Attachment A

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

Bellows Falls Project (FERC No. 1855)

EXHIBIT A: PROJECT DESCRIPTION

January 2024 Revision

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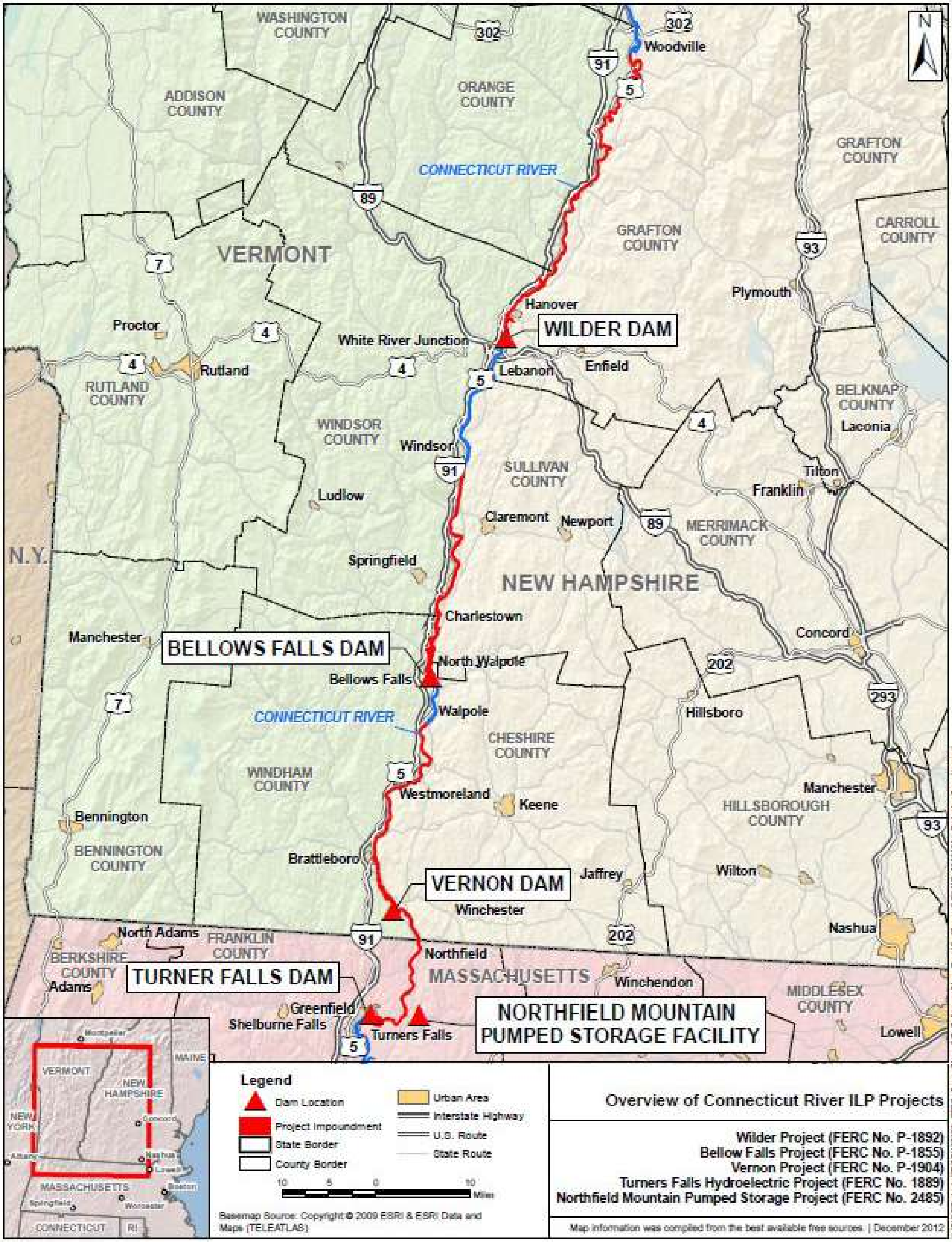
EXHIBIT A: PROJECT DESCRIPTION

Section 5.18(a)(5)(iii) of Title 18 of the Code of Federal Regulations (CFR) refers to Section 4.51 (License for Major Project—Existing Dam) for a description of information that an applicant must include in Exhibit A of its license application. Exhibit A is a description of the Project.

A1 Project Description

The Bellows Falls Project dam, canal, and powerhouse are located on the Connecticut River at river mile (RM) 173.7, about 1 mile upstream of Saxtons River and 3 miles downstream of the Williams River at the upper end of a sharp bend of the Connecticut River at Bellows Falls, Vermont, in the town of Rockingham, Windham County, Vermont, and in the town of Walpole, Cheshire County, New Hampshire. Figure A-1 illustrates the location of the Project in relationship to the other Projects undergoing concurrent relicensing.[2] The Project is located in the towns of Rockingham, Springfield, Weathersfield, and Windsor, Vermont; and Walpole, Charlestown, Claremont, and Cornish, New Hampshire.

[2] The five projects are collectively referred to as "the Connecticut River Projects" and include Great River Hydro's Wilder (FERC No. 1892), Bellows Falls (FERC No. 1855), and Vernon (FERC No. 1904) Projects along with FirstLight's Turners Falls (FERC NO. 1889) and Northfield Mountain Pumped Storage (FERC No. 2485) Projects.



Source: FERC (2013)

Figure A-1. Project location in relationship to the Connecticut River Projects.

The powerhouse is located downstream of the dam at the end of a power canal that is 1,700 feet (ft) long. Figure A-2 shows the primary Project facilities, which include the dam, spillway, power canal, powerhouse, substation and transformers, a line garage and storage building located near the powerhouse, fish passage facilities as described in Section A1.6, and recreation areas and facilities including three boat launches and picnic areas, a portage, and a visitor center with a fish ladder viewing window (see Exhibit E, Section 3.9, *Recreation Resources and Land Use*). Non-Project facilities located within the Project boundary include two switchyards that contain equipment owned by a regional transmission company.

Great River Hydro holds fee ownership of 835 acres of land in the Project. Of this acreage, 62 acres are used for plant and related facilities; 86 acres for public outdoor recreational use; 60 acres of other shoreline lands in Charlestown, New Hampshire; and the remaining 627 acres currently support local agriculture, farming, and wildlife management.

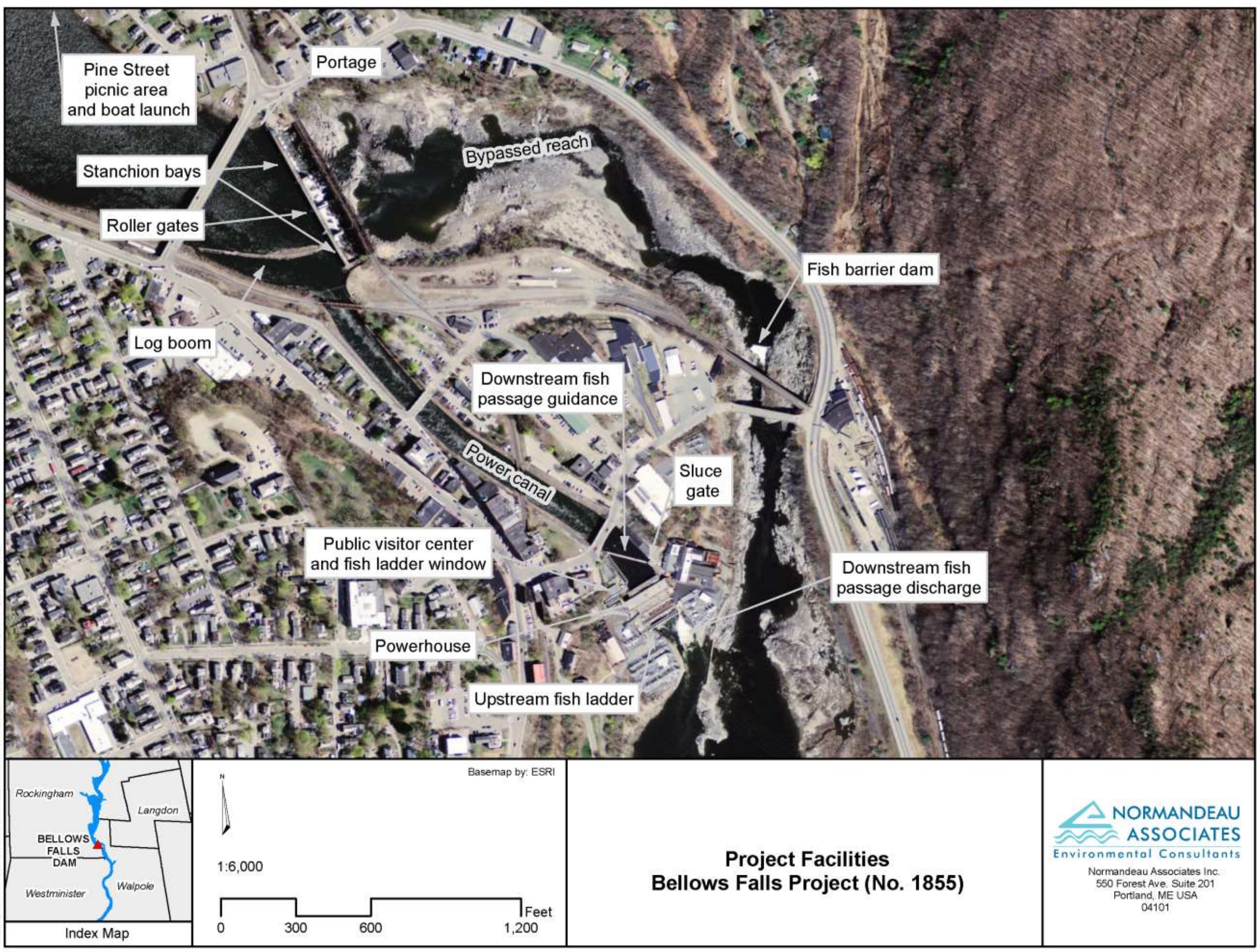


Figure A-2. Primary Project facilities.

A1.1 Impoundment

The Project impoundment extends upstream about 26 miles to Chase Island at Windsor, Vermont, about 1 mile below the Windsor Bridge. The impoundment has a surface area of 2,804 acres, about 74 miles of shoreline, and a total volume of 26,900 acre-feet (acre-ft) at elevation (El.) 291.63[3] ft (National Geodetic Vertical Datum of 1929 [NGVD29]) above mean sea level (m.s.l.) at the top of the stanchion boards. The overall operating range of the Project, accounting for both low inflow and most high inflows conditions, is typically between El. 288.63 ft and 291.63 ft, providing about 7,476 acre-ft of storage in the 3-ft range. The storage volume associated with the typical operating range, under non-spill conditions, between El. 289.6 ft and 291.4 ft is 4,642 acre-ft, or 62 percent of the overall usable storage.

A1.2 Dam and Spillway

The dam is a concrete gravity structure extending across the Connecticut River between Rockingham, Vermont, and Walpole, New Hampshire. Virtually all of the dam structure is located in New Hampshire. It is 643 ft long with a maximum height of about 30 ft and is divided by concrete piers into five bays. Two bays contain steel roller-type flood gates and the three other bays contain stanchion flashboards. A steel bridge runs the length of the dam for access and for operation of flashboards. A 25-ton gantry crane sits atop the bridge (Figure A-3, Table A-1).

Figure A-3. Bellows Falls Dam (from upstream side).

[3] All elevations in this exhibit are stated in National Geodetic Vertical Datum of 1929 (NGVD29).

Table A-1. Spillway facilities.

Gate Type	Number	Size (height or width, by length in ft)	Elevation (ft NGVD29)
Roller gates	2	18 x 115	273.63 (crest)
Stanchion bays	2	13 x 121 with flashboards	273.63 (crest)
Stanchion bays	1	13 x 100 with flashboards	278.63 (crest)

A1.3 Power Canal

A power canal connects the impoundment to the powerhouse (Figure A-4). The canal is lined with stone stabilized by a grid of concrete grade beams and walls. The downstream end of the canal is a concrete walled forebay. The canal is 100 ft wide at the top, about 36 ft wide at the bottom, about 29 ft deep, and approximately 1,700 ft long, including the length of the powerhouse forebay.

The canal creates a natural bypassed reach between the dam and the outlet of the powerhouse tailrace (Figure A-2 above). The reach is about 3,500 ft long and receives minimal water from leakage and significant amounts through spill during periods when flows exceed station capacity.

Figure A-4. Bellows Falls power canal (midstream, looking upstream).

A1.4 Powerhouse and Appurtenant Facilities

The powerhouse superstructure is 186 ft by 106 ft by 52 ft and constructed of steel frame and brick (Figure A-5); the substructure is constructed of reinforced concrete excavated into bedrock. The powerhouse contains three turbine generating units (Figure A-6), electrical equipment, a switchboard (used for local station operation in emergency conditions), a machine shop, excitation equipment, emergency generator, air compressor, an overhead crane, offices, storage rooms, battery room, and ancillary equipment. Table A-2 provides turbine and generator specifications.

The maximum hydraulic capacity (calculated as the sum of each individual unit's maximum discharge capacity) is 11,010 cubic feet per second (cfs) and nameplate generating capacity is ~~13,600~~13,500 kilowatts (kW) for each unit, and 40,800 kW in total. Table A-2 provides turbine and generator specifications. Unit 2 Generator was rewound in 2016, which resulted in a slight increase in it nameplate kVA and kW ratings.

Table A-2. Turbines and generators.

Turbine Units	Nos. 1, 2, and 3		
Type	Vertical Francis		
Design head (ft)	57		
Horsepower rating at design head	18,000		
Capacity kW (based on factor of HP x 0.75)	13,500		
Maximum hydraulic capacity (cfs)	3,670		
Minimum hydraulic capacity (cfs)	700		
Revolutions per minute (rpm)	85.7		
Intake trashrack clear spacing (inches)	4.0		
Generators			
Nameplate capacity (kilovolt-ampere [kVA])	17,000 (U1)	18,400 (U2)	17,000 (U3)
Power factor	0.8		
Nameplate capacity (kW)	13,600 (U1)	14,720 (U2)	13,600 (U3
Phase/frequency	3/60		
Voltage	6,600		

Figure A-5. Powerhouse.

Figure A-6. Unit No. 1 (background) and Unit No. 2 (foreground).

The concrete gravity intake is integral with the powerhouse structure with two water passages for each of the three turbine generating units. Water enters directly from the canal intake and into the scroll or wheel cases. The draft tubes, which have a maximum dimension of 20 ft high by 31 ft wide, discharge into the tailrace excavated partly in the bank and partly in the bed of the river (Table A-3). There are no draft tube gates. The scroll cases and draft tubes are formed in the substructure's concrete, which was poured on rock. The water passages for the three turbine generating units have trashracks with 4-inch clear spacing and two head gates that can be used in any one of the three units. One set of head gates, consisting of two gates measuring 25 ft high by 18.5 ft wide, is shared by all three units. The head gates are equipped with an electrically driven hoist that can be moved along a track system to any of the three units as needed. A hydraulic trashrack rake is used to pull river debris away from the unit intakes. It is manually operated and is driven to the trashracks in front of each unit on a set of tracks that are located on top of the forebay intake structure. The rake head is lowered to the bottom of the racks and retracted upward along the rack to remove debris. The debris is conveyed into a trailer for removal. An ice sluice/skimmer gate is located on the east side of the forebay and is 12 ft wide by 10 ft high. The tailrace is about 900 ft long, of which 500 ft are carved from the existing bedrock.

Table A-3. Dimensions and composition of head gates, draft tubes and draft tube gates.

Unit	Type	Dimension	Composition
Units 1–3	Head gates	2 gates per unit 1 set of gates shared by 3 units 25 ft high x 18 ft, 6 inches wide, each	Steel broome type
	Draft tubes	Varies in dimension Maximum = 20 ft high x 31 ft wide	Cast in concrete foundation
	Draft tube gates	None	n/a

A1.5 Electrical Facilities

Project electrical facilities include the generators, 6.6-kilovolt (kV) generator leads that extend approximately 80 ft from the powerhouse to an outdoor switchgear house located in a substation west of the powerhouse, switchgear, bus work, and two step-up transformers located in the substation (Figures A-7 and A-8). These two switchyards and the tie lines from the Project's step-up transformers are located within the Project boundary but are not Project facilities because this equipment is owned and operated by the regional transmission company, New England Power Company, doing business as National Grid.

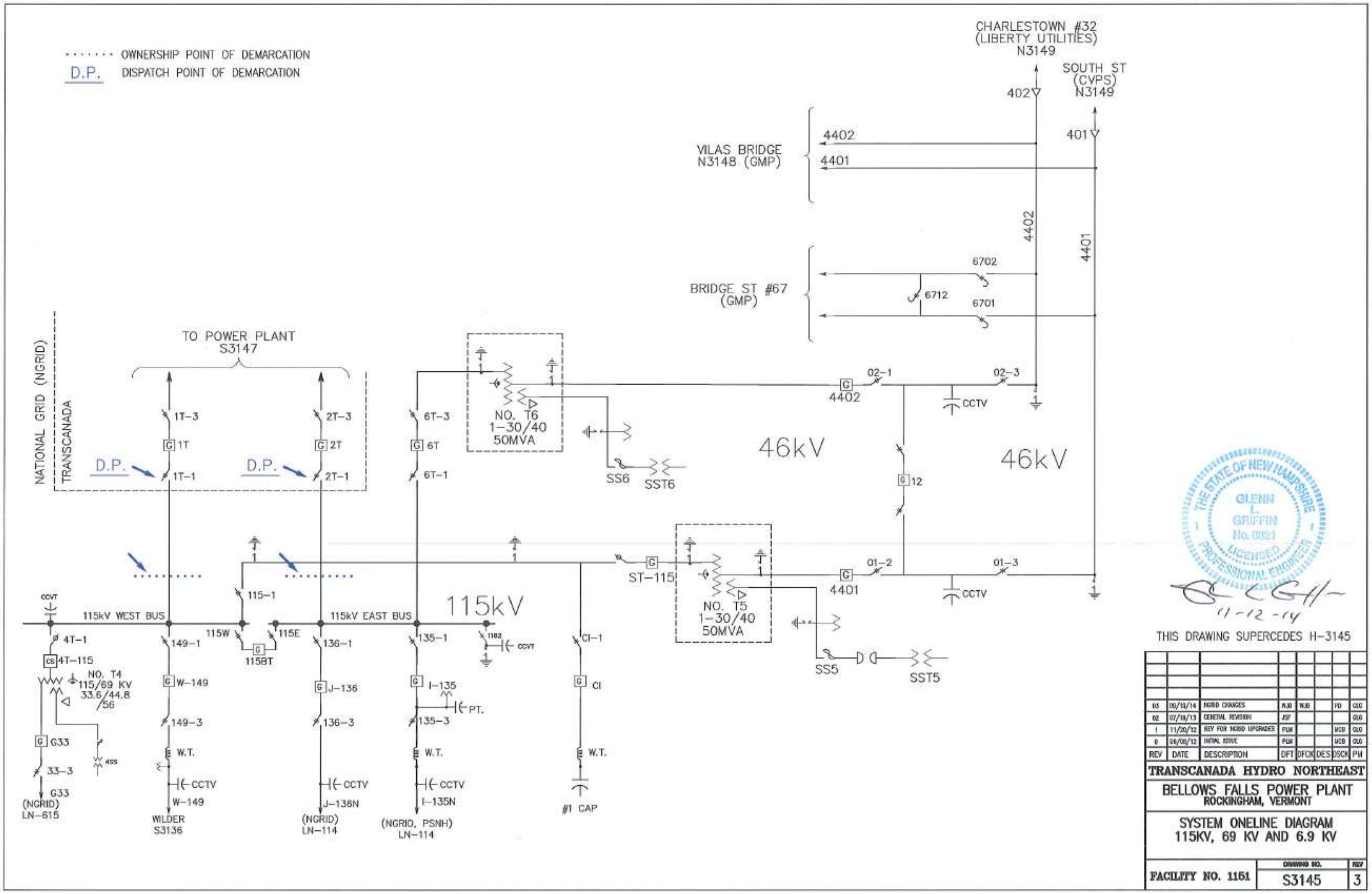


Figure A-7. Transmission interconnection schematic, 115 kV, 69 kV, and 6.9 kV.

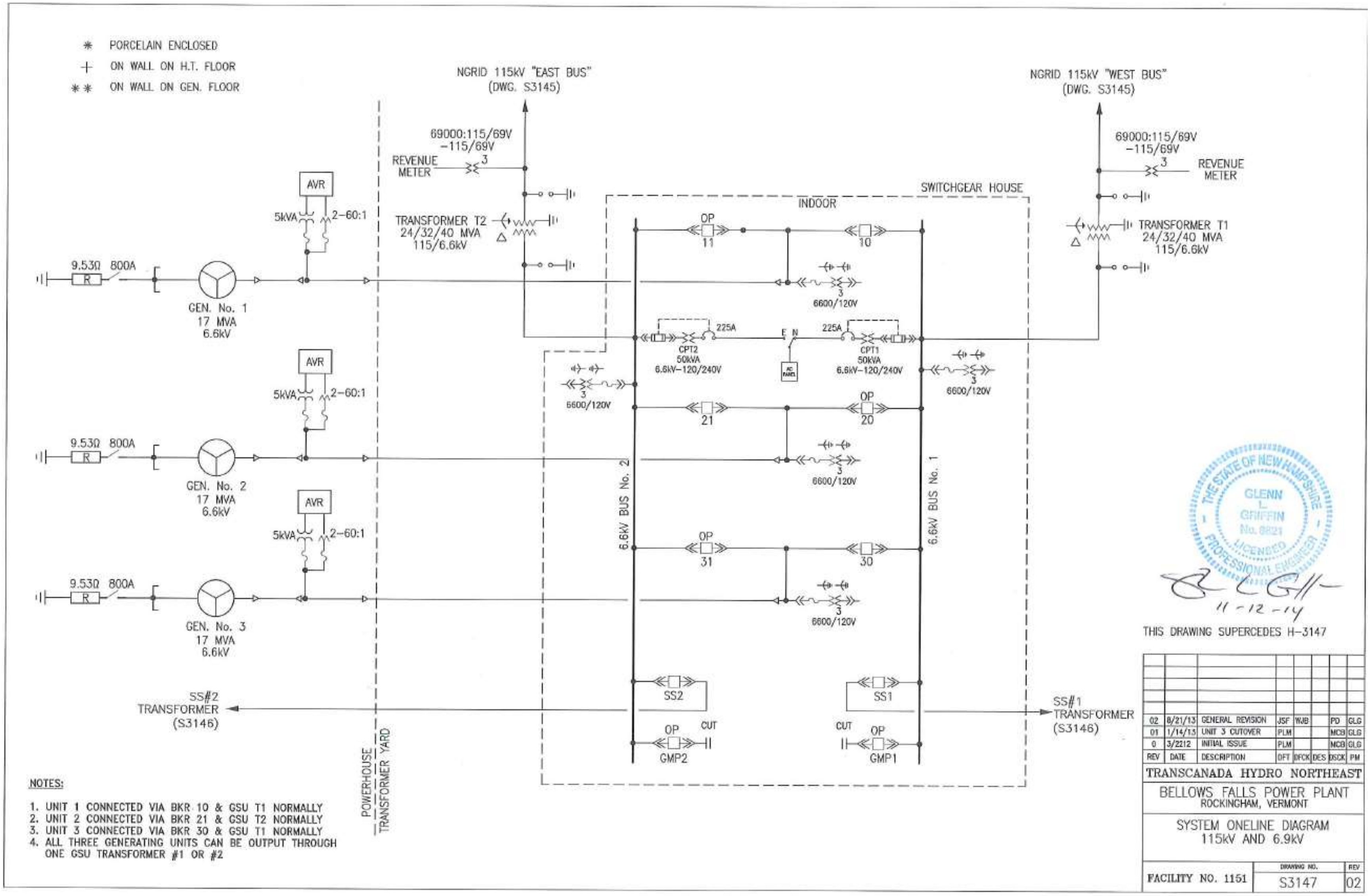


Figure A-8. Transmission interconnection schematic, 115 kV and 6.9 kV.

A1.6 Fish Passage Facilities

A1.6.1 Upstream Passage Facilities

The upstream fish passage system consists of a conventional vertical-slotted weir fish ladder at the powerhouse and an upstream concrete barrier dam in the bypassed reach (Figure A-9). The barrier dam prevents upstream migrating fish from being attracted by spillway discharge into the reach and later becoming trapped in isolated pools after spill ends. The barrier is located just upstream of the Boston and Maine Railroad Bridge. The fish ladder is a 920-ft-long, reinforced concrete structure with accessory electrical, mechanical, and pneumatic equipment that is designed to provide passage for migrating Atlantic Salmon past the dam by way of the forebay and canal, a vertical distance of about 60 ft. Upstream migrating fish are attracted to the tailrace channel by flow from the turbines. Once in the tailrace area, fish are attracted to the main entrance weir at the east end of the powerhouse.

Attraction water is provided by the upper three weirs containing slide gates, which open and close depending on the forebay water surface elevation (WSE) to maintain the required fish ladder flow. A skimmer gate/sluiceway is located in the forebay and is used for additional fish ladder attraction water. Water from this channel enters two diffuser openings at the fish ladder entrance. Fish enter the 8-ft-wide fish ladder entrance channel and "climb" to the forebay by swimming through a series of 67 slots and cascading pools with each succeeding weir spaced 8 ft apart and 12 inches higher than the last. After passing 34 pools, the fish enter a level turning section and pass through another 10 pools to the counting/trapping area. There, fish are guided by flow and crowder screens, travel through a 3-ft-wide flume, and pass an underwater viewing window where they may be observed and counted. From the counting/trapping area, fish continue to climb through an additional 22 pools to the ladder’s 8-ft-wide exit channel into the forebay and canal. The exit channel (i.e., the last pool) includes a motor-driven head gate, widely spaced trashracks (sufficient to pass adult salmon), and slots for wooden stop logs. The last three weirs contain adjustable weir gates that can be lowered (opened) to provide a nearly constant 25 cfs fish ladder flow when the forebay WSE drops through its 3-ft operating range.

The fish ladder visitor center is located adjacent to the upper two pools and exit channel. The building’s basement serves as a public viewing gallery with two underwater windows. The upper floor provides informational displays on hydro generation, recreation, archaeology, and anadromous fish restoration and has a picture window view of the fish ladder to the south (downstream). The Connecticut River Atlantic Salmon Commission (CRASC) provides an annual *Fish Passage Notification Schedule*, which sets the dates for upstream passage for all dams on the Connecticut River. Typically, the upstream fish ladder operates from May 15 through July 15 and in fall from September 15 through November 15 for Atlantic Salmon; however, in recent years, fish ladder operation has been suspended because of low salmon returns and abandonment of the program by the U.S. Department of the Interior, Fish and Wildlife Service (FWS) and the states.

Figure A-9. Upstream fish passage facilities.

A1.6.2 Downstream Passage Facilities

As of February 11, 2016, CRASC no longer requires downstream passage operations at Bellows Falls for Atlantic Salmon smolts (see Exhibit E, Section 3.6, *Fish and Aquatic Resources*). CRASC's annual *Fish Passage Notification Schedule* had set the dates for downstream passage for all dams on the Connecticut River. Downstream passage flows were provided for adult Atlantic Salmon from October 15 to December 31 if 50 or more adults were documented as having passed upstream. Downstream passage was provided by the forebay sluiceway/skimmer gate with fish being guided to the gate by a solid, partial depth diversion boom across the canal. A small auxiliary gate located on the east side of the powerhouse was opened to direct fish that may get under the diversion boom to the sluiceway. The gate is motorized and operated locally as needed to pass river debris and ice.

A2 Lands of the United States

No lands of the United States are located within or adjacent to the Project boundary.

A3 Proposed Modifications and Enhancements

Proposed new facilities include a new 681kW minimum flow turbine generator, an affiliated control house and electrical interconnect equipment to local distribution utility in Vermont. The minimum flow unit will recover a portion of the lost energy, resulting from the 300 cfs provided below the dam into the bypassed reach under the Proposed Project Operation described in Exhibit B, Section 1.3 and Appendix A. Figure A-10 shows the location of the new proposed minimum flow unit on the dam. Table A-4 provides turbine and generator specifications of the proposed minimum flow unit.

The turbine generator will be housed in a concrete intake structure connected to the downstream face of the spillway Stanchion Bay #1. The concrete intake structure is approximately 33' wide by 33 ' long and open to the headpond creating a small forebay for the minimum flow unit. The forebay has a floor that is level with the concrete crest of the dam at elevation 278.6 above msl; one half is concrete, and the other half is a floor screen that serves as a horizontal trash rack above the vertically aligned turbine generator. The trash rack measures approximately 14.4' wide by 30.9' long with 2-inch clear spacing between bars. The average velocity through the entire rack is calculated to be 0.97 feet per second (fps). The average velocity through the rack in an area measuring 11.3' wide by 20.4' long concentrated around the unit itself is approximately 1.88 fps. The average velocity of the flow through the modified portion of the Stanchion Bay #1 which conveys water to the forebay is less than 0.71 fps. The above calculations are based on a turbine flow of 300 cfs.

The length of the concrete intake structure along the spillway face is approximately 33 feet or 26.9% of the 120 foot total length of Stanchion Bay #1, reducing the pre-minimum flow unit maximum discharge capacity of 18,600 cfs potentially by approximately 5011 cfs. However, the design of the concrete intake structure will include three new spill conveyance structures, comprised of a 25-foot wide vertical crest gate, a 14-foot wide downward opening, bottom-hinge crest gate and 14-foot wide bay of removable stoplogs with a combined capacity of 5476 cfs, thus increasing the spill capacity of the existing dam by 465 cfs in addition to generation flow through the minimum flow unit itself. See Figure A-11 for a plan view of the intake structure, new gates, control room and the unit location. See Figures A-12 and A-13 for Section drawings as indicated on the plan view.

The turbine will utilize adjustable-pitch wicket gates to allow ramping of output power for smooth grid interconnection. An existing auxiliary steel bulkhead used to repair and maintain stanchion sections of the dam will continue to function as a means of blocking flow to the intake structure and turbine for construction inspection, service or repair.

The turbine will utilize an elbow draft tube (horizontal outlet) with steel liner supplied by Natel, rather than a straight (vertical) conical draft tube. The elbow draft tube better integrates to the existing conditions.

Proposed Project electrical facilities associated with the minimum flow turbine generator include a direct-drive, housing cooled permanent magnet excited synchronous generator, 480-volt, 3-phase generator leads and disconnects extending approximately 120 feet to a 750kVA, 480V-12.47 kV step-up transformer. This equipment will require an easement over private land but included within a revised project boundary. Output from the proposed turbine generator will be connected to the local 12.47kV 67G3 Feeder owned by Green Mountain Power Co. See Figure A-14.

Table A-4. Minimum flow Turbine Generator Specifications

Turbine Units	Proposed Minimum Flow Unit
Type	Radial Open Flume, Restoration Hydro Turbine (Natel)
Design head (ft)	28.9′ to 31.5′
Horsepower rating at design head	908
Capacity kW (based on factor of HP x 0.75)	681
Maximum hydraulic capacity (cfs)	322
Minimum hydraulic capacity (cfs)	300
Revolutions per minute (rpm)	290
Intake trashrack clear spacing (inches)	2.0
Generators	
Nameplate capacity (kilovolt-ampere [kVA])	725
Power factor	.9
Nameplate capacity (kW)	681
Phase/frequency	3
Voltage	480v

Figure A-10 Location of Proposed Minimum Flow Unit

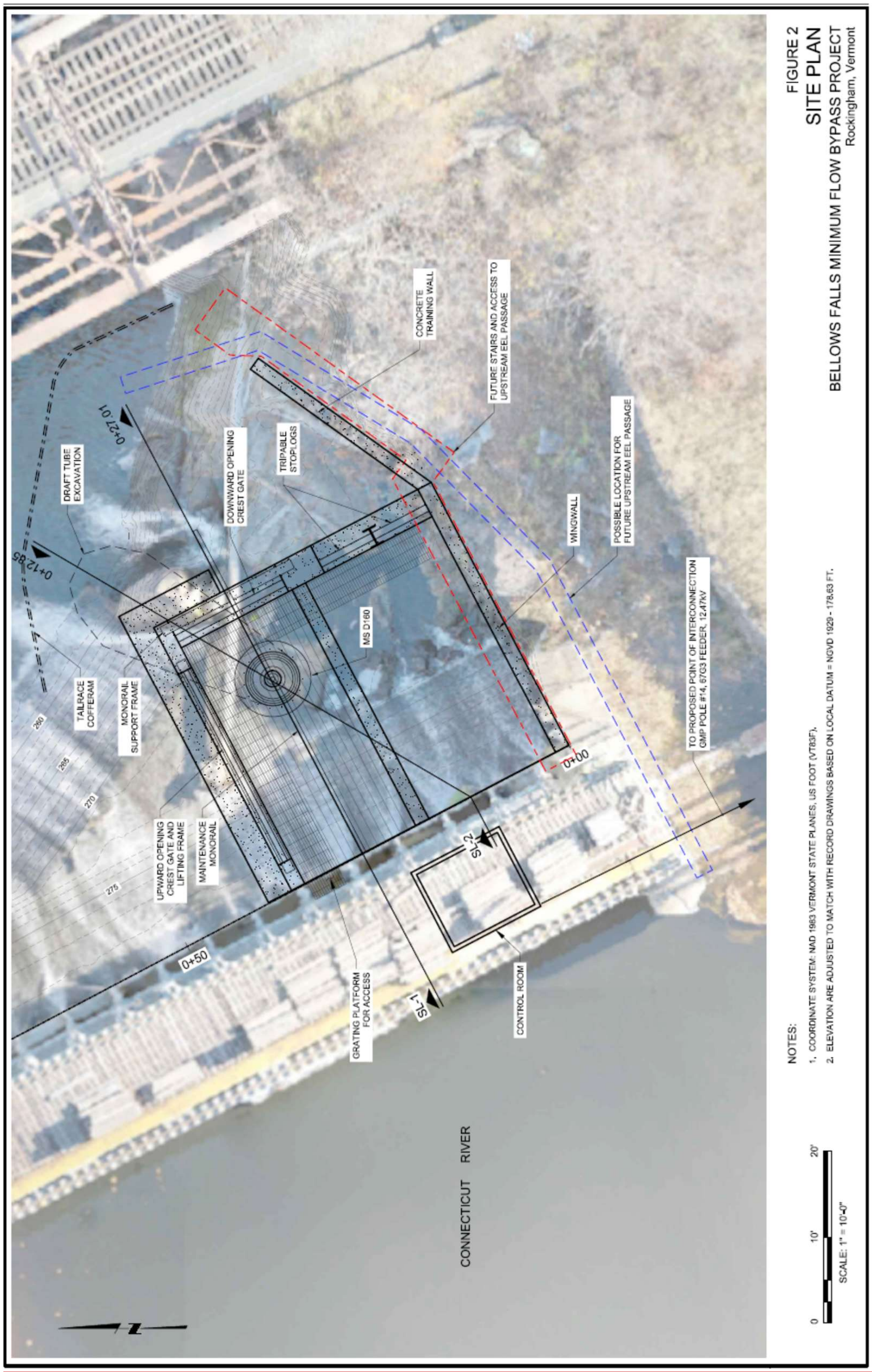


Figure A-11 Plan view of the intake, gates, control house and turbine

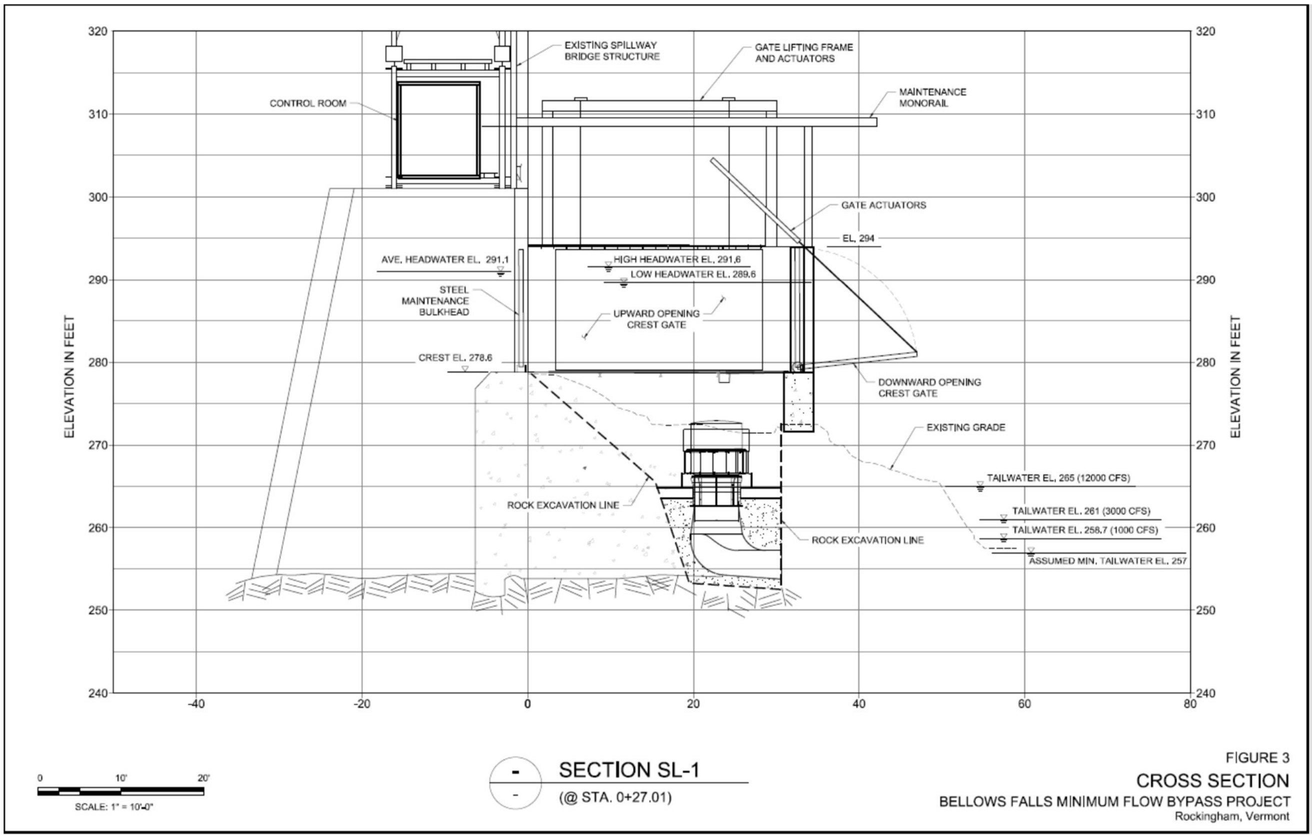


Figure A-12 Section (SL-1) view of the intake, gates, control house and turbine

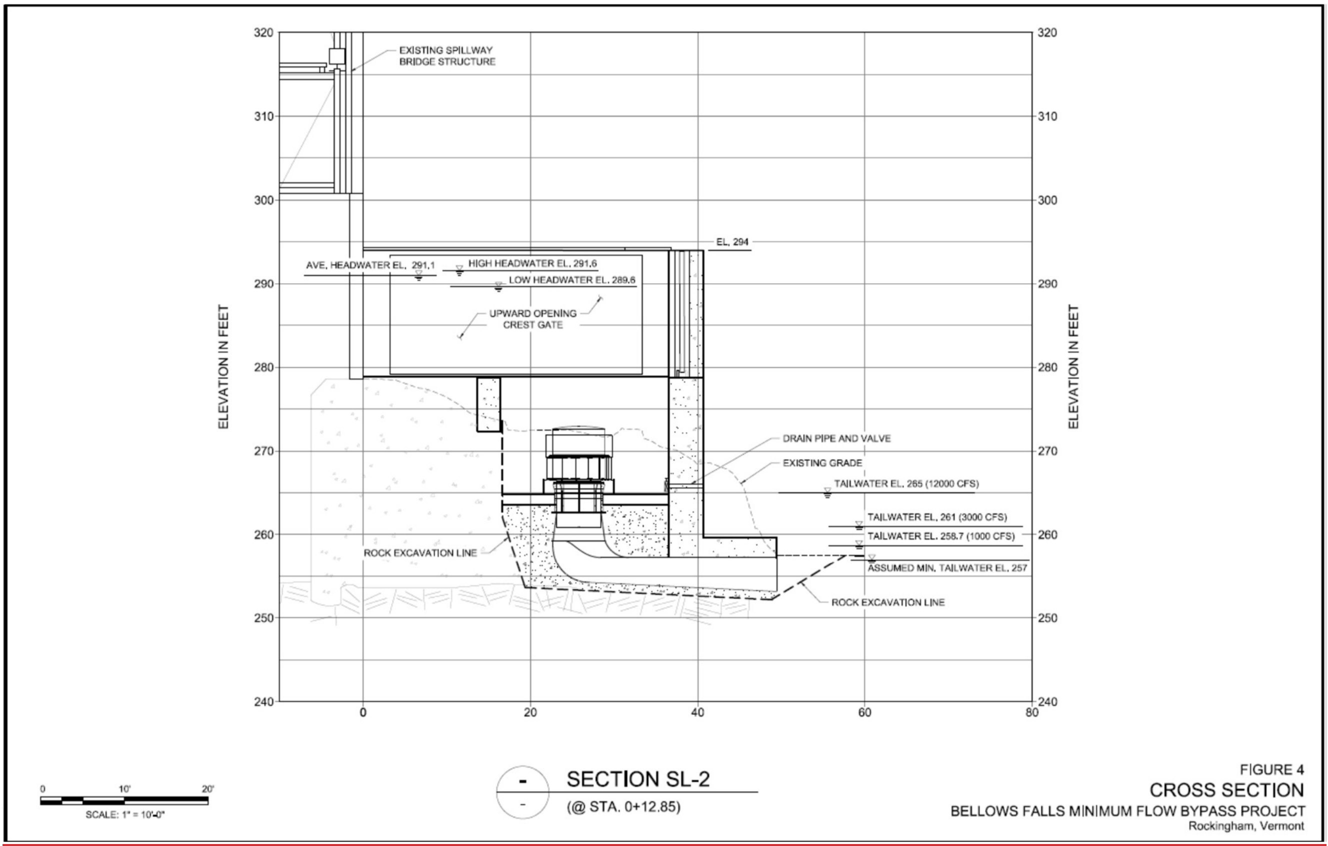


Figure A-13 Section (SL-2) view of the intake, gates, control house and turbine

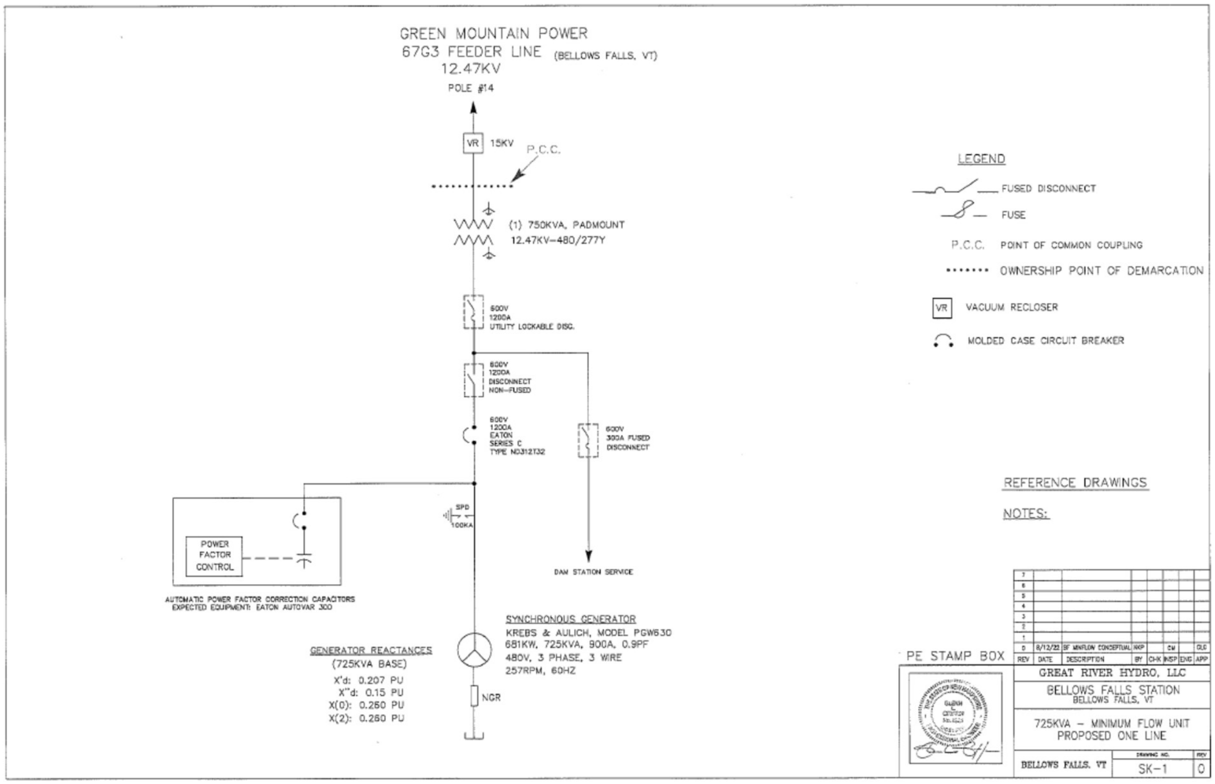


Figure A-14 Distribution Interconnection Schematic 12.47 kV

~~A3~~A4 Literature Cited

FERC (Federal Energy Regulatory Commission). 2013. Scoping document 2 for the Wilder (FERC No. 1892-026), Bellows Falls (FERC No. 1855-045), Vernon (FERC No. 1904-073), and Turners Falls (FERC No. 1889-081) hydroelectric projects, and the Northfield Mountain Pumped Storage Project (FERC No. 2485-063). Federal Energy Regulatory Commission, Washington, DC. April 15, 2013.

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