ENVIRONMENTAL ASSESSMENT

FOR HYDROPOWER LICENSES

Holyoke Number 1 Hydro Project, FERC Project No. 2386-004

Holyoke Number 2 Hydro Project, FERC Project No. 2387-003

Holyoke Number 3 Hydro Project, FERC Project No. 2388-004

Massachusetts

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
888 First Street, NE
Washington, D.C. 20426

November 2019

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ACRONYMS AND ABBREVIATIONS

Advisory Council	Advisory Council on Historic Preservation
APE	area of potential effects
ASMFC	Atlantic Salmon Marine Fisheries Commission
°C	degrees Celsius
Canal System	Holyoke Canal System
CCOP	Comprehensive Canal Operations Plan
COFP	Canal Operations and Flow Plan
certification	water quality certification
CFR	Code of Federal Regulations
cfs	cubic feet per second
Commission	Federal Energy Regulatory Commission
CRASC	Connecticut River Atlantic Salmon Commission
CRMP	cultural resources management plan
CWA	Clean Water Act
DO	dissolved oxygen
EA	environmental assessment
EPRI	Electric Power Research Institute
ESA	Endangered Species Act
ºF	degrees Fahrenheit
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
FWS	U.S. Fish and Wildlife Service
GWh	gigawatt hour
HG&E	Holyoke Gas & Electric Department
HPMP	historic properties management plan
HWP	Holyoke Water Power Company
Interior	U.S. Department of the Interior
ISO-NE	Independent System Operators - New England
kV	kilovolt
kW	kilowatt
mm	millimeters
mg/L	milligrams per liter
MW	megawatt
Mass DEP	Massachusetts Department of Environmental Protection
Mass DFW	Massachusetts Division of Fisheries and Wildlife
MBI	Midwest Biodiversity Institute
MWh	megawatt-hour
NMFS	National Marine Fisheries Service
National Register	National Register of Historic Places

NERC	North American Electric Reliability Corporation
NHPA	National Historic Preservation Act
NLEB	Northern long-eared bat
NPCC	New England Power Pool
PJM	PJM Interconnection LLC
REA	Ready for Environmental Analysis
rpm	rotations per minute
SHPO	Massachusetts State Historic Preservation Office

MULTI-PROJECT

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1.0 INTRODUCTION

1.1 APPLICATIONS

On August 31, 2016, Holyoke Gas & Electric Department (HG&E) filed applications with the Federal Energy Regulatory Commission (Commission or FERC) for subsequent licenses for the 1,056-kilowatt (kW) Holyoke Number 1 Hydro Project No. 2386 (City 1 Project),[1] the 800-kW Holyoke Number 2 Hydro Project No. 2387 (City 2

[1] An annual license for the City 1 Project was issued on February 13, 2019, for the continued operation of the project under the terms and conditions of the prior license, which was issued on February 28, 1989, for a term of 30 years and expired on January 31, 2019. *See* 46 FERC ¶ 62,229.

Project),[2] and the 450-kW Holyoke Number 3 Hydro Project No. 2388 (City 3 Project),[3] collectively referred to in this document as the City Units Projects.[4] The projects are located on the Holyoke Canal System (Canal System),[5] adjacent to the Connecticut River, in the city of Holyoke in Hampden County, Massachusetts (figures 1 and 2). The projects do not occupy federal land.

[2] An annual license for the City 2 Project was issued on September 11, 2018, for the continued operation of the project under the terms and conditions of the prior license, which was issued on September 28, 1988, for a term of 30 years and expired on August 31, 2018. *See* 44 FERC ¶ 62,310.

[3] An annual license for the City 3 Project was issued on March 5, 2019, for the continued operation of the projects under the terms and conditions of the prior license, which was issued on September 28, 1988, with an effective date of June 1, 1990 and an original expiration date of May 31, 2020 (*See* 44 FERC ¶ 62,309). By order issued November 22, 2013, the Commission approved an accelerated expiration date of February 20, 2019 for the City 3 Project to allow HG&E to coordinate its relicensing activities with the City 1 and 2 Projects (*See* 145 FERC ¶ 62,131).

[4] This Environmental Assessment only addresses the three projects noted above and does not address the Holyoke Number 4 Hydro Project Number 7758. A subsequent license for that project was issued on August 15, 2006 for a period of 32 years and 6 months (*See* 116 FERC ¶ 62,128).

[5] The Holyoke Canal System is a licensed project facility of the Holyoke Project No. 2004. A new 40-year license was issued to HG&E for the Holyoke Project No. 2004 on August 20, 1999 (88 FERC ¶ 61,186).

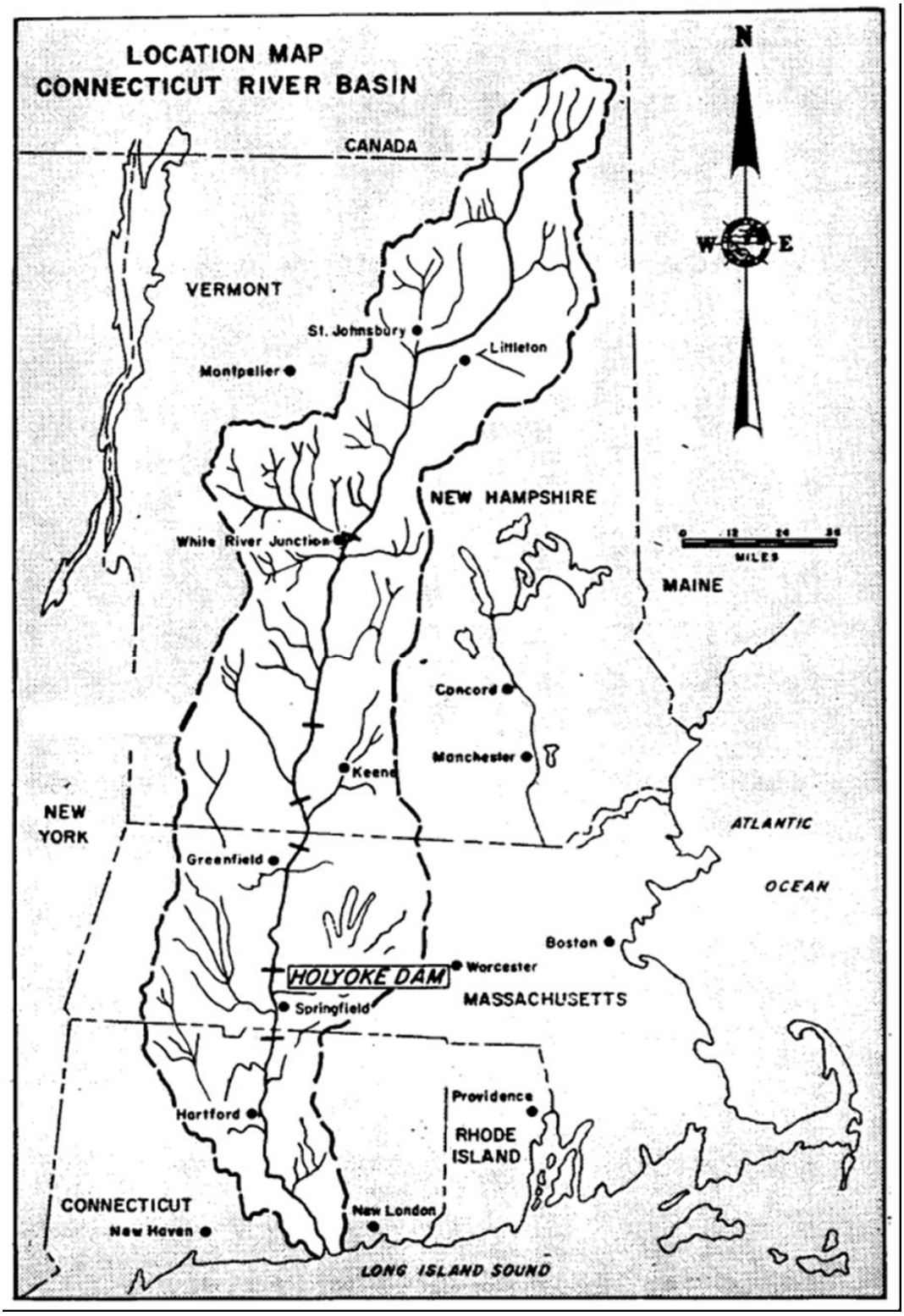

Figure 1. Regional location map (Source: HG&E, as modified by staff)

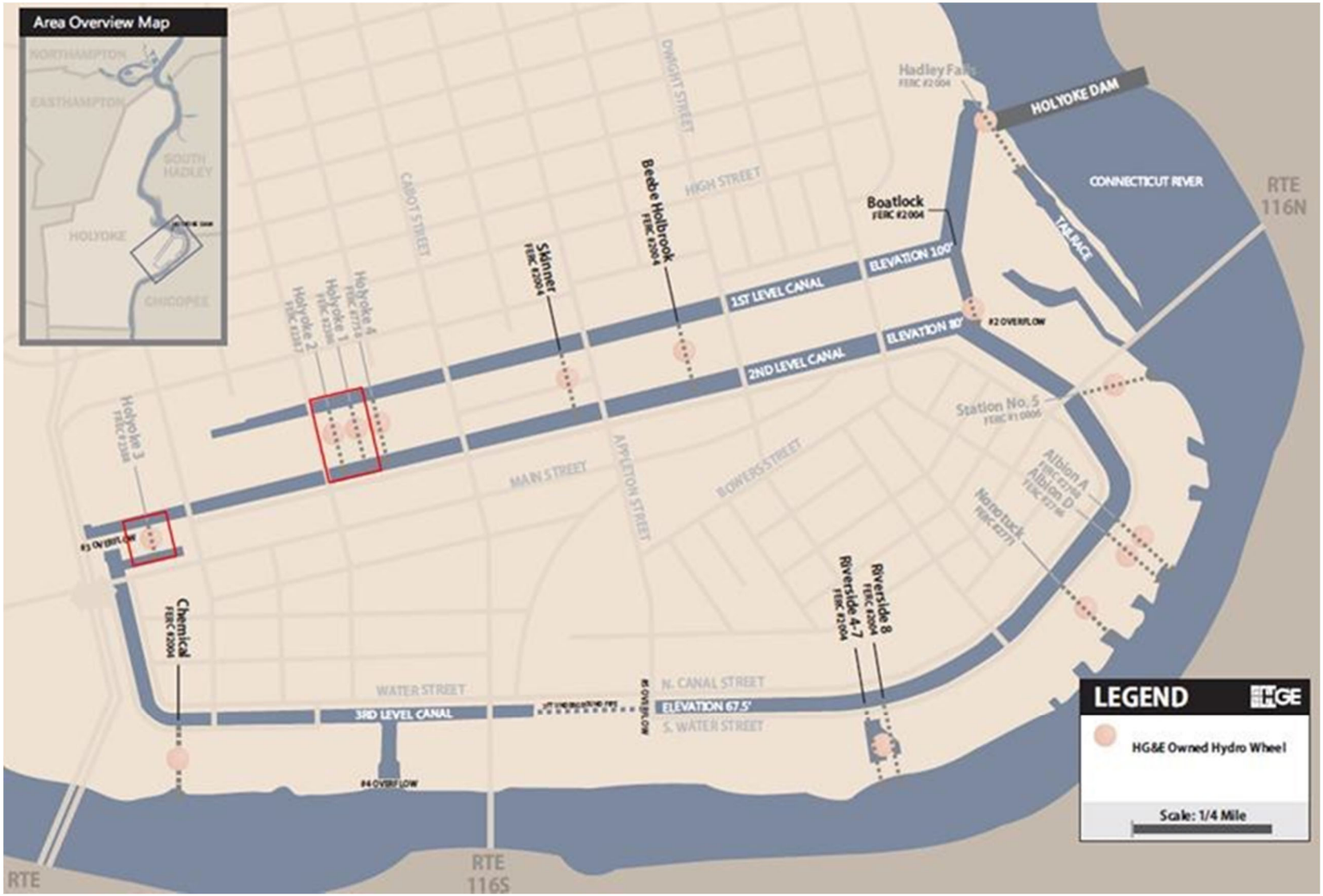

Figure 2. Holyoke Canal System (Source: HG&E, as modified by staff)

1.2 PURPOSE OF ACTION AND NEED FOR POWER

1.2.1 Purpose of Action

The purpose of the City Units Projects is to provide hydroelectric power. Therefore, under the provisions of the Federal Power Act (FPA), the Commission must decide whether to issue subsequent licenses to HG&E for the projects and what conditions should be placed on any licenses issued. In deciding whether to issue a license for a hydroelectric project, the Commission must determine that the project will be best adapted to a comprehensive plan for improving or developing a waterway. In addition to the power and developmental purposes for which licenses are issued (such as flood control, irrigation, or water supply), the Commission must give equal consideration to the purposes of: (1) energy conservation; (2) the protection of, mitigation of damage to, and enhancement of fish and wildlife resources; (3) the protection of recreational opportunities; and (4) the preservation of other aspects of environmental quality.

Issuing subsequent licenses for the City Units Projects would allow HG&E to generate electricity at the projects for the term of each license, making electric power from a renewable resource available to their customers.

This multi-project environmental assessment (EA) assesses the effects associated with operation of the projects, makes recommendations to the Commission on whether to issue subsequent licenses, and if so, recommends the terms and conditions to become part of any issued licenses. In this EA, we assess the environmental and economic effects of operating and maintaining the projects as proposed by HG&E. We also consider the effects of the no-action alternative. Under the no-action alternative, the projects would continue to operate as they do under the existing licenses, and no new environmental protection, mitigation, or enhancement measures would be implemented. For the City Units Projects, the no-action alternative has the same environmental effects as HG&E's proposal because HG&E is proposing to continue to operate and maintain the projects as it currently does. The primary issues associated with licensing the projects are water quality and downstream fish passage and the potential for entrainment mortality.

1.2.2 Need for Power

The City Units Projects provide hydroelectric generation to meet part of Massachusetts' power requirements, resource diversity, and capacity needs. The City 1 Project has an installed capacity of 1,056 kW and generates about 2,710 megawatt hours (MWh) per year. The City 2 Project has an installed capacity of 800 kW and generates about 4,378 MWh per year. The City 3 Project has an installed capacity of 450 kW and generates about 2,119 MWh per year.

The North American Electric Reliability Corporation (NERC) annually forecasts electrical supply and demand nationally and regionally for a 10-year period. The City Units Projects are located within the Northeast Power Coordinating Council's New England region (NPCC-New England) of the NERC. According to NERC's 2018 Long-Term Reliability Assessment, the total internal demand for this region is projected to decrease by approximately 0.25 percent from 2019 to 2028 (NERC, 2018).

Although the demand for power over the long term is expected to decrease in the region, power from the City Units Projects would continue to help meet the need for power in the NPCC-New England region in both the short and long term. In addition, the projects provide power that can displace non-renewable, fossil-fired generation and contribute to a diversified generation mix. Displacing the operation of non-renewable facilities may avoid some power plant emissions and create an environmental benefit.

1.3 STATUTORY AND REGULATORY REQUIREMENTS

Subsequent licenses for the projects would be subject to numerous requirements under the FPA and other applicable statutes. The major regulatory and statutory requirements are described in the following sections.

1.3.1 Federal Power Act

1.3.1.1 Section 18 Fishway Prescriptions

Section 18 of the FPA states that the Commission is to require construction, operation, and maintenance by a licensee of such fishways as the Secretaries of the U.S. Department of Commerce or the U.S. Department of the Interior (Interior) may prescribe. Interior, by letter filed on September 12, 2018, requests that a reservation of authority to prescribe fishways under section 18 be included in any licenses issued for the projects.

1.3.1.2 Section 10(j) Recommendations

Under section 10(j) of the FPA, each hydroelectric license issued by the Commission must include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the projects. The Commission is required to include these conditions unless it determines that they are inconsistent with the purposes and requirements of the FPA or other applicable law. Before rejecting or modifying an agency recommendation, the Commission is required to attempt to resolve any such inconsistency with the agency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency. No recommendations were filed pursuant to section 10(j) of the FPA.

1.3.2 Clean Water Act

Under section 401(a)(1) of the Clean Water Act (CWA), a license applicant must obtain either water quality certification (certification) from the appropriate state pollution control agency verifying that any discharge from a project would comply with applicable provisions of the CWA, or a waiver of such certification.

On July 30, 2018, HG&E filed electronic correspondence from the Massachusetts Department of Environmental Protection (Mass DEP) that states that the certification issued for Holyoke Project No. 2004 includes all conditions necessary to meet state water quality standards and that separate certifications for the City Units Projects are not necessary. Based on this correspondence from the Mass DEP, the certifications for the City Units Projects are considered waived.

1.3.3 Endangered Species Act

Section 7 of the Endangered Species Act (ESA) requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species.

Based on staff's review of information available through the U.S. Fish and Wildlife Service (FWS) Information, Planning, and Consultation database,[6] two endangered species (dwarf wedgemussel and northeastern bulrush) and three threatened species (northern long-eared bat, Puritan tiger beetle, and small whorled pogonia) may occur in the project area. The shortnose sturgeon, which is federally listed as endangered, may also be present in the project area (National Marine Fisheries Service [NMFS], 2015). No designated or proposed critical habitat for these species is presently found within the proposed project boundaries. Our analysis of project impacts on threatened and endangered species is presented in section 3.3.4, *Threatened and Endangered Species*.

Based on our analysis, we conclude that relicensing the City Units Projects as proposed by HG&E would have no effect on the dwarf wedgemussel, northeastern bulrush, northern long-eared bat, Puritan tiger beetle, small whorled pogonia and no further consultation is required under section 7 of the ESA. However, because shortnose sturgeon are likely present in the canal system, our analysis concludes that the continued operation of the City Units Projects is "likely to adversely affect" shortnose sturgeon;

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[6] Staff accessed the Information, Planning, and Consultation database on November 7, 2018, and again on August 21, 2019, to request an updated species list.

however, we do not anticipate any new or additional effects beyond those effects covered by the existing incidental take statement issued by NMFS (2015).

1.3.4 Coastal Zone Management Act

Under section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA), 16 United States Code (U.S.C.) § 1456(3)(A), the Commission cannot issue a license for a project within or affecting a state's coastal zone unless the state CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

On January 9, 2019, HG&E filed correspondence from the Massachusetts Office of Coastal Zone Management that states that the City Units Projects fall outside of the geographical boundaries of the Massachusetts Coastal Zone and, therefore, are not subject to a consistency review. Therefore, CZMA consistency certification is not required.

1.3.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) requires that every federal agency "take into account" how each of its undertakings could affect historic properties. Historic properties are districts, sites, building, structures, traditional cultural properties (TCPs), and objects significant in American history, architecture, engineering, and culture that are eligible for inclusion in the National Register of Historic Places (National Register).

In letters filed on July 9, 2013 and January 13, 2014, the Massachusetts State Historic Preservation Office (SHPO) states that no historic properties would be affected by the relicensing of the City Units Projects as long as no new construction or demolition would occur.

1.4 PUBLIC REVIEW AND COMMENT

The Commission's regulations (18 C.F.R § 16.8) require that applicants consult with appropriate resource agencies, tribes, and other entities before filing an application for a license. This consultation is the first step in complying with the Fish and Wildlife Coordination Act, ESA, NHPA, and other federal statutes. Pre-filing consultation must be complete and documented according to the Commission's regulations.

1.4.1 Scoping

Before preparing this EA, we conducted scoping for the City Units Projects to determine what issues and alternatives should be addressed. We distributed a scoping document to interested agencies and others on October 10, 2017. The document was noticed in the *Federal Register* on October 17, 2017. No entities provided written comments.

1.4.2 Interventions

On December 2, 2016, the Commission issued a notice accepting HG&E's applications to relicense the City Units Projects and setting January 31, 2017 as the deadline for filing motions to intervene and protests. On January 31, 2017, Interior filed a motion to intervene.

1.4.3 Comments on the License Applications

On July 16, 2016, the Commission issued a notice requesting comments, recommendations, preliminary terms and conditions, and preliminary fishway prescriptions. Mass DFW and Interior filed comments on September 10, 2018 and September 12, 2018, respectively. The applicant filed reply comments on October 24, 2018.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 NO-ACTION ALTERNATIVE

Under the no action alternative, the projects would continue to operate under the terms and conditions of the current license, and no new environmental protection, mitigation, or enhancement measures would be implemented. We use this alternative to establish baseline environmental conditions for comparison with other alternatives.

2.1.1 Existing Project Facilities

The projects are located on the Canal System, adjacent to the Connecticut River, in the city of Holyoke in Hampden County, Massachusetts. The Canal System is a licensed facility of the Holyoke Project No. 2004.

City 1 Project

The City 1 Project consists of: (1) an intake at the wall of the first level canal with two 14.7-foot-high by 24.6-foot-wide trash rack screens with 3.5-inch clear spacing; (2) two parallel 10-foot-diameter, 36.5-foot-long penstocks; (3) a 50-foot-long by 38-foot-wide brick powerhouse with two 240-kilowatt and two 288-kilowatt turbine generator units; (4) two parallel 20-foot-wide, 328.5-foot-long brick arched tailrace conduits discharging into the second level canal; and (5) appurtenant facilities. There is no transmission line associated with the project as it is located adjacent to the substation of interconnection.

City 2 Project

The City 2 Project consists of: (1) an intake on first level canal with one 16.2-foot-high by 26.2-foot-wide and two 14.8-foot-high by 21.8-foot-wide trash rack screens with 3-inch clear spacing; (2) two 9-foot-diameter, 240-foot-long penstocks; (3) a 17-foot-high by 10-foot-diameter surge tank; (4) a 60-foot-long by 40-foot-wide by 50-foot high powerhouse with one 800-kilowatt vertical turbine generator unit; (5) two parallel 9-foot-wide, 10-foot-high, 120-foot-long brick arched tailrace conduits discharging into the second level canal; (6) an 800-foot-long, 4.8-kilovolt transmission line; and (7) appurtenant facilities.

City 3 Project

The City 3 Project consists of: (1) an intake on the second level canal with a 14-foot-high by 52.3-foot-long trash rack screen with 3-inch clear spacing; (2) two 11-foot-high by 11-foot-wide headgates; (3) two 85-foot-long, 93-square-foot in cross section low pressure brick penstocks; (4) a 42-foot-long by 34-foot-wide by 28-foot-high reinforced

concrete powerhouse with one 450-kilowatt turbine generator unit; (5) a 29.7-foot-wide, 10-foot-deep, 118-foot-long open tailrace discharging into the third level canal; (6) 4.8-kilovolt generator leads that connect directly to the 4.8-kilovolt area distribution system; and (7) appurtenant facilities.

2.1.2 Existing Project Boundaries

The current project boundaries for the City Units Projects enclose the facilities listed above. HG&E proposes no changes to the projects' boundaries.

2.1.3 Project Safety

The City Units Projects have been operating for more than 30 years under their existing licenses. During this time, Commission staff has conducted operational inspections focusing on the continued safety of the structures, identification of unauthorized modifications, efficiency and safety of operations, compliance with the terms of the license, and proper maintenance.

As part of the licensing process, Commission staff will evaluate the continued adequacy of the projects' facilities under subsequent licenses. Special articles will be included in any license issued, as appropriate. Commission staff will continue to inspect the projects during the term of any subsequent license to assure continued adherence to Commission-approved plans and specifications, special license articles relating to construction (if any), operation and maintenance, and accepted engineering practices and procedures.

2.1.4 Current Project Operations

The City Units Projects operate utilizing flows that are diverted into the Canal System by the Holyoke Project No. 2004. The amount of flow diverted into the Canal System is based on the time of year and the available flows in the Connecticut River in accordance with the Comprehensive Canal Operations Plan (CCOP) and the Comprehensive Operations and Flow Plan (COFP).[7] The CCOP describes the minimum required flows into the Canal System, including the magnitude and distribution of minimum flows throughout the three levels, the seasonal variation of minimum flows, and specific measures to monitor minimum flows through the Canal System. The COFP

[7] The CCOP and COFP are part of a Settlement Agreement (filed with the Commission on March 12, 2004) for the licensing of the Holyoke Hydroelectric Project No. 2004. On August 20, 2015, HG&E filed a revised CCOP and COFP, and the Commission approved these revised plans on May 18, 2016 (155 FERC ¶ 62,124).

describes the operation of the Holyoke Project No. 2004, including the prioritization and release of flows into the Canal System. There are two operational seasons with different flow requirements: (1) fish passage flows (April 1-November 15), and (2) habitat flows (November 16-March 30).

The Canal System begins with a canal gatehouse structure located between the Hadley Falls Station and the west abutment of the Holyoke Dam. The canal gatehouse discharges water from the Connecticut River into the first level canal. To prevent fish from entering the Canal System, a 440-foot-long louver bypass facility is angled across the first level canal beginning 554 feet downstream of the canal gatehouse. This louver bypass facility guides fish to a discharge pipe that transports downstream migrating fish to the tailrace of Holyoke Dam. Water travels from the first level canal into the second level canal through either an overflow structure or several operational hydroelectric generating stations (including the City 1 and City 2 Projects). Water travels from the second level canal into either the Connecticut River via several operational hydroelectric generating stations, or the third level canal via either the City 3 Project or an overflow structure. Finally, water travels from the third level canal into the Connecticut River via operational hydroelectric generating stations or an overflow structure.

The City 1 Project has a maximum hydraulic capacity of 850 cubic-feet-per-second (cfs), an estimated head of 20 feet, and an average annual net generation of 2,710 MWh. The City 2 Project has a maximum hydraulic capacity of 600 cfs, an estimated head of 20 feet, and an average annual net generation of 4,378 MWh. The City 3 Project has a maximum hydraulic capacity of 400 cfs, an estimated head of 12.5 feet, and an average annual net generation of 2,119 MWh.

2.2 APPLICANTS PROPOSAL

HG&E proposes to continue operating and maintaining the projects as it currently does. HG&E does not propose any new environmental measures.

2.3 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

The following alternatives were considered but have been eliminated from further analysis because they are not reasonable in the circumstances of this case: (1) issuing non-power licenses, (2) Federal Government takeover of the projects, and (3) retiring the projects.

2.3.1 Issuing a Non-Power License

A non-power license is a temporary license that the Commission would terminate when it determines that another governmental agency will assume regulatory authority

and supervision over the land and facilities covered by the non-power license. At this point, no agency has suggested a willingness or ability to do so. No party has sought non-power licenses for the projects and we have no basis for concluding that the projects should no longer be used to produce power.

2.3.2 Federal Government Takeover of the Project

Federal takeover and operation of the projects would require Congressional approval. While that fact alone would not preclude further consideration of this alternative, there is currently no evidence to indicate that federal takeover should be recommended to Congress. No party has suggested federal takeover would be appropriate, and no federal agency has expressed an interest in operating the projects.

2.3.3 Project Decommissioning

As the Commission has previously held, decommissioning is not a reasonable alternative to relicensing a project in most cases, when appropriate protection, mitigation, and enhancement measures are available.[8] The Commission does not speculate about possible decommissioning measures at the time of relicensing, but rather waits until an applicant actually proposes to decommission a project, or there are serious resource concerns that cannot be addressed with appropriate license measures, making decommissioning a reasonable alternative to relicensing.[9] This is consistent with the National Environmental Policy Act and the Commission's obligation under section 10(a) of the FPA to issue licenses that balance developmental and environmental interests.

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[8] *See, e.g.*, *Eagle Crest Energy Co.*, 153 FERC ¶ 61,058, at P 67 (2015); *Public Utility District No. 1 of Pend Oreille County*, 112 FERC ¶ 61,055, at P 82 (2005); *Midwest Hydro, Inc.*, 111 FERC ¶ 61,327, at PP 35-38 (2005).

[9] *See generally Project Decommissioning at Relicensing; Policy Statement*, FERC Stats. and Regs., Regulations Preambles (1991-1996), ¶ 31,011 (1994); *see also City of Tacoma, Washington*, 110 FERC ¶ 61,140 (2005) (finding that unless and until the Commission has a specific decommissioning proposal, any further environmental analysis of the effects of project decommissioning would be both premature and speculative).

Project retirement could be accomplished with or without facility removal.[10] Either alternative would involve denial of the license applications and surrender or termination of the existing licenses with appropriate conditions.

No participant has recommended project retirement, there are no critical resource concerns, and we have no basis for recommending project retirement. The City Units Projects are a source of clean, renewable energy. These sources of power would be lost if the projects were retired.

Project retirement without facility removal would involve disabling or removing equipment used to generate power. Certain project works could remain in place and could be used for historic or other purposes. This approach would require the State of Massachusetts to assume regulatory control and supervision of the remaining facilities. However, no participant has advocated for this alternative, and we do not have any basis for recommending it. Removing the facilities would be more costly than retiring them in place, and removal could have substantial, negative environmental effects.

[10] If the Commission denies relicensing of a project or a licensee decides to surrender an existing project, the Commission must approve a surrender "upon such conditions with respect to the disposition of such works as may be determined by the Commission." 18 C.F.R. § 6.2 (2019). This can include simply shutting down the power operations, removing all or parts of the project (including the dam), or restoring the site to its pre-project condition.

3.0 ENVIRONMENTAL ANALYSIS

In this section, we present: (1) a general description of the project vicinities; (2) an explanation of the scope of our cumulative effects analysis; and (3) our analysis of the proposed action and other recommended environmental measures. Sections are organized by resource area. Under each resource area, historic and existing conditions are first described. The existing condition is the baseline against which the environmental effects of the proposed action and alternatives are compared, and any potential cumulative effects of the proposed action and alternatives. Staff conclusions and recommended measures are discussed in section 5.1, *Comprehensive Development and Recommended Alternative*, of this EA.[11]

3.1 GENERAL DESCRIPTION OF THE AREA

The City Unit Projects are located on a Canal System that lies adjacent to the west bank of the Connecticut River. The Canal System is located in the heart of the City of Holyoke, which includes development on both sides of the Connecticut River. The area around the projects is primarily industrial and residential.

The primary current use of the Canal System is hydroelectric generation, with a total of 11 operational hydropower developments located along it.[12] The hydropower developments on the Canal System generate electricity by use of water flowing from a higher elevation canal to a lower canal, or from a canal into the Connecticut River. The amount of flow released into the canal is governed by the COFP and CCOP for the Holyoke Project No. 2004. Water is diverted from the Holyoke Project No. 2004 reservoir and flows through the multi-level, 4.3-mile long canal before being discharged back into the Connecticut River about 0.3 mile downstream of Holyoke Dam.

3.2 SCOPE OF CUMULATIVE EFFECTS ANALYSIS

According to the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (40 CFR § 1508.7), a cumulative

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[11] Unless otherwise indicated, our information is taken from the applications for license for these projects and additional information filed by the applicants as noted in section 7.0, *Literature Cited*.

[12] *See Order Approving Decommissioning of Project Features and Surrender of Project Licenses* 162, FERC ¶ 62,018 (2018) (decommissioning 3 of 14 hydropower developments on the Canal System, Project Nos. 2766, 2768, and 2771). By letter dated October 7, 2019, HG&E informed the commission that it has performed all work related to project decommissioning and that the projects are no longer operational.

effect is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative effects can result from individually minor but collectively significant actions taking place over time, including hydropower and other land and water development activities.

Based on our review of HG&E's license applications and agency comments, we have identified fisheries as a resource that could be cumulatively affected by the proposed continued operation and maintenance of the City Units Projects in combination with other past, present, and foreseeable future activities including multiple hydroelectric projects within the Holyoke Canal System and in the Connecticut River Basin due to fish impingement and entrainment that occurs at each of the facilities.

3.2.1 Geographic Scope

The geographic scope of the analysis defines the physical limits or boundaries of the proposed action's effect on the resources. The geographic scope of analysis for fisheries resources is the Connecticut River.

3.2.2 Temporal Scope

The temporal scope of our cumulative effects analysis in the EA will include a discussion of past, present, and reasonably foreseeable future actions and their effects on each resource that could be cumulatively affected. Based on the potential term of subsequent licenses, the temporal scope will look 40 years into the future, concentrating on the effect on the resources from reasonably foreseeable future actions. The historical discussion will, by necessity, be limited to the amount of available information for each resource. The quality and quantity of information, however, diminishes as we analyze resources further away in time from the present.

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES

In this section, we discuss the effect of the project alternatives on environmental resources. For each resource, we first describe the affected environment, which is the existing condition and baseline against which we measure effects. We then discuss and analyze the site-specific and cumulative environmental issues.

Only the resources that would be affected, or about which comments have been received, are addressed in detail in this EA. Based on this, we have determined that aquatic resources, terrestrial resources, threatened and endangered species, and cultural resources may be affected by the proposed action and alternatives. We have not identified any substantive issues related to geology and soils, land use and recreation, aesthetic resources, or socioeconomics, therefore, these resources are not addressed in the

EA. We present our recommendations in section 5.1, *Comprehensive Development and Recommended Alternative.*

3.3.1 Aquatic Resources

3.3.1.1 Affected Environment

Water Quantity and Use

Flows in the Connecticut River at the point of diversion into the Canal System at Holyoke Dam, range from 550 cfs to 40,700 cfs. The mean annual flow is 13,945 cfs (FERC, 2006).

There are a total of 11 hydroelectric generating stations in-service on the Canal System. The Canal System begins with the canal gatehouse structure located between the Hadley Falls Station and the west abutment of the Holyoke Dam. The canal gatehouse discharges water from the Connecticut River into the first level canal. HG&E operates a downstream fish passage louver bypass facility for the Holyoke Project No. 2004, which is located on the first level canal, beginning 554 ft downstream of the canal gatehouse. The louver bypass facility is 440 ft long, angled across the entrance to the first level canal, to guide fish to a bypass facility and pipe, which transports downstream migrating fish to the tailrace of the Holyoke Project No. 2004 back into the Connecticut River.

Water that passes through the louver bypass facility discharges into the first level canal and is available for use at the 11 hydroelectric generating stations. The first level canal discharges water into the second level canal through seven operating hydroelectric generating stations located along its length, which include the City 1 and 2 Projects, two non-operational generating stations, and a water process facility.[13] The second level canal includes the City 3 Project and three other operating hydroelectric generating stations, along with two overflow structures.[14] The City 3 Project and one of the

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[13] The Boatlock, Beebe-Holbrook, and Skinner developments (Project No. 2004); the Holyoke No. 4 Project (Project No. 7758), and the unlicensed Aubin station (also known as Anitec) are located between the first and second level canals. In addition, there is also the out-of-service Parsons station and the location of the former unlicensed Xidex station. There is also a facility owned by Hart Top Manufacturing, which is used for process water and is not a generating facility.

[14] The Riverside (FERC No. 2004) and Station No. 5 (FERC No. 10806 stations are located between the Second Level Canal and the Connecticut River.

overflow structures discharge water into the third level canal, while the other overflow structure and generating stations discharge water back to the Connecticut River. Figure 2 depicts these facilities.

Canal System flows are regulated by HG&E through operation of the Holyoke Project No. 2004 pursuant to the COFP and CCOP approved on May 18, 2016.[15] Flow in the Canal System downstream of the louver bypass facility ranges from 400 cfs to 6,590 cfs depending on river flow, except during canal drawdowns for maintenance when only leakage flows and some pooling of water are present. Collectively, COFP and CCOP specify flow releases into the Canal System to facilitate downstream fish passage and to protect water quality and aquatic habitat and biota (including freshwater mussel populations) within the Canal System. The hydraulic capacities of the City Units Projects are provided in table 1.

Table 1. Generating and hydraulic capacities of the City Units Projects (Source: HG&E, as modified by staff).

Project	Generator Capacity (kW)	Hydraulic Capacity (cfs)
City 1*	240, 240, 288, 288	190, 200, 230, 230
City 2	800	760
City 3	450	720

* Data is presented as described in the final license application (FLA) for the City 1 Project; however, we note that there is a slight discrepancy in the CCOP and COFP where generating capacities are described as 230, 230, 270 and 270 (kW).

The CCOP specifies that the canal flow allocation is adjusted biannually to provide fish passage and habitat flows pursuant to the COFP. Table 2 describes the canal flow allocation to the City Units Projects between April 1 and November 15 for the zone of fish passage flows; and table 3 demonstrates the canal flow allocation for November 16-March 31 for habitat season flows.

[15] *See* 155 FERC ¶ 62,124.

Table 2. Canal flow allocation (percentage) to City 1, 2, and 3 based on Holyoke Project Operations Plan for Zone of Passage Flows (April 1 – November 15) (Source: HG&E, as modified by staff).

River Discharge (cfs)	Flow Entering Canal (cfs)	Percent River Flow Entering Canal	Canal Flow Downstream of Louvers[a] (cfs)	Percent of Canal Flow[b]		
				City 1 (1st Level)	City 2 (2nd Level)	City 3 (3rd Level)
550	550	100	400	--	100	100
1390	550	39.6	400	--	100	100
2190	990	45.2	400	--	100	100
3070	990	32.2	400	--	100	100
4090	990	24.2	400	--	30	20
5690	2590	54.5	2000	--	30	20
6990	2590	37.1	2000	--	30	20
10190	2590	25.4	2000	--	10.9	7.3
13685	2590	44.5	5495	--	10	6.7
14190	6085	46.4	6000	--	10	6.7
15740	6590	41.9	6000	--	10	6.7
16640	6590	39.6	6000	14.2	10	6.7
18180	6590	36.2	6000	14.2	10	6.7
28740	6590	22.9	6000	14.2	10	6.7
32240	6590	20.4	6000	14.2	10	6.7
37240	6590	17.7	6000	14.2	10	6.7
41200	6150	14.9	6000	14.2	10	6.7

[a] Canal flow downstream of louvers is the flow entering the canal minus louver bypass flow (150 cfs) and fish lift attraction flow.

[b] Less than 100 percent of canal flow entering City 1, 2, and 3 indicates the other Canal System stations are using flow.

Table 3. Canal flow allocation (percentage) to City 1, 2, and 3 based on Holyoke Project Operations Plan for Habitat Season Flows (November 16 – March 31) (Source: HG&E, as modified by staff).

				Percent of Canal Flow[b]		
River Discharge (cfs)	Flow Entering Canal (cfs)	Percent River Flow Entering Canal	Canal Flow Downstream of Louvers (cfs)[a]	City 1 (1st Level)	City 2 (2nd Level)	City 3 (3rd Level)
810	400	49.4	400	--	--	--
1240	400	32.3	400	--	100	100
2120	400	18.9	400	--	100	100
5740	400	7	400	--	100	100
9490	400	4.2	400	--	27.3	100
11290	2200	19.5	2200	--	10	18.2
15090	6000	39.8	6000	14.2	10	6.7
16050	6000	37.4	6000	14.2	10	6.7
18050	6000	33.2	6000	14.2	10	6.7
18350	6000	32.7	6000	14.2	10	6.7
29450	6000	20.4	6000	14.2	10	6.7
32450	6000	18.5	6000	14.2	10	6.7
37450	6000	16	6000	14.2	10	6.7

[a] Louver bypass flow and fish lift attraction flow are not provided during the habitat season, resulting in no difference between flow entering canal and flow downstream of louvers.
[b] Less than 100 percent of canal flow entering City 1, 2, and 3 indicates the other Canal System stations are using flow.

The canal is periodically dewatered for maintenance and repairs. This typically occurs twice a year, once in spring, which lasts one to two days, and once in the fall/summer, which lasts five to seven days. During canal outages and maintenance drawdown periods, flow in the canal consists primarily of leakage.[16]

[16] The FLA is not clear on the sources of leakage.

Water Quality

The Mass DEP, Division of Water Pollution Control has designated the Connecticut River at the Holyoke Dam for the Holyoke Project No. 2004, where water is diverted into the canal, as Class B, Warm Water. Class B waters are designated as a habitat for fish, other aquatic life, wildlife, and for primary and secondary contact recreation. Where designated, Class B waters should have good aesthetic value as well as be suitable for public water supply with appropriate treatment, irrigation, other agricultural uses, as well as for compatible industrial cooling and processing uses.

Water quality standards for Class B waters include: (1) minimum dissolved oxygen (DO) levels of no less than 5.0 milligrams per liter (mg/l) for warmwater fisheries, unless background conditions are lower;[17] (2) a maximum temperature of 83 degrees Fahrenheit (ºF) (28.3 degrees Celsius (ºC)) for warmwater fisheries, and the rise in temperature due to a discharge shall not exceed 5ºF (2.8ºC) in rivers and streams designated as warmwater fisheries; and (3) an acceptable pH range of 6.5 to 8.3 and not more than 0.5 units outside of the background range. In addition, the standard for fecal coliform is a geometric mean of 200 organisms per 100 milliliter (ml) in any representative set of samples, and no more than 10 percent of the samples shall exceed 400 organisms per 100 ml (Mass DEP, 1996).

Water quality in the Canal System is maintained by HG&E through operation of the Holyoke Project No. 2004 pursuant to the COFP and CCOP. Water quality samples (temperature and DO) were collected from the end of the first level canal annually between 2001 and 2015 during May, August, and November (table 4). This location was chosen to represent the worst possible scenario of water quality in the Canal System. The monitoring data show that these water quality conditions in the canal are typically, with the exception of the first monitoring event during August 2001, within the state standards for Class B waters.

[17] Natural seasonal and daily variations above these levels shall be maintained; levels shall not be lowered below 60 percent saturation in warmwater fisheries due to a discharge.

Table 4. Canal System water temperature and DO results 2001-2015 (Source: HG&E, as modified by staff).

Year	Parameter	May	August	November	Class B
2015	DO (mg/L)	8.87	7.66	10.64	> 5.0
	Temp (°C)	15.36	25.71	7.66	< 28.3
2014	DO (mg/L)	9.56	7.36	11.78	> 5.0
	Temp (°C)	14.98	22.35	4.18	< 28.3
2013	DO (mg/L)	9.3	8.43	13.3	> 5.0
	Temp (°C)	15.62	24.86	3.12	< 28.3
2012	DO (mg/L)	11.62	8.43	12.62	> 5.0
	Temp (°C)	14.35	24.86	7.57	< 28.3
2011	DO (mg/L)	11.65	8.32	11.8	> 5.0
	Temp (°C)	16.35	24.8	8.3	< 28.3
2010	DO (mg/L)	9.5	6.9	11.9	> 5.0
	Temp (°C)	21.7	24.31	8.98	< 28.3
2009	DO (mg/L)	9.17	9.9	10.06	> 5.0
	Temp (°C)	17.06	22.67	8.17	< 28.3
2008	DO (mg/L)	10.44	23.6	11.55	> 5.0
	Temp (°C)	15.77	11.35	8.27	< 28.3
2007	DO (mg/L)	10.68	7.96	10.04	> 5.0
	Temp (°C)	14.5	24.66	8.54	< 28.3
2006	DO (mg/L)	13.52	7.63	13.57	> 5.0
	Temp (°C)	13.39	24.25	6.2	< 28.3
2005	DO (mg/L)	9.3	8.6	10.7	> 5.0
	Temp (°C)	14.2	25.3	3.2	< 28.3
2004	DO (mg/L)	8.1	8.6	11.6	> 5.0
	Temp (°C)	19.2	24.8	12.2	< 28.3
2003	DO (mg/L)	10	8.6	8.5	> 5.0
	Temp (°C)	14.8	26.2	21.9	< 28.3
2002	DO (mg/L)	9.2	6.4	10	> 5.0
	Temp (°C)	17.1	26.2	5.6	< 28.3
2001	DO (mg/L)	NA	7.96	11.72	> 5.0
	Temp (°C)	NA	29.7	11.8	< 28.3

Fish and Freshwater Mussels

The Connecticut River supports a diverse fish community that includes resident, migratory, native, non-native, warmwater, and coolwater species in the project vicinity. In addition to the species composition data included in the final license applications for the projects, HG&E provided species composition data from Connecticut River fish surveys conducted by the Midwest Biodiversity Institute in 2008 and 2009 and from sampling at the louver bypass facility conducted in 2006.[18] Midwest Biodiversity Institute (MBI) fish collections within 15 miles upstream of Holyoke Dam were dominated by channel catfish, bluegill, spottail shiner, common shiner, and white sucker. The louver bypass facility samples were dominated by spottail shiner, yellow perch, smallmouth bass, fallfish, rock bass, and pumpkinseed. In its September 2018 comment letter, Fish and Wildlife Service identified nine fish species known to occur in the Canal System.[19] Shortnose sturgeon are the only federally listed endangered fish known to occur in the vicinity of the City Units Projects. Table 5 lists the fish species know to occur in the Connecticut River and likely to be in the vicinity of, or within, the Canal System and the City Units Projects.

Migratory Fish Known to Occur in the Canal System

Shortnose sturgeon (Acipenser brevirostrum), American shad (Alosa sapidissima), and American eel (Anguilla rostrata) are migratory species known to seasonally utilize the Canal System when attempting to migrate downstream past the Holyoke Dam.[20] In the following text we discuss the current status and management and life histories of the Connecticut River shad and American eel. Shortnose sturgeon is a federally listed endangered species and, therefore, is discussed below in section 3.3.3 *Threatened and Endangered Species*.

[18] Holyoke Gas & Electric Department Enhanced Desktop Study in support of relicensing proceedings for P-2386, P-2387 and P-2388, filed on August 14, 2017 (Accession Number: 20170814-5075).

[19] Letter filed September 12, 2018 (Accession Number: 20180912-5056).

[20] Fish and Wildlife Service letter filed September 12, 2018 (Accession Number: 20180912-5056).

Table 5. Fish species know to occur in the Connecticut River and likely to be in the vicinity of, or within the Holyoke Canal System and the City Units Projects (Source: HG&E and U.S. Fish and Wildlife Service, as modified by staff).

Name of species		
American eel [c, e]	Black crappie [b, e]	Fallfish [b, c, e]
Bluegill [b, d, e]	Golden shiner [b, d, e]	Common shiner [b, d, e]
Brown bullhead [d, e]	Chain pickerel [b, e]	Brook trout [d]
Largemouth bass [b, d, e]	Walleye [d]	Smallmouth bass [b, c, d, e]
Pumpkinseed [b, c, d, e]	Shortnose sturgeon [a, c]	White sucker [b, d, e]
Rock bass [b, c, d, e]	Tessellated darter [b, e]	American shad [c, e]
Spottail shiner [b, c, d, e]	Common carp [b, d]	Rainbow trout [d]
Yellow perch [b, c, d, e]	Channel catfish[d]	Brown trout [d]
Sea Lamprey [e]	Blueback herring [e]	Gizzard shad [e]
Striped bass [e]	Redbreast sunfish [e]	Walleye [e]
Longnose dace [e]	Alewife [e]	Atlantic salmon [e]

[a] Shortnose sturgeon are a federally listed endangered species under the Endangered Species Act.
[b] Species collected at the louver bypass facility sampler in 2006 (HG&E).
[c] Species known to occur in the Holyoke Canal System (Fish and Wildlife Service letter filed September 12, 2018 (Accession Number: 20180912-5056)).
[d] Species collected during MBI sampling in 2008 and 2009 (HG&E).
[e] Fish Species identified in the final license applications as being present in the vicinity of the Canal System (HG&E).

American Shad

The Connecticut River American shad population has been cooperatively managed by the state and federal fishery agencies since 1967 (CRASC, 2017). American shad was an important resource used for food along the Atlantic coast until a coast-wide decline ended most commercial efforts (FERC, 1999). The decline in American shad populations was likely attributed to habitat loss, water quality degradation, and over-fishing (FERC, 1999). However, today the American shad population is considered stable with annual estimates of adult returns from 1966 to 2015 ranging between 226,000 and 1,628,000 fish (CRASC, 2017).

American shad migrate into the Connecticut River during late March or April, and arrive at the Holyoke Project (P-2004) fishlifts in late April or early May when water temperatures are generally between 54 and 68 ºF (CRASC, 2017). Shad reaching the Holyoke Project are provided fish passage at the Holyoke fishlifts and allowed to migrate upstream. Spawning typically occurs during June and July, when water temperatures are between 57 and 73 ºF (FERC, 1999). Shad spawn in a variety of habitats but appear to prefer broad, shallow areas of rivers and streams over sand and gravel substrate (Stier and Crance, 1985). When spawning, eggs are broadcast and fertilized in open water. In northern latitudes such as New England, shad often survive spawning, after which they migrate downstream and return to the ocean (Leggett and Carscadden, 1978). Eggs typically hatch within 12 days, depending on water temperature and the larvae drift into areas of lower velocity currents, where they rear. Juvenile shad typically migrate downstream and out of the Connecticut River to the Atlantic Ocean between September and November when water temperatures are between 48 to 57 ºF (FERC, 1999). Shad will remain in the ocean environment for 4 to 6 years before returning to spawn (FERC, 1999).

American eel

American eel is the only catadromous fish species that occurs in the Connecticut River Basin.[21] The American eel spends most of its life in fresh or brackish water before migrating to the Sargasso Sea in the middle of the North Atlantic to spawn. It occurs throughout warm and cold waters of the Atlantic Ocean and Atlantic coastal drainages in North America (Boschung and Mayden, 2004). Within its range, it is most abundant throughout the Atlantic coastal states (ASMFC, 1999).

Spawning likely occurs from February through April in the Sargasso Sea, although the act of spawning has never been observed (Boschung and Mayden, 2004). Fertilized

[21] A catadromous fish spends most of its life in freshwater and migrates to saltwater to breed.

eggs and larvae, known as the planktonic phase, drift with the Gulf Stream currents along the east coast of the United States (Jenkins and Burkhead, 1993). Following this phase, the planktonic leptocephali, ribbon-like eel larvae, transform into what is termed a "glass" eel as it approaches coastal waters. Glass eels are completely transparent and make their way into brackish waters by the use of flood tides. Once skin pigments develop in glass eels, they are considered to be "elvers."[22]

As eels mature, elvers become juvenile, or "yellow" eels. The majority of eels collected in freshwater rivers are typically yellow eel, which is considered to be the primary growth phase of its life cycle (Ross *et al*., 2001). Yellow eels are typically sedentary during the day, often burying in mud or silt, and becoming active at night to feed (Jenkins and Burkhead, 1993). They associate with pools or backwater habitats, and often have relatively small home ranges (Gunning and Shoop, 1962). The juvenile stage can last from 5 to 40 years before finally maturing into silver eels and out-migrating in the fall and mid-winter months to spawning grounds (*i.e.*, Sargasso Sea) (Boschung and Mayden, 2004).[23] Adult eels are presumed to die after spawning (Boschung and Mayden, 2004; Jenkins and Burkhead, 1993).

In New England, adult eel out-migration typically occurs from mid-August through mid-November (Haro *et al*., 2003). Adult eels often move downstream in intermittent pulses, with a large number of eels moving downstream during short periods of activity (1-3 days) followed by longer periods of time (7-20 days) with relatively little downstream eel movement (EPRI, 2001). Peak downstream movements often occur at night, during periods of increasing river flow (Richkus and Whalen, 1999). Other environmental cues such as local rain events and moon phase may also encourage downstream movements of out-migrating eels (EPRI, 2001; Haro *et al*., 2003).

The Holyoke Project No. 2004 is the first barrier to upstream and last barrier to downstream American eel migration on the Connecticut River. Between 2003 and 2014, the Holyoke Project passed between 100 and 50,000 juvenile eels upstream (Normandeau, 2015). During out-migration, eel have three route selections to move downstream past the Holyoke Project, including dam passage via spillway (or Bascule Gates), Hadley Station hydroelectric turbines, or the Canal System. Within the Canal System, out-migrating eel first encounter the louver bypass facility. The bypass array has two-inch bar spacing and is used to guide out-migrating fish to a bypass pipe. The

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[22] Elvers often serve as important forage fish for striped bass and other large piscivores.

[23] Juvenile eels that reside in estuaries reach maturity and migrate earlier than juveniles found in freshwaters. These eels can reach full maturity without migrating to freshwater (Shepard, 2015).

bypass pipe carries migrating fish downstream past the Holyoke Dam and discharges back into the Connecticut River via the Hadley Station tailrace.

Eel that migrate through the louver bypass facility are then exposed to 11 hydroelectric stations, as described in section 2.1.1, *Existing Project Facilities*. Before being discharged back into the Connecticut River, eels passing through the louver bypass facility either travel through one or more of the hydroelectric turbines within the system, or travel through the overflow structures. As described in the COFP, 100 percent of flow passing through the louver bypass guidance facility during eel migration season is dispatched through the City 2 Project and potentially other turbines within the Canal System before being discharged back into the Connecticut River.

Freshwater Mussels

Biennial mussel surveys of the first and second canal levels between 2003 and 2013 indicate that the Canal System provides suitable mussel habitat and populations of the native Eastern elliptio, Alewife floater, and the state listed endangered yellow lampmussel. During the 2013 survey, Asian clam, a non-native invasive species was found in abundance in the first level canal after being detected for the first time in 2012.[24]

3.3.1.2 Environmental Effects

Water Quality and Aquatic Habitat

Operation of the City Units Projects has the potential to affect water quality (primarily DO) and, therefore, aquatic habitat in the Canal System. HG&E proposes to continue operating the City Units Projects with no measures specific to the City Units Projects, to protect water quality or aquatic habitat in the Canal System.

Our Analysis

HG&E protects water quality, aquatic habitat, and aquatic biota (including freshwater mussel populations) in the Canal System through the operation of the Holyoke Project No. 2004 according to the Holyoke Project No. 2004 license's COFP and CCOP. Currently, water quality conditions in the Canal System are consistently within the state standards for Class B waters. Therefore, operation of the Holyoke Project No. 2004 in conjunction with the operation of the City Units Projects does not adversely affect water quality and aquatic habitat within the Canal System.

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[24] HG&E's Twelve-Year Summary Rare Mussel Species Survey Report 2003-2014, filed for the Holyoke Project P-2004, on October 1, 2014 (Accession Number: 20141001-5393).

Fish Passage, Entrainment, and Turbine Mortality

Fish that pass through the louver bypass facility and enter the first level canal could be impinged on project trash racks, entrained into project works and turbines, and suffer project-related injury or mortality. Mass DFW and FWS state that their primary concern is the projects' potential to entrain diadromous fishes, particularly American eel, and the mortality that may occur as a result of entrainment.[25] However, the agencies note that they are not able to recommend fish passage and protection measures until a comprehensive entrainment and turbine survival analysis for each hydropower station on the Canal System has been completed. HG&E does not propose any measures to protect fish from entrainment or impingement at the City Units Projects.

Our Analysis

Turbine blade strikes are thought to be the primary source of mortality for fish entrained through hydropower projects (Franke et al., 1997; Pracheil et al., 2016). Fish size is an important factor in entrainment susceptibility and turbine mortality, whereby smaller fish are more likely to be entrained but experience lower turbine mortality; however, the physical properties of turbine units also play a role in turbine mortality (Winchell et al., 2000; Pracheil et al., 2016).

The City 1 Project is composed of a powerhouse with four turbine-generator units. Two of the turbines have runner diameters of 838 millimeters (mm) with a rotational speed of 200 rotations per minute (rpm) and the other two have diameters of 762 mm and a rotational speed of 180 rpm. The City 2 Project includes a powerhouse with a single vertical turbine-generator, with a diameter of 1,930 mm and a rotational speed of 180 rpm. The City 3 Project includes a powerhouse with a single vertical turbine-generator, with a diameter of 2,180 mm and a rotational speed of 180 rpm.

Diadromous fish that pass through the louver bypass facility during downstream migration, particularly American eel and the federally listed shortnose sturgeon, could be affected by exclusion from passage, prolonged or delayed migration, entrainment in turbines, and project-related mortality at the City Units Projects.[26]

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[25] Comment letters filed by the Massachusetts Division of Fish and Wildlife on September 11, 2018 and the U.S. Department of the Interior on September 12, 2018 (Accession numbers: 20180911-5056 and 20180912-5056, respectively).

[26] We discuss and analyze the projects' effects on the federally listed shortnose sturgeon in section 3.3.3 *Threatened and Endangered Species* below.

With the presence and operation of the louver bypass facility, the number of fish exposed to the intakes of the City Units Projects is limited. The louver bypass facility guides fish, which have been diverted from the Connecticut River at the Holyoke Dam, back into the river via a bypass pipe.

HG&E conducted a literature based *Assessment of Fish Entrainment, Impingement, and Turbine Survival at Holyoke Nos. 1, 2, and 3* (Entrainment Study).[27] The Entrainment Study evaluated impingement, and entrainment and turbine survival of resident fish (e.g., smallmouth bass, yellow perch, and shiners) and diadromous (i.e., American eel and shortnose sturgeon) at each of the City Units Projects. The study found that impingement of fish capable of passing through the narrow spacing of the louver bypass facility is unlikely given the larger spacing of trash racks at the projects.[28]

The potential for entrainment through turbines at the City Units Projects was assessed for fish that are small enough to pass through the louver bypass facility and enter the upper level canal. The study reasonably assumed that the proportion of fish that are entrained at each of the hydropower developments on the canal is proportional to the percentage of flow allocated to each of the developments as specified by the Holyoke Project Operation Plans for Zone of Passage Flows (April 1–November 15) and Habitat Season Flows (November 16–March 31).[29] The Entrainment Study estimated the turbine survival rate for the City Units Projects for resident species, shortnose sturgeon, and American eel.

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[27] Holyoke Gas and Electric Department Enhanced Desktop Study filed August 14, 2017 (Accession Number: 20170814-5075).

[28] Most fish capable of passing through the Louver-bypass are expected to be 300 mm in length or shorter [HG&E, Enhanced Desktop Study filed August 14, 2017 (Accession Number: 20170814-5075)].

[29] Holyoke Gas and Electric Department Revised Comprehensive Operations and Flow Plan and Comprehensive Canal Operations Plan, filed on August 20, 2015 (Accession Number: 20150820-5117).

Resident Species and Shortnose Sturgeon

When operating, turbine survival rate for resident fish at the City 1 Project is estimated to range from 96.6 percent for fish 50 mm in length and 88.2 percent for fish 300 mm in length. The City 2 Project is estimated to have a greater turbine survival rate for resident fish, ranging from 98.6 percent for fish 50 mm in length to 76.6 percent for fish 300 mm in length. The City 3 Project has the highest estimated turbine survival rate for resident fish, ranging from 99.6 percent for fish 50 mm in length to 94.0 percent for fish 300 mm in length.

Fish are assumed to enter the Canal System in proportion to flow (HG&E Entrainment Study, 2017) and then exposed to hydroelectric generating stations. Of those fish able to pass through the 2-inch bar spacing in the louver guidance facility, HG&E reported in their 2017 Entrainment Study that entrainment at the City 1 Project (typically only operated at flows of 6,000 cfs or greater) is estimated to be about 14 percent when the units are operating. The study estimates entrainment at the City 2 and 3 Projects to be 100 percent of fish that passed through the louvers at the lowest canal flow of 400 cfs but would drop to 30 percent or less at each project when canal flow is increased to 2,000 cfs or greater, as other hydroelectric stations are brought online. Though fish could reside within the Canal System for an extended period of time, they are all likely to pass through one or more of the hydroelectric stations eventually.

Because the rate of fish entering the Canal System is low, and the louver guidance facility is estimated to effectively guide 80 percent of those fish to the bypass pipe, and because turbine survival was shown in the HG&E Entrainment Study (2017) to be high, the overall project related mortality of resident fish species is expected to be minimal.

Shortnose sturgeon are discussed below in Section 3.3.3.2 Threatened and Endangered Species, *Environmental Effects.*

American Eel

In their 2017 Entrainment Study, HG&E reported adult (silver) American eel entrainment rates ranged from 0.4 to 1.1 percent at the City 1 Project and approximately 0.2 to 9.0 percent at the City 2 and 3 Projects, based on 80 percent guidance efficiency and unit flow allocation determined by river discharge. Mass DFW and FWS express concern that because it is commonly assumed that out-migrating fish move proportional to flow through a given passage route during August through November, 25 to 46 percent of eels (based on flow allocation information contained in Table 3-1 of the COFP and hydrologic data measured at the U.S. Geological Survey (USGS) stream gauge 01172010) would be expected to move into the Canal System. Of those, 54 to 71 percent may be effectively guided by the louver bypass facility, resulting in potential for 7 to 21 percent of eels entering the first level canal below the bypass, and becoming entrained in any of the 11 operating hydropower stations along the three canal levels. Mass DFW and

FWS state that the 54 percent louver guidance efficiency rate was taken from a 2007 study (EPRI, 2007). In response, HG&E indicates that statement is inaccurate as louver guidance efficiency was not reported in the EPRI study due to concerns that test specimens, collected from the louver bypass, would create a bias because they had already successfully negotiated the bypass facility. Louver guidance efficiency results as reported in Normandeau (2007) and Normandeau (2018) were 67 and 71 percent respectively. HG&E also argues that Mass DFW and FWS failed to consider that eels are known to migrate primarily during high flow events when the proportion of river discharge being diverted into the Canal System is smaller, resulting in a lower proportion of eels entering the Canal System altogether.

Mass DFW and FWS also question the eel turbine passage survival results for the City 1 Project, noting that the Entrainment Study concludes that "…because the Francis turbine survival data for eels are limited, any regression analysis will not be overly rigorous and robust from a statistical perspective." In addition, the agencies note that the turbines used to develop the regression model to conduct the entrainment analysis were not representative of the City 1 turbines, where the smallest turbine used in the model was nearly twice the size of those of the City 1 Project. Adult silver eels typically range in size from 584 to 889 mm. The presumption is that eels have relatively high survival rates through Francis turbines because they "ball up" in the turbine buckets, thereby avoiding blade strike injuries. However, an eel that is the same size as, or larger than, the diameter of the turbine is unlikely to be able to use this behavioral mechanism to avoid blade strike injury. As a result, the agencies are concerned that the relatively high survival rates estimated via the Alden regression model (approximately 90 percent) could be overly optimistic. In response to this comment, HG&E contends that the primary difference between City 1 turbines and the smallest turbine for which eel survival data were available is blade spacing, not turbine size, as indicated by the agencies, and therefore the study results are indicative of anticipated turbine mortality through the City 1 Project.

Finally, Mass DFW and FWS note that only 3 of the 11 hydropower stations on the Canal System are part of these relicensing proceedings and that passage/protection measures must consider the system as a whole. For instance, requiring installation of exclusionary screening over the intakes of the City Units Projects would prevent entrainment in those units, but would not necessarily reduce overall mortality (if, for example, turbine-induced mortality would be higher through other stations). The agencies note that screening of project intakes could also lead to migratory delay if the only stations operating are those with exclusionary screening or if they are the preferred downstream pathway for eel. As described by Mass DFW and FWS, one measure to address these concerns would be to not operate projects with exclusionary screening during the eel migration; however, that could force eel to select a more volatile, less

friendly passage route as other units on the Canal System would be used for generation instead.

In the report filed by HG&E on April 30, 2007, "*American Eel Emigration Approach and Downstream Passage Routes at the Holyoke Project, 2006"* (Normandeau, 2006), 19 American eels were tracked migrating through the Holyoke Project. Six eels (32 percent) passed through the canal gatehouse and into the Canal System. Of those, four were directed by the louver bypass array into the bypass pipe (67 percent louver guidance efficiency). Two of the eels in the Canal System (33 percent) passed through the louver bypass facility where they were exposed to one or more generating turbines.

In a report filed by HG&E April 30, 2018, "*Downstream Passage of Silver-Phase American Eel: Post Construction Monitoring for Hadley Falls Station Downstream Passage Protection at Holyoke Dam"* (Normandeau, 2018), out-migration route selections were tracked for 101 of 107 eels tagged and released upstream of the Holyoke Project (P-2004). Of these, 24 (24 percent) passed the canal gatehouse and entered the Canal System. Of the 24 eel that moved through the canal gatehouse and into the Canal System, 17 (71 percent) were effectively guided back into the Connecticut River through the louver bypass facility (comparable to the 2007 report indicating a 67 percent louver guidance efficiency). These results, which occurred when the Holyoke Project units were operating at a full capacity of 6,000 cfs, suggest that the actual louver bypass facility guidance efficiency is about 67 to 71 percent, which is lower than the HG&E 2017 Entrainment Study assumption of 80 percent efficiency when the units are operated at full capacity (6,000 cfs).

Because the proportion of eels migrating into the Canal System was determined (by Mass DFW and FWS) based on data provided in the COFP and USGS stream gauge data, we find that likely between 25 and 46 percent of out-migrating eels in the Connecticut River become entrained within the Canal System during migration season. At a louver bypass facility guidance efficiency rate of 67 to 71 percent (29 to 33 percent passage through the louver array), approximately 7 to 15 percent of out-migrating American eels will be exposed to power generating turbines within the Canal System.

In the Entrainment Study, HG&E also estimated turbine survival of American eels passing through turbines at the City 2 and 3 Projects using a multiple linear regression model developed from field studies conducted at more than 50 hydro projects with Kaplan or fixed-blade propeller units in Europe and North America. Because there is no similar-sized data set of eel survival studies for Francis turbines, recent evaluations conducted with silver eels at four projects upstream of the Holyoke Dam were used to develop a regression model for City 1 turbine survival. HG&E estimates survival of eel passing through City 1 to be approximately 90 percent depending on which turbines they pass through. Turbine survival estimates for silver eels passing through the City 1 Project (Francis turbines) were approximately 90 percent. Eels passing through City 2

and 3 Projects were estimated to have lower survival estimates; 41 to 58 percent through City 2, and 48 to 65 percent for eel entrained through City 3.

The turbine diameters at Turner Falls Station No. 1 range between 838 and 1,219 mm as reported in "*Direct Injury and Relative Survival of Adult American Eel at the Turners Falls Hydroelectric Project (No. 1889)"* (Normandeau, 2016). This is slightly larger on average than turbine diameters at the City 1 project, which are 762 and 838 mm. City 1 Francis turbines also each have 15 blades, while turbines at Turners Falls Station No. 1 have 13 blades. The smaller spacing between blades associated with the larger number of blades increases blade strike and potentially higher strike-related mortality (Entrainment Study). However, unlike other fish species with a more typical body shape (e.g., salmonids, centrarchids, catostomids, cyprinids, percids, and clupeids), entrainment studies indicate that turbine survival for eels is, in general, higher for Francis turbines than Kaplan and fixed-blade propeller units (Normandeau, 2017).

Turbine mortality of eels at the City 1 Project is likely higher than the 10 percent estimated by HG&E in its Entrainment Study due to: (1) the field data used to develop the regression model were obtained from turbines with slightly larger blade diameters and fewer blades than those at City 1, and (2) the guidance efficiency at the louver bypass facility in the Canal System is likely lower than reported. However, eel are known to out-migrate more actively during high flows and the proportion of flow diverted into the Canal System from the Connecticut River decreases as river flow increases, meaning eel are likely to be out-migrating most actively when the proportion of water being diverted into the Canal System is low. Therefore, eel are likely to be out-migrating most actively during periods when the proportion of eel entering the Canal System relative to those remaining in the river is lowest. For these reasons, and because overall turbine related mortality is low, the continued operation of the City Units Projects is not likely to adversely affect the American eel population in the Connecticut River

Cumulative Effects

There are 16 hydropower projects located along the mainstem of the Connecticut River and 11 hydropower projects within the Canal System. Due to this, the City Units Projects have the potential to cumulatively affect fisheries resources within the Connecticut River in conjunction with these other projects due to fish impingement and entrainment that occurs at each of the facilities. However, as discussed in section 3.3.1.1 (*Affected Environment*) above, the presence of the louver bypass facility and the downstream bypass facility associated with the Holyoke Project No. 2004 limits the exposure of downstream migrating fish from impingement and/or entrainment at the City Unit Projects. Therefore, because HG&E proposes no change to the operation or hydraulic capacities of the projects, it is unlikely that continued operation of the projects, as proposed by HG&E, would further impact the existing fishery resources of the Connecticut River.

3.3.2 Terrestrial Resources

3.3.2.1 Affected Environment

Botanical Resources

The area surrounding the projects is entirely located within the City of Holyoke, which is an urban area with concentrated industrial development. Therefore, within the area of the projects there is very little opportunity for vegetation of any kind to colonize. Tree cover and wetlands in the area have been lost in the process of urbanization. The principal tree cover in the developed areas represents second growth stands. The forest is heaviest at the top and along the slopes of the bluffs, with small-scattered clumps and individual trees occurring in isolated open space parcels. The understory vegetation in the forested area is minimal and typical of those species found in association with the trees present. The area surrounding the Canal System is located in what was historically an oak chestnut region of natural vegetation. Limited aquatic plant species grow in the Canal System.

Invasive Species

In the vicinity of the Canal System, the vegetation is typical of disturbed urban sites, and includes invasive species such as Japanese knotweed, box elder, purple loosestrife, ragweed, and cocklebur.

Wildlife and Species of Special Concern

The small footprints for the projects and the density of development in this urban area precludes the existence of a diverse or large wildlife population. However, nearby undeveloped bluffs, steep slopes and dikes provide habitat for certain small mammal species such as gray squirrels, cottontail rabbits, muskrats, Norway rats, raccoons, beaver, weasels, pheasants and small field mammals that are fairly common to the broader area surrounding the projects.

Despite the urban character of the projects, the nearby area supports a variety of songbird species. The range of available habitat attracts numerous birds to the metropolitan environments. Many waterfowl species, including common goldeneye, Canada geese, and the common merganser are found in the Connecticut River. Cormorants are seen in greater concentrations in the vicinity of the dam than in other portions of the area. Herring gulls are common throughout this area.

Due to the transient nature of the bald eagle, it may at times be observed near the Canal System. While the bald eagle is no longer listed under the Endangered Species Act, it is still federally protected under The Bald and Golden Eagle Protection Act. It winters along the Connecticut River in the vicinity of Holyoke Project No. 2004 and

nesting pairs are established in that project area. The bald eagle perches in riverbank trees and circles over the river searching for food. HG&E constructed three bald eagle nesting platforms in the fall of 2003, which are located outside of the City of Holyoke in West Springfield, Hatfield, and North Hadley. As described in the Bald Eagle Annual Report for 2008, two of the nest sites were used in 2008, and since platform construction in 2003, 16 eaglets have successfully fledged from HG&E monitored nest sites. These platforms are not, however, located within the project boundaries, nor are there potential nesting or perching trees at the City Units Projects, which have no impoundment and include no actual shoreline.

3.3.2.2 Environmental Effects

Wildlife and Species of Special Concern

HG&E does not propose any new construction or any changes to project operation and maintenance for the City Units Projects, nor does it propose any PM&E measures for wildlife other than those already being provided in accordance with its license for the Holyoke Project No 2004. No PM&E measures for wildlife have been recommended by stakeholders.

Our Analysis

The City 1 Project does not have any transmission facilities associated with it. In the FLA, HG&E stated that the City 3 Project had a 12,000 foot-long, 4.8-kV line; however, HG&E later clarified that this was associated with another facility and not a project feature of City 3 (FERC, 2018a). The City 2 Project has an 800-foot-long, 4.8-kV transmission line. Waterfowl such as Canada goose, common goldeneye, and common merganser are known to occur in the Connecticut River. Because these species travel in flocks, they have a higher risk of collision with transmission lines (Avian Power Line Interaction Committee, 2012). However, it is more likely that waterfowl, including the Canada goose, common goldeneye and common merganser, would use the Connecticut River as a flyway rather than the immediate areas around the projects, where buildings and other infrastructure would make navigation difficult. Gulls also have a moderate risk of collision with power lines based on their body size, weight, and maneuverability (Avian Power Line Interaction Committee, 2012). However, herring gulls prefer more open water habitats such as river shorelines or coasts (Cornell Lab of Ornithology, 2017), and would therefore be more likely to occur the Connecticut River than around the projects. Therefore, the project transmission line presents minimal risk of collision or electrocution for avian species in the area. Continued operation of the projects is expected to have no effect on the bald eagle because there is no suitable habitat for this species in the vicinity of the projects.

3.3.3 Threatened and Endangered Species

3.3.3.1 Affected Environment

According to the FWS Information, Planning, and Consultation database, two endangered species (dwarf wedgemussel and northeastern bulrush) and three threatened species (northern long-eared bat, Puritan tiger beetle, and small whorled pogonia) may occur in the project area. No designated or proposed critical habitat for these species is presently found within the City Units Projects' boundaries (FWS, 2019). A third federally listed endangered species, the shortnose sturgeon, may also be present in the project area (NMFS, 2015).

Shortnose Sturgeon

Shortnose sturgeon is a federally listed endangered species that typically inhabits slow moving riverine waters or near shore marine waters and periodically migrates into faster moving fresh water areas to spawn. Shortnose sturgeon tend to inhabit the deep channel sections of large rivers. They are known to occur at a wide range of depths ranging up to 30 meters, but normally occur in water depths less than 20 meters (Dadswell et al., 1984).

Shortnose sturgeon feed on a variety of food including mussels and other benthic macroinvertebrates. Shortnose sturgeon can live 30-40 years or longer. Males mature at 5 to 10 years, while females mature between 7 and 13 years. Shortnose sturgeon exhibit three distinct movement patterns associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 8ºC, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from April to May and may last from a few days to several weeks depending upon water temperature. Shortnose sturgeon spawning migrations are characterized by rapid, directed and often extensive upstream movement (NMFS, 1998). Shortnose sturgeon are thought to spawn every two to five years and have fecundity rates of up to 208,000 eggs per female (Dadswell et al., 1984).

Eggs generally hatch after approximately 13 days, absorb their yolk sac in 9 to 12 days, and develop into post-yolk sac larvae (NMFS, 2005). Kinard (1997) found that young sturgeon likely move downstream in two steps; a two to three-day migration by larvae followed by a one-year residency period, then a resumption of downstream migration by yearlings.

After spawning, adult sturgeon typically begin a downstream migration to feeding areas and then meander during summer and winter (Dadswell et al., 1984; Buckley and Kynard, 1985; O'Herron et al. 1993). These post-spawning migrations are triggered by increases in water temperature and changes in river flow (Kieffer and Kynard, 1993).

Connecticut River Shortnose Sturgeon

Prior to the installation of dams on the Connecticut River, shortnose sturgeon migrated and spawned within the lower reaches of the River. Turners Falls is believed to have been the upstream extent of their natural range in the Connecticut River due to the height of the natural falls found there (NMFS, 2005).

The Holyoke Dam (FERC Project No. 2004), built in 1849, initially blocked sturgeon from entering or leaving the 36-mile reach of river between Holyoke and Turners Falls, Massachusetts. A fish lift to pass fish upstream of Holyoke Dam was installed at the project's tailrace in 1955. In 1976, the fish lift was improved, and a second lift was installed in the bypass area at the Holyoke Dam. These facilities provided shortnose sturgeon access above Holyoke Dam upstream to their historic limit at Turners Falls Dam (FERC Project No. 1889); however, no shortnose sturgeon have passed upstream of the Holyoke Dam between 1999 and 2015. Whereas upstream sturgeon passage between 1975-1999 was an average of four fish per year (NMFS, 2015). The shortnose sturgeon population above the Holyoke Dam is referred to as the "upper river population" and is considered separate from the "lower river population," which occurs downstream of the Holyoke Dam. Despite this separation, the populations are not genetically distinct (NMFS, 2015).

Distribution and Spawning Success of the Upper River Shortnose Sturgeon

During summer, upper river shortnose sturgeon congregate near the confluence of the Deerfield River; this group overwinters at Whitmore, Massachusetts, a few miles downstream from the Turners Falls Hydroelectric Project No. 1889. Both adults and juveniles have been found to use the same river reaches and range about 10 kilometers (km) during spring, summer and fall (Savoy, 1991; Seibel, 1991). In the winter these sturgeon migrate downstream about 1.2 miles to deep water (Seibel, 1991).

Successful spawning of Connecticut River shortnose sturgeon has been documented upstream of the Holyoke Dam (NMFS, 2015), just downstream of the Turners Falls Project (Vinogradov, 1997). This area is just downstream of the species' historical limit in the Connecticut River at Turners Falls (river mile 123).

In the early 1980s, the total adult abundance of shortnose sturgeon in the upper river population was estimated at 297 to 516 adults (NMFS, 2005). Population estimates conducted in the 1990s resulted in similar results with a range of 297 to 714 adults (NMFS, 2005). The most recent estimate of adult shortnose sturgeon upstream of Holyoke Dam, is approximately 328 (NMFS, 2015). The population in the Connecticut River is considered to be small but stable (NMFS, 2015).

Upper River Population Downstream Migration

While downstream passage is known to occur, the number of sturgeon passing downstream of the Holyoke Dam is unknown (NMFS, 2015). Approximately 50 percent of age-one juveniles are expected pass downstream of the Holyoke Dam during the spring, summer, and fall (NMFS, 2015). Some age-two and older juveniles are also expected to move from upstream to waters below the dam in the spring and summer (NMFS, 2015). Adults are also known to pass downstream of the dam in the spring, summer, and fall (NMFS, 2015). No movement from above the dam to downstream areas is known to occur in the winter.

Dwarf wedgemussel

Once known to occur in at least 70 locations in 15 major Atlantic slope drainages from New Brunswick to North Carolina, the dwarf wedgemussel is now known to only occur in 20 localities in eight drainages. These localities are in New Hampshire, Vermont, Connecticut, New York, Maryland, Virginia, and North Carolina. The dwarf wedgemussel was listed as an endangered species in 1990 (FWS, 1993a). A recent 5-year review by FWS suggests that viable occurrences also exist in New Jersey and Pennsylvania (FWS, 2007). In Massachusetts, this species was historically found in the mainstem of the Connecticut River, its tributaries, and four other rivers within the northeastern and southeastern part of the state. However, it is believed to be extirpated from these sites and records show it now only occurs in four bodies in the Connecticut River watershed (Mass DFW, 2015b).

Northern long-eared bat

The northern long-eared bat (NLEB) was listed as threatened in 2015 (FWS, 2018). It is found in 37 states in the eastern and north central U.S., and the District of Columbia. In the summer, the insectivorous NLEB inhabit areas with live and dead trees (the latter referred to as snags), or in cavities and crevices; they may roost singly or in a colony. NLEB hibernate in caves and mines in the winter (FWS, 2018a). There are no known maternity roosts or hibernacula in the project boundaries. The closest known sites frequented by NLEB are approximately 19 miles away near Chester, Massachusetts (Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, 2018).

Puritan tiger beetle

The Puritan tiger beetle is found in only two regions: along the Connecticut River in New England and along the Chesapeake Bay in Maryland. In New England, two known populations of Puritan tiger beetle exist in Hadley, Massachusetts, and Cromwell, Connecticut. It was listed as threatened throughout its entire range in 1990 (FWS, 2013). The Puritan tiger beetle historically inhabits stretches of sandy beaches and silt banks of

the Connecticut River; however, urban development and degradation of the beach habitats has reduced the amount of suitable habitats (Mass DFW, 2015). The closest Puritan tiger beetle population to the City Units Projects is located in Hadley, Massachusetts (FWS, 2013).

In Massachusetts, adult beetles emerge from July through August, and feed on small invertebrates. Mating and egg laying throughout that timeframe, until mid-August and females deposit eggs in upper margins of beaches. The eggs hatch from late August to early September and remain in their burrows, predating small invertebrates. They enter diapause and overwinter in the burrows, feed throughout the following summer and are fully grown the following autumn. They then pupate and merge the following summer as adults. The average lifespan for the Puritan tiger beetle is two years (Mass DFW, 2015).

Northeastern bulrush

The northeastern bulrush is a perennial sedge that was listed as endangered in 1991 (FWS, 1993 and Mass DFW, 2015a). It is known to occur in most states from Vermont to Virginia and inhabits a variety of wetland types with organic soils and fluctuating water levels, and requires full sun (Mass DFW, 2015a). There are no known occurrences in the project areas and northeastern bulrush is currently known in the state from Franklin County (Mass DFW, 2015a), approximately 25 miles north of the projects.

Small whorled pogonia

The small whorled pogonia was listed as an endangered species in 1982 and was reclassified as threatened in 1994. Its distribution extends to 18 states in the eastern United States, but it is rare, with populations normally consisting of up to 20 individual plants. The small whorled pogonia is found in hardwood stands of beech, birch, maple, oak, and hickory that have an open understory. It occasionally grows in hemlock stands. The primary threats to small whorled pogonia are habitat loss due to urban development, and habitat degradation from recreational activities, such as trampling while hiking (FWS, 2018b).

3.3.3.2 Environmental Effects

Shortnose Sturgeon

Hydroelectric projects have the potential to affect shortnose sturgeon by causing migration delays, impingement on intake screens, and/or entrainment into project intakes. HG&E does not propose any PM&E measures for shortnose sturgeon and none have been recommended by stakeholders.

Our Analysis

At the Holyoke Project No. 2004, juvenile shortnose sturgeon (less than 510 mm in length) can pass through the Louver-Bypass facility and enter the Canal System. Fish larger than 510 mm are excluded from the Canal System by the Louver-Bypass facility (NMFS, 2015). As a result, only juvenile shortnose sturgeon are likely to be subject to impingement and/or entrainment at the City Units Projects and the other 8 hydroelectric developments operating on the Canal System.

In 2005, HG&E conducted an evaluation of the Louver-Bypass facility for guiding sturgeon to a downstream-bypass and verify the guidance efficiency of the Louver-Bypass facility (EPRI 2006). Thirty radiotagged age-two shortnose sturgeon were released upstream of the louver. Ten fish were released in each of three varying flow conditions. Six of the tags failed before results could be obtained. Of the remaining 24 fish, 21 (88 percent) were excluded from the Canal System by the louvers and entered the bypass pipe. Three fish (12 percent) entered the Canal System. While there is a possibility that sturgeon in the canal could pass safely back into the Connecticut River, they may also be subject to impingement and/or entrainment and may be injured or killed due to 11hydroelectric developments operating on the Canal System, including the City Units Projects.

In its 2015 biological opinion for the Holyoke Project No. 2004, NMFS anticipates 12 percent of all juvenile shortnose sturgeon that pass through the Louver-Bypass facility will enter the Canal System (NMFS 2015). Given the uncertainty associated with passage through the Canal System, NMFS assumes for the purposes of the biological opinion that all juvenile shortnose sturgeon that pass through the louvers and enter the Canal System will be injured or killed. NMFS uses the estimate of 325 downstream migrating juveniles annually, and therefore anticipates up to 19 juvenile shortnose sturgeon would pass into the Canal System and potentially suffer injury or mortality. The incidental take statement included in the 2015 biological opinion provides for the annual take of 6 to 19 juvenile shortnose sturgeon that enter the Canal System and are assumed to be injured or killed. As a result, with the presence of juvenile shortnose sturgeon in the canal system, it is likely that the continued operation of the City Units Projects would result in the injury or mortality associated with the entrainment or impingement of these fish. Therefore, while we find that the projects are "likely to adversely affect" shortnose sturgeon, we do not anticipate any new or additional effects beyond those effects covered by the existing incidental take statement issued by NMFS (2015).

Dwarf wedgemussel

Hydroelectric projects may affect dwarf wedgemussel through habitat disturbance, erosion and sedimentation, creation of impoundments, manipulation of stream flows

regimes, and blocking host fish migration that disrupt mussel life cycles.[30] HG&E does not propose any PM&E measures for dwarf wedgemussel and none have been recommended by any stakeholders.

Our Analysis

HG&E conducted biennial mussel surveys of the first and second canal levels between 2003 and 2013 indicate that the Canal System provides suitable mussel habitat for populations of native mussels (Eastern elliptio, Alewife floater, and the state listed endangered yellow lampmussel). However, dwarf wedgemussel were not documented during the multi-year survey. Because the dwarf wedgemussel does not occur in the Canal System, the continued operation of the City Units Projects would have no effect on dwarf wedgemussel.

Northern long-eared bat

HG&E does not propose any project construction and changes to operation or maintenance, nor do they propose any PM&E measures for this species. No PM&E measures for the NLEB have been recommended by any stakeholders.

Our Analysis

The NLEB do not occur within the project boundaries and the closest known roosting or hibernacula sites are located 19 miles away in Chester, Massachusetts. The projects lack suitable habitat for roosting or hibernacula and do not contain the forest understory habitat that is preferable for foraging (FWS, 2018a). As such, the continued operation of the projects would have no effect on the NLEB.

Puritan tiger beetle

HG&E does not propose any project construction and changes to operation or maintenance, nor do they propose any PM&E measures for this species. No PM&E measures for the Puritan tiger beetle have been recommended by any stakeholders.

Our Analysis

Puritan tiger beetles do not occur within the project boundaries and the closest known population is located in Hadley, Massachusetts, approximately 10 miles north of the projects. The City Units Projects are in highly developed, urban areas and do not

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[30] Source: https://www.fws.gov/raleigh/species/es_dwarf_wedgemussel.html; retrieved on January 10, 2019.

contain suitable habitat for the Puritan tiger beetle. Therefore, the continued operation of the projects will have no effect on the Puritan tiger beetle.

Northeastern bulrush

HG&E does not propose any project construction and changes to operation or maintenance, nor do they propose any PM&E measures for this species. No PM&E measures for northeastern bulrush have been recommended by any stakeholders.

Our Analysis

Northeastern bulrush is not present within the project boundaries and the closest known occurrences are nearly 25 miles north in Franklin County, Massachusetts. The City Units Projects are in highly developed, urban areas and do not contain suitable habitat for the northeastern bulrush, and the presence of buildings and other infrastructure would block the full sun that it requires. Therefore, the continued operation of the projects would have no effect on the northeastern bulrush.

Small whorled pogonia

HG&E does not propose any project construction and changes to operation or maintenance, nor do they propose any PM&E measures for this species. No PM&E measures for small whorled pogonia have been recommended by any stakeholders.

Our Analysis

Small whorled pogonia is not present within the project boundaries and the existence of any nearby populations are unknown. However, it is unlikely that it occurs anywhere in the vicinity of the projects due to the highly developed urban area, which does not contain suitable habitat for the species. As a result, the continued operation of the projects would have no effect on the small whorled pogonia.

3.3.4 Cultural Resources

3.3.4.1 Affected Environment

Section 106 of the NHPA requires the Commission to evaluate potential effects on properties listed or eligible for listing in the National Register prior to an undertaking. In this case, the undertaking is the issuance of subsequent licenses for each of the City Units Projects.

Historic properties are defined as any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register. Traditional cultural properties are a type of historic property eligible for the National Register because of

their association with cultural practices or beliefs of a living community that are: (1) rooted in that community's history or (2) important in maintaining the continuing cultural identity of the community. In this EA, we also use the term "cultural resources" to include properties that have not been evaluated for eligibility for listing in the National Register. In most cases, cultural resources less than 50 years old are not considered eligible for the National Register.

Section 106 also requires that the Commission seek concurrence with the Massachusetts SHPO on any finding involving effects or no effects on historic properties and allow the Advisory Council on Historic Preservation (Advisory Council) an opportunity to comment on any finding of effects on historic properties. If Native American properties have been identified, section 106 requires that the Commission consult with interested Native American tribes that might attach religious or cultural significance to such properties.

On April 15, 2014, the Commission designated the applicant as the non-federal representatives for carrying out day-to-day consultation regarding the licensing efforts pursuant to section 106 of the NHPA. However, the Commission remains largely responsible for all findings and determinations regarding the effects of the proposed projects on any historic property, pursuant to section 106.

Areas of Potential Effects

Pursuant to section 106, the Commission must take into account whether any historic property could be affected by the issuance of subsequent licenses for the City Units Projects within each project's area of potential effect (APE). According to the Advisory Council's regulations, an APE is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist."[31]

The APE for the City Units Projects includes all lands that are enclosed by each of the individual project boundaries, and any lands or properties outside the project boundaries where project operation or project-related actions may cause changes in the character or use of historic properties, if any exist.[32]

[31] 36 C.F.R. § 800.16(d) (2019).

[32] The current project boundaries are delineated in the Exhibit G drawings provided in the FLAs.

Cultural Resources

The City Units Projects consist of three separate developments within the Canal System (City 1, 2, and 3) where each development contains a powerhouse, intake and tailrace structure, penstock, and other appurtenant facilities. The City Units Projects (put into service in the 1920s, 1930s, and 1940s, respectively) are considered not eligible for listing in the National Register, due to modifications made on them over the years, however, they are connected to the Canal System, which is a contributing element in the Holyoke Canal Historic District, which is listed in the National Register.

Cultural History Overview

The prehistoric cultural chronology for southern New England is divided into three major periods: Paleo-Indian (12,500-10,000 BP), Archaic (10,000-3,000 BP), and Woodland (3,000-450 BP). The Contact Period (450-300 BP) is a temporal division between the prehistoric and historic periods and consists of a time when indigenous populations underwent rapid change due to European colonization.

In the 1860s, the earliest hydroelectric projects in New England were developed in Massachusetts by Holyoke Water Power Company (HWP), the owner of the Holyoke Project previous to HG&E, and the Turner Falls Company. These companies generated power along canals on the Connecticut River and distributed the power to local industries.

Historically, the Connecticut River was a main artery for travelers throughout New England. Agriculture flourished along its shores as well. Even prior to railroads the Connecticut River was integral for trade and commerce. Goods and material were transported through the region by horse and wagon on land, and by water on flat boats. The falls in South Hadley prevented boat passage; therefore, cargo was unloaded and transported around the falls by horse-drawn wagons (HWP, 1994). In 1992, the Massachusetts legislature formed a group of leading area citizens charged with the task of making the Connecticut River navigable upstream of the Chicopee River (HWP, 2000). This group was incorporated and called the Proprietors of the Locks and Canals and within three years had built a dam across the Connecticut River at the head of the rapids. The water was diverted into a 2.5 mile-long navigation canal located on the east side of the River and became known as the South Hadley Canal (HWP, 1994).

The South Hadley Canal was used well into 1840s and even during the period of steam-powered riverboats. However, with the rise in railroad technology, and the construction of the Connecticut River Railroad along the other site of the River, the South Hadley Canal was rendered obsolete for transportation uses. The last canal boat is reported to have passed through the South Hadley Canal in 1862 (HWP, 1994).

The Hadley Falls Company was incorporated in 1848 to develop the hydropower potential of Hadley Falls. In October of 1848, nearly all of the shares of the Locks and Canals Company were purchased from individual owners, giving ownership of the entire South Hadley Canal to the Hadley Falls Company (HWP, 1994). During this time, the Hadley Falls Company led the development of a new industrial town, now known as the City of Holyoke (HWP, 2000).

In 1848, the Hadley Falls Company built the first timber crib power dam across the Connecticut River (HWP, 2000), which failed but was rebuilt in 1849. The construction of the Holyoke Canal System began in 1849 and provided the industrial development of the Present City of Holyoke (HWP, 1994). Construction of the Canal System continued over a 42-year period, paralleling the industrialization of the City of Holyoke.

Through a series of transactions, the Hadley Falls Company was sold to HWP in 1859. The properties included the locks and canals, the timber crib dam, the partially completed Canal System and vacant industrial lands (HWP, 1994). HWP worked between 1870 and 1885 to lengthen the three canal levels and the overflow structures, and completed construction of the Canal System in 1893. The Canal System served several mills and textile companies and supplied water for paper manufacturing and water turbines (HWP, 2000). Hydroelectric potential was developed from 1893 to 1985 along the Canal System, parallel to technological advances.

Pre-contact and historic-era research has been conducted for the area in and around the APE, including the Canal System, during 1995 through 1997. HWP performed a cultural recourses reconnaissance survey (PAL, 1997) and developed a Cultural Resources Management Plan (HWP, 2000), which HG&E continues to implement as part of its FERC license for the Holyoke Project No. 2004.

Pre-Contact Archaeological Sites or Traditional Cultural Properties

No pre-contact archaeological sites or Traditional Cultural Properties have been located in the APE.

By letters issued May 31, 2016, Commission staff initiated consultation with the Narragansett Indian Tribe, Wampanoag Tribe of Gay Head, and Mashpee Wampanoag Tribe. No responses to these letters were received and no consulted tribes have reported any known traditional cultural properties within the proposed projects' APEs. In a letter dated June 25, 2014, and included in the FLAs, the Stockbridge-Munsee Tribal Historic Preservation Office stated that they do not have any concerns for cultural resources involving the proposed subsequent licenses.

3.3.4.2 Environmental Effects

HG&E does not propose any project construction and changes to operation or maintenance, nor do they propose, or stakeholders recommend, any measures to protect or manage historic properties within the projects' APEs.

Our Analysis

Although the City Unit Projects are not considered eligible for inclusion in the National Register, they are connected to the Canal System, which is a contributing element to the larger Holyoke Canal Historic District, which is listed in the National Register. Nevertheless, the proposed licensing would have no adverse to the Canal System, as HG&E proposes no new construction or related activities that would affect this historic property.

In letters filed on July 9, 2013 and January 13, 2014, the SHPO states that no historic properties would be affected by the relicensing as long as no new construction or demolition would occur, and Commission staff concurs.

3.4 NO-ACTION ALTERNATIVE

Under the no-action alternative for each project, the project would continue to operate as it has in the past and environmental conditions at the project would remain the same.

4.0 DEVELOPMENTAL ANALYSIS

In this section, we look at each project's use of the Connecticut River's available water resources to generate hydropower to see what effect various environmental measures would have on the projects' costs and power generation. Under the Commission's approach to evaluating the economics of hydropower projects, as articulated in *Mead Corp*.,[33] the Commission compares the current project cost to an estimate of the cost of obtaining the same amount of energy and capacity using a likely alternative source of power for the region (cost of alternative power). In keeping with Commission policy as described in *Mead Corp.*, our economic analysis is based on current electric power cost conditions and does not consider future escalation of fuel prices in valuing the hydropower project's power benefits.

For each of the licensing alternatives, our analysis includes an estimate of: (1) the cost of alternative power; (2) the total project cost (i.e., for construction, operation, maintenance, and environmental measures); and (3) the difference between the cost of alternative power and total project cost. If the difference between the cost of alternative power and total project cost is positive, the project produces power for less than the cost of alternative power. If the difference between the cost of alternative power and total project cost is negative, the project produces power for more than the cost of alternative power. This estimate helps to support an informed decision concerning what is in the public interest with respect to a proposed license. However, project economics is only one of many public interest factors the Commission considers in determining whether, and under what conditions, to issue a license.

4.1 POWER AND DEVELOPMENTAL BENEFITS OF THE PROJECTS

Table 4-1 summarizes some of the assumptions and economic information we use in our analysis. The table contains information that pertains to all three projects.

The values provided by the applicant are reasonable for the purposes of our analyses. For each project, cost items common to all alternatives except the no-action alternative include: taxes and insurance costs, estimated future capital investment required to maintain and extend the life of plant equipment and facilities, costs to prepare the license application, normal operation and maintenance cost, and Commission fees.

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[33] *See* Mead Corporation, Publishing Paper Division, 72 FERC ¶ 61,027 (July 13, 1995). In most cases, electricity from hydropower would displace some form of fossil-fueled generation, in which fuel cost is the largest component of the cost of electricity production.

The no-action alternative only includes the cost to prepare each of the license applications. All dollars are year 2019, unless specified otherwise.

Table 6. Parameters for the economic analysis common to all of the City Units Projects (Source: HG&E and staff).

Parameters	**Values (2019 dollars)**
Period of analysis (years)	30[a]
Term of financing (years)	20[a]
Total average annual generation (MWh)	9,207 MW-h[b]
Energy Value ($/MWh)	$40.6[c]
Payments in lieu of taxes	Exempt
Insurance and administration costs (year)	250
Interest/discount rate	6.0 percent[a]
Operation and Maintenance, $/year	$80,000[c]

[a] Assumed by Staff.
[b] Three projects combined – Estimated by the applicant (HG&E)
[c] Estimated by Staff.

Under staff's approach to evaluating the economics of hydropower projects, we use an analysis that uses current costs to compare the costs of a project and the likely alternative. By using this approach, our analysis gives a general estimate of the current power benefits and costs of a project.

For all three Projects, the applicant (HG&E) proposes to operate the project as it currently does and staff does not recommend any additional measures. Therefore, the general estimate of the projects' benefits and costs is the same for each action alternative considered in this EA

City 1 Project

The 1,056-kW City 1 Project has an estimated annual project cost of $88,000 or $32.30/MWh. The project generates an average of 2,710 MWh electricity annually. When we multiply HG&E's estimate of average generation by our estimate of the current value of power of $40.6/MWh, we get a total value of the project's power of $110,000. To determine whether the projects are currently economically beneficial, staff subtracts the project's cost from the value of the project's power. Therefore, in the first year of operation, the project would cost about $22,000 or $8.30/MWh less than the likely alternative cost of power.

City 2 Project

The 800-kW City 2 Project has an estimated annual project cost of $88,000 or $20/MWh. The project generates an average of 4,378 MWh electricity annually. When we multiply HG&E's estimate of average generation by our estimate of the current value of power of $40.6/MWh, we get a total value of the project's power of $178,000. In the first year of operation, the projects would cost about $90,000 or $20.60/MWh less than the likely alternative cost of power.

City 3 Project

The 450-kW City 3 Project has an estimated annual project cost of $88,000 or $41.30/MWh. The project generates an average of 2,119 MWh electricity annually. When we multiply HG&E's estimate of average generation by our estimate of the current value of power of $40.6/MWh, we get a total value of the project's power of $86,000. In the first year of operation, the projects would cost about $2,000 or $0.7/MWh more than the likely alternative cost of power.

Though Commission staff's analysis shows that the City 3 Project would have an initial annual cost that exceeds the current power value, staff does not explicitly account for the effects inflation may have on the future cost of electricity. The fact that hydropower generation is relatively insensitive to inflation compared to fossil-fueled generators is an important economic consideration for power producers. Based on the Commission's policy under the *Mead Corp.* decision, it is the applicant who must decide whether to accept any license and the financial risk that entails.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE

Sections 4(e) and 10(a) of the FPA require the Commission to give equal consideration to the power development purposes and to the purposes of energy conservation; the protection, mitigation of damage to, and enhancement of fish and wildlife; the protection of recreational opportunities; and the preservation of other aspects of environmental quality. Any licenses issued shall be such as in the Commission's judgment will be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses. This section contains the basis for, and a summary of, our recommendations for licensing the three City Units Projects

Based on our independent review of agency and public comments filed on these projects and our review of the environmental and economic effects of the projects, we selected the applicant's proposal as the preferred alternative for each of the City Units Projects. We recommend this alternative because: (1) issuance of a subsequent license for each project would allow the applicants to operate the projects as economically beneficial and dependable sources of electrical energy; (2) the combined 2.018 MW of electric capacity comes from a renewable resource that does not contribute to atmospheric pollution; and (3) the public benefits of this alternative in all three cases would exceed those of the no-action alternative.

5.1.1 Measures Proposed by the Applicants

HG&E does not propose any environmental measures.

5.1.2 Conclusion

Based on our review of the agency and public comments filed on the project and our independent analysis pursuant to sections 4(e), 10(a)(1), and 10(a)(2) of the FPA, we conclude that licensing the City Units Projects, as proposed by HG&E, would be best adapted to a plan for improving the Connecticut River Basin.

5.2 UNAVOIDABLE ADVERSE EFFECTS

Continued operation of the City Units Projects could result in some fish entrainment and turbine mortality. However, there is no indication that any losses due to entrainment or turbine mortality have had significant effects on fisheries resources within the project area.

5.3 CONSISTENCY WITH COMPREHENSIVE PLANS

Section 10(a)(2)(A) of the FPA, 16 U.S.C. § 803(a)(2)(A), requires the Commission to consider the extent to which a project is consistent with federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project. We reviewed 13 qualifying comprehensive plans that are applicable to the three City Units Projects located in Massachusetts. We did not find any inconsistencies.

The following is a list of qualifying comprehensive plans relevant to the City Units Projects:

Massachusetts

Connecticut River Atlantic Salmon Commission. 1998. Strategic plan for the restoration of Atlantic Salmon in the Connecticut River. July 1998.

Connecticut River Atlantic Salmon Commission. 2017. Connecticut River American Shad Management Plan. Sunderland, Massachusetts. June 9, 2017.

Franklin County Planning Department. 1990. Deerfield River comprehensive management plan. Greenfield, Massachusetts. June 1990.

Massachusetts Department of Environmental Management. 1987. Ipswich River Basin: inventory and analysis of current and projected water use. Boston, Massachusetts. Volume I. June 1987.

Massachusetts Department of Environmental Management. 1987. Ipswich River Basin: analysis of water resources, water use, and development of alternatives to meet projected water demand. Boston, Massachusetts. Volume II. July 1987.

Massachusetts Department of Environmental Management. 1989. Ipswich River Basin plan: recommended alternatives to meet projected water demand. Boston, Massachusetts. Volume III. January 1989.

Massachusetts Department of Environmental Quality Engineering. 1983. Connecticut River Basin water quality management plan. Westborough, Massachusetts. June 1983.

Massachusetts Department of Fish and Game. 2006. Comprehensive wildlife conservation strategy. West Boylston, Massachusetts. September 2006.

Massachusetts Executive Office of Energy and Environmental Affairs. Statewide Comprehensive Outdoor Recreation Plan (SCORP): Massachusetts Outdoor 2006. Boston, Massachusetts.

Technical Committee for Fisheries Management of the Connecticut River. 1981. Connecticut River Basin fish passage, flow, and habitat alteration considerations in relation to anadromous fish restoration. Hadley, Massachusetts. October 1981.

United States

U.S. Fish and Wildlife Service. 1995. Silvio O. Conte National Fish and Wildlife Refuge final action plan and environmental impact statement. Department of the Interior, Turners Falls, Massachusetts. October 1995.

U.S. Fish and Wildlife Service. Canadian Wildlife Service. 1986. North American waterfowl management plan. Department of the Interior. Environment Canada. May 1986.

National Marine Fisheries Service. Atlantic Salmon (*Salmo salar*) - Amendment 1 to the New England Fishery Management Council's (NEFMC) Fish Management Plan (FMP) on Atlantic salmon (March 1988). October 1998

National Marine Fisheries Service. 1998. Final Recovery Plan for the shortnose sturgeon (Acipenser brevirostrum). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. December 1998.

6.0 FINDING OF NO SIGNIFICANT IMPACT

Relicensing the City Units Projects as proposed would not have significant impacts on environmental resources. Based on our independent analysis, issuance of subsequent licenses for the City Units Projects, as proposed, would not constitute a major federal action significantly affecting the quality of the human environment.

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8.0 LIST OF PREPARERS

Federal Energy Regulatory Commission

Kenneth Hogan – Fisheries and Aquatic Resources and Water Resources, (Fishery Biologist; B.T., Fisheries Management and Aquaculture)

Benjamin Mann – Fisheries and Aquatic Resources and Water Resources, (Fish Biologist; B.S., Fisheries and Wildlife Science)

Khatoon Melick – Need for Power and Developmental Analysis, (Environmental Engineer; Ph.D., P.E., Civil Engineering)

Kyle Olcott – Project Coordinator

Frank Winchell – Cultural Resources, (Archeologist; B.A., M.A., Ph.D., Anthropology)

Kelly Wolcott – Terrestrial Resources and Threatened and Endangered Species, (Environmental Biologist; M.S., Natural Resources)