# Great River Hydro, LLC

# LIHI Recertification Application

# Deerfield Hydroelectric Project

# LIHI Certification # 90

**November 2020**

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# 1.0 Introduction

The Deerfield River Project (FERC License No. 2323) is owned and operated by Great River Hydro, LLC ("GRH" or "the Company") and is located on the Deerfield River, a major tributary to the Connecticut River draining about 665 square miles, in Bennington and Windham Counties in Vermont, and in Berkshire and Franklin Counties in Massachusetts. The project consists of eight developments: Somerset, Searsburg, Harriman, Sherman, Deerfield No. 5, Deerfield No. 4, Deerfield No. 3, and Deerfield No. 2 (Figure 1).

On September 15, 2012, the Deerfield River Project was certified as low impact for an eight-year term, effective April 25, 2012 and expiring April 25, 2020. This certification was issued with the following conditions:

> <u>Condition 1</u>: *If the U.S. Fish and Wildlife Service or the State of Massachusetts requests upstream and/or downstream eel passage facilities at the Project, the Project owner shall so notify LIHI within 30 days and shall enter into, and provide LIHI with a copy of, an agreement reached among the Project owner, the U.S. Fish and Wildlife Service, and/or the State of Massachusetts to provide both interim (if requested by a Resource Agency) and permanent safe, timely, and effective passage for American eel. The Agreement must be finalized within 120 days of the request for passage and must include a description of the planned passage and protection measures and the implementation schedule for design, installation, and operations. The agreement shall be filed with LIHI within 30 days of its execution.*
>
> As reported to LIHI in GRH's Compliance Statement and Condition Status Reports filed annually with LIHI, no such request has been made.
>
> <u>Condition 2</u>: *If the State of Vermont requests modification of the Project or its operation at Harriman Dam to address temperature and/or dissolved oxygen concerns pursuant to Article 415 of the Project FERC license, the Project owner shall so notify LIHI within 30 days and shall enter into, and provide LIHI with a copy of, an agreement reached among the Project owner and the State of Vermont to address those concerns. The Agreement must be finalized within 120 days of the request for Project modification and must include a description of the planned measures and the implementation schedule for those measures. The agreement shall be filed with LIHI within 30 days of its execution.*
>
> As reported to LIHI in GRH's Compliance Statement and Condition Status Reports filed annually with LIHI, no such request has been made.

On May 15, 2016 LIHI was notified that TransCanada Hydro Northeast Inc. was converted to a limited liability company on April 7, 2017, becoming TransCanada Hydro Northeast LLC. On April 19, 2017, the name of the company was changed from TransCanada Hydro Northeast LLC to Great River Hydro, LLC.

Since the last LIHI certification in 2012, the following changes have been made to the project:

- On June 22, 2015, FERC issued an order suspending license Articles 409, 410, 411, and 413. These Articles required the Company to implement requirements for the upstream passage of Atlantic Salmon at the Deerfield No. 2 development (Articles 409 and 410) and monitor effectiveness of both upstream and downstream passage modifications (Article 411). This was in response to the Company notifying FERC, on March 31, 2015, of U.S. Fish and Wildlife Service's (USFWS) announcement that they discontinued the Atlantic Salmon stocking program. The Company consulted with both the USFWS and Massachusetts Division of Fisheries and Wildlife (MDFW) on this issue and received concurrence with the Company's approach as documented in its March 31, 2015 filing with FERC.

- On March 24, 2016, FERC issued an order (and errata notice) suspending license Article 408. Article 408 required the Company to implement a plan to provide downstream fish passage facilities for out-migrating Atlantic salmon smolts at the Deerfield No. 4, Deerfield No. 3, and Deerfield No. 2 Developments. This was in response to Company's March 2, 2016, March 3, 2016 and March 18, 2016 letters notifying FERC of the USFWS announcement that they discontinued the Atlantic Salmon stocking program, notification from the Connecticut River Atlantic Salmon Commission that restoration efforts were terminated, and concurrence from USFWS and MDFW with the Company's request to suspend passage requirements. With the suspension of this Article, structural modifications, including an angled bar rack system at Deerfield No. 3, were removed and seasonal operating constraints lifted.

- On May 18, 2017, FERC issued an order amending license Articles 401, 402, 403, 406, and the Vermont Flow Monitoring and Reservoir Operations Plan relative to loon nesting. The company filed an amendment request in response to requests from the Vermont Agency of Natural Resources (VANR) and the Vermont Division of Fish and Wildlife (VDFW) to adjust the licensed target elevation of Somerset Reservoir during the common loon nesting period, and change the target elevation period to align with optimal nesting habitat and the end of the minimum flow constraint at the Searsburg development and attempt to reduce potential for conflicting requirements to simultaneously manage reservoir elevation and provide downstream flow.

- On January 5, 2016, FERC issued an order approving amendment to the Deerfield River Environmental Enhancement Fund. The amended terms of the DREEF modernize the investments to a diversified investment strategy and the disbursement calculation that reflects a total return approach that aligns with the type of investment returns produced by a diversified portfolio.

- In June 2018, the skimmer gate at Deerfield No. 2 was automated, providing remote operation from GRH's Renewable Operations Control Center in Wilder, Vermont, and significantly reducing average time to restore minimum flow when unforeseen outages occur. Prior to automation, operation of the gate required the dispatch, or after-hours call-in, of a mechanic to the site to manually adjust the gate.

- On August 6, 2019, FERC issued an order amending the license for installation of a new turbine-generator unit in the existing minimum flow structure located at Deerfield No. 5. The turbine has a rated capacity of 230 kW, a hydraulic capacity ranging from 76.5 to 88 cfs, depending upon net head conditions, and is expected to produce approximately 1,269,385 kilowatt-hours each year. Installation and use of the new turbine to deliver the minimum flow will not result in any changes to project operation. There were no agencies or other stakeholder that expressed opposition to this amendment and the MADEP did not require a 401 WQC as no work would be done in the river and no changes in flow or water quality was anticipated. This project has not been completed.


**Figure 1. Overview of Deerfield River Project Locations within the Deerfield River Watershed**

## 2.0 Project Description

The Deerfield River mainstem and its tributaries can all be characterized as shallow, rapid flowing mountain streams. The headwaters of the Deerfield River are in the Green Mountains in the southern part of Vermont. The upper (Vermont) river basin is predominantly composed of well-drained soils with shallow bedrock and steep slopes which contribute to the "flashiness" of the Deerfield River and its tributaries. The lower (Massachusetts) river basin contains soils with characteristics similar to the upper river basin that are well to moderately drained and are shallow to bedrock. Prominent features include rocky and stony hills, narrow steep-sided valleys with fast flowing mountain streams. Most of the upper river basin is in the Green Mountains where land usage is primarily forest land (Figure 2). Agricultural land is primarily concentrated on the western border of the river basin but is also scattered throughout the Green Mountains where topography is level. The majority of the urban land is located in the valley areas and consists of small towns. The only major urbanized region in the lower river basin is Greenfield, Massachusetts located at the confluence of the Deerfield and Connecticut Rivers.

Since the early 1900s, the Deerfield River's primary use has been for the generation of electricity. The steep gradients and narrow valleys mean that the dams necessary for hydroelectric power could be relatively small and economical. The Somerset Reservoir and the lower four developments of the Deerfield River Project have been in operation for over 100 years. The youngest of the developments, Sherman, has been in operation for 93 years. Development of the Project provided flood control as well as electricity to the area. The flashiness of the Deerfield River runoff season is moderated by storage in the reservoirs and water is released during the summer months when otherwise there would be little flow in the river.

The Deerfield River Project encompasses about a 66-mile reach of the Deerfield River and consists of three developments in Vermont (Somerset, Searsburg, and Harriman) and five in Massachusetts (Sherman, Deerfield No. 5, Deerfield No. 4, Deerfield No. 3, and Deerfield No. 2) (Figure 1). The Project has a total installed capacity of 86 MW and all dam and generation operations are controlled remotely from the Renewable Operations Control Center in Wilder, Vermont.

Two other developments not owned by the Company are located in this stretch of the river. The Bear Swamp Power Company’s Fife Brook Dam impounds the lower reservoir for the Bear Swamp Pumped Storage Project (FERC Project No. 2669), located between Deerfield No. 5 and Deerfield No. 4 Developments; and Central Rivers Power’s Gardner Falls Project (FERC Project No. 2234) located between the Deerfield No. 3 and the Deerfield No. 2 Developments.

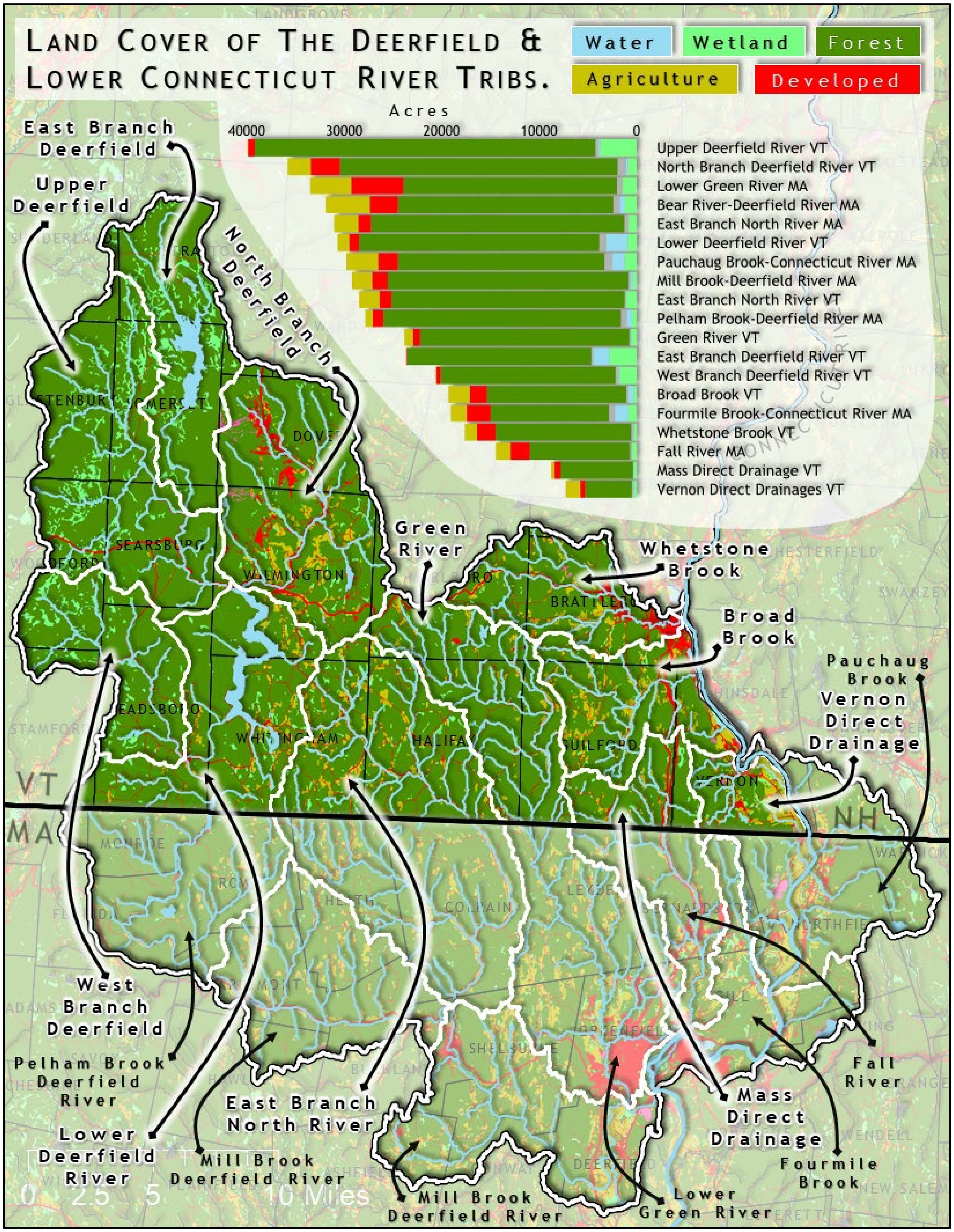


**Figure 2. The Deerfield River Basin showing tributary drainage areas and land cover. Source: VDEC Deerfield River and Lower Connecticut River Tactical Basin Plan (2020).**

The current License for the Deerfield River Project was one of the first to adopt terms and conditions applicable to the entire Project, stipulated in a multiple stakeholder, comprehensive Settlement Agreement (filed October 5, 1994). A five-year cooperative consultation process involving state and federal resource agencies, numerous, local, regional, and national non-governmental organizations and the licensee (at that time New England Power Company) resulted in settlement by the parties. The process of reaching this agreement included examination of the power and non-power tradeoffs and effects of a wide variety of operational scenarios. This negotiation process, after careful consideration of alternatives, resulted in a balancing of power and non-power interests associated with the Project through the Settlement Agreement. The FERC License conditions for the Project consist of the operational and environmental measures defined by the Settlement Agreement. The Settlement Agreement demonstrated the ability of diverse interests to come together in good faith to balance environmental quality, recreation, fishing, energy production, land preservation and other purposes. The agreement ensures that the Deerfield River will be managed over the License term to improve resource protection while recognizing the value of hydropower storage and release as a critical renewable energy resource.

The eight individual developments from upstream to downstream are described below, photographs are provided in Appendix B:

In Vermont:

- Somerset - Reservoir and Dam (no hydropower generation)
- Searsburg – Reservoir, Dam, and Powerhouse (5 MW)
- Harriman – Reservoir, Dam, and Powerhouse (41 MW)

In Massachusetts:

- Sherman - Reservoir, Dam, and Powerhouse (6 MW)
- Deerfield No. 5 – Reservoir, Dam, Powerhouse, and Dunbar Brook Diversion Structure (14 MW)
- Deerfield No. 4 - Reservoir, Dam, and Powerhouse (6 MW)
- Deerfield No. 3 – Reservoir, Dam, and Powerhouse (7 MW)
- Deerfield No. 2 – Reservoir, Dam, and Powerhouse (7 MW).

**Somerset –** The Somerset Development is located on the East Branch of the Deerfield River, and is the furthest upstream, it consists of a storage reservoir, dam, outlet works and spillway. There are no power generating facilities at this development. Somerset Reservoir is roughly 5.6 miles long and 1.1 miles across at its widest point, with a surface area of 1,514 acres, gross storage of 57,345 acre-feet, and 20,614 acre-feet of usable storage. The earth-fill dam is about 110 feet high and 2,101 feet long. Water can be conveyed from the reservoir at two locations. The main outlet works, located in the gatehouse at the eastern end of the dam has two gated 48-inch diameter pipes used to control reservoir discharge and minimum flow. In addition to the main outlet works, there is a side channel spillway with 3-foot flashboards located at the western end of the dam. The spillway channel is about 800 feet long, 45 feet wide, and from 6 to 30 feet deep. This spillway is used only for extreme flood events.

**Searsburg –** The Searsburg Development is the first development on the mainstem of the Deerfield River, approximately 11 miles downstream of its headwaters, and is the point of confluence with the East Branch. The Searsburg Development is operated on a peaking, daily storage basis. It consists of an earth-fill dam and spillway, intake and penstock, powerhouse, and substation. Searsburg Reservoir is roughly 0.9 miles long and 0.16 miles across at its widest point. It has a surface area of 30 acres, 412 acre-feet of gross storage and 197 acre-feet of useable storage within its operating range. Searsburg Dam is an earth-fill structure about 50 feet high and 475 feet long with a 137-foot long concrete gravity spillway, penstock intake gate, and sluice gate which is located in the south abutment. Water is conveyed by either the overflow spillway, the 6-foot by 8-foot sluice gate, or the penstock, which leads to the powerhouse. The intake facility includes a penstock intake gate with an 8-foot diameter wood stave conduit that runs 18,412 feet to a steel differential surge tank 50 feet in diameter and 34 feet high, and a steel penstock 6.5 feet in diameter and 495 feet long. Bond Brook, which enters the Deerfield River at RM 58.6, is diverted into the wood stave conduit. The powerhouse contains one vertical Francis unit with a capacity of 5 MW.

**Harriman –** The Harriman Development is operated on a peaking, seasonal storage basis. The facility consists of a storage reservoir, an earth-fill dam, a “morning glory” spillway, intake, conveyance tunnel and penstocks, powerhouse, and substations. Harriman Reservoir is approximately 9 miles long and 0.78 mile across at its widest point and has a surface area of 2,039 acres. It has a maximum depth of 180 feet and a useable drawdown of 86 feet. It has 103,375 acre-feet of useable storage and 117,300 acre-feet of gross storage. The Harriman Dam is an earth-fill dam 215.5 feet high and 1250 feet long. The “morning glory” spillway is normally equipped with 6 feet of flashboards. A 21.5-foot high horseshoe shaped tunnel discharges water from the spillway to the downstream channel. There is also a 4-foot diameter pipe that leads from the original construction diversion tunnel to the morning glory spillway tunnel. In 1998 the outlet pipe was modified to hold a 14-inch diameter fixed cone discharge valve. This valve is used to discharge the minimum flows for the bypass. The flow of water to the powerhouse intake is controlled by two 8-foot diameter valves. Water is conveyed through these valves to the powerhouse via a 12,812-foot long, 14-foot diameter concrete lined horseshoe shaped tunnel, a steel differential surge tank 34 feet in diameter and 184 feet high, and three steel penstocks 9 feet in diameter and 620 feet long. The powerhouse contains three vertical Francis units with a capacity of 13.7 MW each.

**Sherman –** The Sherman Development is operated on a peaking, weekly storage basis. The facility consists of an earth-fill dam and spillway, intake and penstock, powerhouse, and substation. Sherman Reservoir is roughly 2 miles long and 0.25 miles across at its widest point with a surface area of 218 acres, 1359 acre-feet of useable storage and gross storage of 3593 acre-feet. The impoundment also formerly provided once-through cooling water for the now decommissioned Yankee Atomic Electric Power Company’s Rowe Station. Sherman Dam is an earth-fill structure 110 feet high and 810 feet long with a 179-foot long concrete gravity spillway and a concrete and brick intake structure. Four feet of flashboards are maintained on the spillway year-round. Water is conveyed from Sherman Reservoir either through spillage, or via the powerhouse intake. Water is conveyed to the powerhouse via a concrete conduit 98 feet in length with a cross-sectional area of 142 square feet, and a steel penstock 13 feet in diameter and 227 feet long. There are no diversion canals or tunnels. The powerhouse contains one vertical Francis unit with a capacity of 6 MW.

**Deerfield No. 5 –** The Deerfield No. 5 Development is operated on a peaking, daily storage basis. The facility consists of two dams, a series of diversion tunnels, canals and penstocks, the powerhouse, and a substation. The impoundment is about 0.75-mile-long and 180 feet across at its widest point with a surface area of 38 acres, and gross storage of 118 acre-feet. It is comprised of a concrete gravity spillway 35 feet high and 90 feet long; a concrete intake structure that directs water to a minimum flow pipe; two low level sluices; and a power tunnel located in the west abutment. Water is conveyed from the impoundment by spillage, the minimum flow pipe, the sluice gates, or by the intake tunnel to the powerhouse. Hydraulically controlled steel flap gates are used to maintain normal reservoir elevation along the entire spillway crest. The control gates in the western abutment intake structure are composed of two 8-foot wide by 7.75-foot high sluices and a single 12.5-foot by 13-foot intake gate. Two tunnels, two concrete conduits, and three canals crisscross River Road and total 14,941 feet in length. The Deerfield No. 5 tunnel/canal system includes a small concrete gravity diversion structure about 12 feet high and 160 feet long on Dunbar Brook which directs water from the impounded brook (approximately 0.1-mile long and 175 feet across) into the southernmost tunnel. Collectively, these structures convey water from the dam to a 400-foot long, 10-foot diameter steel penstock and then to the powerhouse. The powerhouse is a steel frame and concrete structure constructed in 1974. It replaced the original station which was removed when the Bear Swamp Pumped Storage Project (P-2669) was built. The powerhouse contains one vertical Francis unit with a capacity of 14 MW. The Dunbar Brook diversion structure was completely redesigned and reconstructed in 1993. Two gates control water level in the canals and can divert flow to the powerhouse or release water into the Deerfield River via Dunbar Brook.

**Deerfield No. 4 –** The Deerfield No. 4 Development is operated on a peaking, daily storage basis. The facility consists of an earth-fill dam, spillway and sluice gates, intake and tunnel, forebay and penstocks, powerhouse, and substation. The impoundment is roughly 2 miles long and 500 feet across at its widest point, with a surface area of 75 acres, gross storage of 467 acre-feet and usable storage of 432 acre-feet. The dam is comprised of an earth-fill embankment (with a concrete core) approximately 50 feet high and 160 feet long, a 241-foot long concrete gravity spillway, and three sluice gates located in the east abutment. The dam is equipped with flashboards ranging in height from 6 to 8 feet. Water is conveyed from the impoundment either by spillage or by sluice gates located in the eastern abutment. The intake gates include a 10-foot by 10-foot, an 8-foot by 10-foot and a single 10-foot by 14-foot surface sluice. In addition, a 6-foot by 12-foot surface sluice gate is located adjacent to, and downstream of, the power tunnel intake racks. This gate discharges into a 10-foot diameter vertical conduit which in turn, discharges into a 4-foot diameter pipe that discharges into the tailrace. It has an electric operator that is remotely controlled from the River Control Center and used to pass minimum flows and was used for downstream fish passage. The power tunnel conveys water from the intake structure at the impoundment via a 12.5-foot diameter, 1514-foot-long concrete and brick lined horseshoe shaped tunnel that leads to the powerhouse forebay. The earthen forebay has a 12,000 square foot surface area and a 35-foot depth. From the forebay, water is conveyed through three 10-foot diameter, 154-foot-long steel penstocks to the powerhouse. The powerhouse is a steel frame and brick structure constructed in 1913. It contains three horizontal Francis units with a capacity of 2 MW each.

**Deerfield No. 3 –** The Deerfield No. 3 Development is operated on a peaking, daily storage basis. The facility consists of a concrete gravity dam and sluice gates, intake, tunnel, forebay and penstocks, powerhouse, and substation. The impoundment is roughly 1.3 miles long and 300 feet across at its widest point with a surface area of 42 acres, 221 acre-feet of gross storage and 200 acre-feet of useable storage. The dam is composed of a concrete gravity spillway approximately 15 feet high and 475 feet long equipped with 6-foot flashboards, two sluice gates and a power tunnel intake located in the south abutment. The sluice gates in the south abutment include a 10-foot wide surface sluice and an 8-foot wide by 4-foot high submerged sluice. A 6 foot by 10 foot surface sluice gate, located adjacent to, and downstream of, the power tunnel intake racks, discharges directly into the tailrace. This gate has an electric operator that is remotely controlled from the Renewable Operations Control Center and used to pass minimum flows and was the downstream fish passage. The power tunnel exiting the gated intake is a 677-foot long, 17-foot wide by 12.5-foot high concrete conduit. It runs underground to an 880-foot long forebay from which water is conveyed via three 59-foot long, 10-foot diameter steel penstocks to the powerhouse. The powerhouse is a steel frame and brick structure built in 1912. It contains three horizontal Francis units with a capacity of 2.3 MW each. The tailwater for Deerfield No. 3 is formed by the headwaters of the downstream impoundment of the Gardner’s Falls Project (owned by Central Rivers Power, P-2334). The Deerfield No. 3 powerhouse discharges into an impounded section of the river even when Gardner’s Falls is maintained at its lowest level.

**Deerfield No. 2 –** The Deerfield No. 2 Development is operated on a peaking, daily storage basis. The facility consists of a concrete gravity dam and sluice gates, an inflatable bladder, trippable flashboards, intake and penstocks, powerhouse, and substation. The impoundment is roughly 1.5 miles long and 500 feet across at its widest point with a surface area of 63.5 acres, 550 acre-feet of gross storage and 500 acre-feet of useable storage. The dam consists of a concrete gravity spillway approximately 70 feet high and 447 feet long, with an inflatable bladder, trippable flashboards, sluice gates and an integral powerhouse located at the western end of the spillway. Water can be conveyed from the impoundment by either spillage, sluice gates or through the powerhouse. Ten feet of trippable flashboards on top of the spillway crest and the inflatable bladder (112 feet long by 10 feet high) are used to maintain normal impoundment elevation. When water is at the top of the bladder, it will deflate automatically if inflow exceeds the powerhouse discharge. The two surface sluices are each 10 feet wide. A 6-foot by 16-foot surface sluice gate is located between the two 10-foot wide sluices and the inflatable bladder. It discharges directly into the tailrace, downstream of the dam. This gate has an electric operator which is remotely controlled from the Renewable Operations Control Center and was used for downstream fish passage. The powerhouse is a steel frame and brick structure constructed in 1913 and integral to the Deerfield No. 2 Dam. The powerhouse includes a gated intake structure with three steel penstocks, each of which is 11 feet in diameter and 35 feet long. The powerhouse contains three horizontal Francis units with a capacity of 2.3 MW each.

For this reapplication, the Project area has been divided into 22 Zones of Effect (ZoE) as described below and mapped in Figures 3-10.

- Zone 1 - Somerset impoundment – from RM 71.6 to the Somerset Dam (RM 66).
- Zone 2 - Somerset downstream reach – from the Somerset Dam (RM 66) to the Searsburg impoundment (RM 61.2).
- Zone 3 - Searsburg impoundment – from RM 61.2 to the Searsburg Dam (RM 60.3).
- Zone 4 - Searsburg bypassed reach – from the Searsburg Dam (RM 60.3) to the Searsburg Powerhouse (RM 56.8).
- Zone 5 - Searsburg downstream reach – from the Searsburg Powerhouse (RM 56.8) to the Harriman impoundment (RM 55.7).
- Zone 6 - Harriman impoundment - from RM 55.7 to the Harriman Dam (RM 48.5).
- Zone 7 - Harriman bypassed reach – from the Harriman Dam (RM 48.5) to the Sherman impoundment (RM 44.1).
- Zone 8 - Harriman tailrace - approximately 430 ft from the Harriman powerhouse to the confluence with the Deerfield River at the Sherman impoundment (RM 44.1).
- Zone 9 - Sherman impoundment - from RM 44.1 to the Sherman Dam (RM 42).
- Zone 10 – Sherman tailrace and Deerfield No. 5 impoundment - from the Sherman Dam (RM 42) to the Deerfield No. 5 dam (RM 41.2).
- Zone 11 - Deerfield No. 5 bypassed reach – from the Deerfield No. 5 dam (RM 41.2) to the Fife Brook impoundment (RM 38.5).
- Zone 12 - Deerfield No. 5 tailrace - within the upper end of the Fife Brook impoundment at the Deerfield No. 5 powerhouse (RM 38.5).
- Zone 13 - Dunbar Brook impoundment (about 400 ft long) - located along the Deerfield No. 5 canal system.
- Zone 14 – Dunbar Brook downstream reach (about 0.2 RM long) – from the Dunbar Brook Diversion Structure to the brook's confluence with the Deerfield River at RM 40.

[*The Bear Swamp Project, FERC No. 2669, owned by Bear Swamp Power Company LLC encompasses the Deerfield River from RM 38.5 to RM 23.*]

- Zone 15 - Deerfield No. 4 impoundment - from RM 22 to the Deerfield No. 4 dam (RM 20).
- Zone 16 – Deerfield No. 4 bypassed reach – from the Deerfield No. 4 dam (RM 20) to the upper end of the Deerfield No. 3 impoundment and Deerfield No. 4 powerhouse (RM 18.5).
- Zone 17 – Deerfield No. 4 tailrace – within the upper end of the Deerfield No. 3 impoundment (RM18.5).
- Zone 18 - Deerfield No. 3 impoundment - from RM 18.5 to the Deerfield No. 3 dam (RM 17).

- Zone 19 – Deerfield No. 3 bypassed reach – from the Deerfield No. 3 dam (RM 17) to the Deerfield No. 3 powerhouse (RM 16.8).
- Zone 20 – Deerfield No. 3 tailrace – within the upper and of the Gardner Falls impoundment (RM 16.8).

[*The Gardner Falls Project, FERC No. 2234, LIHI Certificate No. 80, owned by Central Rivers Power MA, LLC encompasses the Deerfield River from RM 16.5 to RM 14.7.*]

- Zone 21 - Deerfield No. 2 impoundment - from RM 14.7 to the Deerfield No. 2 dam and powerhouse (RM 13.2).
- Zone 22 – Deerfield No. 2 downstream reach – from the Deerfield No. 2 dam (RM 13.2) to the project boundary at RM 7.3.

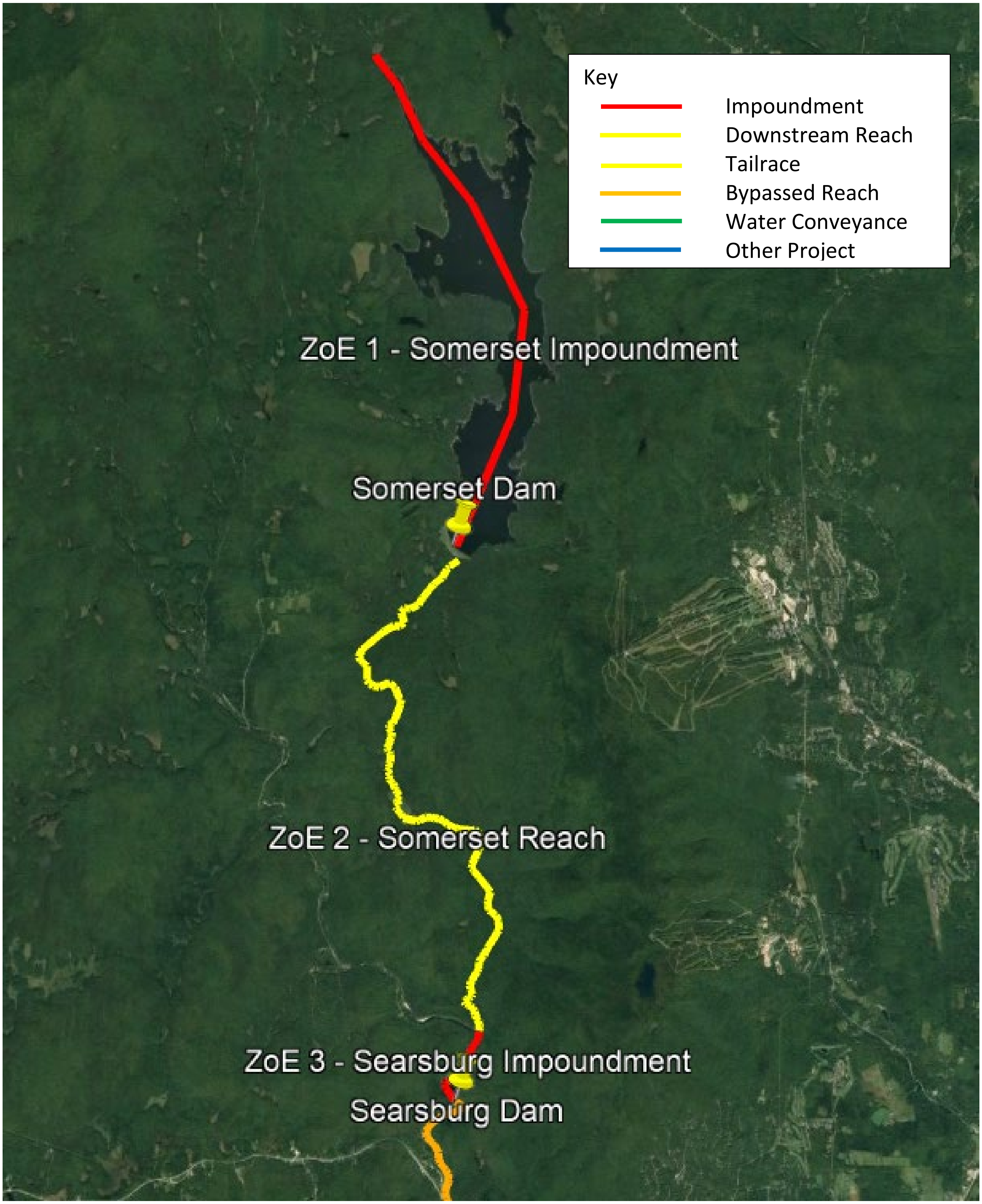


**Figure 3. Somerset Development**

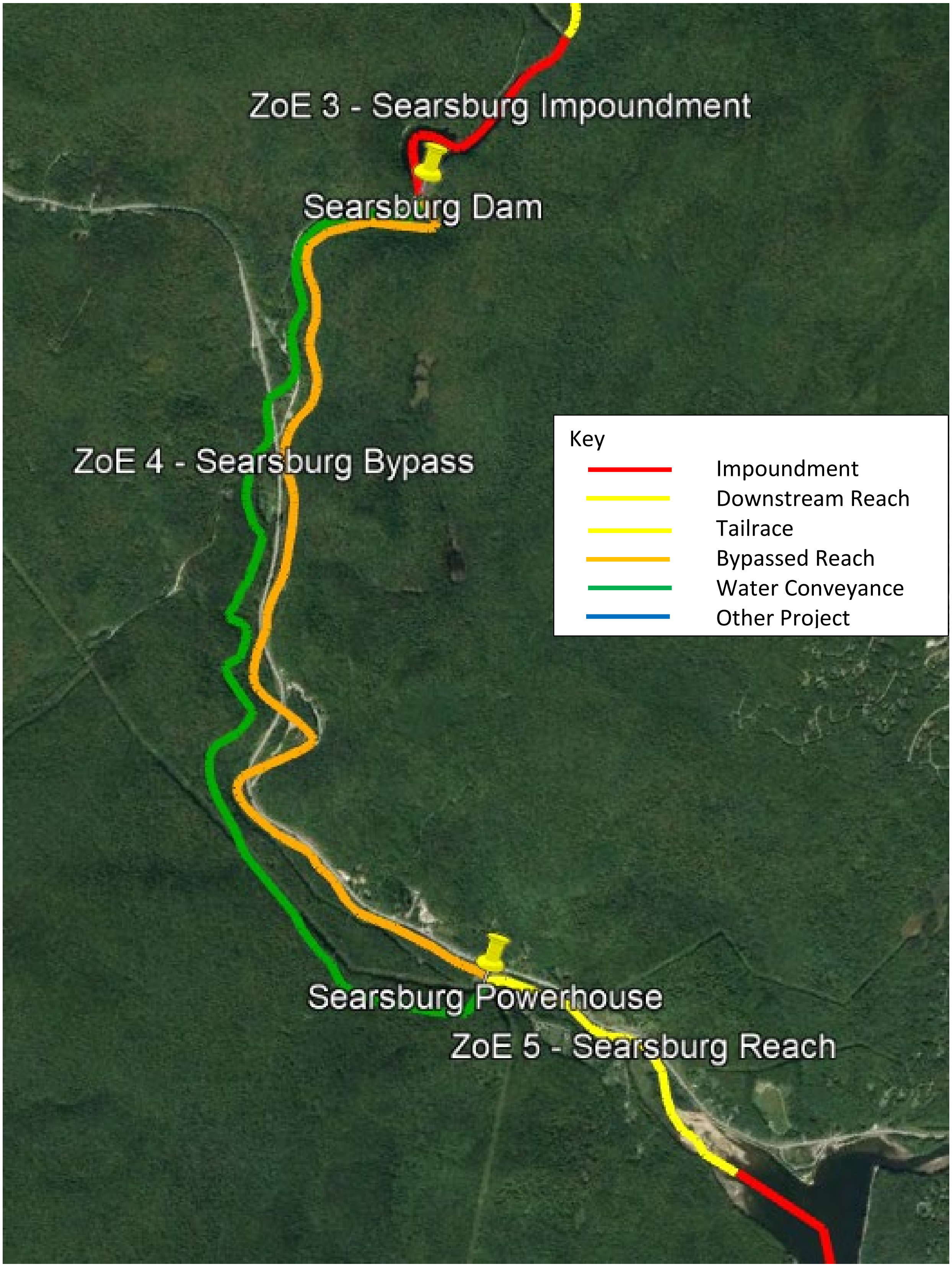


**Figure 4. Searsburg Development**

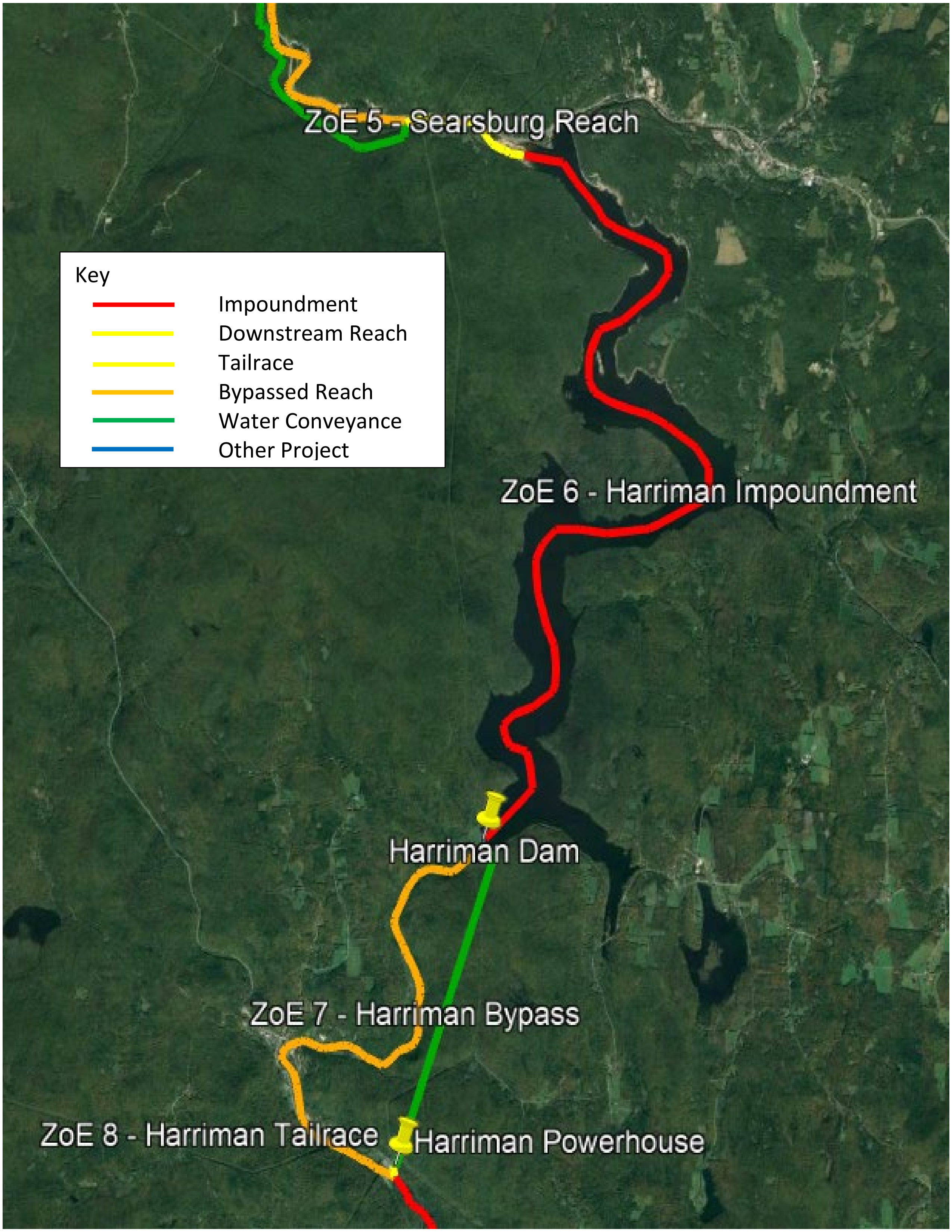


**Figure 5. Harriman Development**

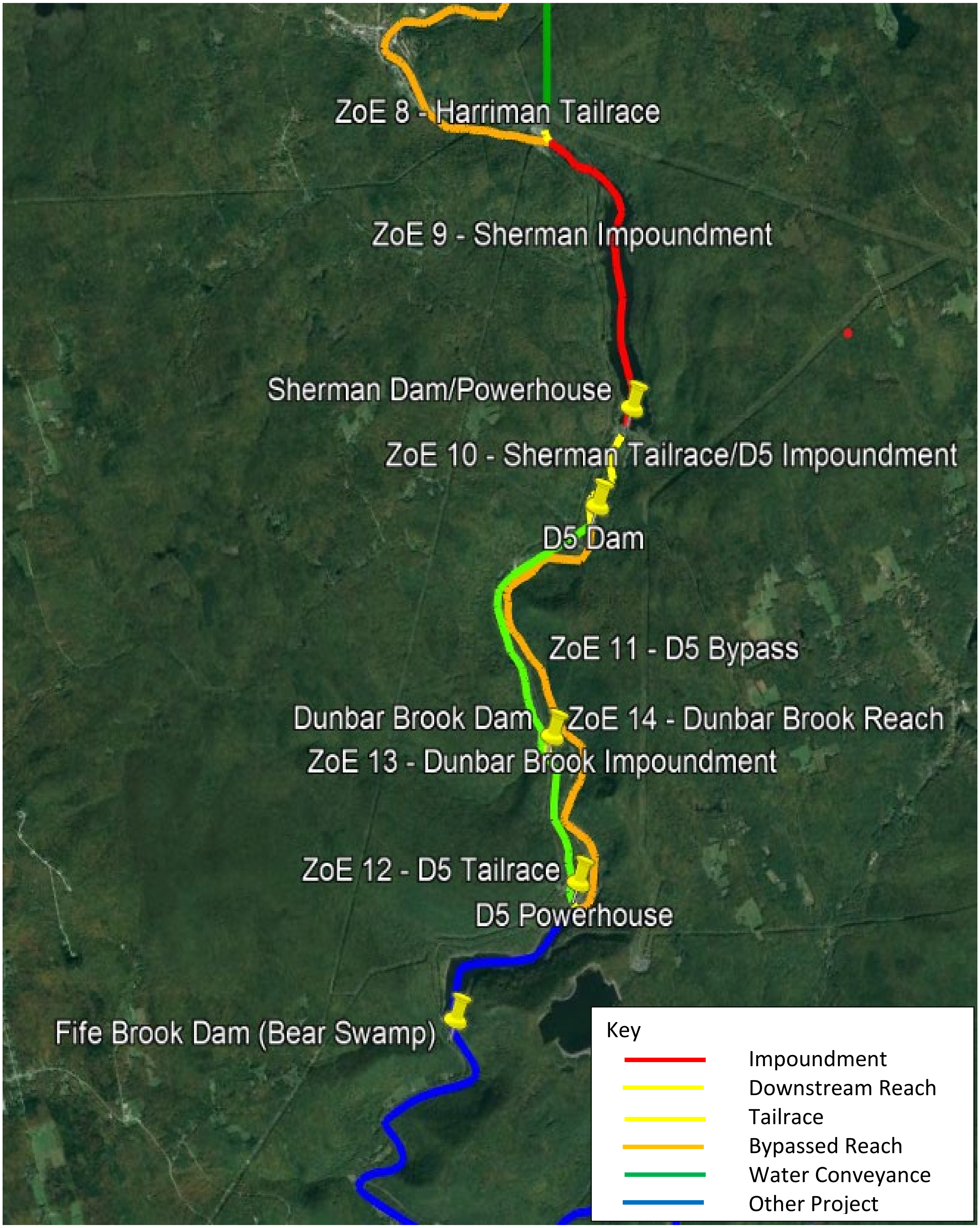


**Figure 6. Sherman and Deerfield No. 5 Developments**

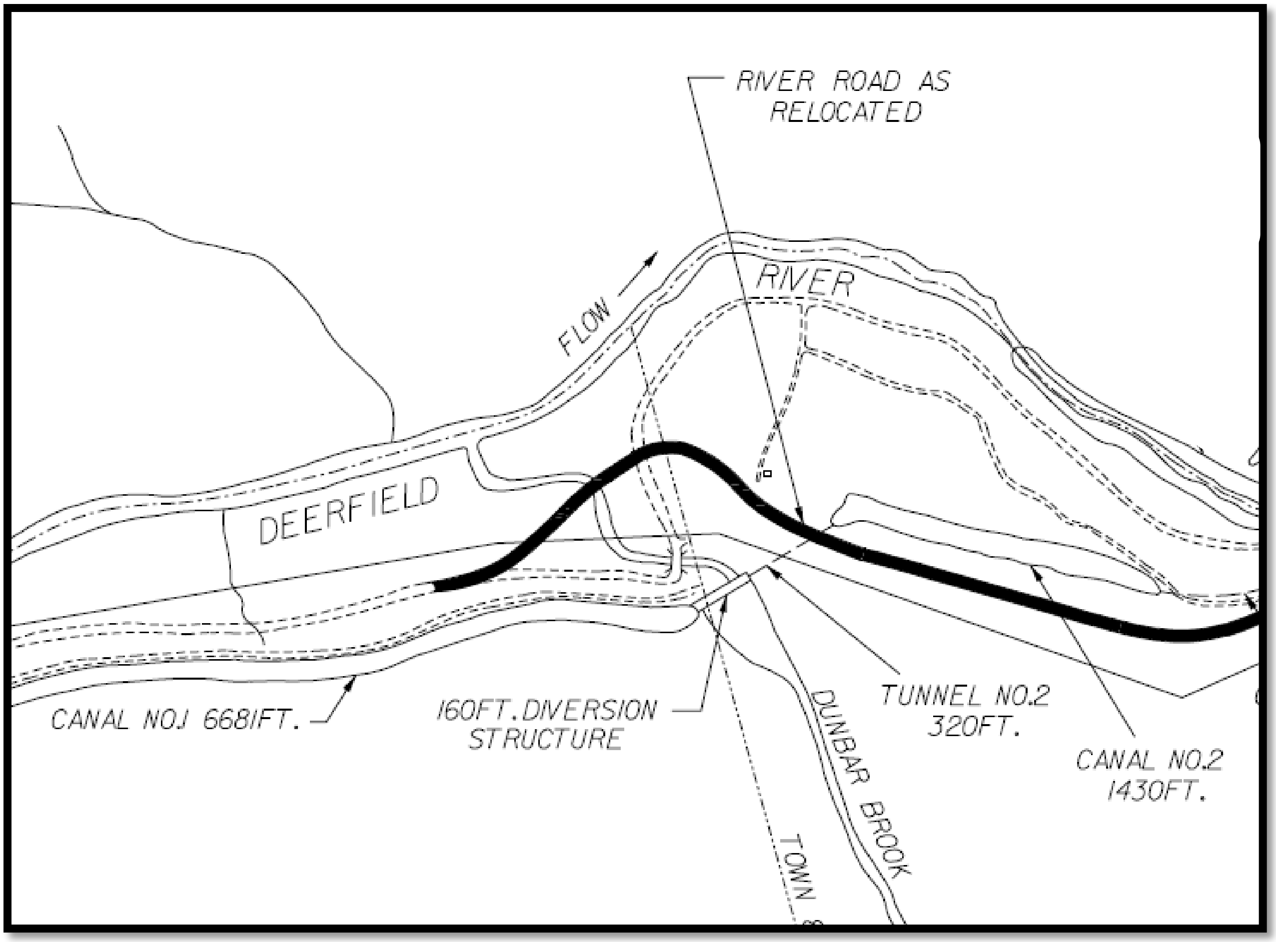


**Figure 7. Dunbar Brook**

Integration of Dunbar Brook with Deerfield No. 5 canal and tunnel structure. The system is such that water surface elevation in Dunbar Brook remains the same as that in the adjacent canal and tunnel.


**Figure 8. Fife Brook Development**

Development is under the Bear Swamp Pumped Storage Project, FERC No. 2669, owned by Bear Swamp Power Company and not part of GRH's Deerfield River Project.

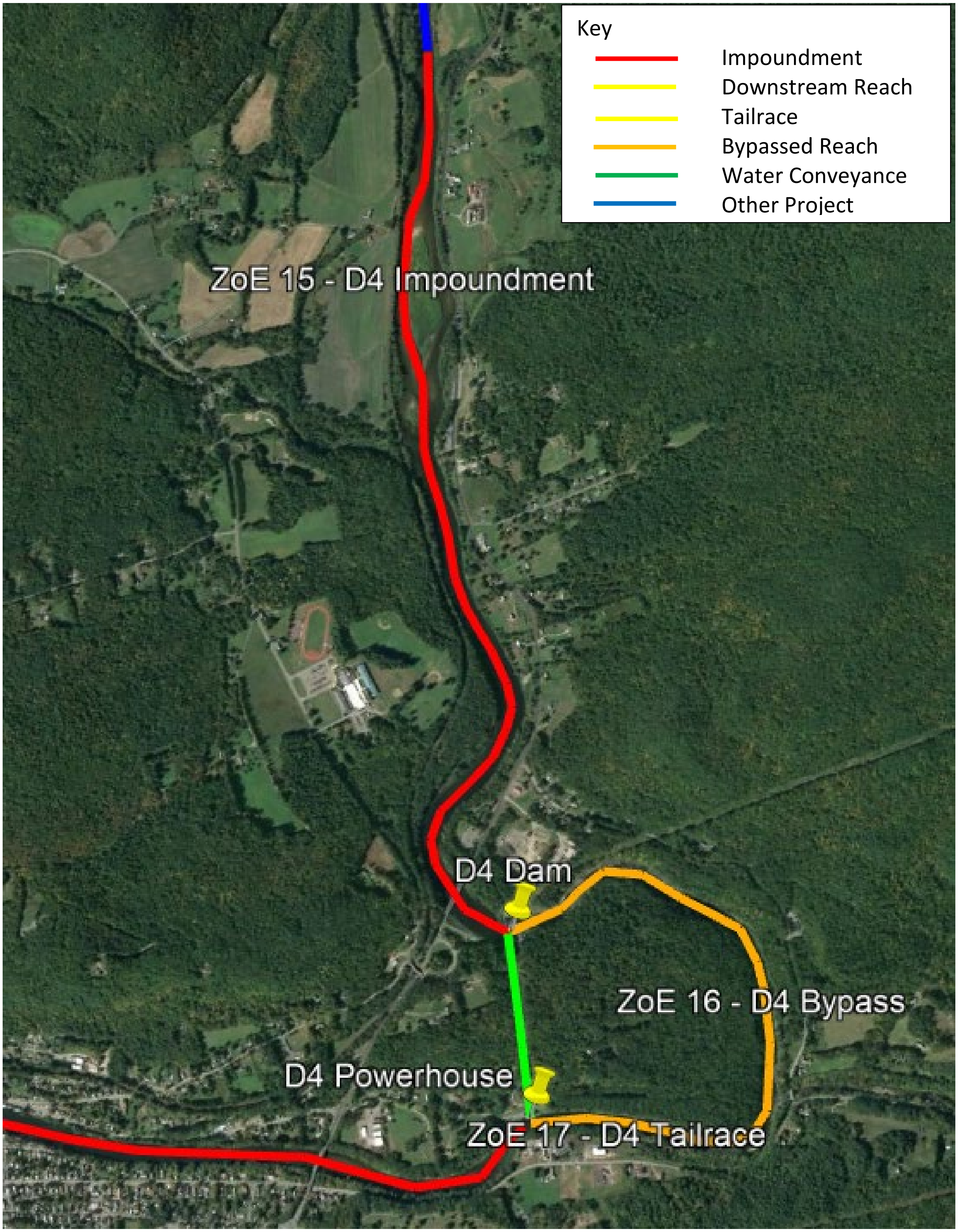


**Figure 9. Deerfield No. 4 Development**

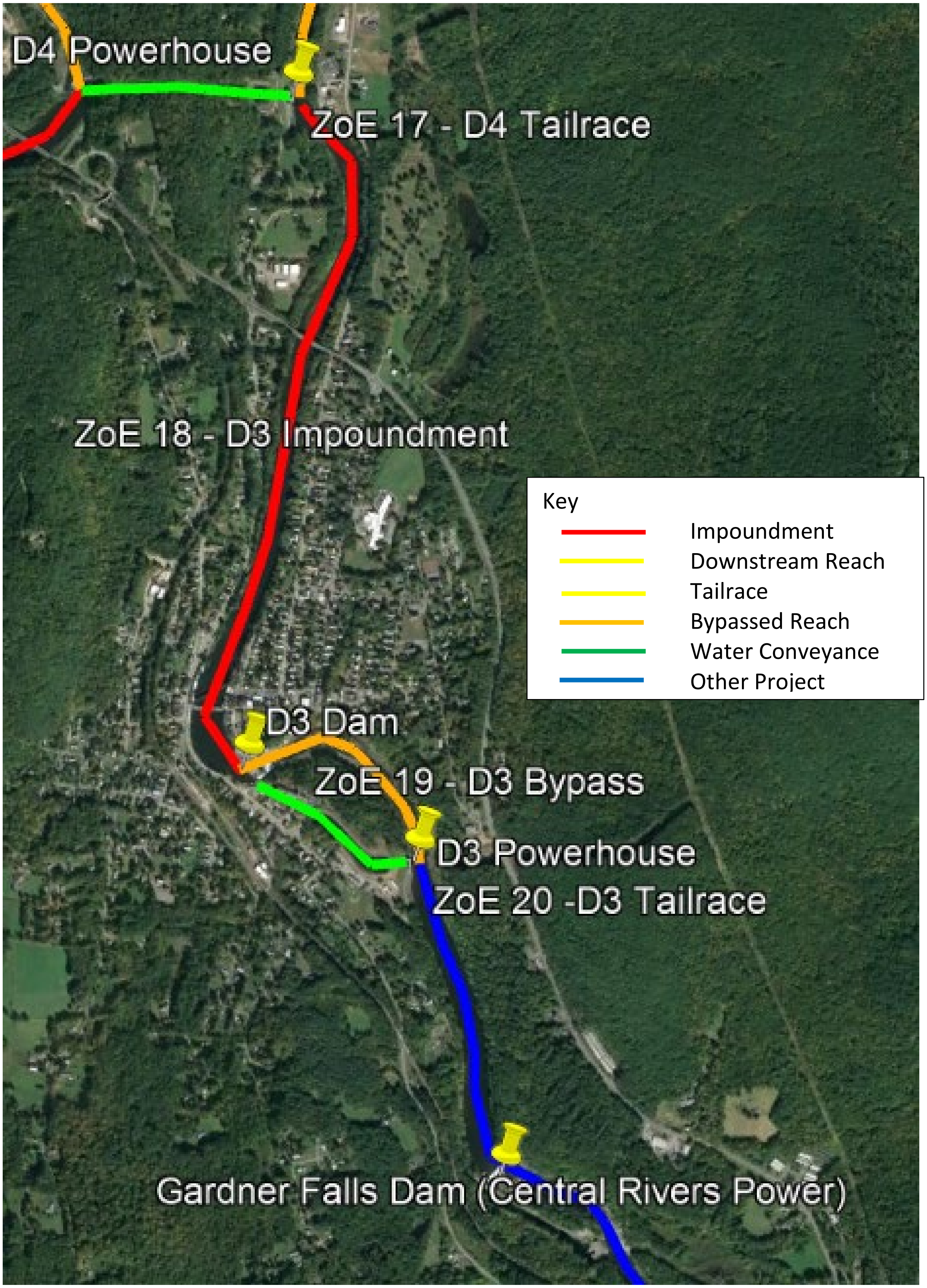


**Figure 10. Deerfield No. 3 Development**

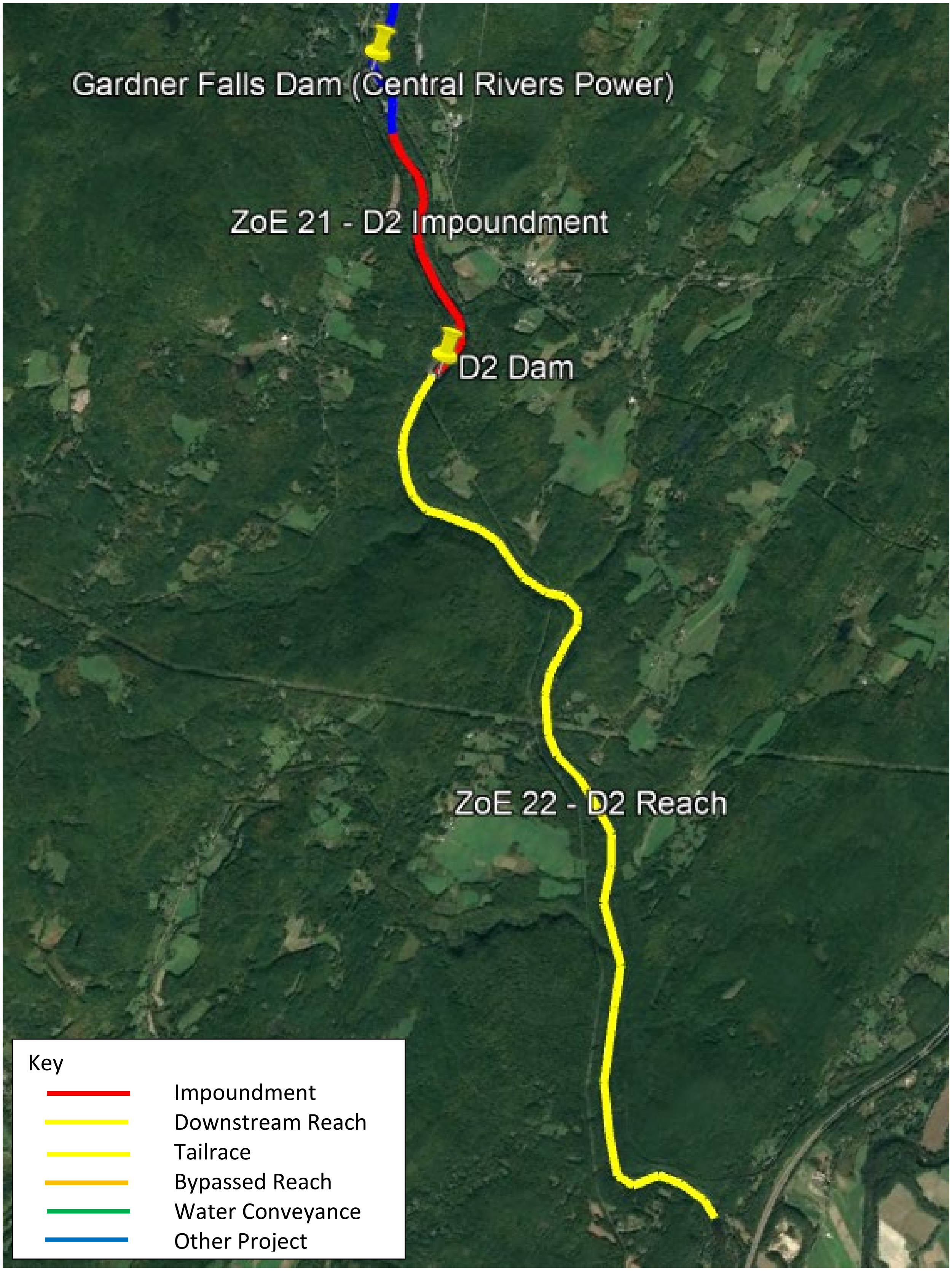


**Figure 11. Deerfield No. 2 Development**

Due to the complexity of the Deerfield River Project, Facility Information (Table B-1.1 in LIHI's Certification Handbook, 2nd Edition) required for this application is provided in two tables. Table 1, provided below, includes information common to all eight developments and 2, included as an embedded Excel spreadsheet, provides facility specific information.

**Table 1. Facility Information Common to all Developments**

| ***Item*** | ***Information Requested*** | ***Response (include references to further details)*** |
|---|---|---|
| ***Name of the Facility*** | Facility name (use FERC project name or other legal name) | Deerfield River Project (P-2323) |
| ***Location*** | River name (USGS proper name) | Deerfield River |
| | Watershed name<br>(select region, click on the area of interest until the 8-digit HUC number appears. Then identify watershed name and HUC-8 number from the map at: https://water.usgs.gov/wsc/map_index.html) | Deerfield HUC 01080203 |
| | Nearest town(s), county(ies), and state(s) to dam | See Table 1b. |
| | River mile of dam | |
| | Geographic latitude of dam | |
| | Geographic longitude of dam | |
| ***Facility Owner*** | Application contact names (Complete the Contact Form in Section B-4 also): | John Ragonese, FERC License Manager<br>Jennifer Griffin, FERC License Specialist |
| | Facility owner company and authorized owner representative name.<br>**For recertifications: If ownership has changed since last certification, provide the date of the change.** | Great River Hydro, LLC<br>John Ragonese, FERC License Manager<br>Ownership transferred from TransCanada to GRH on April 19, 2017 |
| | FERC licensee company name (if different from owner) | N/A |
| ***Regulatory Status*** | FERC Project Number (e.g., P-xxxxx), issuance and expiration dates, or date of exemption | P-2323<br>Issued – April 4, 1997<br>Expires – March 31, 2037 |
| | FERC license type (major, minor, exemption) or special classification (e.g., "qualified conduit", "non-jurisdictional") | Major |

| *Item* | *Information Requested* | *Response (include references to further details)* |
|---|---|---|
| | Water Quality Certificate identifier, issuance date, and issuing agency name. Include information on amendments. | MA, issued December 14, 1994, Massachusetts Department of Environmental Protection<br>VT, January 30, 1995, Vermont ANR<br>Both were included as appendices to the 1997 FERC license.[1] |
| | Hyperlinks to key electronic records on FERC e-library website or other publicly accessible data repositories | FERC License and WQC |

| ***Pre-Operational Facilities Only***<br>***Deerfield No. 5 Development – Minimum Flow Unit*** | | |
|---|---|---|
| ***Expected operational date*** | Date generation is expected to begin | Spring 2022 |
| ***Dam, diversion structure or conduit modification*** | Description of modifications made to a pre-existing conduit, dam or diversion structure needed to accommodate facility generation. This includes installation of flashboards or raising the flashboard height.<br>Date the modification is expected to be completed | No changes are planned to the existing conduit that will house the minimum flow turbine. The existing minimum flow conduit was constructed with the intent of housing a Flygt brand turbine-generator unit, with the existing orifice plate having been installed to regulate minimum flow in the interim. The proposed turbine essentially entails a “drop-in” installation. |
| ***Change in water flow regime*** | Description of any change in impoundment levels, water flows or operations required for new generation | No change in impoundment level, water flow or operation is required for the new generation. |

**Table 2. Facility Specific Information**

Deerfield Table 2-Facility Informatio

see project webpage 2020 recertification files

[1] Included as Appendix B-6.2 is an email from Vermont ANR stating the WQC issued July 30, 1995 remains valid. Continued validity of the MA WQC is evidenced by DEP’s statement in 2018 that the new turbine installation at Deerfield No. 5 would not require an amended WQC.

## 3.0 Standards Matrices

Table 3. Matrix of Alternative Standards for all Zones of Effect.

| | Criterion | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H |
| **Zone No., Zone Name, and Standard Selected (including PLUS if selected)** | **Ecological Flows** | **Water Quality** | **Upstream Fish Passage** | **Downstream Fish Passage** | **Shoreline and Watershed Protection** | **Threatened and Endangered Species** | **Cultural and Historic Resources** | **Recreational Resources** |
| 1: Somerset impoundment | 1 | 2 | 1 | 1 | 2+ | 4 | 2 | 2 |
| 2: Somerset downstream reach | 2 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 3: Searsburg impoundment | 1 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 4: Searsburg bypassed reach | 2 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 5: Searsburg downstream reach | 2 | 2 | 1 | 1 | 2+ | 4 | 2 | 2 |
| 6: Harriman impoundment | 1 | 2 | 1 | 1 | 2+ | 4 | 2 | 2 |
| 7: Harriman bypassed reach | 2 | 2 | 1 | 1 | 2+ | 4 | 2 | 2 |
| 8: Harriman tailrace | 2 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 9: Sherman impoundment | 1 | 2 | 1 | 1 | 2+ | 4 | 2 | 2 |
| 10: Sherman tailrace and Deerfield No. 5 impoundment | 2 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 11: Deerfield No. 5 bypassed reach | 2 | 2 | 1 | 1 | 2+ | 4 | 2 | 2 |
| 12: Deerfield No. 5 tailrace | 2 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 13: Dunbar Brook impoundment | 1 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 14: Dunbar Brook downstream reach | 2 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 15: Deerfield No. 4 impoundment | 1 | 2 | 1 | 2 | 2+ | 4 | 2 | 2 |
| 16: Deerfield No. 4 bypassed reach | 2 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 17: Deerfield No. 4 tailrace | 2 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 18: Deerfield No. 3 impoundment | 1 | 2 | 1 | 2 | 2+ | 1 | 2 | 2 |
| 19: Deerfield No. 3 bypassed reach | 2 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 20: Deerfield No. 3 tailrace | 2 | 2 | 1 | 1 | 2+ | 1 | 2 | 2 |
| 21: Deerfield No. 2 impoundment | 1 | 2 | 1 | 2 | 2+ | 4 | 2 | 2 |
| 22: Deerfield No. 2 downstream reach | 2 | 2 | 2 | 1 | 2+ | 1 | 2 | 2 |

# 4.0 Supporting Information

## 4.1 Ecological Flow Regimes

The Project is in compliance with flow conditions and reservoir elevations for fish and wildlife protection, mitigation and enhancement for reaches below all tailraces and all bypassed reaches. Flows and reservoir elevations are monitored continuously. Hourly flow and elevation data for each month at each Project development are reported annually to FERC and the Resource agencies. Temporary flow deficiencies have occurred infrequently at some facilities. Most have been caused by emergency situations, mechanical equipment or instrumentation failure, or low inflows. In all but one case, these deficiencies were of short duration; in all cases corrective and preventative actions were taken immediately to avoid recurrence; and all incidents were reported to FERC and the resource agencies (Appendix B-6.3). The single longer event resulted in FERC issuing a violation with no enforcement action taken. The event was a minimum flow reduction at the Deerfield No. 4 and 3 developments that occurred during a seasonal operational change. When the seasonal fish passage flow requirement ended at midnight on 6/15/15, the gates providing both fish and minimum flows were mistakenly shut. When the minimum flow alarm signaled, it was misinterpreted as a fish passage flow alarm. Mitigation measures were immediately implemented to prevent a similar deviation from occurring: (a) changes were made to the SCADA alarm controls to add a second alarm distinct from all other alarms, specific to each minimum flow requirement. The minimum flow alarms cannot be cleared until flow rates are adequately provided; (b) new Site Specific Instructions for scheduling and terminating license required operations such as downstream passage termination were instituted; and (c) the incident was reviewed with all control center operators for quality management and best practices improvements.

Current ecological flow regimes were established in the April 4, 1997 FERC Order issuing a new 40-year license. The flows were based upon extensive instream flow studies, both quantitative and qualitative, designed to identify basin-specific seasonal and annual aquatic base flows where appropriate. In most locations below dams, flows are specified as "or inflow if less" however, guaranteed minimum flows from reservoir storage is stipulated below Harriman Dam and No. 2 Dam. Management of the developments is described in the Vermont Flow Monitoring and Reservoir Operations Plan ("Vermont Plan" filed December 10, 1997, approved July 16, 1999, revised April 10, 2017, and approved May 18, 2017) and the Massachusetts Minimum Flow Plan ("Massachusetts Plan" filed December 10, 1997 and approved July 16, 1999). The monitoring plans were prepared in consultation with the Vermont Agency of Natural Resources (VANR), Vermont Department of Fish Wildlife (VDFW), MDFW, and USFWS. The purpose of the plans is to ensure operation of the developments protects the fishery resources and water quality of the Deerfield River.

| *Criterion* | *Standard* | *Instructions* |
|---|---|---|
| A | 1 | Not Applicable / De Minimis Effect:<br>• Confirm the location of the powerhouse relative to dam/diversion structures and demonstrate that there are no bypassed reaches at the facility.<br>• For run-of-river facilities, provide details on operations and demonstrate that flows, water levels, and operation are monitored to ensure such an operational mode is maintained. If deviations from required flows have occurred, discuss them and the measures taken to minimize reoccurrence.<br>• In a conduit facility, identify the source waters, location of discharge points, and receiving waters for the conduit system within which the hydropower facility is located. This standard cannot be used for conduits that discharge to a natural waterbody.<br>• For impoundment zones only, explain water management (e.g., fluctuations, ramping, refill rates) and how fish and wildlife habitat within the zone is evaluated and managed. ***NOTE:*** this is required information, but it will not be used to determine whether the Ecological Flows criterion has been satisfied. All impoundment zones can apply Criterion A-1 to pass this criterion. |

The following Project impoundments related Zones of Effect meet Standard 1 for Criteria A – Ecological Flow Regime:

- ZoE 1 – Somerset Impoundment
- ZoE 3 – Searsburg Impoundment
- ZoE 6 – Harriman Impoundment
- ZoE 9 – Sherman Impoundment
- ZoE 10 – Sherman tailrace and Deerfield No. 5 Impoundment
- ZoE 13 – Dunbar Brook Impoundment
- ZoE 15 - Deerfield No. 4 Impoundment
- ZoE 18 – Deerfield No. 3 Impoundment
- ZoE 21 – Deerfield No. 2 Impoundment

The Project includes eight main stem impoundments and a small impoundment on Dunbar Brook associated with the Deerfield No. 5 Development. The Deerfield No. 5 impoundment and the Sherman tailrace are treated as a single reach due to the limited impoundment fluctuation and short length and is discussed below. The remaining seven include four small impoundments, i.e., less than 500 acre-feet of usable storage, that provide daily storage capacity, and three larger impoundments that provide weekly and seasonal storage capacity. The small impoundments (Searsburg, Deerfield No. 4, Deerfield No. 3, and Deerfield No. 2) are managed through minimum flow requirements of upstream developments and regulated outflow dependent on inflow (described below). The larger storage reservoirs (Somerset, Harriman, and Sherman) are further managed through elevation requirements, and at Somerset: fluctuation restrictions.

The Vermont Plan outlines methods to establish, maintain, verify, and report on reservoir levels, inflows, and minimum flows at Somerset, Searsburg and Harriman. Operations data, including inflow, outflow (bypass, generation, spill) and reservoir elevation, is provided to the Vermont Agency of Natural Resources (VANR) quarterly and filed with VANR, USFWS, and FERC annually. Additionally, Somerset operations data is provided to VANR biweekly during loon nesting season.

The Somerset reservoir, located on the upper reach of the East Branch Deerfield River with a drainage area of 30 square miles, is managed as a seasonal storage reservoir that supplies a constant and reliable source of water for the downstream hydropower developments. In addition, the reservoir is managed for common loon nesting and aquatic biota. To support successful loon nesting an elevation of 2128.23 feet is targeted from May 15 to July 31. If the elevation is below 2128.23 feet on May 15, we continue to raise the elevation to 2128.23 until June 1 or until notification by VANR that a loon pair has begun nesting. If the elevation is above 2128.23 feet on May 15, we release water as necessary to reach 2128.23 feet until notification of loon nesting or June 1. Once the reservoir is stabilized, we maintain the elevation within a range of +/- 3 inches until July 31 or notification by VANR that nesting is complete or will not occur. Since 2012, when the Project was last certified under LIHI, 12 loon chicks were documented to have fledged and survived through the summer on Somerset reservoir.

Somerset reservoir is drawn down in winter to augment downstream flows and create storage capacity for spring runoff and snowmelt, and in the summer to supply constant river flow. The amount of drawdown varies seasonally depending on the amount of precipitation but is restricted to a maximum annual winter drawdown of 2107 ft mean sea level (msl) from November 2 to April 30 and maximum summer/fall drawdown of 2120 ft msl from August 1 to November 1.

The Searsburg reservoir provides daily storage; inflow to Searsburg reservoir is from gated discharge from Somerset reservoir and unregulated inflow from the mainstem Deerfield River and the East Branch below Somerset (minimal). Reservoir elevation is maintained between 1746.6 ft msl and 1755.6 ft msl from May 1 to October 31, and between 1746.6 ft msl and 1749.6 ft msl from November 1 to April 30. When natural inflow exceeds station hydraulic capacity (340 cfs) excess flow is spilled. Minimum flows are discharged to a bypassed reach through a sluice gate or over the fixed elevation concrete crest. Searsburg impoundment provides generation water to the downstream station by means of a wood stave conduit 8 ft in diameter and 18,412 ft long.

The Harriman reservoir is fed from the Searsburg Development and the North Branch Deerfield River. Like the Somerset reservoir, it functions as a seasonal storage reservoir that captures spring runoff and fall rains and releases the captured water to augment downstream flows during the summer and winter dry periods. The amount of drawdown is restricted to elevation

1475.0 ft msl from April 1 to November 1 and 1440.0 ft msl from November 2 to March 31. In addition, to support rainbow smelt and smallmouth bass spawning and early life stage development and recruitment, Harriman reservoir is operated in a rising or stable mode from April 1 to June 15 when flows are within operating control, followed by a maximum drawdown rate of 1 ft per day from June 16 to July 15.

The limited reservoir storage is used over the course of the summer and early fall and typically refilled by fall rain. The winter drawdown occurs from around mid-December to mid-March and provides much of the downstream flow in the downstream basin when natural flows are limited. The reservoir drawdown and discharge are calculated to capture all of the spring run-off above the dam. The reservoir refills to normal full pool elevation between March and May. Like the Somerset reservoir, the amount of drawdown also varies seasonally depending on the anticipated amount of runoff from snowmelt determined through basin wide snow depth and water content measurements taken prior to the spring snowmelt.

Minimum flows are released through a low flow valve at the base of the intake tower into the lower portion of the spillway tunnel that exits at the base of the earthen dam into the 4.4-mile-long bypassed reach below the Harriman dam which also receives flows from the West Branch of the Deerfield River that empties into the lower portion of the bypassed reach. Harriman dam has no operable spill gate capacity, only a passive glory-hole design spillway that passes flow into the bypassed reach below when the reservoir exceeds crest elevation. The flow of water to the powerhouse intake is controlled by two eight-foot diameter valves within the reservoir intake tower. Water is conveyed through these valves to the powerhouse via a 12,812-ft long, 14-ft diameter concrete lined horseshoe shaped tunnel.

The Massachusetts Plan outlines methods to monitor, verify and report on reservoir levels, inflows and minimum flows at Sherman, Deerfield No. 5, Deerfield No. 4, Deerfield No. 3, and Deerfield No. 2 to ensure that fishery resources and water quality are protected. Operations data, including inflow, outflow (bypass, generation, spill) and reservoir elevation, is filed with MDFW, USFWS, and FERC annually. There are no reservoir elevation or ramping restrictions specified for these development reservoirs.

The Sherman Development is operated to modulate river flow downstream using weekly impoundment storage. The Sherman reservoir is supplied by regulated releases from the Harriman Development (which empties directly into the Sherman reservoir) and from unregulated flows entering the Deerfield River from its West and South Branches. The South Branch, Tower Brook, and Wheeler Brook also empty directly into the Sherman reservoir. Operation of the Sherman Development is dictated by Harriman's operation unless there are high flows in the river and then the development operates continuously. Flows in excess of the hydraulic capacity of the development (1,200 cfs) are spilled over the concrete crest portion of the dam; there is no spillway gate capability. The Sherman powerhouse discharges directly into the Deerfield No. 5 impoundment, which backwaters the base of the powerhouse. Sherman has no specified instantaneous minimum flow requirement but due to the limited storage in the Deerfield No. 5 impoundment and its minimum flow requirement, Sherman operates frequently in order to provide downstream minimum flow for the Deerfield No. 5 Development and the downstream Fife Brook station (owned by Bear Swamp Power Company).

The Deerfield River No. 5 Development has a small impoundment with direct hydraulic connectivity to a series of canals and tunnels that collectively provide limited, daily operating storage above the powerhouse. Water provided largely by Sherman passes through the impoundment to a concrete intake structure, which directs water to a minimum flow pipe, two low level sluices, and a power tunnel-canal system to the powerhouse, bypassing the river. Water to the bypassed reach is conveyed by the minimum flow pipe or alternatively by the two sub-gates or two spillway flap gates. Scheduled whitewater releases as well has natural high flows in excess of station capacity are discharged through the dam via the two flap gates.

The FERC approved (Order dated August 6, 2019) minimum flow unit will be a vertical turbine placed directly inside the existing minimum flow pipe. The minimum flow pipe was designed for this unit when the dam was reconstructed in early 1990's. The new minimum flow unit will pass 76.5 cfs at a minimum under lowest net head conditions and approximately 88 cfs under maximum net head operating conditions; more than enough to satisfy the required 73 cfs or inflow if less requirement.

The Dunbar Brook structure is located within the Deerfield No. 5 Development immediately above the confluence of Dunbar Brook and the bypassed reach. The concrete structure is an integral part of Deerfield No. 5's Canal #1, which runs parallel to the bypassed reach and creates a small, 1-acre pool at the base of the Dunbar Brook structure for the purpose of passively providing water into the canal when available. Overflow not needed or capable of diversion into the canal is spilled over a concrete crest into the Deerfield No. 5 bypassed reach downstream of the structure. There were no agency or stakeholder issues associated with operating this augmentation structure during relicensing and there are no specific operational requirements in the license.

Deerfield River Project Development No.'s 4, 3, and 2 are closely aligned in operation because the impoundments hold little storage and flows from the upstream development are necessary to maintain operating and minimum flows at the next downstream development. Inflows to these developments is provided from Deerfield No. 5 Development discharge passing through the Fife Brook Development of the Bear Swamp Pumped Storage Project (Bear Swamp Power Company). Water from Deerfield No. 4 impoundment is used for minimum flow and daily cycle generation. Flows in excess of the station capacity as well as required minimum flow is spilled at the dam through either three manually operated sluice gates or over the 241-ft spillway crest into the 1.5-mile long bypassed reach. The Deerfield No. 4 dam is located approximately 1.5 miles upstream of the Deerfield No. 4 station. At the dam, water is diverted via a 12.5 ft diameter, 1514 ft long concrete and brick lined horseshoe shaped tunnel to an earthen forebay before passing through the station and back into a free-flowing stretch of river.

The Deerfield No. 3 Development is operated in a coordinated manner with Deerfield No. 4 Development. Flow into the Deerfield No. 3 impoundment is from Deerfield No. 4 station discharge, the bypassed minimum flow, and unregulated inflow from, primarily, the North River which enters the bypassed reach of the Deerfield River just below Deerfield No. 4 dam. Like the Deerfield No. 4 impoundment, this development operates on a daily run-of-river cycle using minimal reservoir storage that is replenished by inflow. Flow in excess of station capacity and the required minimum flow are spilled through one of two sluice gates or over the dam crest into the 0.5-mile long bypassed reach. The Deerfield No. 3 dam is located approximately 0.5 mile upstream of the Deerfield No. 3 station. At the dam, water is diverted via a 677-ft long, 17-ft wide by 12.5-ft high concrete conduit to a 880-ft long earthen forebay before passing through the station and into a section of the Deerfield River that is impounded by the Gardner Falls Project (Central Rivers Power).

The Deerfield No. 2 Development is operated in a coordinated manner with Deerfield No. 3 Development. Flow into the Deerfield No. 2 reservoir is from the upstream Deerfield No. 3 Development, passing directly through the Gardner Falls Project, and from minor unregulated inflows. As with Deerfield No. 3 and Deerfield No. 4, it operates on a daily run-of-river cycle using reservoir storage that is replenished from inflow. A portion of the storage is also used to pass the guaranteed minimum flow requirement that is significantly greater than the Deerfield No. 3, Deerfield No. 4, and Gardner Falls minimum flow requirement. Flows in excess of the station capacity are spilled. Minimum flow is typically provided by unit discharge as there is no bypassed reach associated with this development.

| *Criterion* | *Standard* | *Instructions* |
|---|---|---|
| A | 2 | <u>Agency Recommendation:</u><br>• Identify the proceeding and source, date, and specifics of the agency recommendation applied (NOTE: there may be more than one; identify and explain which is most environmentally protective).<br>• Explain the scientific or technical basis for the agency recommendation, including methods and data used. This is required regardless of whether the recommendation is or is not part of a Settlement Agreement.<br>• Explain how the recommendation relates to agency management goals and objectives for fish and wildlife.<br>• Explain how the recommendation provides fish and wildlife protection, mitigation and enhancement (including in-stream flows, ramping and peaking rate conditions, and seasonal and episodic instream flow variations). |

The following bypassed, downstream, and tailrace reaches meet Standard 2 for Criterion A, Ecological Flows:

- ZoE 2 – Somerset Downstream Reach
- ZoE 4 – Searsburg Bypass Reach
- ZoE 5 – Searsburg Downstream Reach
- ZoE 7 – Harriman Bypass Reach
- ZoE 8 – Harriman Tailrace

- ZoE 11 – Deerfield No. 5 Bypass Reach
- ZoE 12 – Deerfield No. 5 Tailrace
- ZoE 16 – Deerfield No. 4 Bypass Reach
- ZoE 17 – Deerfield No. 4 Tailrace
- ZoE 19 – Deerfield No. 3 Bypass Reach
- ZoE 20 – Deerfield No. 3 Tailrace
- ZoE 22 – Deerfield No. 2 Downstream Reach

Ecological flows are specified in the Deerfield River Project license which includes, by reference, the Deerfield River Project Settlement Agreement. The Vermont Plan and the Massachusetts Plan outline methods to establish, maintain, verify, and report on reservoir levels, inflows, and minimum flows at the developments. Operations data, including inflow, outflow (bypass, generation, spill) and reservoir elevation, is provided to VANR quarterly and filed with VANR, MDFW, USFWS, and FERC annually.

Instream flow incremental methodology (IFIM) as well as qualitative instream flow assessment (teams of stakeholder experts in the river evaluating flows and habitat) was used to assess habitat flows for all developments of the Deerfield River Project when the project was relicensed in 1997. All minimum flows established were for the purpose of benefiting aquatic biota, particularly resident fish species, and maintaining state water quality standards.

At the Somerset Development seasonal minimum flows are provided to the 6-mile East Branch of the Deerfield River downstream reach to support a cold-water fishery, primarily wild brook trout. Seasonal reservoir storage and discharge augments downstream natural flow, supporting both operation of the downstream hydro developments as well as various ecological and recreation resource requirements. The seasonal minimum flows below Somerset Dam are:

- 30 cfs from Oct 1 to Dec 15
- 48 cfs from Dec 16 to Feb 28 (29)
- 30 cfs from March1 to April 30
- 12 cfs from May 1 to July 31, or inflow if less than 12 cfs, but not less than 9 cfs
- 12 cfs from Aug 1 to Sep 31

Discharge increases are limited to 100 cfs or less over 24 hours from August 1 to April 30, and discharge decreases are limited to 50 cfs over 24 hours from August 1 to April 30.

At the Searsburg Development, 35 cfs or inflow if less, is passed to the 3.5-mile bypassed reach from June 1 to September 30, and 55 cfs or inflow if less, from October 1 to May 31. In the 1.1-mile downstream reach of the Searsburg station, 175 cfs or inflow if less, is provided from April 20 to May 15 to provide riverine spawning habitat for smelt originating from the Harriman Reservoir.

At the Harriman Development, 70 cfs is passed to the 4.4-mile bypassed reach from October 1 to June 30, and 57 cfs from July 1 to September 30. The bypassed flow, plus natural inflow and Harriman powerhouse discharge provide inflow into the Sherman impoundment.

At Sherman Development, flow and water below the dam is maintained by a combination of station discharge and backwater above Deerfield No. 5 dam. There are no gates or controlled spill capability at the Sherman dam. Sherman station discharge capacity is less than that of Harriman and provides a regulation function. Additionally, cyclical discharge throughout each day provides water to maintain the minimum flow requirements at Deerfield No. 5 Development, guaranteed minimum flow at Fife Brook Development (Bear Swamp Pumped Storage Project), and support downstream operation of Deerfield Development No.'s 4, 3, and 2. There are no minimum flow requirements below the Sherman dam because the tailrace forms the upper end of the small Deerfield No. 5 impoundment.

Below the Deerfield No. 5 dam, a flow of 73 cfs or inflow, whichever is less but not less than 57 cfs, is passed to the 3-mile bypassed reach all year. White water releases are passed at this location during summer as described in Section 4.8.

At the Deerfield No. 4 Development, 100 cfs or inflow, whichever is less, is passed to the 2-mile bypassed reach between the dam and the station tailrace from October 1 to May 31, and 125 cfs or inflow, whichever is less, from June 1 to September 30. The North River flows into the bypassed reach at about mid-reach.

At Deerfield No. 3 Development, 100 cfs or inflow, whichever is less, is provided year-round into the 0.2-mile bypassed reach between Deerfield No. 3 dam and the station tailrace, year-round.

At Deerfield No. 2 Development, there is no bypassed reach and station discharge provides the minimum flow of 200 cfs year-round. This flow is a guaranteed flow provided by upstream impoundment storage as needed.

Minimum flows can be temporarily modified if required by operation emergencies beyond the control of the license, or for short periods upon agreement between the licensee and the State resource Agency. Minimum flows below Searsburg dam may be modified if there are low inflow conditions during flashboard reinstallation, or when maintenance operations require a drawdown of the impoundment. Under those conditions, up to 10% of inflow is placed in storage, and the minimum bypass flow adjusted accordingly.

## 4.2 Water Quality

| ***Criterion*** | ***Standard*** | ***Instructions*** |
|---|---|---|
| B | 2 | Agency Recommendation:<br>• If facility is located on a Water Quality Limited river reach, provide a link to the state's most recent impaired waters list and indicate the page(s) therein that apply to facility waters. If possible, provide an agency letter stating that the facility is not a cause of such limitation.<br>• Provide a copy of the most recent Water Quality Certificate and any subsequent amendments, including the date(s) of issuance. If more than 10 years old, provide documentation that the certification terms and conditions remain valid and in effect for the facility (e.g., a letter from the agency).<br>• Identify any other agency recommendations related to water quality and explain their scientific or technical basis.<br>• Describe all compliance activities related to water quality and any agency recommendations for the facility, including on-going monitoring, and how those are integrated into facility operations. |

Applicable Zones of Effect meet Water Quality Standard 2. The Project is in compliance with all conditions of the Clean Water Act Section 401 water quality certifications. The Vermont water quality certification was issued January 30, 1995 and the Massachusetts water quality certification was issued on December 14, 1994. In both cases, conditions related to water quality, flow and reservoir management and aquatic and terrestrial resource are included as License Articles and therefore remain in effect and are FERC compliance obligations. Both are included as appendices to the 1997 FERC License. We have no Notices or Letter Notifications of Non-Compliance from either Massachusetts, Vermont or the FERC.

Some areas within the Project are identified by Vermont and Massachusetts in their respective Clean Water Act Section 303(d) List of Impaired Waters. However, no Project facilities are identified as causing these water quality impairments.

Vermont water quality standards are found here. The designated use classifications for the 88.7 miles of the Upper Deerfield River and tributaries are (see Appendix, page 86 of the standards):

- Aquatic biota and wildlife that may utilize or are present in the waters – A1;
- Aquatic habitat to support aquatic biota, wildlife, or plant life – A1;
- The use of waters for swimming and other primary contact recreation – B2;
- The use of waters for boating and related recreational uses B2;
- The use of waters for fishing and related recreational uses – A1;
- The use of waters for the enjoyment of aesthetic conditions – B2;
- The use of the water for public water source – B2; and
- The use of water for irrigation of crops and other agricultural uses – B2.

The Vermont Department of Environmental Conservation Watershed Management Division (VDEC WMD)'s *State of Vermont 2018 303(d) List of Impaired Waters* (found here) identifies two sections of the Deerfield River within the Project area as impaired: below Somerset Dam and below Searsburg Dam. For both, the impairment is acidification, which is classified as from atmospheric deposition (page 7). The VDEC MWD also publishes a list of Priority Surface Waters that are assessed as impaired and have completed and approved TMDLs in place (this corresponds to Category 4a of EPA's Consolidated Assessment Listing Methodology) (found here). The impairments are mercury in fish tissue for Somerset, Harriman, Sherman and Searsburg Reservoirs, and below Somerset and Searsburg Reservoirs; and acid for Somerset Reservoir (pages 13 and 14). The mercury impairment is described as entering water from polluted runoff and from precipitation containing mercury (atmospheric deposition) (see "mercury" link found on page 46), and the acid impairment from atmospheric deposition.

Massachusetts water quality standards are found here. The Deerfield River from the state line to the confluence with the Connecticut River is Class B, with a qualifier of Cold Water for the upper portion (from the state line to the confluence with North River) and Warm Water for the lower portion (from the North River confluence to the Connecticut River), see Table 5 of the standards. Massachusetts describes Inland Class B waters:

> 4.05(3)(b) Class B. These waters are designated as a habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation. Where designated in 314 CMR 4.06, they shall be suitable as a source of public water supply with appropriate treatment ("Treated Water Supply"). Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value.

The current list of impaired waters for Massachusetts, published in 2019, is the *Massachusetts Year 2016 Integrated List of Waters Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act* (found here). It separates waters into five different categories of impairment with only Category 5 waters on the 303(d) list, requiring a TMDL for the causative impairment. Of the Massachusetts portion of the Deerfield River, three of five segments are Category 5: the Sherman Reservoir, listed for mercury in fish tissue (page 191); and two contiguous sections from the confluence with the North River to the confluence with the Connecticut River, listed for *Escherichia Coli* (*E. coli*; page 191). Neither impairment is attributable to project operations. As stated in the report, the majority of mercury pollution in the Northeast derives from atmospheric deposition (p. 36). The *Massachusetts Consolidated Assessment and Listing Methodology (CALM) Guidance Manual for the 2016 Reporting Cycle* (found here) identifies the following sources for *E. coli* impairment (page F6): municipal point source discharges, combined sewer overflows, municipal (urbanized high density area), discharges from municipal separate storm sewer systems (MS4), unspecified urban stormwater, wet weather discharges (non-point source), illicit connections/hook-ups to storm sewers, urban runoff/storm sewers, waterfowl, introduction of non-native organisms (accidental or intentional), and source unknown.

## 4.3 Upstream Fish Passage

| ***Criterion*** | ***Standard*** | ***Instructions*** |
|---|---|---|
| C | 1 | <u>Not Applicable / De Minimis Effect:</u><br>• Explain why the facility does not impose a barrier to upstream fish passage in the designated zone. Typically, impoundment zones will qualify for this standard since once above a dam and in an impoundment, there is no facility barrier to further upstream movement.<br>• Document available fish distribution data and the lack of migratory fish species in the vicinity.<br>• If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this. |

| ***Criterion*** | ***Standard*** | ***Instructions*** |
|---|---|---|
| C | 2 | <u>Agency Recommendation:</u><br>• Identify the proceeding and source, date, and specifics of the agency recommendation applied (NOTE: there may be more than one; identify and explain which is most environmentally stringent).<br>• Explain the scientific or technical basis for the agency recommendation, including methods and data used. This is required regardless of whether the recommendation is or is not part of a Settlement Agreement.<br>• Describe any provisions for fish passage monitoring or effectiveness determinations that are part of the agency recommendation, and how these are being implemented.<br>• Provide evidence that required passage facilities are being operated and maintained as mandated (e.g. meets season, coordination with agencies) |

The Project is in compliance with all conditions in the License for upstream fish passage for all Zones of Effect. All Zones of Effect meet criterion standard C-1 except Zone 22, Deerfield No. 2 downstream reach, which meets criterion standard C-2.

Historically, Atlantic salmon used the Deerfield River for spawning and records show they reached Shelburne Falls, where the Deerfield No. 3 and Deerfield No. 4 Developments are located (FERC 1996). MDFW's efforts to re-establish Atlantic salmon in the river basin included stocking fry in tributaries above Deerfield No. 4 since before the Deerfield River Project was relicensed. The 1997 FERC license included upstream passage initiatives at Deerfield No. 2 (Articles 409, 410, 411, and 413). These requirements were complied with and in place through June 2015 when they were suspended by FERC (see Section 1 for document links). In 2013, the USFWS formally announced that its Atlantic salmon stocking efforts in the Connecticut River basin had not achieved restoration levels and that stocking efforts would be discontinued. In light of this decision, on March 31, 2015 the Company filed a license amendment request with the Commission to suspend or remove those Articles associated with upstream passage of Atlantic salmon at the Deerfield No. 2 Development. In its filing, the Company included correspondence from USFWS and MDFW stating that "…upstream passage for Atlantic salmon on the Deerfield River is no longer a concern." On June 22, 2015, the Commission issued Order Suspending License Articles 409, 410, 411, and 413 for the Deerfield River Project. To date there have been no requests for providing upstream passage for other species by either State or Federal fishery management agencies.

Migratory species in the Connecticut River Basin are managed by the Connecticut River Atlantic Salmon Commission (CRASC). It was established in 1983 by Congress "to promote the restoration of anadromous Atlantic salmon in the Connecticut River Basin by the development of a joint interstate program for stocking, protection, management, re-search, and regulation" with the purpose of restoring Atlantic salmon to the Connecticut River in numbers as near as possible to their historical abundance. Agency representation includes: USFWS, National Marine Fisheries Service, Connecticut Department of Environmental Protection, MDFW, New Hampshire Department of Fish and Game, and Vermont Department of Fish and Wildlife. The CRASC expanded their mission to include all diadromous species in the Connecticut River Basin and they developed management plans for American shad, river herring (i.e., blueback herring and alewife), and sea lamprey. Management goals of these plans focus on the mainstem Connecticut River.

Migratory species in the Connecticut River with access to the Deerfield River include American shad, blueback herring, sea lamprey, American eel, and shortnose sturgeon. American eel enter the Connecticut River as juveniles and move upstream and into tributaries. They have few habitat preferences and can move around most obstructions, allowing them to inhabit most aquatic habitats including within the Deerfield River. Sea lamprey entering the lower Deerfield River may find suitable spawning habitat; however, American shad and blueback, migrating up the Connecticut River to spawn in deep, slow moving water, are unlikely to be found in the relatively shallow, swift moving water of the lower Deerfield River.

A naturally reproducing population of shortnose sturgeon inhabits the Connecticut River between the Cabot Project, located on the Connecticut River just above the mouth of the Deerfield River, and the downstream Holyoke Hydroelectric Project and may opportunistically forage in the Deerfield River. However, shortnose sturgeon have not been identified at the Deerfield No. 2 Development (FERC 1996).

Both states, Massachusetts and Vermont, stock trout species in the Project area. In the mainstem Deerfield River, Vermont stocks brook and rainbow trout, brook trout are stocked in Somerset and Searsburg impoundments, brown trout in Sherman impoundment, and in Harriman impoundment brook, brown, rainbow and lake trout are stocked as well as landlocked salmon. In the Massachusetts reach of the Deerfield River, brown, brook and rainbow trout are stocked in various locations.

Additional fish species reported to occur in the upper Deerfield River include blacknose dace, bluegill, brown bullhead, chain pickerel, common shiner, creek chub, fallfish, golden shiner, largemouth bass, longnose dace, longnose sucker, mimic shiner, pumpkinseed, rainbow smelt, rock bass, slimy sculpin, smallmouth bass, white sucker, and yellow perch (VANR 2020).

## 4.4 Downstream Fish Passage

| ***Criterion*** | ***Standard*** | ***Instructions*** |
|---|---|---|
| D | 1 | Not Applicable / De Minimis Effect:<br>• Explain why the facility does not impose a barrier to downstream fish passage in the designated zone, considering both physical obstruction and increased mortality relative to natural downstream movement (e.g., entrainment into hydropower turbines). Typically, tailwater/downstream zones will qualify for this standard since below a dam and powerhouse there is no facility barrier to further downstream movement. Bypassed reach zones must demonstrate that flows in the reach are adequate to support safe, effective and timely downstream migration.<br>• For riverine fish populations that are known to move downstream, explain why the facility does not contribute adversely to the sustainability of these populations or to their access to habitat necessary for successful completion of their life cycles.<br>• Document available fish distribution data and the lack of migratory fish species in the vicinity.<br>• If migratory fish species have been extirpated from the area, explain why the facility is or was not the cause of this. |

| ***Criterion*** | ***Standard*** | ***Instructions*** |
|---|---|---|
| D | 2 | Agency Recommendation:<br>• Identify the proceeding and source, date, and specifics of the agency recommendation applied (NOTE: there may be more than one; identify and explain which is most environmentally stringent).<br>• Explain the scientific or technical basis for the agency recommendation, including methods and data used. This is required regardless of whether the recommendation is part of a Settlement Agreement or not.<br>• Describe any provisions for fish passage monitoring or effectiveness determinations that are part of the agency recommendation, and how these are being implemented. |

The Project is in compliance with conditions in the License for downstream fish passage for all Zones of Effect. All Zones of Effect meet criterion standard D-1 except Zones 15 (Deerfield No.

4 impoundment), 18 (Deerfield No. 3 impoundment) and 21 (Deerfield No. 2 impoundment), which all meet criterion standard D-2.

The 1997 FERC license included downstream passage requirements at Deerfield No. 4, Deerfield No. 3, and Deerfield No. 2. These requirements were complied with and in place through March 2016 when they were suspended by FERC (see Section 1 for document links). After USFWS officially discontinued Atlantic salmon stocking efforts in the Connecticut River basin, the former licensee, TransCanada, filed a license amendment request with the Commission on March 2, 2016 to suspend or remove License Article 408, associated with downstream passage of Atlantic salmon at Deerfield River Project developments Deerfield No. 4, Deerfield No. 3, and Deerfield No. 2. In its filing, TransCanada included correspondence from USFWS and MDFW supporting suspension of the requirement to provide downstream passage for Atlantic salmon smolts at the Deerfield River developments. On March 24, 2016 the Commission issued Order Suspending License Article 408 for the Deerfield River Project.

## 4.5 Watershed and Shoreline Protection

| ***Criterion*** | ***Standard*** | ***Instructions*** |
|---|---|---|
| E | 2 | <u>Agency Recommendation:</u><br>• Provide copies or links to any agency recommendations or management plans that are in effect related to protection, mitigation, or enhancement of shoreline surrounding the facility (e.g., Shoreline Management Plans).<br>• Provide documentation that indicates the facility is in full compliance with any agency recommendations or management plans that are in effect. |

| ***Criterion*** | ***Standard*** | ***Instructions*** |
|---|---|---|
| E | PLUS | <u>Bonus Activities:</u><br>• Provide documentation that the facility has a formal conservation plan protecting a buffer zone of 50% or more of the undeveloped shoreline that the facility owns around its reservoirs and river corridors<br>• In lieu of a formal conservation plan, provide documentation that the facility has established a watershed enhancement fund for ecological land management that will achieve the equivalent land protection value of an ecologically effective buffer zone of 50% or more around undeveloped shoreline. |

The Project meets Standard 2 and Plus for Watershed and Shoreline Protection for all Zones of Effect.

There are no Shoreline Management Plans or similar protection requirements for the Deerfield River Project and no agency recommendations or management plans for shoreline management. In large part this is due to the fact that the vast majority of the shoreline is owned in fee, undeveloped, available for day-use only, has a number of resource specific management plans to address resource far more expansive than a Shoreline Management Plan and lastly the shorelines are also overseen by the perpetual conservation easement holders.

Overall, land use within the predominately rural Deerfield River watershed is classified as 81% forested, 13% agriculture/open land, 4% urban, and 2% water (MA DEP 2000). Approximately half of the Deerfield River watershed is in southern Vermont (318 $mi^2$) and half is in western Massachusetts (347$mi^2$). In the northern and western areas of the watershed the topography is mountainous and the river's profile is steep, making it attractive for hydroelectric power generation. The Vermont Department of Environmental Conservation (VDEC)'s 2020 Deerfield River & Lower Connecticut River Tactical Basin Plan characterizes the Vermont portion of the Deerfield River basin as the second most forested, the least developed, and the least cultivated basin in the State of Vermont. Forested land covers the greatest area at 82%, open water covers 2% (due to the large areas covered by the Harriman and Somerset reservoirs), wetlands 5%, agricultural crop land 4.6%, and developed land 4.7%. Over 27% of the Basin is part of the Green Mountain National Forest which covers most of the western basin, including almost all of the Upper Deerfield, and most of the East and West Branches (see Figure 2). Only 40% of the Vermont portion of the basin lacks some form of conservation protection (VT DEC 2020).

The Massachusetts portion of the watershed contains most of the population and the land use, although still heavily forested, contains more of a mix of agricultural, residential, and industrial uses. The largest and only city in the watershed is Greenfield, MA, at the confluence with the Connecticut River. In 2003 it contained almost half the population of the entire watershed (MA DEP 2004).

Great River Hydro owns approximately 17,707 acres of forest land in Vermont and Massachusetts adjacent to the Deerfield River that has been in professional forest management since 1962. The current Forest Management Plan emphasizes multiple-use of various forest resources, production of higher quality timber for saw logs and other wood products, passive recreation, and wildlife management.

The Settlement Agreement and License Article 427 include protection from development of 17,098 acres of land through permanent conservation easements (Figures 11-13). The Vermont Land Trust holds the easement on lands in Vermont and the Massachusetts Department of Environmental Management holds the easement for the lands in Massachusetts. Collectively, these easements cover primarily undeveloped land, some of which is in agricultural and forestry use. These lands provide wildlife habitat, natural resource protection, and recreational and scenic opportunities. The easements preserve in their natural state the protected properties associated with the Project, while allowing for the continued operation of Project facilities. The protected lands cannot be used for purposes other than agricultural, forestry, educational, non-commercial recreation, open space, and the present and future operation of electric transmission and hydroelectric generation facilities.

In accordance with License Article 429, the Company created the Deerfield River Basin Environmental Enhancement Fund, in the amount of $100,000. The fund's purpose is to finance watershed conservation; development of low impact recreational and educational projects and facilities; and the planning, design, maintenance and monitoring of such facilities and projects. The Vermont Community Foundation is the Fund Trustee, and they administer grants distributed under the fund. To date, over $56,000 has been distributed, and as of June 2020 the fund balance was $120,465.

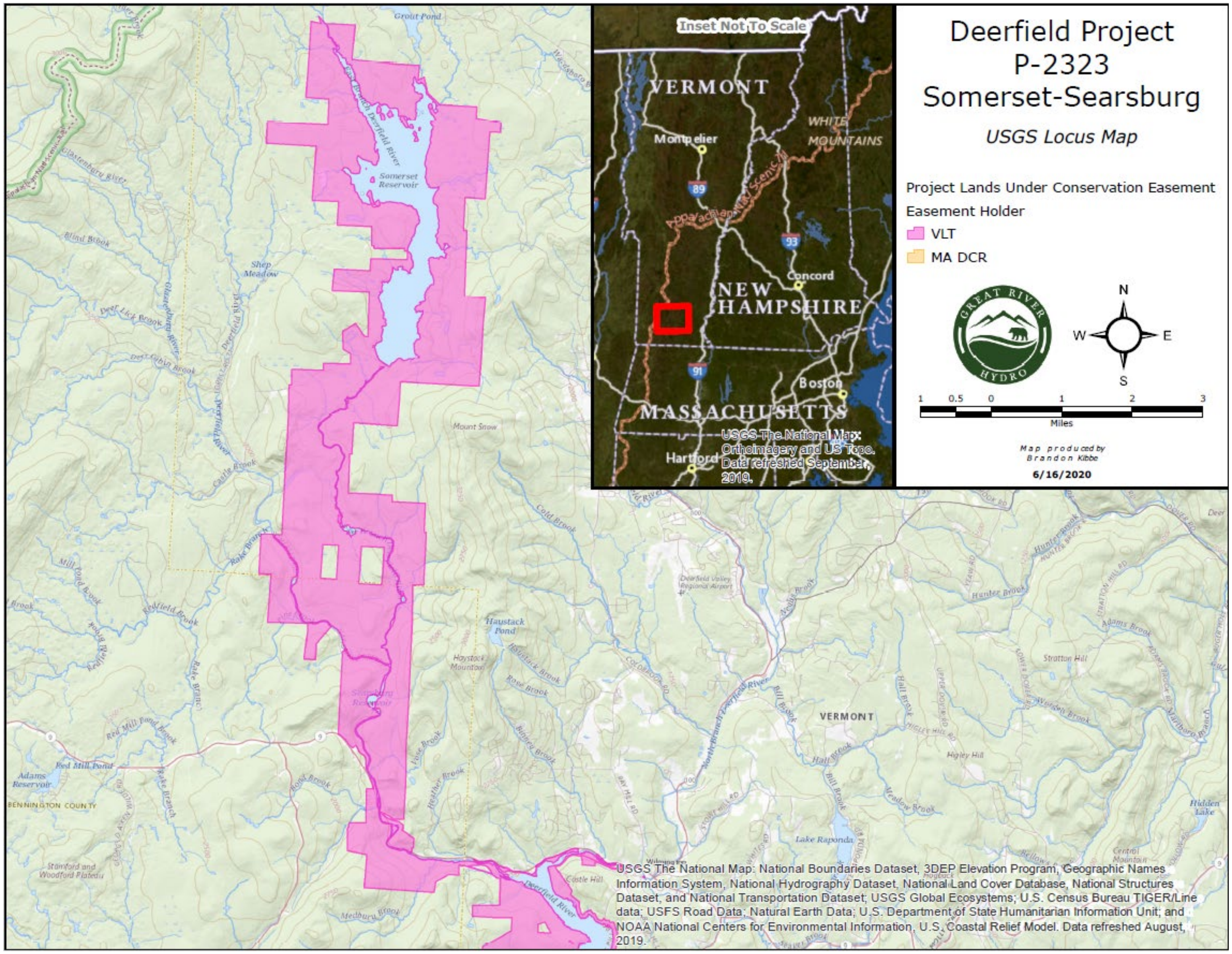


Figure 12. Deerfield River Project (P-2323) lands around the Somerset and Searsburg Developments under Conservation Easement.

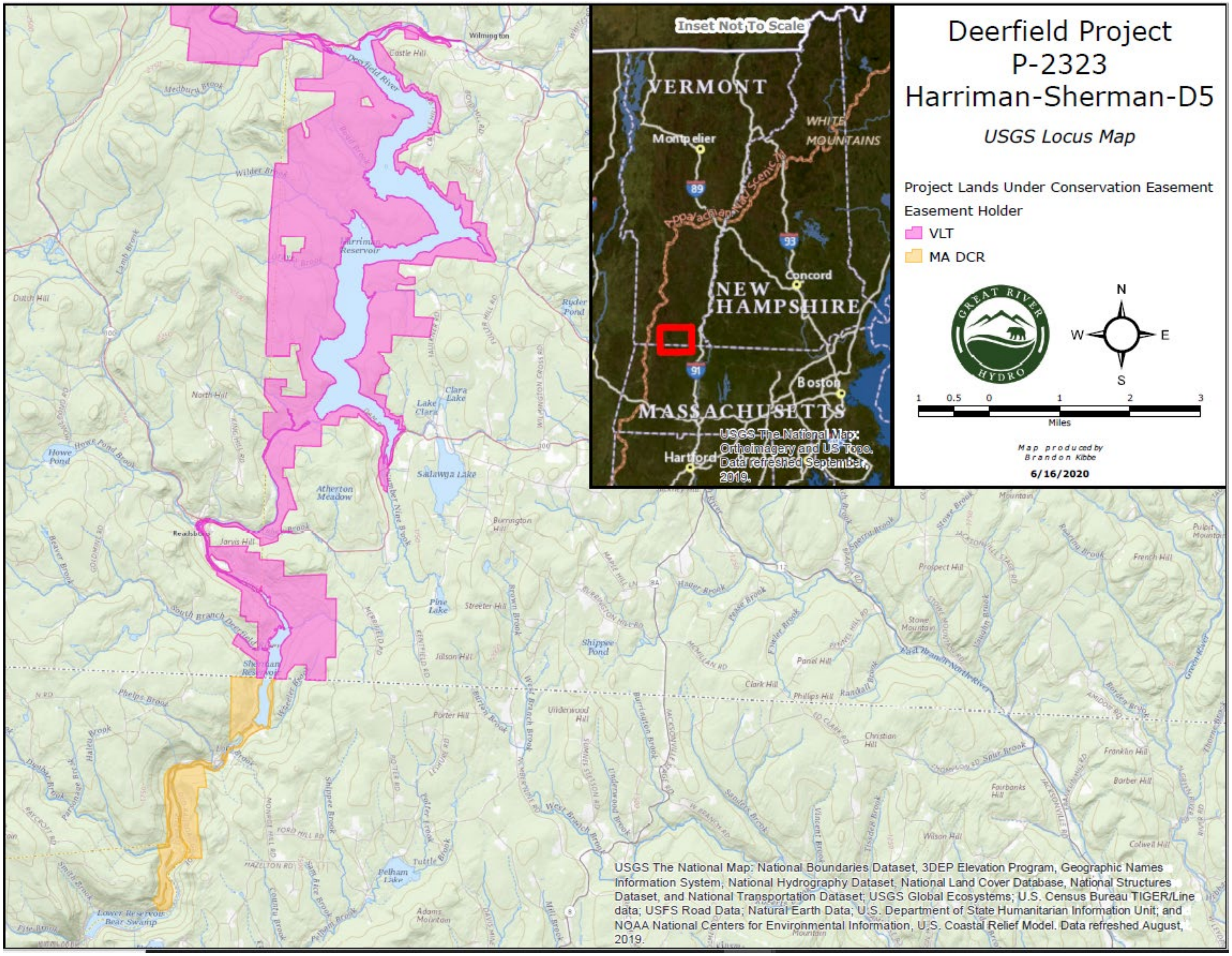


Figure 13. Deerfield River Project (P-2323) lands around the Harriman, Sherman, and Deerfield No. 5 Developments under Conservation Easement.

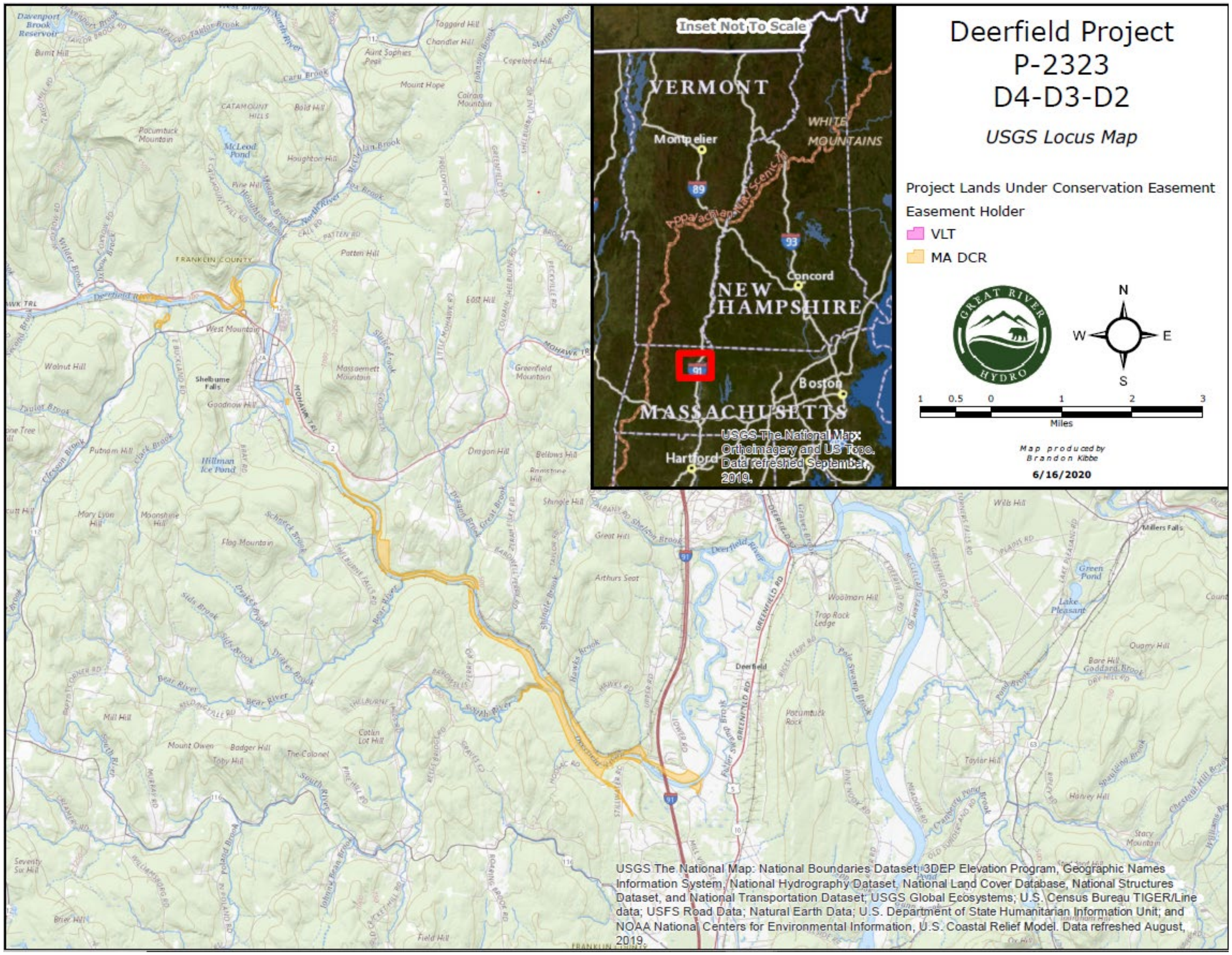


Figure 14. Deerfield River Project (P-2323) lands around the Deerfield No. 4, 3, and 2 Developments under Conservation Easement.

### 4.6 Threatened and Endangered Species Protection

| ***Criterion*** | ***Standard*** | ***Instructions*** |
|---|---|---|
| F | 1 | Not Applicable / De Minimis Effect:<br>• Document that there are no listed species in the facility area or affected riverine zones downstream of the facility.<br>• If listed species are known to have existed in the facility area in the past but are not currently present, explain why the facility was not the cause of the extirpation of such species.<br>• If the facility is making significant efforts to reintroduce an extirpated species, describe the actions that are being taken. |
| F | 4 | Acceptable Mitigation:<br>• If newly listed species are present for which environmental requirements have not been fully determined, describe any significant measures that the facility is implementing to avoid or minimize the impacts on such newly ***listed species.***<br>• Document that the mitigation measures for newly listed species are being implemented to the interim satisfaction of applicable resource agencies. |

The Project meets Standard 1 for Threatened and Endangered Species Protection for the following Zones of Effect:

- ZoE 2 – Somerset Downstream Reach
- ZoE 3 – Searsburg Impoundment
- ZoE 4 – Searsburg Bypass Reach
- ZoE 8 – Harriman Tailrace
- ZoE 10 – Sherman Tailrace and Deerfield No. 5 Impoundment
- ZoE 12 – Deerfield No. 5 Tailrace
- ZoE 13 – Dunbar Brook, above
- ZoE 14 – Dunbar Brook, below
- ZoE 16 – Deerfield No. 4 Bypass Reach
- ZoE 17 – Deerfield No. 4 Tailrace
- ZoE 18 – Deerfield No. 3 Impoundment
- ZoE 19 – Deerfield No. 3 Bypassed Reach
- ZoE 20 – Deerfield No. 3 Tailrace
- ZoE 22 – Deerfield No. 2 Downstream Reach

And Standard 4 for the remaining Zones of Effect:

- ZoE 1 – Somerset Impoundment
- ZoE 5 – Searsburg Downstream Reach
- ZoE 6 – Harriman Impoundment
- ZoE 7 – Harriman Bypassed Reach

- ZoE 9 – Sherman Impoundment
- ZoE 11 – Deerfield No. 5 Bypassed Reach
- ZoE 15 - Deerfield No. 4 Impoundment
- ZoE 21 - Deerfield No. 2 Impoundment

When the Deerfield River Project was licensed in 1997, the common loon (*Gavia immer*) was endangered in Vermont and operating constraints (discussed in Section 4.1) were established at Somerset Reservoir, where mating pairs were known to nest. Though the loon was removed from the endangered list in 2005, the Company continues to manage the reservoir for loon nesting. The loon population in Vermont has grown from a range of 13 to 16 breeding pairs in 1989, to just over 100 currently, and there are estimated to be 300 to 500 adult loons in the state during the summer months (VDFW 2020). On Somerset Reservoir, two to four breeding pairs nest each year and have produced 45 loons since 1978 (personal communication Eric Hanson, Vermont Center for Ecostudies).

Prior to the 1997 relicensing, the tubercled orchid (*Platanthera flava var. herbiola*), a threatened species in Vermont, occupied the Searsburg and Harriman bypassed reaches. Increased minimum flows to the reaches, as required by License Article 405, would negatively impact the plants survival. In accordance with Article 419 of the License, a Tubercled Orchid Mitigation and Monitoring Plan to protect the orchid and its habitat from the effects of increased flows was prepared in consultation with the VANR. The Plan included provisions for: 1) relocating and maintaining populations of the orchid affected by the increased flows; 2) monitoring the success of the relocated plants; 3) a monitoring schedule; 4) mapping the specific transplant and monitoring locations in relation to project features; and 5) conducting follow-up work if the relocated orchid populations fail to survive. All provisions of the Plan were successfully carried out and the Company filed its final report on December 31, 2002. The report provided a summary of monitoring methods and results for the five year effort, which indicated that, as a result of transplanting, monitoring, seeding, and identification of new plants over the five years, the orchid had successfully repopulated within the monitoring site. On March 13, 2003, the VDFW, Nongame and Natural Heritage Program filed a letter thanking and commending the Company and the Company's consultant on its efforts. On May 9, 2003, FERC acknowledged the Company's report and VDFW's letter, and concluded that no further action was required.

The tubercled orchid is one of four state of Vermont threatened or endangered species identified by the Vermont Fish and Wildlife's Natural Heritage Inventory as occurring in the area of one or more Zones of Effect, location maps are provided in Appendix C-7.0 – Privileged (not for public distribution). The other species, little brown bat (*Myotis lucifugus*), tricolored bat (*Perimyotis subflavus*), and bald eagle (*Haliaeetus leucocephalus*) are endangered, though the bald eagle has been recommended for down-listing to threatened. One bald eagle nest has been identified in the Project area. GRH works with Vermont Fish and Wildlife via the Audubon Society to monitor the site.

The VANR listed the little brown and tricolored bat as endangered due to high mortality caused by white-nose syndrome, a fatal fungus that infects the skin of bats and spreads between individuals in hibernating bat colonies. Both little brown and tricolored bats are categorized as cave bats, hibernating in caves and mines during winter. Management in Vermont is focused on studying the population in relation to white-nose syndrome. The status of the species is not impacted by operation of the Project.

Atlantic salmon is a federally endangered species that was extirpated from the Connecticut River and reintroduced through stocking in the 1960's. As discussed above in sections 4.3 and 4.4, resource agency efforts to restore the population were unsuccessful and the program was discontinued in 2013. In 2016, with resource agency concurrence, FERC suspended Atlantic salmon passage efforts associated with the Deerfield River Project.

The shortnose sturgeon is a federally and state (Massachusetts) listed endangered species found in the Connecticut River. The population is thought to be divided between two areas: one landlocked between Turners Falls and Holyoke Dam, and the other below Holyoke Dam to Long Island Sound. The former population has access to the Deerfield River. Tagging studies conducted in the early to mid-1990's indicate that shortnose sturgeon occasionally use the lower portions of the Deerfield River as a resting area--as a refuge or place to escape from the high flows occurring during April and May in the Connecticut River--as they travel up the Connecticut River toward their spawning sites located about 3 miles upstream from the mouth of the Deerfield River (FERC 1996). Sturgeon that entered the Deerfield River generally spent less than a week before returning to the Connecticut River and did not move upstream as far as the Deerfield No. 2 station.

Three threatened and no endangered species protected under Massachusetts Endangered Species Act (MESA) are associated with one or more of GRH's facilities, all of the threated species are vascular plants: American bittersweet (*Celastrus scandens*), muskflower (*Mimulus moschatus*), and sandbar cherry (*Prunus pumila var. depressa*). In accordance with Massachusetts rare species and habitat regulatory requirements, the Company consults with MassWildife's Natural Heritage Endangered Species Program (NHESP) annually to update our NHESP Operations and Management Compliance Plan. Approval of such a plan by NHESP exempts an organization's listed operations and maintenance activities from additional regulatory review. To attain approval, the operation and maintenance activities must comply with the Massachusetts Endangered Species Act for state-listed rare species and habitats, as regulated by the NHESP. The NHESP provides GRH with GIS shapefiles for listed species in the facility areas and best management practices (BMP). In the Compliance Plan, GRH outlines its operations and maintenance activities within the Deerfield River project area and incorporates the BMP for implementation within the habitat areas defined by the shapefiles. Location maps for the three threatened species are provided in Appendix C-7.0 (not for public distribution) and the following documents associated with the NHESP 2019-2020 consultation cycle are provided in Appendix B-6.4:

- GRH letter dated January 15, 2020 summarizing O&M and exempt activities conducted under GRH's 2019 Compliance Plan
- GRH's 2020 Compliance Plan
- NHESP letter dated February 24, 2020 approving GRH's 2020 Compliance Plan

No non-compliances have been issued by the regulating agency, NHESP, since the Project was last certified by LIHI in 2012.

## 4.7 Cultural and Historic Resources Protection

| *Criterion* | *Standard* | *Instructions* |
|---|---|---|
| G | 2 | Approved Plan:<br>• Provide documentation of all approved state, federal, and recognized tribal plans for the protection, enhancement, and mitigation of impacts to cultural and historic resources affected by the facility.<br>• Document that the facility is in compliance with all such plans. |

The Project meets Standard 2 for Cultural and Historic Resources Protection for all Zones of Effect.

The Project is in compliance with Article 428 of the License, which provides for cultural resources protection, via implementation of a Programmatic Agreement (PA) executed in 1996 between FERC, the Advisory Council on Historic Preservation, the Vermont State Historic Preservation Officer (VT SHPO) and the Massachusetts State Historic Preservation Officer (MA SHPO). The PA specified that a Cultural Resources Management Plan (CRMP) be developed by the Company. The CRMP was completed and approved in 1999. The PA was is included as Appendix B to the CRMP.

The hydroelectric facilities are considered eligible for listing in the National Register of Historic Places (Register). Forty standing structures were identified as eligible for the Register. During the archeological surveys, twenty-five documented and two undocumented historic sites were identified at six Project developments, consisting of nineteenth and twentieth century residences, mill/factory complexes, mining complexes, schoolhouses, bridge abutments, and one family cemetery. An historical summary of the Project prepared for the Company by the Public Archeology Laboratory Inc. is provided in Appendix B-6.5.

The CRMP included mitigation measures for the historic properties, including an evaluation of any site that will be impacted by an activity. All of the archeological sites were monitored to establish a baseline. A Historic American Building Survey/Historic American Engineering Record of the historic buildings and structures was also conducted. This baseline information is updated at 10-year intervals, through visual inspections by a qualified professional architectural historian; the last 10-year report was filed in December 2011.

The CRMP also integrates cultural resource management into the Company's master planning process for the Project. Cultural resources are evaluated during planning for any alterations to Project facilities, and consultation with the appropriate SHPO is initiated if activities could impact those resources. Annual reports filed with FERC and the two SHPOs summaries these evaluations and document consultation. The 2020 annual report is found here. Appendix B-6.6 provides a tabulated summary of consultation for projects within Project Zones of Effect for which MA or VT SHPO was consulted in accordance with the CRMP.

## 4.8 Recreational Resources

| *Criterion* | *Standard* | *Instructions* |
|---|---|---|
| H | 2 | Agency Recommendation:<br>• Document any comprehensive resource agency recommendations and enforceable recreation plan that is in place for recreational access or accommodations.<br>• Document that the facility is in compliance with all such recommendations and plans. |

The Project meets Standard 2 for Recreational Resources for all Zones of Effect.

The Project is in compliance with agency requirements for recreational access, accommodation (including recreational flow releases) and facilities. In accordance with Article 423 and in consultation with resource agencies, citizen's groups, and recreationalists, upgrades to existing and construction of new recreational areas for picnicking, boating, and hiking are in place and maintained as described in the Final Completion Status Report for Deerfield River Project Comprehensive Recreation Management Plan. Safety devices such as signage, warning lights, sirens, and recorded messages are in place to ensure that recreational users, particularly fishermen, are properly warned of sudden changes in discharge flows. The location of each safety device is specified in the Company's Public Safety Plan filed with FERC and updated when changes are made or at least every 10-years.

Scheduled releases from the Deerfield No. 5 Dam are provided for whitewater boating. Releases occur for at least four continuous hours on Fridays starting at 11:00 a.m., at least five continuous hours on Saturdays starting at 10:00 a.m., and at least four continuous hours on Sundays starting at 10:00 a.m. The flow levels for the whitewater release periods are distributed equally over the schedule in order to average 1,000 cfs. The schedule provides for 26 weekend days or holidays and six Fridays from May 1 to October 31 annually:

| Month | Allocation |
|---|---|
| May | 2 weekend days |
| June | 5 weekend days and 2 Fridays |
| July | 6 weekend days and 2 Fridays |

| | |
|---|---|
| August | 7 weekend days and 2 Fridays |
| September | 4 weekend days |
| October | 2 weekend days releases |
| Holidays | May be substituted for weekend days upon agreement between the Company and the citizens groups before April 1 of each year. |

The Company meets annually with representative citizens groups, including New England FLOW, before January 1 of each year, in order to collaboratively develop the whitewater release schedules for the coming summer. An annual schedule is published by April 1 of each year following further consultation with these citizens groups. In cases where emergencies, power generation needs, equipment failure or other factors preclude scheduled releases, the Company consults with stakeholders to provide alternative scheduling of equivalent releases.

The Company also provides a 24-hour telephone and website (http://h2oline.com) that lists current and forecasted flows at all Project developments to give recreational users an opportunity to time their visits with river flows conducive to their particular recreation purposes (e.g., fishing, whitewater boating).

In addition, the Company maintains minimum reservoir levels for open water recreation (e.g., boating) at Somerset and Harriman reservoirs. These reservoir restrictions have been incorporated into the Project's water management and operations protocols.

FERC conducted an environmental and public use inspection of the Deerfield Project on August 2 and 3, 2018. As stated in FERC's October 1, 2018 letter "the project was found to be in compliance with the license articles related to fish and wildlife, recreation, public safety, and cultural resources. No follow-up items or non-compliance matters were identified during the inspection of the project."

## 4.9 Literature Cited

Federal Energy Regulatory Commission (FERC), Office of Hydropower Licensing. August 1996. Final Environmental Impact Statement, Deerfield River Projects, Vermont and Massachusetts (FERC Project Nos 2323-012, 2669-02, and 2334-01). Federal Energy Regulatory Commission, 888 First Street, NE. Washington, DC, 20426.

Vermont Agency of Natural Resources (VANR), Water Investment Division. May 2020. Deerfield River and Lower Connecticut River Tactical Basin Plan. Available at: https://dec.vermont.gov/sites/dec/files/WID/WPP/Deerfield%20River%20Tactical%20Basin%20Plan%20-%202020.pdf

Vermont Division of Fish and Wildlife (VDFW). Common Loon. Available at: *https://vtfishandwildlife.com/learn-more/vermont-critters/birds/common-loon* Accessed June 2020.

# 5.0 APPENDIX A - CONTACTS

## 5.1 Facility Contacts

| | |
|---|---|
| **Project Owner:** | |
| Name and Title | Scott Hall |
| Company | Great River Hydro, LLC |
| Phone | 603-268-2802 |
| Email Address | shall@greatriverhydro.com |
| Mailing Address | 112 Turnpike Road, Suite 202, Westborough, MA 01581 |
| **Project Operator (if different from Owner):** | |
| Name and Title | |
| Company | |
| Phone | |
| Email Address | |
| Mailing Address | |
| **Consulting Firm / Agent for LIHI Program (if different from above):** | |
| Name and Title | |
| Company | |
| Phone | |
| Email Address | |
| Mailing Address | |
| **Compliance Contact (responsible for LIHI Program requirements):** | |
| Name and Title | John Ragonese, FERC License Manager |
| Company | Great River Hydro, LLC |
| Phone | 603-498-2851 |
| Email Address | jragonese@greatriverhydro.com |
| Mailing Address | 40 Pleasant St. Suite 202, Portsmouth, NH 03801 |
| **Party responsible for accounts payable:** | |
| Name and Title | Marie LeBlanc |
| Company | Great River Hydro, LLC |
| Phone | 413-773-6700 |
| Email Address | mleblanc@greatriverhydro.com |
| Mailing Address | 112 Turnpike Road, Suite 202, Westborough, MA 01581 |

## 5.2 Agency Contacts

| **Agency Contact** (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources X_, Watersheds __, T/E Spp. __, Cultural/Historic Resources __, Recreation __): | |
|---|---|
| Agency Name | Vermont Fish and Wildlife Department |
| Name and Title | Lael Will, Fisheries Biologist |
| Phone | 802-885-8890 (office), 802-777-0827 (cell) |
| Email address | Lael.will@vernont.gov |
| Mailing Address | 100 Mineral Street, Suite 302, Springfield, VT 05156-3168 |

| **Agency Contact** (Check area of responsibility: Flows_X_, Water Quality _X_, Fish/Wildlife Resources __, Watersheds _X_, T/E Spp. _X_, Cultural/Historic Resources __, Recreation _X_): | |
|---|---|
| Agency Name | Vermont Department of Environmental Conservation |
| Name and Title | Jeff Crocker, Supervising River Ecologist |
| Phone | 802-490-6151 |
| Email address | Jeff.crocker@vermont.gov |
| Mailing Address | 1 National Life Drive, Main 2, Montpelier, VT 05620-3522 |

| **Agency Contact** (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources __, Watersheds __, T/E Spp. __, Cultural/Historic Resources _X_, Recreation __): | |
|---|---|
| Agency Name | Vermont Division for Historic Preservation |
| Name and Title | Elizabeth Peebles, Historic Resources Specialist |
| Phone | 802-828-3049 |
| Email address | Elizabeth.peebles@vermont.gov |
| Mailing Address | 1 National Life Drive, Davis Bldg, 6th Floor, Montpelier, VT 05620-0501 |

| **Agency Contact** (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources __, Watersheds ___, T/E Spp. X__, Cultural/Historic Resources ___, Recreation __): | |
|---|---|
| Agency Name | Vermont Department of Fish and Wildlife |
| Name and Title | Bob Popp, Department Botanist |
| Phone | 802-476-0127 |
| Email address | Bob.popp@vermont.gov |
| Mailing Address | 5 Perry St. Suite 40, Barr, VT 05641 |

| **Agency Contact** (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources X_, Watersheds __, T/E Spp. _X_, Cultural/Historic Resources __, Recreation __): | |
|---|---|
| Agency Name | US Fish and Wildlife Service |
| Name and Title | Melissa Grader, Fish and Wildlife Biologist |
| Phone | 413-548-8002 x8124 |
| Email address | melissa_grader@fws.gov |
| Mailing Address | 103 East Plumtree Road, Sunderland, MA 01375 |

| **Agency Contact** (Check area of responsibility: Flows__, Water Quality __, Fish/Wildlife Resources _X_, Watersheds __, T/E Spp. __, Cultural/Historic Resources __, Recreation __): | |
|---|---|
| Agency Name | Massachusetts Division of Fisheries and Wildlife |
| Name and Title | Caleb Slater, Anadromous Fish Project Leader |
| Phone | 508-389-6331 |
| Email address | caleb.slater@state.ma.us |
| Mailing Address | 1 Rabbit Hill Road, Westborough, MA 01581 |

| **Agency Contact** (Check area of responsibility: Flows _X_, Water Quality _X_, Fish/Wildlife Resources ___, Watersheds _X_, T/E Spp. __, Cultural/Historic Resources __, Recreation __): | |
|---|---|
| Agency Name | Massachusetts Department of Environmental Protection |
| Name and Title | Robert Kubit, Division of Watershed Management |
| Phone | 508-767-2854 |
| Email address | Robert.kubit@state.ma.us |
| Mailing Address | 8 New Bond Street, Worcester, MA 01606 |

| **Agency Contact** (Check area of responsibility: Flows __, Water Quality __, Fish/Wildlife Resources ___, Watersheds ___, T/E Spp. __, Cultural/Historic Resources _X_, Recreation __): | |
|---|---|
| Agency Name | Massachusetts Historical Commission |
| Name and Title | Brona Simon, SHPO and Executive Director |
| Phone | 617-727-8470 |
| Email address | mhc@sec.state.ma.us |
| Mailing Address | 220 Morrissey Boulevard, Boston, MA 02125 |

| **Agency Contact** (Check area of responsibility: Flows _X_, Water Quality _X_, Fish/Wildlife Resources ___, Watersheds _X_, T/E Spp. __, Cultural/Historic Resources __, Recreation __): | |
|---|---|
| Agency Name | Massachusetts Department of Environmental Protection |
| Name and Title | Robert Kubit, Division of Watershed Management |
| Phone | 508-767-2854 |
| Email address | Robert.kubit@state.ma.us |
| Mailing Address | 8 New Bond Street, Worcester, MA 01606 |

| **Agency Contact** (Check area of responsibility: Flows ___, Water Quality ___, Fish/Wildlife Resources ___, Watersheds ___, T/E Spp. X_, Cultural/Historic Resources __, Recreation __): | |
|---|---|
| Agency Name | Massachusetts Division of Fisheries & Wildlife, Natural Heritage & Endangered Species Program |
| Name and Title | Melany Cheeseman, Endangered Species Review Assistant |
| Phone | 508-389-6357 |
| Email address | Melany.cheeseman@mass.gov |
| Mailing Address | 1 Rabbit Hill road, Westborough, MA 01581 |

## 5.3 Non-governmental Stakeholders

| Non-Governmental Stakeholder | |
|---|---|
| Organization | American Whitewater |
| Name and Title | Bob Nasdor, Northeast Stewardship Director |
| Phone | 617-584-4566 |
| Email address | bob@americanwhitewater.org |
| Mailing Address | 365 Boston Post Road, Suite 250, Sudbury, MA 01776 |

| Non-Governmental Stakeholder | |
|---|---|
| Organization | Appalachian Mountain Club |
| Name and Title | Norman Sims |
| Phone | |
| Email address | normansims1@gmail.com |
| Mailing Address | 77 Back Ashuelot Rd, Winchester, NH 03470-2710 |

| Non-Governmental Stakeholder | |
|---|---|
| Organization | Zoar Outdoor |
| Name and Title | Kevin McMillan |
| Phone | 413-339-4010 |
| Email address | kevin@zoaroutdoor.com |
| Mailing Address | PO Box 245, Charlemont, MA, 01339 |

| Non-Governmental Stakeholder | |
|---|---|
| Organization | Trout Unlimited |
| Name and Title | David Deen |
| Phone | 802-869-3116 |
| Email address | strictlytrout@vermontel.net |
| Mailing Address | 5607 Westminster West Road, Westminster, VT 05346 |

# 6.0 APPENDIX B - SUPPORTING DOCUMENTATION

## 6.1 Photographs

Somerset Dam and Impoundment

Searsburg Dam and Impoundment

Searsburg Station

Harriman Dam and Impoundment

Harriman Station and Tailrace

Dunbar Impoundment

Dunbar Dam and Tailrace

Deerfield No. 5 Dam and Impoundment

Deerfield No. 4 Dam and Impoundment

Deerfield No. 4 Station and Tailrace

Deerfield No. 3 Dam and Impoundment

Deerfield No. 3 Station

Deerfield No. 2 Impoundment

Deerfield No. 2 Dam and Tailrace

## 6.2 VANR email regarding Deerfield River Project 401 Water Quality Certificate

**From:** Crocker, Jeff
**To:** Jennifer Griffin
**Subject:** RE: Deerfield River WQC
**Date:** Thursday, October 8, 2020 2:22:45 PM

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**[EXTERNAL EMAIL]** DO NOT CLICK links or attachments unless you recognize the sender and know the content is safe.

Jen,

As requested below, the Vermont Agency o Natural Resources issued a Section 401 water quality certification for the Deerfield Hydroelectric Project on January 30, 1995. The water quality certification remains valid for the Project.

Jeff

*Due to the coronavirus (COVID-19) we are taking additional safety measures to protect our employees and customers and are now working remotely while focusing on keeping our normal business processes fully functional. Please communicate with our staff electronically or via phone to the greatest extent possible since our processing of postal mail may be slowed during this period.*

*Division staff contact information can be found online here: https://dec.vermont.gov/watershed/contacts.*

*Thank you for your patience during this challenging time. We wish you and your family the best.*

**Jeff Crocker,** *Supervising River Ecologist*

1 National Life Drive, Davis 3
Montpelier, VT 05620-3522
802-490-6151 / Jeff.Crocker@vermont.gov
www.watershedmanagement.vt.gov

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION
RIVERS PROGRAM

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**From:** Jennifer Griffin <jgriffin@greatriverhydro.com>
**Sent:** Wednesday, October 7, 2020 1:46 PM
**To:** Crocker, Jeff <Jeff.Crocker@vermont.gov>
**Subject:** Deerfield River WQC

**EXTERNAL SENDER: Do not open attachments or click on links unless you recognize and trust the sender.**

Hi Jeff,

Could you provide a statement from VANR that the Deerfield River Project 401 Water Quality Certificate is in place and remains valid? LIHI is requesting such for our recertification application. Either letter format or email are acceptable.

Thanks so much,
Jen

***Jennifer Griffin***
Great River Hydro, LLC
*P: 603-445-6806*
*M: 603-966-0477*
jgriffin@greatriverhydro.com

### 6.3 List of Flow Deviations

| Event Date | Project - Event | GRH Filing | FERC response letter | FERC decision | Notes |
|---|---|---|---|---|---|
| 6/12/2013 | Somerset - elevation deviation | 6/21/2020 | 11/25/2013 | No violation | A storm event produced heavy inflows that surpassed the discharge capacity of the dam. Inflows eventually exceeded gate capacity and the reservoir surcharged slightly above the allowable loon nesting elevation limit before inflows receded. |
| 6/12/2013<br>6/14-15/2013 | Harriman - elevation deviation | 6/21/2013 | 11/25/2013 | No violation | High flow during the stable or rising constraint period resulted in inflow exceeding station capacity which resulted in spill at the “Glory Hole” spillway. During active spill over the crest (there are not operating gates at the spillway), as inflows drops so does the reservoir elevation. |
| 7/2/2013<br>7/8/2013 | Harriman - pre-planned min flow reduction | 7/11/2013 | 11/25/2013 | No violation | Pre-planned minimum flow reductions for less than 2 hours each day, to facilitate dam safety inspections of the spillway tunnel at Harriman Dam. |
| 8/29/2013<br>8/30/2013 | Harriman - pre-planned min flow reduction | 9/9/2013<br>10/15/2013 | No letter issued | No letter issued | Pre-planned minimum flow reductions for less than 2 hours each day, to facilitate dam safety inspections of the spillway tunnel at Harriman Dam. |
| 4/20/2014 | Searsburg - minimum flow reduction | 4/30/2014 | 7/1/2014 | No violation | The single station generator tripped off-line due to a plugged cooling water strainer and minimum flow was interrupted before flow from the dam reached the station tailrace. |
| 8/19/2014 | Deerfield No. 4 - minimum flow reduction | 8/28/2014 | 1/26/2015 | No violation | Flow was reduced to facilitate re-installation of 4-foot high flashboards. |

| Event Date | Project - Event | GRH Filing | FERC response letter | FERC decision | Notes |
|---|---|---|---|---|---|
| 10/3/2014 | Deerfield No. 2 - minimum flow reduction | 10/14/2014 | 1/26/2015 | No violation | Unit 1 went off-line and minimum flow was interrupted due to equipment malfunction. |
| 5/25-6/1/2015 | Harriman - elevation deviation | 6/4/2015 | No letter issued | No letter issued | Natural inflow was insufficient to maintain conflicting license constraints of ‘stable or rising’ and guaranteed minimum flows from storage through the basin. Elevation deficit was less than 0.22 ft. |
| 6/16/2015 | Deerfield No. 4 and No. 3 - minimum flow reduction | 6/24/2015 | 9/21/2015 | Violation - no enforcement action taken | The seasonal fish passage flow requirement ended at midnight on 6/15. The gates providing both fish and minimum flows were shut. When the minimum flow alarm signaled, it was misinterpreted as a fish passage flow alarm.<br>The following mitigation measures were implemented to prevent a similar deviation from happening in the future: (a) changes made to the SCADA alarm controls to add a second alarm distinct from all other alarms, specific to each minimum flow requirement. The minimum flow alarms cannot be cleared until flow rates are adequately provided; (b) instituted new Site Specific Instructions for scheduling and terminating license required operations such as downstream passage termination; and (c) reviewed this incident with all control center operators for quality management and best practices improvements. |
| 8/4/2015 | Deerfield No. 2 - minimum flow reduction | 8/4/2015 | 9/21/2015 | No violation | The station tripped off-line due to a transmission line fault and minimum flow was interrupted. |

| Event Date | Project - Event | GRH Filing | FERC response letter | FERC decision | Notes |
|---|---|---|---|---|---|
| 9/6/2016 | Deerfield No. 2 - minimum flow reduction | 6/20/2016 | 9/1/2016 | No violation | The station tripped off-line due to a transmission line fault. Line is owned and operated by National Grid. |
| 8/13/2016 | Deerfield No. 2 - minimum flow reduction | 8/19/2016 | 11/16/2016 | No violation | The station tripped off-line due to a transmission line fault. Line is owned and operated by National Grid. |
| 12/18/2016 | Somerset - down ramping rate exceeded | 12/18/2016 | 2/2/2017 | No violation | A 2.5-hour, pre-mature timing of the reduction was operator oversight in an attempted to manage downstream flow and reduce spill at Searsburg Dam as river flow increased rapidly due to heavy rain occurring earlier than forecasted. |
| 4/30/2017 | Searsburg - minimum flow reduction | 5/10/2017 | 6/29/2017 | No violation | An operating emergency beyond our control - a rapid build-up of debris on the trash racks caused a decrease in generation, and therefore minimum flow. The unit automatically backed down to 1 MW, a programmed safety measure to ensure the stability of the trash racks. Flow was maintained at 75% of required flow and was promptly restored to 100%. |
| 6/6-8/2017 | Somerset - reservoir elevation fluctuation deviation | 5/16/2017 | 9/20/2017 | No violation | Multiday rain event caused inflow to exceed gate capacity and our ability to limit elevation within the fluctuation restriction. Operators made every attempt to maintain the elevation within the allowable range (matching discharge to inflow), until inflow exceeded gate capacity. |
| 8/3/2017 | Deerfield No. 2 - minimum flow reduction | 8/10/2017 | 10/19/2017 | No violation | Lightning caused a transmission line fault that tripped the power station. |

| Event Date | Project - Event | GRH Filing | FERC response letter | FERC decision | Notes |
|---|---|---|---|---|---|
| 9/9/2017 | Deerfield No. 2 - minimum flow reduction | 9/19/2017 | 10/9/2017 | No violation | Lightning caused a transmission line fault that tripped the power station. |
| 5/9/2018 | Searsburg - minimum flow reduction | 5/21/2018 | 7/12/2018 | No violation | An operating emergency beyond our control when a rapid build-up of debris on the trash racks caused a decrease in generation, and therefore minimum flow. The unit automatically backed down to 1 MW, a programmed safety measure to ensure the stability of the trashracks. Flow was maintained at 75% of required flow and was promptly restored to 100%. |
| 6/9-15/2018 | Harriman - elevation deviation | 6/25/2018 | 7/26/2018 | No violation | Sustained natural dry conditions resulting in low inflow to the reservoir. The only outflow was to maintain required minimum flow from storage. |
| 6/4/2019 | Harriman - reservoir elevation, stable or rising deficiency | 6/14/2019 | 8/1/2019 | No violation | Caused primarily by inaccurate estimation of instantaneous inflow from the 180-mile drainage basin. Operators managed elevation and flow constraints upstream with ISO-NE flow schedules while natural inflow dropped rapidly overnight. |
| 6/9/2019 | Harriman - reservoir elevation, stable or rising deficiency | 6/14/2019 | 8/1/2019 | No violation | Caused by a combination of factors including inaccurate estimation of instantaneous inflow from the 180-mile drainage basin, uncalculated flashboard leakage, and lack of anticipated elevation correction after brief operation. |

| Event Date | Project - Event | GRH Filing | FERC response letter | FERC decision | Notes |
|---|---|---|---|---|---|
| 6/8-15/2020 | Harriman - reservoir elevation, stable or rising deficiency | 6/26/2020 | 9/14/2020 | No violation | With state agency concurrence, and due to emergency low water conditions in the Deerfield River, downstream minimum flows were maintained by allowing Harriman reservoir elevation to drop slightly. |
| 7/28/2020 | Deerfield No. 2 - minimum flow reduction | 8/11/2020 | 10/2/2020 | No violation | The station tripped off-line due to a transmission line fault and minimum flow was interrupted. |

### 6.4 Massachusetts Natural Heritage Endangered Species Program, Operation and Maintenance Compliance

- GRH letter dated January 15, 2020 summarizing O&M and exempt activities conducted under GRH’s 2019 Compliance Plan
- NHESP letter dated February 24, 2020 approving GRH’s 2020 Compliance Plan
- GRH’s 2020 Compliance Plan

Kari Sparks
Environmental Specialist
Great River Hydro, LLC.
152 Governor Hunt Rd, PO Box 155
Vernon, VT 05354
office 802-254-3040
e-mail ksparks@greatriverhydro.com

Wednesday, January 15, 2020

Endangered Species Review Biologist
Natural Heritage and Endangered Species Program
Massachusetts Division of Fisheries & Wildlife
1 Rabbit Hill Road
Westborough, MA 01581

RE: Great River Hydro, LLC, Operations and Maintenance Activities – 2019
2020 Plan Submittal NHESP tracking #19-39085

To Whom It May Concern:

In accordance with the provisions of the Massachusetts Endangered Species Act Regulations (321 CMR 10.00) and exemptions included therein (321 CMR 10.14), Great River Hydro is providing a summary of O&M and exempt activities conducted in 2019. This work was conducted in accordance with Great River Hydro's approved 2019 Compliance Plan and guidelines.

If you have any questions or require additional information, please contact me at (802) 254-3040.

Best,

Kari Sparks

Kari Sparks
Environmental Specialist
Great River Hydro, LLC.
office: 802-254-3040
cell: 802-299-5943
ksparks@greatriverhydro.com

## Great River Hydro O&M Activities Completed by Area (2019)

| Proposed Activity | Sherman Dam, Intake, Powerhouse | No.5 Conduit/ Canal | No.5 Dam and Station | No.4 Dam, Forebay, and Station | No.3 Dam, Forebay, and Station | No.2 Dam and Station | Recreation Sites | Charlemont Islands |
|---|---|---|---|---|---|---|---|---|
| Rack Raking | X | X | X | X | X | X | | |
| Minor concrete work on Dams | X | X | X | | X | X | | |
| Minor concrete work on buildings | X | | X | X | X | X | | |
| Mowing | X | X | X | X | X | X | X | |
| Herbicide Use | X | X | X | X | X | X | X | X |
| Rd Repair / Grading (access roads, parking areas) | X | X | X | X | X | X | X | |
| Ditch and Culvert Maintenance | X | X | X | X | X | X | X | |
| Rip Rap Repair | X | X | X | | X | X | | |
| Fence Repair | X | | X | X | X | X | X | |
| Piezometer Pit Maintenance | X | X | X | | | | | |
| Minor Construction / Laydown | X | X | X | X | X | X | X | |
| Dredging dam areas | X | | X | | X | | | |
| Oil Transfers and Filtering of Transformers | X | | X | | X | | | |
| Install and remove bubblers | X | | X | X | X | X | | |
| Install and remove flashboards | X | | | X | X | X | | |
| Install and maintain safety booms | X | | X | X | X | X | | |
| Install / Maintain / remove debris booms | | | | X | | | | |

| Proposed Activity | Sherman Dam, Intake, Powerhouse | No.5 Conduit/ Canal | No.5 Dam and Station | No.4 Dam, Forebay, and Station | No.3 Dam, Forebay, and Station | No.2 Dam and Station | Recreation Sites | Charlemont Islands |
|---|---|---|---|---|---|---|---|---|
| Temporary Bulkheads for Spillgate Maintenance | X | | X | X | X | X | | |
| Painting building and dam structures | X | | X | X | X | X | X | |
| Pump septic tank | | | X | | | | | |
| Small construction projects | X | X | X | X | X | X | X | |
| Repair conduit leaks | | X | | | X | | | |
| Transporting sediment / debris off site | X | X | X | X | X | X | X | |
| Disposal of Solid Waste / rock and concrete | X | X | X | X | X | X | X | |
| Onsite Disposal of Solid Waste | X | | X | | X | | | |
| Snow plowing and sanding | X | | X | X | X | X | X | |
| Diving for rack maintenance | X | | X | | X | | | |
| Rack Replacement | X | | X | | X | | | |
| Vegetation Control Program | X | X | X | X | X | X | X | X |

DIVISION OF
**FISHERIES & WILDLIFE**

1 Rabbit Hill Road, Westborough, MA 01581
p: (508) 389-6300 | f: (508) 389-7890
**MASS.GOV/MASSWILDLIFE**

February 24, 2020

Kari Sparks
Great River Hydro, LLC.
152 Governor Hunt Road
Vernon, VT 05354

| | | |
|---|---|---|
| RE: | Applicant: | Great River Hydro, LLC. |
| | Project Description: | Guidelines for Operation and Maintenance Plan 2020 |
| | NHESP File No.: | 19-39085 |

Dear Kari:

Routine operation and maintenance activities are exempt from review pursuant to the Massachusetts Endangered Species Act Regulations (MESA) (321 CMR 10.00), which are administered by the Natural Heritage and Endangered Species Program of the Division of Fisheries and Wildlife (Division). The exemption is conditional based on the Division's annual review and approval of an Operation and Maintenance Plan (OMP) (321 CMR 10.14 (11)). We have evaluated your "2020 Compliance Plan for Great River Hydro, LLC Operation and Maintenance Activities" and its associated shapefiles. Below, we provide best management practices to avoid and minimize harm to state-listed species (e.g. rare plants) and their habitats associated with OMP activities scheduled to occur within Priority Habitat. These areas are identified and labeled in a shapefile that the Division is providing as an attachment herein. The best management practices listed below shall be incorporated into the OMP and followed by crews in the field unless otherwise approved by the Division in advance. Provided that the best management practices contained herein, and in the 2020 OMP shapefile are adhered to, the OMP for 2020 shall meet the requirement for exemption from review under 321 CMR 10.18 through 10.23 and is hereby approved.

## General Best Management Practices

The following general best management practices (BMPs) shall be incorporated into the OMP and implemented within all mapped Priority Habitat of state-listed species, as indicated in the enclosed shapefile:

1. **Resource Areas:** No cutting, filling, or stockpiling of materials shall occur within wetland Resource Areas or Certified Vernal Pools, even if the wetlands are seasonally dry. If these activities are deemed necessary and no practicable alternative exists, then the Division shall be contacted to discuss special provisions that may be required to protect state-listed species and their habitats. Please note that in general, the use of swamp mats in wetlands is approved unless otherwise indicated by the Division.

2. **Native shrubs:** Areas dominated by low-growing native shrub species (e.g., lowbush blueberry, huckleberry, sheep laurel, New Jersey tea, sweet-fern, scrub oak) shall be encouraged rather

than eliminated. If excavation within these areas is necessary, the areas should be restored to similar native shrub habitat once work is completed.

3. **Water quality:** Water quality within wetlands in Priority Habitat shall be protected by following the strictest BMPs. Water levels of ponds, wetlands, vernal pools, beaver impoundments, and other Resource Areas within Priority Habitat shall not be altered without prior consultation with Division.

4. **State-listed Species Observations**: Any state-listed species encountered by COMPANY or its subcontractors shall be reported to the Division through the Vernal Pool and Rare Species (VPRS) online reporting system.

    a. State-listed species observations (i.e. turtles) should be photographed and the following relevant information included: date, location (i.e. nearest pole number and Line). The Division strongly encourages quarterly qualitative reporting (i.e. via email) with photos and locations of species observed by crews or contactors.
    b. COMPANY shall compile all observations and submit an annual report to the Division.
    c. In addition, observations of state-listed plant species must also be reported via VPRS at https://www.mass.gov/service-details/vernal-pool-rare-species-vprs-information-system.

5. **Data Sensitive Species**: A subset of species protected under the MESA have been determined by the Division to be "Data Sensitive Species" (denoted in the "Data_Sens" column of the shapefile). These species are highly susceptible to collection and are therefore of high concern to the Division. Information about these species (including presence/absence) cannot be released to anyone else (especially including release to third parties or published) unless such release is agreed to in writing by the Division (See Massachusetts Public Records law: M.G.L. chapter 66 section 17D).

## Species-specific Best Management Practices

In addition to the general BMPs provided above, extra care must be taken to avoid and minimize impacts to state-listed species by implementing the species-specific BMPs below, including but not limited to avoiding OMP activities during the sensitive dates provided in the shapefile table.

6. **State-listed Turtles**: Turtles are long-lived and the loss of even a single adult turtle can negatively impact the persistence of a local population. Extra care must be taken to avoid direct impacts to state-listed turtles by following the BMPs summarized below and provided in the "Guide_1" and "Guide_2"columns of the shapefile table.

    a. Sensitive Dates: State-listed turtles are generally active from 1 April – 31 October (the "turtle active season"). In general, OMP activities conducted between 1 November and 31 March will pose minimal or no risk to state-listed turtles. Guide 1 must be implemented for any OMP work during the state-listed turtle "Sens_date" period.

    b. "Guide 1" - Avoid direct harm to turtles: During the turtle active season (see "Sens-dates") every effort should be made to conduct visual inspections of the work area for turtles by trained personnel prior to the commencement of work. If turtles are encountered, they should be removed from the work zone and reported to the Division (see #4). If operation and maintenance activities are to occur between 1 April and 31 October, extra care should be used when using heavy machinery or traveling in vehicles through these mapped areas. Any silt fencing used in these areas should be removed as soon as site stabilization has occurred, as such fencing can be a barrier to turtle movements. If required, excavation should be completed within one day and/or open trenches should be backfilled daily to prevent turtles from becoming trapped.

c. <u>“Guide 2” - Avoid wetland work</u>: This management recommendation applies only to mapped habitats for the Blanding’s Turtle, Bog Turtle and Northern Red-bellied Cooter at any time of year. OMP activities within these wetlands should be minimized to the greatest extent practicable. However, if work must occur in wetland areas, any work should be reported to the Division in the attached Wetland Work Form within 1 month of the commencement of proposed work. ***Please note that any necessary work within wetlands mapped as habitat for the Bog Turtle or Northern Red-bellied Cooter must be reviewed on an individual basis by the Division.***

7. **State-listed Plants:** In general, *vegetation management activities* conducted between 1 November and 15 April, excluding the broadcast application of herbicides, will pose minimal or no risk to state-listed plants and can proceed. Vegetation management activities occurring between 16 May and 31 October may harm state-listed plants and BMPs must be implemented to avoid said harm. Extra care must be taken to avoid direct impacts to state-listed plants by following the BMPs summarized below and provided in the “Guide_1” and “Guide_2”columns of the shapefile table.

   a. <u>Sensitive Dates - O</u>peration and maintenance activities (e.g., structure replacement, counterpoise installation), regardless of when the activity occurs, may cause harm to state-listed plants. Therefore, no sensitive dates are included for plants in the “Sens_dates” column of the shapefile table.

   b. <u>“Guide 1” - Delineate population and avoid</u>: Surveys must be conducted by a qualified botanist who will be required to identify the extent and condition of state-listed plant populations , flag these populations for work crews, and file a report with the Division prior to commencement of operation and maintenance activities in these areas. Work crews are required to avoid these areas. All observed state-listed plants shall be reported to the Division (see #4).

   c. <u>“Guide 1” or “Guide 2” - Avoid wetland work</u>: This practice applies only to mapped habitats for wetland plants. If work <u>must</u> occur in these wetland areas, strict BMPs shall be implemented to avoid harm to state-listed species and their habitats (e.g. using swamp mats). Any work occurring within these wetland areas should be reported to the Division in the included Wetland Work Form within 1 month of the commencement of proposed work. <u>Please note that any excavation proposed in these areas **requires consultation with the Division** for additional guidance prior to the commencement of work</u>.

8. **State-listed Moths and Butterflies (Lepidoptera)**: Many state-listed Lepidoptera are host specific, with caterpillars feeding exclusively on one or two plant species. Extra care should be taken to avoid direct impacts to state-listed Lepidoptera by following the BMPs summarized below and provided in the "Guide_1" and "Guide_2"columns of the shapefile table.

    a. "Host_plant": This field contains the identity (common name and scientific name) of specific host plants associated with rare Lepidoptera species, if this information is available.

    b. <u>"Guide_1" - Avoid host plant to greatest extent possible</u>: Certain host plants for state-listed species are easily identified in the field with minimal training and can be avoided by operation and maintenance activities. The known host plants for these state-listed species are included in the shapefile.

    c. <u>"Guide_1" - Utilize appropriate erosion control measures</u>: Haybales, silt fencing, etc. should be utilized when excavations or other activities resulting in soil disturbance will occur near wetland habitats.

    d. <u>"Guide_2": Minimize loss of native vegetation</u>: The host plants of many state-listed moth and butterfly species are fairly common plant species, and efforts should be taken to avoid excessively clearing or otherwise removing native vegetation. This will protect many host plant species from direct harm and from competition from non-native invasive plants which may thrive in disturbed areas

    e. <u>"Guide_2" - Avoid wetland work</u>: This practice applies only to areas mapped as habitat for Lepidoptera with wetland host plant species. If work must occur in these wetland areas, strict BMPs shall be implemented to avoid harm to state-listed species and their habitats (e.g. using swamp mats). Any work occurring within these mapped areas should be reported to the Division in the included Wetland Work Form within 1 month of the commencement of the proposed work. <u>Please note that any excavation proposed in these areas shall require consultation with the Division for additional guidance prior to the commencement of work.</u>

9. **State-listed Beetle species**: The Division should be contacted for further guidance (see "Guide_1") for OMP work in areas mapped for state-listed beetles.

    a. <u>"Guide_1" - Consult with Division</u>: Prior to any OMP activities proposed within habitat for state-listed beetles, the Division must be contacted for further guidance.

10. **State-listed Bird species**: Birds are very sensitive to visual and auditory disturbances during the breeding season. Extra care should be taken to avoid disturbing breeding birds by following the BMPs summarized below and provided in the "Guide_1" and "Guide_2"columns of the shapefile table.

    a. "Sens_Dates": Varies by species. **Refer to shapefile table for species-specific breeding periods.** Typically, sensitive dates begin in April/May and conclude in August/September.

b. “Guide 1” - Avoid work in marsh, lake, and pond habitats during sensitive dates: **Marsh birds** and wetland bird species establish territories in the spring, nest in spring and summer, and fledge their young by late summer/early fall. They are highly sensitive to disturbance throughout this time period.

c. “Guide 1”: Avoid work during breeding season: Refer to “Sens_date” column in shapefile. Birds can be fairly timid creatures that are very sensitive to disturbance throughout this time period.

d. “Guide 2” - Minimize audio and visual disturbance to wetland: **Marsh birds** are fairly timid creatures that establish territories in the spring, nest in spring and summer, and fledge their young by late summer/early fall. They are very sensitive to disturbance including loud equipment, sudden movements or activities, etc.

11. **State-listed Amphibians**: These species breed in vernal pools and or suitable wetland areas but spend the majority of their lives in forested upland habitats. Extra care should be taken to avoid direct impacts to wetland breeding and upland forest habitats by following the BMPs summarized below and provided in the “Guide_1” column of the shapefile table.

    a. “Sens_Dates”: Varies by species. **Refer to shapefile table for species-specific vernal pool and wetland breeding periods.**

    b. “Guide 1” - Avoid impacts to wetlands: This practice applies to areas mapped as habitat for state-listed amphibian species. However, if work must occur in wetland areas mapped for these species, strict BMPS shall be implemented to avoid harm to state-listed species and their habitats (e.g. using swamp mats).

12. **State-listed Aquatic Species** (i.e. fish, mussels, dragonflies, damselflies, snails, etc.)**:** These species are particularly sensitive to alterations to water quality of their aquatic habitats, which can include, but are not limited to changes in temperature, sediment delivery, and pollutant concentrations in the water body. Additionally, dragonflies and damselflies, which are aquatic as larvae, need vegetated foraging habitat in close proximity of their aquatic larval homes. Extra care should be taken to avoid direct impacts to wetland breeding and abutting upland habitats by following the BMPs summarized below and provided in the “Guide_1” and “Guide_2” columns of the shapefile table.

    a. “Guide_1” - Utilize appropriate erosion control measures: Haybales, silt fencing, etc. should be utilized when excavations or other activities resulting in soil disturbance will occur near wetland habitats.

    b. “Guide 2” - Minimize loss of native vegetation: This will allow dragonflies and damselflies to forage as adults in close proximity to their breeding sites. Additionally, retaining native vegetation near wetland habitats provides better erosion control and helps protect water quality.

13. **State-listed Snake Species**: Crew members should be aware that any snakes observed during vegetation management activities may be state-listed and protected pursuant to MESA. Direct harm to or capture of state-listed snakes without a permit from the Division is considered an unauthorized Take and may be punishable by fines or imprisonment (321 CMR 10.06).

    a. “Guide_1” - Consult with Division: Prior to any OMP activities proposed within habitat for state-listed snakes, the Division must be contacted for further guidance.

14. **State-listed Bat Species**: The Division should be contacted for further guidance (see “Guide_1”) for OMP work in areas mapped for state-listed bats.

    a. “Guide_1” - Consult with Division: Prior to any OMP activities proposed within habitat for state-listed bats, the Division must be contacted for further guidance.

As a condition of this OMP, the Division shall be provided in writing the names and phone numbers of designated contacts who will know where and when all work in mapped Priority Habitat will be occurring. Division personnel may visit OMP sites to assess compliance with the BMPs provided herein. **Additionally, within one (1) year from the date of this Division approval letter, a written summary (and/or shapefile) of activities that occurred within Priority Habitat, including locations, dates, a description of work, and BMPs implemented to protect state-listed species, shall be submitted to the Division.**

COMPANY shall notify the Division at least 72 hours in advance of performing any OMP activities not shown in the current OMP. The Division will review said new OMP activities and provide guidance regarding any procedures or conditions necessary to protect state-listed species and their habitats. Pursuant to 321 CMR 10.15, emergency maintenance and repair activities within Priority Habitat may be conducted without prior Division notification. However, the Division must be notified of such emergency activities pursuant to 321 CMR 10.15 and mitigation may be required for any damage done to state-listed species habitats. Whenever possible, we recommend that the Division be notified in advance of emergency management activities so that we can provide immediate guidance about state-listed species associated with the work area and recommended BMPs. An emergency work form is also provided via email attachment, which will assist you in providing the Division with necessary information for emergency work performed within Priority Habitat.

Provided that the best management practices contained herein and in the 2020 OMP shapefile are adhered to, the OMP for 2020 meets the requirement for exemption from review under 321 CMR 10.18 through 10.23 and is hereby approved. **This approval of the 2020 Great River Hydro OMP is valid for one (1) year from the date of issuance of this letter**. We appreciate the measures that Great River Hydro is taking to manage and protect state-listed rare species and their habitats, and we look forward to working with you to further streamline the regulatory review process. If you have any questions or suggestions, please contact Lauren Glorioso, Endangered Species Review Biologist, at (508) 389-6361 (lauren.glorioso@mass.gov) or David Paulson, Senior Endangered Species Review Biologist, at (508) 389-6366 (david.paulson@mass.gov).

Sincerely,

Everose Schlüter, Ph.D.
Assistant Director

Kari Sparks
Environmental Specialist
Great River Hydro, LLC.
152 Governor Hunt Rd
Vernon, VT 05354
Office: 802-254-3040
e-mail: ksparks@greatriverhydro.com

Wednesday, December 18, 2019

Natural Heritage and Endangered Species Program
Attn: Regulatory Review
Massachusetts Division of Fisheries & Wildlife
1 Rabbit Hill Rd
Westborough, MA 01581

Reference: Request for review- Massachusetts Natural Heritage and Endangered Species Program
2020 Compliance Plan for Great River Hydro, LLC
Operations and Maintenance Activities

Regulatory reviewer,

Please find the Operation and Maintenance Compliance Plan per 321 CMR 10.14 (7) for your review.

Please contact me at ksparks@greatriverhydro.com or via telephone at (802) 254-3040 if you have any questions or need further documentation.

Best,

Kari Sparks

Kari Sparks
Environmental Specialist
Great River Hydro, LLC.
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Cell: 802-299-5943
ksparks@greatriverhydro.com

Massachusetts Natural Heritage and
Endangered Species Program

# 2020 COMPLIANCE PLAN
for
GREAT RIVER HYDRO, LLC
OPERATIONS AND MAINTENANCE ACTIVITIES

**Executive Summary**

In Massachusetts, a utility company's routine operation and maintenance activities are exempt from review pursuant to the MA Endangered Species Act Regulations (MESA) (321 CMR 10.00) as administered by the Natural Heritage and Endangered Species Program (NHESP) of the MA Division of Fisheries and Wildlife (Division). The exemption is conditional based on the NHESP's annual review and approval of an Operation and Maintenance Plan (OMP) [321 CMR 10.14 (11)].

This Massachusetts Natural Heritage and Endangered Species Program 2020 Compliance Plan (Compliance Plan) outlines Great River Hydro, LLC's (Great River Hydro) Operations and Maintenance (O&M) activities within the Deerfield River project area in order to meet Massachusetts rare species and habitat regulatory requirements. Once approved, the O&M activities will comply with MESA (M.G.L c.131A) and its implementing regulations (321 CMR 10.00) for state-listed rare species and habitats. Additional discussion is provided regarding the Massachusetts Wetlands Protection Act (WPA; M.G.L. c. 131 § 40) and its implementing regulations (310 CMR 10.00) for wetland resource areas. The overall goal of the plan is to ensure that the O&M activities are approved through the appropriate regulatory processes.

Much of the Deerfield River project area is mapped as Priority Habitat and/or Estimated Habitat and is therefore subject to MESA and the WPA. The majority of the proposed activities are located within 200 feet of the Deerfield River, which is designated as Riverfront Area, and are therefore subject to the WPA. Examples of the proposed O&M activities include repair of concrete on buildings, mowing of vegetation, application of herbicides to maintain areas free of vegetation, roadside ditch and culvert maintenance and repairs, installation and removal of safety booms, and maintenance of trash racks.

This Compliance Plan outlines standard hydroelectric maintenance activities and will be submitted to the NHESP for approval prior to its implementation in 2020. After review of this Compliance Plan and the corresponding maps, it is anticipated that the NHESP will reply with specific information regarding species or habitats of concern within various project areas. Additional studies may be required based on the proposed activity and the potential impact on species or habitats. Timing restrictions or other modifications may be required to protect the sensitive species or habitats. It is anticipated that the NHESP will also confirm which activities are exempt from review. Great River Hydro will work cooperatively with the NHESP to achieve regulatory compliance.

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# 1.0 INTRODUCTION

This Massachusetts Natural Heritage and Endangered Species Program (NHESP) Compliance Plan (Compliance Plan) outlines Great River Hydro, LLC's (Great River Hydro) proposed Operations and Maintenance (O&M) activities within the Deerfield River project area in order to meet Massachusetts natural resource regulatory requirements. This plan includes a description of:

- the regulatory framework within Massachusetts as it pertains to state-listed rare species, rare species habitat, and wetlands;
- the Deerfield River project area;
- the O&M activities undertaken by Great River Hydro and its authorized contractors operating on properties located within priority habitat in Massachusetts;
- potential resource impacts;
- avoidance and minimization of proposed impacts to protected resources; and
- proposed mitigation measures and conclusions.

# 2.0 REGULATORY FRAMEWORK

Following are brief summaries of the Massachusetts Endangered Species Act (MESA), the Massachusetts Wetlands Protection Act (WPA), and the Massachusetts Environmental Policy Act (MEPA) as they potentially apply to the project.

## 2.1. MASSACHUSETTS ENDANGERED SPECIES ACT

MESA and its implementing regulations (321 CMR 10.00) establish procedures for the listing and protection of rare plants and animals. Priority Habitat is the mapped geographical extent of known habitat for state-listed rare plant and animal species. Activities that are proposed within Priority Habitat have the potential to result in a "take" of a state-listed species, and as a result are subject to regulatory review by the NHESP in compliance with MESA. "Take" is defined as, "in reference to animals to harass, harm, pursue, hunt, shoot, hound, kill, trap, capture, collect, process, disrupt the nesting, breeding, feeding or migratory activity or attempt to engage in any such conduct, or to assist such conduct, and in reference to plants, means to collect, pick, kill, transplant, cut or process or attempt to engage or to assist in any such conduct. Disruption of nesting, breeding, feeding, or migratory activity may result from, but is not limited to, the modification, degradation or destruction of Habitat." If a project is determined to result in a take, then it may be possible to redesign the project in order to avoid a take. If such revisions are not possible, projects resulting in a take may only be permitted if they qualify for a Conservation and Management Permit (321 CMR 10.23). Permits for taking rare species for scientific, educational, conservation, or management purposes may be granted by the Massachusetts Division of Fisheries and Wildlife.

Estimated Habitat is based on the geographical extent of habitat for state-listed rare wetland-dependent wildlife as codified under the WPA. The WPA does not protect state-listed rare plants. State-listed wetland-dependent wildlife species are protected under MESA, as well as the WPA. If a project is proposed within Estimated Habitat and requires a Notice of Intent (NOI), then a copy of the NOI must also be submitted for review to the NHESP.

### 2.1.1. Endangered, Threatened, and Special Concern Species in Massachusetts

As described above, MESA protects state-listed rare species and their habitats by prohibiting the "take" of any plant or animal species listed as endangered, threatened, or of special concern by the NHESP (321 CMR 10.03(6)). Any native species listed as endangered or threatened by the

U.S. Fish and Wildlife Service is also included on the state list. The rules, regulations, and definitions are presented in 321 CMR 10.00 et seq.

2.1.2. Exemptions from Review for Projects or Activities in Priority Habitat (321 CMR 10.14)

Although Great River Hydro's O&M activities will be reviewed for compliance with MESA, it is anticipated that many proposed activities within Priority Habitat qualify as exempt from review (321 CMR 10.14). The following excerpts from the regulations apply to O&M actions.

> (3) "the maintenance, repair, removal, or replacement, or additions that do not exceed 50% of the footprint of existing commercial and industrial buildings, multifamily and mixed-use structures within existing paved areas and lawfully developed and maintained lawns or landscaped areas;
>
> (6) "construction, repair, replacement or maintenance of septic systems, private sewage treatment facilities, utility lines, sewer lines, or residential water supply wells within existing paved areas and lawfully developed and maintained lawns or landscaped areas, provided there is no expansion of such existing paved, lawn and landscaped areas;"
>
> (11) "routine operation and maintenance on existing electrical, gas, and telecommunication distribution and transmission lines and existing substations, provided that the operation and maintenance are part of an operation and maintenance plan approved by the Division, for which a review fee shall be charged, the amount of which shall be determined by the commissioner of administration under the provisions of M.G.L. c.7, §3B"
>
> (12) "the maintenance, repair or replacement, but not widening, of existing paved roads, shoulder repair… paved and unpaved driveways, and paved and unpaved parking areas…"
>
> (13) "the maintenance or replacement but not the expansion of existing lawns and landscaped areas…"
>
> (16) "The management of vegetation within existing utility rights-of-way provided that the management is carried out in accordance with a vegetation management plan approved in writing by the Division prior to the commencement of work for which a review fee shall be charged, the amount of which shall be determined by the commissioner of administration under the provisions of M.G.L. c.7, §3B."

The above-listed excerpts regarding activities exempt from review appear to include such O&M actions as building maintenance activities (e.g., concrete repair and painting), septic pumping, road repair and plowing, and vegetation control work such as mowing, weed whacking, and herbicide use. Finally, Great River Hydro's vegetation control work within the rights-of-way has been described and presented to NHESP under a separate report prepared by Vegetation Control Service, Inc. This work was approved and met the exemption requirement as described in (12), above.

For those O&M activities that are not considered exempt under MESA, coordination with NHESP will be required before these activities may proceed. The determination regarding rare species concerns is independent of many of the interests protected by the WPA.

## 2.2. Wetland Protection Act

The WPA and its implementing regulations (c. 131 § 40 and 310 CMR 10.00) establish procedures for the protection of wetlands and other regulated resource areas such as Bordering Vegetated Wetlands, Banks (upper and lower), Land Under Water Bodies, Bordering Land Subject to Flooding, and Riverfront Area. The Riverfront Area is comprised of all lands within 200 feet of the river, which include nearly the entirety of the Deerfield project area. Therefore, it is anticipated that those O&M activities not considered exempt under the MESA would be subject to the WPA. The required Massachusetts regulatory applications would likely include NOI forms submitted to the Massachusetts Department of Environmental Protection and municipal Conservation Commissions for altering a WPA resource area (e.g., the Riverfront Area). Although man-made canals and forebays are not considered a part of the river, these areas are afforded 100-foot buffers, and activities within these areas are subject to regulation.

The WPA protects rare animal species by prohibiting alterations that would have short- or long-term adverse effects on the wetland habitats of rare wildlife species. WPA regulations require that proposed alterations to wetland habitats of rare wildlife be reviewed by the NHESP.

## 2.3. Massachusetts Environmental Policy Act

The MEPA (M.G.L. c.30, secs. 61-62H) and its implementing regulations (301 CMR 11.00) also provide for the review of proposed projects for potential impacts to state-listed rare species in order to avoid, minimize, and mitigate any potential adverse environmental impacts. MEPA applies to projects above a certain size threshold that involve some state agency action. This can either entail projects proposed by a state agency, or projects proposed by another party that require a permit, financial assistance, or land transfer from a state agency. In Great River Hydro's case, MEPA review could be implemented if a project results in a take of state-listed rare species on a project site of two or more acres located within Priority Habitat. In this instance, Great River Hydro would be required to file an Environmental Notification Form (ENF) with the MEPA office (301 CMR 11.03(2)). Projects that require the filing of an ENF are screened by NHESP staff for review.

## 2.4. Wetlands Protection Act/ Massachusetts Endangered Species Act Streamlined Review

A streamlined review process is available for projects that would have previously required independent filings for compliance with MEPA and WPA. This streamlined process coordinates agency reviews, and formulates one regulatory performance standard (e.g., take/no take as subject to MESA). This is attained by submitting the newly revised WPA Form 3, NOI, to request joint MESA/WPA endangered species review. A single NHESP response is issued to both the MESA and WPA filings [DWW Policy 06-1 (BRP/DWM/WWP 06-1)].

# 3.0 PROJECT AREA DESCRIPTION

Great River Hydro operates 13 hydroelectric generating stations: 6 on the Connecticut River in Vermont and New Hampshire, and 7 on the Deerfield River in Vermont and Massachusetts. The Deerfield River system spans approximately 65 miles of the Deerfield River in southern Vermont and northwestern Massachusetts. This system includes Vermont's Somerset Reservoir at the northern end of the watershed downstream to the confluence with the Connecticut River. Some of the conventional hydroelectric facilities are run-of-the-river plants that only have a small amount of storage capacity. Their operations are subject to large seasonal variations in water volume, and their use depends upon water flow.

For this Compliance Plan, the project area is approximately 80 acres in size and includes Great River Hydro's ongoing O&M activities on its properties along the Deerfield River in Massachusetts (see Table 1). Specifically, they include the Sherman Dam at the northern limit of the Deerfield River in Massachusetts, and continue downstream to include the No. 5 Dam, conduit, canal, and Station; the No. 4 Dam and Station; the No. 3 Dam and Station, and the No. 2 Dam and Station. In addition to the dam facilities, Great River Hydro also operates several recreational and natural areas along the Deerfield River. These include the No. 5 boat slide, Dunbar Picnic Area, Charlemont Islands, East Charlemont Picnic Area, North Charlemont Boat Launch, No.4 Angler Access, and Malley Park. Finally, Great River Hydro has office space in both Monroe Bridge and Buckland. Each of these locations has specific activities associated with its use and operation.

Much of the project area is considered Priority Habitat as defined by MESA. The portion of the project area near the No. 3 and 5 facilities is also mapped as Estimated Habitat for wetland wildlife. In addition, areas within 200 feet of the Deerfield River are designated as regulated Riverfront Area and are therefore subject to the WPA. Most of Great River Hydro's properties and activities within the Deerfield system are located within 200 feet of the river and thus are considered Riverfront Areas. The canals and forebays are regulated areas with 100-foot buffers. As a result, the O&M activities potentially could be subject to both MESA and the WPA.

## 4.0 OPERATIONS AND MAINTENANCE ACTIVITIES AND OVERSIGHT

Great River Hydro conducts ongoing O&M activities on its facilities in Massachusetts. These facilities were re-licensed by Federal Energy Regulatory Commission (FERC) No. 2323 in 1997. Many of the items included in Great River Hydro's ongoing O&M work are required as part of the FERC license to provide safe and efficient operation of the facilities. For example, dams and areas covered by riprap are required to be free of vegetation, with annual maintenance to limit herbaceous vegetation. Concrete maintenance may be required along the faces of intake structures or powerhouses, depending upon their condition. Dredging of the forebays is required to provide adequate flow and operation of the facilities. FERC conducts regular inspections to assess the safety and compliance of Great River Hydro's facilities, and Great River Hydro has a schedule of compliance tasks for environmental and public safety purposes.

The attached Table 2 shows the O&M tasks undertaken by Great River Hydro within the Deerfield River project area. Appendix A, Figures 1 through 16, show the O&M project areas and the activities that occur within the different project areas. The corresponding shapefiles will be submitted to the NHESP in order to coordinate oversight of the on-going O&M activities. Following is a description of the various activities that occur within each project area. Table 3 includes a list of activities by project area. In addition, Photographs 1-14 in Appendix B show representative locations within the project area.

### 4.1. SHERMAN DAM

Within the Sherman Dam project area, O&M activities include FERC-required repair and maintenance work on or near the dam, intake, and powerhouse; in-water activities such as installation and removal of safety booms, debris booms, and bubblers; installation and removal of flashboards; maintenance of transformers; road repair, plowing, and ditch maintenance; mowing and herbicide application for vegetation control; rip-rap repair; dredging in the vicinity of the dam; transportation of sediment and debris off-site; on-site disposal of solid waste; piezometer pit maintenance; use of temporary bulkheads for spillgate maintenance; small construction projects; rack raking and replacement; and possible diving for rack maintenance.

Figure 2 illustrates the project area and the locations of the various O&M activities at Sherman Dam. Photographs 1 and 2 provide views of the dam.

### 4.2. No. 5 Dam, Conduit, Canal, and Station

O&M activities in the vicinity of the No. 5 Dam, Conduit, Canal, and Station (see Figures 3-9 and Photographs 4 and 5) include FERC-required activities such as installation and maintenance of safety and debris booms; road repair, plowing, ditch/culvert maintenance and repair; conduit repair; piezometer pit maintenance; mowing and vegetation control along the canal rip-rap areas; rip-rap repair; transportation of sediment and debris off-site; on-site disposal of solid waste; septic pumping; maintenance of transformers; use of temporary bulkheads for spillgate maintenance; small construction projects; rack raking and replacement; and diving for rack maintenance. In this vicinity, additional streambank stabilization work to repair damages from Tropical Storm Irene was conducted in 2015 and completed in 2016.

### 4.3. No. 4 Dam, Forebay, and Station

O&M activities in the vicinity of the No. 4 facilities include road repair, grading, and ditch/culvert maintenance and repair; road plowing and sanding; mowing; application of plant growth regulator along steep slopes near the station; building maintenance; installation and maintenance of debris and safety booms and bubblers; installation and removal/replacement of flashboards; use of temporary bulkheads for spillgate maintenance; septic pumping; vegetation control; maintenance of transformers; small construction projects; rack raking and replacement; and diving for rack maintenance. Dredging of the forebay is also included (see Figures 12 and 13, and Photographs 7-13). These activities are required by FERC. In this vicinity, additional streambank stabilization work to repair damages from Tropical Storm Irene was completed in 2015.

### 4.4. No. 3 Dam, Forebay, and Station

O&M activities in the vicinity of the No. 3 facilities include road repair, grading, and ditch/culvert maintenance; road plowing and sanding; mowing; application of herbicides along steep slopes near the station; vegetation control; building maintenance (e.g., concrete repair, painting); maintenance of transformers; installation and maintenance of debris and safety booms and bubblers; installation and removal/replacement of flashboards; use of temporary bulkheads for spillgate maintenance; small construction projects; repair of conduit; rack raking and replacement; and diving for rack maintenance. Dredging of the forebay is also included (see Figure 14). These activities are requirements of the FERC license.

### 4.5. No. 2 Dam and Station

The No. 2 Dam and Station mark the southern limit of the project area (refer to Figures 15 and 16). Activities conducted on these facilities are similar to those at the other dam and station sites. Activities include FERC required activities such as installation and maintenance of safety and debris booms; removal/replacement of flashboards; rubber dam maintenance; road repair, plowing, and ditch/culvert maintenance and repair; mowing and vegetation control along the canal rip-rap areas; rip-rap repair; transportation of sediment and debris off-site; on-site disposal of solid waste; use of temporary bulkheads for spillgate maintenance; small construction projects; rack raking and replacement; and diving for rack maintenance.

### 4.6. RECREATIONAL FACILITIES

Within the Deerfield project area, there are several Great River Hydro recreation sites. The O&M activities at these sites vary depending upon their size and use, but maintenance is required by the FERC license. At the northern end of the project area, the No. 5 boat slide is located downstream of the No. 5 dam. Work at this site includes fence and stair repair, as well as signage upkeep (see Figure 3 and Photograph 3). There is a gated trail along the river that provides emergency access to Bear Swamp. Work here includes road maintenance along with culvert/ditch maintenance.

Downstream of the No. 5 dam is the Dunbar Picnic Area, the largest of the recreation sites. Numerous O&M activities occur at this site, including road repair, grading, and ditch/culvert maintenance and repair; mowing; building upkeep; fence repair; installation and repair of picnic tables and grills; parking area maintenance; trash removal; hazard tree removal; and trail work (see Figure 7 and Photograph 6).

The Charlemont Islands have undergone a rigorous vegetation management process to eliminate Japanese knotweed (*Fallopia japonica*) and other invasive species (refer to Figure 10). This is an ongoing process that includes topical application of herbicide. This process is further described in Section 4.7.

Activities at the East Charlemont Picnic Area include parking area maintenance and repair; mowing; installation and repair of picnic tables and grills; trash removal; and installation, maintenance; and removal of portable toilets (see Figure 10). O&M activities at the North Charlemont Boat Launch are limited to vegetation control, parking lot maintenance, boat launch maintenance, and trash removal (see Figure 11). The No. 4 Angler Access and Malley Park have limited O&M activities that include vegetation control, hazard tree removal, trash removal, and upkeep of parking areas (see Figures 12 and 14). Please note that Malley Park was heavily damaged by floodwaters from Tropical Storm Irene and was repaired in 2014.

### 4.7. VEGETATION MANAGEMENT PROGRAM

The final O&M activity is Great River Hydro's Vegetation Management Program. This program covers maintenance and vegetation controls implemented on both annual and three-year cycles and includes FERC-required vegetation removal and control. Right-of-way work is conducted on the three-year cycle and was conducted in 2016. A separate Vegetation Management Plan has been submitted for this work. For example, dams and areas covered by riprap are required to be free of vegetation, with annual maintenance to limit herbaceous vegetation. Activities may include mowing, spraying, tree trimming and removal, weed control, herbicide application along steep slopes near the stations, disposal of chips and/or trees, and herbicide application near parking lots and buildings.

As mentioned above, the Charlemont Islands were treated with herbicide to eliminate Japanese knotweed and other invasive species. This was required by FERC to help keep the islands free of woody debris to prevent ice build-up. In the fall of 2002, a low-volume foliage herbicide was applied to the knotweed and other invasive species such as multiflora rose (*Rosa multiflora*) and Morrow's honeysuckle (*Lonicera morrowii*). The intent of this activity was to eliminate the potential of rhizome fragments washing downstream to establish new patches. In 2003, a follow-up application of low-volume herbicide was conducted on re-emerging stems. This area is monitored on an annual basis, but due to scouring following Tropical Storm Irene, it is not currently scheduled for re-treatment as part of the Vegetation Management Program.

These activities are further described in the Vegetation Management Plan submitted to the NHESP.[1]

## 5.0 POTENTIAL IMPACTS

Given the diversity of O&M activities conducted in the Deerfield River project area, there are a range of potential impacts to the natural environment. For example, ongoing vegetation management may disturb rare plant species or rare wildlife and its habitat. Likewise, disturbance of aquatic habitat due to activities such as rack raking, flashboard repair, and dredging, or potential fuel spills onto land and water, could affect aquatic species. These potential impacts are minimized through a number of Best Management Practices (BMPs) and operation controls.

Please refer to Table 2 for additional potential impacts and controls by activity.

## 6.0 AVOIDANCE AND MINIMIZATION

Avoidance and minimization of adverse impacts are essential to Great River Hydro's ongoing O&M activities. Foremost is the use of trained and qualified personnel (i.e., Great River Hydro employees or approved and licensed vendors). This workforce employs BMPs when carrying out the range of activities within the project area. Using approved products, materials, and machinery, potential adverse impacts can be avoided and minimized to the extent feasible. In addition, following established protocol and rules, under supervision of additional trained staff, results in a safe and environmentally sensitive company. Activities are conducted in accordance with FERC regulations and standards for both worker and environmental safety.

Great River Hydro has in place an Environmental Management Program (see Appendix C for contact information). The existing protocols for safety, compliance checklists, spill prevention plans, and other established programs help maintain the highest level of safety, conformance, and environmental sensitivity. In addition, Great River Hydro will provide an overview of MESA regulations to maintenance personnel and others so that staff members will be aware of the regulatory framework and requirements, and the Priority Habitat, Estimated Habitat, and regulated resource areas designated within the Deerfield River project area.

## 7.0 MITIGATION MEASURES

As shown in Table 2, there are several controls already in place to mitigate any potential impacts to sensitive resources within the project area. Staff and contractors are trained and supervised, and BMPs are implemented. For example, regular vehicle and equipment inspections are conducted to aid in the safe and effective operation of machinery. Areas of impact are minimized, approved methods are employed, and updated tools and techniques are utilized. Erosion and siltation control measures are utilized as needed to protect the regulated resources. Timing restrictions or seasonal work windows may be developed if there are any species-related requirements. Any future adaptive management measures that are implemented to protect the resources will comply with federal regulations and FERC requirements.

[1] Prepared by Vegetation Control Service, Inc. June, 2014.

## 8.0 CONCLUSIONS

Great River Hydro anticipates that submittal and approval of this Compliance Plan will enable them to anticipate applicable Massachusetts regulatory requirements under MESA. By including a detailed list of O&M activities, regulators can review potential activities and determine the permitting framework for ongoing O&M activities within the Deerfield River project area. It is anticipated that the NHESP will also confirm that most of these activities are exempt from review. Great River Hydro will work cooperatively with the NHESP to meet regulatory compliance.

# TABLES

**Table 1. Great River Hydro O&M Proposed Activities and Acreage**

| Activity | Acreage |
|---|---|
| Building Maintenance | 1.1 |
| Building Maintenance/Concrete Repair | NA |
| Concrete Repair | NA |
| Dam Maintenance | 0.8 |
| Dredging | 1.1 |
| Flashboard Maintenance | 0.2 |
| Laydown Area | 0.4 |
| Maintenance Boom | NA |
| Recreation Area | 2.3 |
| Rip Rap | 8.0 |
| Road Maintenance | 21.0 |
| Safety Boom | 0.3 |
| Stair & Railing Maintenance | NA |
| Transformer Maintenance | 0.2 |
| Trash Rack Maintenance | 0.2 |
| Vegetation Management | 34.5 |
| Vegetation Management - Herbicide | 8.6 |
| **Total** | **78.7** |

**Table 2. Great River Hydro O&M Proposed Activities, Potential Impacts, and Controls**

| Proposed Activity | Potential Impact | Control |
|---|---|---|
| Rack Raking | Turbidity in Water<br>Disposal of Debris | BMPs / Training<br>No raking from river bottom<br>Disposal in designated areas |
| Minor concrete work on Dams | Concrete falling in water<br>Lowering water levels | BMPs / Training<br>Containment under concrete<br>Maintain levels within FERC required limits |
| Rip Rap Repair | Disturb vegetation / habitat | BMPs / Training / FERC requirements |
| Dredging dam areas | Turbidity in water<br>Fish Habitat<br>Debris removal / sediment<br>Water elevations / De-watering<br>Fuel spills | Regulatory approvals<br>BMPs / Training<br>Electro-shock fish for removal and relocation<br>Proper disposal |
| Oil Transfers and Filtering of Transformers | Spills to land and water | BMPs / Training<br>Install spill equipment / barriers prior to start |
| Install and remove bubblers | Turbidity in water<br>Fish Habitat | BMPs / Training<br>Install in minimum impact areas |
| Install and remove flashboards | Boards / Plastic falling in river<br>Disposal of boards | BMPs / Training<br>Use approved disposal methods |
| Install and maintain safety booms | Spills in water | BMPs / Training<br>On-site supervision |
| Install / Maintain / remove debris booms | Disposal of booms<br>Heavy equipment near water<br>Spills<br>Disrupt river bank | BMPs / Training<br>Use qualified vendor<br>Spill equipment on site<br>Proper disposal methods |
| Temporary Bulkheads for Spillgate Maintenance | Disrupt habitat<br>Turbidity in water | BMPs / Training<br>Minimum impact area next to dam<br>Do not disturb river bottom<br>Use qualified vendor |
| Transporting sediment / debris off site | Leaking containers | BMPs / Training<br>On site rep keeps sediment / debris secure in container |
| Diving for rack maintenance | Turbidity<br>Habitat disturbance | BMPs / Training<br>Use Qualified vendor |
| Rack Replacement | Turbidity<br>Habitat disturbance | BMPs / Training<br>Use Qualified vendor |

*(continued)*

| Proposed Activity | Potential Impact | Control |
|---|---|---|
| Small construction projects – e.g., install footings for No. 2 Dam portage with floating platform | Disrupt habitat<br>Heavy equipment near water | BMPs / Training<br>Use approved vendor<br>Spill equipment on site |
| Minor concrete work on buildings* | Concrete falling on land | BMPs / Training<br>Containment under concrete |
| Mowing * | Fuel leak<br>Species disruption | Vehicle inspections<br>BMPs / Training<br>Vegetation Management Plan in place |
| Road Repair / Grading *<br>(access roads, parking areas) | Increase of road surface | Stay within road footprint<br>BMPs / Training |
| Ditch and Culvert Maintenance* | Disturb vegetation / habitat | BMPs / Training<br>Minimize area of impact |
| Fence Repair * | Minor ground / vegetation disturbance | BMPs / Training |
| Piezometer Pit Maintenance * | Minor ground / vegetation disturbance | BMPs / Training |
| Minor Construction / Laydown * | Minor ground / vegetation disturbance | BMPs / Training<br>Use approved area for laydown |
| Painting building and dam structures * | Lead paint in water<br>Spill paint in water | BMPs / Training<br>Use licensed vendor<br>Spill controls in place |
| Pump septic tank * | Spill onto land | Use approved vendor |
| Repair conduit leaks * | Minor ground / vegetation disturbance | BMPs / Training<br>Hand dig only – minimize area of impact |

*(continued)*

| Proposed Activity | Potential Impact | Control |
| --- | --- | --- |
| Disposing of Solid Waste / rock and concrete * | Improper disposal | BMPs / Training<br>Follow Solid Waste Rules |
| Onsite Disposal of Solid Waste * | Improper waste into dumpsters | BMPs / Training<br>On site rep. sees that only approved waste is disposed of in dumpsters |
| Snow plowing and sanding * | Scarification of soils<br>Sand enters river | BMPs / Training<br>Minimize areas of impact |
| Recreation Site maintenance: *<br>• Install and remove docks<br>• Install, maintain, remove portable toilets<br>• Install, maintain, remove buoys<br>• Install picnic tables and grills<br>• Mowing<br>• Parking area maintenance<br>• Trash removal<br>• Vegetation Control/Clearing<br>• Trail Work | Spills onto land and water<br>Disturb habitat<br>Minor vegetation disturbance<br>Product spills from spraying<br>Leaking equipment<br>Species disruption | BMPs / Training<br>Use Qualified vendors<br>Spill equipment on site<br>Follow solid waste rules<br>Use approved products and materials |
| Vegetation Control Program: *<br>• Mowing<br>• Spraying<br>• Tree trimming and removal<br>• Weed control<br>• Herbicides<br>• FERC required vegetation removal / control<br>• Canal Work (vegetation removal and control)<br>• Dispose of chips and /or trees<br>• Parking lots / access roads/ buildings / footpaths / dams / rip rap / portage stairways / canals / fences / equipment laydown area | Spills onto land and water<br>Disturb habitat<br>Minor vegetation disturbance<br>Product spills from spraying<br>Leaking equipment<br>Species disruption<br>Affect desirable plant species | BMPs / Training<br>Licensed vendors<br>Spill equipment on site<br>Follow solid waste rules<br>Use approved products and materials<br>Proper disposal of unused products |

* Activities likely exempt under 321 CMR 10.14

**Table 3. Great River Hydro O&M Activities by Area**

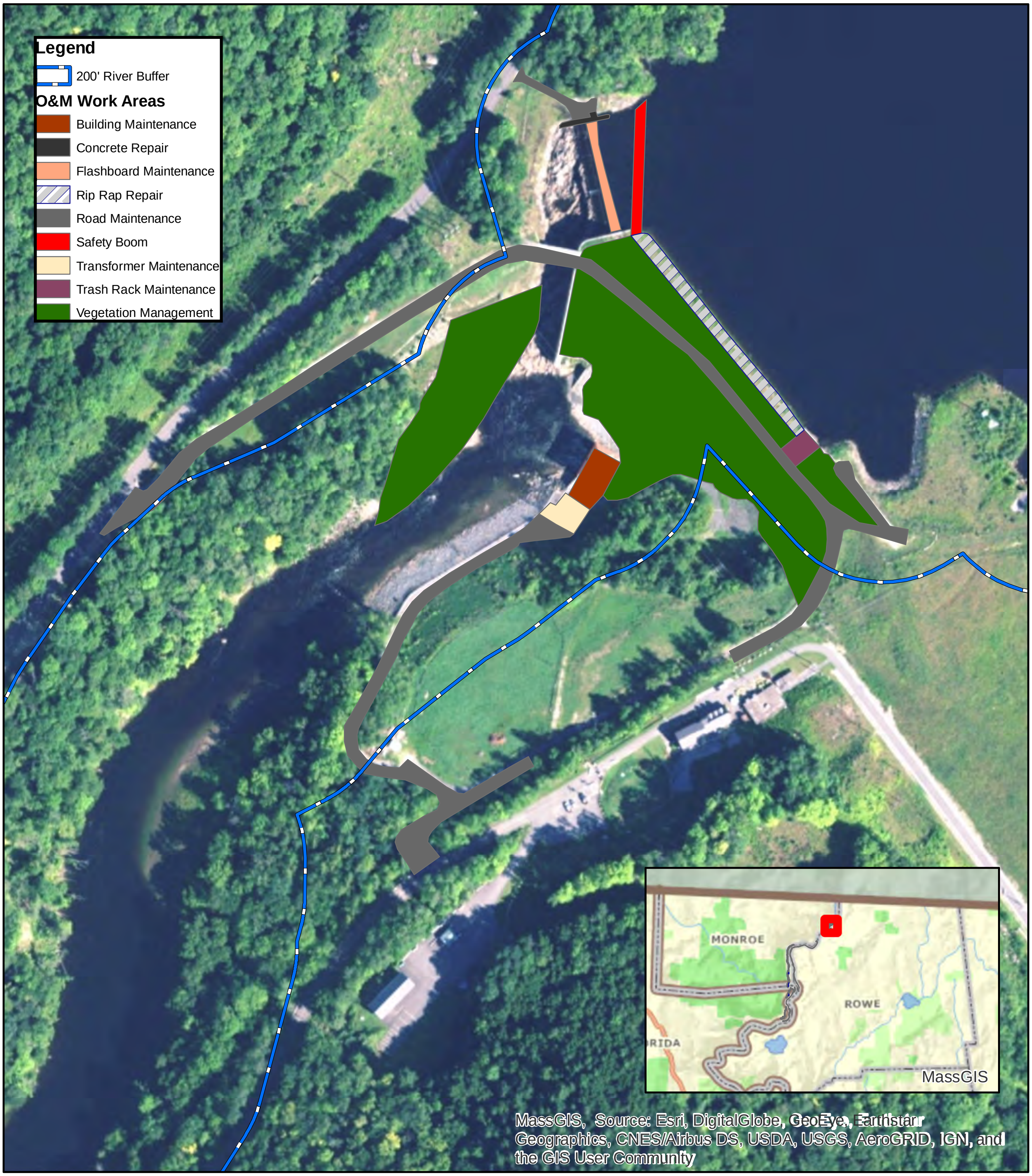
| Proposed Activity | Sherman Dam, Intake, Powerhouse | No.5 Conduit/ Canal | No.5 Dam and Station | No.4 Dam, Forebay, and Station | No.3 Dam, Forebay, and Station | No.2 Dam and Station | Recreation Sites | Charlemont Islands |
|---|---|---|---|---|---|---|---|---|
| Rack Raking | X | X | X | X | X | X | | |
| Minor concrete work on Dams | X | | X | X | X | X | | |
| Minor concrete work on buildings | X | | X | X | X | X | | |
| Mowing | X | X | X | X | X | X | X | |
| Herbicide Use | X | X | X | X | X | X | X | X |
| Rd Repair / Grading (access roads, parking areas) | X | X | X | X | X | X | X | |
| Ditch and Culvert Maintenance | X | X | X | X | X | X | X | |
| Rip Rap Repair | X | X | X | X | X | X | | |
| Fence Repair | X | | X | X | X | X | X | |
| Piezometer Pit Maintenance | X | X | X | | | | | |
| Minor Construction / Laydown | X | X | X | X | X | X | X | |
| Dredging dam areas | X | | X | X | X | X | | |
| Oil Transfers and Filtering of Transformers | X | | X | X | X | X | | |
| Install and remove bubblers | X | | X | X | X | X | | |
| Install and remove flashboards | X | | | X | X | X | | |
| Install and maintain safety booms | X | | X | X | X | X | | |
| Install / Maintain / remove debris booms | | | | X | X | X | | |
| Temporary Bulkheads for Spillgate Maintenance | X | | X | X | X | X | | |
| Painting building and dam structures | X | | X | X | X | X | X | |

*(continued)*

| Proposed Activity | Sherman Dam, Intake, Powerhouse | No.5 Conduit/ Canal | No.5 Dam and Station | No.4 Dam, Forebay, and Station | No.3 Dam, Forebay, and Station | No.2 Dam and Station | Recreation Sites | Charlemont Islands |
|---|---|---|---|---|---|---|---|---|
| Pump septic tank | | | X | X | X | | X | |
| Small construction projects | X | X | X | X | X | X | X | |
| Repair conduit leaks | | X | | | X | | | |
| Transporting sediment / debris off site | X | X | X | X | X | X | X | |
| Disposal of Solid Waste / rock and concrete | X | X | X | X | X | X | X | |
| Onsite Disposal of Solid Waste | X | | X | X | X | X | | |
| Snow plowing and sanding | X | | X | X | X | X | X | |
| Diving for rack maintenance | X | | X | X | X | X | | |
| Rack Replacement | X | | X | X | X | X | | |
| Vegetation Control Program | X | X | X | X | X | X | X | X |

# APPENDIX A

## Figures



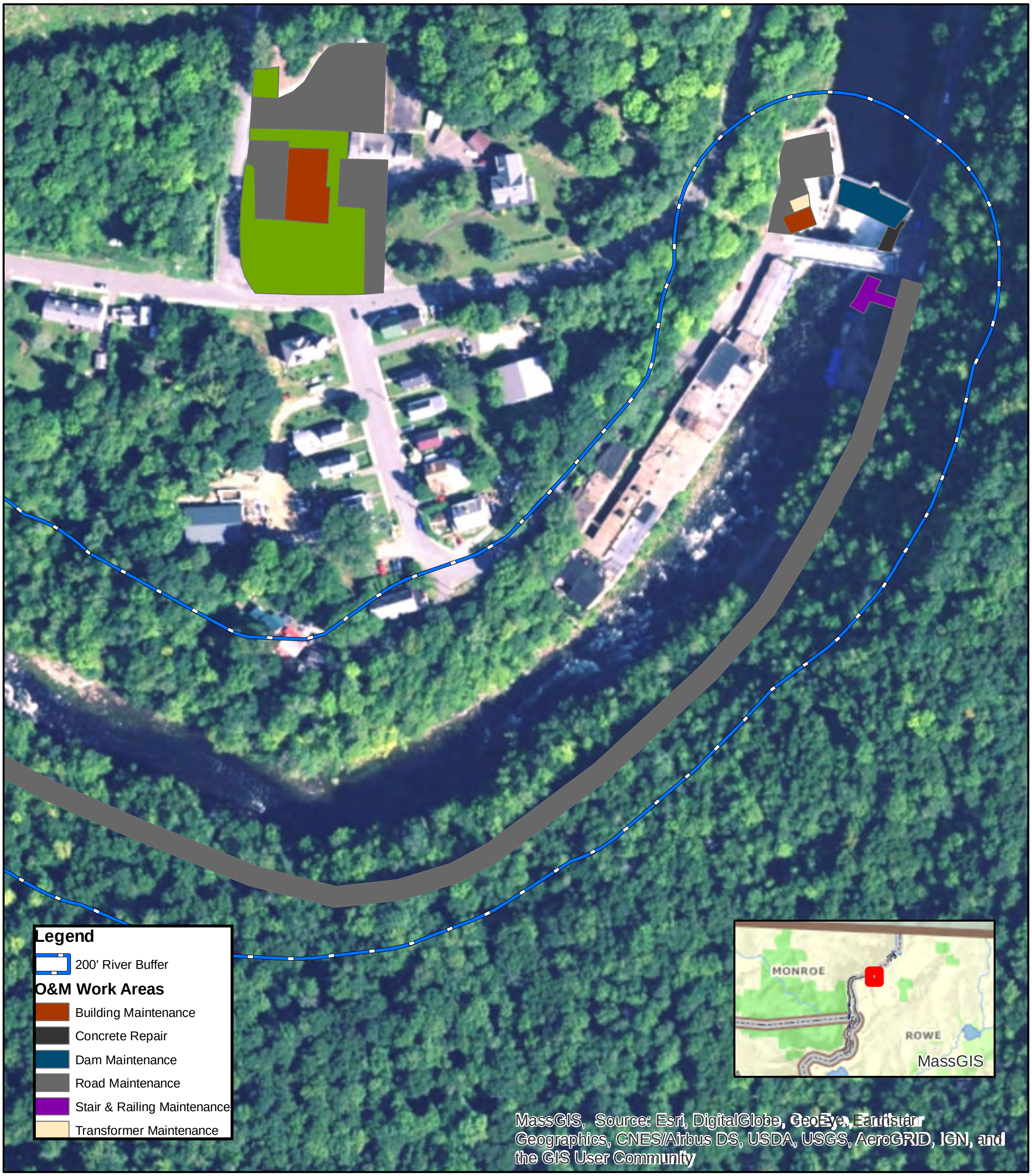

# Sherman Dam

Compliance plan for operations and maintenance

N

160 80 0 160 Feet

1 inch = 0.05 miles



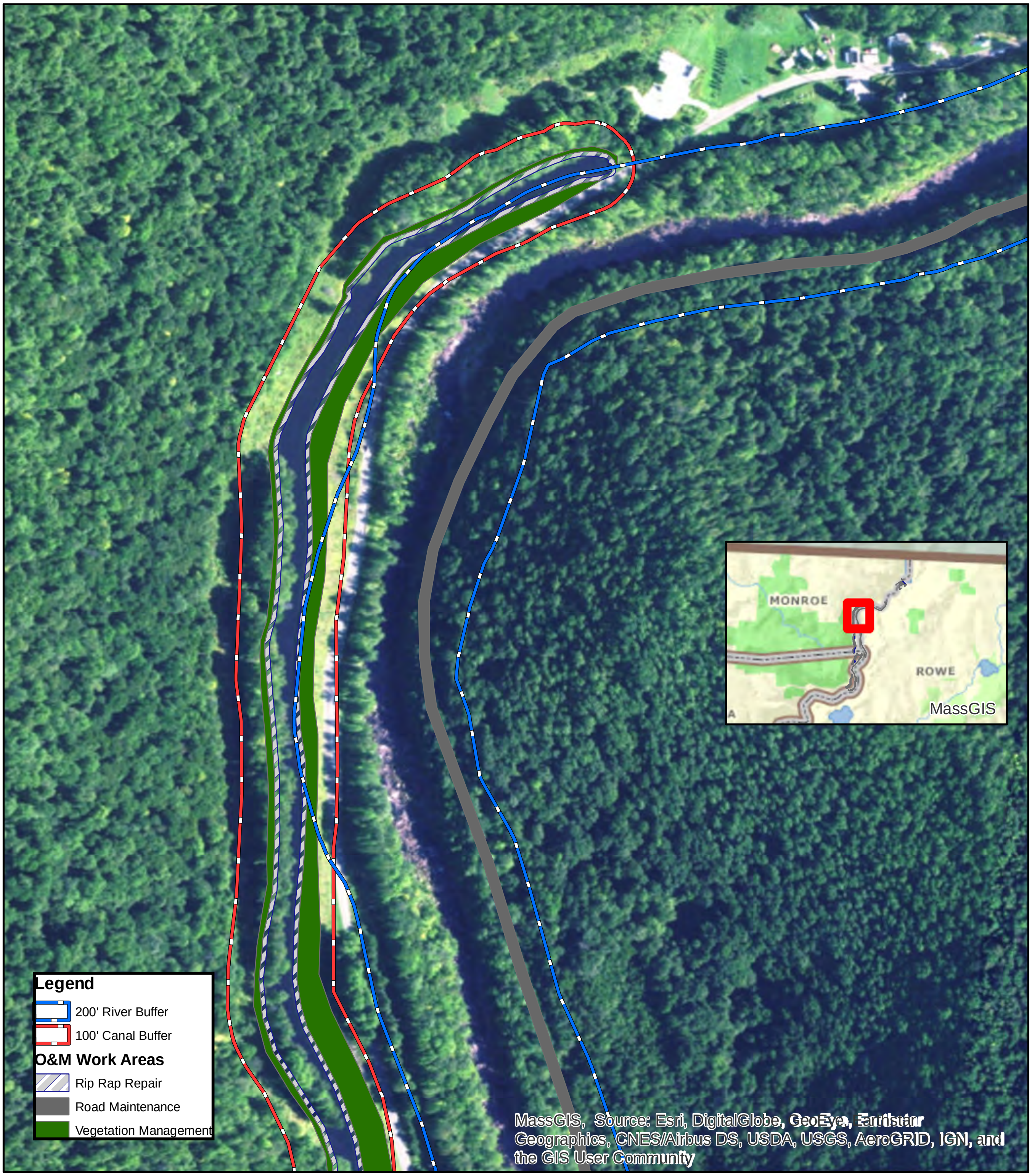

# Number 5 Dam and Monroe Bridge Office

## Compliance plan for operations and maintenance

N

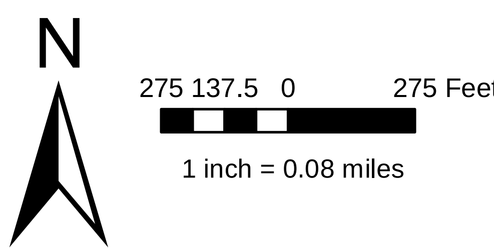
130 65 0 130 Feet

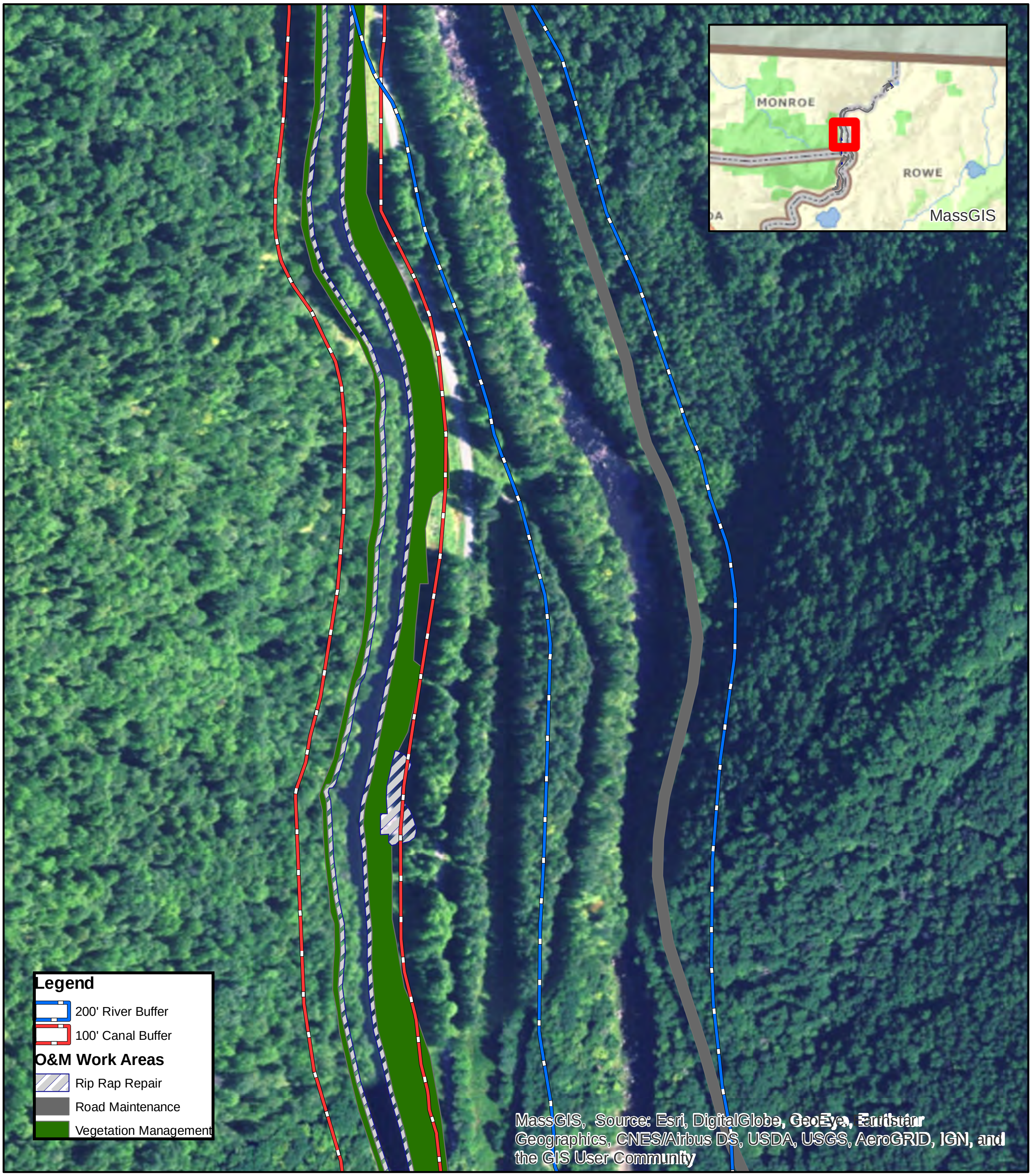
1 inch = 0.04 miles




Canal 1 map 1

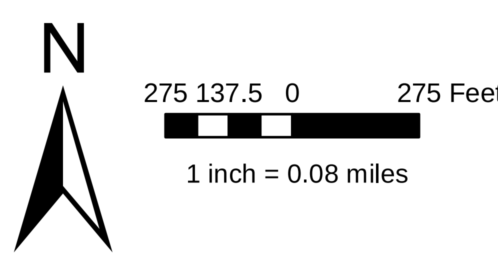
Compliance plan for operations and maintenance

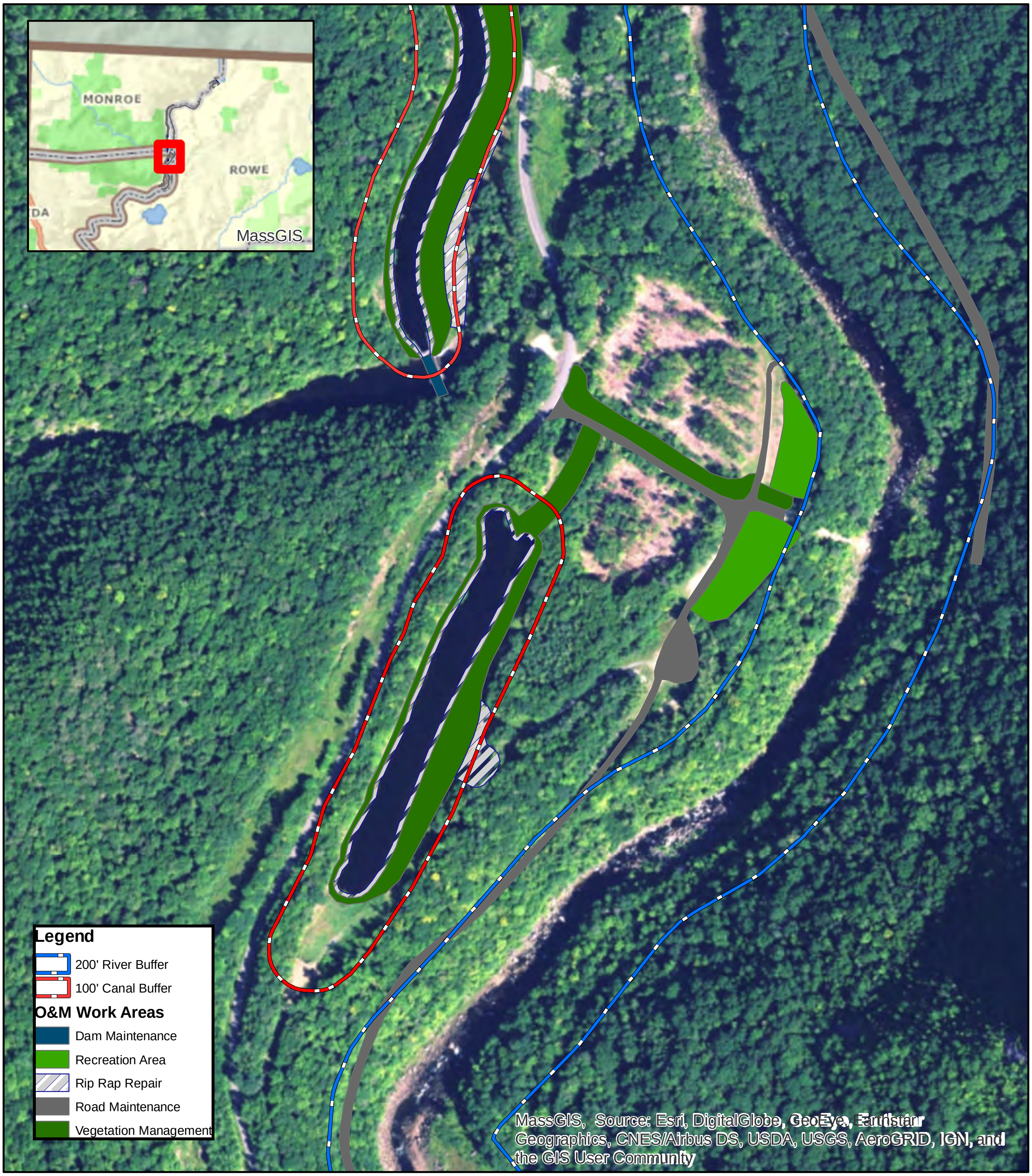





Canal 1 map 2

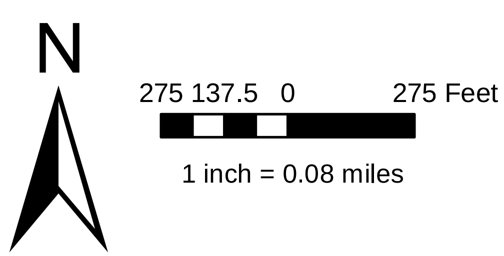
Compliance plan for operations and maintenance

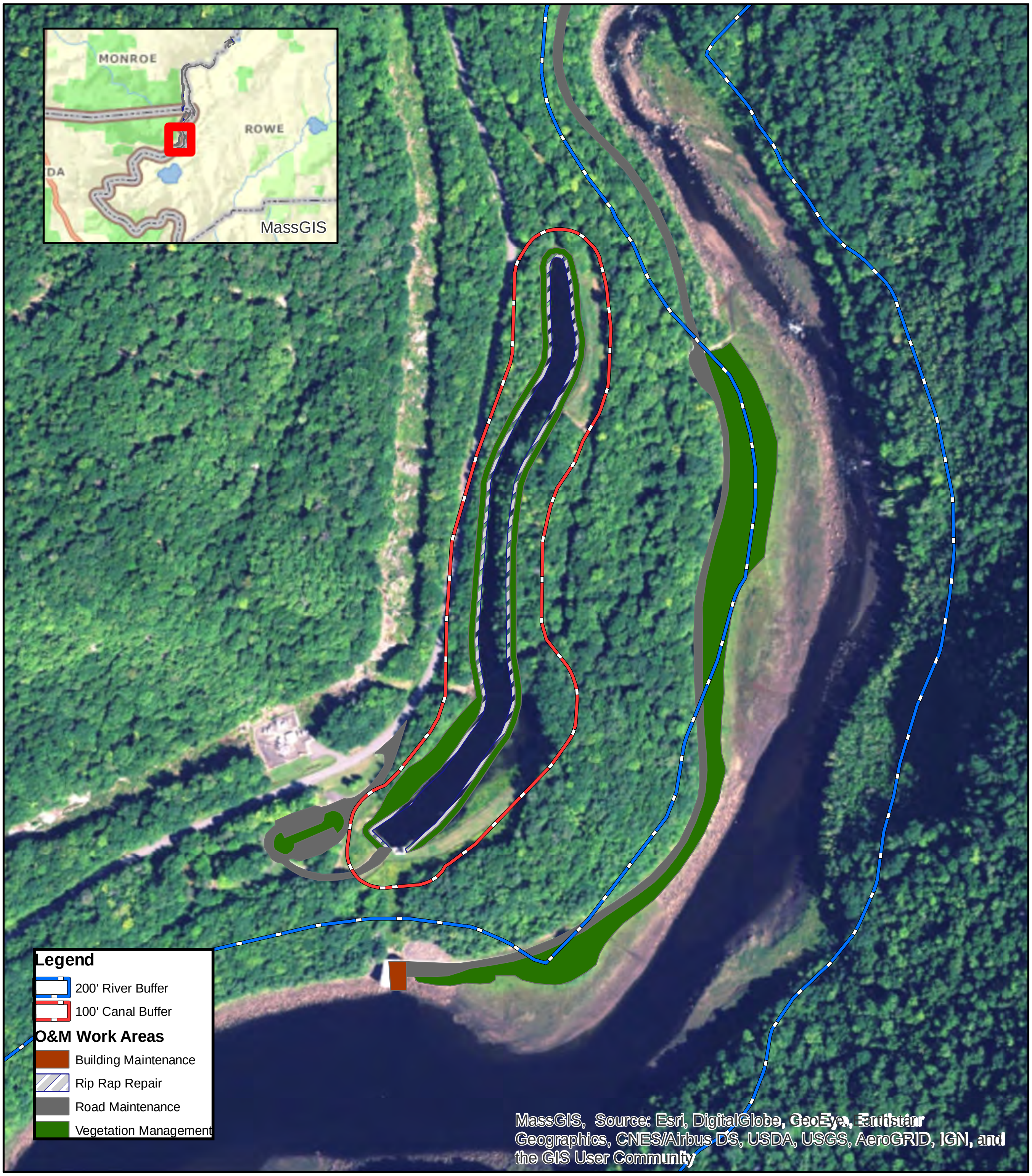





# Dunbar Brook Recreation Area and Canal 2

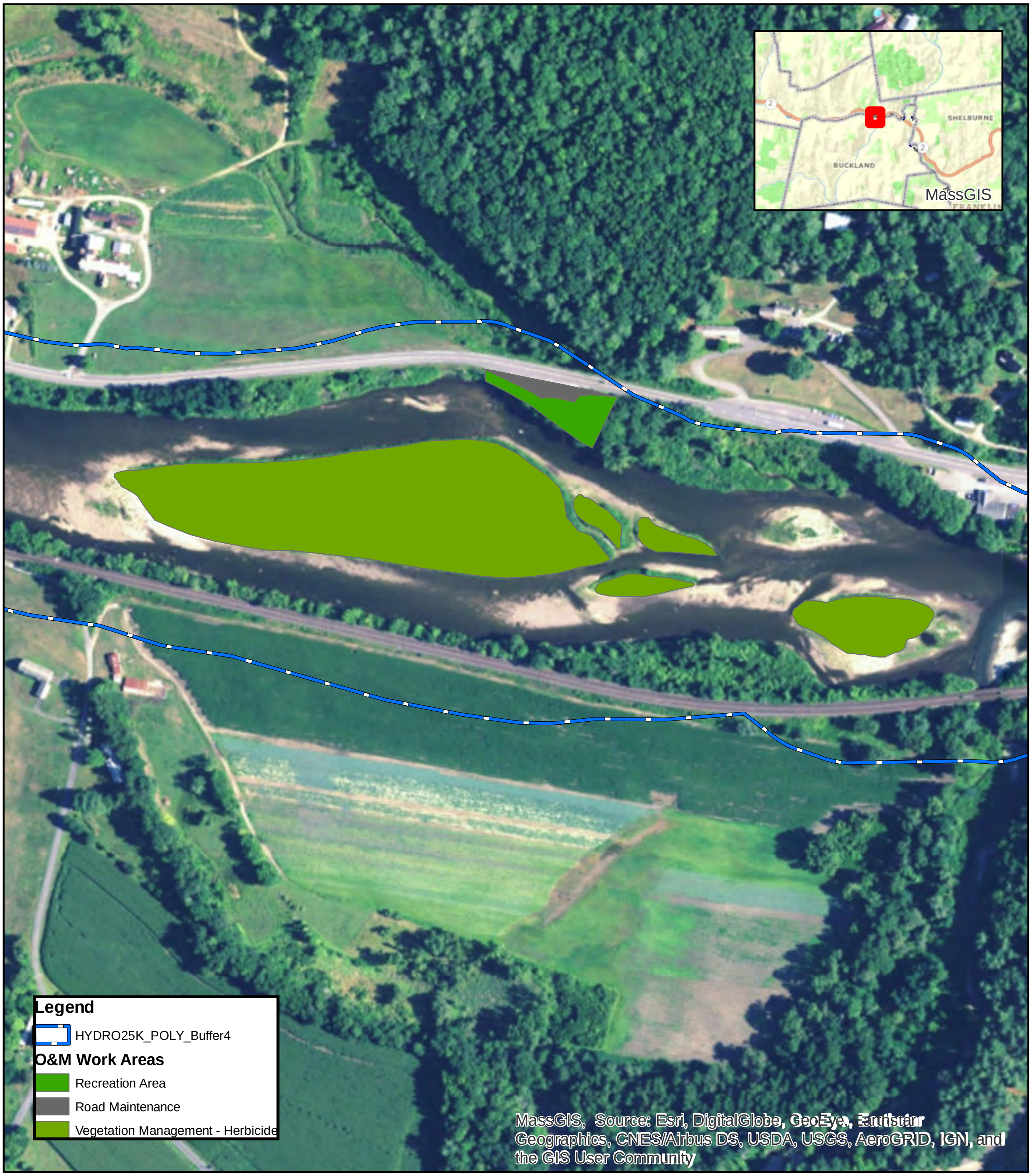
## Compliance plan for operations and maintenance






# Number 5 Station and Canal 3

Compliance plan for operations and maintenance




# Charlemont Islands and Picnic Area

## Compliance plan for operations and maintenance

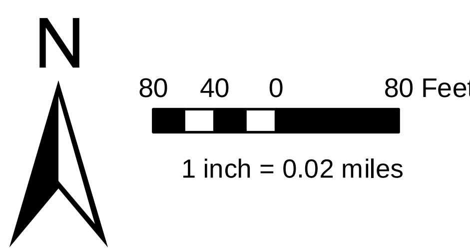
N

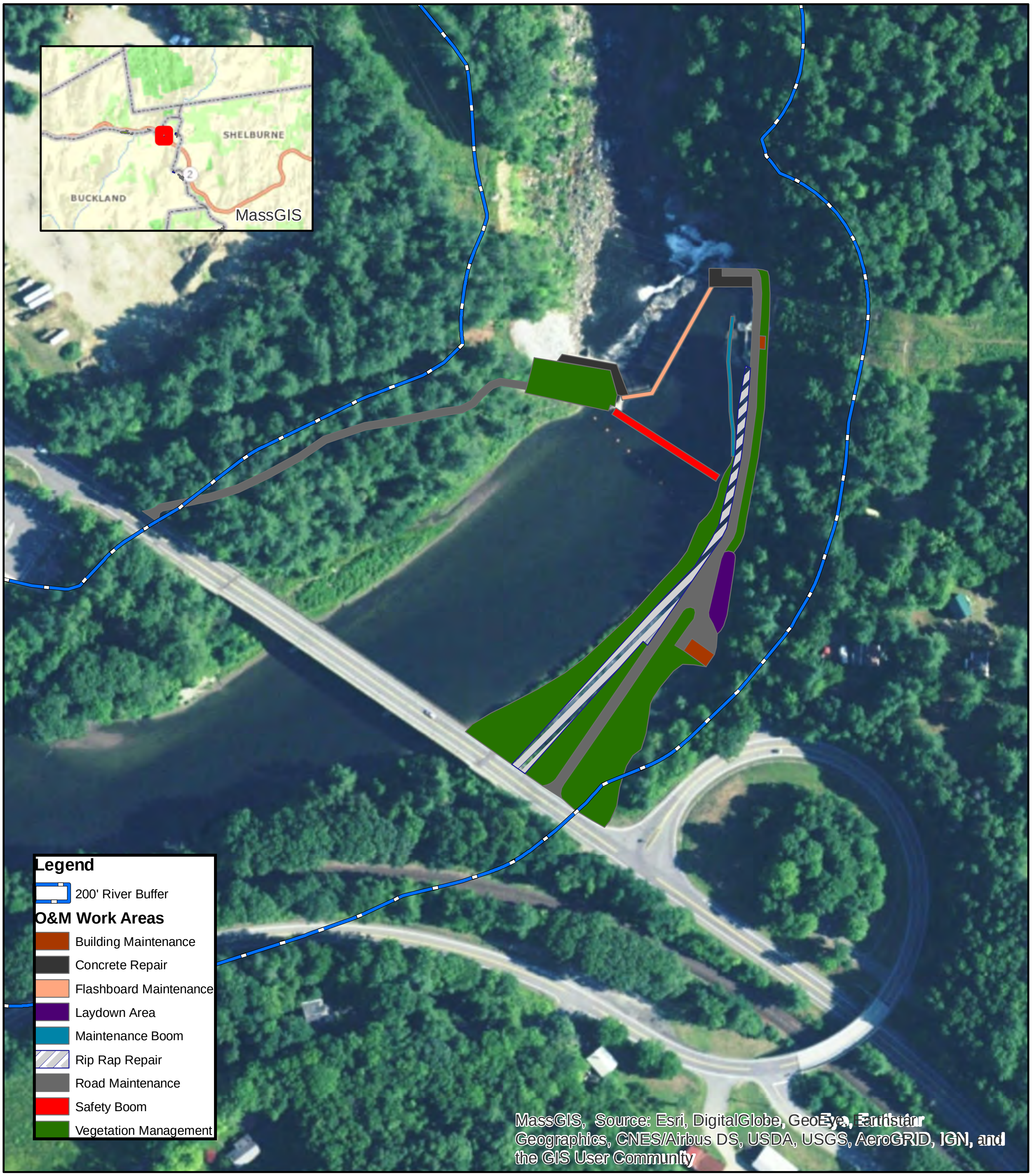
250 125 0 250 Feet

1 inch = 0.07 miles


# Deerfield Boat Launch

Compliance plan for operations and maintenance





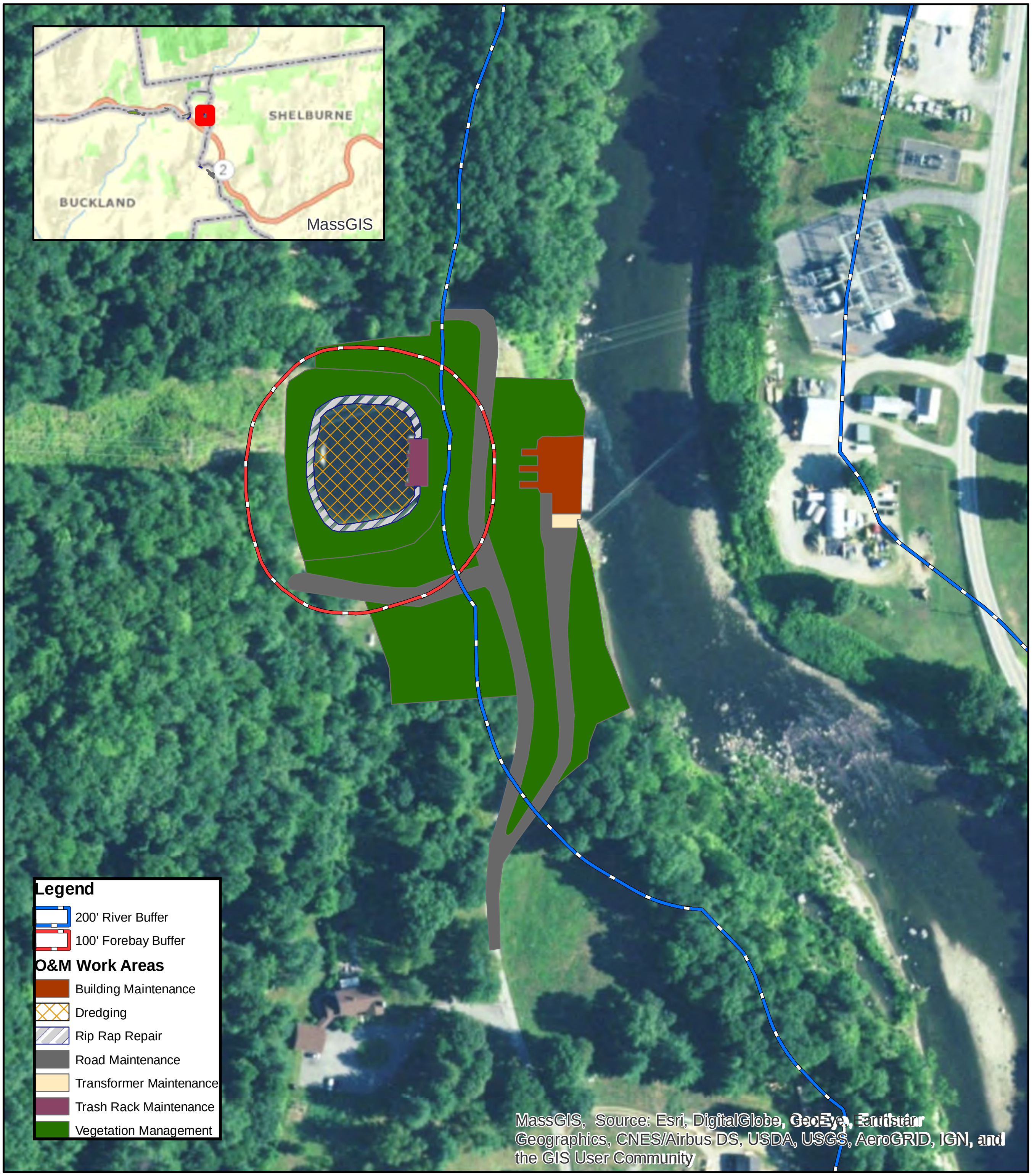

# Number 4 Dam

## Compliance plan for operations and maintenance

N

150 75 0 150 Feet

1 inch = 0.04 miles



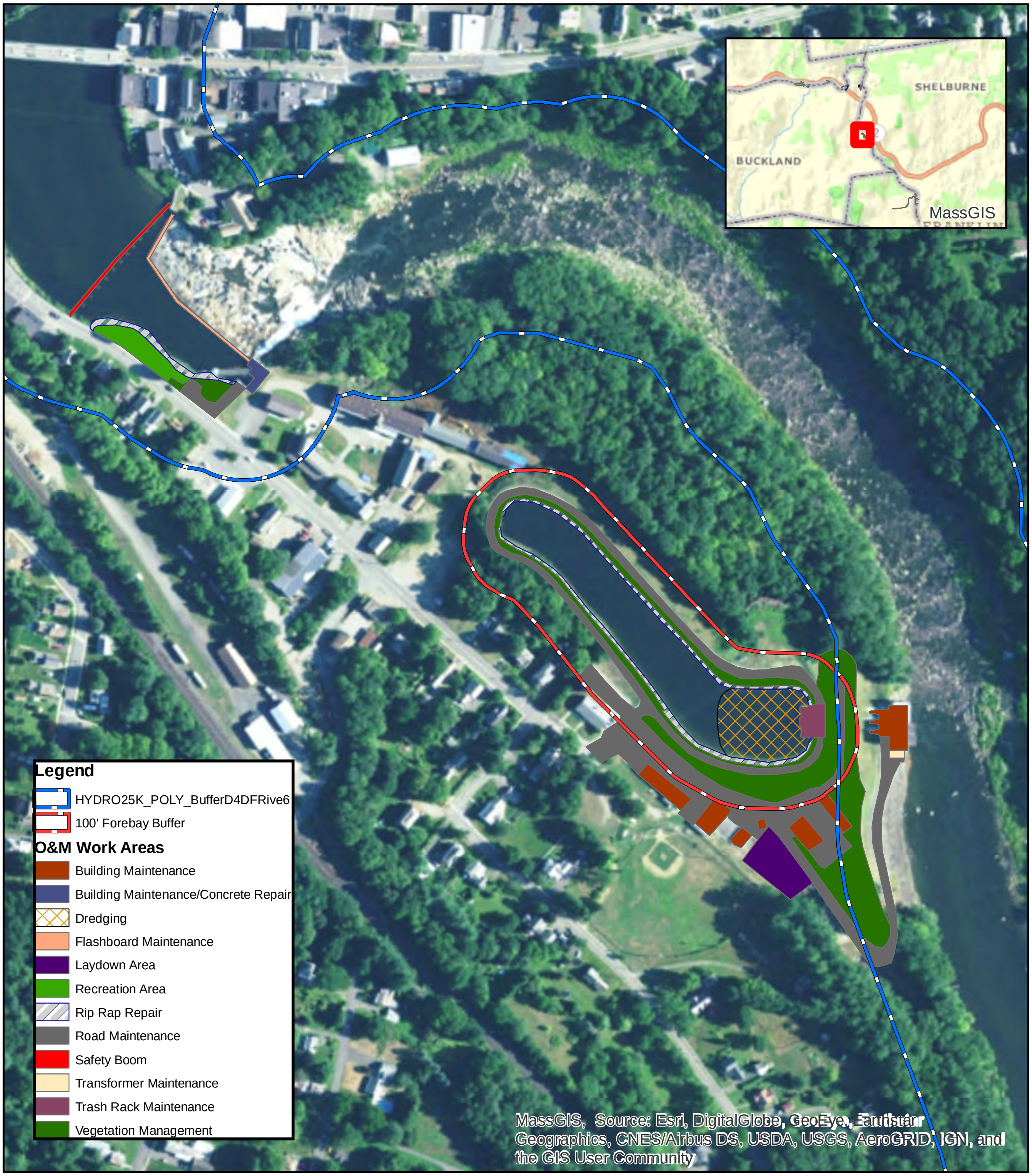

# Number 4 Forebay

## Compliance plan for operations and maintenance

N

130 65 0 130 Feet

1 inch = 0.04 miles




Number 3 Dam and Forebay

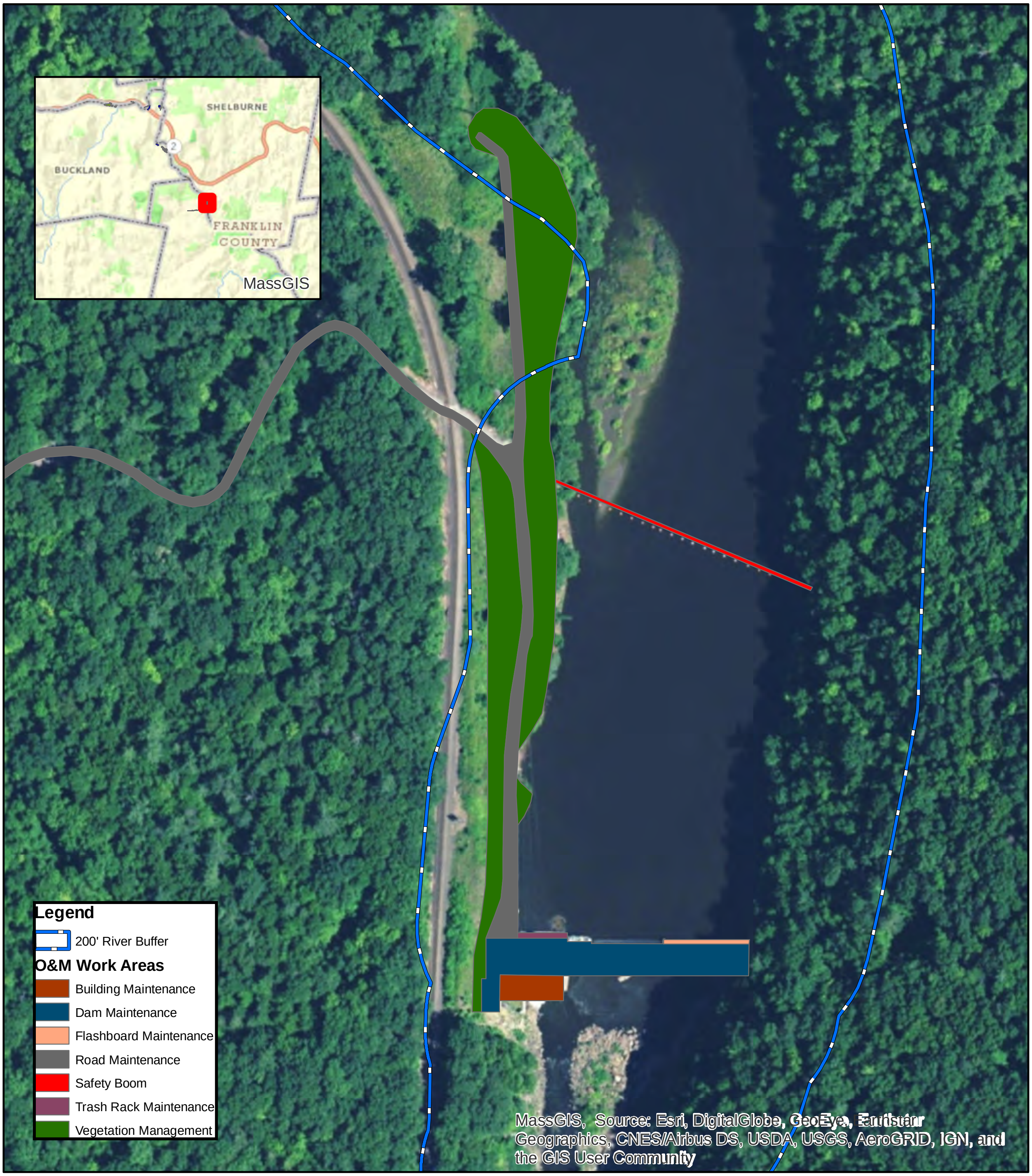
# Compliance plan for operations and maintenance

N

225 112.5 0 225 Feet

1 inch = 0.06 miles

December 2017




# Number 2 Dam and Access Road

## Compliance plan for operations and maintenance

N

160 80 0 160 Feet

1 inch = 0.05 miles

# APPENDIX B

## Site Photographs

**Photograph 1.** View of the Sherman Dam with riprap, road, fence, and safety boom maintenance areas.
Woodlot Alternatives, Inc., August 2007.

**Photograph 2.** View of the Sherman Dam with a trash rack at the intake.
August 2018.

**Photograph 3.** Recreation facilities include stairs to access the Deerfield River's whitewater area below the No. 5 dam. August 2018.

**Photograph 4.** Concrete and buildings at the No. 5 dam. August 2018.

**Photograph 5.** Man-made canals convey water. The rip-rapped banks are maintained and treated with herbicide to restrict growth. August 2018.

**Photograph 6.** Recreation sites, such as the Dunbar Brook Picnic Area, are mowed regularly. Roads, picnic sites, and portable toilets are also maintained. August 2018.

**Photograph 7.** View of debris boom in foreground, and plastic covered flashboards in distance. August 2018.

**Photograph 8.** No. 4 dam with flashboards on top and safety floats in distance. Vegetation at side of dam is maintained with herbicide. August 2018.

**Photograph 9.** Eroding concrete and painted equipment require ongoing maintenance and repair. August 2018.

**Photograph 10.** Equipment laydown areas and access roads are located within Priority Habitat and Estimated Habitat areas at the No. 4 dam. August 2018.

**Photo 11.** The No.4 Forebay. August, 2018.


**Photograph 12.** The No.4 Station building requires ongoing maintenance. The vegetated slope is treated with herbicide to limit growth. August 2018.

**Photograph 13.** Fences and roads are regularly maintained.
August 2018.

**Photograph 14.** Office and maintenance buildings within fenced area.
August 2018.

# APPENDIX C

# Contact Information

Natural Heritage & Endangered Species Program
Regulatory Review
Massachusetts Division of Fisheries & Wildlife
1 Rabbit Hill Road
Westborough, MA 01581
Phone: (508) 389-6360, Fax: (508) 389-7891

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Environmental Specialist
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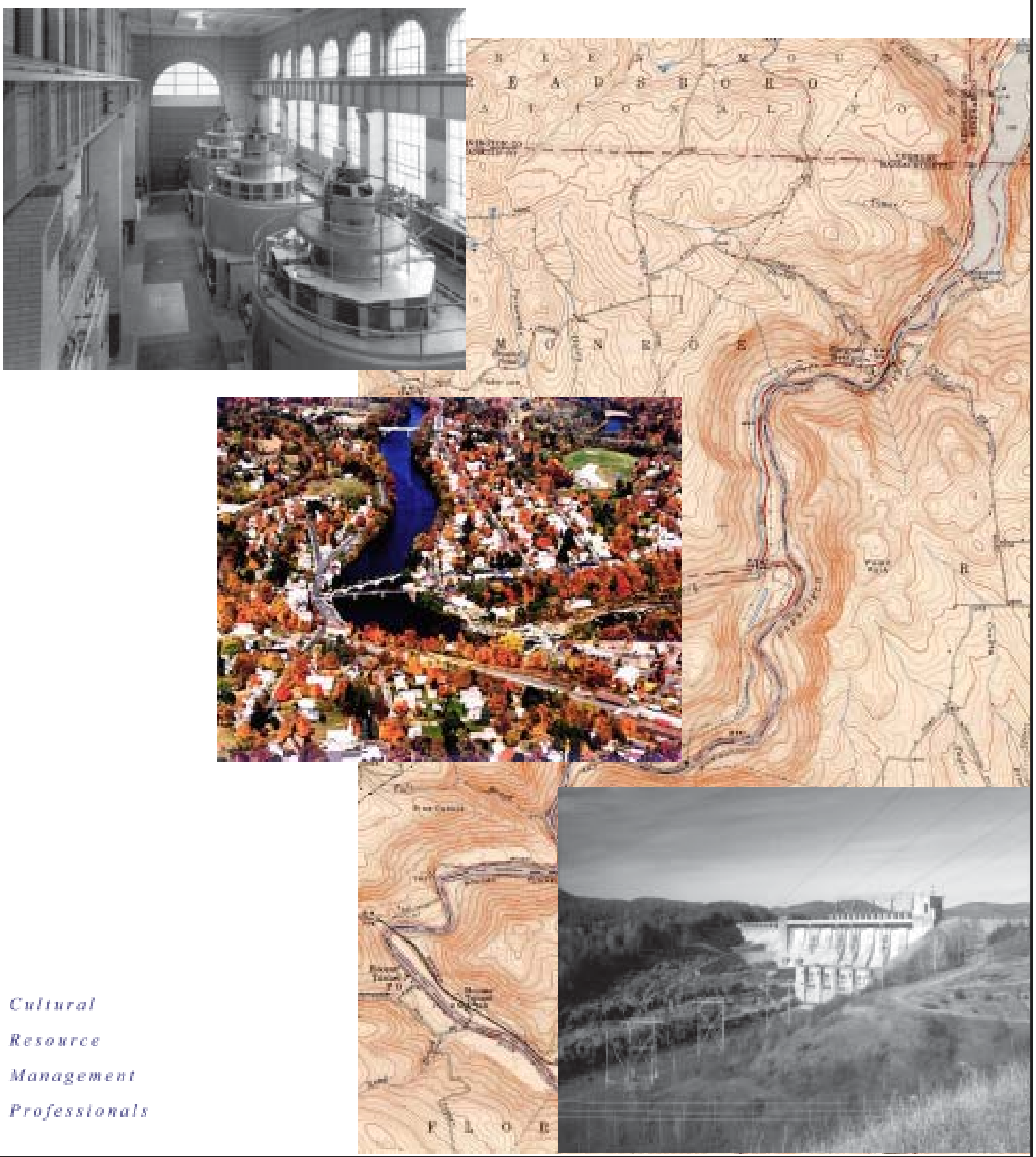
Vernon, VT 05354
Email: ksparks@greatriverhydro.com
Phone: (802) 254-3040
Cell: (802) 299-5943

## 6.5 History of Hydroelectric Development on the Connecticut and Deerfield Rivers

# HISTORY OF HYDROELECTRIC DEVELOPMENT ON THE CONNECTICUT AND DEERFIELD RIVERS



PAL

Cultural Resource Management Professionals

# HISTORY OF HYDROELECTRIC DEVELOPMENT ON THE CONNECTICUT AND DEERFIELD RIVERS

## INTRODUCTION

In 1903, Malcolm Greene Chace (1875-1955) and Henry Ingraham Harriman (1872-1950) established Chace & Harriman, a company that, in its many incarnations over the course of the following decades, grew into one of the largest electric utility companies in New England. The company built a series of hydroelectric facilities on the Connecticut and Deerfield rivers in Vermont, New Hampshire and western Massachusetts, which were intended to provide a reliable and less expensive alternative to coal-produced steam power. Designed primarily to serve industrial centers in Massachusetts and Rhode Island, the facilities also provided power to residential customers and municipalities in New England. Chace & Harriman eventually evolved into the New England Power Association (NEPA) in 1926, which became the New England Electric System (NEES) in 1947. In the late 1990s NEES was purchased by the U.S. Generating Company and the hydroelectric developments were placed in a division of the company called USGen New England, Inc (USGenNE). (Landry and Cruikshank 1996:2-5, 29, 39, 67, 141; Cook 1991:13).

The history of electrical power generation in the United States is characterized by several stages of development. From about 1880 to 1895, direct current was produced by steam and/or hydroelectric stations and transmitted over small geographic areas, providing power to arc and incandescent lights. Improvements in the 1890s initiated a second phase of development, which focused on the potential of hydroelectric power for the transmission of alternating current over long distances. In the 1920s, the industry matured, equipment and designs became more standardized, and the structure of management companies became increasingly complex. While the Depression limited further growth of the industry, a new era emerged after World War II, with streamlined management structures and increased regulations and government involvement (Cook 1991:4; Landry and Cruikshank 1996:2-5). The first of the 14 hydroelectric facilities built on the Connecticut and Deerfield rivers by Chace & Harriman and its successors were developed in the early 1900s, shortly after the potential of hydroelectric power was realized on a large scale. Subsequent facilities were constructed during the maturation of the industry in the 1920s, and two of the stations were completed in the post-World War II era. The history of the companies that built these stations is intrinsically linked with broader trends in the history of electricity, hydropower technology, and industrial architecture in America. As such, the facilities together tell the story of hydroelectric power from its late- nineteenth-century origins to the present day.

## EARLY AMERICAN ELECTRICAL HISTORY

Electricity first gained popularity in America in the 1870s with the introduction of the arc lamp by inventor Charles Brush of Cleveland. With their bright light and short life span, arc lamps predominated in commercial applications and public street lighting. Initially these lamps were run on individual generators, called dynamos. As their numbers increased, businesses began to support the construction of urban generating stations that could run up to a maximum of 60 lamps connected in series. These early stations used coal to drive a steam engine, which then turned a generator to produce electricity. The complex technology involved and the small size of the stations kept prices high and demand limited, posing little competition to the established gas-lighting companies. Despite these disadvantages, by 1880 Brush had installed central electric stations in major American cities like San Francisco, New York, Philadelphia, and Boston, and had over 5,000 arc lights in operation (Glover and Cornell 1951:671; Landry and Cruikshank 1996:11-14; Marcus and Segal 1989:143-5).

About the same time, Thomas Alva Edison's Edison Electric Company developed and introduced the enclosed incandescent light. In contrast to arc lamps, a large number of incandescent lights could be wired in parallel with low voltage direct current (DC), lowering the cost of illumination. The enclosed nature of the light, which was composed of a filament within a vacuum tube, also made it suitable for indoor use. While arc lights remained standard for public and commercial exterior use, these two factors immediately increased the demand for electric lights among residential consumers, creating a fierce rivalry with the existing gas companies. When Edison opened his first central generating station in New York City in 1882, the electrical power was initially distributed for free, enticing many converts (Landry and Cruikshank 1996:14-15; Marcus and Segal 1989:145-148).

Although Edison Electric had few rivals in the distribution and production of DC incandescent lighting, the technology had limited application until the development of alternating current (AC). The dissipation of DC electricity over distance caused most stations to be located in downtown areas, neglecting the demand for electricity in rural areas and preventing the exploitation of most potential water-power sites. DC also required a continual expansion in the number of powerhouses, as each quickly reached its maximum capacity.

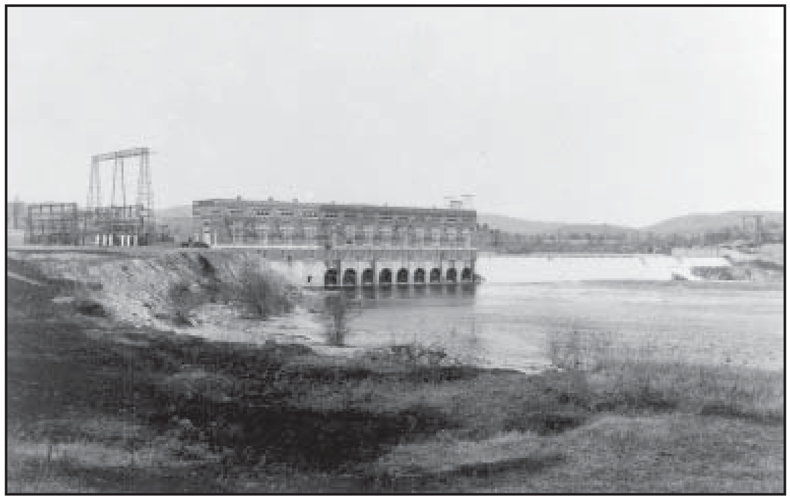
The introduction of AC electricity by George Westinghouse made electrical power more practical for both household and industrial use, allowing variations in voltage as well as decreased energy loss during transmission. At the 1893 World's Fair, Westinghouse won a contest that allowed him to build a generating station at Niagara Falls. His station was a brilliant success, transmitting power over a distance of 26 miles to Buffalo, New York with high profits, thereby triggering a "hydromania" for powerhouse construction and long-distance transmission. AC electricity was quickly embraced by those in thinly-populated areas who had not received DC power because of its prohibitively high cost. With its greater flexibility, lower cost, and unrestricted capacity, AC power began to challenge DC in the cities, encouraging the creation of larger central stations that could spread power throughout the outlying areas (Glover and Cornell 1951:674; Landry and Cruikshank 1996:18-23; Marcus and Segal 1989:149-150).

By the turn of the century, 18 utilities in Massachusetts generated hydroelectric power, although in most cases it was a supplement to, or back-up for, coal-produced steam power. The cost of transporting great amounts of coal to New England was high, however, and as hydroelectric technology improved, it became an obvious alternative. Unfortunately, most rivers were located in northern New England, far from the industrial centers that demanded the power source. Many also lacked the reservoirs needed to ensure a steady flow of water. Within three years demand had grown such that the Massachusetts legislature passed a law allowing special permits for new utility companies. Thus began the odyssey of Malcolm Greene Chace and Henry Ingraham Harriman, who built a series of remote hydroelectric power plants along the Connecticut and Deerfield Rivers, successfully transmitting the new power to the manufacturing centers of the region.

## NEP Hydroelectric Power Development on the Connecticut and Deerfield Rivers

In 1903 Chace, the son of a textile worker, and Harriman, whose father was a judge and textile machinery inventor, formed Chace & Harriman with the intent of exploiting hydroelectric power in Maine. In 1907 a potential site was identified, not in Maine, but rather at Vernon, Vermont, on the

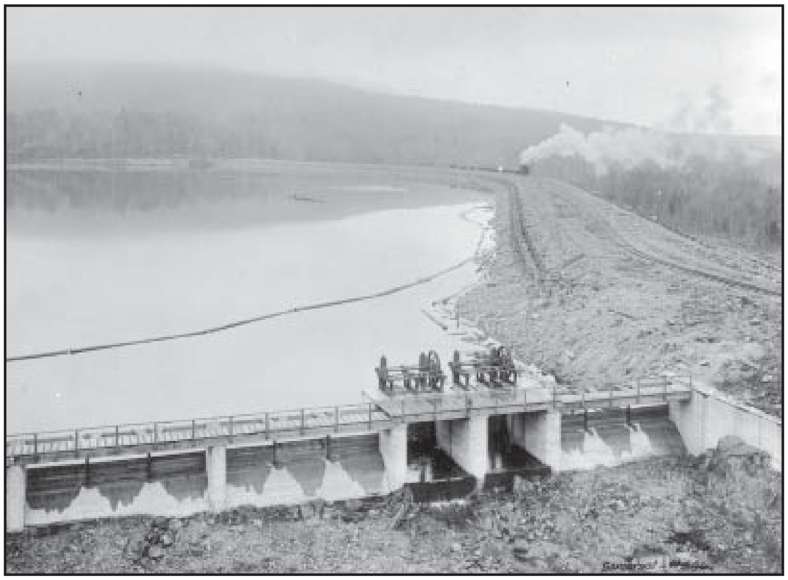
Connecticut River. This river, which flows approximately 400 miles from Third Lake in northern New Hampshire to Long Island Sound, drops 2,000 feet over the course of its journey. With its many falls, the river had attracted mills since colonial times. Local investors already had plans for its development as a hydroelectric power source by the time Chace & Harriman took over the project in 1907. The design of the Vernon Development was largely the work of the mechanical engineering firm of Charles T. Main, Inc., of Boston. An 1876 graduate of the Massachusetts Institute of Technology, Main was an authority on water and steam power and his firm, established in 1907, had been involved in the design of over 80 hydroelectric facilities by the time of his death in 1943. The construction of the Vernon station was completed by J. G. White & Company of New York, with 450 workers assigned to the project (Landry and Cruikshank 1996:26-35; Cook 1991:18-19).



**Vernon Development, Hinsdale, NH/Vernon, VT, built 1907–1909, 1920. View looking northeast from the Vermont side of the Connecticut River, showing from left to right, the switchyard, powerhouse, and dam (undated photo). When completed, Vernon was the largest hydroelectric plant east of Niagara Falls, and was the first northeastern U.S. hydroelectric plant to deliver load via long-distance transmission lines.**

Vernon was an ambitious facility that required raising the river 30 feet, flooding all or parts of 150 farms. Construction was finished within two years, however, and Chace & Harriman attempted to secure rights-of-way for transmission into north-central Massachusetts. After many complicated financial arrangements, including the creation of a holding company and a subsidiary company (Connecticut River Power Company of Maine and Connecticut River Transmission Company of Massachusetts, respectively), they received special permission to enter Massachusetts markets, provided sales were restricted to bulk customers. The first generator at the Vernon station went on line on July 27, 1909, supplying 60-cycle AC power at 19 kilovolts to the Estey Organ Works in Brattleboro, Vermont. By 1910 eight generating units produced a total of 20 megawatts, sent at 66 kilovolts a distance of over 60 miles, dwarfing the output of all other stations in the east. The unprecedented voltage and distance of transmission, as well as the construction of a line into Worcester, Massachusetts, quickly secured large customers such as the American Steel and Wire Company and Worcester Electric Light Company (Landry and Cruikshank 1996:26-35).

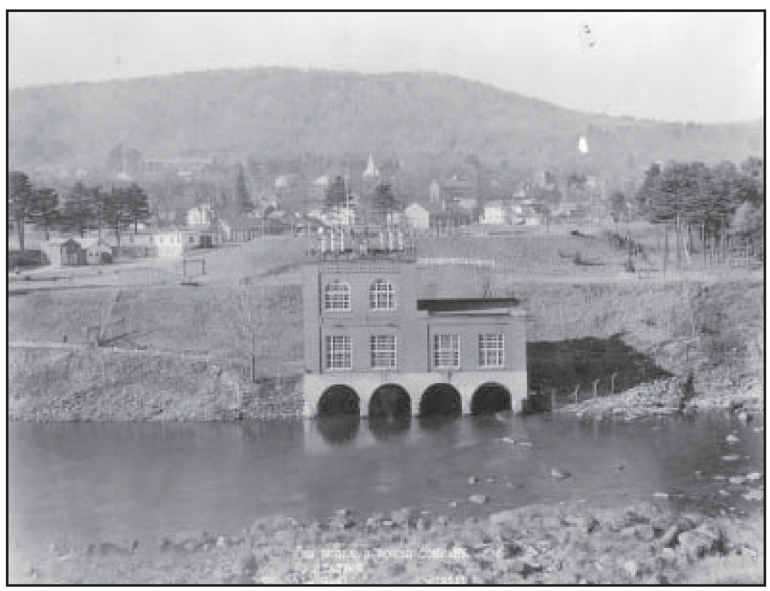
As demand grew and Vernon became unable to provide enough power during the dry season, Chace & Harriman focused their attention on the Deerfield River, which runs through southern Vermont and western Massachusetts before joining the Connecticut River below Turners Falls. Twenty miles southwest of Vernon, in Shelburne Falls, Massachusetts, the river drops 300 feet, creating an ideal location for a series of generating stations, provided a large reservoir could be built to regulate the flow and prevent flooding. Chace & Harriman created a Massachusetts-based company, New England Power, to oversee the construction of the Deerfield facilities, with financial backing from New England Power of Maine. The Power Construction Company, a subsidiary created by New England Power and headed by George Bunnell, managed the construction of the facilities. J. G. White & Company and Charles T. Main, Inc., both of whom had worked on the Vernon station, were employed as design consultants on the Deerfield River projects (Landry and Cruikshank 1996:38-40; Cook 1991:18-19; Cavanaugh et. al. 1993a; Cavanaugh et. al. 1993b).



*Somerset Development, Somerset, VT, built 1911–1913. View of 2,100-ft-long, 110-ft-high modified hydraulic earth fill dam looking south with spillway in foreground. Construction railway track and steam locomotive pulling dump cars are visible on dam crest (ca. 1913).*

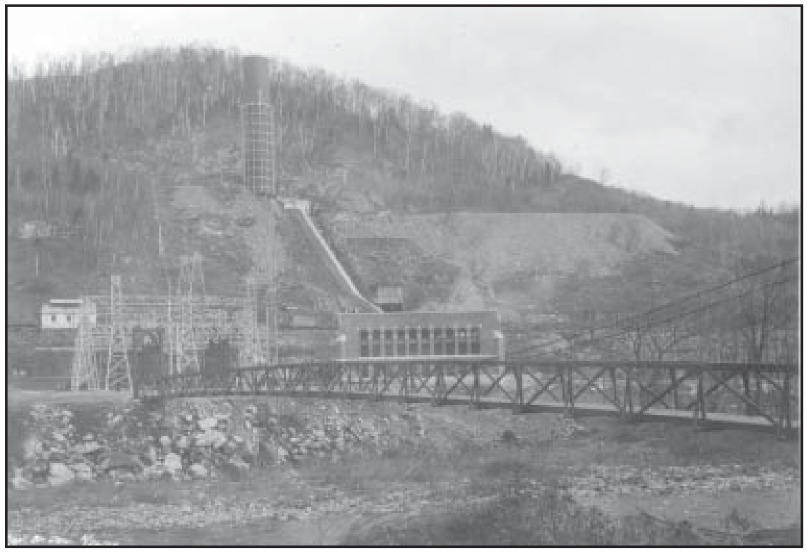
In 1914, Chace & Harriman's various companies were consolidated into the New England Company, a Massachusetts voluntary trust. At this time the company was the largest power provider in Massachusetts, providing more than all other companies in the state combined, Boston Edison aside. Rather than providing competition to steam power stations, however, the hydroelectric generating stations provided a convenient counterbalance to their output. In the winter, when more power was needed because of shorter daylight hours, water was more plentiful, while in the summer, when demand decreased, so did the flow of water. Advances in electric motor development also increased daytime industrial usage, expanding overall demand and distributing consumption more evenly over a 24-hour period. As the New England Company became more dominant in its position and demand continued to grow, it became evident that

By 1911, a three-mile-square (2.5 billion cubic foot) reservoir with a 456-foot long earthen dam had been built in Somerset, Vermont, north of Shelburne Falls. At the same time three standardized stations (Deerfield No. 2, Deerfield No. 3, and Deerfield No. 4) were built, each with its own concrete dam. These stations came online in 1912 and 1913, providing a total capacity of 18 megawatts. A fourth station, Deerfield No. 5, was built slightly upstream to provide power to the Hoosac Tunnel, a 4.75-mile-long railroad tunnel in the Berkshire Mountains that connected Boston with the Hudson River Valley. This station had a larger capacity of 15 megawatts, allowing it to accommodate the demand for sudden large bursts of wattage. Thus with the creation of the Deerfield transmission line and the addition of a full switching station at Millbury, Massachusetts, the transmission network was able to operate as a Vernon-Worcester-Millbury-Shelburne Falls-Vernon loop, allowing a broad customer base (Landry and Cruikshank 1996:38-40).



*Deerfield No. 3 Development, Buckland/Shelburne, MA, built 1912 et seq. View of powerhouse looking south across Deerfield River from Shelburne Falls to Buckland (November 25, 1941photo). View shows turbine outfall arches below powerhouse. Deerfield No. 3 was the administrative and maintenance center for the Lower Deerfield developments, and several of the workshops and storage buildings are visible behind the powerhouse to the left.*

the company needed to find its own seasonal steam-power backup, as well as build more stations. Satisfying these needs would require contracts with steam power producers, large investments in land, and costly reservoir construction (Landry and Cruikshank 1996:42-43).



***Harriman Development, Whitingham/Readsboro, VT, built 1924 et seq. View of Readsboro facility looking east across Deerfield River, showing from left to right, switchyard, surge tank, powerhouse, and footbridge (November 26, 1924 photo). The Harriman Development incorporated several major works of engineering and was the showpiece of the Deerfield River developments.***

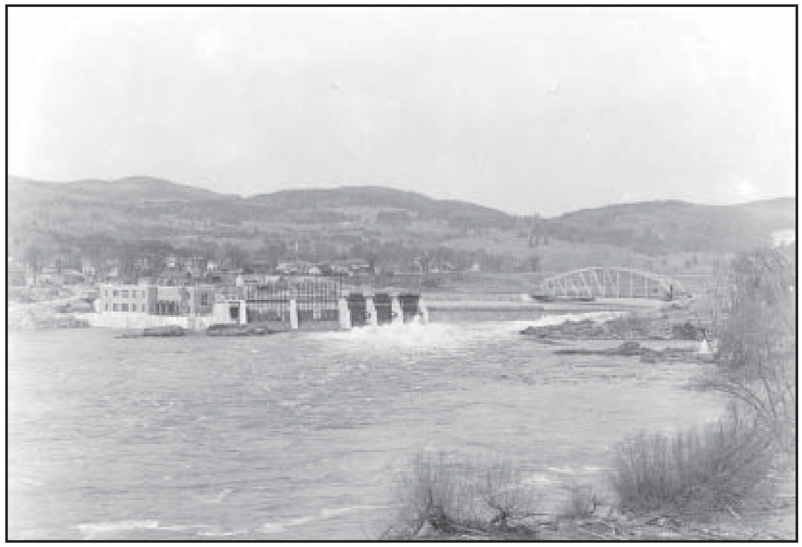
World War I caused severe shortages and a drastic increase in the cost of power. The price of coal doubled and the workforce was severely reduced, inspiring a push towards conservation and the adoption of daylight savings time. New construction was limited to connections to areas of strategic military importance, forcing small utilities to buy power from larger utilities, which were better able to balance power distribution to accommodate shifting needs. Despite rate increases caused by wartime shortages, annual kilowatt sales between 1916 and 1920 grew from 246 million to 431 million. The war also fostered an interconnection of transmission lines among utilities, and by 1920 the New England Company controlled 300 miles of line, a fivefold increase from a decade earlier, creating a network that stretched from Lake Erie to the Atlantic Ocean (Landry and Cruikshank 1996:52-53).

To ease the wartime power shortage, the U.S. Department of the Interior agreed to work with the company to pay for the Davis Bridge Development (later named Harriman) in Whitingham, Vermont. Called the "White Coal Project," this endeavor included an expanded powerhouse and two 4.2 megawatt generators at Vernon, nearly doubling its peak-hour capacity, as well as a 5-megawatt station and dam at Searsburg, Vermont. Despite Vernon's increased capacity, it was soon to be dwarfed by the Harriman station. Approximately 1,200 people worked on the $10 million project, which included the construction of a large powerhouse, a concrete spillway, and a 2,200-acre reservoir, creating the largest man-made lake in Vermont, with double the storage capacity of the Somerset reservoir. At 1,300 ft long and 215 ft high, the dam was the highest earthen dam built at the time of its construction. Previous Deerfield River projects regulated the western branch of the river; with the addition of the Harriman station, the eastern branch was brought under control as well. Together with the Somerset dam, the Harriman dam was one of the earliest structures outside of the Panama Canal to employ the hydraulic fill method of construction, which involved dumping material into two dikes, and then washing the dikes with water to filter the fines into the ditch between them. This procedure produced a dam with an impervious core. When it opened in 1924, the Harriman Development, named in honor of its founder, was the largest hydroelectric facility east of Niagara Falls and supplied 40,000 kW, almost doubling the total output of the Deerfield River. Its large size necessitated the construction in 1927 of a smaller hydroelectric station downstream at Sherman to even out any sudden discharges. After the construction of both stations was complete, power was transmitted from Harriman to Millbury, Massachusetts, on a 110 kilovolt line, the first to exceed the 66-kilovolt standard (Landry and Cruikshank 1996:38-40, 54-59; Cavanaugh et. al. 1993b).

***Bellows Falls Development, North Walpole, NH/Rockingham, VT, built 1925–1928. View of powerhouse looking north with transformers at right (November 3, 1941 photo).***

Despite the large scale of Harriman, demand for electricity continued to increase beyond the available supply. Much of this demand came from residential customers who were beginning to use electric appliances as well as electric lights. In 1918, less than one-third of American homes were wired for electricity. By 1929, however, the number had grown to over two thirds. Therefore, as soon as Harriman was finished, the company broke ground at a site 30 miles north of Vernon at Bellows Falls, the downtown location of a small subsidiary known as the Bellows Falls Power Company. This company had been created by Chace & Harriman in 1912 through the purchase and reorganization of a canal company and two small hydroelectric companies. In 1918 they decided to rebuild the canal and build a new power station, guaranteeing the Fall Mountain Paper Company (partial owners of the water rights) a supply of electricity. Within eight years the paper company shut down and sold their water rights to Bellows Falls Power. The construction of a new hydroelectric station began immediately, despite delays caused by the flood of 1927. While the old canal provided one million gallons per minute and produced 10,000 horsepower, the new canal was able to send 4.2 million gallons per minute to the turbines providing 60,000 hp to produce 49,000 kW. This dramatic increase in water capacity was achieved through the construction of a new dam, which was slightly higher than its predecessor. Although the head was only 60 feet, the power capacity of the Bellows Falls station matched that of Harriman (Landry and Cruikshank 1996:59-62, 72).

After World War I, the New England Company was desperately in need of financial backing and feared the loss of their customer base to the larger holding companies that had emerged in the prosperous years after the war. To assuage these worries, Chace & Harriman decided in 1926 to sell most of their company to the International Paper Company. While the International Paper mills were no longer economical paper producers, they were still capable of creating hydroelectric power. Archibald Graustein, President of International Paper, was open to replacing his failing paper empire with a power empire. At the same time, Chace & Harriman were anxious to get an infusion of equity capital from International Paper, thereby allowing the company to launch a counterattack against bigger companies and establish a larger customer base. Therefore, Graustein, Chace & Harriman developed the New England Power Association (NEPA), which was essentially a compilation of its old holding companies and all of its subsidiaries. International Paper, Northeastern Power, and Stone & Webster were ceded a majority position in the enterprise in exchange for $20 million, and Chace & Harriman retired to the board. This reorganization was followed by a wave of acquisitions handled by the newly-hired President, Frank Comerford. Even with the increased efficiency and capacity of the existing hydroelectric stations, the most efficient power sources continued to combine steam and water power, leading Comerford to purchase a gas company, multiple retail units, and more steam plants before the onset of the Depression (Landry and Cruikshank 1996:65-84).



***McIndoes Falls Development, Monroe, NH/Barnet, VT, built 1931. View looking northwest from the New Hampshire side of the Connecticut River, showing, from left to right, the powerhouse and dam (April 13, 1931 photo). McIndoes Falls, one of three facilities in the Fifteen Mile Falls Development, was built as a run-of-river facility to even out discharge flows from the larger Comerford Development upstream.***

Harriman had purchased the rights to an area known as Fifteen Mile Falls on the Connecticut River in 1910. At the time, the Falls' low volume made development impractical, and Harriman soon sold his rights. Immediately after the company's reorganization in 1926, however, NEPA was more confident and re-purchased the site. Its power potential was high, allowing for two large reservoirs of an extremely high volume. Unfortunately, NEPA's customer base was not large enough to justify building at such a large, yet cost-efficient size. To solve this problem, Comerford arranged a deal with Boston Edison in which they would buy one-third of the station's output (150 million kilowatts) at $2 million per year for 20 years. Thus began one of NEPA's greatest engineering feats. To divert the river, reshape the old river bed, and build the dam, the company excavated more than 1 million cubic yards of rock, mixed and poured 300,000 cubic yards of concrete, and consumed 5,000 tons of structural steel. A small town of workmen emerged on a hillside in Barnet Township, Vermont, to construct the complex, which doubled NEPA's peak capacity for hydroelectricity by adding 160 megawatts and saving the 200,000 tons of coal that would have been needed for steam power. Water first spun the turbines in September, 1930, after a month of accumulating in the reservoir behind the dam. Aptly named "Comerford," the station transmitted power to a switching station in Tewksbury, MA, traveling a distance of 126 miles, through 2,000 steel towers, and over 800 miles of aluminum cable (Landry and Cruikshank 1996:87, 90-91).

NEPA had planned three developments at Fifteen Mile Falls. The second project was located seven miles downstream from Comerford. A small auxiliary plant, the new facility was designed to even out any sudden discharges of water. This plant, called McIndoes Falls, came on line in 1931, one year after Comerford, bringing the Fifteen Mile Falls capacity to a total of 175,300 kW. The stations at Comerford and McIndoes Falls were both designed by Charles T. Main. The development of the third site at Fifteen Mile Falls was postponed until a further increase in demand warranted the investment (Landry and Cruikshank 1996:90-91, Cook 1991:18-19).

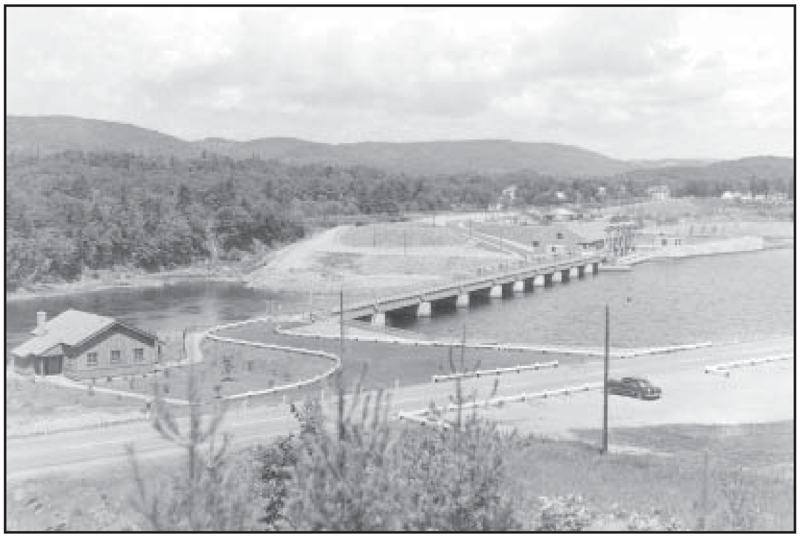
NEPA's period of expansion in the early 1930s came to a halt with the Depression, as the company struggled to pay for McIndoes Falls. Investors were scared off, emergency taxation was introduced, and NEPA was plagued with cumbersome finances, an overly complicated organization, overcapitalized holdings, as well as several new businesses. A series of natural disasters also plagued the company during the 1930s, including the great flood of 1936 and the Hurricane of 1938, both of which caused damage to several of NEPA's facilities. In 1932 the company's retail sales, which had always risen, declined for the first time and employment levels fell. When enraged investors forced the government to investigate utilities after the market crash, NEPA's convoluted financial organization was disclosed and the company was forced to implement an immediate simplification of the corporate structure. The Federal Trade Commission then passed the "Public Utilities Holding Company Act," which prohibited holding companies that unnecessarily complicate corporate structure and gave the Federal Power Commission the power to regulate interstate utilities. After working carefully together with the government on this issue, Harriman resigned, Comerford became president of Boston Edison, and International Paper and many of its subsidiaries were liquidated.

The Depression also spurred several positive changes, allowing NEPA to emerge as a stronger company when the economy finally bounced back. Government intervention made NEPA once again independent by 1947 and created a simpler organizational structure. The lower demand forced a decrease in rates, as well as an intensification of "load-building" programsCaggressive marketing and merchandising programs designed to increase residential demand. NEPA sold appliances to increase household electrical use and pushed for rural electrification by encouraging the agricultural use of utilities. By 1940 demand was again rising and employment was up, allowing NEPA to incorporate line extensions and upgrades (Landry and Cruikshank 1996:93-119).

With the onset of World War II, NEPA began strengthening those operations that had slackened during the preceding decade. Many employees were sent off to war, and those that remained were under pressure to meet the heavy demands of the many military and war-related factories despite severe shortages of labor and materials. Many of NEPA's employees also worked with the government to speed the transition of new weapons from experimental to operational. This advanced technical involvement gave NEPA the experience that would later give it a prominent role in post-war energy planning. As the economy began an upswing, civilian energy use remained limited and many furnaces were converted from oil (the newer fuel source) back to coal. During this time NEPA also saw an influx of new executives, including President Irwin Moore and Vice-President William Webster (Landry and Cruikshank 1996:121-135).

On June 3, 1947, NEPA was renamed New England Electric System (NEES), creating a new holding company and refinancing all other assets, including three wholesale companies, 36 retail companies, one service company, a street railway, and four miscellaneous companies. At the same time, a number of large shoe and textile manufacturers began to close, bringing unemployment to New England and threatening load growth. As increasing numbers of businesses were forced to close, the public began to blame utilities, which were consistently more expensive in New England than elsewhere in the country. Contrary to popular belief, utilities were expensive because of the higher costs of transporting fossil fuels over a large distance and the need for materials to withstand harsh weather. In addition, the failure of businesses was due less to high utility bills, and more to increases in unionization, wages, and taxation. The public also failed to acknowledge its increasing use of electricity, noting only the rising total cost. Regardless of the facts, dissatisfaction quickly led to the demand for public utilities. As the economy became more diversified, however, new jobs were offered at higher wages, increasing load and eventually silencing the public utility scare (Landry and Cruikshank 1996:137-149).

Despite the fact that hydroelectric power remained economical, post-war development included only two new hydroelectric plants, both on the Connecticut River. These complexes were the last conventional hydroelectric stations brought into the NEES system. In 1950, a $16 million, 33-megawatt plant went on-line in Wilder, Vermont, 40 miles north of Bellows Falls. This plant replaced an earlier facility called Olcott Falls, and drew substantial local opposition. The new 2,000-foot-wide dam raised the water level 15 feet, extending the existing pond 27 miles upstream toward the McIndoes station. Steep banks kept flooding to a minimum, affecting only 1,200 acres of land and submerging 335 acres of farmland. To ease tensions NEES agreed to pay for the flooded land and to move any utilities, such as railroads or roads, that were affected (Landry and Cruikshank 1996:149-151).



***Wilder Development, Lebanon, NH/Hartford, VT, built 1950. View looking northwest from the New Hampshire side of the Connecticut River, showing from left to right, the visitors' center, dam, and powerhouse (July 17, 1952 photo). This development was the first built on the Connecticut River after World War II. It replaced a preexisting plant and was constructed to meet increasing peak period electricity demands.***

The new Wilder complex covered some of the increasing peak demand, but in 1952 a dark forecast was issued by a group of utility executives known as the Electric Coordinating Council of New England. They predicted that peak load requirements would more than double over the next 20 years, from 3,800 megawatts to 8,000 megawatts. The generous reserve margins of the depression era had dropped to 16 percent, meaning that even more peak-load power would be needed. Bob Brandt, the head of power planning in the 1950s, worked with the Federal Power Commission and neighboring utilities to ensure that the New England region would remain covered. Only one potential site remained undeveloped: the property at the upper part of the Fifteen Mile Falls area, originally purchased in the 1920s. Whereas the site's development would have been excessive and impractical several decades ago, NEES was now criticized for taking so long to build an additional station. The new Samuel C. Moore station (named after President Irwin Moore's father and the company's longtime general manager) resembled Comerford in size and construction, with a massive concrete and earth core dam that created a reservoir covering 3,500 acres. The powerhouse, with four identical turbines producing 190 megawatts at full capacity, was located below the dam. The $41 million project took three years to complete, and employed 500 people. It was $9 million below budget and began producing electricity in 1957. This large conventional hydroelectric development allowed the Connecticut River to operate as a hydropower delivery system, combining multiple reservoirs and powerhouses. As the river wound from Moore to Vernon, each cubic foot of water produced 37 kilowatt-hours for the system. Downstream stations added an additional 530 megawatts and the Deerfield tributary another 110. No other river of comparable length in the country could equal the Connecticut for hydropower development (Landry and Cruikshank 1996:149-150).

In 1954, President Eisenhower signed Senator John Pastore's bill allowing the private development of nuclear power. NEES' Vice President, William Webster, who had returned from consulting on the wartime Atomic Energy Commission in 1951, was convinced that nuclear power was the energy of the future. He arranged a consortium of nine northeastern and midwestern companies to study the commercial applications of nuclear fission. With preliminary research behind him, he announced the formation of the Yankee Atomic Electric Company as soon as the bill was passed. His desire was for all of the regional utilities to share in the benefits, as well as the risks, inherent in the development of the new technology. Nine other utilities, as well as key government officials, businesses, and the press, decided to back the project. In 1957, after the completion of a smaller experimental facility by Westinghouse and Stone & Webster at Shippingport, Pennsylvania, construction began on the first full-scale demonstration plant, situated in Rowe, Massachusetts in the Deerfield River Valley. The plant went online in 1960 at a cost of $39 million, well below the $57 million estimate. It was the second commercial atomic plant in the country, setting many of the standards for subsequent reactors (Landry and Cruikshank 1996:162-167).

In the following decade, regional prosperity and lower-cost power combined to put NEES in a stronger operating position than in previous decades. Substantial savings from continual consolidation and the growing use of computers simultaneously allowed for wage increases and a decrease in rates. These two factors combined with tax cuts to allow New England to reach the national average in economic and load growth despite its low population increase. By 1962, NEES' electric properties had been consolidated along functional lines into one retail company, a single power wholesaler, and a service company in each state. Webster, president of the company since 1959, saw three possibilities for increased prosperity: lower costs through newer plants, economies of scale through higher loads, and lower fuel costs. Therefore, he began to try to license increasing numbers of nuclear plants, whose capacity dwarfed that of hydroelectric plants. In response to the blackout of 1965, Webster also participated in the philosophy of power pooling with other regional utilities, sharing resources in times of natural disaster. Consequently, the New England Power Exchange (NEPEX) was organized in 1967, linking all utilities to prevent shortages or blackouts. Shortly thereafter the New England Power Pool (NEPOOL) was formed to develop region-wide power dispatching (Landry and Cruikshank 1996:170-195).

The beginning of the fuel crisis was marked by a sharp increase in the price of imported oil in 1973. Escalating inflation exacerbated the crisis, causing many power companies to return to burning coal despite an increased sensitivity to pollution. In response to these problems, NEES began a large-scale initiative to cut back costs, improve finances, and develop a new customer relations strategy. Nuclear plants, which had been the hope of the future, were no longer tenable because of high interest rates, skeptical investors, and grass-roots environmental opposition. Thus NEES began a new strategy based on conservation and domestic fossil fuels, concentrating on domestic oil exploration. A large Research and Development department was created to explore alternate fuel sources and ways to reduce pollution. Other changes included the establishment of conservation and load management to minimize capacity requirements, the diversification of energy sources, and the decision to purchase power from plants that ran off of renewable energy sources such as trash, solar, and wind. Together, these changes reduced dependence on imported oil, allowing the country and the company to weather the crisis (Landry and Cruikshank 1996:199-229).

When prosperity returned in the 1980s, the focus on cost-consciousness and conservation remained. Most of the steam-generating units had been converted to coal and fuel prices fell dramatically. NEES emerged from the 1980s poised to face any future restructuring with stronger finances, an improved generating position, and slow load growth. The ever increasing environmental awareness, however, caused a number of small, yet significant changes. While hydroelectric plants are on balance non-polluting, they can prevent fish from migrating upstream to spawn. In the early 1980s, state wildlife officials required NEES to construct fish ladders, which channel fish around dams and turbines. These bypass mechanisms, built at a cost of $10 million each, were installed at Vernon in 1981, and later at Bellows Falls and Wilder, allowing anadromous fish such as Atlantic Salmon and shad to reproduce. By the 1990s the fish population in the Connecticut River had again reached healthy levels (Landry and Cruikshank 1996:231-242). Fish ladders are currently being installed at the Deerfield complexes.

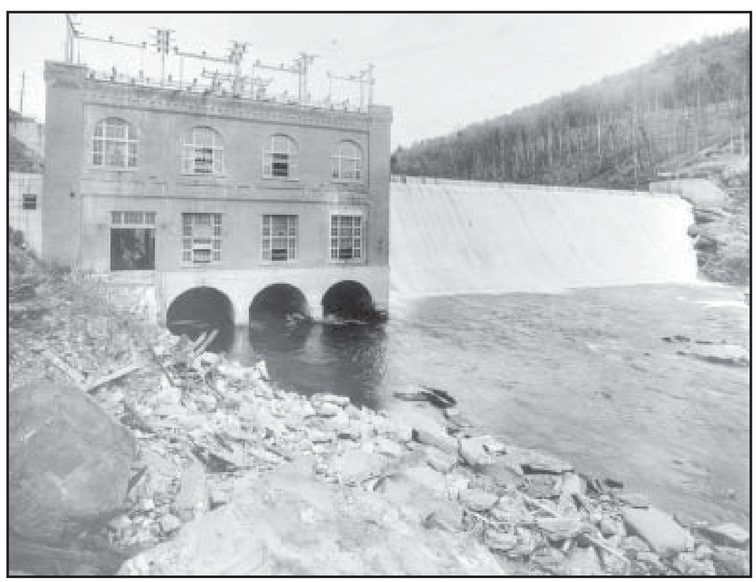
In the 1990s deregulation became a dominant theme in the restructuring of the power generation industry. It created a more competitive power-generating market that allows private power producers to utilize extant transmission and distribution systems, thereby providing consumers with a wider choice of producers. This development caused a number of large utilities, including NEES, to agree to separate power generation from transmission and distribution, recreating Chace & Harriman's initial arrangement. In 1998, USGenNE acquired the hydroelectric generating facilities on the Deerfield and Connecticut rivers. As part of the agreement NEES retained control of the transmission facilities. USGenNE was subsequently acquired by the PG&E Corporation and became part of the company's PG&E National Energy Group (PG&E NEG). In 2003, PG&E NEG and its subsidiaries, including USGenNE, declared bankruptcy. As part of the companies restructuring effort, PG&E NEG was separated from the parent company and changed its name to the National Energy and Gas Transmission, Inc. (NEGT). USGenNE continues to operate the hydroelectric developments on the Deerfield and Connecticut rivers as a subsidiary of NEGT.

## HYDROPOWER TECHNOLOGY ON THE CONNECTICUT AND DEERFIELD RIVERS

At the end of the nineteenth century, hydroelectric generating technology was in its infancy, and utilized equipment configurations adapted from textile mill practice and other water-powered industrial applications. During the first quarter of the twentieth century, hydroelectric engineers developed a variety of water delivery systems, and standardized mechanical and electrical equipment that allowed generating capacity to meet growing demand. USGenNE's Connecticut and Deerfield river developments incorporate a range of water delivery infrastructure and generating equipment reflecting the history of hydropower technology from its earliest forms to mature industry standards.

The Vernon Development (1909), Chace & Harriman's first hydroelectric station, was conceived as a single project. Vernon was important technologically as the first northeastern U.S. hydroelectric plant built remote from a load center and to deliver its load via long-distance transmission lines. Transformers at Vernon raised the electricity to 66 kV, enabling it to be transmitted over 60 miles to Gardner and Fitchburg, Massachusetts, a voltage and distance that were unprecedented in the northeast. When Chace & Harriman turned their attention to the Deerfield River (1911-1927), they envisioned developing the whole river drainage as an integrated, multi-station system, much like the Big Creek and other hydroelectric systems being developed in California at that time. Upstream reservoirs at Somerset (1911) and Harriman (1924) insured a reliable, regulated flow of water, and run-of-river facilities like Sherman (1927) evened out sudden discharges from larger powerhouses. This integrated, river-as-system approach was also taken by the New England Power Association and New England Electric System with their development of the three Connecticut River developments at Fifteen Mile Falls, Comerford (1930), McIndoes Falls (1931), and Moore (1957), where McIndoes absorbed surges of water from Comerford.

Hydroelectric facilities incorporate two types of water delivery systems, concentrated-fall, and divided-fall. In a concentrated-fall system the dam



***Deerfield No. 2 Development, Conway/Shelburne, MA, built 1912–1913. View of powerhouse and dam looking north from Conway side of the Deerfield River (ca. 1913 photo). Deerfield No. 2 is a concentrated fall facility, where the dam and powerhouse are integral.***


***Searsburg Development, Searsburg, VT, built 1922. View looking south across Deerfield River showing surge tank (above) and powerhouse (below) (June 29, 1923 photo). Searsburg is a divided-fall facility, where the dam and powerhouse are separate. Water from the Searsburg dam is directed to the powerhouse through a 3.5-mile-long, banded wood stave penstock.***

and powerhouse are integral or closely spaced, and the impoundment behind the dam acts as a forebay, providing water directly to the powerhouse. In a divided-fall system, the dam and impoundment are located at some distance from the powerhouse. Divided-fall systems are usually found in more rugged terrain, such as in the Deerfield River Valley, and concentrated-fall systems are more typical of flatter areas, such as the Connecticut River Valley. On the Deerfield River, the large Somerset and Harriman storage reservoirs were built to provide a constant, regulated flow of water to a series of mostly divided-fall generating stations downstream, some of which received their water through a variety of delivery systems. On the wider Connecticut River, which has a greater, more regular flow, most of USGenNE's hydroelectric developments are of the concentrated-fall type.

At some of the Deerfield River developments, the water delivery systems involved considerable feats of engineering. On the Deerfield River, large dams were built at Somerset, Searsburg (1922), Hariman, and Sherman. These dams were constructed in whole or in part using variations on the hydraulic-fill method, where a series of parallel dikes of rock and earth were built up with dump cars or railroad cars, and water was sluiced over the dikes to wash the loose material into the space between them to form a core that was impervious to water (Hay 1991:53). The Harriman dam was the largest semi-hydraulic earth-fill dam built to date when it was completed, and created the largest man-made body of water in Vermont (New England Power Company 1992: AHarriman Development). Most of the dams at the USGenNE developments incorporate ogee-profile, gravity-type spillway sections. Gravity dams rely on their own weight on their bedrock foundation to hold back the water behind them. The first concrete gravity dam was built in San Mateo, California in 1887 (Hay 1991:xix). This type of dam was a departure from the rock-filled wooden crib dams that were typical in New England at the time, and came into standard use in the region during the first quarter of the twentieth century (Cook 1991:18-19). USGenNE's gravity dams are typical in their linear form and ogee profile. These dams incorporate a variety of types of height-regulating equipment including flashboards and sluice gates. Most of the larger dams use tainter-type gates, however, the Bellows Falls dam (1928) is unique on USGenNE's Deerfield and Connecticut rivers for its use of roller-type gates.

Some of the water delivery systems were comparable to those employed in hydroelectric developments in California and the rugged American west (Hay 1991:44, 53-58). At Searsburg, water was conveyed from the dam to the powerhouse via a sinuous, 18,412 ft long, 8 ft diameter, wood-stave conduit that provided 230 ft of head. The utilization of this type of water conduit was made possible by the invention of the surge tank, a type of large standpipe that equalized pressure differences within a pipeline that could potentially damage the system when turbine gates were closed rapidly (Hay 1991:58-59). At Searsburg, the New England Power Company incorporated a Johnson differential surge tank in the conduit system to regulate system pressure. The Deerfield No. 4 Development (1912) included a 1,514 ft long tunnel blasted out of bedrock to connect the dam to the forebay above the powerhouse. The Harriman Development incorporated two additional engineering feats. A 12,812 ft long, 14 ft diameter bedrock tunnel was built to connect the dam and powerhouse, providing 390 ft of head. The 180 ft deep vertical shaft spillway was the deepest such structure built up to that time. The Harriman water delivery system also incorporated a 184 ft high surge tank. Rock tunnels were also part of the Deerfield No. 3 and No. 5 developments, with the latter also incorporating a 2.8 mile long canal/conduit/tunnel water delivery system.

In addition to constructing new water delivery infrastructure, preexisting industrial waterpower infrastructure was adapted and modified for subsequent hydroelectric development. This was not an unusual practice in New England, where many major waterpower privileges had been developed for industry (Hay 1991:44). Examples include the use of the International Paper Company's mill rights and power canal at the Bellows Falls Development, the development of the Lamson & Goodnow Manufacturing Company's dam site at the Deerfield No. 3 Development (1912) and the use of the former James Ramage Paper Company's dam at the Deerfield No. 5 Development (1913).

One of the most important improvements in hydroelectric technology was the development of the modern vertical-shaft turbine-generator unit, which dictated the configuration of powerhouse infrastructure including the penstocks, generator room, and foundation substructure. Around 1900, most turbines were set vertically, which was a more efficient orientation hydrologically, however, the thrust bearing technology required to practically link vertical turbines and generators had not yet been developed, and most electrical generators were designed for horizontal shaft operation. Early vertical-shaft hydroelectric turbine-generator configurations consisted of single- or multiple-runner Francis-type fixed-blade turbines set into open flumes, where the weight of the water in the open flume pressing against the turbine blades spun them by force of gravity. Horizontal Francis turbine-generator settings placed the turbine in a cylindrical steel case that was prone to efficiency-robbing turbulence and made maintenance of submerged bearings problematic. These were the limitations of the two basic turbine-generator configurations at the time that Chace & Harriman began to plan their hydroelectric developments.

The first practical direct-connected vertical turbine-generator units were developed in 1905 by Gardner S. Williams and placed into service in a hydroelectric plant at Sault Ste. Marie, Michigan. This new technology may have influenced the choice for vertical units at Chace & Harriman's 1909 Vernon powerhouse, which incorporated vertical turbine settings with triple Francis runners in open flumes for the first eight units installed. These generating units were a hybrid of new and old technology. They

***Deerfield No. 3 Dam, Buckland/Shelburne, MA, built 1912, The dam was constructed on an existing water priviledge initially developed in the nineteenth century by the Lamson & Goodnow Manufacturing Co. (undated photo).***

incorporated new vertical bearing technology with open flumes and stock pattern turbines, which were typical of lower-efficiency, late- nineteenth-century mill waterpower technology (Hay 1991:65-67).

Early vertical thrust bearings were, however, maintenance-prone as they employed mechanical ball, cone, or roller bearings, which wore out rapidly. This may have prompted Chace & Harriman to choose horizontal shaft settings for Deerfield 2, 3, and 4 developments, built between 1911 and 1913. The turbines at these developments were set in cylindrical, riveted sheet steel "boilerplate" cases, with the shaft passing through a stuffing box into the powerhouse where the generators are located.

Subsequent improvements in vertical thrust bearings incorporated pressurized oil films, although these systems required pumps and extensive piping. In 1898 Albert Kingsbury developed the pressure-wedge thrust bearing, which did not require pumped oil. This bearing saw its first application in 1912 at the McCalls Ferry hydroelectric station on the Susquehanna River in Pennsylvania. The introduction of pressurized oil-film and Kingsbury pressure wedge-type bearings resulted in a dramatic change in hydroelectric plant design, as it made possible vertical-shaft turbine and generator settings of much greater size. The vertical setting swept hydroelectric plant design, and by 1915 many plants were being built with vertical settings (Hay 1991:71-75). The Deerfield No. 2, 3, and 4 developments are USGenNE's only horizontal-shaft units. The remainder of the Deerfield River and all the Connecticut River developments incorporate vertical shaft turbine settings using variations on oil-film bearings.

The development of successful vertical-shaft turbine settings led to advances in turbine efficiency. New powerhouse substructures began to be built with specially designed scroll cases surrounding the turbines. These spiral-shaped cast concrete or metal channels directed water into the turbine blades in a spiral motion, increasing the efficiency of the turbines. Improved elbow-shaped draft tubes were also developed to improve the efficiency of tailraces that carried water way from the turbines (Hay 1991:80-85).

In 1920 the New England Company added two new generating units to the Vernon powerhouse, consisting of two vertical-shaft, Francis-type, single fixed-runner turbines set into concrete substructures with scroll cases and draft tubes. The improved efficiency of this new technology prompted the New England Company to reequip units 5-8 with improved wheel cases and runners to improve efficiency in 1921-1922. Between 1923 and 1925, units 1-4 were radically redesigned, their triple-runner turbines replaced with single-runner units and updated substructures. All units were subsequently outfitted with improved, Gibbs-type vertical thrust bearings. The variety of turbines and substructures installed at Vernon is evidence of efforts to keep its equipment in line with industry advances over time (New England Power Company 1992: "Vernon Development," New England Power n.d.: Vernon Station).

During this time, increasingly large and powerful vertical shaft turbine-generator units with improved thrust bearings and scroll case/draft tube substructures were employed on the Deerfield River at Searsburg, Harriman, and Sherman. At the time of its completion, the Harriman Development was the largest hydroelectric power development east of Niagara Falls, supplying power on a 110-kV line to Millbury, Massachusetts. This line was the first to exceed the 66-kV standard. In total Harriman produced 140 million kV annually, almost doubling the previous output of the Deerfield River (New England Power Company 1992: "Harriman Development," New England Power n.d.: Davis Bridge Development). The Harriman Development, notable for its major engineering feats in its water delivery system, was also important for its powerhouse design, which represented the culmination of progress in hydroelectric generating made during the first quarter of the twentieth century. Its multiple-unit, vertical-shaft, large-diameter, single-runner, Francis-type turbine arrangement, combined with oil-pressure bearings and special scroll cases and draft tubes, were a mature expression of hydropower technology and infrastructure, and was the mode adopted for the New England Power Association's expanding development of the Connecticut River starting with the Bellows Falls Development in 1928, which incorporated the same technology and types of equipment.

After Bellows Falls was completed, the Connecticut River developments increased dramatically in physical size and generating capacity. These developments include Comerford, McIndoes Falls, Wilder (1950), and Moore. The increase in generating capacity was due to ever-increasing power of head, turbine runner diameter, and generator size. Technologically, these Connecticut River developments are typical of hydroelectric generating facilities of the mid- twentieth century that incorporated standardized equipment configurations that were interconnected to provide electricity to larger areas (Cook 1991:4, Hay 1991:xi-xii). The powerhouses incorporate the major elements that characterize large-scale hydroelectric generating technology during this period, including multiple, vertical-shaft, single-runner, large-diameter, high-horsepower, low-rpm turbines with scroll cases cast into their foundations, vertical thrust bearings, and improved tailrace draft arrangements. The technological advances incorporated in the Connecticut River developments mainly consisted of changes in turbine blade design and speed control governors.

The Comerford Development was a massive undertaking and the largest hydroelectric development in New England when completed. The powerhouse generated 162,300 kW, twice the combined capacity of the three previous New England Power Association Connecticut River hydroelectric developments. The high generating capacity of these large units is evidence of the ability of technological advances to meet increased electrical demand. The Comerford turbine-generator units incorporate fixed-blade, Francis-type turbines. Although this type of turbine has its origins in nineteenth-century technology, the runners at these later powerhouses are of modern design incorporating highly-efficient vane contours, and are appropriate for their high-head water sources, which provide flows of little variation (Hay 1991:78-80).

In 1931 the McIndoes Development was built downstream from Comerford as a run-of-river station to even out any large releases of water from Comerford. It is not a high-capacity station. The most significant technological feature of the McIndoes Falls Facility was its use of variable-pitch, Kaplan propeller-blade turbines, a first for New England (Cook 1991:26). The first Kaplan-type propeller runner in the U.S. was installed at the Lake Walk powerhouse in Del Rio, Texas, in 1929 (Hay 1991:xix). Kaplan-type turbines were smaller, lighter, less prone to debris damage, operated at higher speeds, and were more economical for low-head applications like McIndoes, where the volume of water was more variable (Hay 1991:79). The low-head Wilder Development also incorporated Kaplan-type, variable-pitch propeller turbines.

During the mid-1930s a significant change took place in the technology of governor mechanisms that controlled turbine runner speed. Turbine governors utilized a feedback-loop system with a speed sensor attached to the generator shaft that actuated a hydraulic arm that controlled the wicket gate openings on the turbine, thus regulating its speed. All USGenNE Connecticut River and Deerfield River powerhouses up to and including the McIndoes powerhouse incorporated hydraulic systems with traditional flyball-type

mechanical governors. By the 1920s the Woodward Company of Rockford, Illinois, had come to dominate the market for this type of equipment. During the mid-1930s, Woodward introduced governors with electromagnetic speed sensors attached to generator shafts. This no longer required that governors be located close to turbines, and "cabinet" type governor stands could be placed almost anywhere near the unit (Hay 1991:88-89). The original hydraulic, flyball governor units are in place and in varying states of modification at

McIndoes Falls and all other earlier powerhouses. The first-generation cabinet governor control units are still in place at Wilder and Moore, although they have been superceded by more modern equipment. Comerford's early governor cabinets have been removed and are stored at the Moore powerhouse (Cultural Resource Consulting Group 1997:15).

The Moore Development, completed in 1957, has a generating capacity of 191,300 kW, and remains the largest single development of a natural resource for power production in New England. Like Comerford, it utilizes conventional, although large, Francis-type, fixed-blade turbines appropriate for its high-head setting (New England Power 1992: "Moore Development").

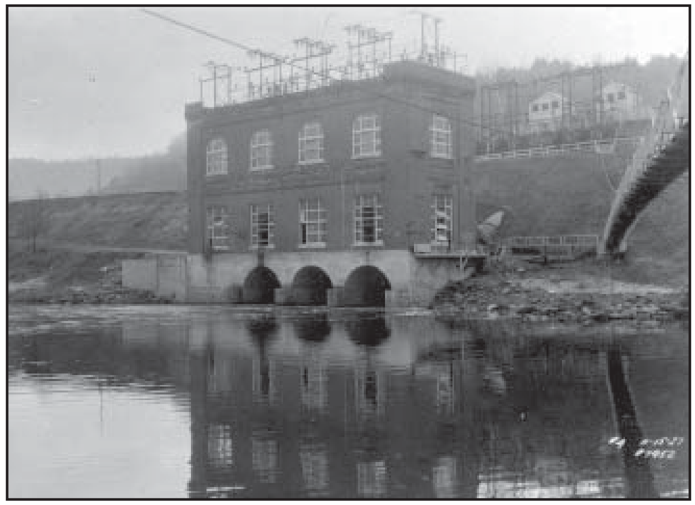
Automation and remote control are also part of the hydropower technology on USGenNE's Connecticut and Deerfield hydroelectric systems. When completed in 1922, the Searsburg hydroelectric power facility was said to be the largest fully automated plant in the United States, producing 25 million kilowatt-hours per year. It was designed for non-attendant automatic operation run off a time clock that allowed the turbine to be opened at a certain time and carry a predetermined load, and shut itself down. It was also designed to carry load based on pool height behind the Searsburg Reservoir by means of an electric float switch (Cavanaugh et al.1993). Most other developments on USGenNE's Deerfield River and Connecticut River systems were designed for full-time manned control, and have been automated over time. All Deerfield River developments are now controlled from the Harriman powerhouse. On the Connecticut River, the Moore and McIndoes developments are controlled from Comerford, and Vernon, Bellows Falls, and Wilder remain manned facilities.

USGenNE's Connecticut River and Deerfield River hydroelectric developments encompass the full range of hydroelectric generating technology developed and utilized from the late-nineteenth to mid- twentieth centuries. Turbine settings range from the triple-runner, vertical-shaft, open-flume configuration still in use in several units at Vernon; through horizontal-shaft, double-runner, "boilerplate"-case units at Deerfield Nos. 2, 3, and 4; to modern vertical-shaft settings with specially-designed scroll cases and draft tubes at the remaining developments. Conventional, fixed-blade Francis-type turbines predominate. However, Kaplan-type fixed and variable-pitch propeller type turbines are in use on the Connecticut River at the McIndoes Falls and Wilder powerhouses. The developments include a range of types of dams, spillways, gate mechanisms, water delivery systems, governors, and other mechanical and electrical equipment. The Deerfield River system incorporates particularly dramatic engineering solutions, and a landmark early automated powerhouse at Searsburg. The showpiece Harriman Development, which culminated the development of the Deerfield River, included engineering superlatives including its earth-fill semi-hydraulic dam, vertical shaft spillway, underground tunnel, and powerhouse with its mature expression of hydroelectric generating technology.

## HYDROPOWER ARCHITECTURE ON THE CONNECTICUT AND DEERFIELD RIVERS

Architecturally, American powerhouses represent a synthesis of constant, highly specific functional and structural requirements, and changing popular corporate architectural styles. Powerhouses are a specialized derivative of the "erecting shop," a type of industrial building designed to house moveable cranes for building large, heavy machines. These buildings required wide, open interior spaces unobstructed by interior support columns, and incorporated steel-framed outer walls and trussed roofs, often enclosed in a masonry skin. The dimensions of powerhouses are primarily dictated by the size and number of generating units required, and the volume of the interior open space required for the structurally-integral traveling crane that is used to install and maintain the interior equipment.

As most early twentieth-century heavy manufacturing buildings were privately-owned, out of the public eye, and designed to be purely functional, they exhibited little, if any, significant decorative elements. Early powerhouses, however, were often more visible, provided a public service, and were constructed by concerns eager to promote an image of strength and reliability. Examples of early twentieth-century precedents for elaborate clear-span-interior structures intended to convey a positive public image included buildings such as banks and large urban railroad terminals, which were often modeled after historical building types ranging from medieval fortresses to Roman baths.



***Deerfield No. 4 Powerhouse, built 1912. The powerhouse is an example of the Classically inspired architecture used in the designs of the early twentieth century hydroelectric facilities on the Deerfield and Connecticut rivers (November 15, 1927 photo).***

Throughout the history of powerhouse construction, the regular spacing of wide structural bays and the need for large quantities of natural interior light have inspired a variety of stylistic architectural surface treatments. Early twentieth-century powerhouse architecture was clearly influenced by a lingering Victorian historicism. Most of the architectural schemes for these powerhouses were spare and Classically-derived. Examples of this phase of powerhouse architecture include the Deerfield No. 2, 3, and 4 (1912-1913), and Searsburg (1922) powerhouses. These powerhouses were designed in a restrained Renaissance Revival-style scheme most evident in the large, repeated arched windows and decorative brickwork.

Some early twentieth-century powerhouses were more decorative, and incorporated elements of other architectural styles including the Romanesque, seen at Vernon (1909) and Gothic, at Harriman (1924) and Bellows Falls (1928). The Vernon Powerhouse was designed in a restrained Renaissance Revival-style scheme, and its decoration includes elements of the Romanesque, notably the triple machicolations repeated in the cornice in the west and south elevations. The Harriman and Bellows Falls powerhouses incorporated a variety of mostly Classical details, but also included skewed Gothic buttresses with cast stone trim at the corners.

By the late 1920s, this “Powerhouse Renaissance” style was slowly abandoned in favor of a “Stripped Classicism” that incorporated rectangular windows rather than the previously ubiquitous arched ones, and retained a more limited selection of masonry embellishments, such as Sherman (1927) and McIndoes Falls (1931). The Sherman Powerhouse was designed in a transitional style that combines the restrained Renaissance Revival style popular in earlier powerhouses with the emerging stripped Classical Revival-style scheme that was becoming more common for large utility and industrial buildings of its period. The building does incorporate a Spanish terra cotta tile roof, a typical Renaissance Revival style roof cladding material, but lacks the hallmark arched windows that are characteristic of true Renaissance Revival powerhouse. The McIndoes Falls Powerhouse incorporates rectangular windows instead of arched windows, and decoration limited to a thin continuous string course below the roofline.

During the 1930s, the influence of the Art Moderne style incorporated in new skyscrapers and institutional buildings led to the adoption of hybrid styles for industrial buildings that emphasized verticality, such as the Collegiate Gothic style chosen for the Comerford Powerhouse (1930). It was designed in a Streamlined Moderne version of the Collegiate Gothic style, the most distinctive elements of which are the flat, pointed Gothic arches in the windows, which are repeated in the downstream face of the Dam, and the general emphasis on verticality. The widespread popularity of the Colonial Revival style also manifested itself in powerhouse architecture, as seen at Wilder (1950), which includes Colonial Revival features including elliptical arches, prominent gable roof returns, mock end chimneys, and ocular gable pediment windows. Ultimately, the functional tenets of Modernism resulted in the abandonment of historical references and decorative elements in powerhouse architecture in favor of buildings incorporating pure geometry and simple materials, such as the Moore Powerhouse (1957), which exhibits bold, sharp, rectangular form; lack of ornamentation; and functional use of metal sash and copings, and glass block windows.

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## 6.6 Cultural Resources Management Plan – Projects Reviewed

| ZOE | Project - Event | Submittal to SHPO | SHPO Response | SHPO Determination | Notes |
|---|---|---|---|---|---|
| 1 | Somerset - Spillway Abutment Rehab | 3/22/18 | | | Follow-up email sent 5/7/18 after no response to 3/22/18 Project Review Cover and description. No response to email, therefore concurrence with "no adverse effect," and project was completed. |
| 6 | Harriman - Town of Whitingham – NGrid Line Y25N | 9/9/15 | 10/13/15 (phone) | Phase IB testing-no archaeological findings, no further investigations recommended. | |
| 6 | Harriman Reservoir - Intake Power Feeder Replacement | 10/24/19 | 12/5/19 | No adverse effect | |
| 8 | Harriman Station - switchyard expansion (NGrid) | 2/24/15 | 9/30/15-PSB issued certificate of public good | No undue adverse effects | NGrid expanded their switchyard onto a portion of property owned by GRH, which falls under the Deerfield CRMP. 4/10/15 filing with Vermont Public Service Board included archaeological and historic effects assessment concluding no undue adverse effects. |

| ZOE | Project - Event | Submittal to SHPO | SHPO Response | SHPO Determination | Notes |
|---|---|---|---|---|---|
| 9 | Sherman - Sherman Carbide, Site VT-WD-144 | 5/23/14 - Phase IB | | | No comments received, assume concurrence with recommendations that site is eligible for listing in the National Register of Historic Places and that the site will continue to be monitored for potential impacts in accordance with the schedule established in the Deerfield CRMP. |
| 9 | Sherman Dam - access road to Yankee Rowe - erosion remediation | 6/12/13 | 7/10/13 | No adverse effect | Damage from Irene |
| 9 | Sherman - Roof Repair | 5/11/20 | 6/4/20 | No adverse effect | |
| 11 | Deerfield No. 5 - Erosion remediation | 6/12/13 | 7/10/13 | No adverse effect | Damage from Irene |
| 15 | Deerfield No. 4 - Powerhouse Restoration | 10/30/12 | 12/10/12 | No adverse effect | Damage from Irene |
| 15 | Deerfield No. 4 - Station Bridge | 10/30/12 | 12/10/12 | No historic integrity | Damage from Irene |
| 15 | Deerfield No. 4 - Access road erosion remediation | 3/10/2015 | 4/16/15 | Unlikely to have an adverse effect if remediation conducted as outlined in Project Notification Form. | Damage from Irene |

| ZOE | Project - Event | Submittal to SHPO | SHPO Response | SHPO Determination | Notes |
|---|---|---|---|---|---|
| 15 | Deerfield No. 4 - Warming Hut and Cable Hoist House Removal | 10/28/15 | 11/23/15 | Adverse effect. MOA with mitigation stipulations recommended. | MOA dated 1/26/16 - Cable Hoist components preserved, and MHC Inventory form updated for the Deerfield No. 4 Hydroelectric Dam. Updated form sent to MHC on 5/5/16. All terms of MOA completed by Summer 2018. |
| 18 | Deerfield No. 3 - Malley Park erosion remediation | 6/12/13 | 7/10/13 | 1. No archeological testing recommended<br>2. Solicit comments from Buckland Historical Commission<br>3. Provide comments to MHC (SHPO) | Damage from Irene. SHPO recommendations were implemented. Restoration completed Fall 2014 as reported to FERC in letter dated 9/30/14. |
| 18 | Deerfield No. 3 - electrical service shed replacement | 4/7/15 | 5/7/15 | No adverse effect | PAL project assessment included in 2014 annual report - no effect finding. |
| 18 | Deerfield No. 3 - Guardrail Replacement | 3/4/19 | 3/12/19 | No adverse effect concurrence | |
| 21 | Deerfield No. 2 - Powerhouse Restoration | 10/30/12 | 12/10/12 | No adverse effect | Damage from Irene |

| ZOE | Project - Event | Submittal to SHPO | SHPO Response | SHPO Determination | Notes |
|---|---|---|---|---|---|
| 21 | Deerfield No. 2 - Storage Building Removal | 8/18/20 | 9/8/2020 | 1. Solicit comments from Conway Historical Commission (CHC)<br>2. Recommend preparation of MA Historical Commission Inventory Form B<br>3. Execute MOA that takes into account comments from CHC | CHC requested additional review time to late November. GRH preparing MOA for SHPO and CHC review. |

## 7.0 APPENDIX C – PRIVILEGED: Threatened and Endangered Species Location Maps

## 8.0 APPENDIX D - SWORN STATEMENT

All applications for LIHI Certification must include the following sworn statement before they can be reviewed by LIHI:

**SWORN STATEMENT**

As an Authorized Representative of __Great River Hydro, LLC_____, the Undersigned attests that the material presented in the application is true and complete.

The Undersigned acknowledges that the primary goal of the Low Impact Hydropower Institute's Certification Program is public benefit, and that the LIHI Governing Board and its agents are not responsible for financial or other private consequences of its certification decisions.

The undersigned further acknowledges that if certification of the applying facility is issued, the LIHI Certification Mark License Agreement must be executed prior to marketing the electricity product as LIHI Certified*.*

The undersigned Applicant further agrees to hold the Low Impact Hydropower Institute, the Governing Board and its agents harmless for any decision rendered on this or other applications, from any consequences of disclosing or publishing any submitted certification application materials to the public, or on any other action pursuant to the Low Impact Hydropower Institute's Certification Program.

**PLEASE INSERT ONLY FOR PRE-OPERATIONAL CERTIFICATIONS** (See Section 4.5.3)**:**
For applications for pre-operational certification of a "new" facility the applicant must also acknowledge that the Institute may suspend or revoke the certification should the impacts of the project, once operational, fail to comply with the certification criteria.

Company Name: _____Great River Hydro, LLC________________________

Authorize Representative Name: Erin A. O'Dea________________________

Title: Vice President - Legal________________________

Authorized Signature: ________________________

Date: November 17, 2020________