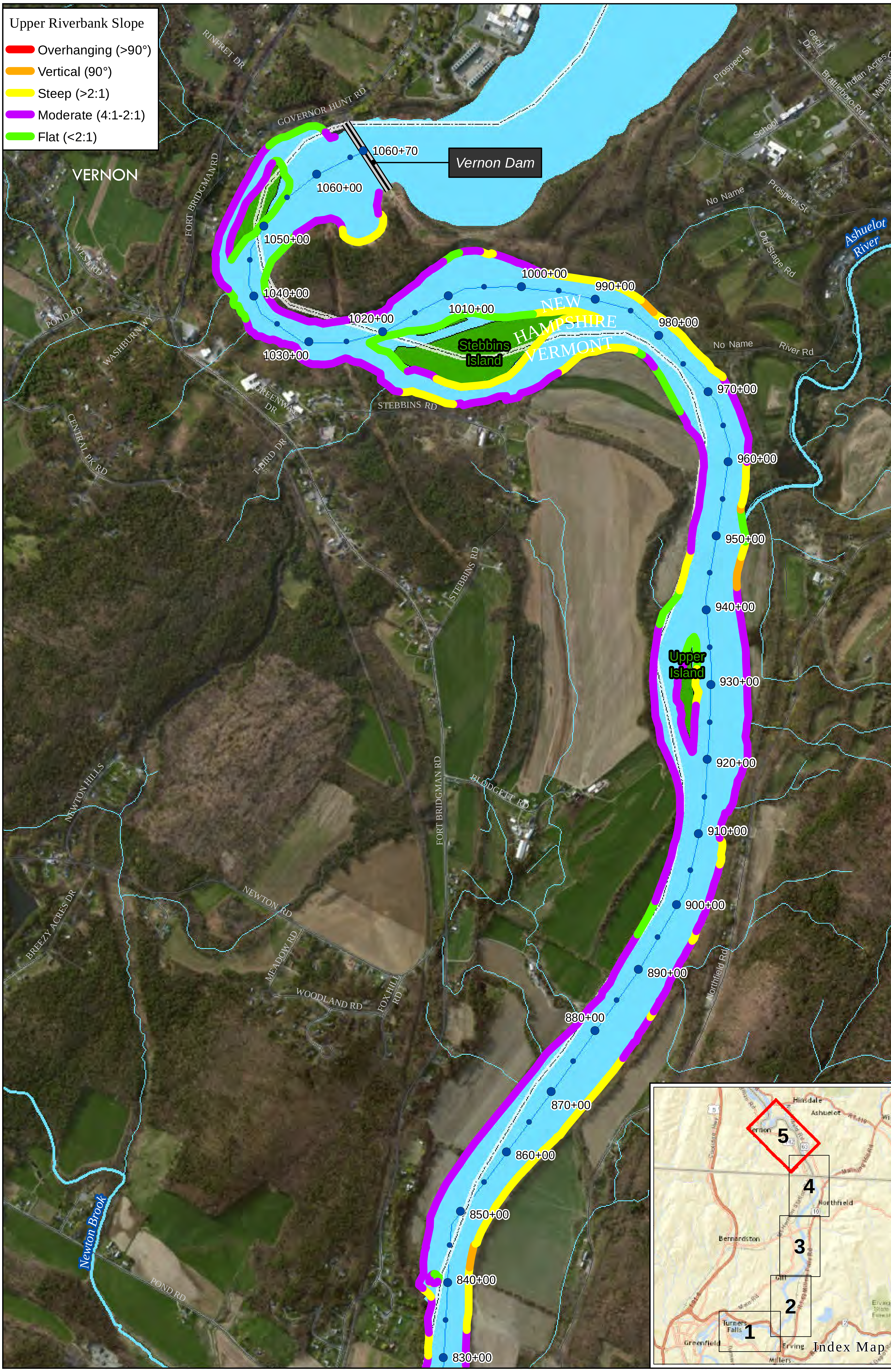

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Upper Riverbank Slope

Map 5

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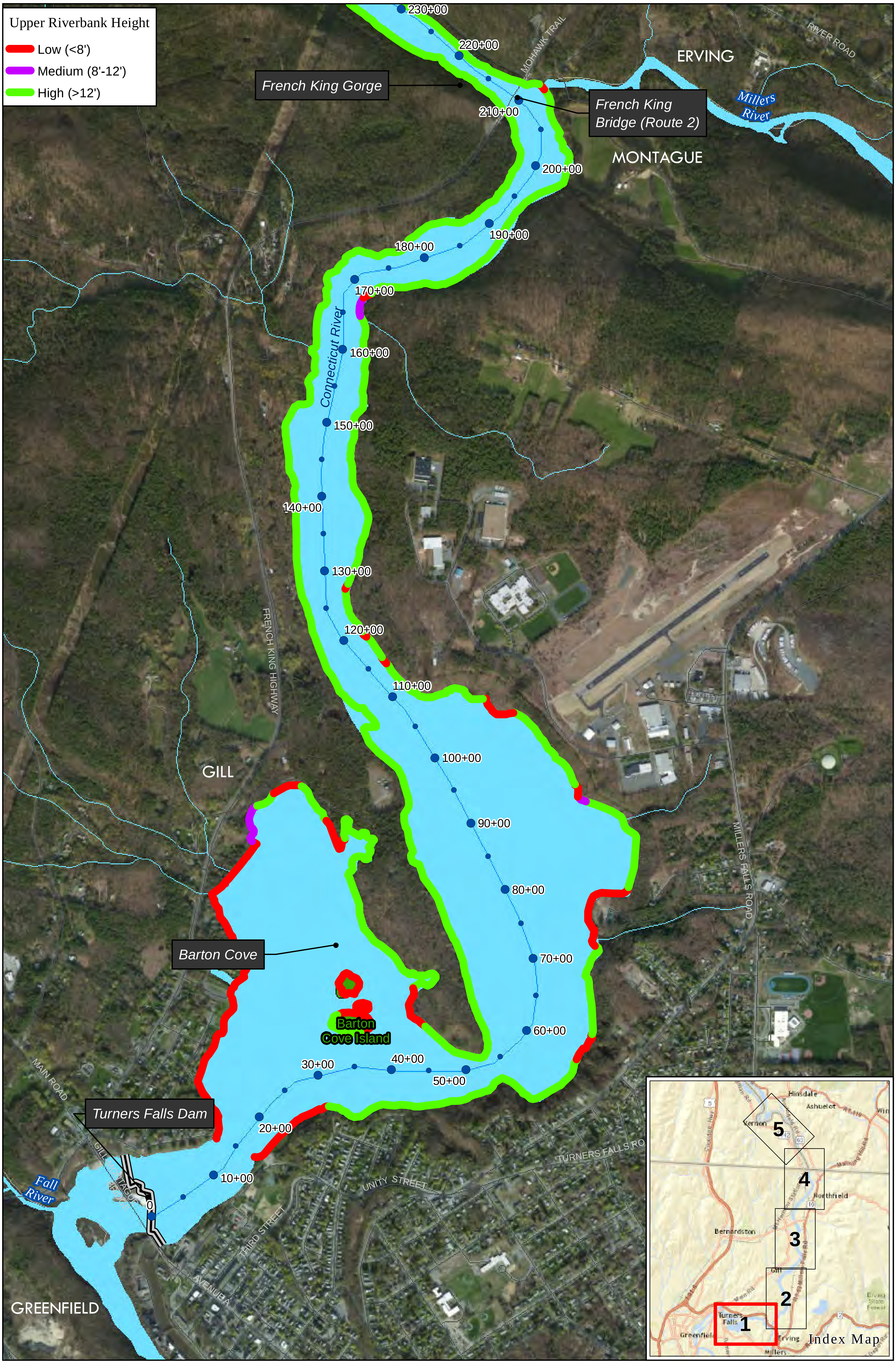

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Upper Riverbank Height

Map 1

0 650 1,300 2,600 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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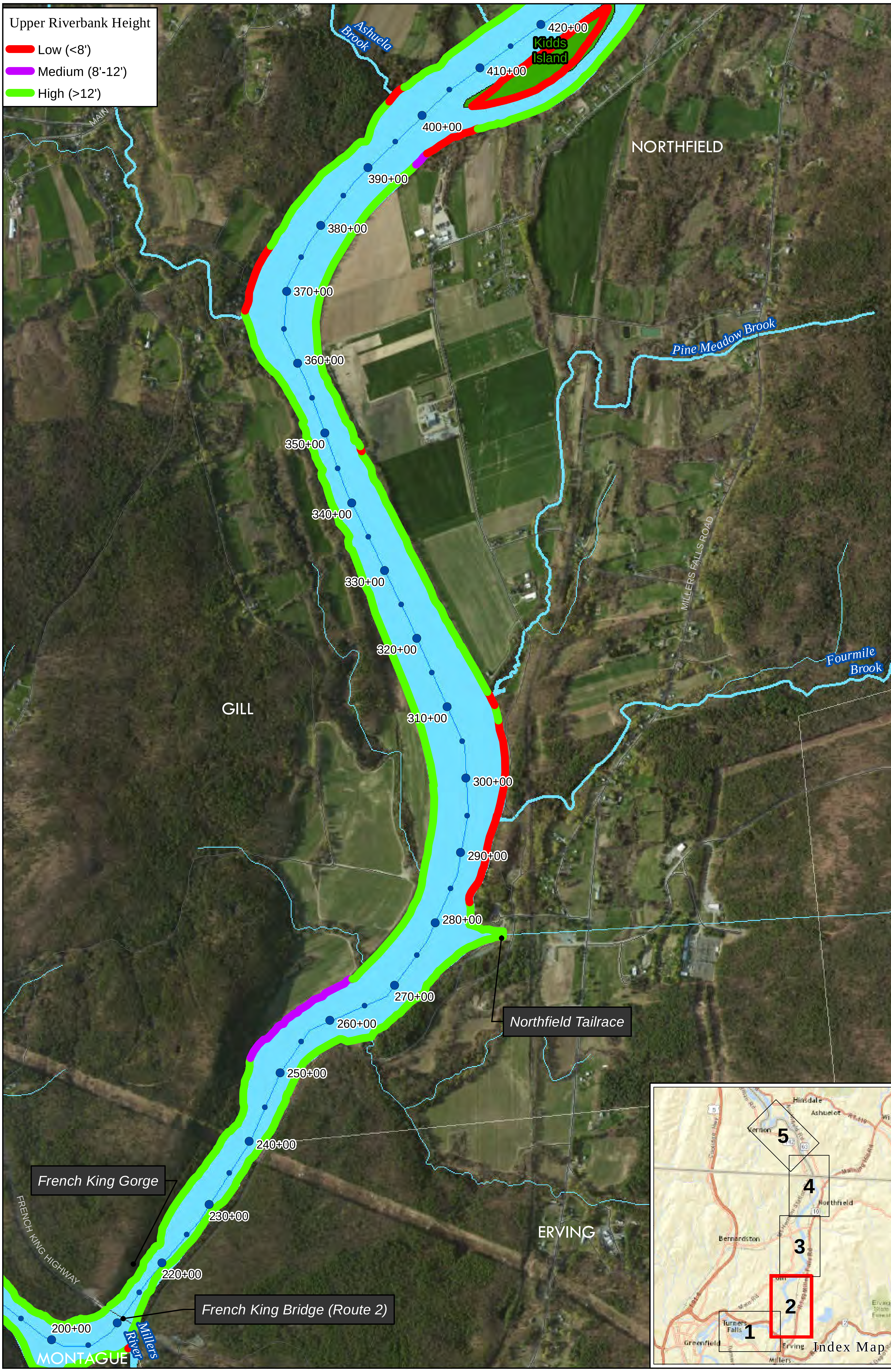

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Upper Riverbank Height

Map 2

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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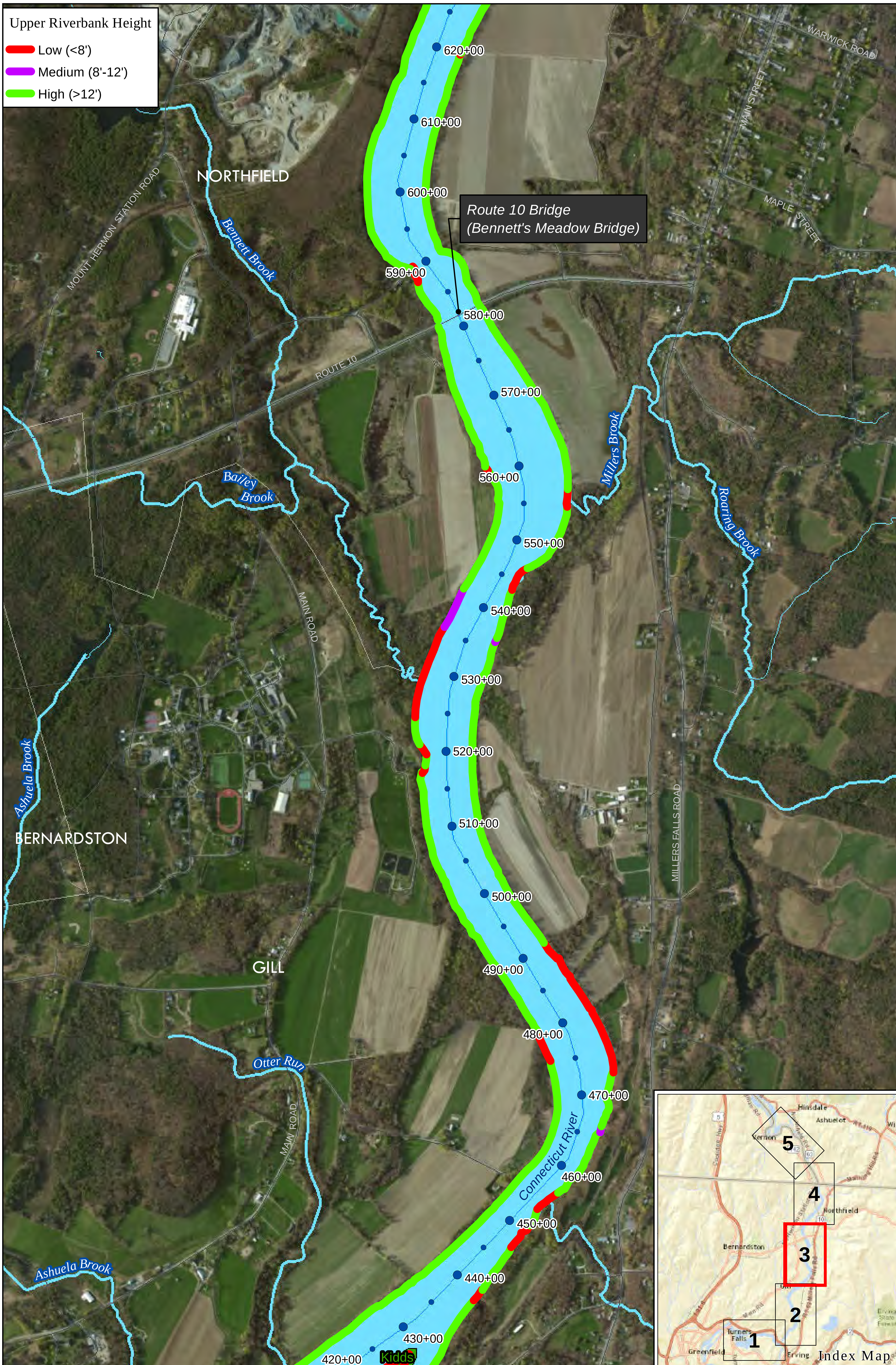

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600
Feet

Upper Riverbank Height

Map 3

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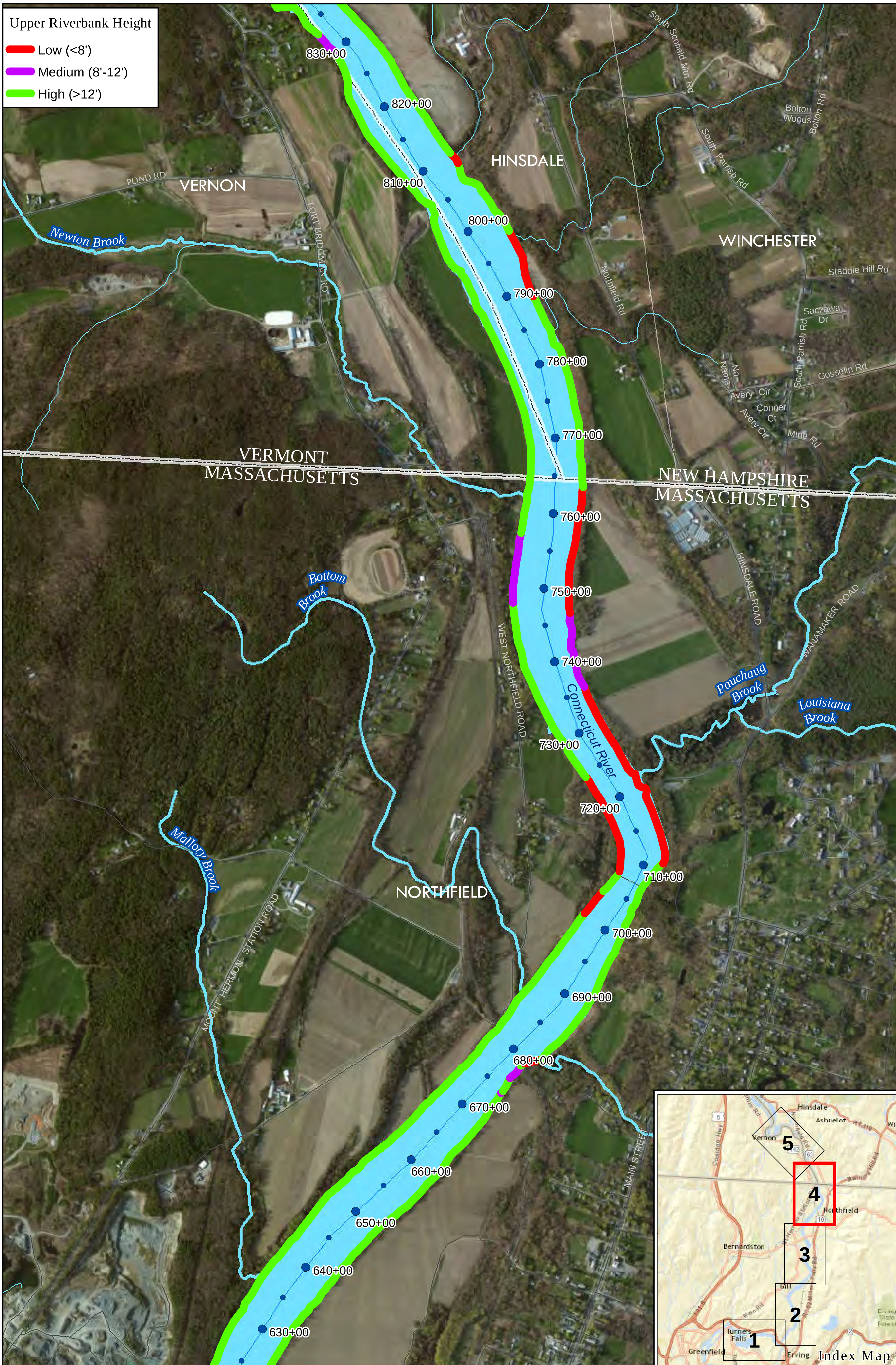

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Upper Riverbank Height

Map 4

N

0 650 1,300 2,600 Feet

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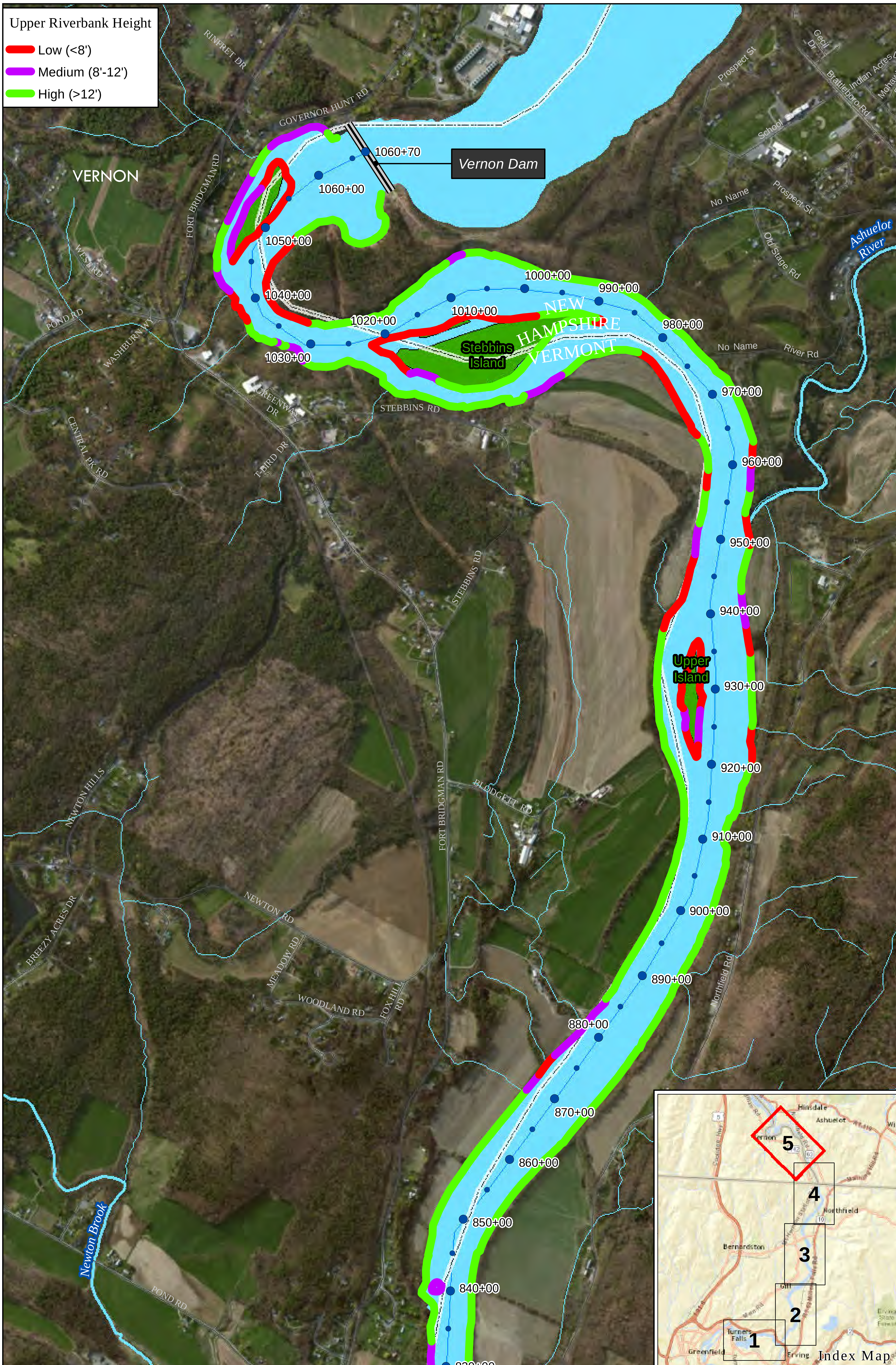

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Upper Riverbank Height

Map 5

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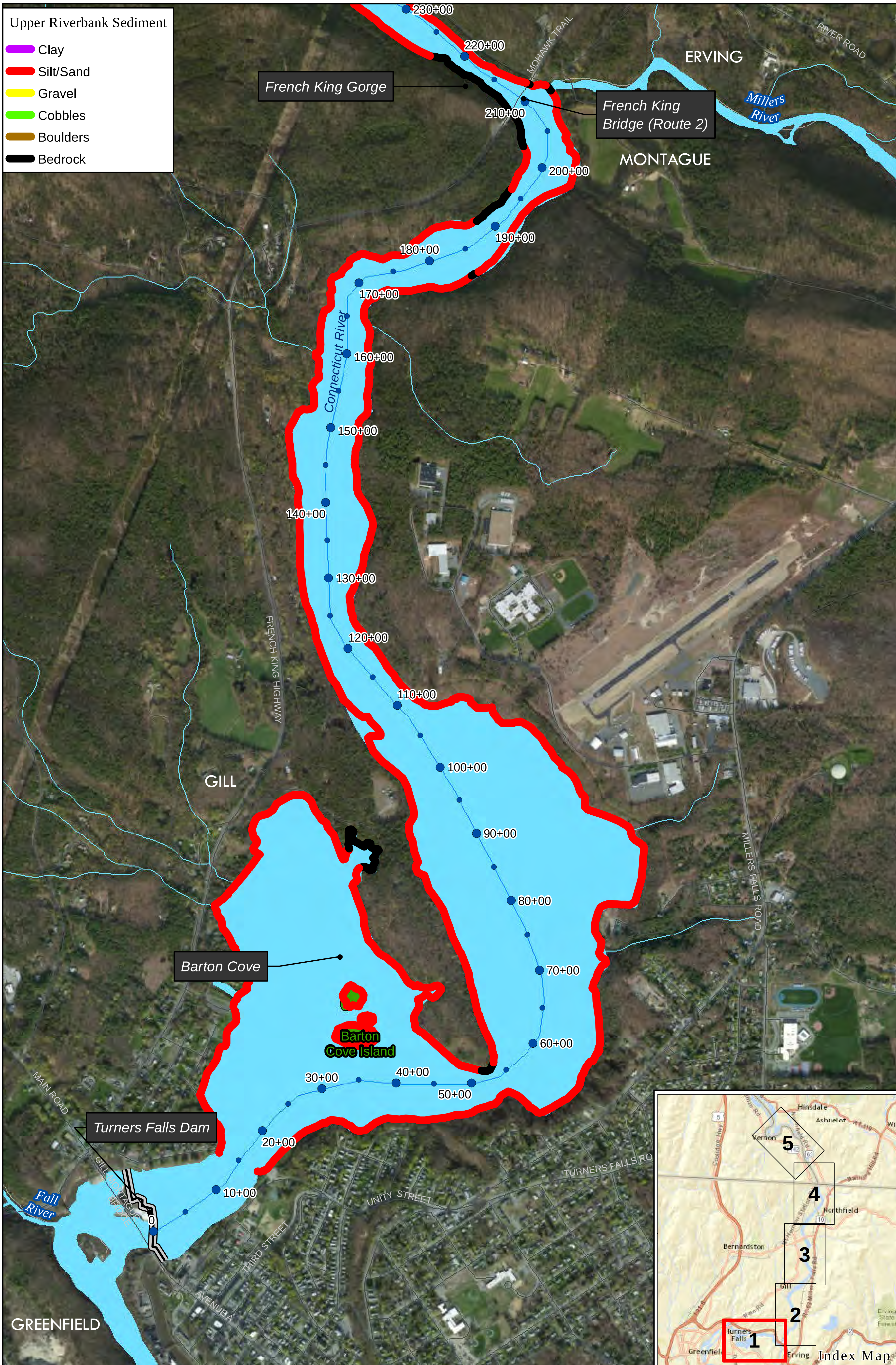

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Upper Riverbank Sediment

Map 1

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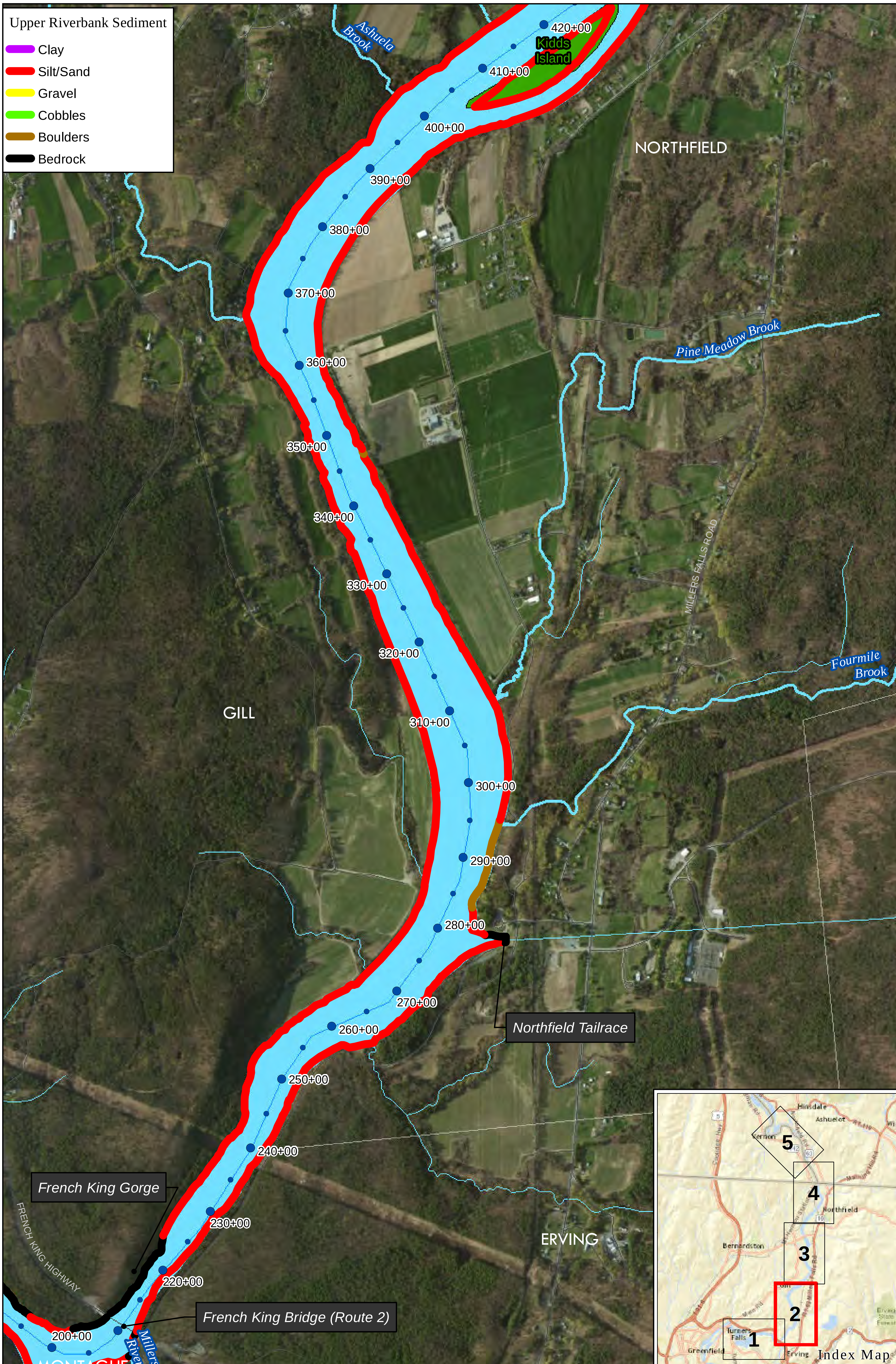

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Upper Riverbank Sediment

Map 2

N

0 650 1,300 2,600 Feet

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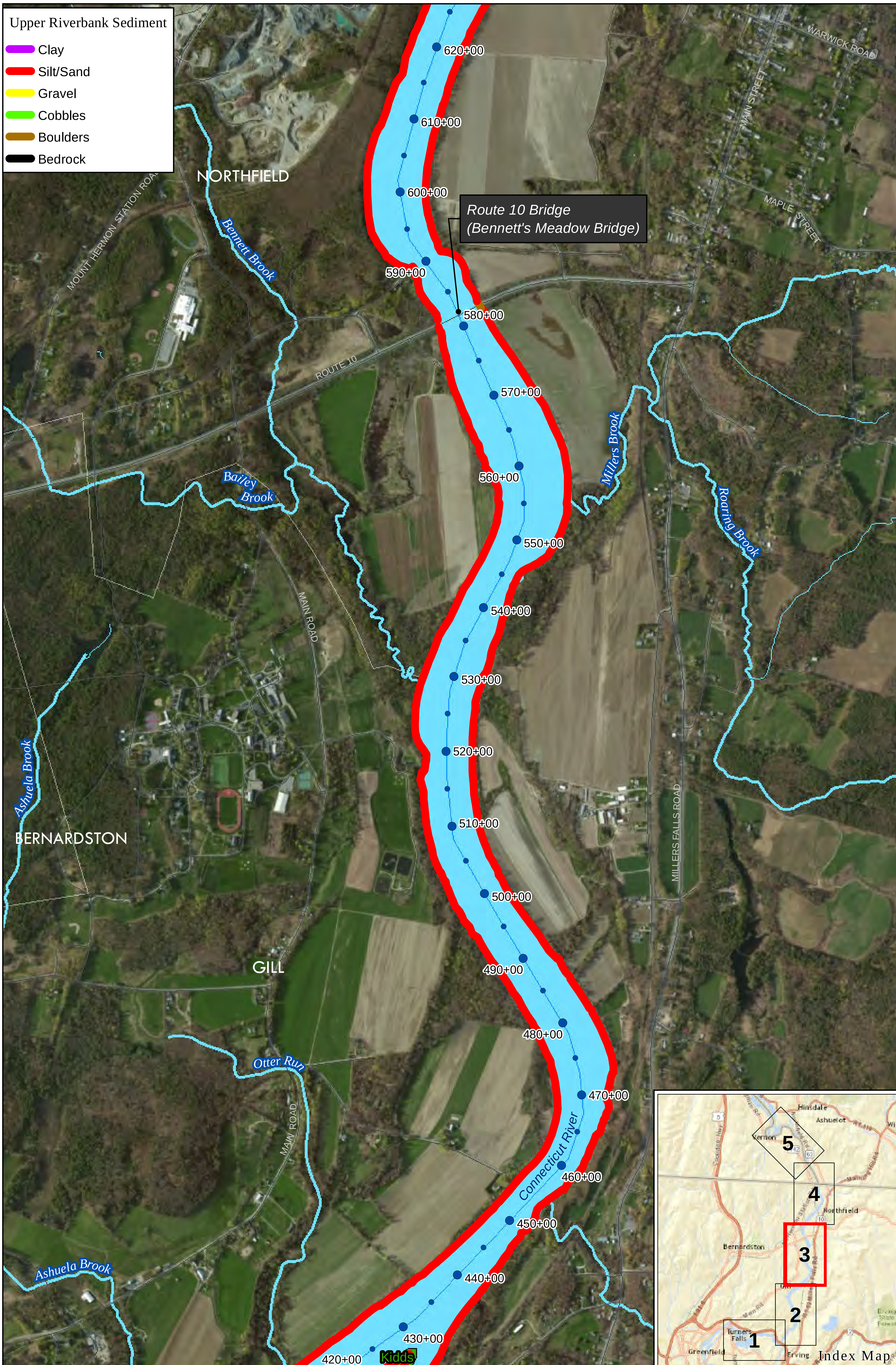

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Upper Riverbank Sediment

Map 3

N

0 650 1,300 2,600
Feet

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

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Upper Riverbank Sediment

Map 4

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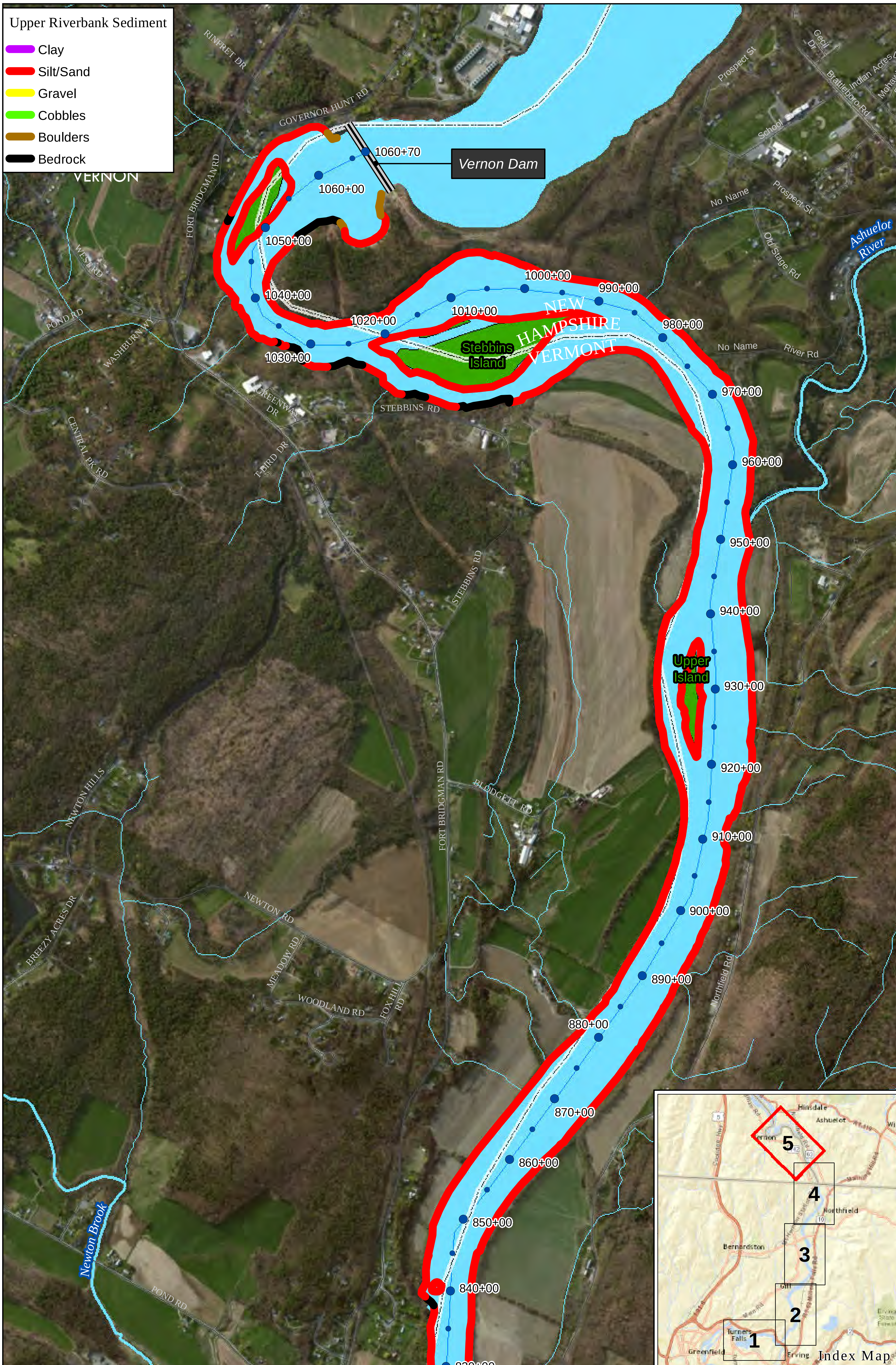

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1

NORTHFIELD MOUNTAIN/TURNERS FALLS

FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Upper Riverbank Sediment

Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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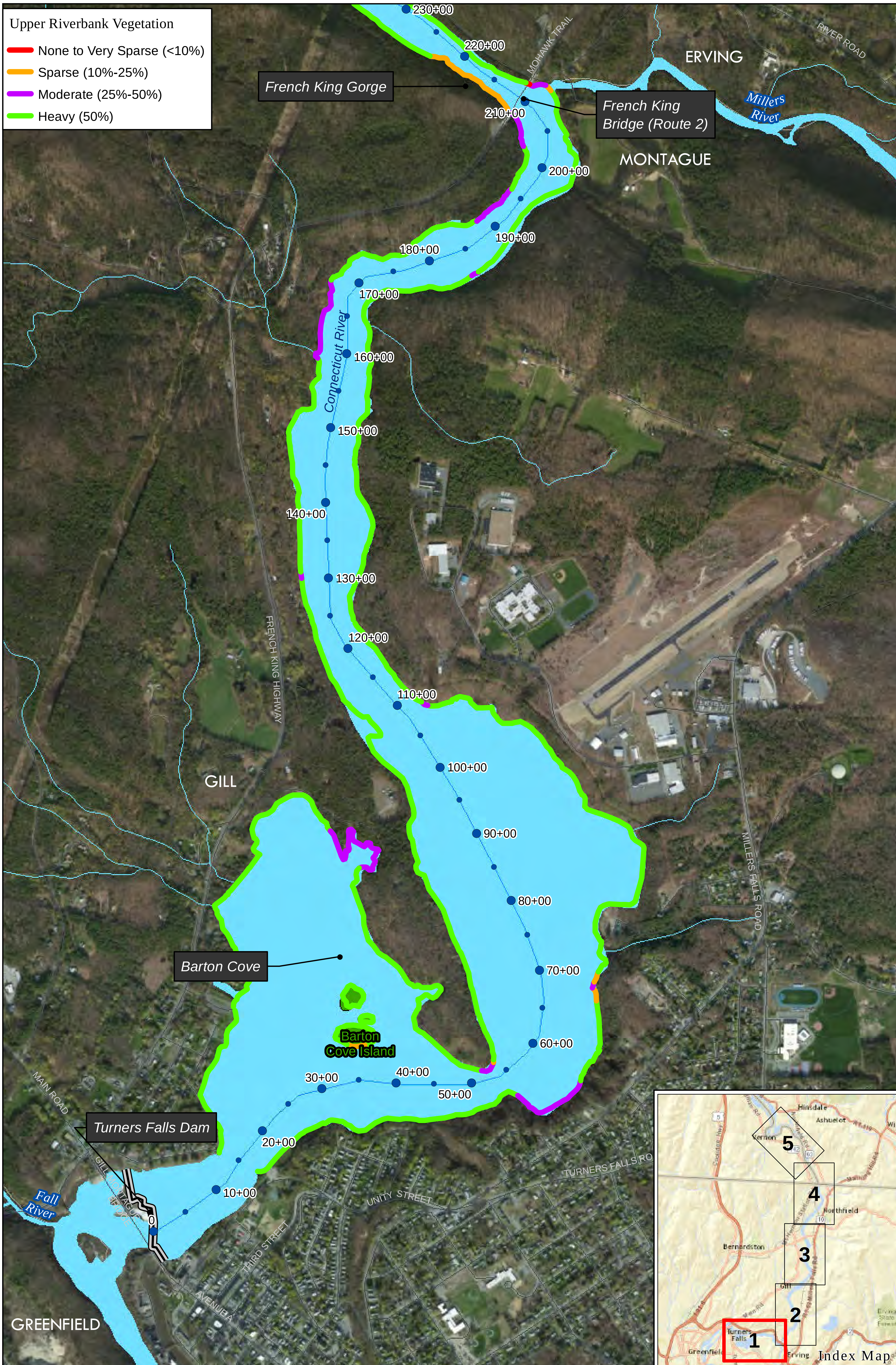

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Upper Riverbank Vegetation

Map 1

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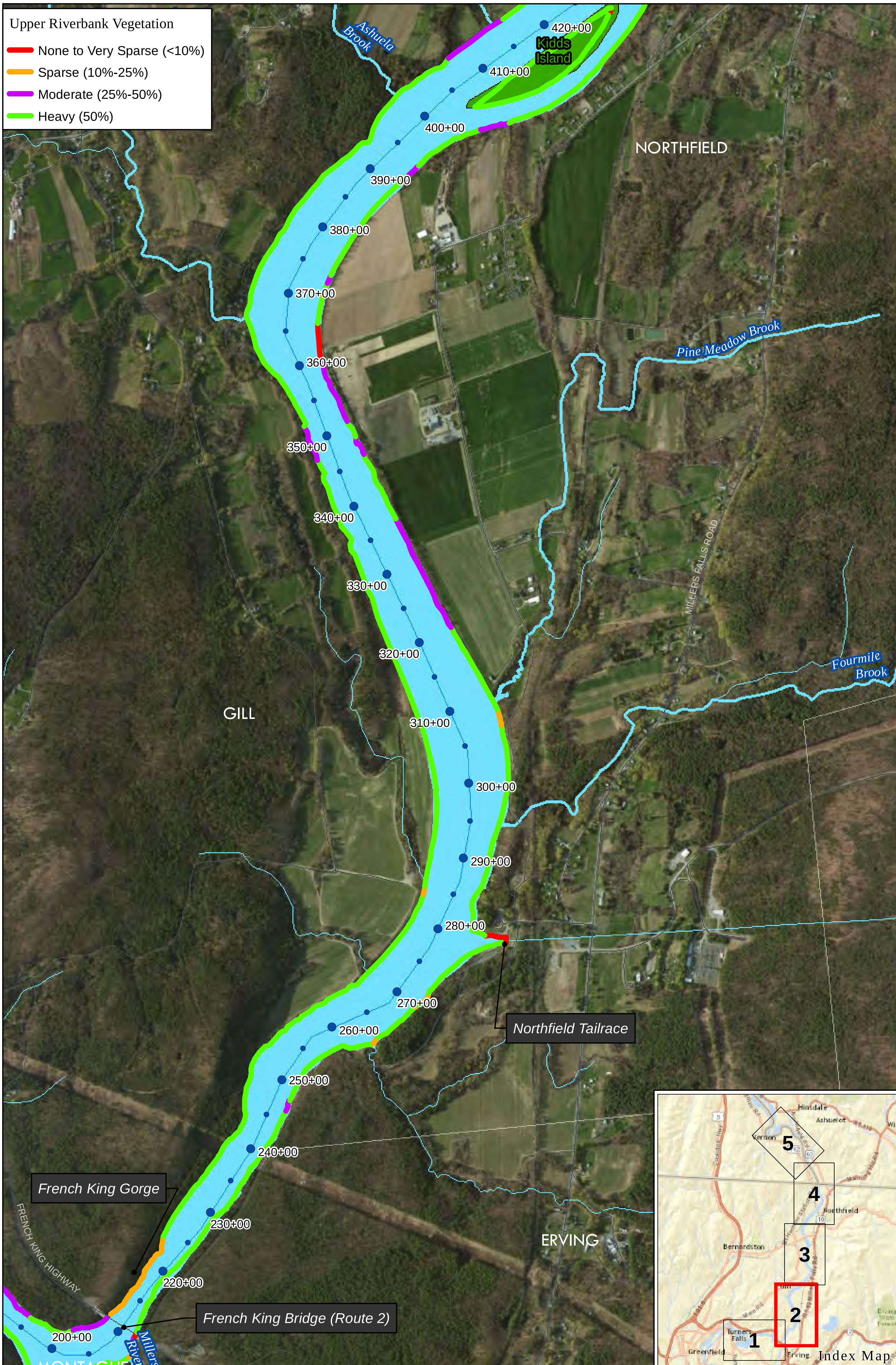

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N

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Upper Riverbank Vegetation

Map 2

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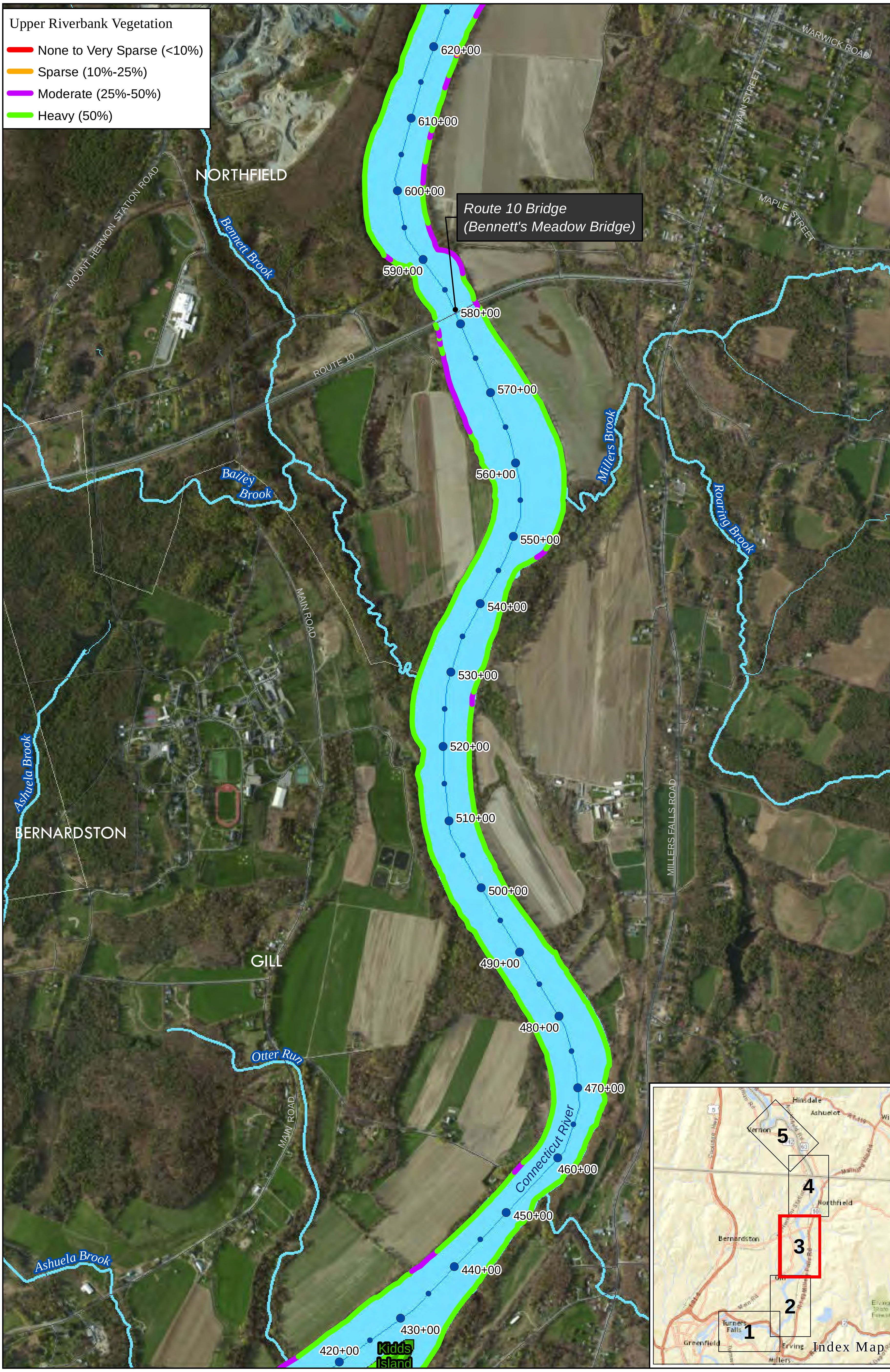

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Upper Riverbank Vegetation

Map 3

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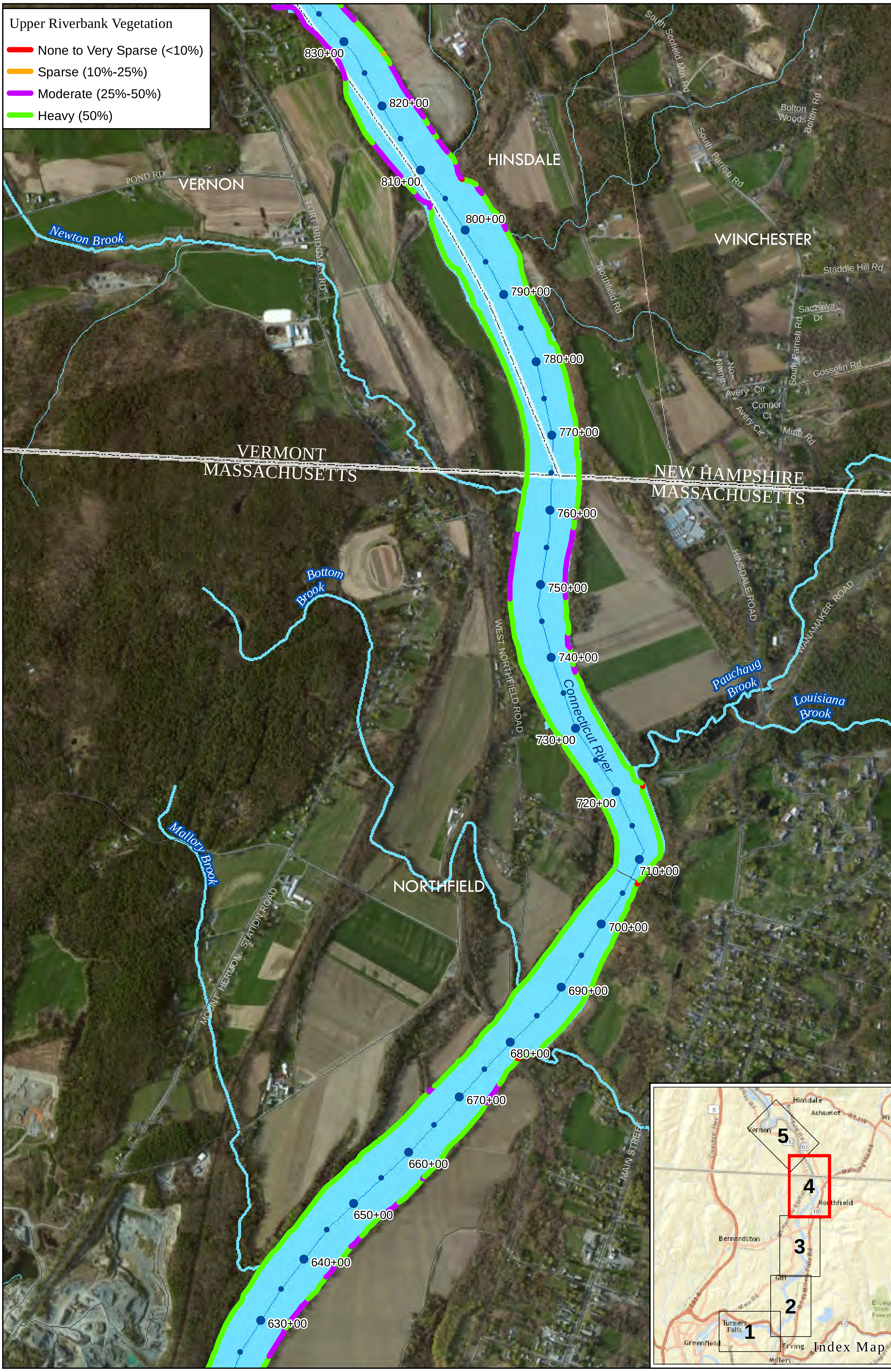

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Upper Riverbank Vegetation

Map 4

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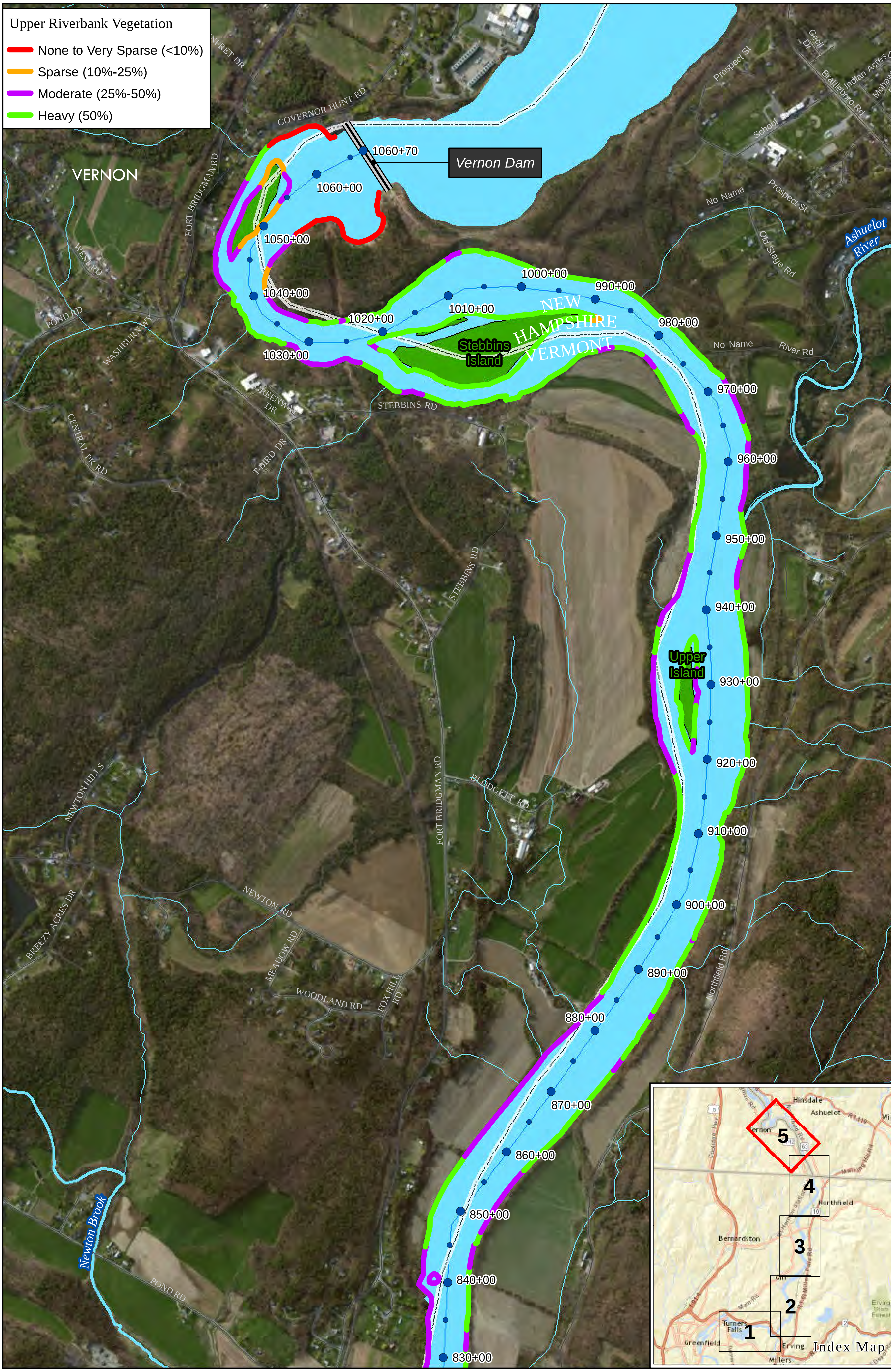

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600
Feet

Upper Riverbank Vegetation

Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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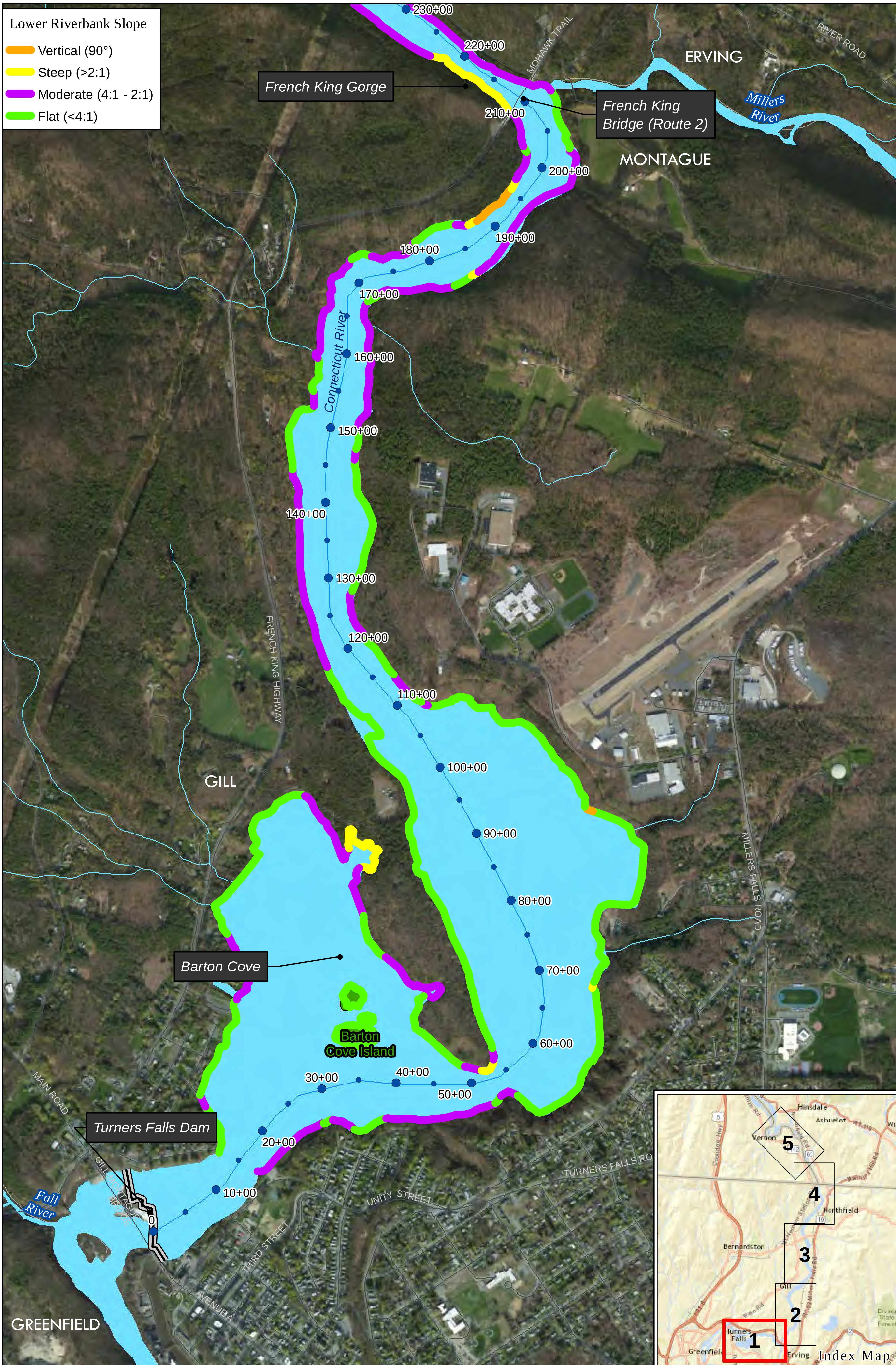

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Lower Riverbank Slope

Map 1

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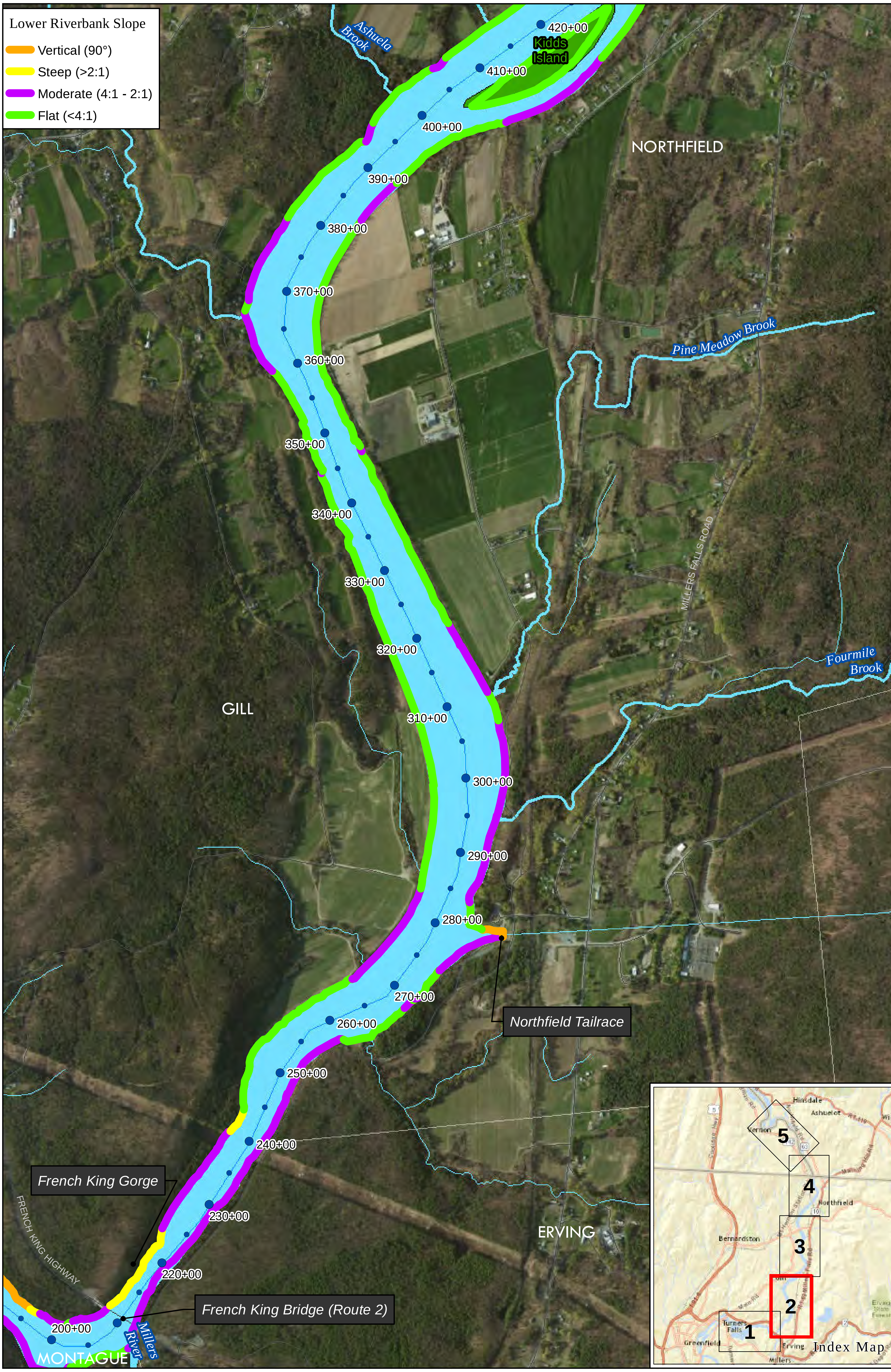

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

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N

0 650 1,300 2,600 Feet

Lower Riverbank Slope

Map 2

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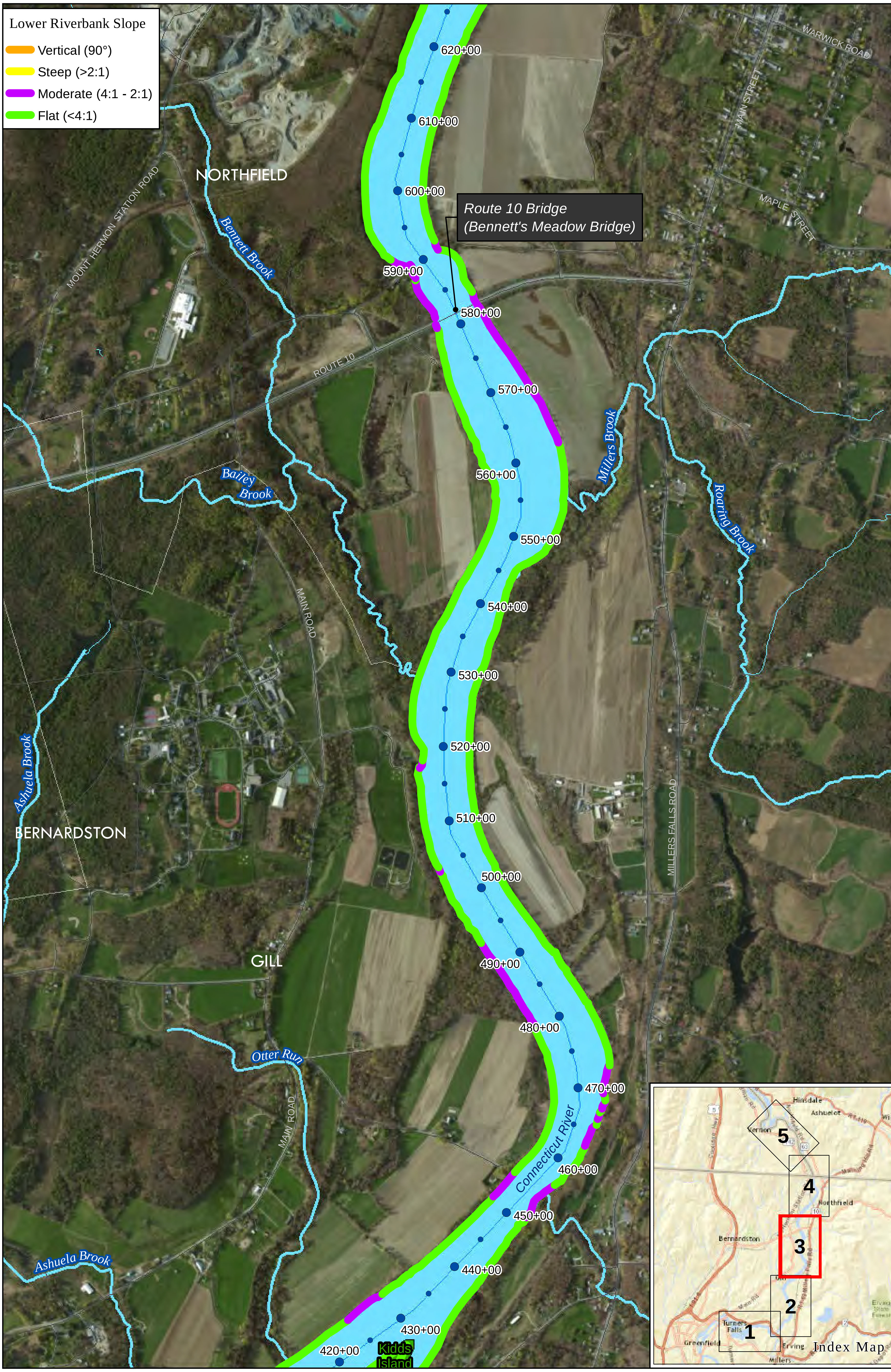

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Lower Riverbank Slope

Map 3

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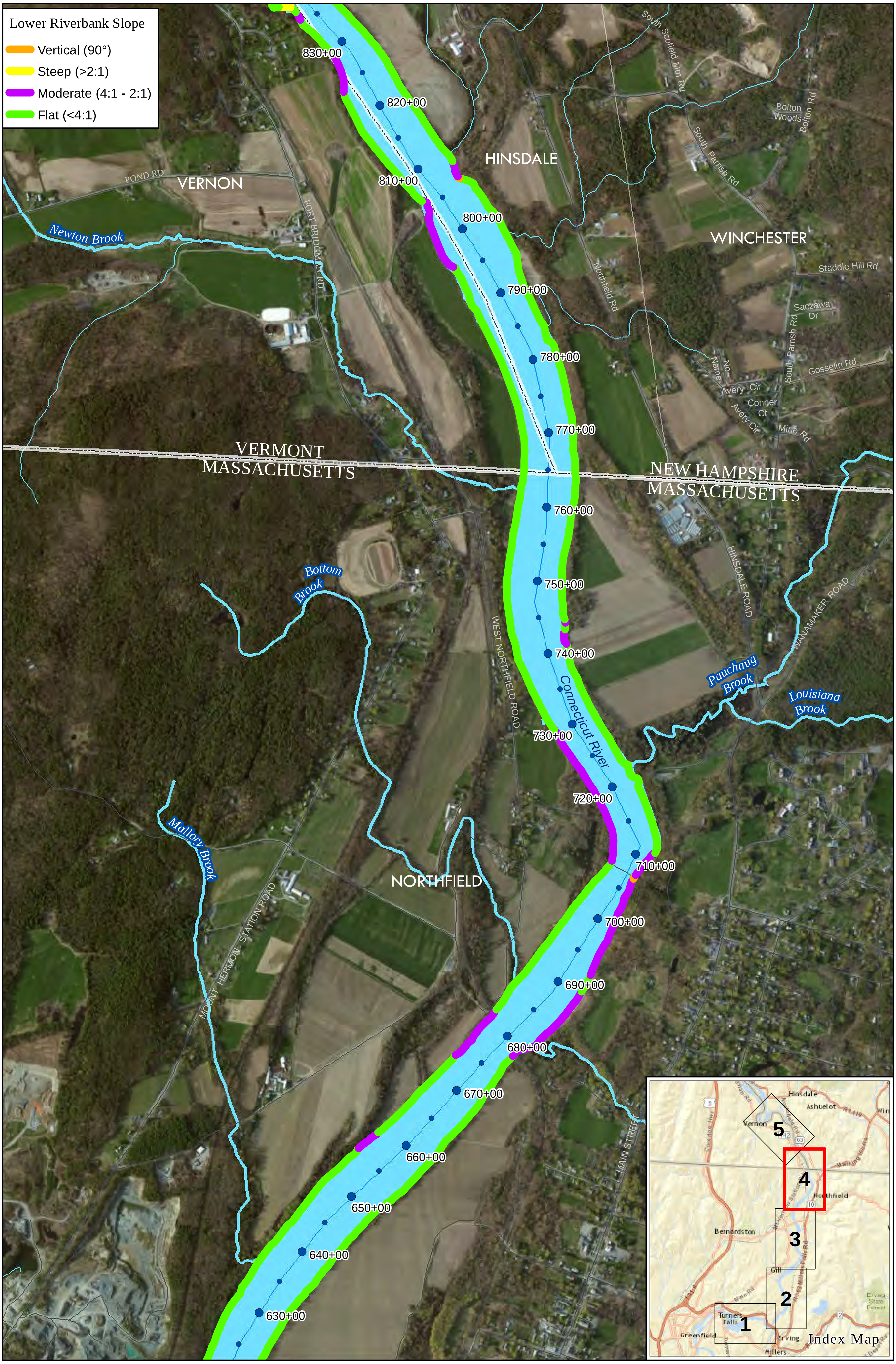

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Lower Riverbank Slope

Map 4

N

0 650 1,300 2,600 Feet

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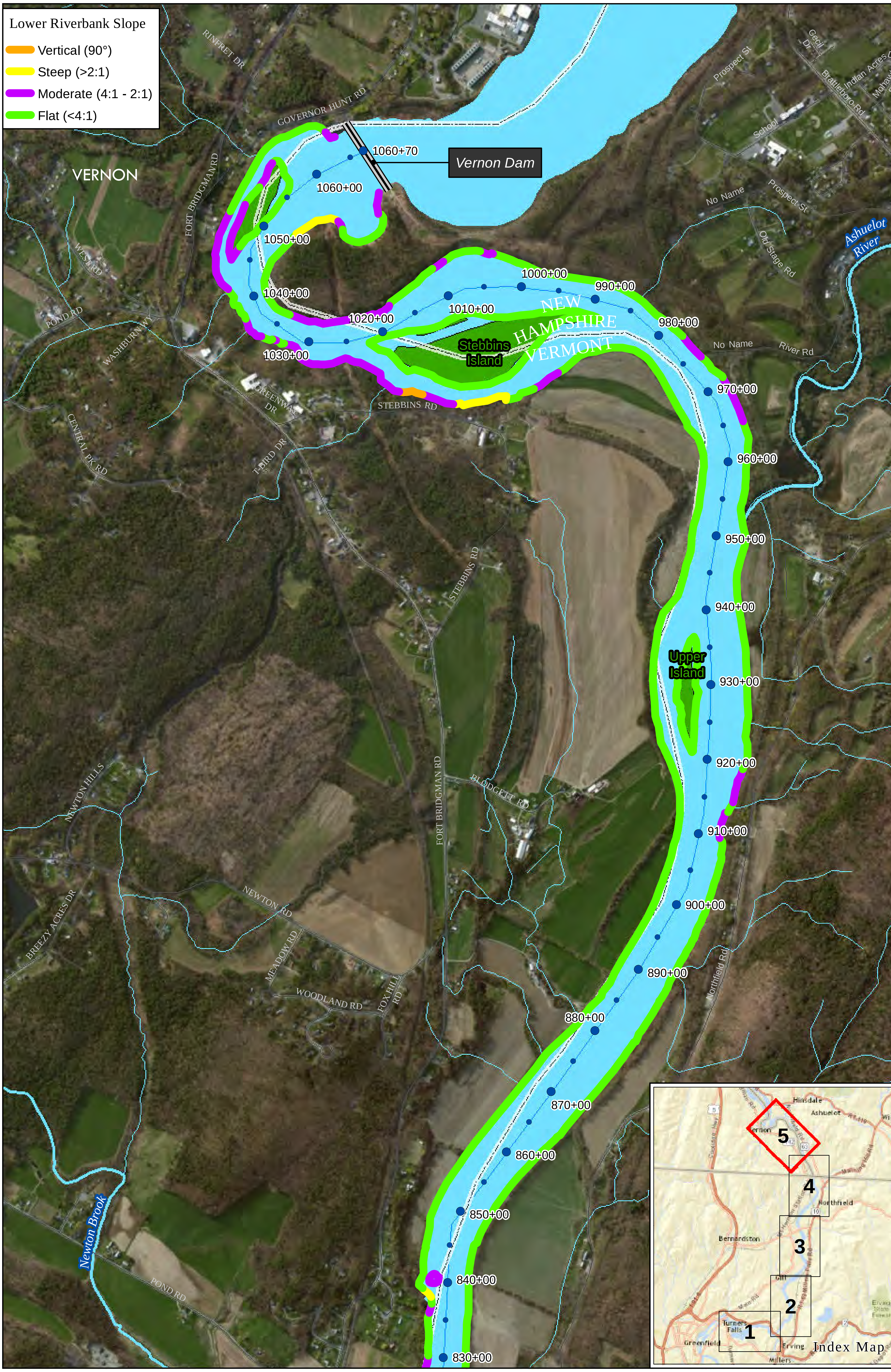

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Lower Riverbank Slope

Map 5

0 650 1,300 2,600 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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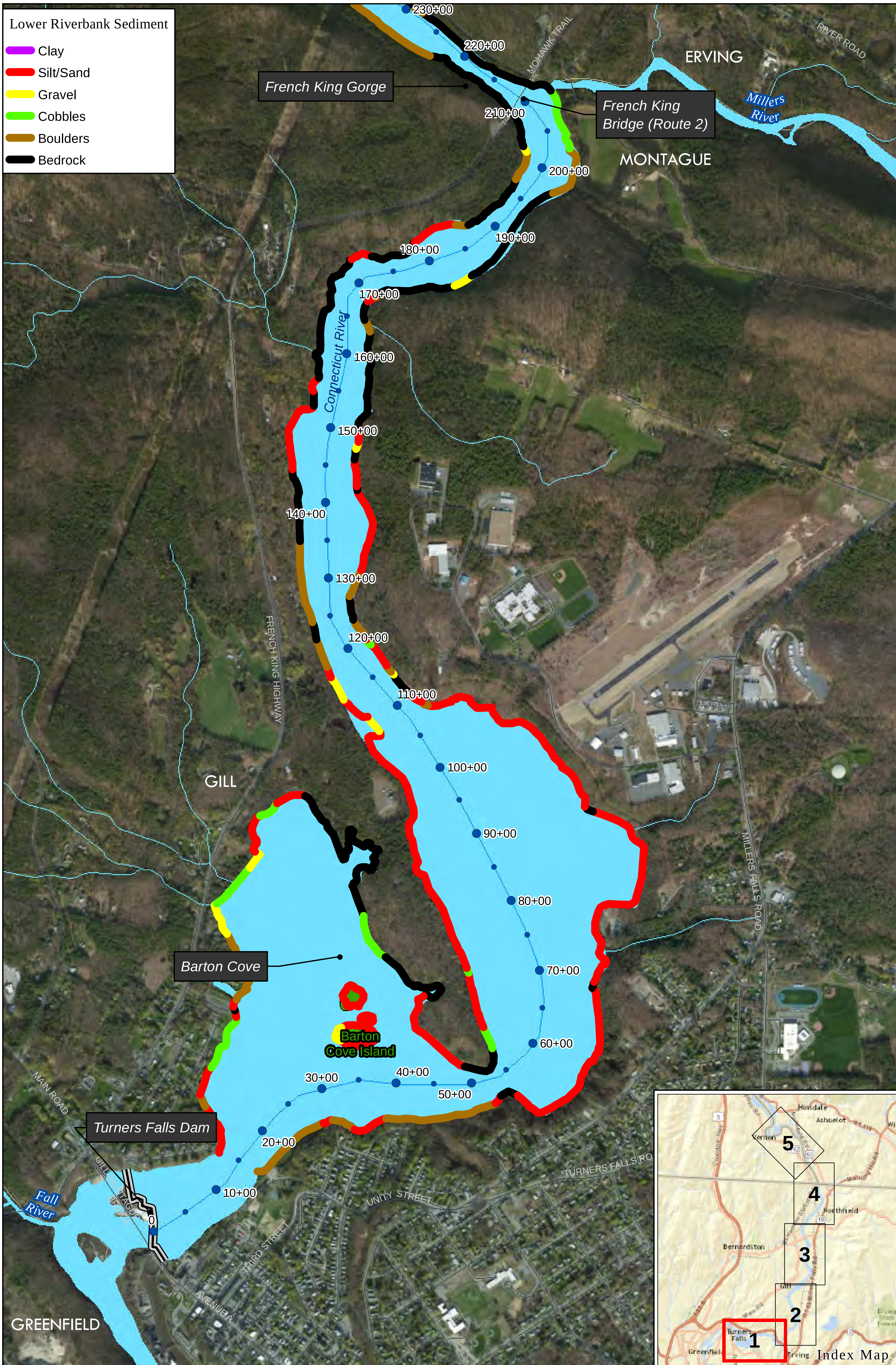

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Lower Riverbank Sediment

Map 1

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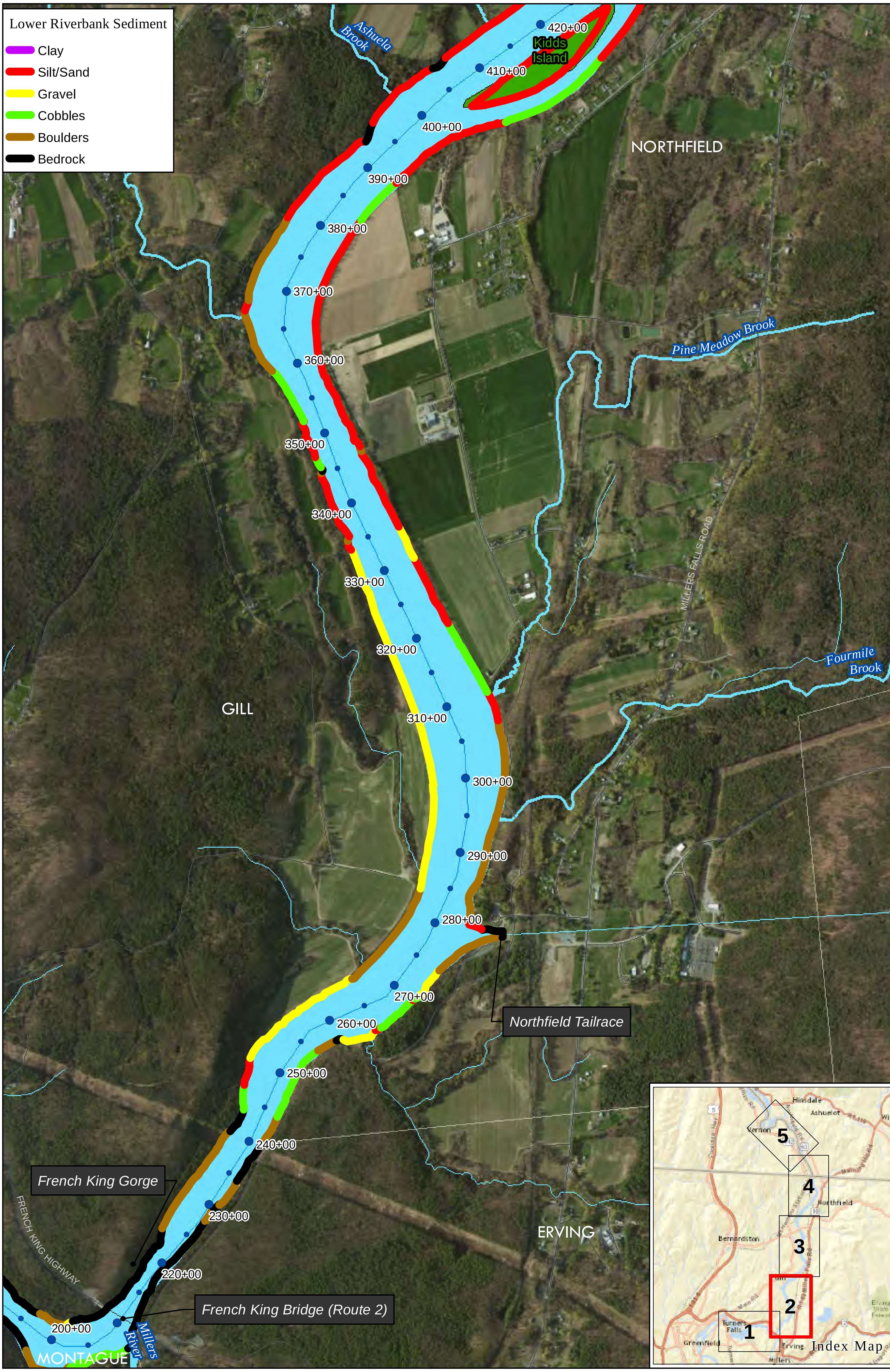

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RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Lower Riverbank Sediment

Map 2

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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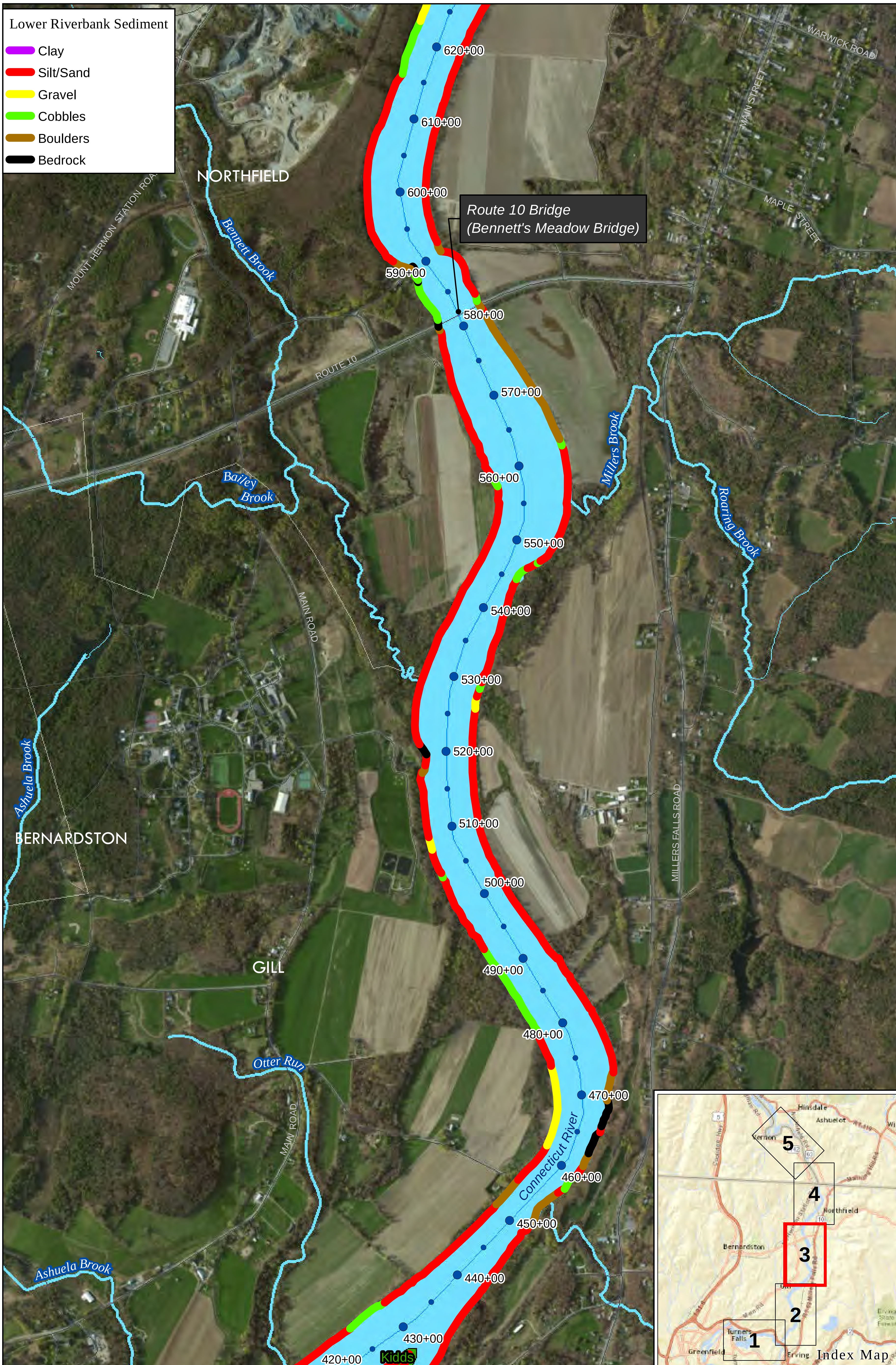

N

0 650 1,300 2,600 Feet

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Lower Riverbank Sediment

Map 3

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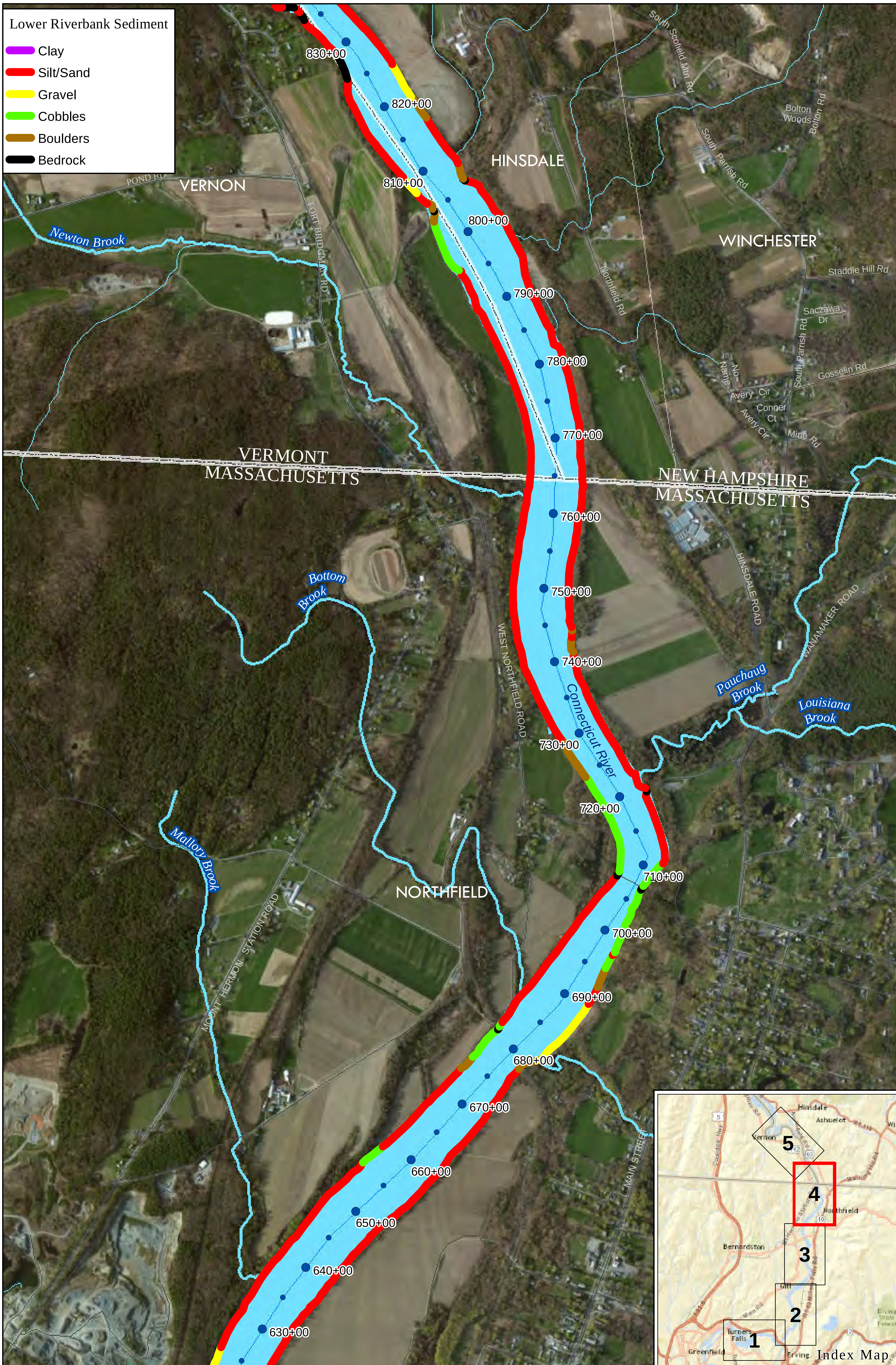

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Lower Riverbank Sediment

Map 4

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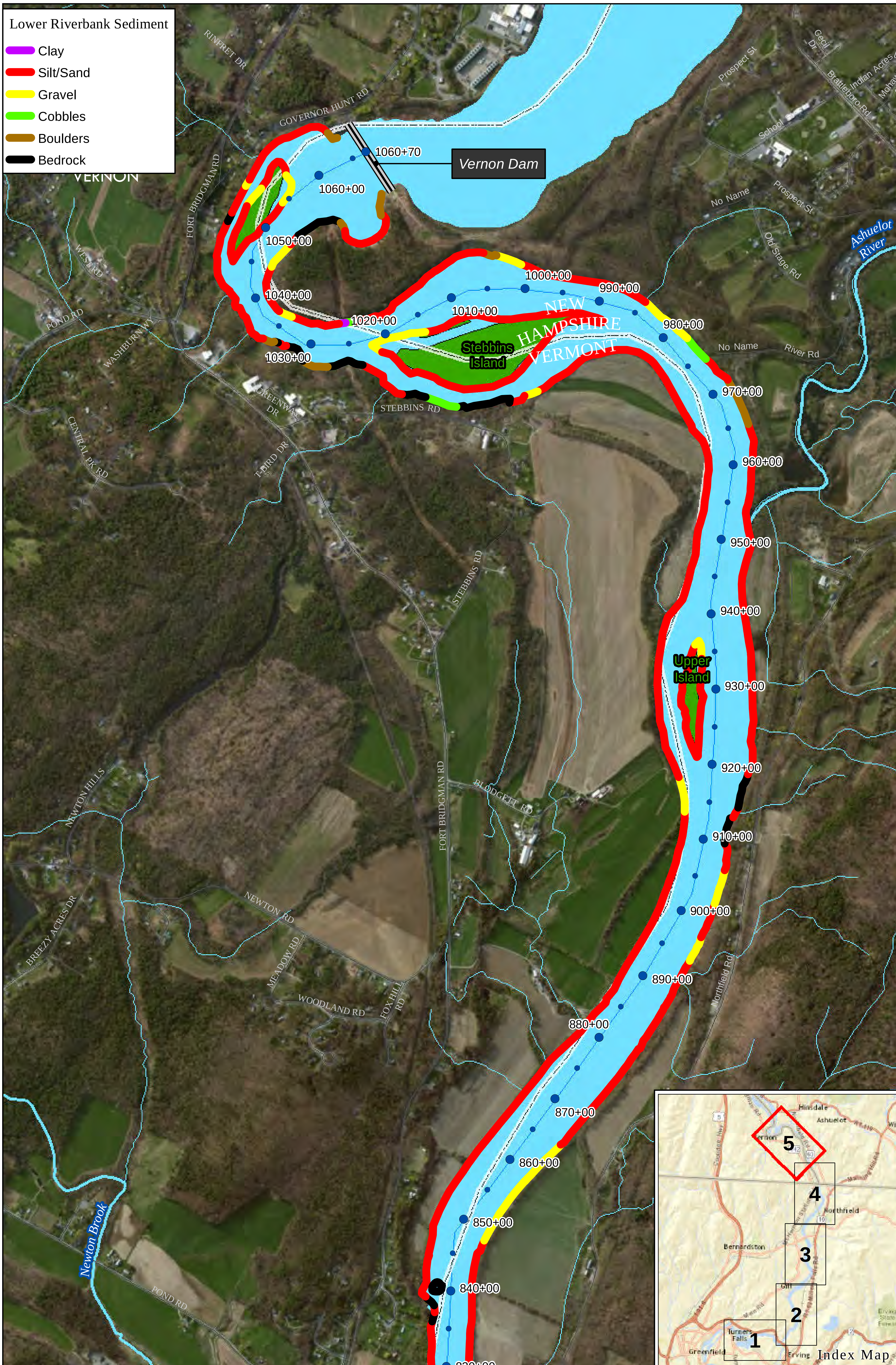

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Lower Riverbank Sediment

Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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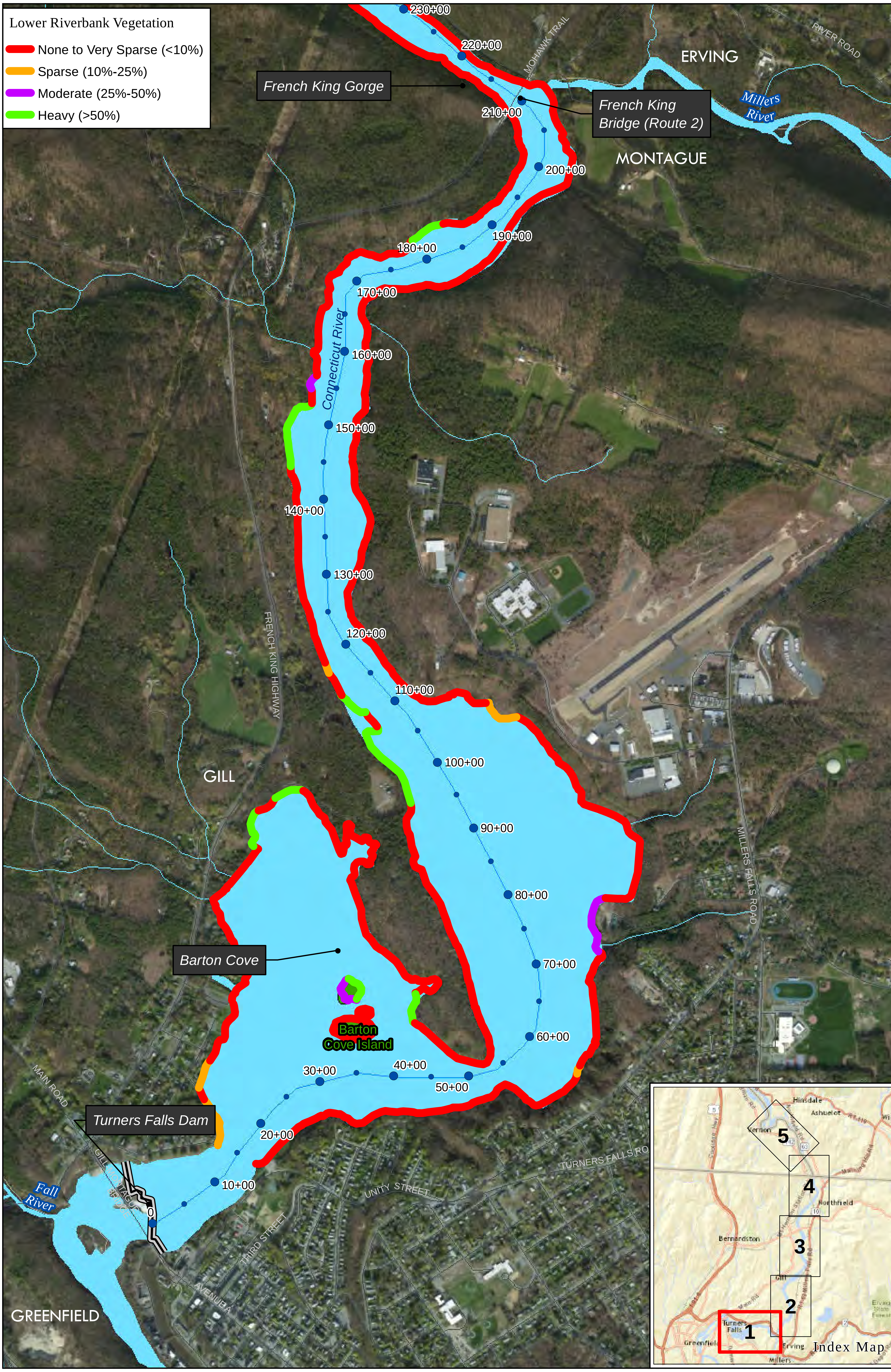

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Lower Riverbank Vegetation

Map 1

N

0 650 1,300 2,600 Feet

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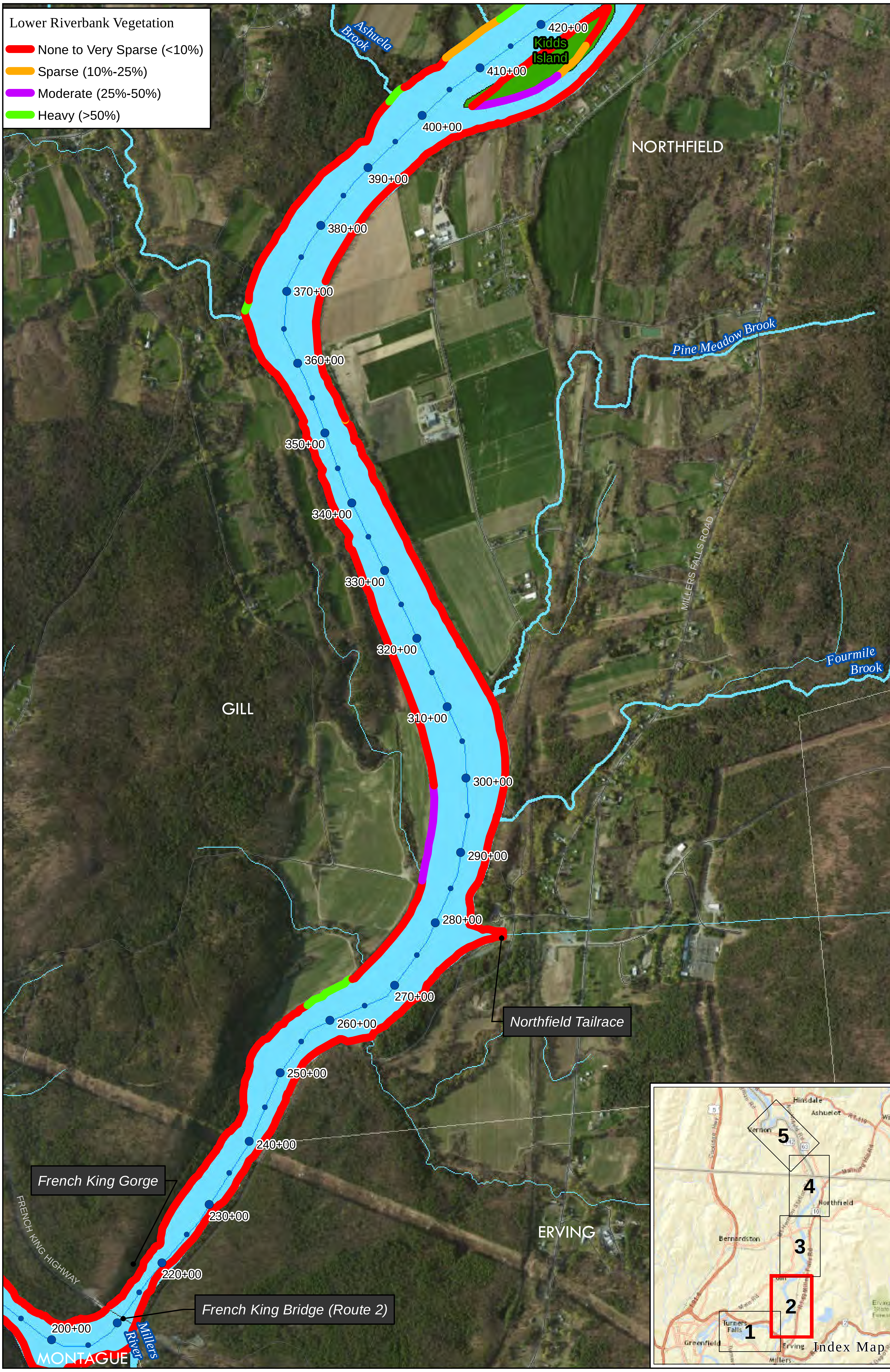

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600
Feet

Lower Riverbank Vegetation

Map 2

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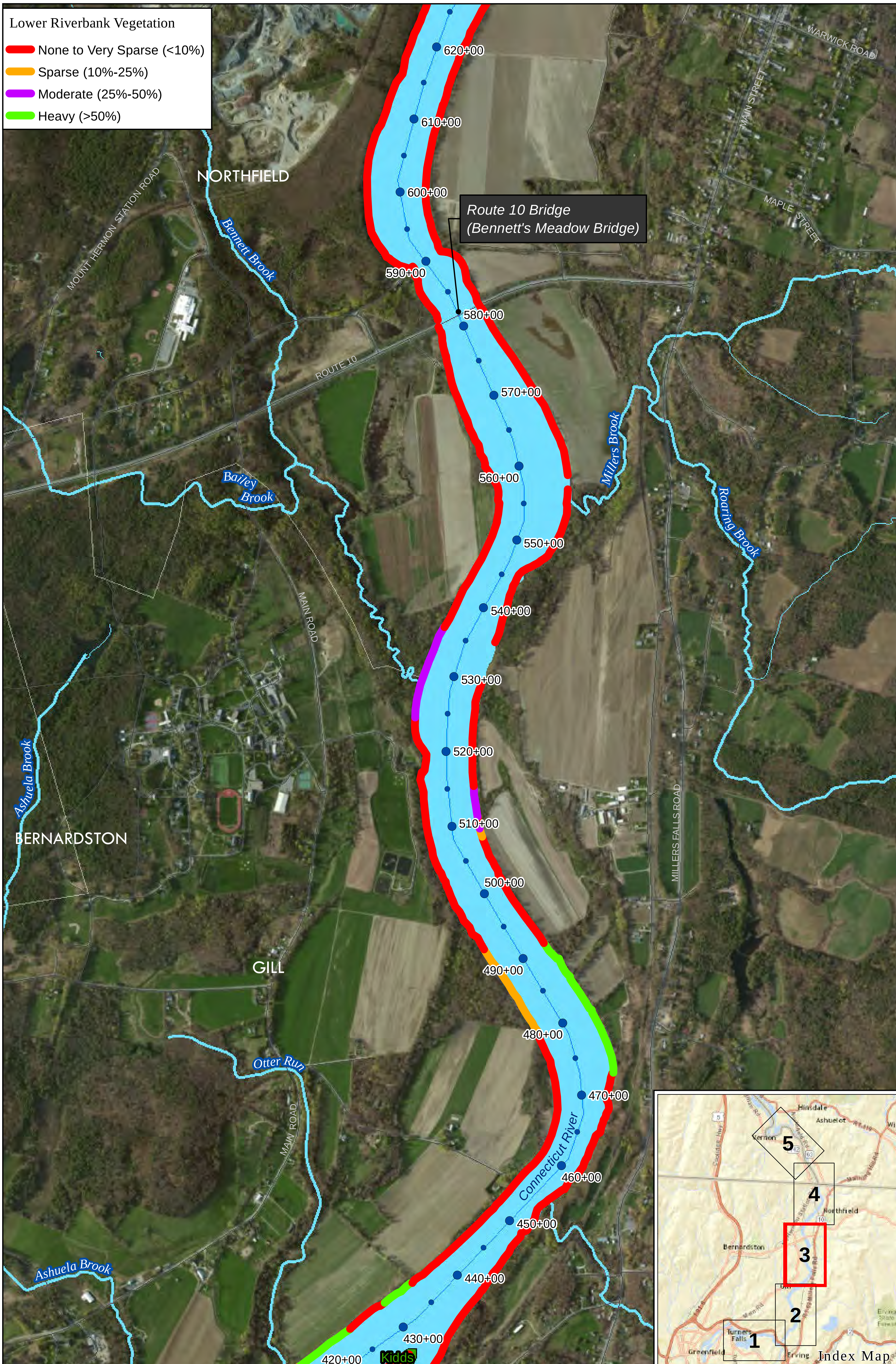

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Lower Riverbank Vegetation

Map 3

N

0 650 1,300 2,600 Feet

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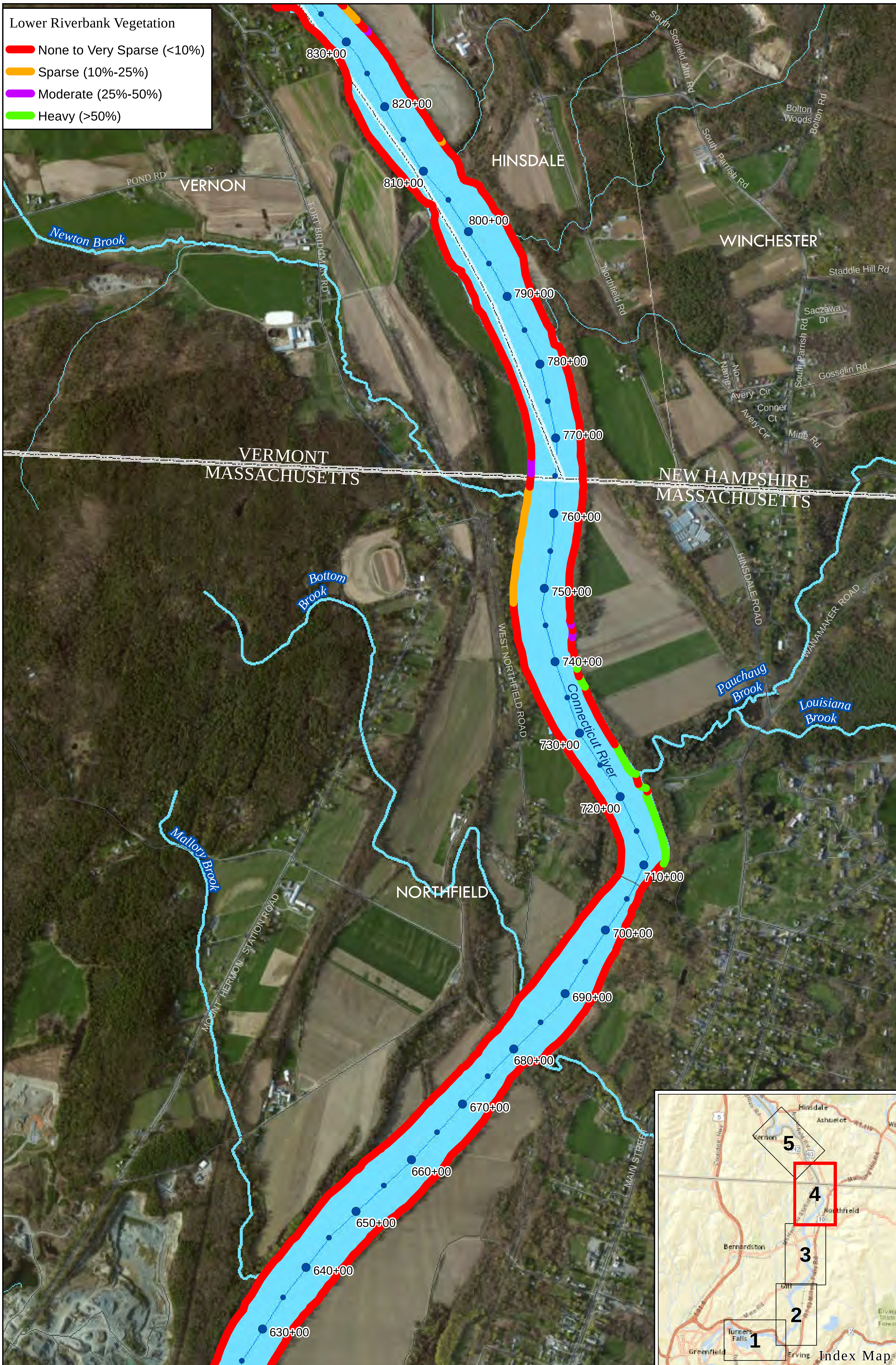

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Lower Riverbank Vegetation

Map 4

N

0 650 1,300 2,600 Feet

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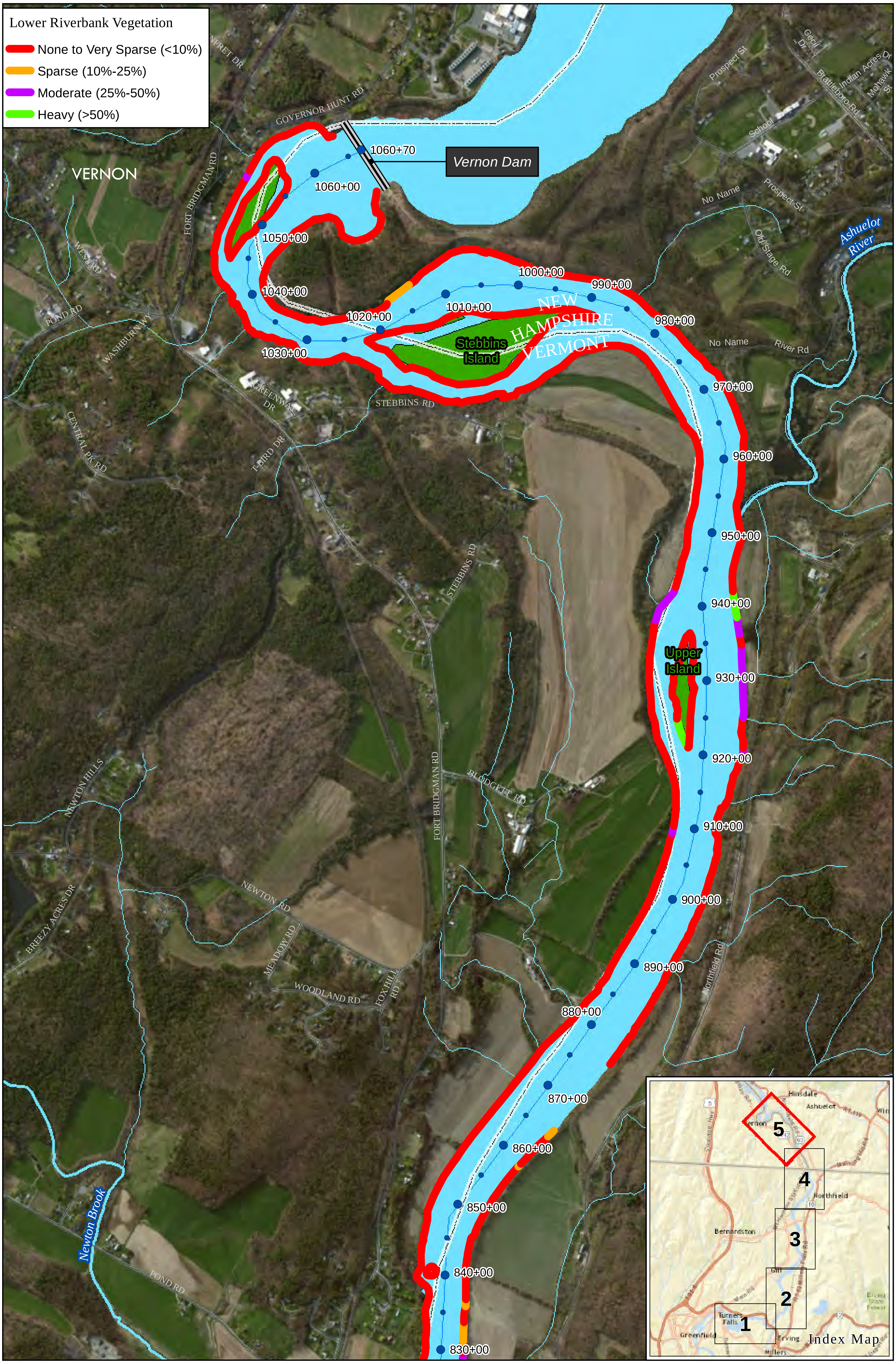

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Lower Riverbank Vegetation

Map 5

0 650 1,300 2,600 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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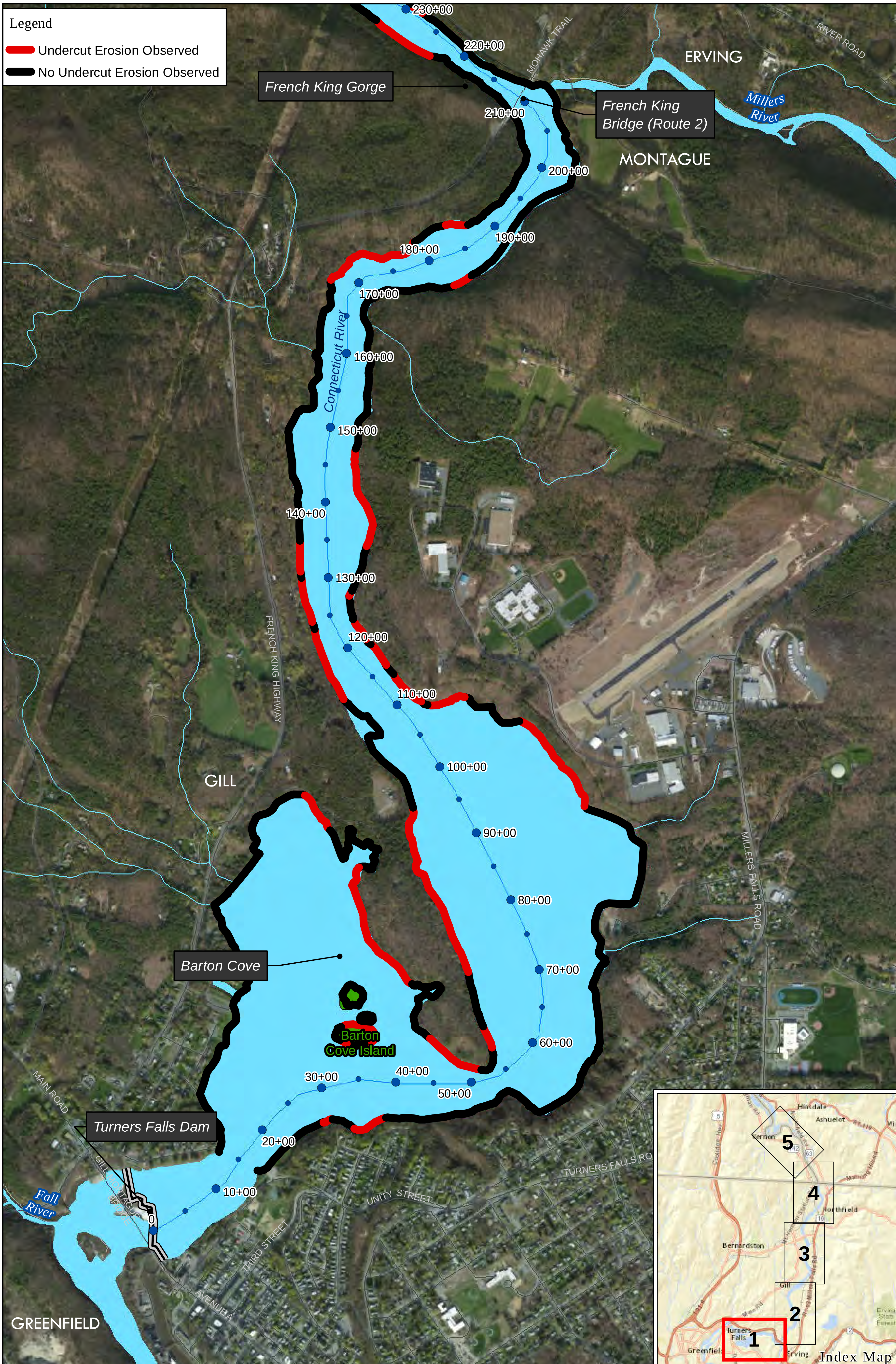

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Falls - Undercut

Map 1

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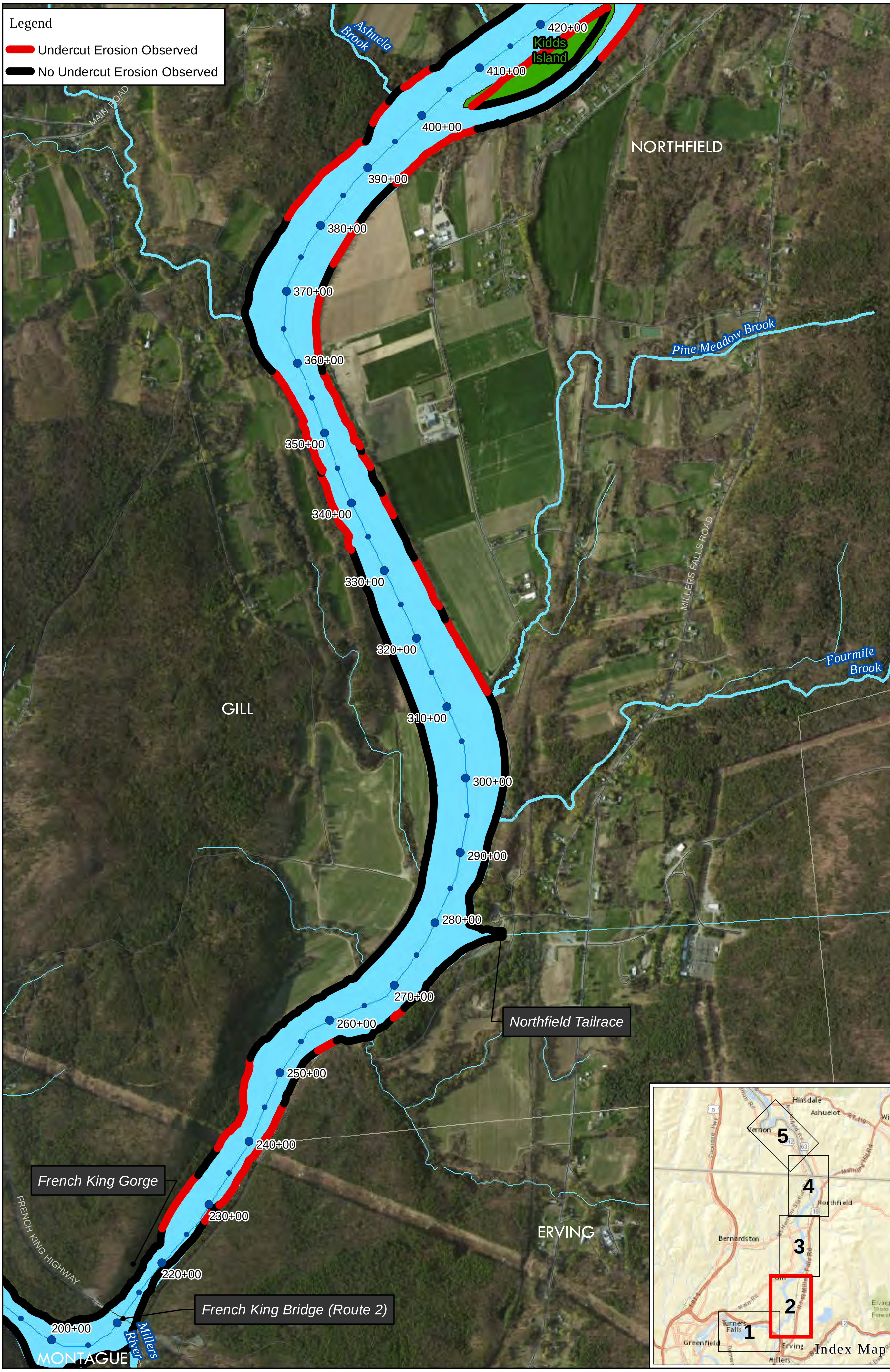

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Falls - Undercut

Map 2

N

0 650 1,300 2,600 Feet

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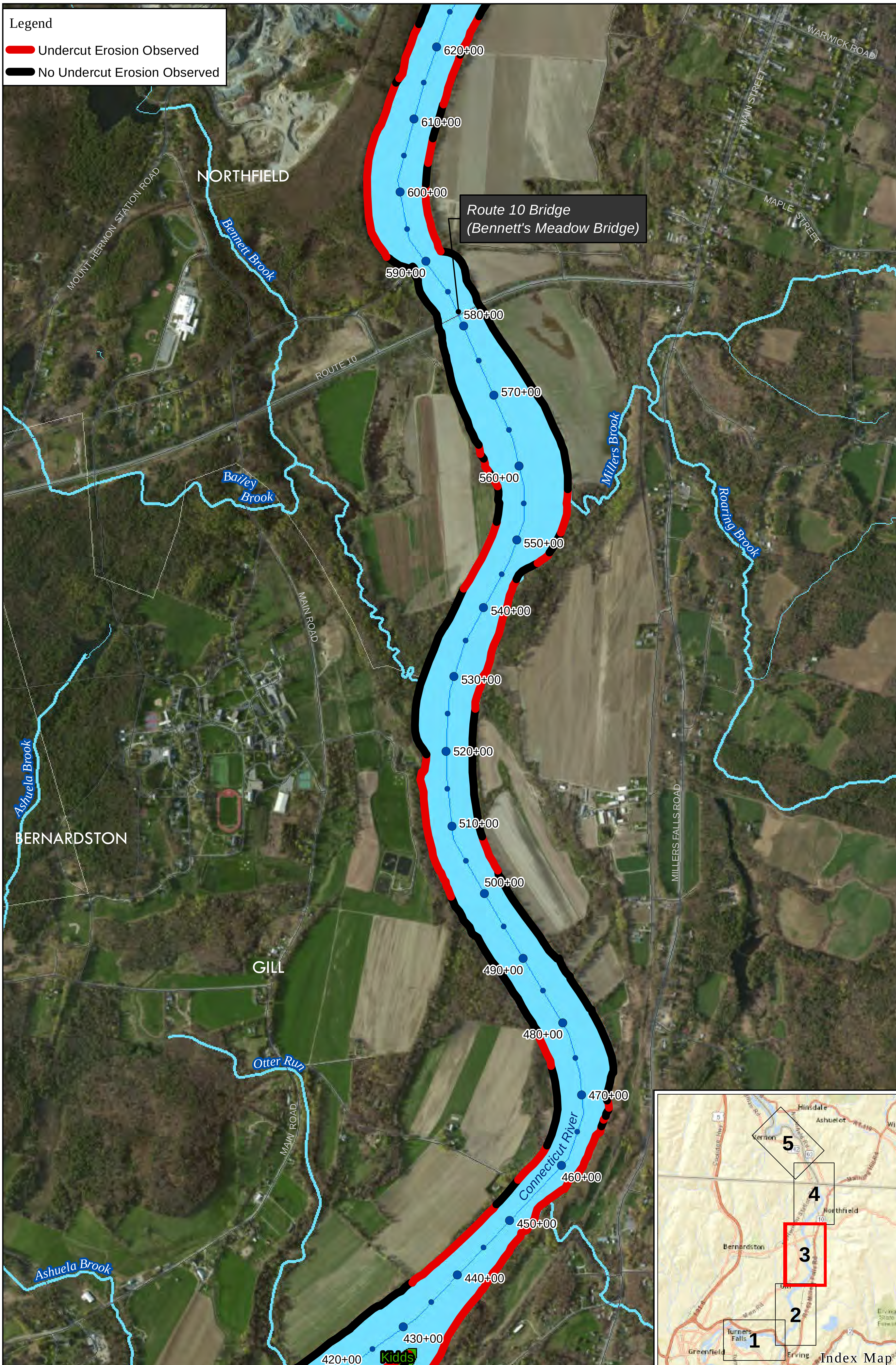

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Falls - Undercut

Map 3

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

RELICENSING STUDY 3.1.1

NORTHFIELD MOUNTAIN/TURNERS FALLS

FULL RIVER RECONNAISSANCE

Falls - Undercut

Map 4

N

0 650 1,300 2,600 Feet

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Falls - Undercut

Map 5

0 650 1,300 2,600
Feet

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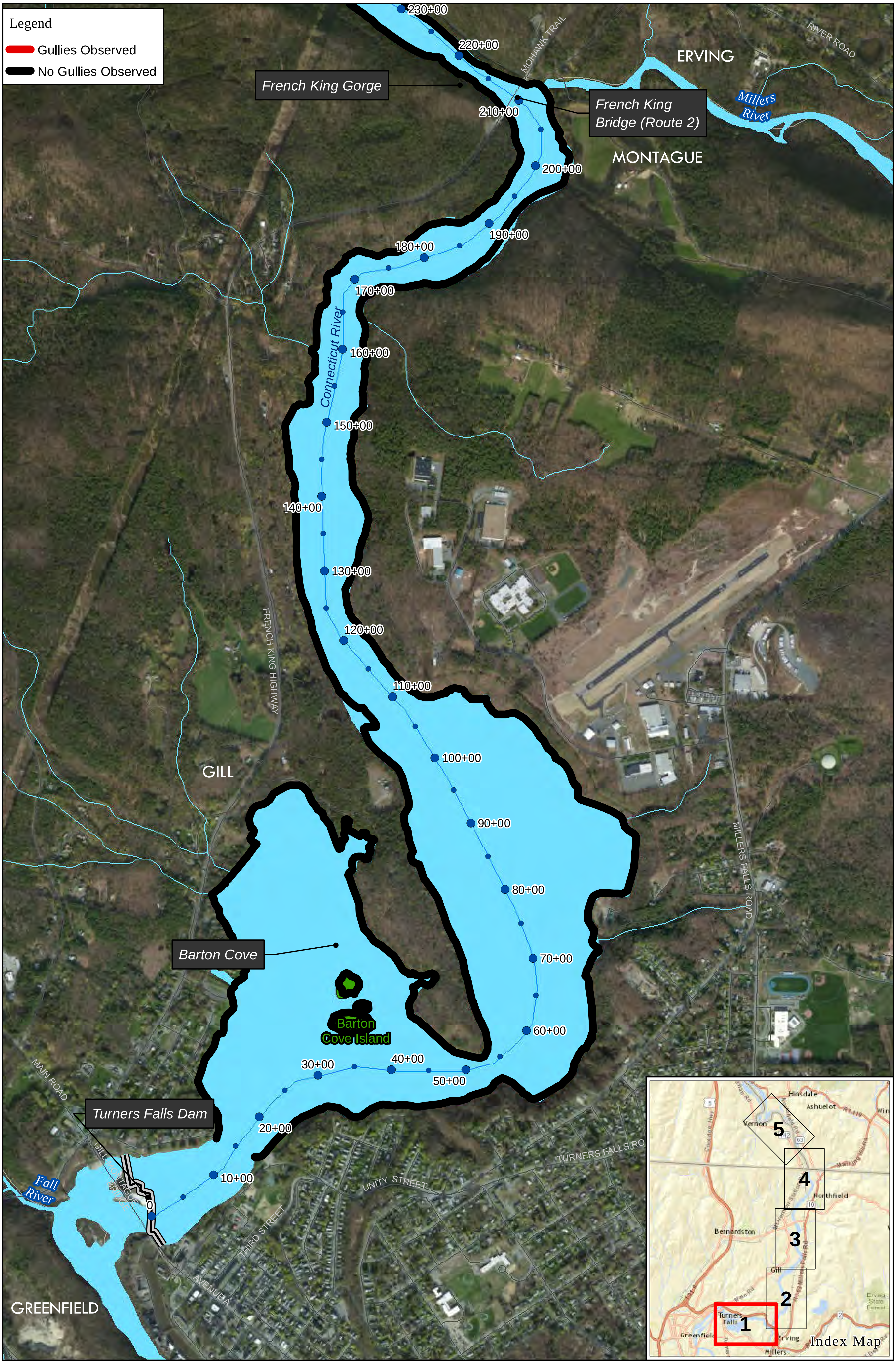

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Falls - Gullies

Map 1

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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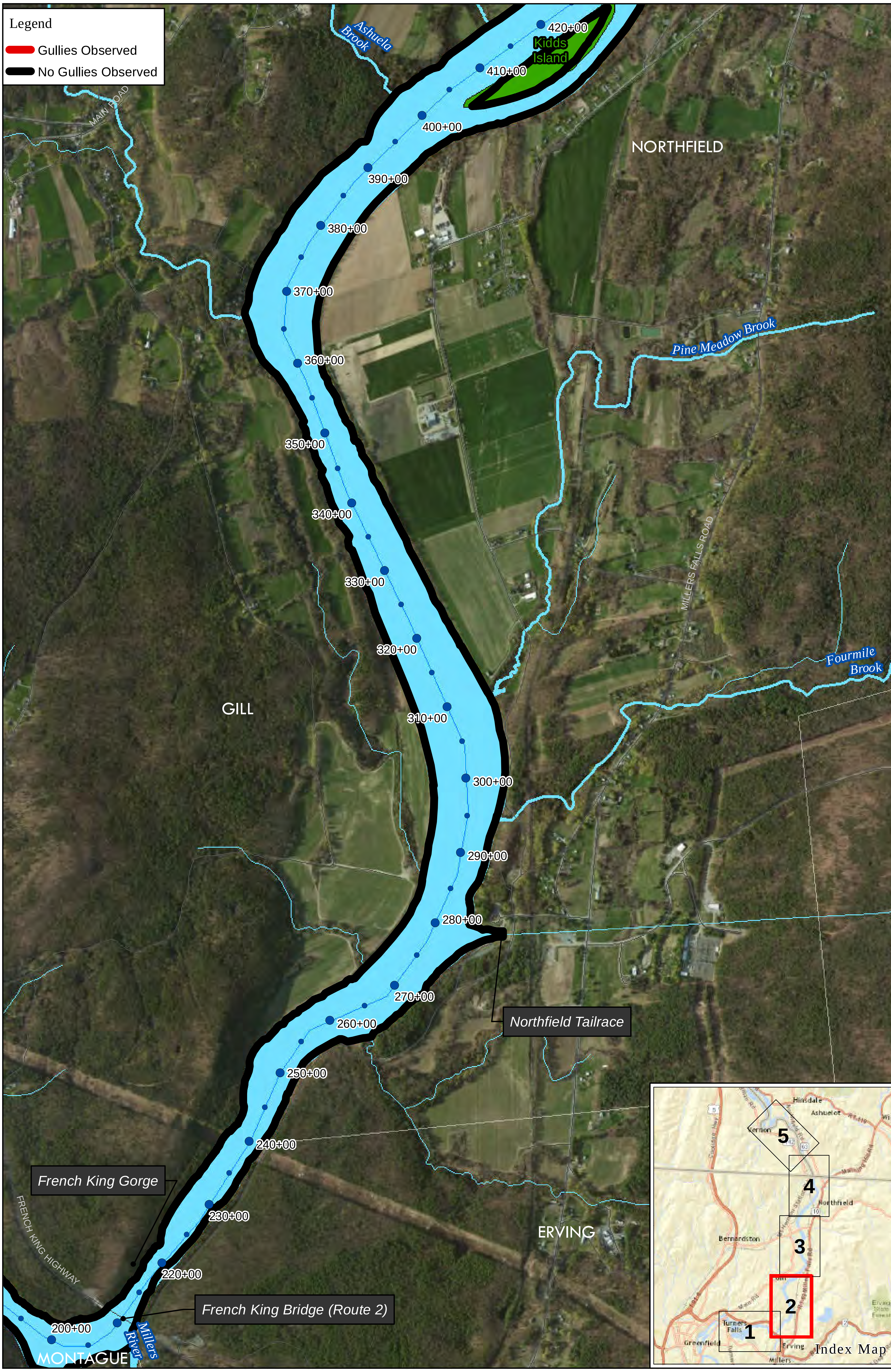

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Falls - Gullies

Map 2

N

0 650 1,300 2,600 Feet

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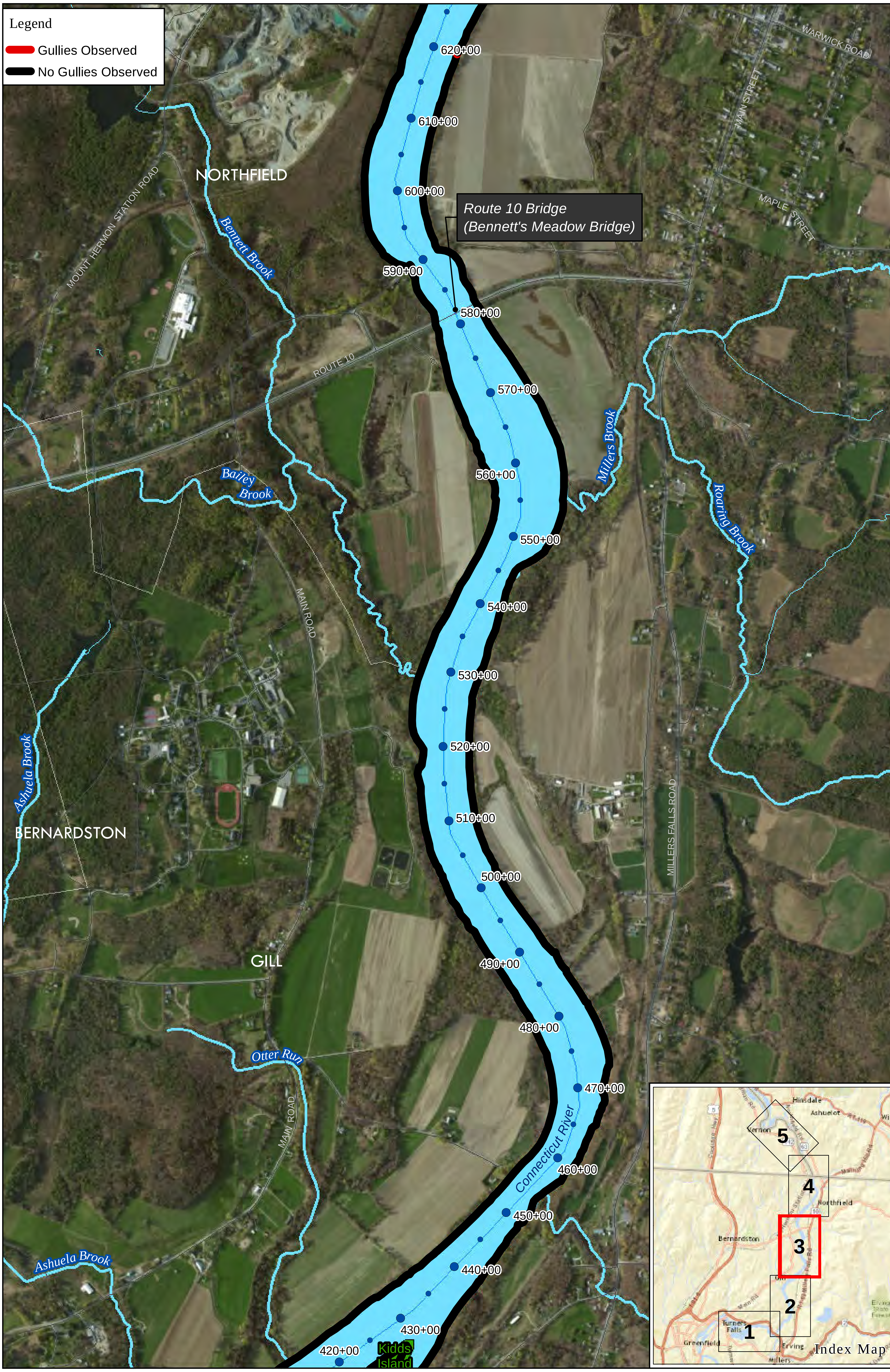

FirstLight
GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Falls - Gullies

Map 3

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Falls - Gullies

Map 4

0 650 1,300 2,600 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600
Feet

Falls - Gullies

Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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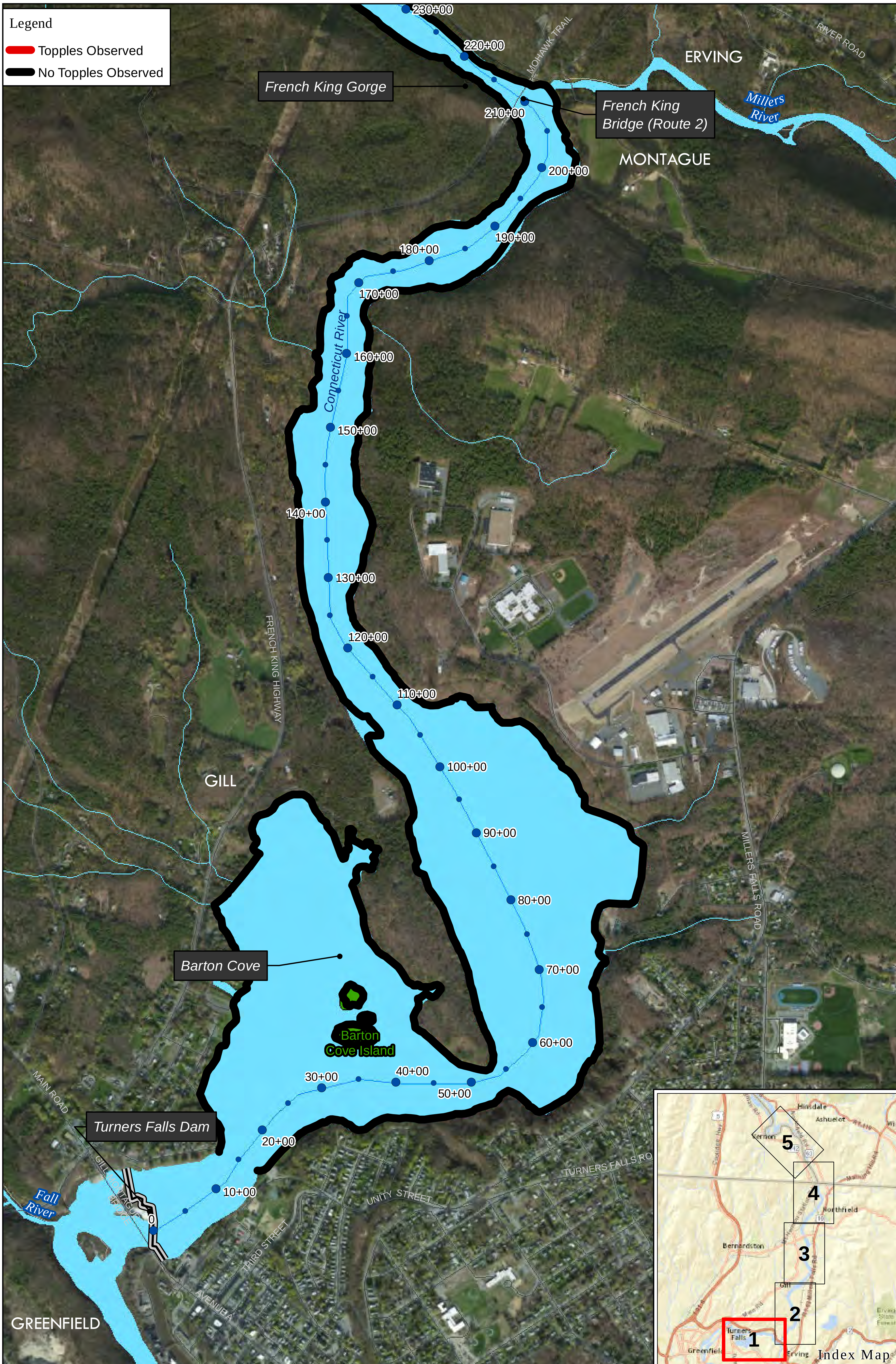

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Topples

Map 1

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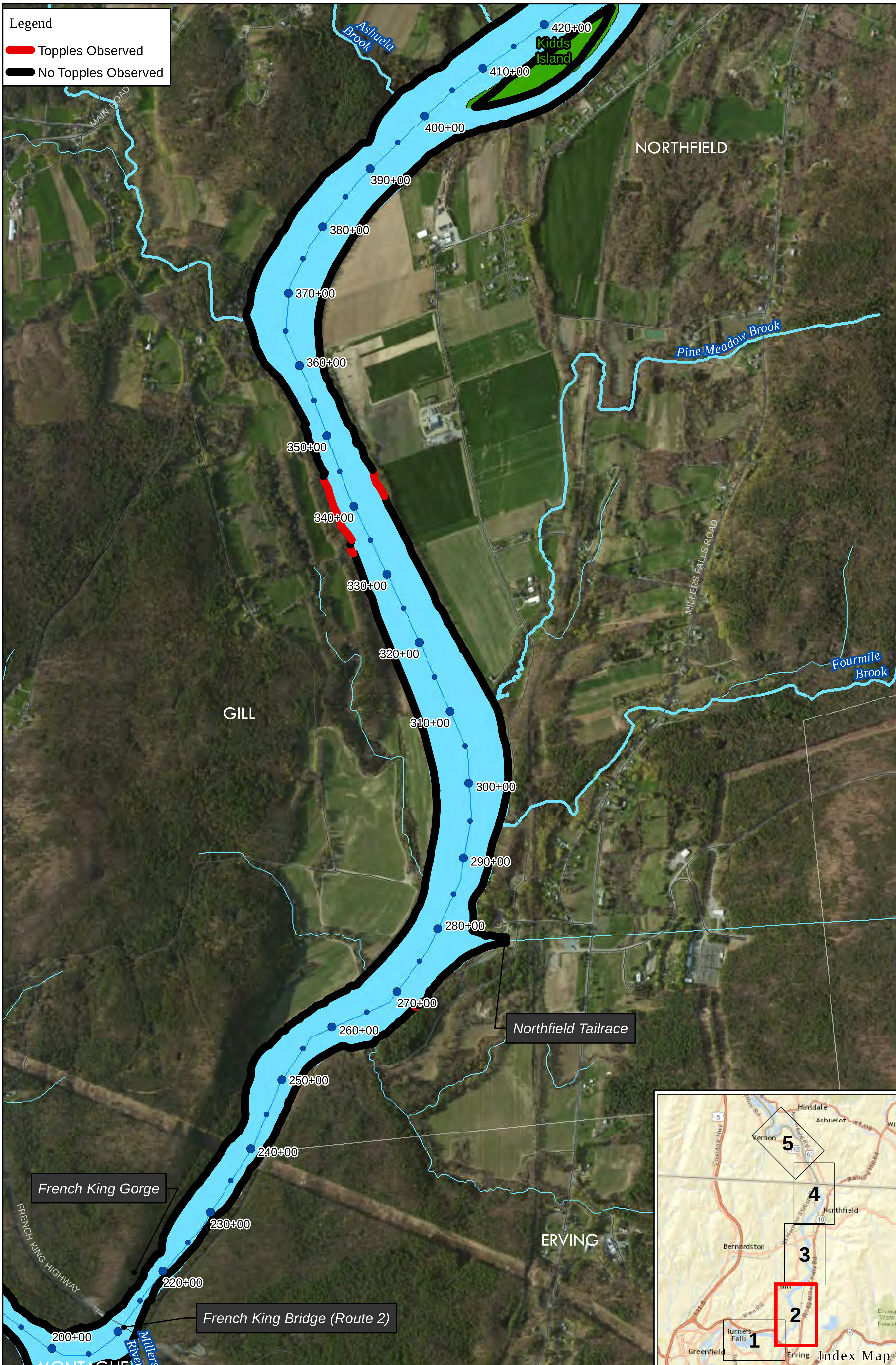

FirstLight GDF SUEZ

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Topples

Map 2

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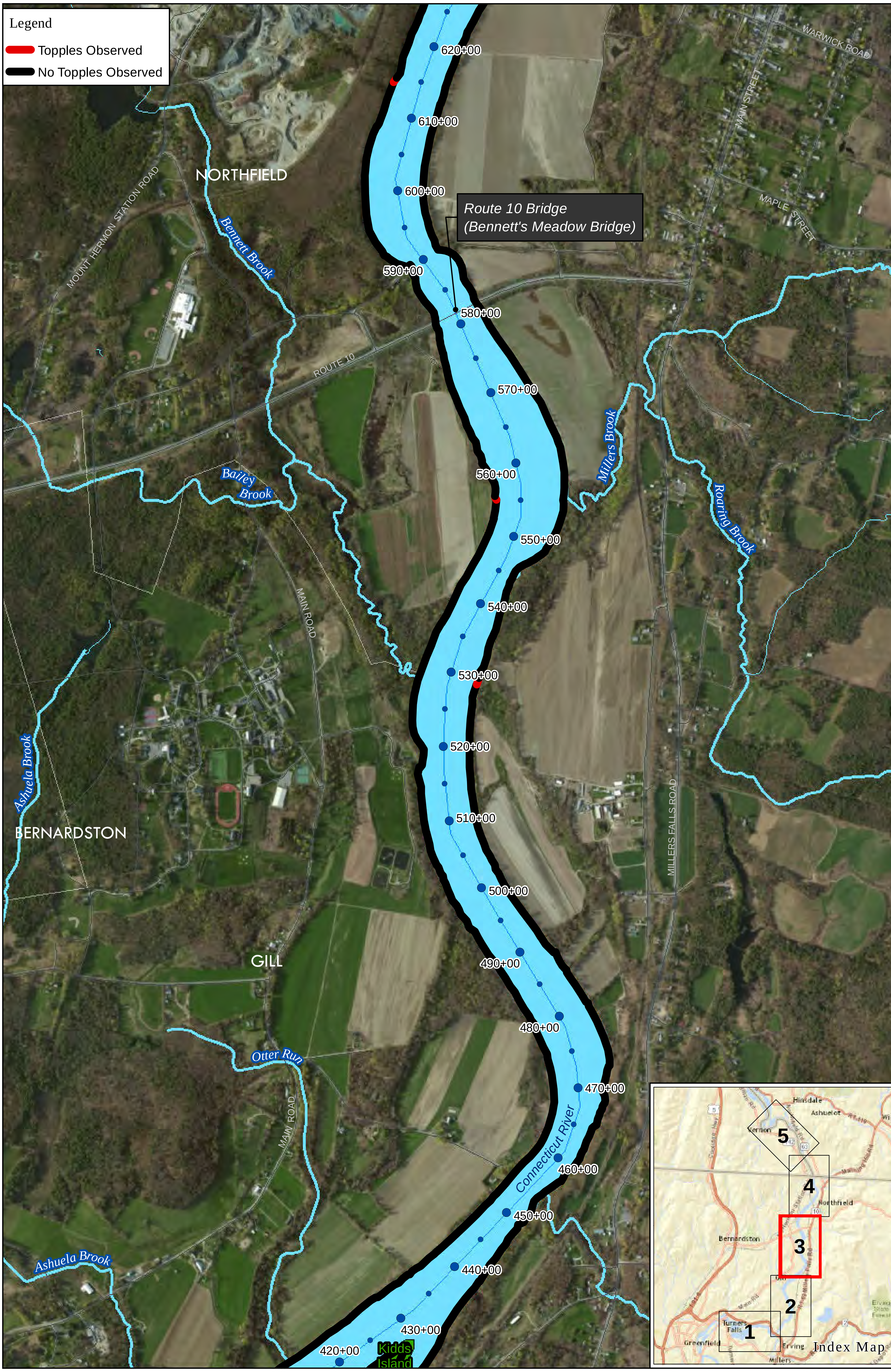

FirstLight
GDF SUEZ

N

0 650 1,300 2,600 Feet

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Topples

Map 3

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Topples

Map 4

0 650 1,300 2,600 Feet

N

FirstLight GDF SUEZ

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Topples

Map 5

0 650 1,300 2,600 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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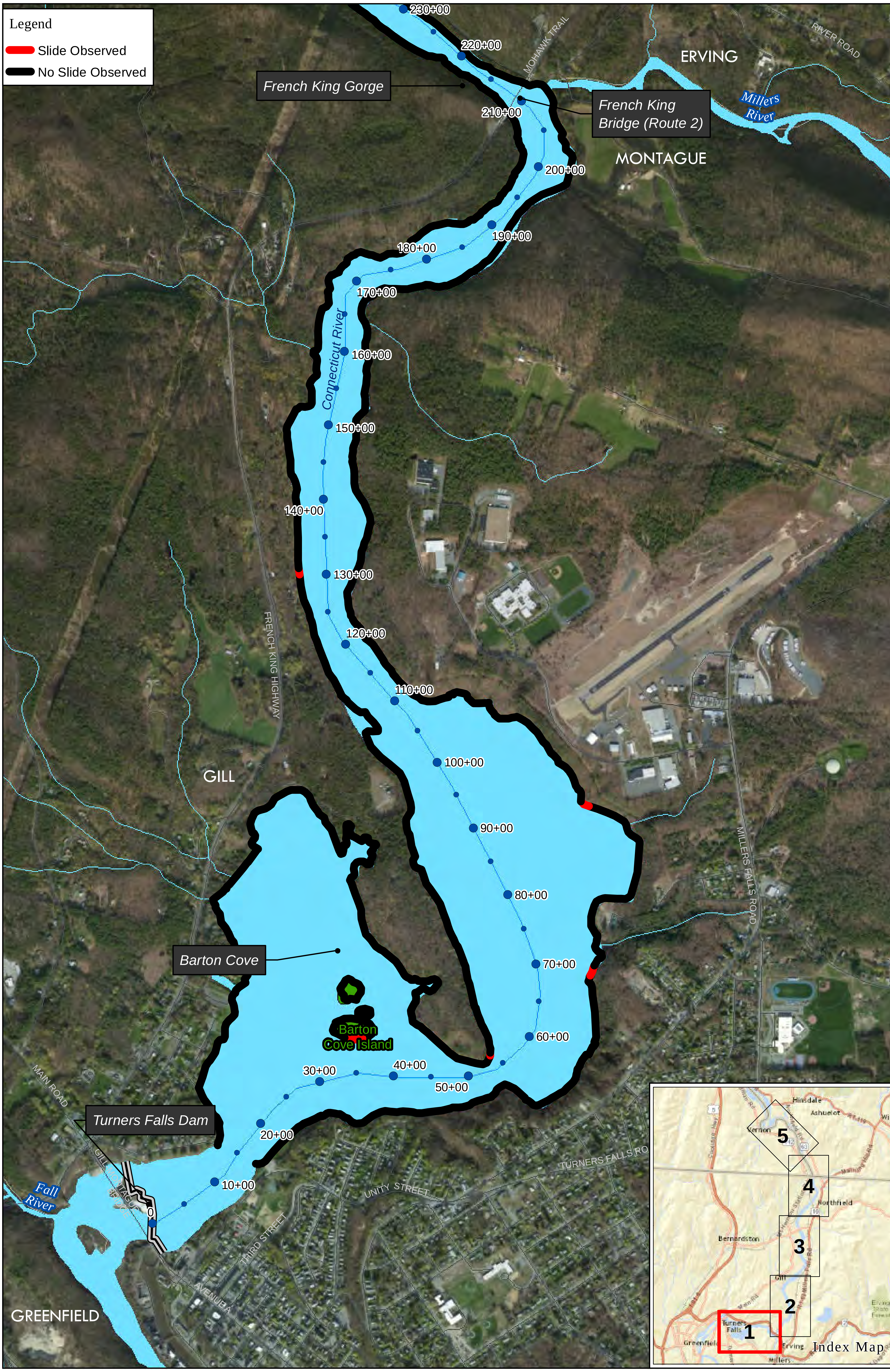

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Slide

Map 1

N

0 650 1,300 2,600 Feet

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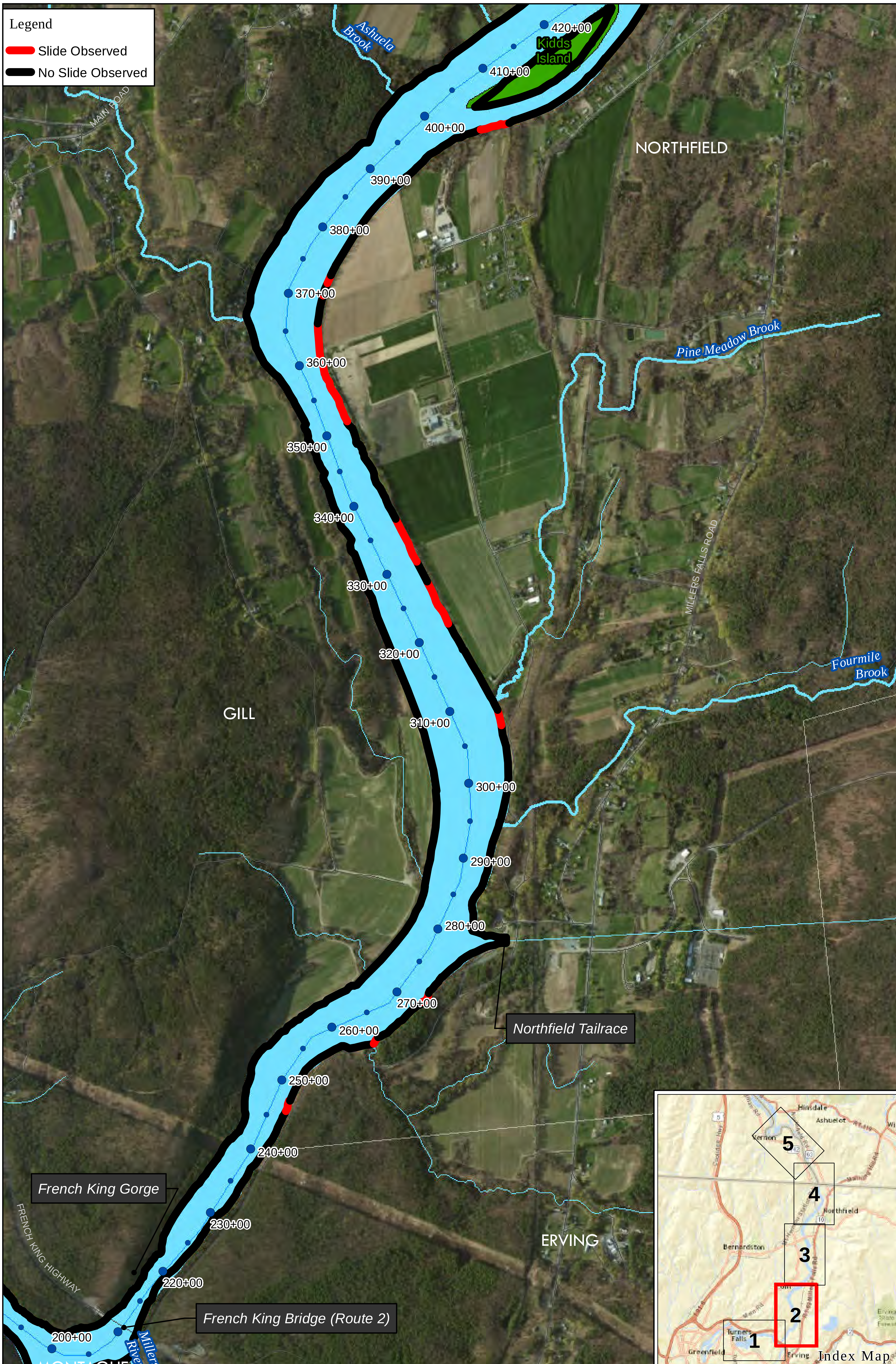

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Slide

Map 2

N

0 650 1,300 2,600 Feet

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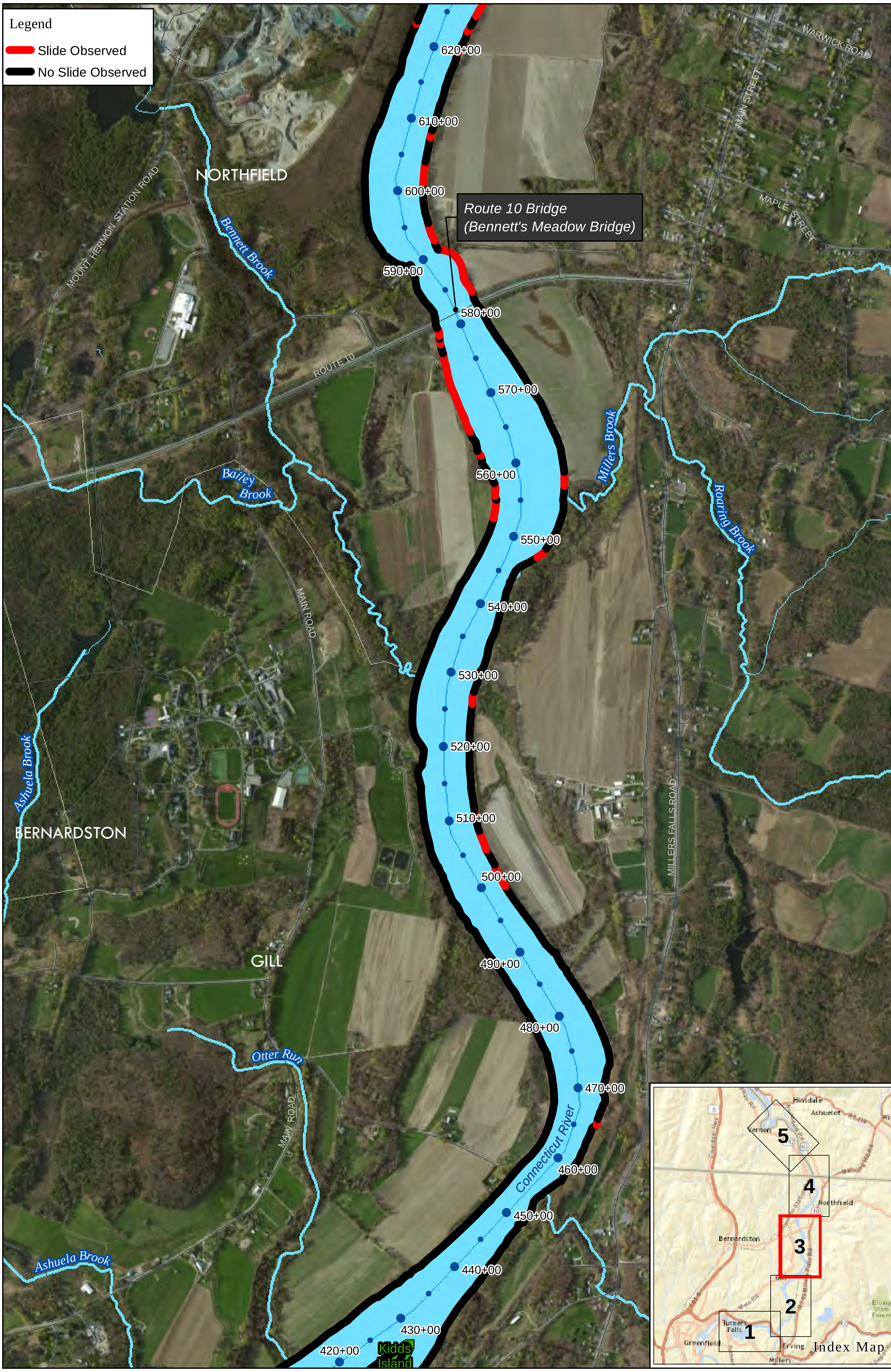

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Slide

Map 3

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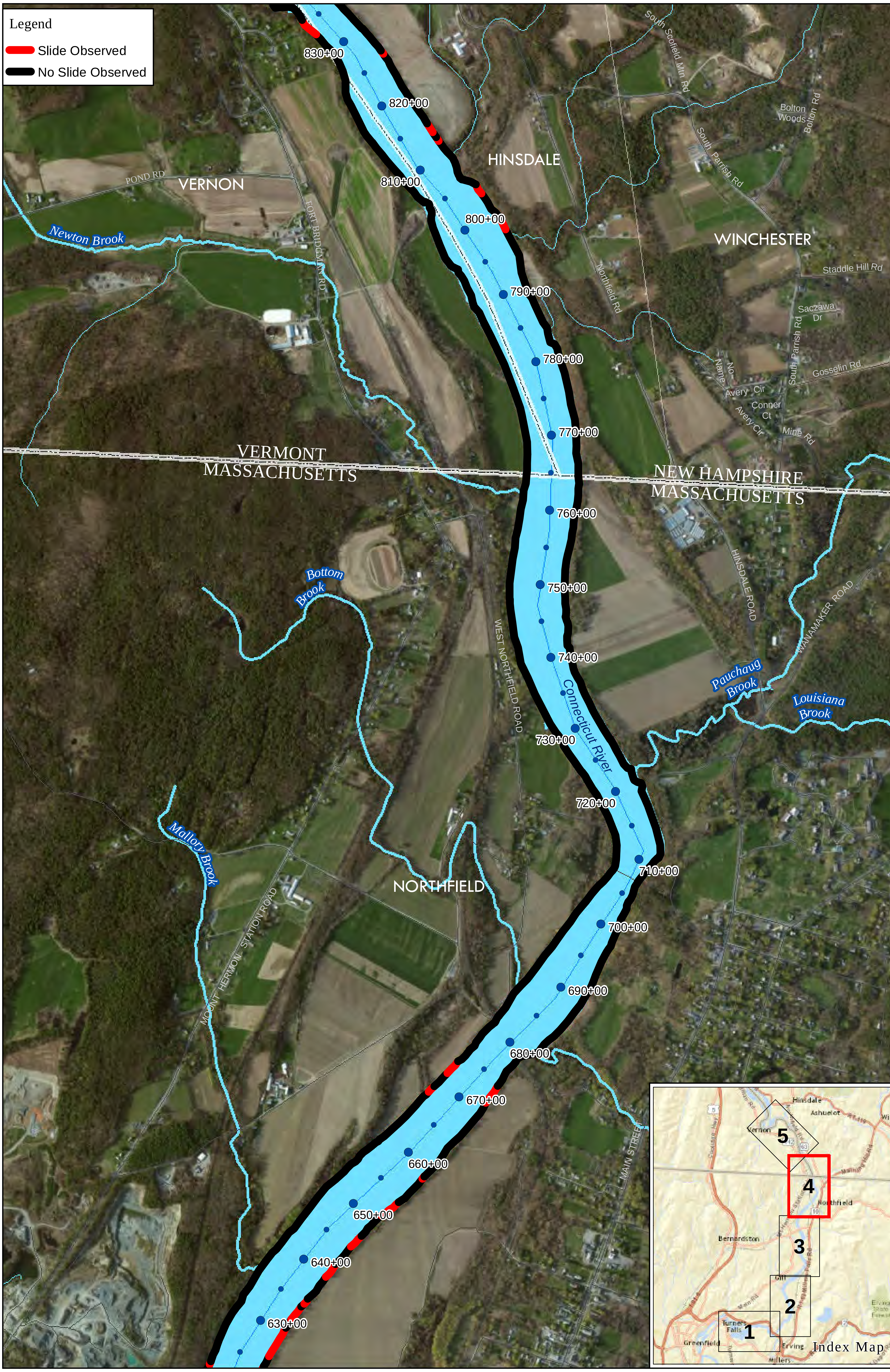

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Slide

Map 4

N

0 650 1,300 2,600 Feet

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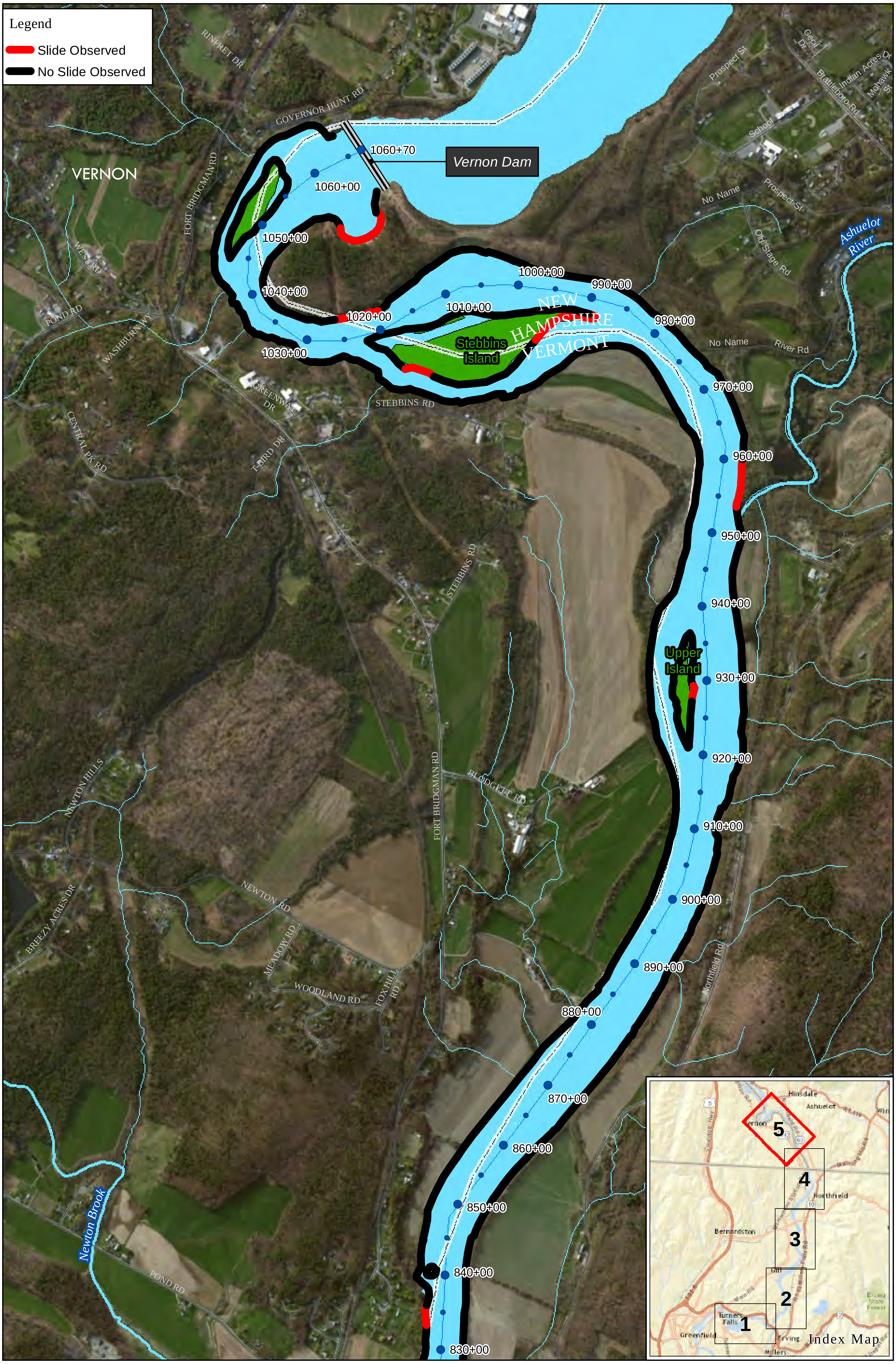

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Slide

Map 5

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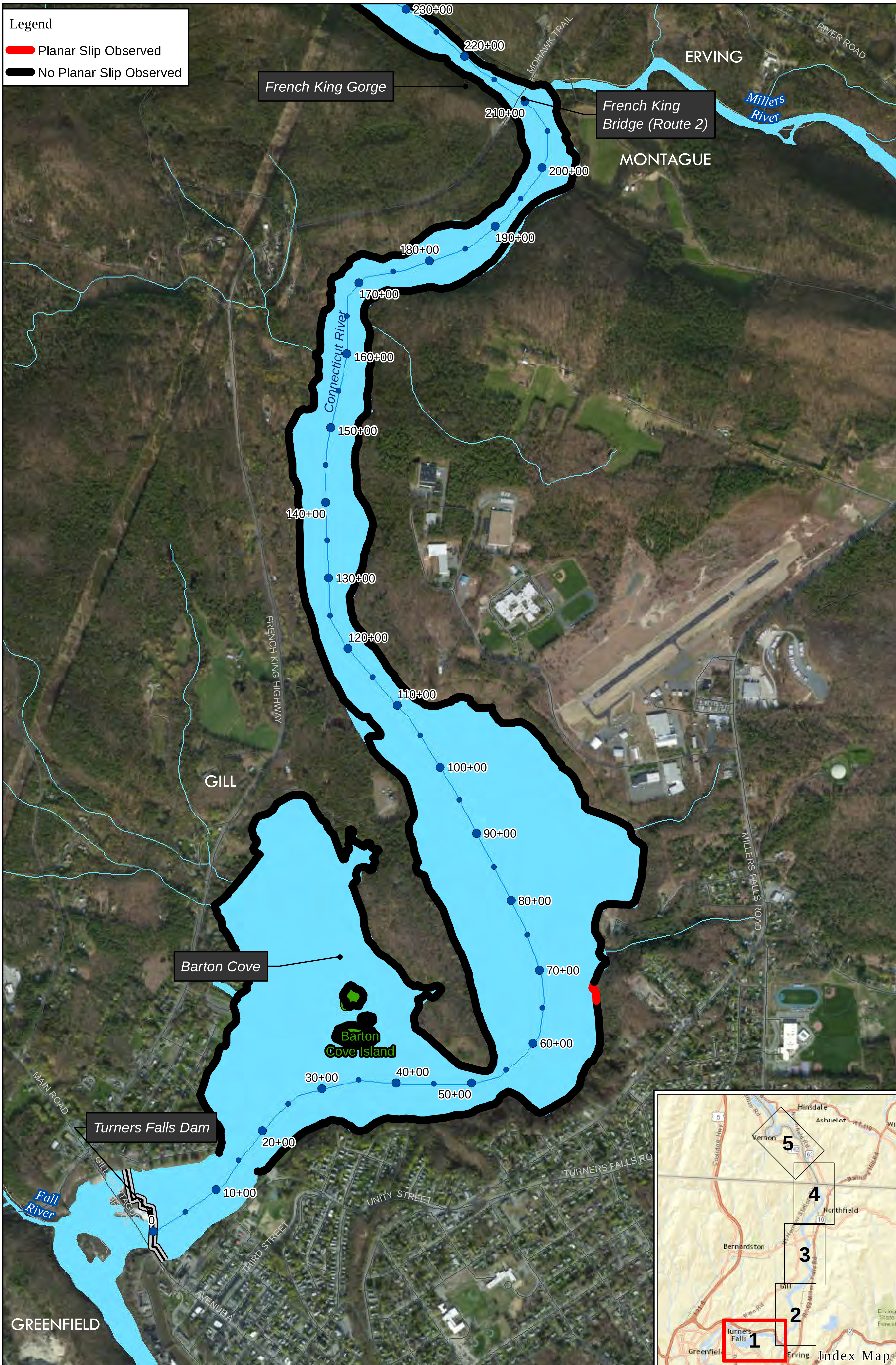

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Planar Slip

Map 1

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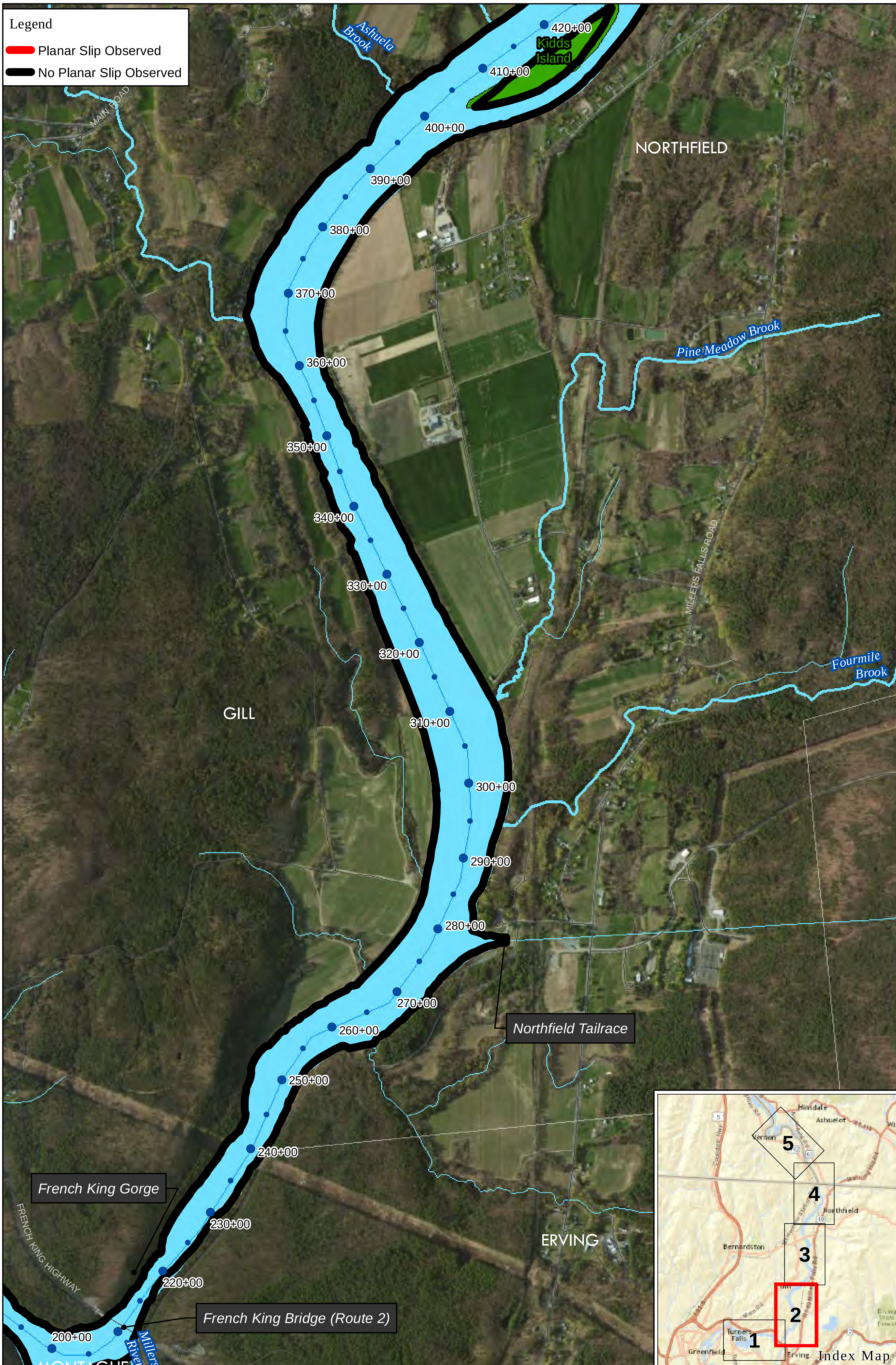

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Planar Slip

Map 2

N

0 650 1,300 2,600 Feet

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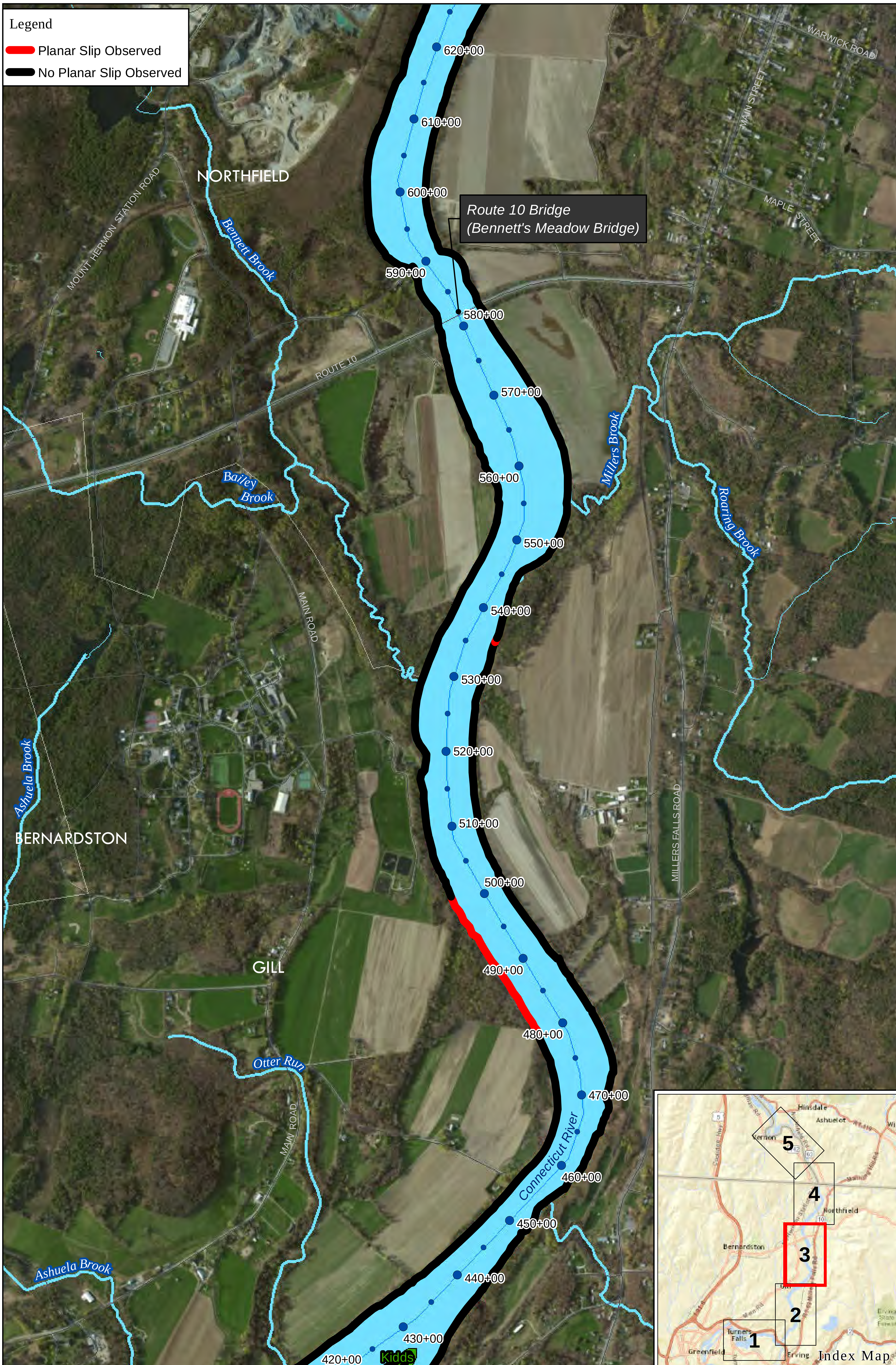

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N

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Planar Slip

Map 3

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

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Planar Slip

Map 4

N

0 650 1,300 2,600 Feet

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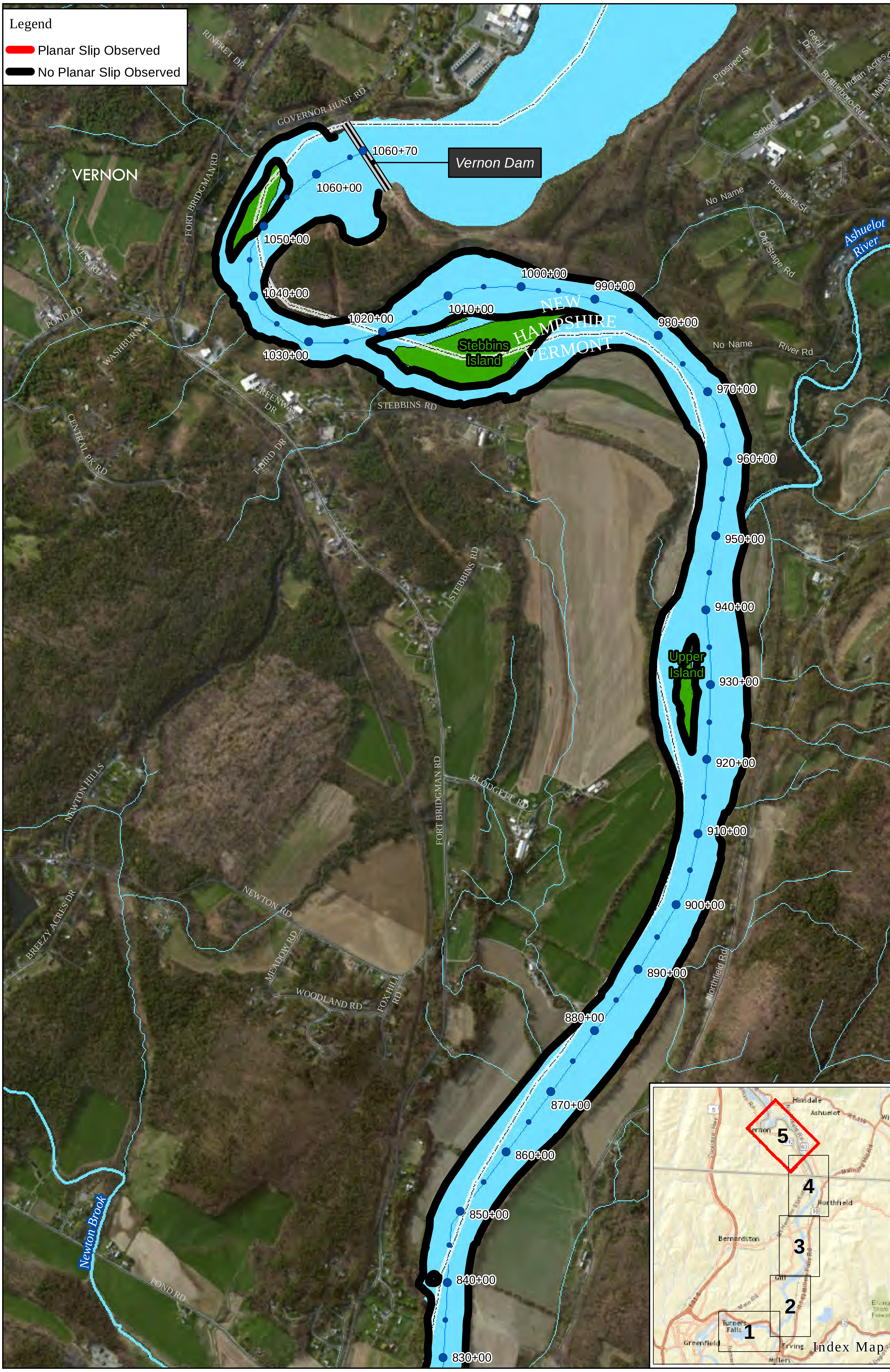

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1

NORTHFIELD MOUNTAIN/TURNERS FALLS

FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Planar Slip

Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri

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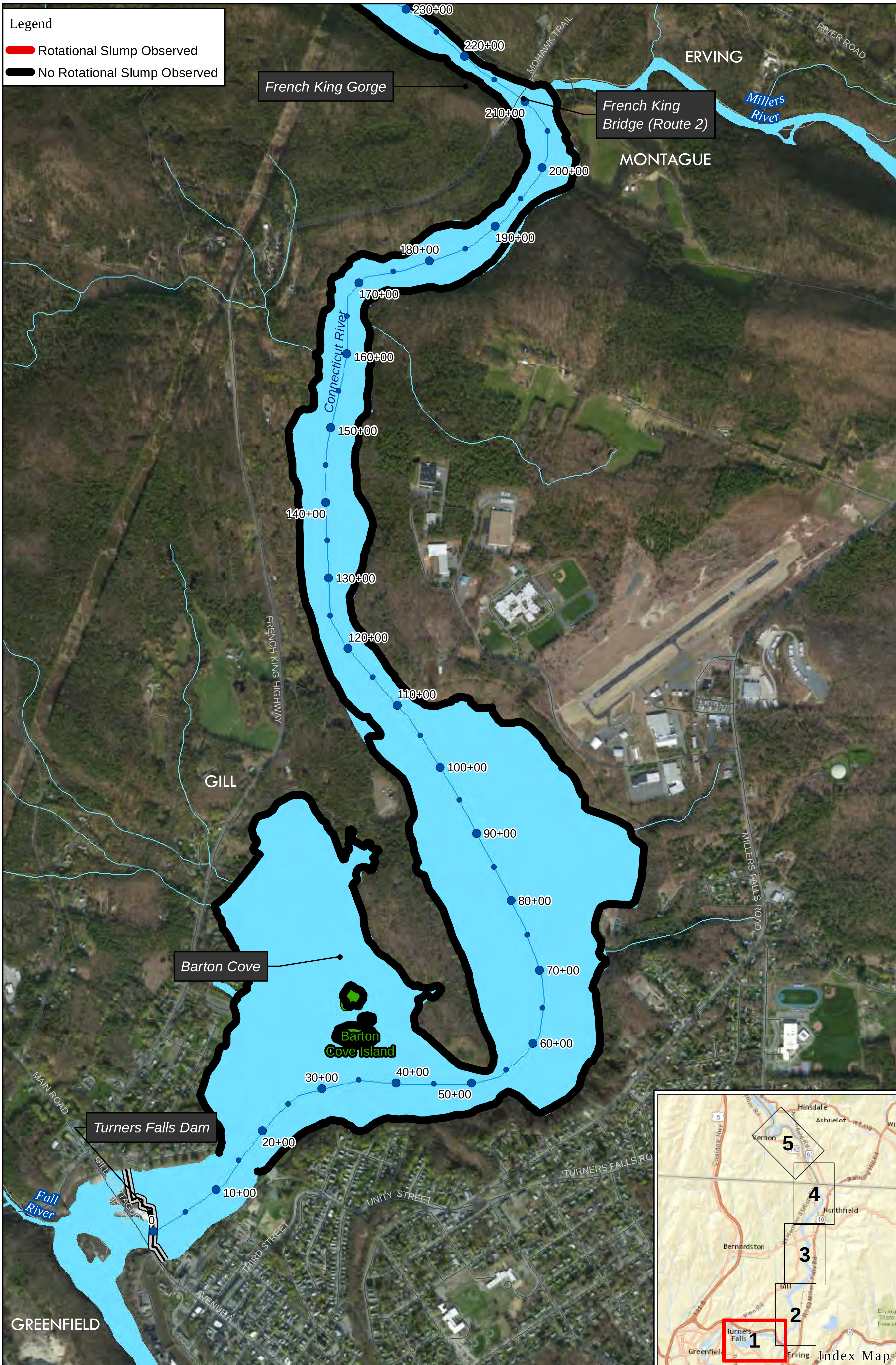

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Rotational Slump

Map 1

0 650 1,300 2,600 Feet

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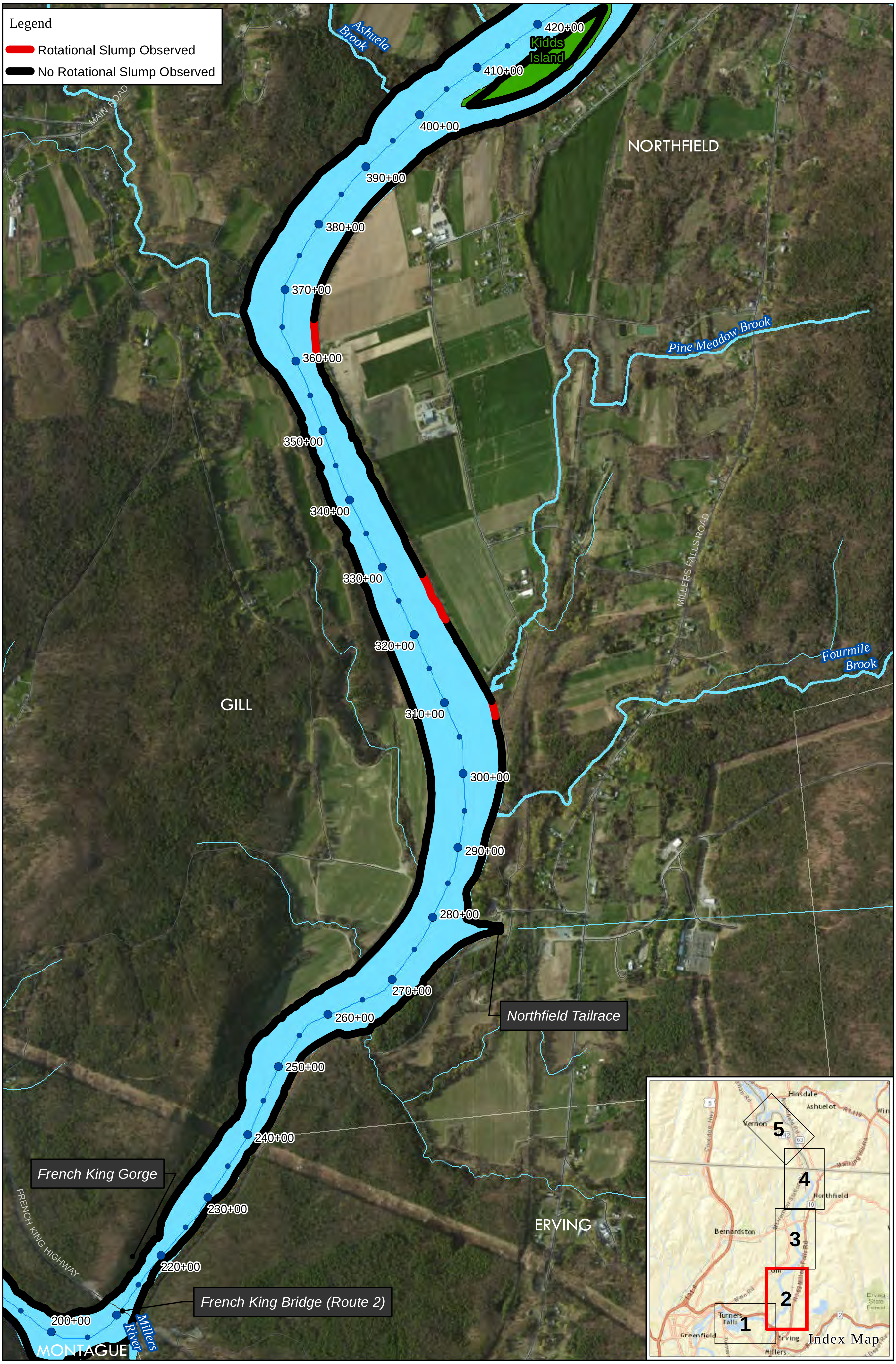

N

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Rotational Slump

Map 2

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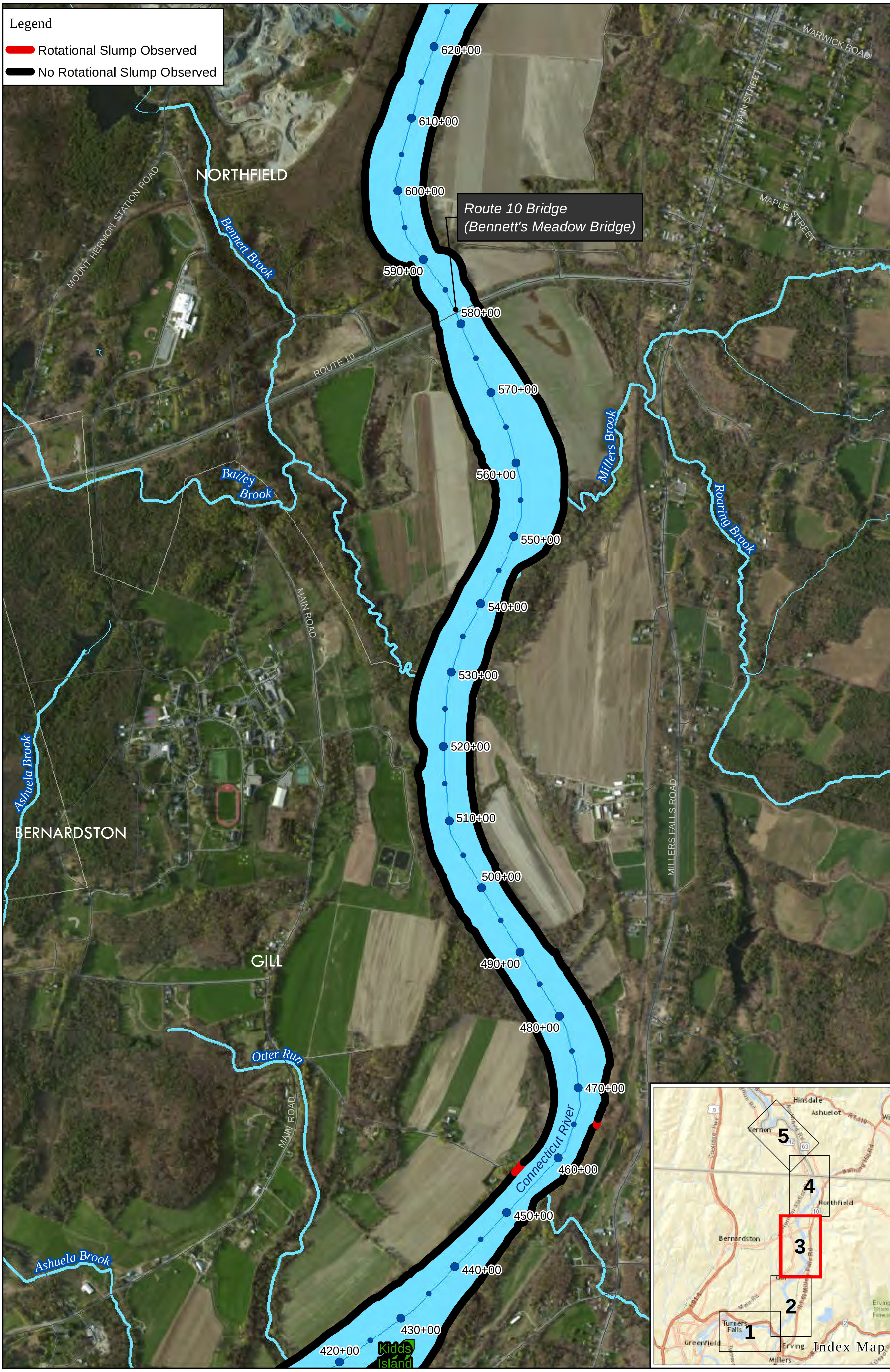

FirstLight GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Rotational Slump

Map 3

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

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Rotational Slump

Map 4

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

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Rotational Slump

Map 5

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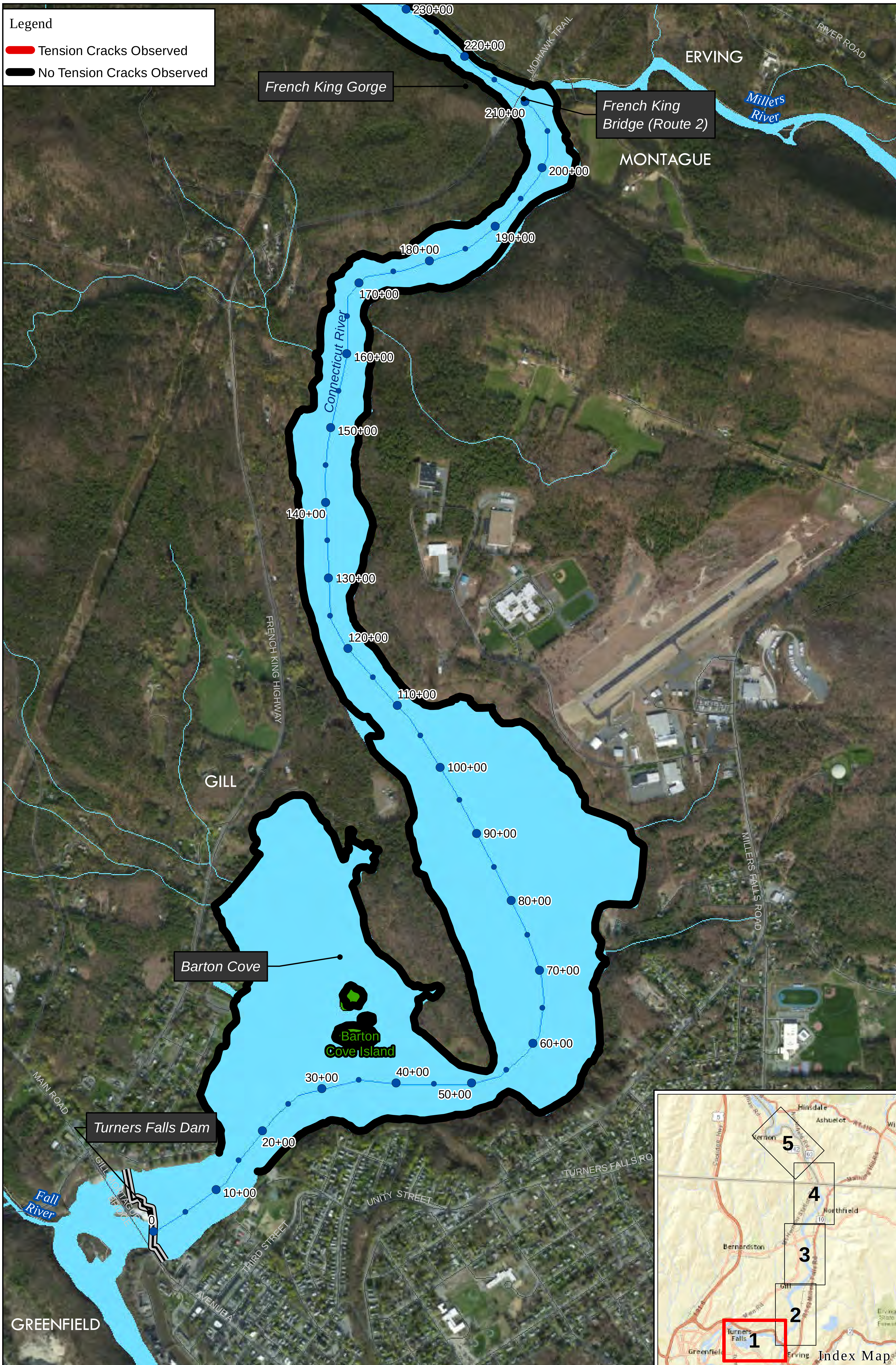

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Tension Cracks

Map 1

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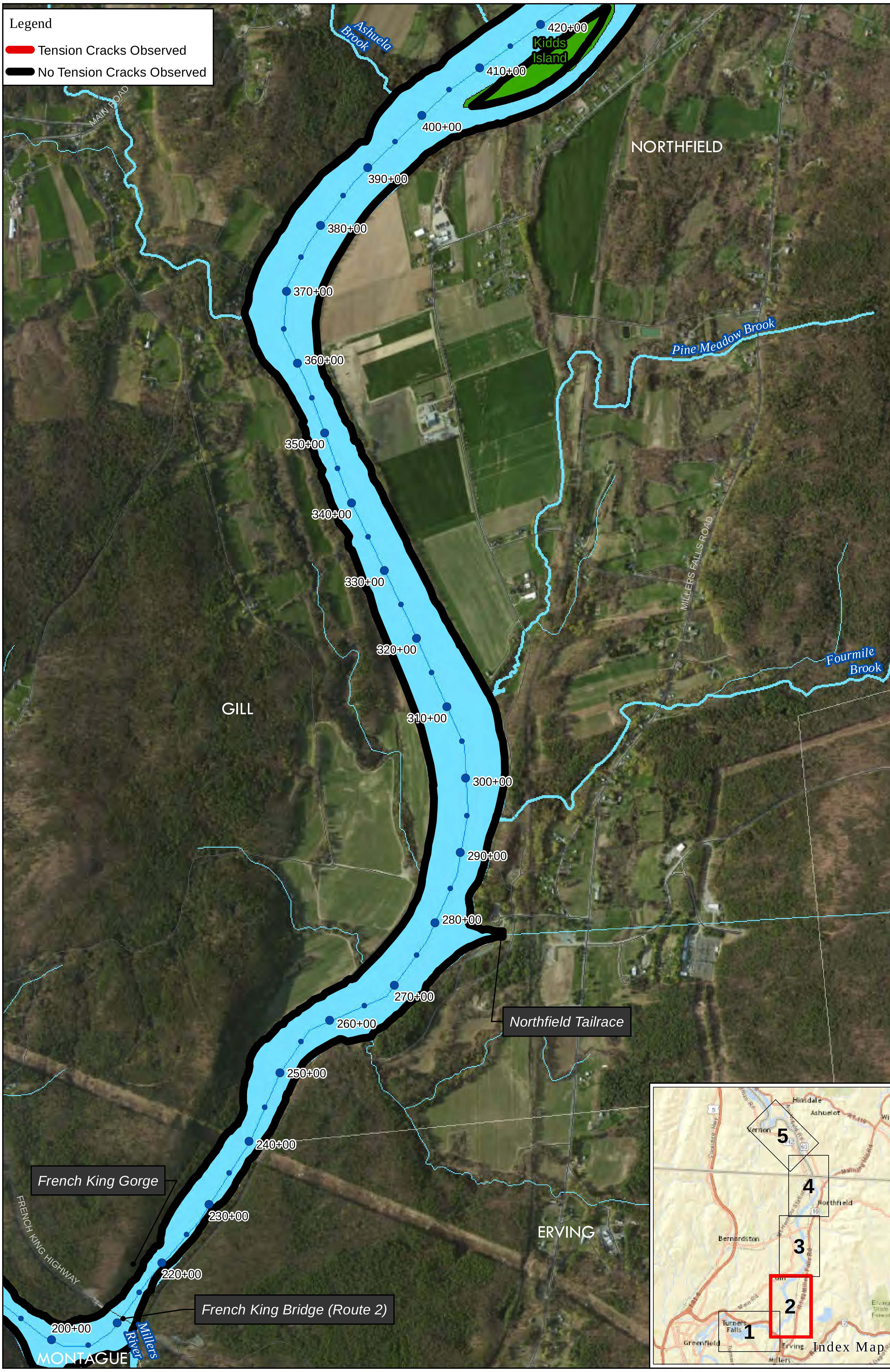

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Tension Cracks

Map 2

FirstLight GDF SUEZ

N

0 650 1,300 2,600 Feet

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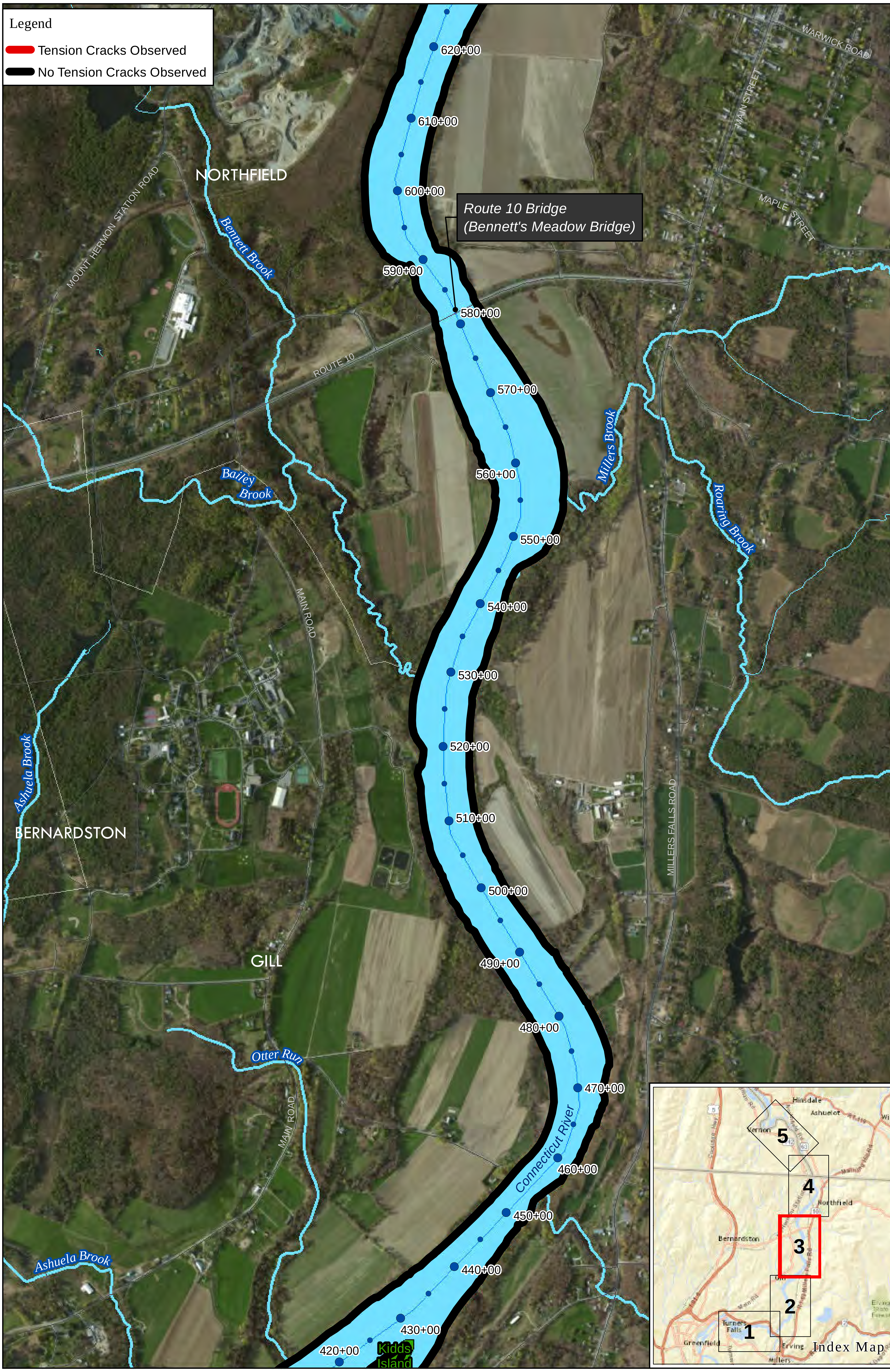

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Tension Cracks

Map 3

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

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Tension Cracks

Map 4

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

RELICENSING STUDY 3.1.1

NORTHFIELD MOUNTAIN/TURNERS FALLS

FULL RIVER RECONNAISSANCE

Tension Cracks

Map 5

0 650 1,300 2,600 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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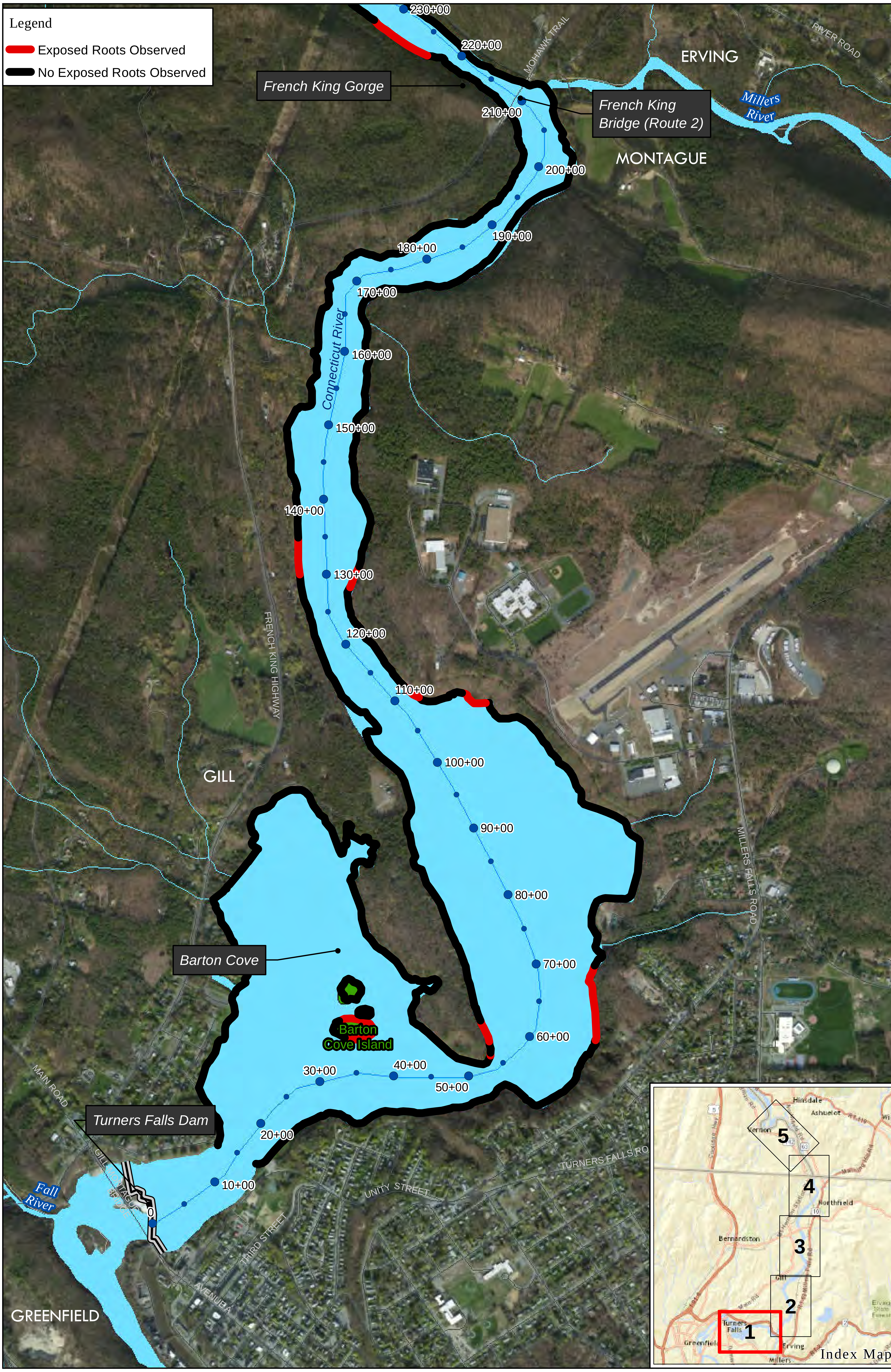

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Exposed Roots

Map 1

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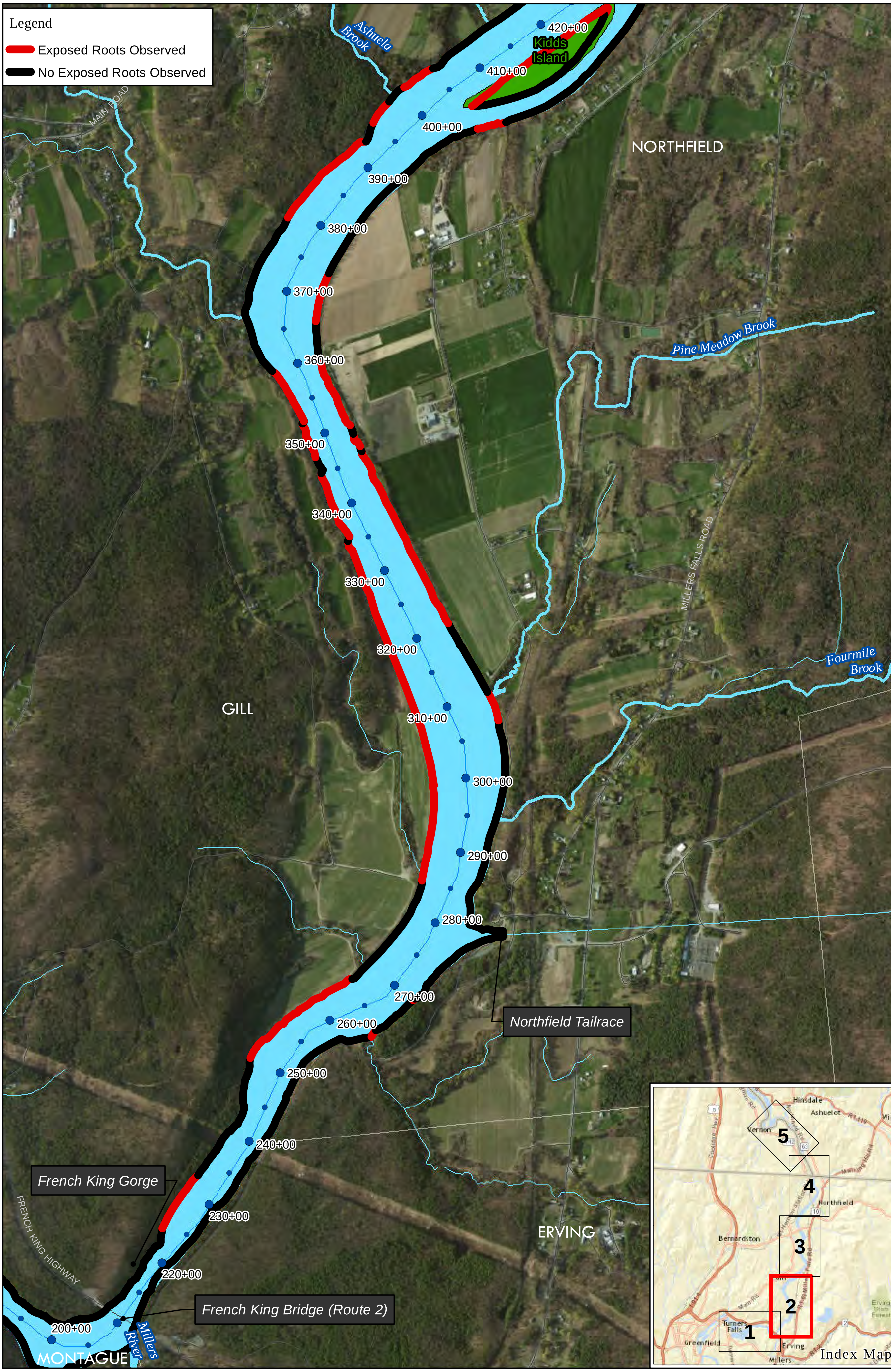

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

N

FirstLight GDF SUEZ

Exposed Roots

Map 2

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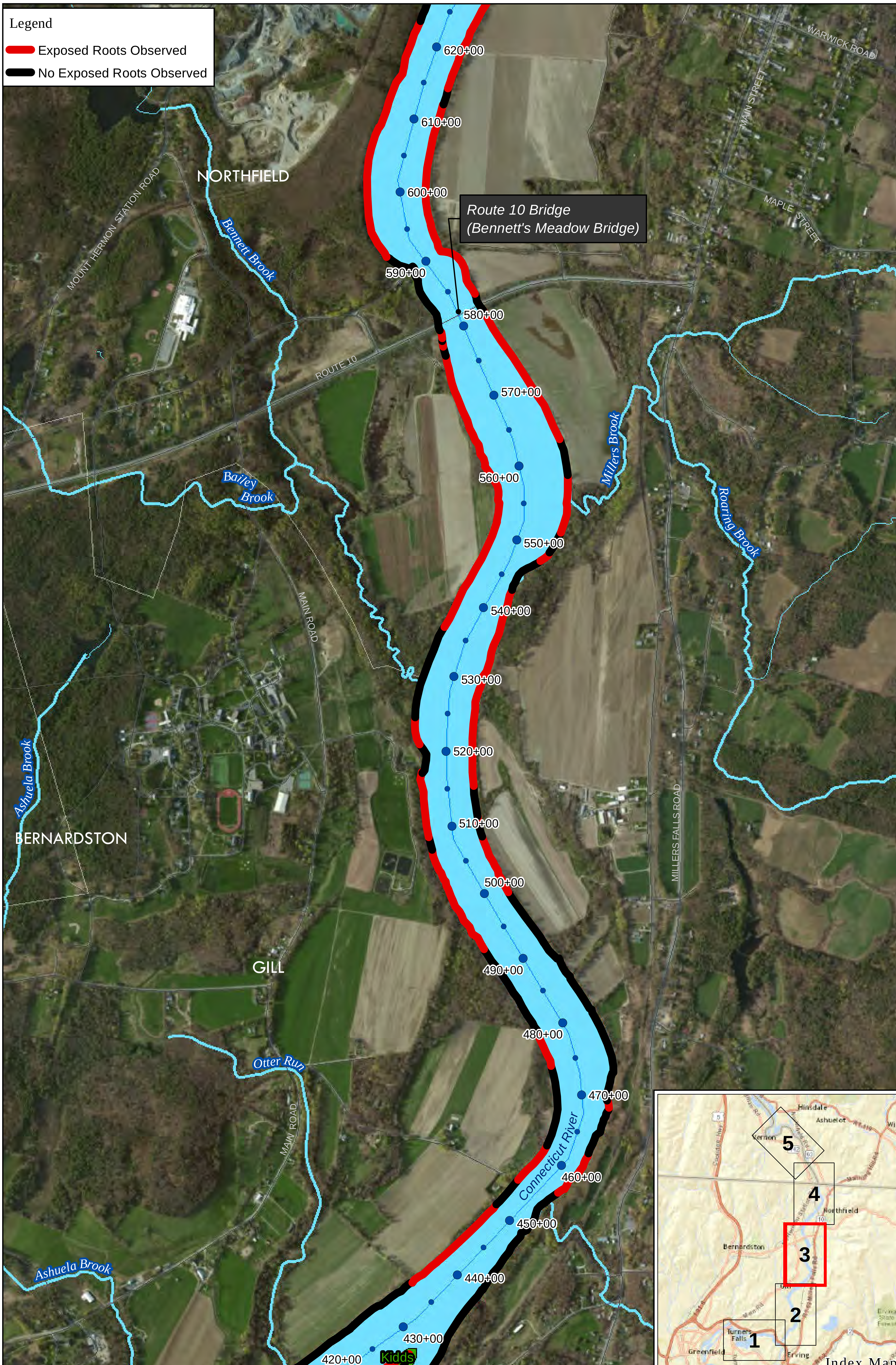

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Exposed Roots

Map 3

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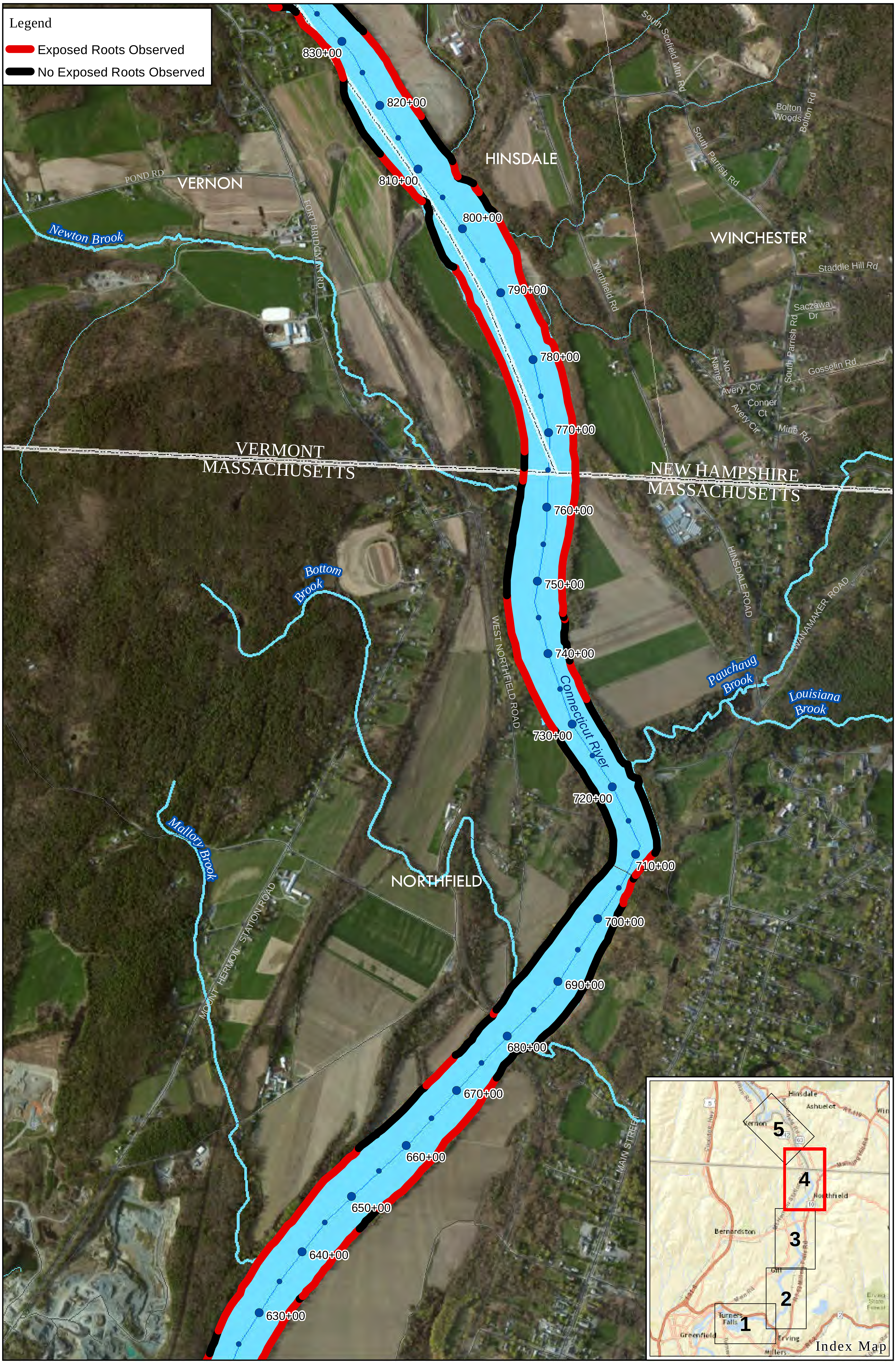

FirstLight GDF SUEZ

N

0 650 1,300 2,600 Feet

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Exposed Roots

Map 4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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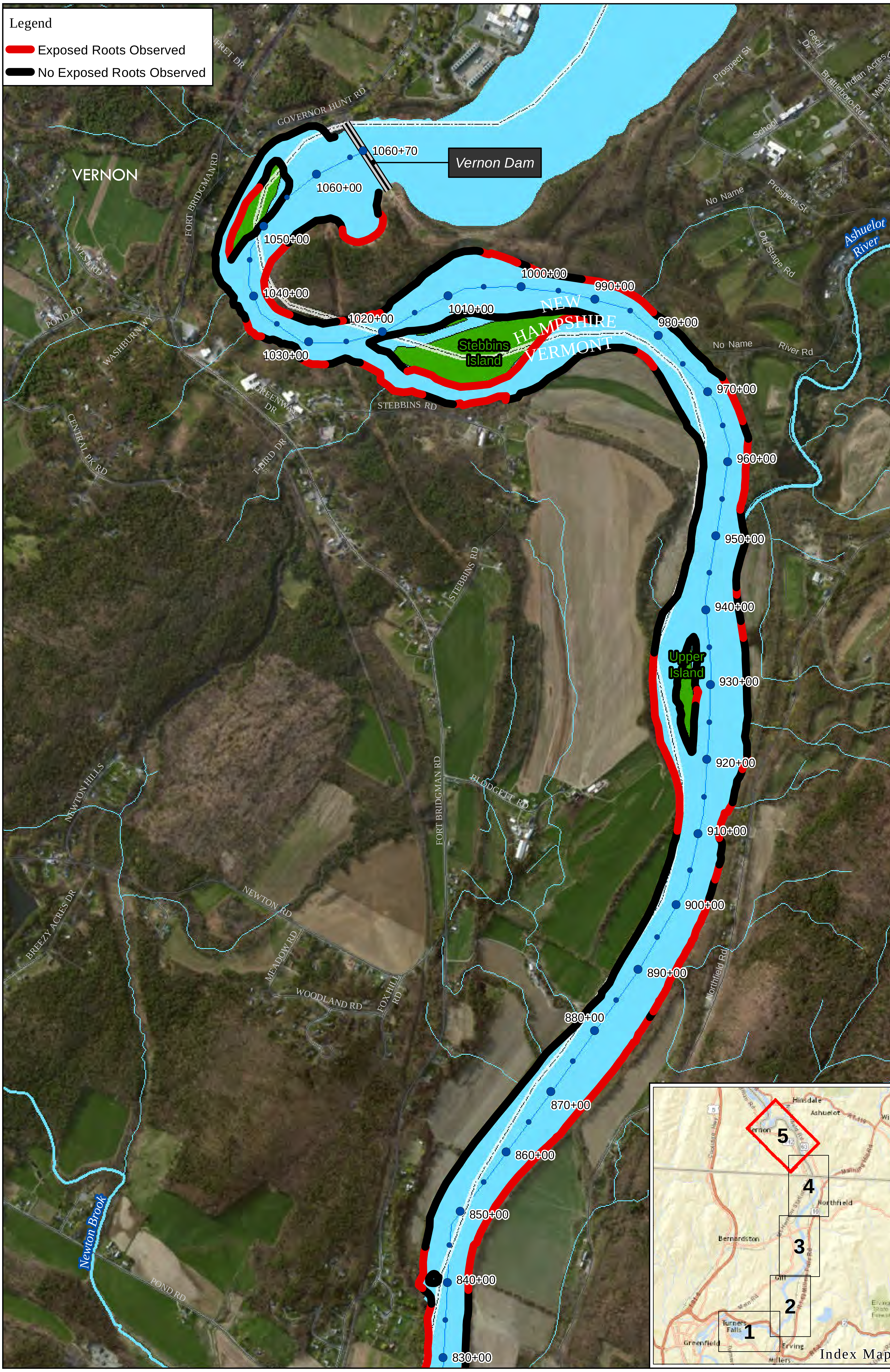

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Exposed Roots

Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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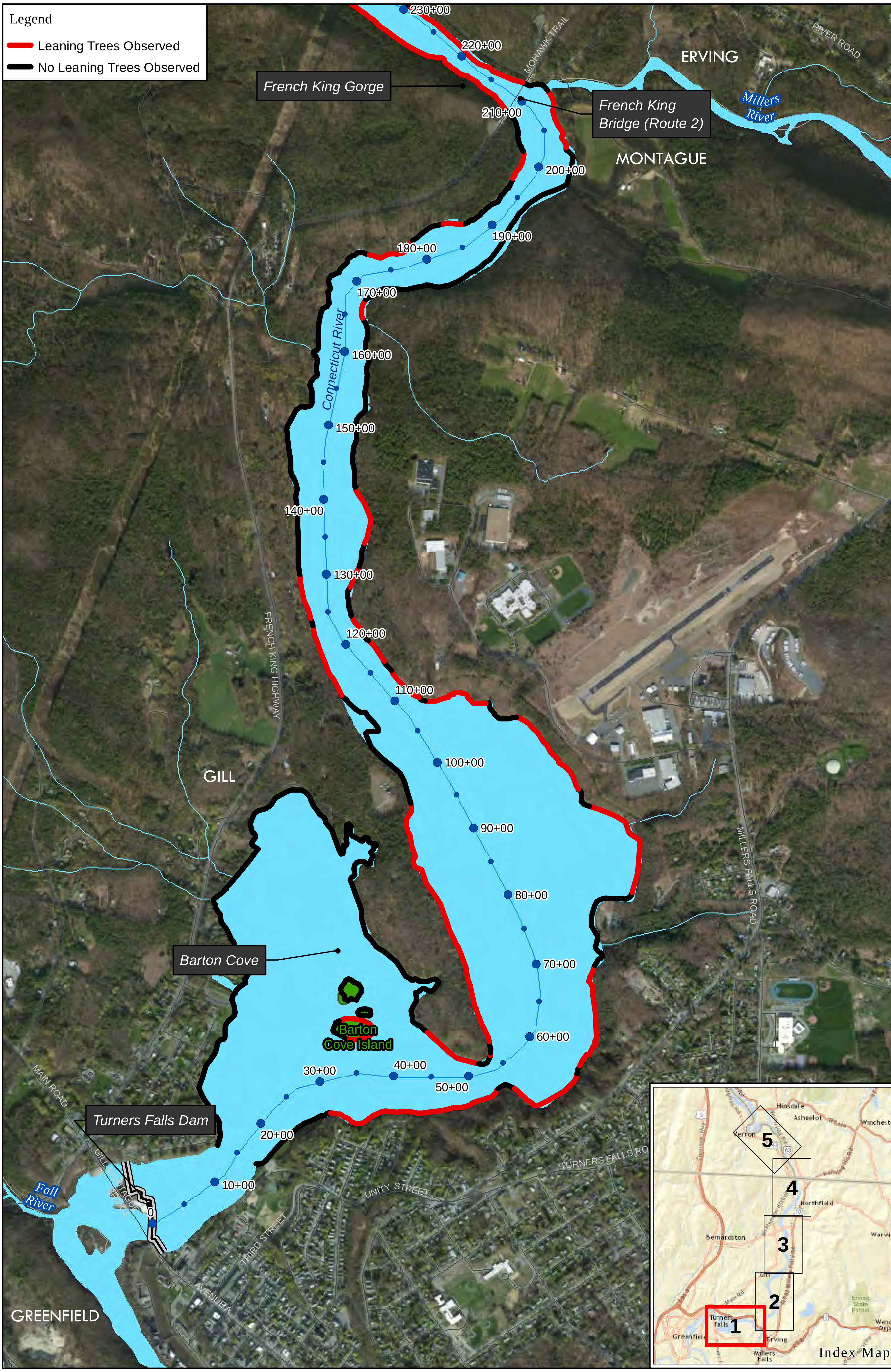

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Creep/Leaning Trees

Map 1

0 650 1,300 2,600 Feet

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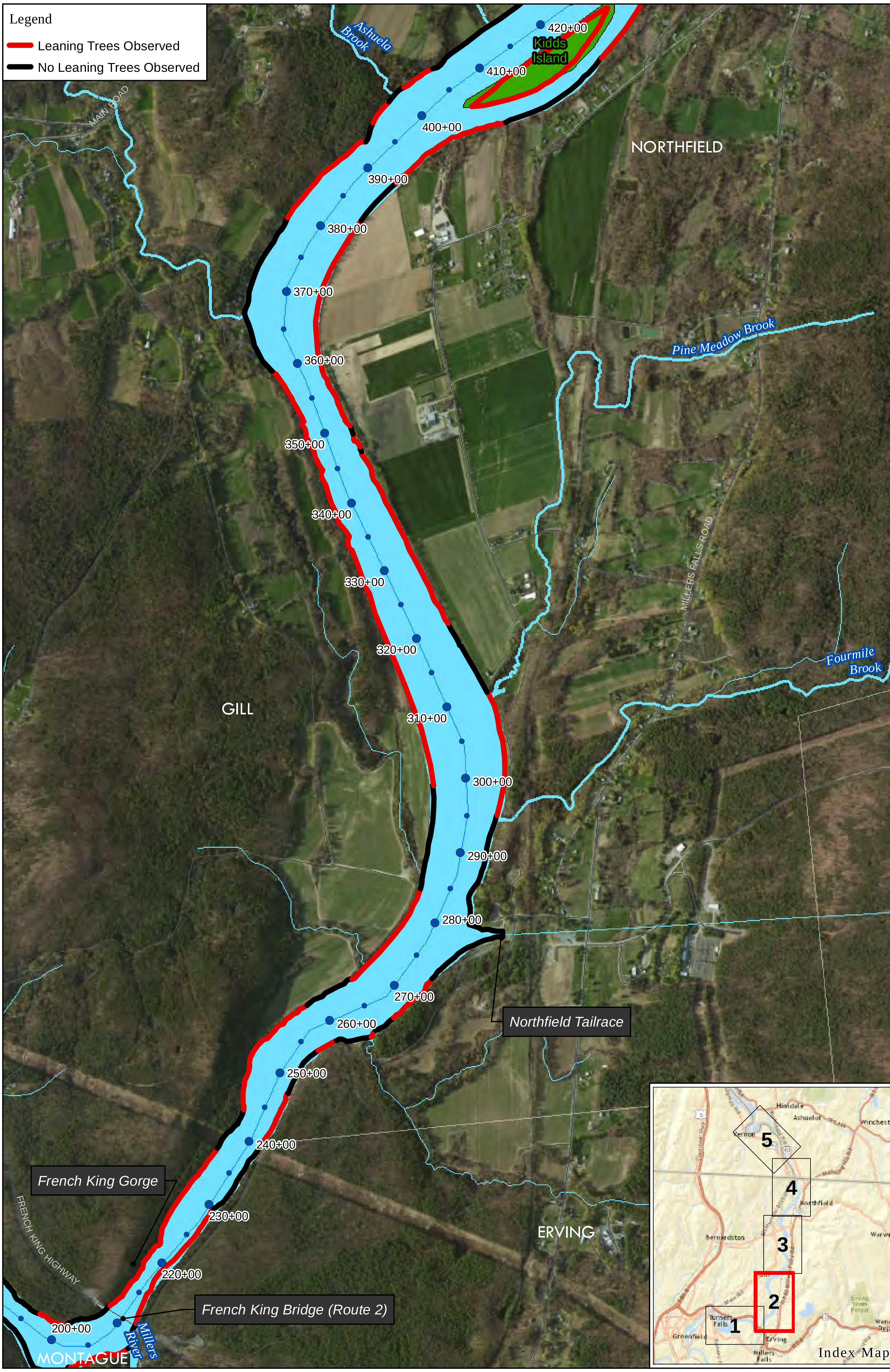

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Creep/Leaning Trees

Map 2

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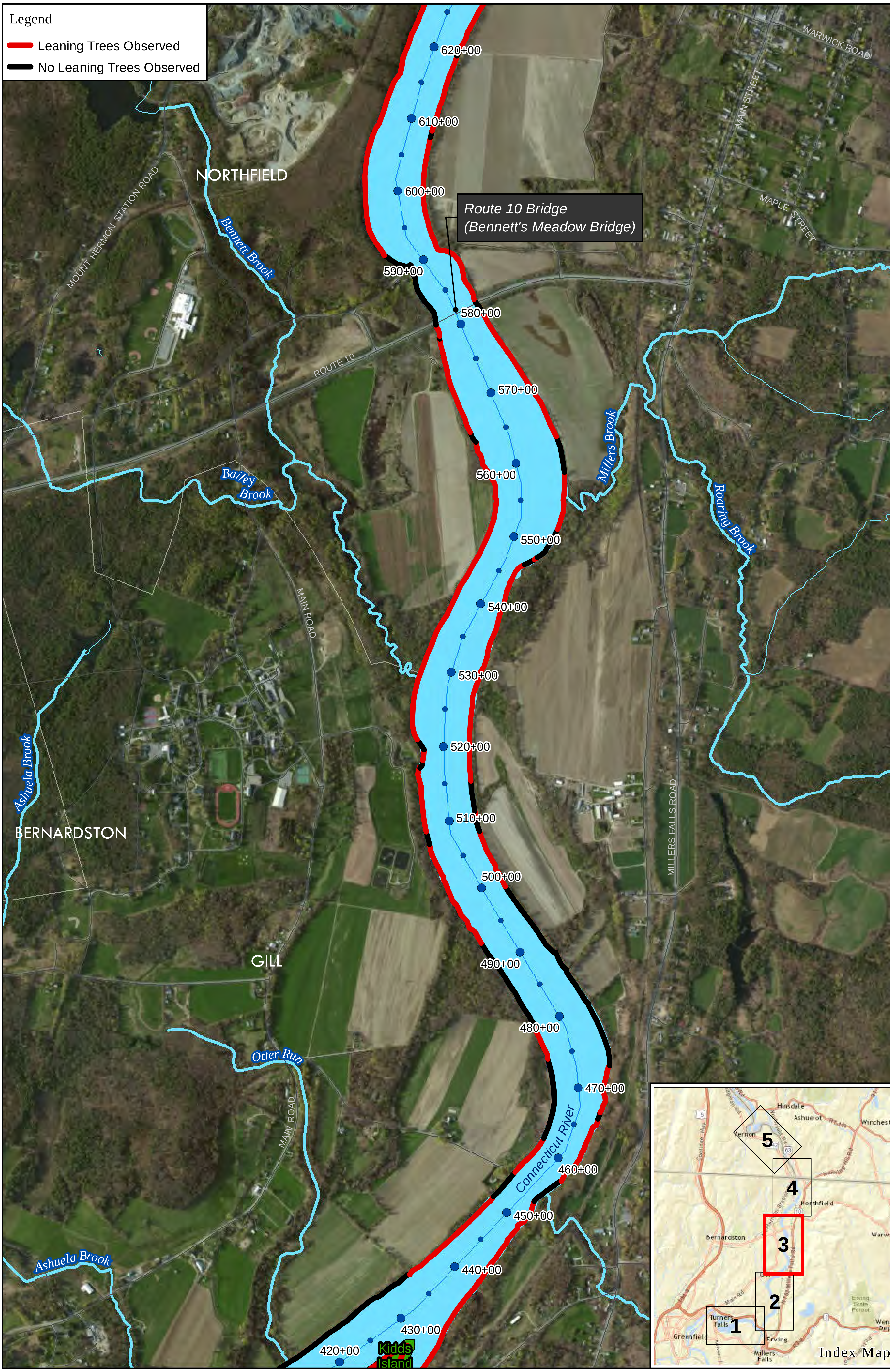

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Creep/Leaning Trees

Map 3

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Creep/Leaning Trees

Map 4

N

0 650 1,300 2,600 Feet

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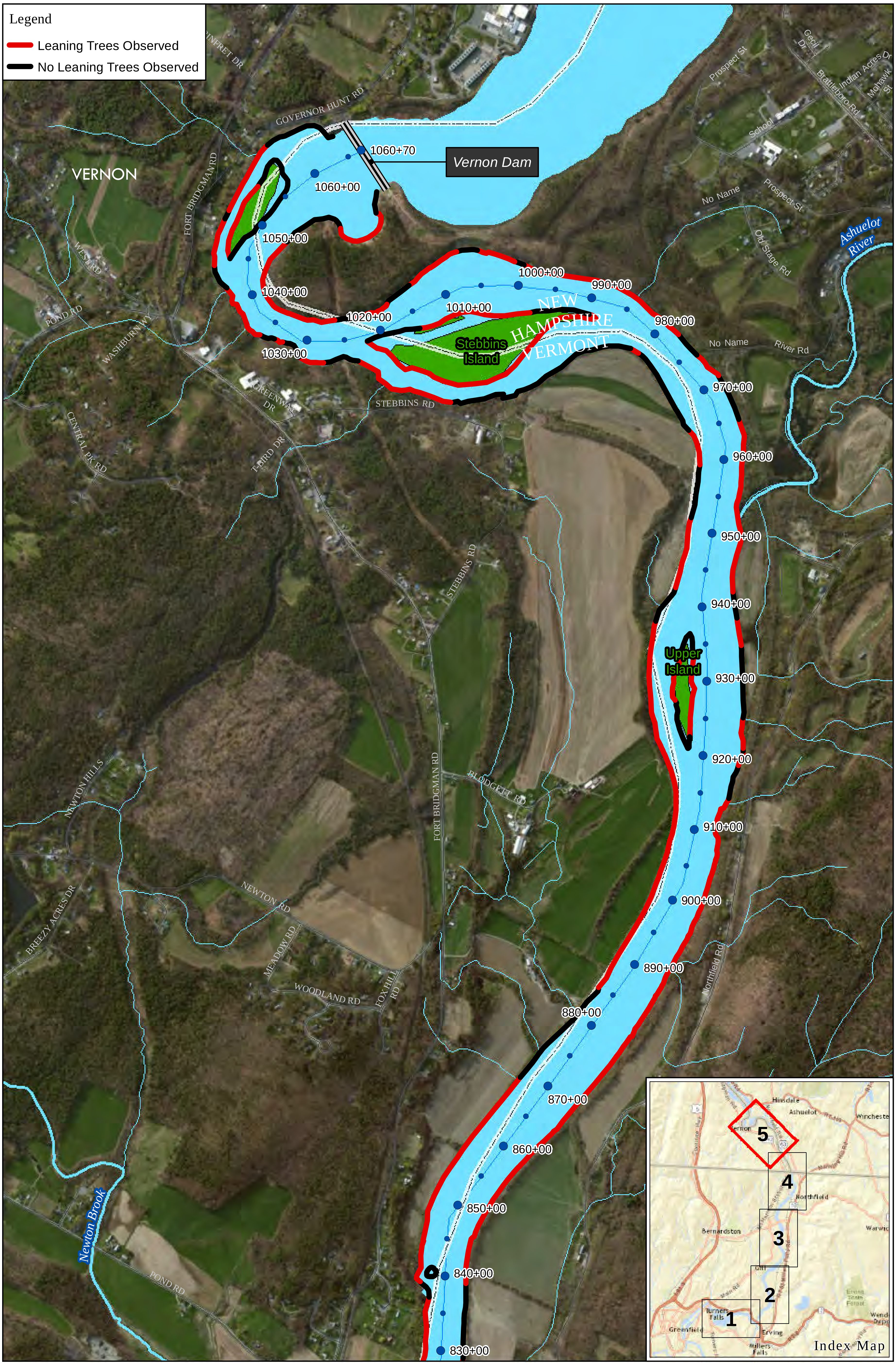

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Creep/Leaning Trees

Map 5

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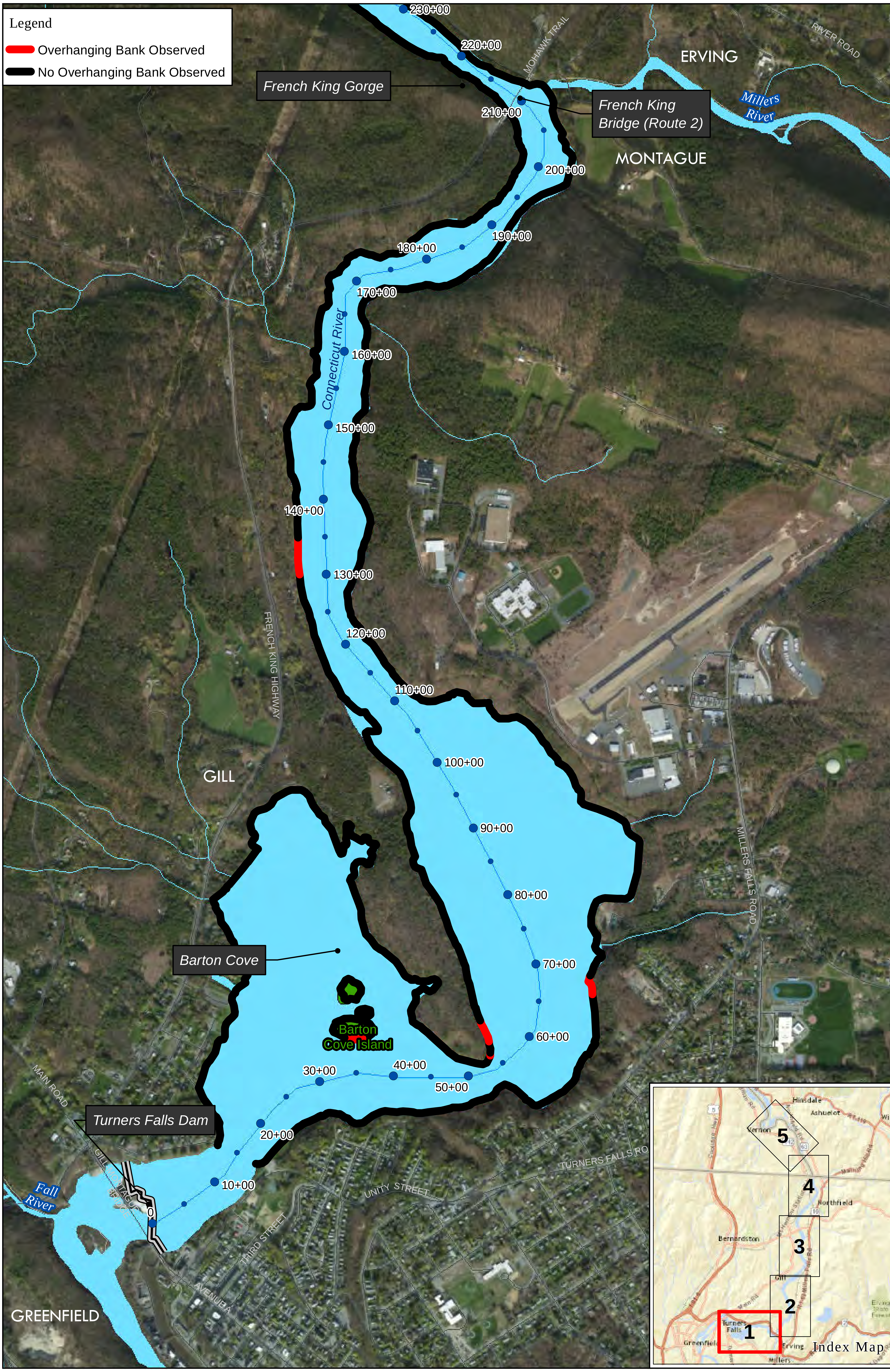

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Overhanging Bank

Map 1

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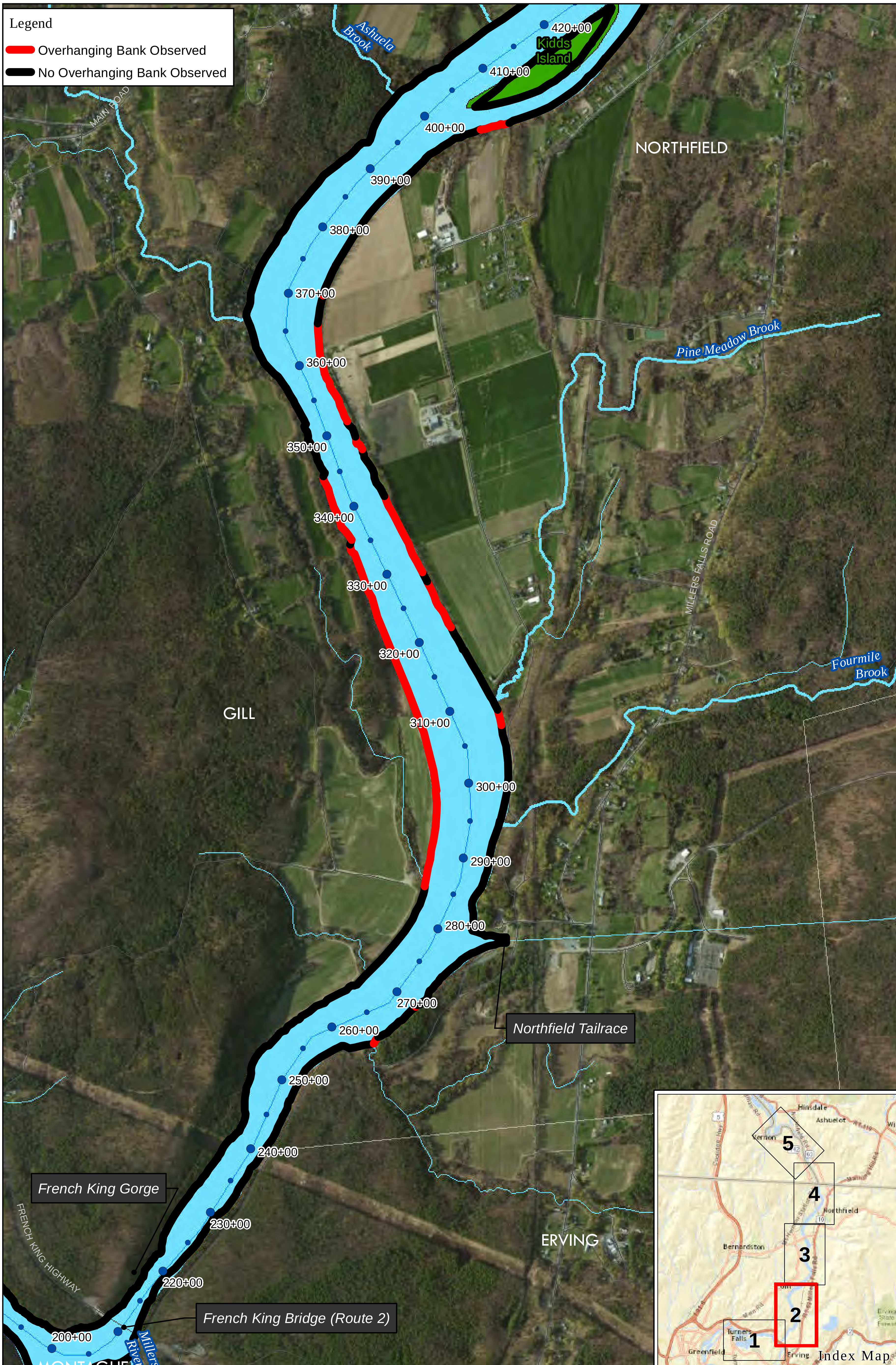

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600
Feet

Overhanging Bank

Map 2

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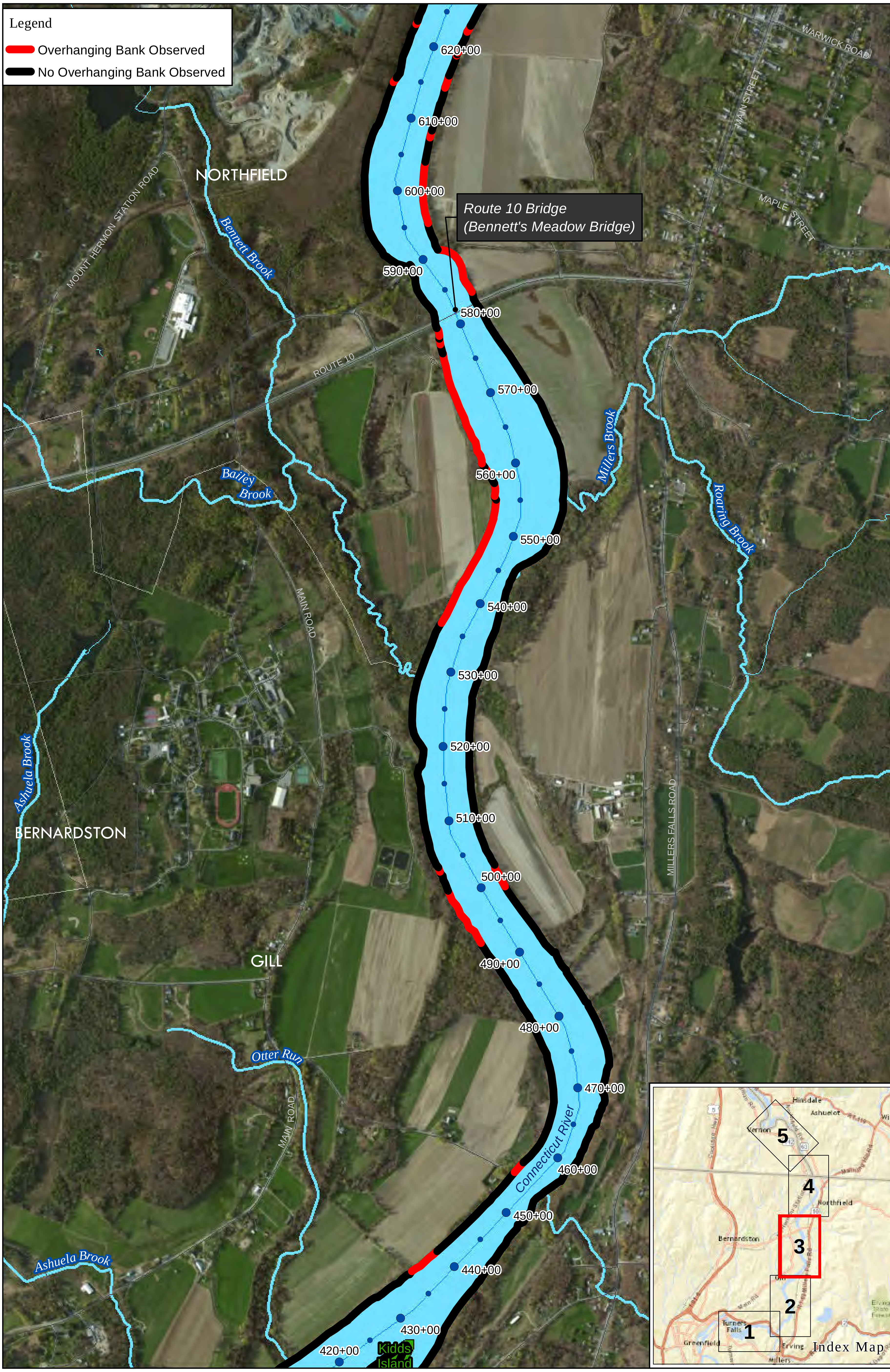

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

N

Overhanging Bank

Map 3

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

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Overhanging Bank

Map 4

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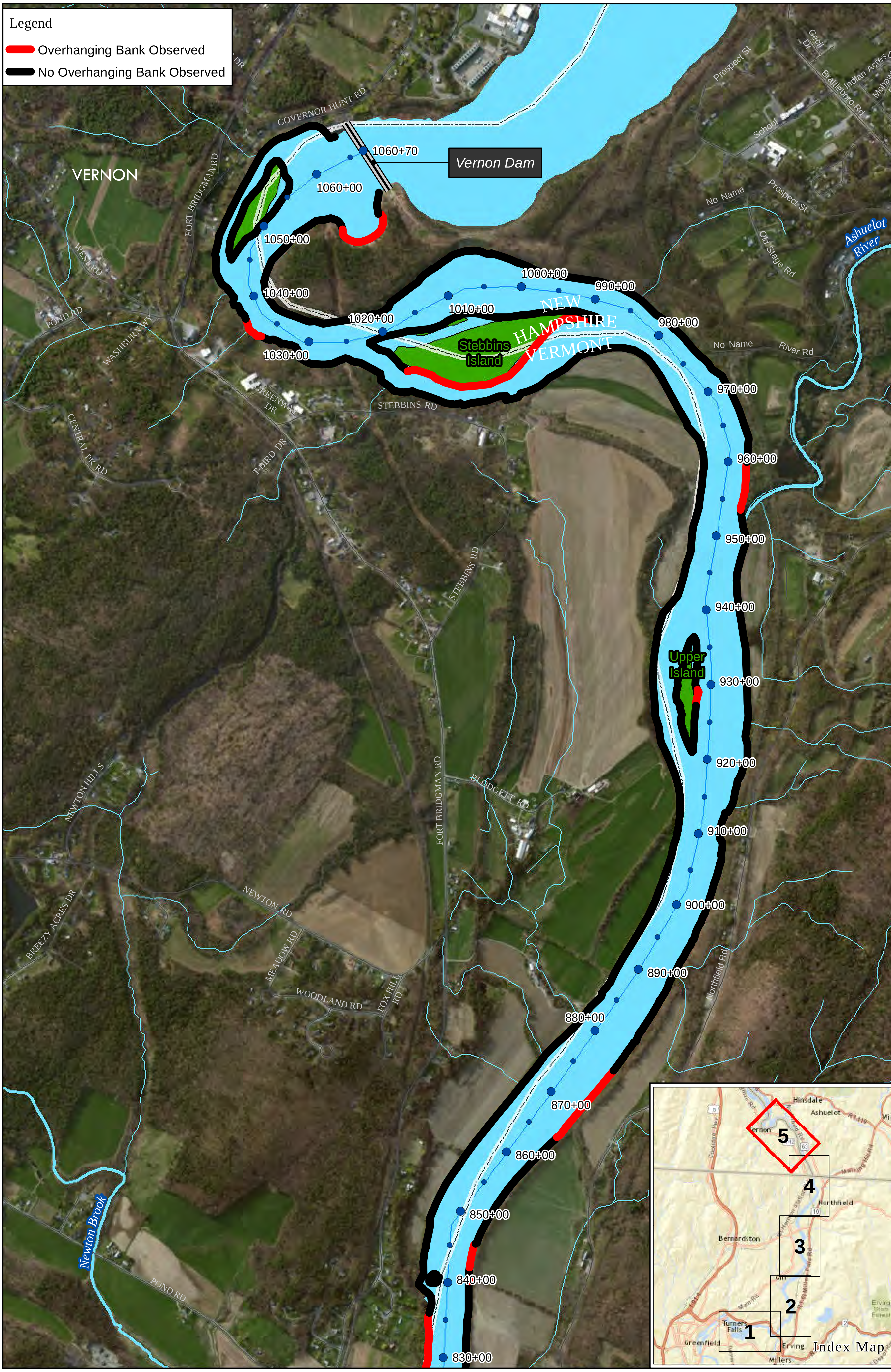

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Overhanging Bank

Map 5

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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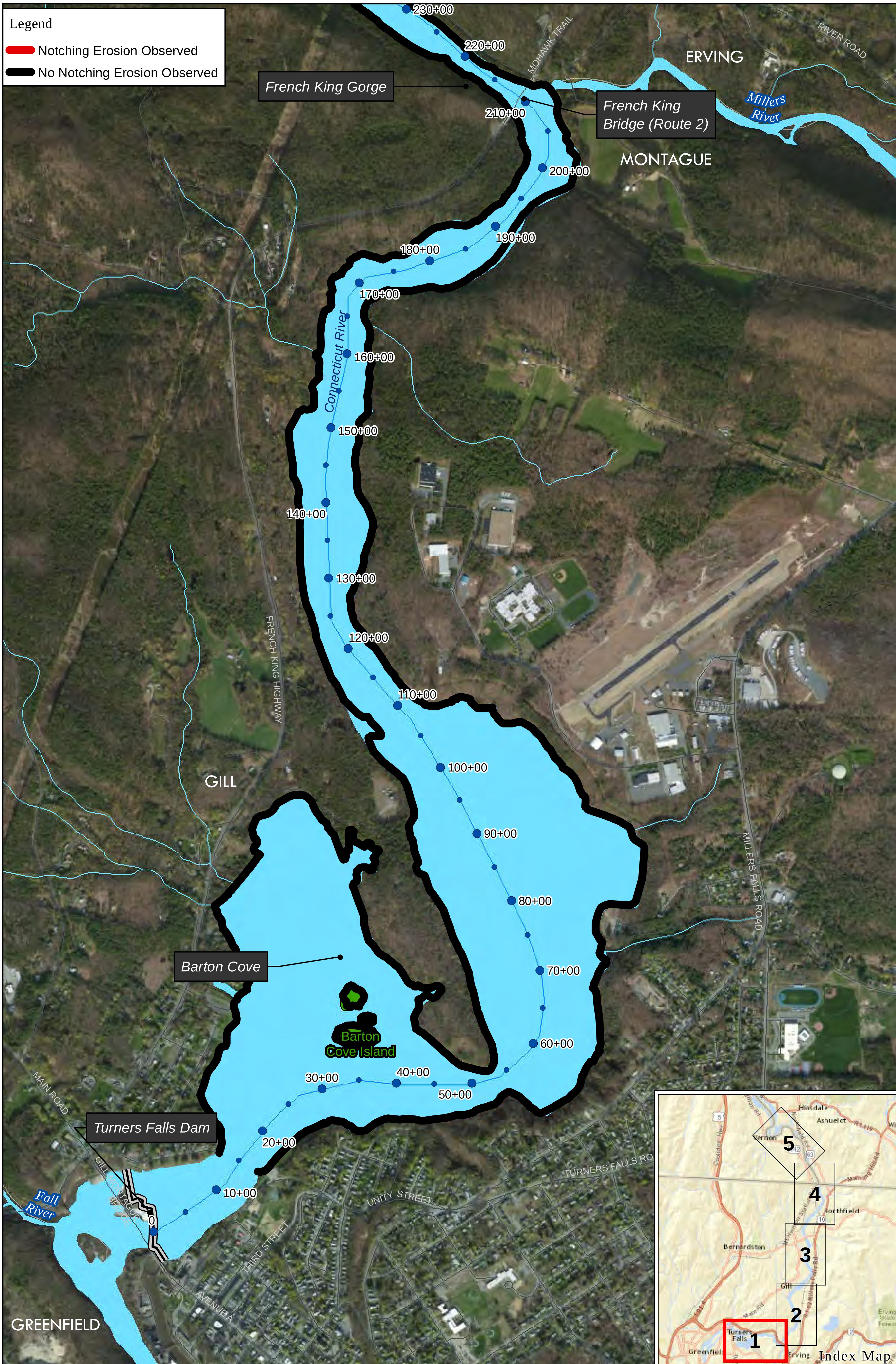

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Notching

Map 1

0 650 1,300 2,600 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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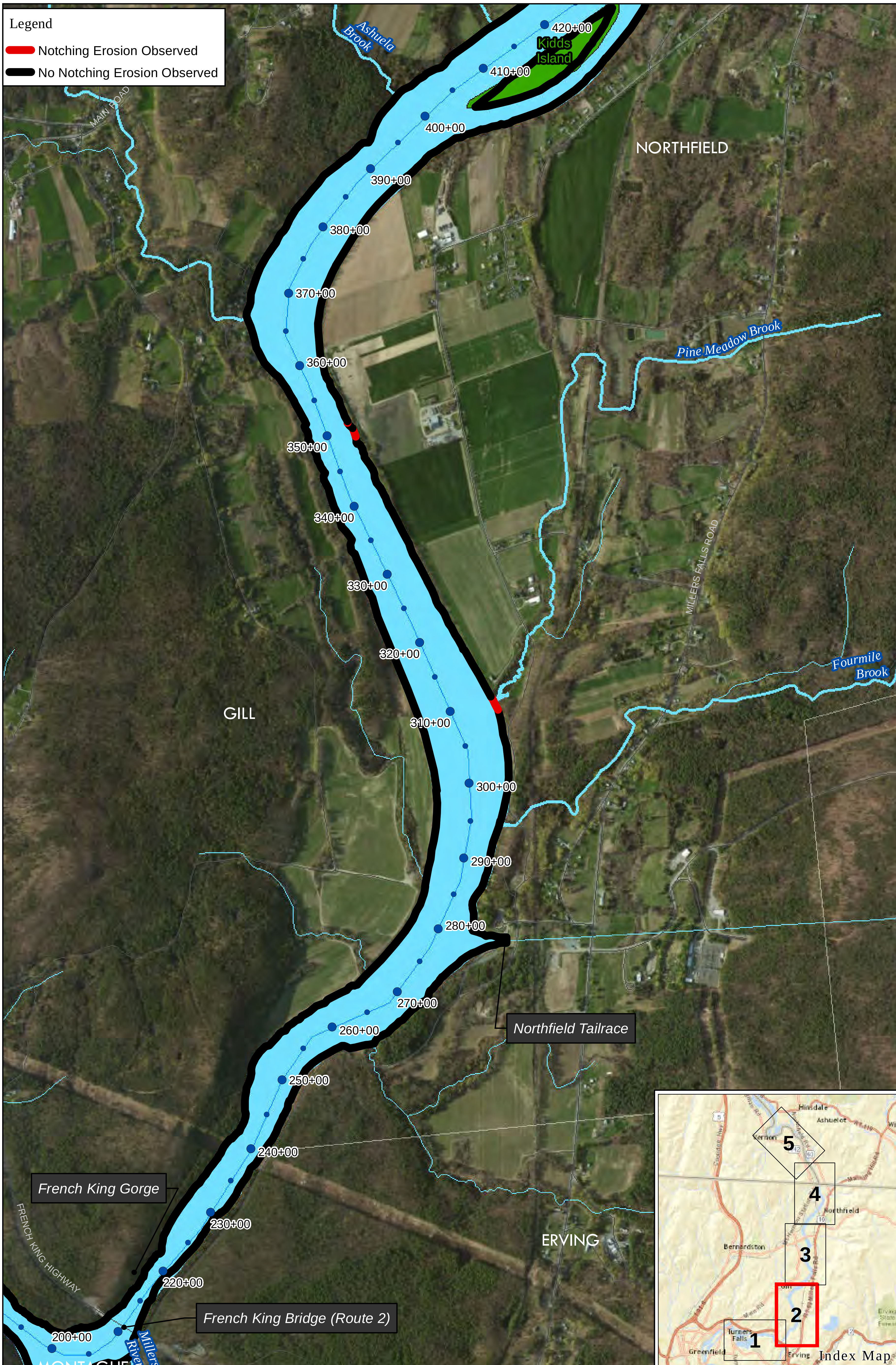

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Notching

Map 2

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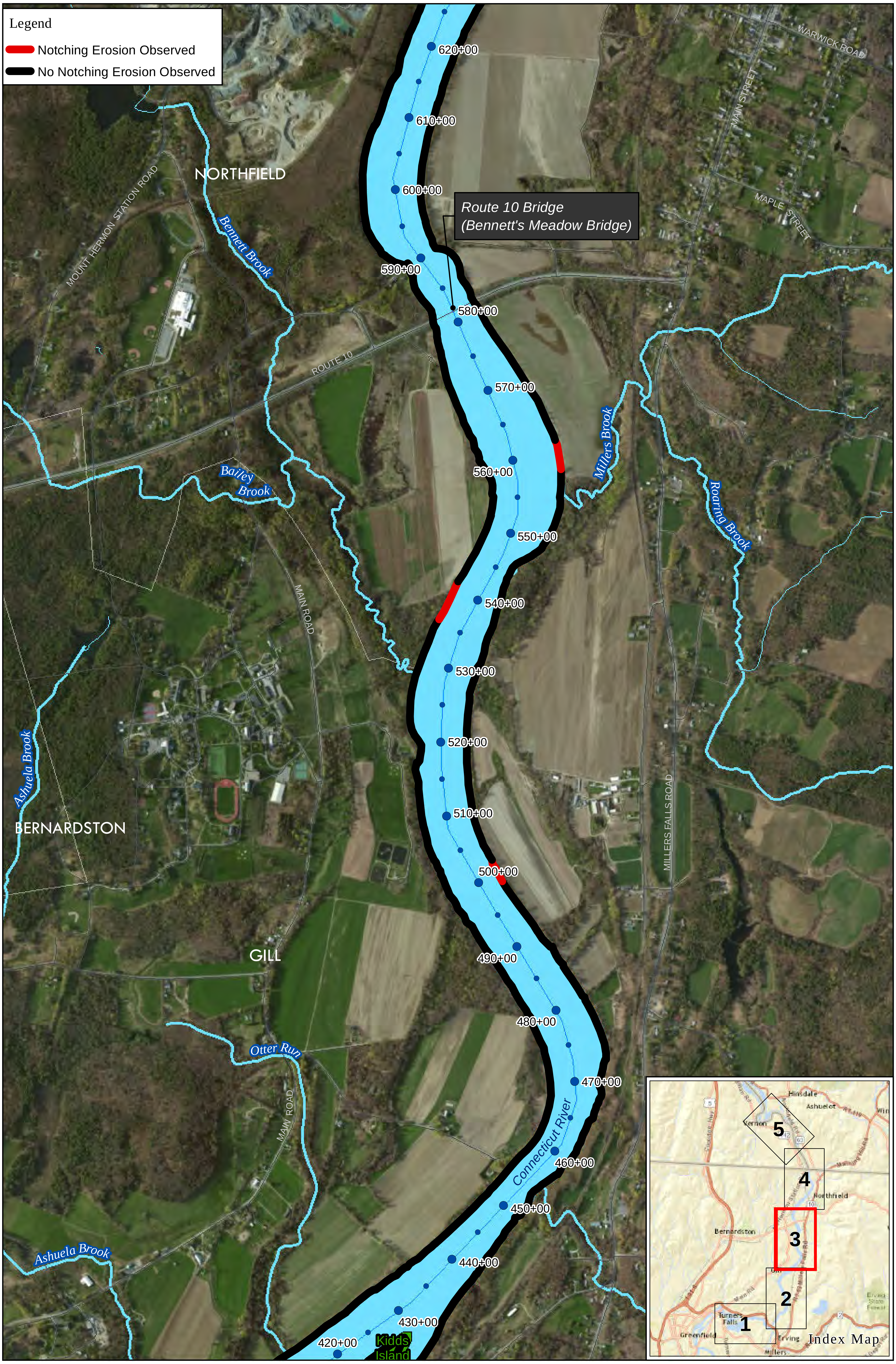

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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Notching

Map 3

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

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Notching

Map 4

N

0 650 1,300 2,600 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Notching

Map 5

N

0 650 1,300 2,600 Feet

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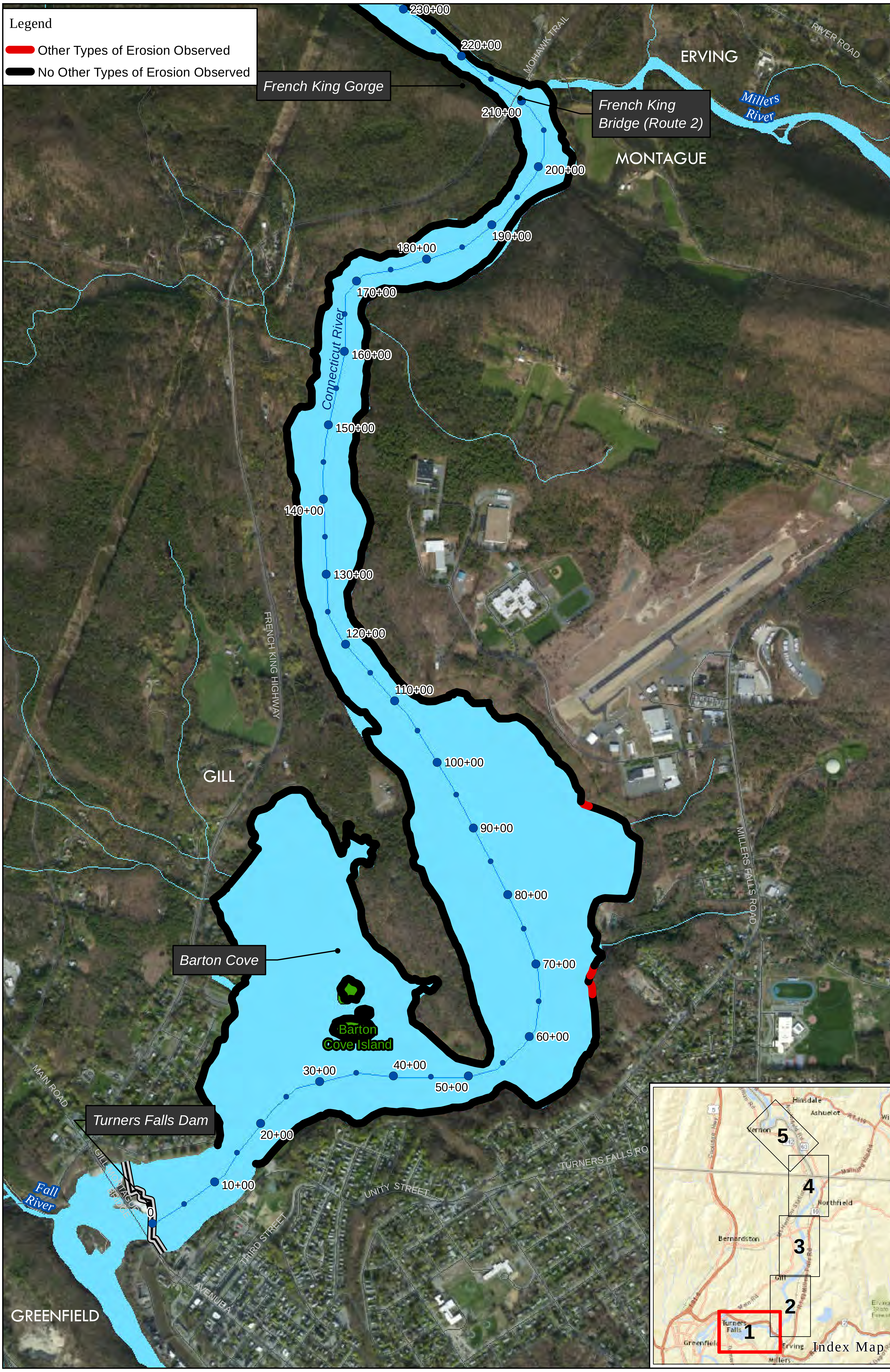

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Other Types of Erosion

Map 1

0 650 1,300 2,600 Feet

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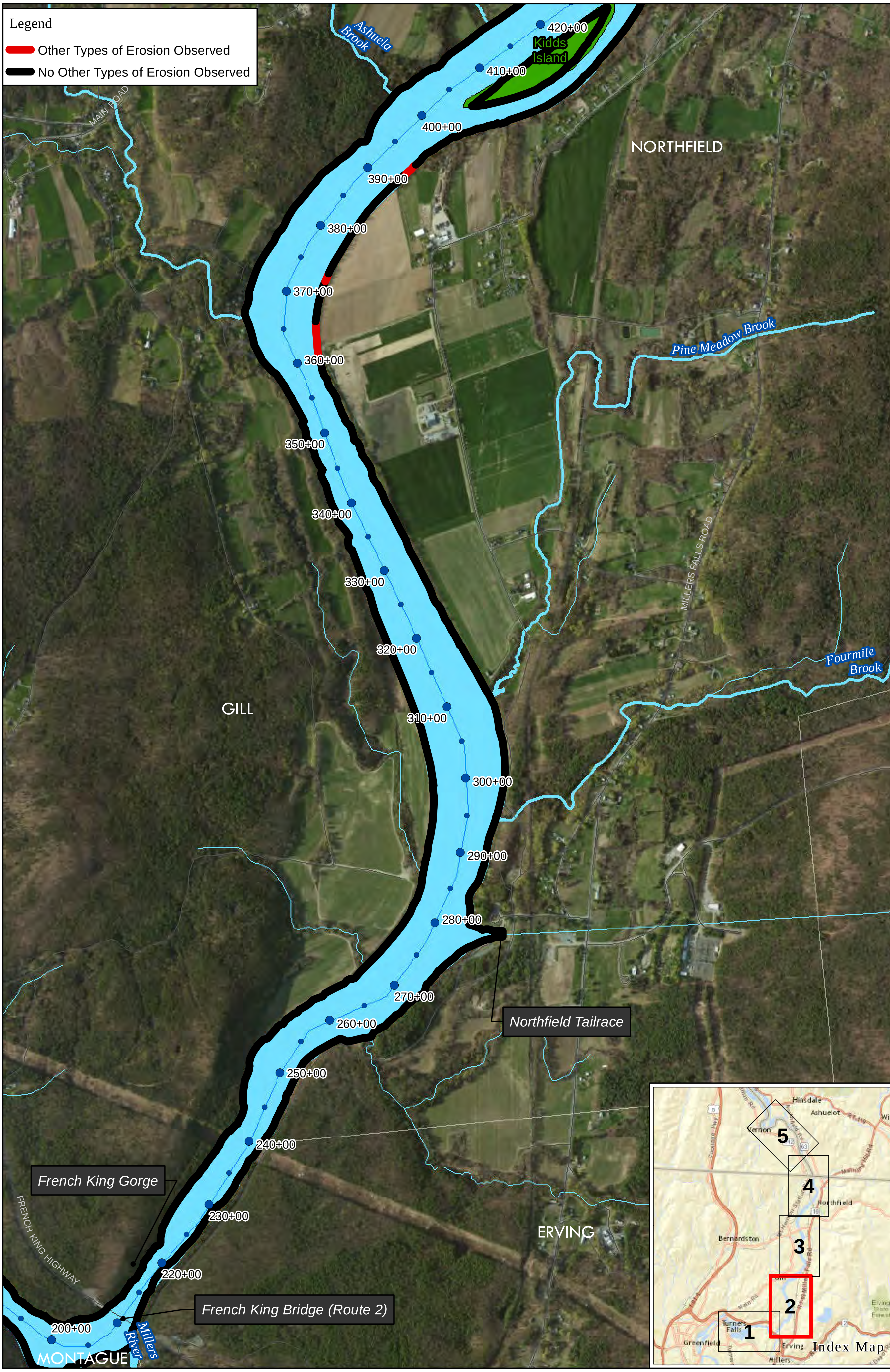

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FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600
Feet

Other Types of Erosion

Map 2

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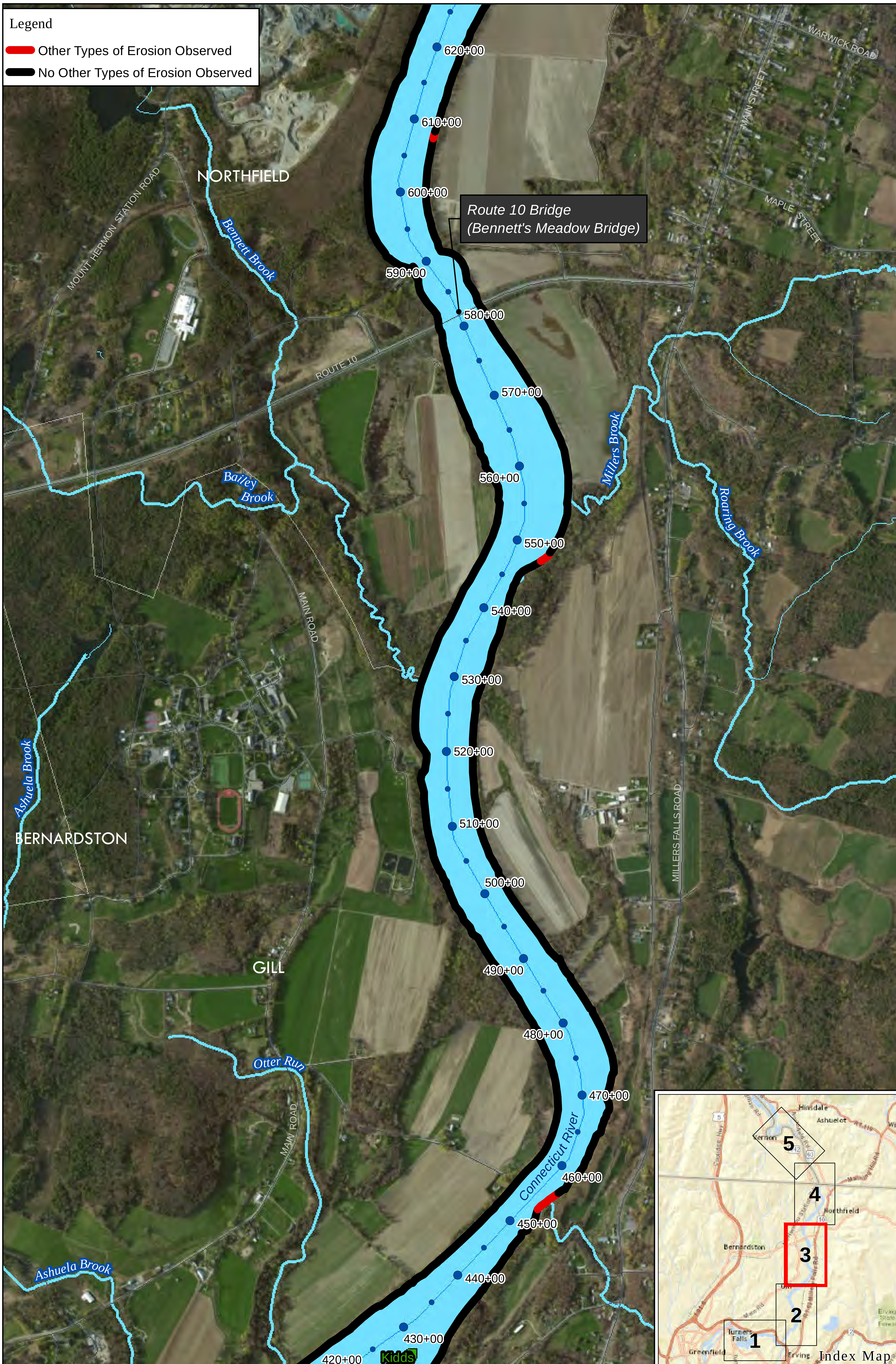

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Other Types of Erosion

Map 3

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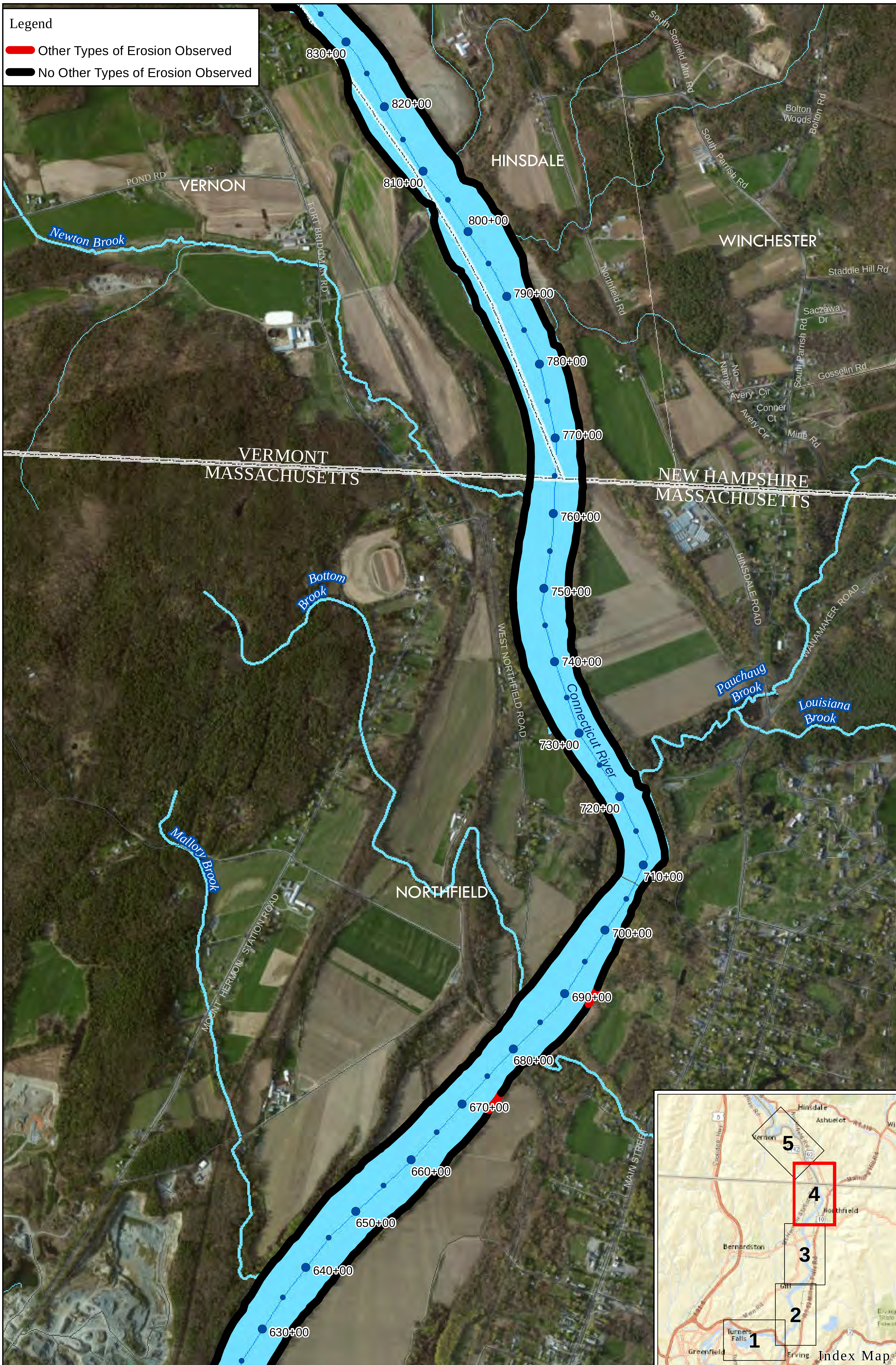

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Other Types of Erosion

Map 4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
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FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Other Types of Erosion

Map 5

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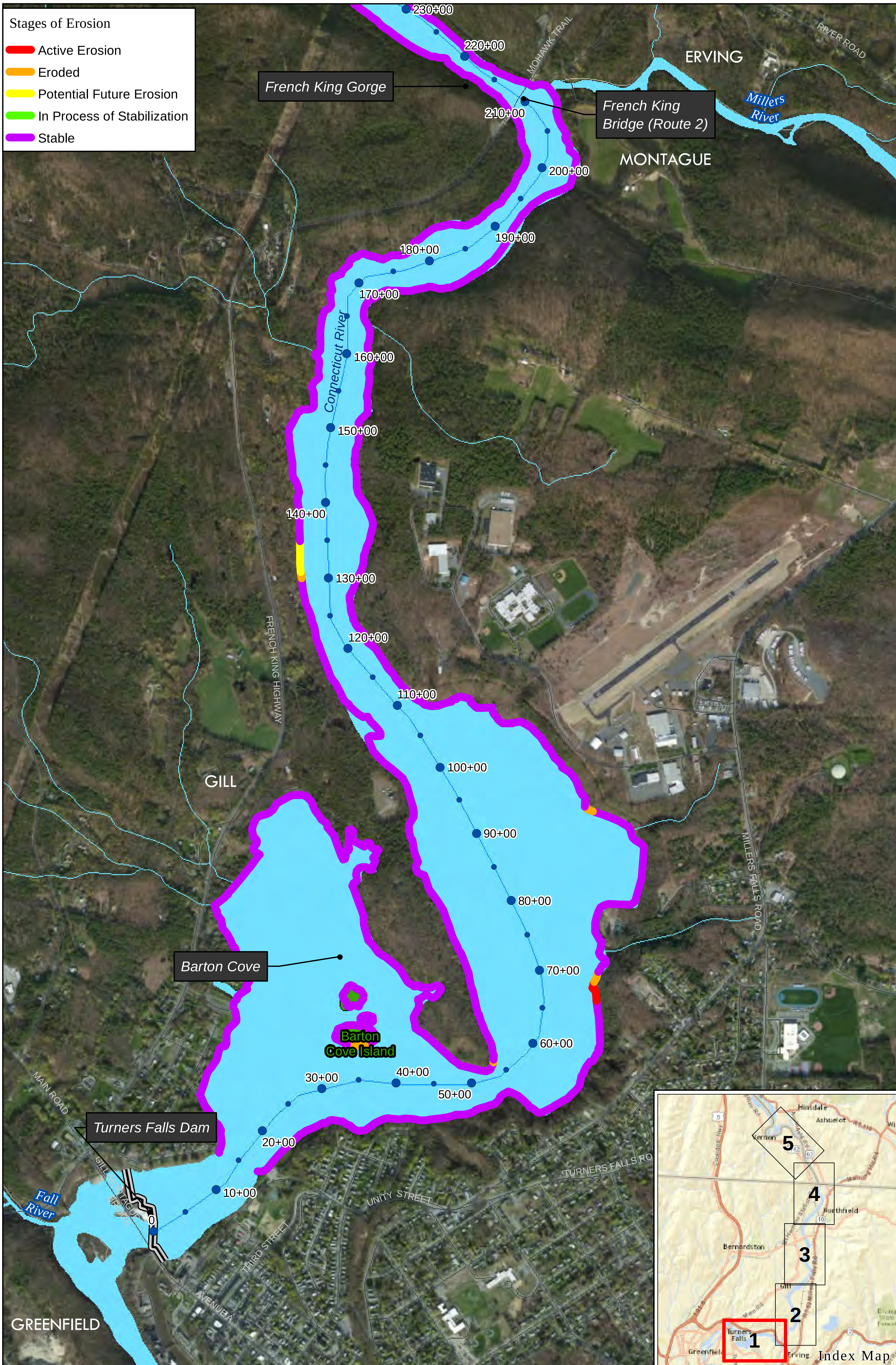

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Stages of Erosion

Map 1

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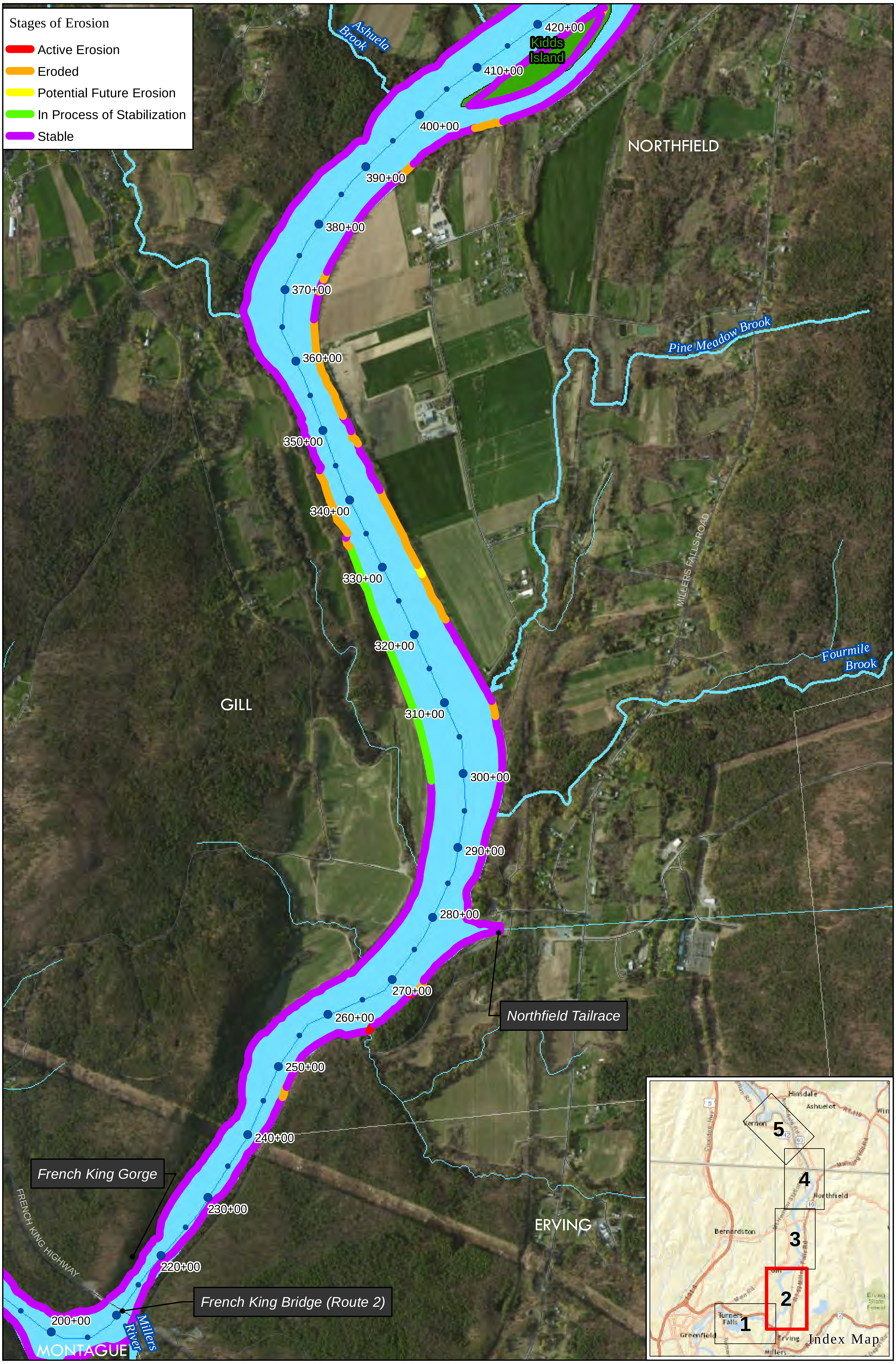

FirstLight
GDF SUEZ

N

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Stages of Erosion

Map 2

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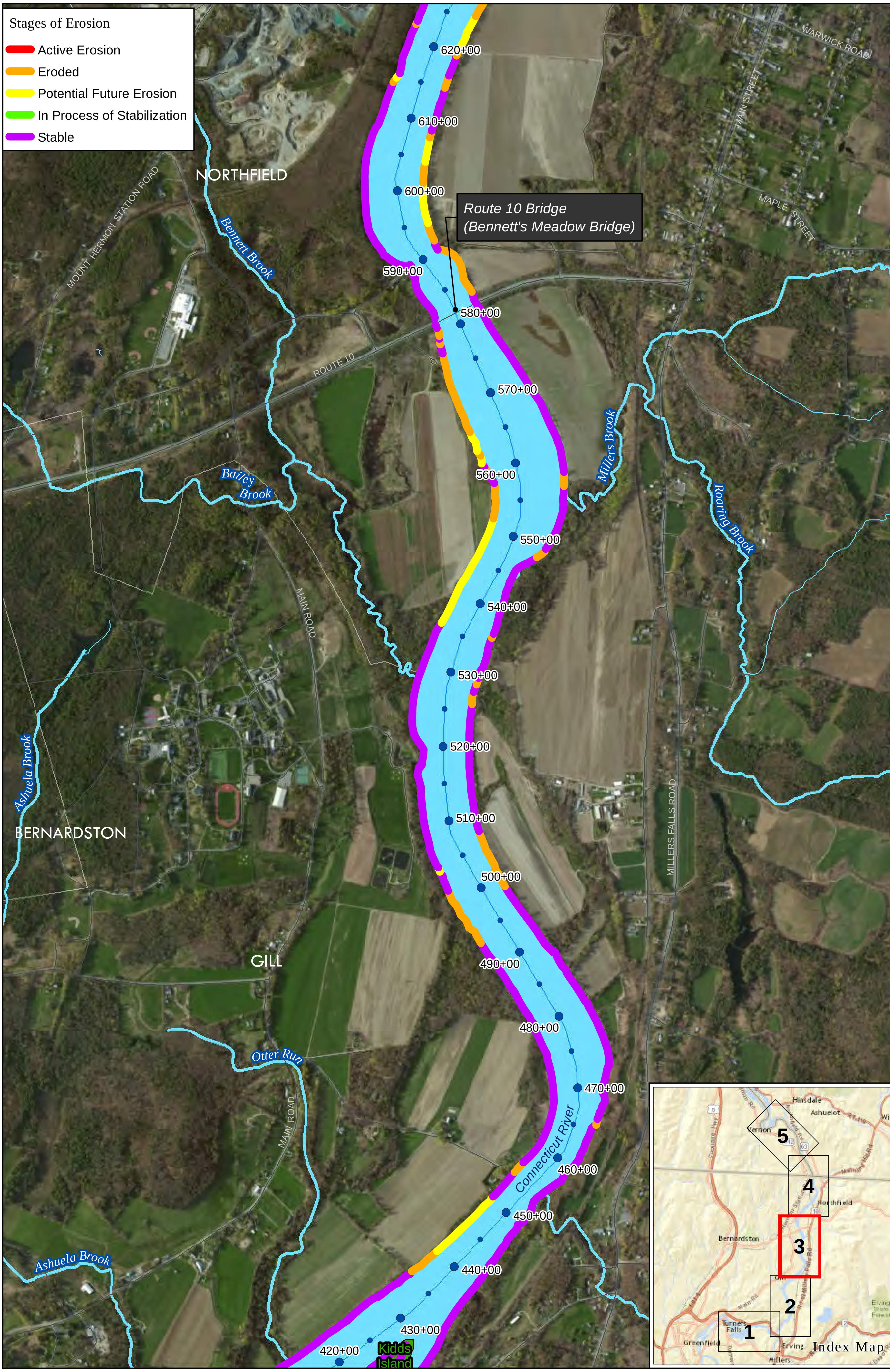

FirstLight GDF SUEZ

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

0 650 1,300 2,600 Feet

Stages of Erosion

Map 3

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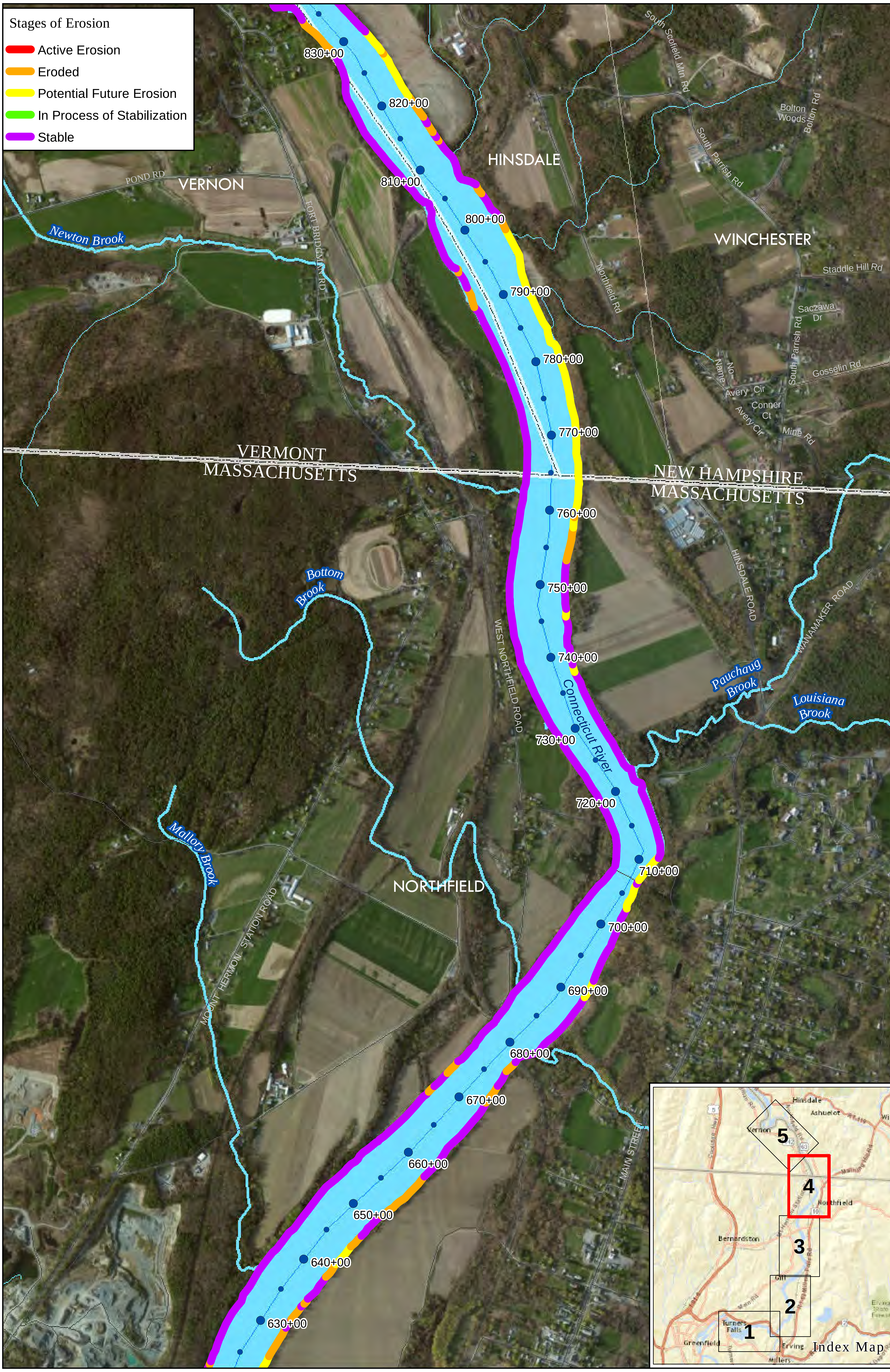

FIRSTLIGHT POWER RESOURCES

RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

N

0 650 1,300 2,600 Feet

Stages of Erosion

Map 4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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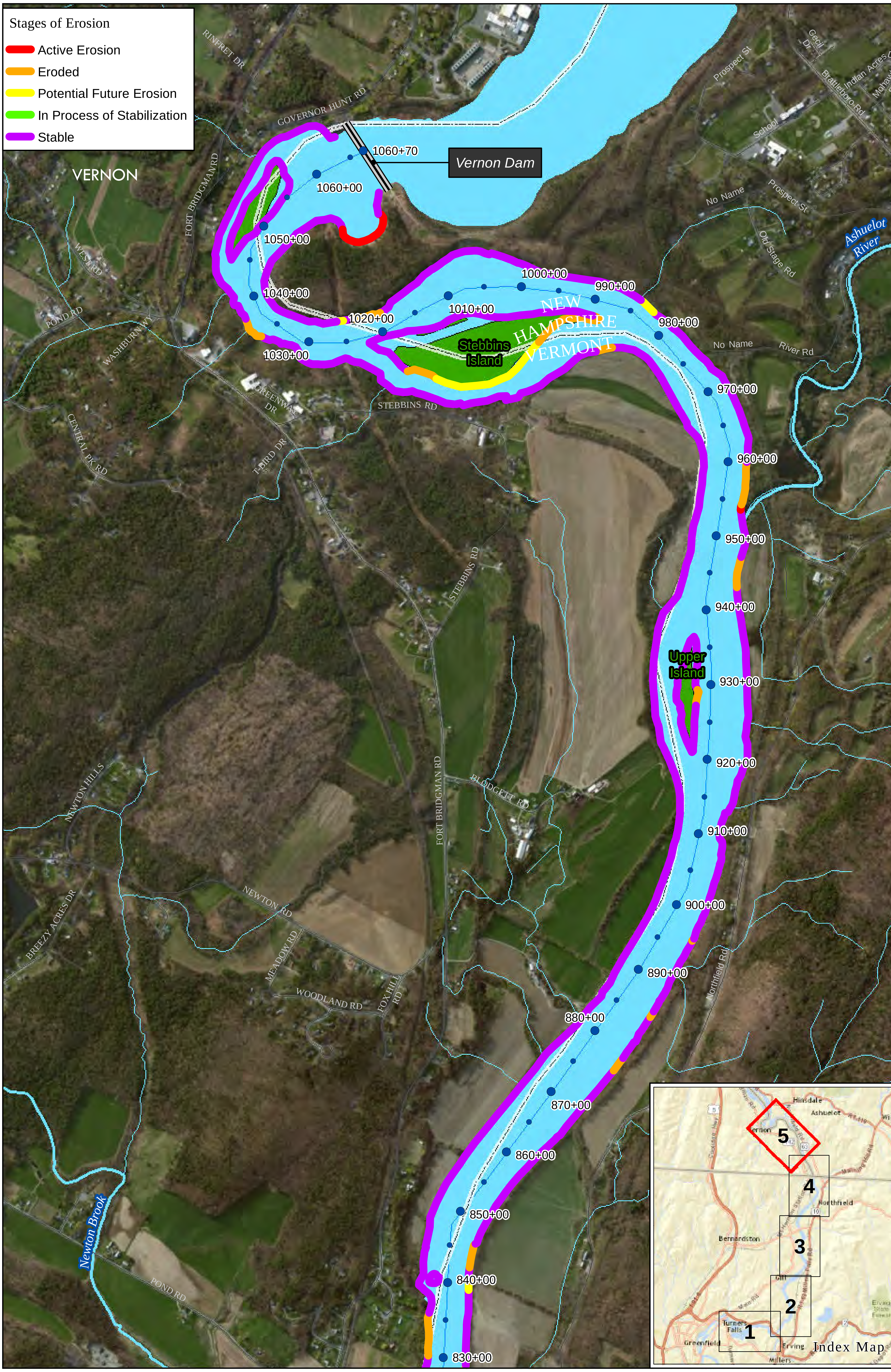

FIRSTLIGHT POWER RESOURCES
RELICENSING STUDY 3.1.1
NORTHFIELD MOUNTAIN/TURNERS FALLS
FULL RIVER RECONNAISSANCE

Stages of Erosion

Map 5

0 650 1,300 2,600 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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APPENDIX K – DIGITAL APPENDIX (PHOTOS & VIDEO)

DVD AVAILABLE UPON REQUEST

APPENDIX L – BANK STABILIZATION PROJECTS – BEFORE AND AFTER PHOTOS

Photo 1: Wickey following construction, 1996

Photo 2: Wickey-Post Construction 2014

Photo 3: Shearer pre-construction, 1996

Photo 4: Shearer-Post Construction 2014

Photo 5: Crooker during-construction, 1997

Photo 6: Crooker-Post Construction 2014

Photo 7: L'Etoile 2011

Photo 8: L'Etoile -Post Construction 2014

Photo 9: Flagg Farm, 1998 Pre-Construction

Photo 10: Flagg Farm -Post Construction 2014 downstream (upper photo) upstream (lower photo)

Photo 11: Urgiel Upstream pre- construction, 2001

Photo 12: Urgiel Upstream -Post Construction 2014

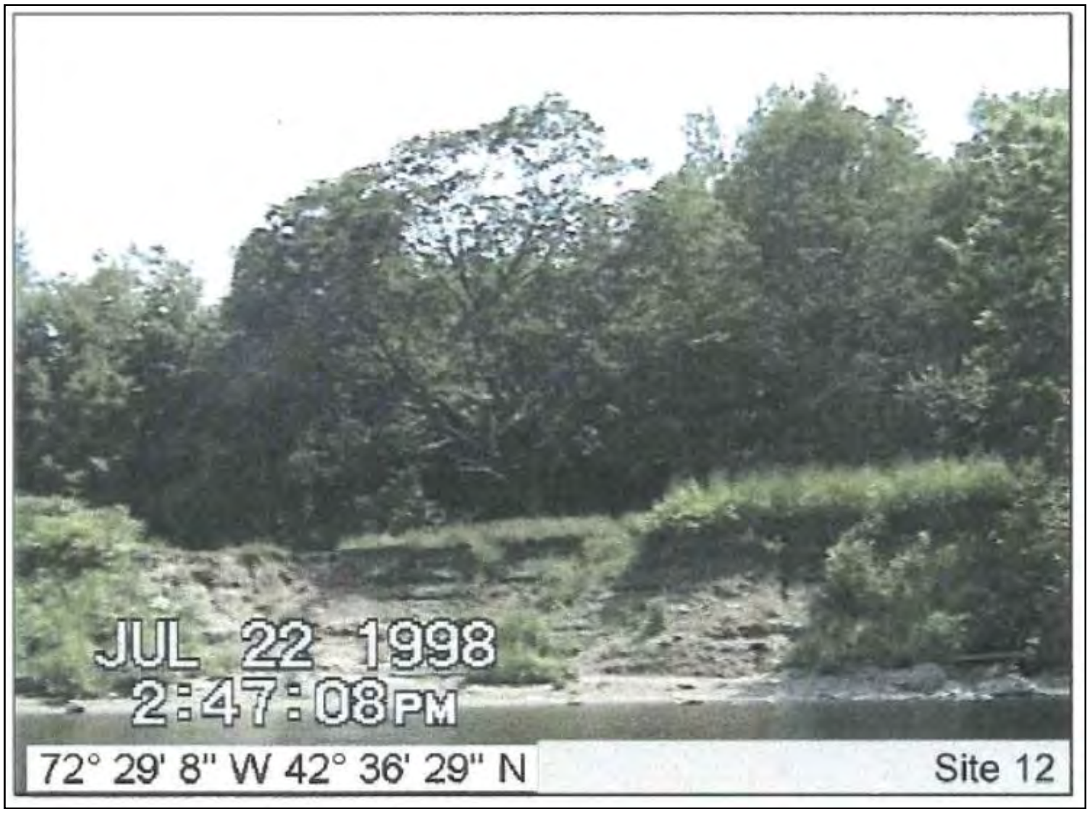

Photo 13: Durkee Point pre- construction, 1998


Photo 14: Durkee Point -Post Construction 2014

Photo 15: River Road pre- construction, 2001


Photo 16: River Road-Post Construction 2014

Photo 17: Rod & Gun Club (Camp 2E) pre- construction, 2004

Photo 18: Rod & Gun Club (Camp 2E) Post Construction 2014


Photo 19: Skalski pre-construction, 1998


Photo 20: Skalski Post Construction 2014

Photo 21: Bennett Meadow during-construction, 2005

Photo 22: Bennett Meadow, Post Construction 2014


Photo 23: Urgiel Downstream- pre-construction, 2005


Photo 24: Urgiel Downstream, Post Construction 2014

Photo 25: Country Road- pre-construction, 2006

Photo 26: Country Road- Post Construction 2014

Photo 27: Campground Point- pre-construction, 2008

Photo 28: - Campground Point- Post Construction 2014

Photo 29: Montague Rod & Gun Club Point- pre-construction, 2008

Photo 30: - Montague Rod & Gun Club Point (eroded segment)- Post Construction 2014

Photo 31: Kendall Farm- pre-construction, 2008

Photo 32: Kendall Farm- Post Construction 2014

Photo 33: Lower Split River Farm- construction 2009

Photo 34: Lower Split River Farm- Post Construction 2014. Bank Detail from August, 2014

Photo 35: Upper Split River Farm I and II 2010

Photo 36: Upper Split River Farm I- Post Construction 2014. Detail from August, 2014

Photo 37: Upper Split River Farm I and II 2010

Photo 38: Upper Split River Farm II- Post Construction 2014. Detail from August, 2014

Photo 39: Bathory/Gallagher & Wallace/Watson pre-construction 2012

Photo 40: Bathory/Gallagher & Wallace/Watson Post Construction 2014. Detail from August, 2014

Photo 41: Camp 2W pre-construction 2011

Photo 42: Camp 2W Post Construction 2014.


Photo 43: Camp 2E pre-construction 2011


Photo 44: Camp 2E Post Construction 2014.

Photo 45: Camp 6E pre-construction 2011

Photo 46: Camp 6E Post Construction 2014.

Photo 47: Camp 7E pre-construction 2011, detail of bank

Photo 48: Camp 7E Post Construction 2014.

Photo 49: Camp 8E pre-construction 2011. Detail of bank

Photo 50: Camp 8E Post Construction 2014.

Photo 51: Camp 10W pre-construction 2011. Detail of bank

Photo 52: Camp 10W Post Construction 2014.

Photo 53: Bonnette Farm pre-construction 2012.

Photo 54: Bonnette Farm- Post Construction 2014.

APPENDIX M – RECOMMENDED STABILIZATION SITES – FEATURES AND CHARACTERISTICS

Appendix M: Bank Restoration Recommendations - Riverbank Features and Characteristics

Recommended Bank Stabilization/Preventative Maintenance Sites

Year	Location/Name	River Station (ft)	Length (ft)
2014	Shearer (89)	311+00 to 321+00	1060
2015	Camps 4E & 3E	108+00 & 88+00	100 &120: 220
2016	Camp 2W (387, 388)	132+00 to 137+00	500
2017	70, 75, 77 12-13 (Montague)	268+00, 270+00 & 273+00 67+00	105, 35 & 155: 295 280

Shearer (Segment 89, repair of previously stabilized site)

609

Segment #89 Riverbank features and characteristics

Riverbank Features	Characteristics
Upper Riverbank Slope	Moderate
Upper Riverbank Height	High
Upper Riverbank Sediment	Silt/Sand
Upper Riverbank Vegetation	Heavy
Lower Riverbank Slope	Moderate
Lower Riverbank Sediment	Cobbles
Lower Riverbank Vegetation	None-Very Sparse
Type of Erosion	Undercut
Potential Erosion Indicators	None
Stage of Erosion	Stable
Extent of Erosion	None/Little

Camp 4E (Segment 25)

Segment #25 Riverbank features and characteristics

Riverbank Features	Characteristics
Upper Riverbank Slope	Moderate
Upper Riverbank Height	High
Upper Riverbank Sediment	Silt/Sand
Upper Riverbank Vegetation	Moderate
Lower Riverbank Slope	Moderate
Lower Riverbank Sediment	Boulders
Lower Riverbank Vegetation	None-Very Sparse
Type of Erosion	Slide
Potential Erosion Indicators	Creep/Leaning Trees, Other
Stage of Erosion	Eroded
Extent of Erosion	Some

Camp 3E (Segment 19)

233

Segment #19 Riverbank features and characteristics

Riverbank Features	Characteristics
Upper Riverbank Slope	Moderate
Upper Riverbank Height	Medium
Upper Riverbank Sediment	Silt/Sand
Upper Riverbank Vegetation	Heavy
Lower Riverbank Slope	Vertical
Lower Riverbank Sediment	Bedrock (wood wall)
Lower Riverbank Vegetation	None-Very Sparse
Type of Erosion	Slide
Potential Erosion Indicators	Other
Stage of Erosion	Eroded
Extent of Erosion	Some

Camp 2W (Segment 387-388)

439

Segment #387 Riverbank features and characteristics

Riverbank Features	Characteristics
Upper Riverbank Slope	Steep
Upper Riverbank Height	High
Upper Riverbank Sediment	Silt/Sand
Upper Riverbank Vegetation	Moderate
Lower Riverbank Slope	Moderate
Lower Riverbank Sediment	Boulders
Lower Riverbank Vegetation	None-Very Sparse
Type of Erosion	Slide
Potential Erosion Indicators	Overhanging Bank
Stage of Erosion	Eroded
Extent of Erosion	Some

Segment #388 Riverbank features and characteristics

Riverbank Features	Characteristics
Upper Riverbank Slope	Moderate
Upper Riverbank Height	High
Upper Riverbank Sediment	Silt/Sand
Upper Riverbank Vegetation	Heavy
Lower Riverbank Slope	Moderate
Lower Riverbank Sediment	Boulders
Lower Riverbank Vegetation	None-Very Sparse
Type of Erosion	Undercut
Potential Erosion Indicators	Overhanging Bank, Exposed Roots
Stage of Erosion	Potential Future Erosion
Extent of Erosion	Some

Segment #12 Riverbank features and characteristics

253

Riverbank Features	Characteristics
Upper Riverbank Slope	Steep
Upper Riverbank Height	High
Upper Riverbank Sediment	Silt/Sand
Upper Riverbank Vegetation	Sparse
Lower Riverbank Slope	Flat/Beach
Lower Riverbank Sediment	Silt/Sand
Lower Riverbank Vegetation	None-Very Sparse
Type of Erosion	Planar Slip, Overhanging Bank
Potential Erosion Indicators	Overhanging Bank, Creep/Leaning Trees, Exposed Roots, Other
Stage of Erosion	Active Erosion
Extent of Erosion	Extensive

Segment #13 Riverbank features and characteristics

252

Riverbank Features	Characteristics
Upper Riverbank Slope	Moderate
Upper Riverbank Height	High
Upper Riverbank Sediment	Silt/Sand
Upper Riverbank Vegetation	Moderate
Lower Riverbank Slope	Steep
Lower Riverbank Sediment	Bedrock
Lower Riverbank Vegetation	None-Very Sparse
Type of Erosion	Planar Slip, Overhanging Bank
Potential Erosion Indicators	Overhanging Bank, Creep/Leaning Trees, Exposed Roots
Stage of Erosion	Active Erosion
Extent of Erosion	Extensive

Segment #70 Riverbank features and characteristics

122

Riverbank Features	Characteristics
Upper Riverbank Slope	Steep
Upper Riverbank Height	High
Upper Riverbank Sediment	Silt/Sand
Upper Riverbank Vegetation	Sparse
Lower Riverbank Slope	Flat/Beach
Lower Riverbank Sediment	Gravel
Lower Riverbank Vegetation	None-Very Sparse
Type of Erosion	Slide
Potential Erosion Indicators	Creep/Leaning Trees, Overhanging Bank, Exposed Roots
Stage of Erosion	Active Erosion
Extent of Erosion	Extensive

Segment #75 Riverbank features and characteristics

118

Riverbank Features	Characteristics
Upper Riverbank Slope	Vertical
Upper Riverbank Height	High
Upper Riverbank Sediment	Silt/Sand
Upper Riverbank Vegetation	Sparse
Lower Riverbank Slope	Flat/Beach
Lower Riverbank Sediment	Silt/Sand
Lower Riverbank Vegetation	None-Very Sparse
Type of Erosion	Topple
Potential Erosion Indicators	Creep/Leaning Trees, Overhanging Bank, Exposed Roots
Stage of Erosion	Active Erosion
Extent of Erosion	Extensive

Segment #77 Riverbank features and characteristics

117

Riverbank Features	Characteristics
Upper Riverbank Slope	Steep
Upper Riverbank Height	High
Upper Riverbank Sediment	Silt/Sand
Upper Riverbank Vegetation	Sparse
Lower Riverbank Slope	Flat/Beach
Lower Riverbank Sediment	Gravel
Lower Riverbank Vegetation	None-Very Sparse
Type of Erosion	Slide
Potential Erosion Indicators	Creep/Leaning Trees
Stage of Erosion	Eroded
Extent of Erosion	Some to Extensive