Royal River, Yarmouth, Maine
Section 206, Aquatic Ecosystem Restoration

CEQ ID - EAXX-202-00-E6P-172863450

Draft Integrated Detailed Project Report & Environmental Assessment

October 2024

US Army Corps of Engineers
New England District

YARMOUTH
MAINE

Royal River, Yarmouth, Maine
Section 206, Aquatic Ecosystem Restoration

EXECUTIVE SUMMARY

STUDY INFORMATION

This report examines the feasibility of restoring riverine fish passage and aquatic habitat on the Royal River in Yarmouth and North Yarmouth, Maine. The goal of the study is to recommend a plan that will restore degraded significant ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. For the Royal River, the plan would restore the aquatic resources of the river to a healthy, viable, and self-maintaining system for fish and wildlife. The project area encompasses two low-head dams (Bridge Street and East Elm Street Dams) and one natural fall with a modified back channel (Middle Falls) on the river and seven miles of waterway, from the head-of-tide to the upstream limit of the East Elm Street Dam impoundment at Baston Park.

This project is authorized by Section 206 of the Water Resources Development Act of 1996, P.L. 104-303, as amended. Section 206 provides programmatic authority for the U.S. Army Corps of Engineers (USACE) to carry out aquatic ecosystem restoration projects that improve environmental quality, are in the public interest, and are cost effective. The Town of Yarmouth, ME is the non-federal sponsor for the study.

PROBLEM

The primary problem is the loss of fish passage and separation of historical populations of aquatic species within the Royal River. As the area surrounding the river was developed, the dams sub-divided the ecosystem into segments by interrupting the natural flow of the river. Prior to the construction of the dams in the 1800s, fish passage was unobstructed along the full extent of the Royal River. The two dams currently located within the study area obstruct fish passage to approximately 135 river miles of reproductive and nursery habitat in the river’s main stem and tributaries.

Low-head dams, in general, are known to be a safety concern to the public who use the surrounding area and river. Additionally, the dams will require significant future expenditures for operations & maintenance (O&M), repair and replacement to support their structural integrity.

OBJECTIVES

There are four objectives of this study. These include:

1. Improve aquatic passage for all species within the Royal River Watershed over the study period of analysis.
2. Restore habitat and reconnect disjointed habitats within the Royal River Watershed over the study period of analysis.
3. Reduce the significant risk costs of O&M, repair and replacement of the existing dams and

4. Improve public safety within Yarmouth over the study period of analysis.

PLANS CONSIDERED

The two Royal River dams and the Middle Falls area were assessed for potential aquatic ecosystem restoration opportunities. The three locations were assessed primarily for their potential to benefit the aquatic health and function of the Royal River ecosystem, and secondarily for their impacts on public safety and future O&M, repair, and replacement costs. Plan formulation (**Section 3.0**) considered multiple measures leading to the development of eighteen alternative plans that were evaluated for the potential to restore the Royal River ecosystem.

TENTATIVELY SELECTED PLAN

The Royal River Integrated Detailed Project Report/Environmental Assessment (DPR/EA) recommends Alternative 2: East Elm Street Dam and Bridge Street Dam and Fish Ladder Removal + Middle Falls Diversion to Side Channel. This recommendation is the National Ecosystem Restoration plan. It has the following components:

- Removal of a 120 linear foot (LF) section of the East Elm Street Dam and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- Removal of Bridge Street Dam across the entire width of the river, which includes 275 LF of structure and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- Installation of a diversion structure at the top of Middle Falls to divert streamflow into the existing side channel. Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

PROJECT IMPACTS

The tentatively selected plan would have both minimal long and short-term impacts on the resources within the study area. The impacts to the resources have been assessed using the following three categories: positive (benefiting the resource), negative (adversely affecting the resource) or neutral. While other impacts, such as impacts to aesthetics, are subjective in nature and would depend on the individual's perspective. The table below describes the impacts to each resource.

Resource	Impact
Recreational Opportunities	Fishing - Long-Term positive impacts Boating, swimming, winter sports - Long-term neutral minor impacts
Aesthetics	Long-term subjective impacts
Air Quality & Green House Gasses	Short-term negative impacts
Water Quality	Short-term negative impacts, long-term minor impacts

Resource	Impact
Hydrologic & Hydraulic	Long-term neutral impacts
Floodplain & Wetlands	Floodplain - No impacts Wetlands - Long-term positive impacts
Cultural Resources	Long-term negative impacts
Fisheries	Long-term positive impacts
Wildlife	Short-term negative impacts, long-term positive impacts
Threatened & Endangered Species	No impact
Vegetation	Short-term negative impacts
Noise	Short-term negative impacts
Hazardous, Toxic, and Radioactive Waste	No impacts
Socioeconomics	No impacts
Transportation, Infrastructure	No impacts
Occupational Health & Safety	Long-term impacts - safety concerns will change but not get worse or better.

PROJECT SCHEDULE

Project Task	Milestone Code	Current Scheduled Date
Federal Interest Determination	CW170	Apr 2020 (A)
Execute Feasibility Cost Share Agreement	CW130	Sep 2021 (A)
Tentatively Selected Plan Meeting	CW190	Apr 2024 (A)
Agency Technical Review		Oct 2024
Final Report Submittal to North Atlantic Division (NAD)	CW150	Mar 2025
NAD approves Final DPR/EA	CW170	May 2025
Execute Project Partnership Agreement	CW130	Aug 2025

(A) = Actual

BENEFITS AND COST

In accordance with USACE regulations, the tentatively selected plan represents a cost-effective plan that reasonably optimizes environmental benefits that are in the national interest. The project first cost was estimated at $5,100,000 in October 2023 (Fiscal Year

2024) dollars. Based on the anticipated schedule with the mid-point of construction occurring in the 1st Quarter of Fiscal Year 2028, the fully funded Total Cost is estimated to be $5,718,000.

This alternative provides an aquatic habitat output of 25,880 habitat units within the study area. Further details on the tentatively selected plan can be found in **Section 3.9**.

FINDING OF NO SIGNIFICANT IMPACT
Section 206, Aquatic Ecosystem Restoration Royal River Project Yarmouth, Maine

The U.S. Army Corps of Engineers (USACE) proposes to conduct an ecosystem restoration project on the Royal River in Yarmouth, Maine in partnership with the town of Yarmouth, Maine. This project is authorized by Section 206 of the Water Resources Development Act of 1996, P.L. 104-303, as amended. Section 206 provides programmatic authority for the U.S. Army Corps of Engineers to carry out aquatic ecosystem restoration projects that improve environmental quality, are in the public interest, and are cost effective. The Town of Yarmouth, ME is the non-federal sponsor for the study. USACE's Aquatic Ecosystem Restoration Program focuses on restoration of ecosystem structures, function, and natural processes necessary to support fish and wildlife habitat.

The purpose of the project is to restore river habitat and fish passage through the removal or alteration of the East Elm Street and Bridge Street Dams on the Royal River, and the construction of a diversion channel at Middle Falls. The two low-head dams decrease the connectivity and limit upstream and downstream movement by aquatic species. The proposed project meets the requirements of Section 206 of the Water Resources Development Act of 1996, which allows the Secretary of the Army to carry out an aquatic ecosystem restoration and protection projects that improve the quality of the environment in the public interest and are cost-effective. The dams have fragmented the river system, impeded species movement, and limited access to nursery and spawning areas.

The project includes the removal of a 120 linear feet (LF) section of the East Elm Street Dam and the Denil-type fish passage structure located on the right descending bank of the Royal River; removal of Bridge Street Dam across the entire width of the river, which includes the 275 LF structure and the Denil-type fish passage structure located on the right descending bank of the Royal River; and modification of the Middle Falls side channel, by placing large boulders in the main river channel and performing hydraulic modifications in the side channel. The large boulders will be sourced from the demolition of the East Elm Street Dam and repurposed as a diversion structure to increase the water depth and velocity in the channel around Factory Island, while reducing false attractive flow from the main branch of the Royal River. The project will restore access to 311 acres of historic spawning and nursery habitat for anadromous alewife (*Alosa pseudoharengus*), that supporting a population of approximately 35,000 individuals.

I find that based on the evaluation of environmental effects discussed in the Environmental Assessment, this project is not a major federal action significantly affecting the quality of the environment. The Environmental Assessment includes an evaluation of the affected environment and the geographical context and intensity of the direct, indirect, and cumulative long-term and short-term effects of the action. The effects of the recommended plan relative to significance criteria are summarized below. None are implicated to warrant a finding of National Environmental Policy Act significance.

The degree to which the action may adversely affect public health and safety. The project is expected to have a positive effect on public health and safety. Removal of the dams will eliminate the potential for catastrophic flooding if the dams were to fail.

The degree to which the action may adversely affect unique characteristics of the geographic area such as historic or cultural resources, parks, Tribal sacred sites, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas. The project will have short-term and long-term effects on the local area. The adverse effects of the project will be short term and insignificant. The project will temporarily increase water column turbidity due to construction activity and the release of sediment build up behind the dams. The river bottom upstream and downstream of the dams has very little accumulated sediment and consists primarily of bedrock/cobble. Chemical concentrations in sediment samples taken at the dams were found to be very low. Erodible sediment is mostly located along riverbanks, reducing the potential for long-term increases in turbidity. Riverbank erosion may occur during the lowering of the water level during construction. Other short-term effects include temporary noise and air pollution from construction equipment. None of these short-term effects will significantly affect the environment.

The project will have long-term, beneficial effects. Long-term effects include increased connectivity for native diadromous fish and hydrologic changes, such as changes in the patterns of flow and a lowered water level in the location of the existing dam impoundments. The project will improve access to 135 river miles of upstream spawning habitat for diadromous fish and provide fish and wildlife habitat and recreational value. The partial removal of East Elm Street Dam will train water away from the northern channel around Gooch Island and into the main branch of the river. Water is still predicted to backflow up the eastern portion of the channel but a reach of approximately 200 LF will be dewatered under normal conditions. This channel is approximately one foot (ft) deep under normal conditions and is poorly suited to recreation. Under conditions of a 100 year or greater flooding event, the remaining portion of the dam will act as a spillway and inundate the dewatered channel. The exact degree to which the channel will be impacted is unclear. Under normal flow conditions the channel is fed by water moving between the blocks of the dam, not by water flowing over it. No long-term significant adverse effects are expected.

Whether the action may violate relevant Federal, State, Tribal, or local laws or other requirements or be inconsistent with Federal, State, Tribal, or local policies designed for the protection of the environment. The action will not violate federal, state or local laws protecting the environment or be inconsistent with federal state, tribal or local policies for the protection of the environment.

The degree to which the potential effects on the human environment are highly uncertain. The project effects are not uncertain. USACE and other agencies and entities have completed numerous dam removal, fish passage, and river restoration projects and the potential effects are well known.

The degree to which the action may adversely affect resources listed or eligible for listing in the National Register of Historic Places. Removal of the Bridge Street Dam would constitute an adverse effect upon a National Register eligible historic property, which is a contributing element of the proposed Royal River Manufacturing Company. Additionally, removal of both the East Elm Street Dam (which was previously determined to be ineligible for the National Register) and the Bridge Street Dam would result in a drawdown of the Royal River watershed of up to four feet on portions of the river. Native American archaeological sites that may be present along the Royal River beneath the current water level could potentially be exposed and subject to erosion and weathering processes along the banks. Due to the paucity of archaeological data for the watershed and the presence of several sites upstream of the East Elm Street area, USACE will conduct an archaeological monitoring and documentation survey upon completion of the dam removals. Identified sites would be evaluated and documented in accordance with a Programmatic Agreement (PA) that will address how impacts to historic properties will be addressed in the Design and Implementation and Construction phases of the project.

The degree to which the action may adversely affect an endangered or threatened species or its habitat, including habitat that has been determined to be critical under the Endangered Species Act of 1973. The project will have no effect on any federal threatened or endangered species or designated critical habitat for such species.

The degree to which the action may adversely affect communities with environmental justice concerns. The project is not expected to have any adverse effect on environmental justice communities. This project will greatly supplement the fishery of the river with the reestablishment of a large annual migration of alewife. The adult alewife, their eggs, and their juveniles serve as a substantial food source for many game and non-game species alike and will result in healthier, more robust fish for anglers to target. Across the state of Maine, local organizations and municipalities celebrate the returning alewife with a variety of events and festivals. Events such as these drive community involvement and awareness of the natural resources of the community.

The degree to which the action may adversely affect rights of Tribal Nations that have been reserved through treaties, statutes, or Executive Orders. The project will not adversely affect rights of Tribal Nations that have been reserved through treaties, statutes, or Executive Orders.

Based on my review and evaluation of the environmental effects as presented in the Environmental Assessment, I have determined that the Royal River Aquatic Ecosystem Restoration Project is not a major federal action significantly affecting the quality of the environment and is therefore exempt from requirements to prepare an Environmental Impact Statement.

____________________ ____________________________________

Date

Justin R. Pabis, PE
Colonel, Corps of Engineers
District Engineer

ROYAL RIVER, YARMOUTH, MAINE
SECTION 206 AQUATIC ECOSYSTEM RESTORATION
CEQ ID - EAXX-202-00-E6P-172863450

DRAFT INTEGRATED DETAILED PROJECT REPORT & ENVIRONMENTAL ASSESSMENT

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1.0 INTRODUCTION

This integrated Detailed Project Report and Environmental Assessment (DPR/EA) presents the result of this study that formulated and evaluated alternatives to restore aquatic resources.

1.1 STUDY AUTHORITY

This aquatic ecosystem restoration study was conducted under the authority of Section 206 of the Water Resources Development Act (WRDA) of 1996. This authority allows the U.S. Army Corps of Engineers (USACE), in cooperation with its project sponsor and partners, to develop aquatic ecosystem restoration and protection projects that improve the quality of the environment and are in the public's interest while being cost effective. The Aquatic Ecosystem Restoration Program focuses on restoration of ecosystem structure and function necessary to support fish and wildlife habitat.

Section 206 of the WRDA of 1996 PL 104-303 entitled *Aquatic Ecosystem Restoration*, states in part,

> "The Secretary [of the Army] may carry out an aquatic ecosystem restoration and protection project if the secretary determines that the project – will restore the quality of the environment and is in the public interest; and is cost-effective."

The Continuing Authorities Program (CAP) Section 206 authority stipulates that USACE provides the first $100,000 of study costs. The non-Federal sponsor (NFS) must contribute 50 percent of the cost of the feasibility study after the first $100,000 of expenditures. The project limit is $10-million Federal funds that are matched at 35 percent non-federal to 65 percent Federal funding sources, for an upper limit of total project cost of approximately $15.3 million. One hundred percent of the cost of operation and maintenance is the responsibility of the non-Federal sponsor. The sponsor receives a credit for the value of real estate necessary to implement the project. The proposed alternative must be cost effective, which is measured by a quantified output of environmental benefits that an alternative may generate compared to the project cost to design and construct that alternative. Environmental justice and climate change must be accounted for.

1.2 BACKGROUND INFORMATION

Interest in the aquatic ecosystem of the Royal River, with emphasis on restoration of fish passage, began as early as the 1950s. As a result, the lower reach of the Royal River has been studied extensively, with numerous investigations being completed over the past 30 years. This study has relied on the information collected from these past study efforts.

On April 8, 2013, the town of Yarmouth, Maine (ME) sent a Letter of Intent to the New England District to request USACE assistance. This request was initially made under Section 1135 of the WRDA of 1986, as amended. However, the project was ultimately pursued under Section 206 of the WRDA of 1996. The initial request specifically called for assistance in investigating the potential of restoring fish passage through the removal or alternation of the two dams owned by the Town. The historic dams decrease the connectivity and limit movement both upstream and downstream for aquatic species.

In June 2020, the New England District completed a Federal Interest Determination report of the project. On August 10th, 2020, the New England District was approved to continue the full feasibility study. Federal funding was allocated in Fiscal Year 2021, at which point the New England District executed a Feasibility Cost Sharing Agreement with the town of Yarmouth, ME, signed by the Town Manager, and executed on September 14, 2021.

The industrialization of the Royal River watershed in the 1800s resulted in the construction of several dams along its course to power textile, paper, flour mills and sawmills. The historic dams obstruct upstream migration to historic spawning habitat for alewife (*Alosa pseudoharengus)* and passage for other diadromous (migratory between salt and freshwater) fish species. The result was the loss of reproductive potential for alewife and other species. Diadromous fish passage is a critical component of aquatic ecosystem restoration in river systems.

The purpose of the feasibility study is to develop a plan to restore riverine habitat and improve connectivity within the Royal River. These include analysis of the first two dams above the head of tide on the Royal River, which are owned by the Town: The Bridge Street Dam and the East Elm Street Dam, and the Middle Falls area.

The feasibility study developed an array of alternatives to support the restoration goals for the Royal River. USACE determined the merit of each alternative with respect to functionality, constructability, impacts to environmental and cultural resources, real estate requirements, and cost. Additionally, the array was compared across four evaluation criteria (completeness, effectiveness, efficiency and acceptability). If an alternative is found to be worth the investment, the next steps include approval of the decision document, signing of a Project Partnership Agreement (PPA) and development of a contract set of Plans and Specifications and project implementation.

The NFS for the study is the Town of Yarmouth, ME.

1.3 PURPOSE AND NEED*

The purpose of the Royal River Aquatic Ecosystem Restoration Project is to restore habitat connectivity and aquatic ecosystem function and values to the Royal River. The Bridge Street and Elm Street Dams have fragmented the river system, impeded species movement limiting access to nursery and spawning areas, and have created upstream impoundments, resulting in altered habitat characteristics and reduced riverine aquatic habitat value. The impoundments are deeper and have weaker currents, with water moving slower than areas of the river not impeded by the dams. These adverse habitat and connectivity conditions reduce species abundance and richness (i.e., number of different species) of riverine specific species.

1.4 STUDY AREA

The Royal River Watershed is located in southeastern ME. The watershed includes the Royal River, Chandler Brook, and their tributaries, and is approximately 142 square miles. It is one of five major watersheds that makes up the larger Casco Bay Watershed. The towns found within the watershed include Brunswick, Freeport, Cumberland, Gray, New Gloucester, Pownal, Raymond, North Yarmouth and Yarmouth in Cumberland County and Auburn, Poland and Durham in Androscoggin County. The watershed includes many waterbodies, including lakes and ponds (e.g., Crystal Lake, Runaround Pond and Sabbathday Lake) and tributaries such as Chandler Brook, Collyer Brook and Collins Brook (**Figure 1**).

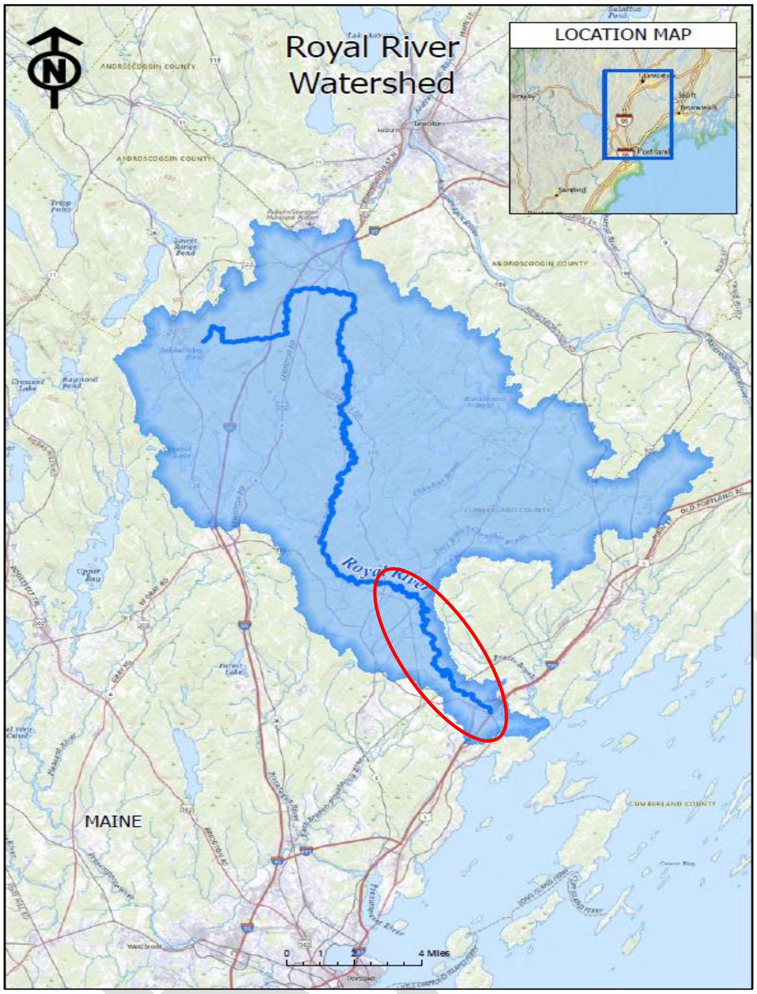

Figure 1: The Royal River Watershed (*The study area is circled in red*)

The headwaters of the Royal River originate in Sabbathday Lake, New Gloucester and flows downstream for approximately 39 miles; ultimately emptying into Casco Bay, Yarmouth, ME. The Royal River is a freshwater environment and is the second largest contributor of freshwater to the Casco Bay. The river transitions into an estuarine, tidally influenced aquatic environment in Yarmouth. The head of tide is located approximately at the East Main Street and Route 88 Bridge in Yarmouth shown on **Figure 2**.

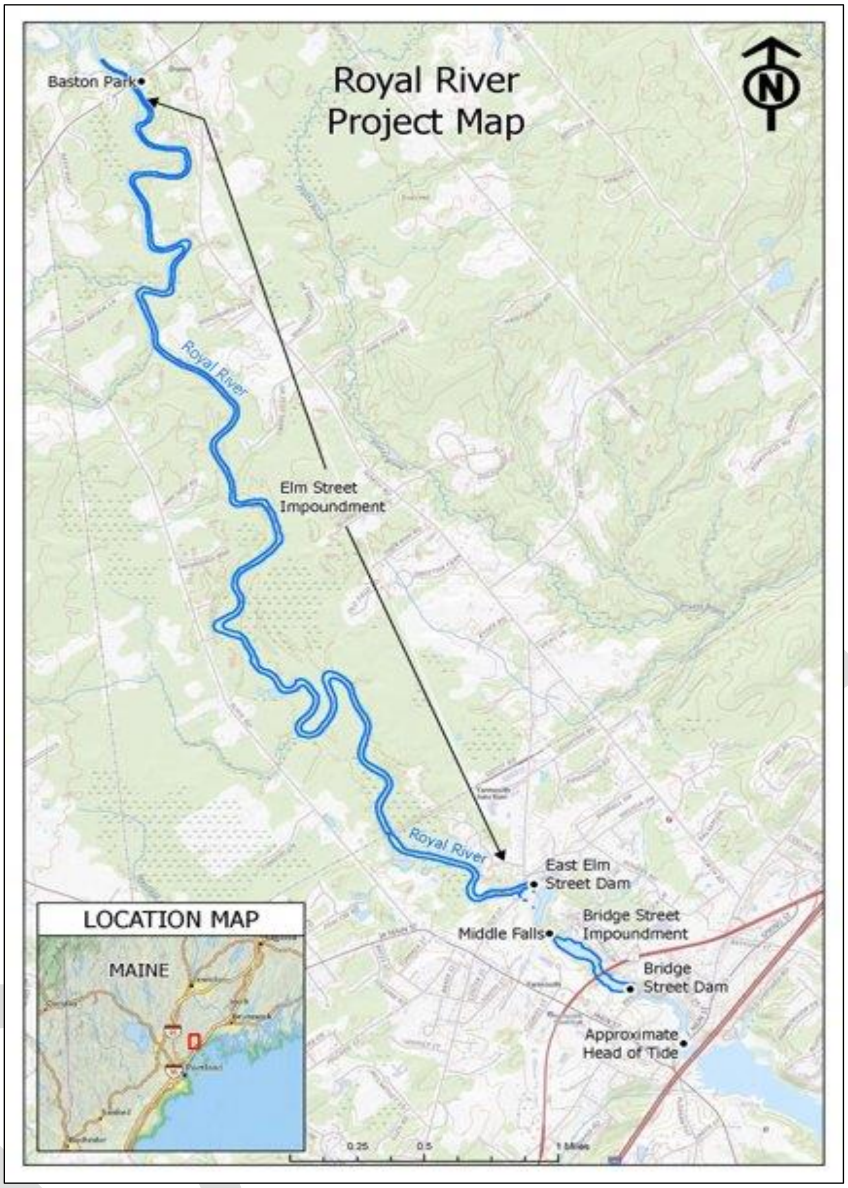

Figure 2: The Study Area

The study area is located in the towns of Yarmouth and North Yarmouth and is approximately 12 miles north of the state's largest city, Portland. The study area runs from the head of tide (also known as First Falls) to a site 750 feet (ft) upstream of Baston Park (**Figure 2**), which includes approximately 7.0 miles of the Royal River. The northern most limit of water affected by the East Elm Street Dam extends between 5,000 to 12,000 ft (0.95 to 2.27 miles) upstream depending on the height of the river.

There are three impediments to fish passage found within the study area. Two are man-made, the East Elm Street Dam and the Bridge Street Dam. The third impediment is an area which include a natural cascade and a modified side channel, commonly referred to as Middle Falls. All three locations are in the vicinity of both private and public properties and will require real estate coordination for construction operations.

1.5 NATIONAL ENVIRONMENTAL POLICY ACT REQUIREMENTS

This report was prepared pursuant to the National Environmental Policy Act (NEPA) of 1969, the Council on Environmental Quality's (CEQ) Guidance Regarding NEPA Regulations, and the USACE's Procedures for Implementing NEPA (33 Code of Federal Regulations (CFR) 230).

NEPA requires Federal agencies to integrate environmental review into their planning and decision-making process. To support this requirement, this draft feasibility report includes an EA. An EA briefly provides sufficient evidence and analysis for determining whether to prepare a more intensive environmental impact statement or a finding of no significant impact (FONSI).

The final EA must include the following elements:

- A statement of the purpose and need for the proposed agency action
- A description of the alternatives
- An evaluation of the environmental effects of the proposed action and alternatives
- A list the Federal agencies, State, Tribal, and local governments and agencies or persons consulted.

Sections of the report that are required to fulfill the requirements of NEPA are marked with an asterisk (*) in the headings.

1.6 PRIOR STUDIES

1.6.1 Studies Completed by USACE

Federal Interest Determination Report (2020): The New England District, USACE completed a report that assessed the federal interest in pursuing an aquatic ecosystem restoration study on the Royal River. The initial appraisal determined that there was a federal interest for continued investigations and recommended that a full feasibility study be undertaken. The purpose of the proposed study was identified as improving fish passage, with the assessment of the first two dams above the head of tide on the Royal River owned by the Town of Yarmouth: The Bridge Street Dam and the East Elm Street Dam.

1.6.2 Studies Completed by Others

Since 1958, considerable historical information and scientific data has been collected in the Royal River Watershed. This list provides a summary of many of the studies that focused on aquatic ecosystem restoration and improvement of fish passage within the study area. Information provided in these reports was utilized to formulate the tentatively selected plan (TSP).

Royal River Watershed: A Water Quality Management Plan (1998). The University of Southern Maine developed this document, which laid out “a long-term water quality management plan to protect and enhance the river and its watershed so that future generations could benefit from the full potential of the natural resources”. The management plan described the state of water quality in the Royal River at that time and offered suggestions on how to provide long and short-term protection to groundwater and surface water of the Royal River.

Royal River Corridor Study, Yarmouth, Maine, Natural Resource Reconnaissance Surveys (July 2008): Stantec Consulting Services, Inc. (Stantec) prepared a report that evaluated the natural resources that were present in a 1.5-mile study area. The study focused on four topics which include 1. Aquatic habitats, fisheries and dam infrastructure, 2. Wetlands, Streams, and Natural Communities, 3. Wildlife/Rare Species and 4. Soils and Slopes.

Royal River Corridor Master Plan (January 2009): This plan provides a long-term vision for the enhancement of the Royal River Corridor in order to influence land use decisions of the Town of Yarmouth. The plan also provides a wide range of recommendations for the area surrounding the Royal River which address the management of natural resources, interconnectedness, planning and development and corridor-wide improvements.

Fisheries & Aquatic Habitat Restoration Feasibility Study, Royal River Restoration Project Yarmouth, Maine (2010): Stantec completed this study for the Town of Yarmouth, ME. This report described a feasibility study designed to evaluate the potential of fisheries and aquatic habitat restoration of the Royal River. The 2010 report provided opportunities and constraints associated with the restoration of fisheries and aquatic habitat.

Royal River Restoration Project, Summary of Recreational Changes Associated with Dam Removal & River Restoration (2013): Maine Rivers developed a summary of recreational changes that would occur on the Royal River if the Bridge Street and East Elm Street Dams were removed. This report considered impacts to recreational activities including boating and boating access, fishing, swimming, wildlife and bird watching and shellfishing.

Royal River Restoration Project: Phase II Analysis and Reporting (September 2013): Stantec completed this study for the town of Yarmouth, ME. The Phase II report presents the potential changes in the Royal River upstream from the East Elm Street Dam if the dam was removed. The report addressed changes in water surface levels, recreational opportunities, and sediment delivery to Yarmouth Harbor resulting from dam removal. The report also provided the results of sediment sampling that occurred in 2010 to assess the presence of environmental contaminants in sediment in the East Elm Street Dam Impoundment.

Estimated Sediment Volume: Bridge Street Dam Impoundment (June 2015): Stantec completed this study for the town of Yarmouth, ME. This report presented information on the composition, volume, and potential mobility of sediment accumulated upstream of the Bridge Street Dam on the Royal River. This report estimated that the volume of accumulated sediment in the impoundment was 5,040 cubic yards (cy) which included a 20% contingency to account for observed localized sediment deposits observed upstream from the Sparhawk Mill hydroelectric facility trash racks and adjacent to the stormwater outfalls. The study concluded that the volume of accumulated sediment found in the Bridge Street Dam impoundment would not change due to high-water events and was representative of the typical volume of sediment that would be found behind the dam.

Sediment Sampling and Analysis, Bridge Street Dam Impoundment, Royal River, Yarmouth, Maine (March 2016): Stantec completed this study for The Nature Conservancy. This report presents methods and results of a sediment sampling study in the impoundment formed by the Bridge Street Dam. The study investigates the potential for remobilization of sediment and environmental contaminants in the impoundment if the dam is removed. Sediment samples were collected in December 2015. One of the ten samples exceeded the threshold effect concentration (TEC) for mercury and six of ten exceeded at least one TEC for polycyclic aromatic hydrocarbons (PAHs).

Fishway Assessment and Cost Analysis Report, Royal River, Yarmouth ME (January 2018): This report was completed by Inter-Fluve for The Nature Conservancy. The report described a detailed assessment of the potential for fish passage at the Bridge Street and East Elm Street dams on the Royal River. It identified four alternative approaches to enhance fish passage and assessed the cost of each alternative. These alternatives include no action, retrofit/rebuild a technical fishway, nature-like fishway, and dam removal.

Royal River Fish Passage Studies Summary Report. Royal River Watershed, Yarmouth, North Yarmouth, New Gloucester, Pownal, Durham, Gray, and Auburn, Maine (January 2018): This report was prepared by GZA GeoEnvironmental, Inc. for The Nature Conservancy. This document provides a review of prior project reports and work completed in the Royal River Watershed, with the objective to identify key points from historical studies and to evaluate restoration of fish passage between Casco Bay and the upper Royal River Watershed.

2.0 EXISTING CONDITIONS AND AFFECTED ENVIRONMENT*

2.1 DAMS AND STUDY AREA CONDITIONS

2.1.1 Bridge Street Dam

The Bridge Street Dam is located approximately 2,000 ft upstream from the head of tide on the Royal River, near East Main Street and the State Route 88 Bridge (**Figure 3**). This site is known as the Second Falls of the Royal River in Yarmouth, ME. The dam is constructed on visible metamorphic bedrock 250 ft upstream from Bridge Street.

The dam is a gravity type run-of-river structure spanning the full width of the river. It is constructed of masonry and reinforced concrete. The structure is approximately 275 ft in length and is 10-ft in height. In the most recent inspection report, the dam is described from left to right as being comprised of "a 102-ft-long non-flow section, an approximately 10-ft-wide by 8-ft-wide right sluice bay section with stoplogs, an approximately 130-ft-long undated spillway section and a 7.5-ft-wide by 10-ft-high left sluice bay section with stoplogs" (Johnson, 2014). The dam has a sloped upstream face and a vertical downstream face. The spillway is located near the center of the dam, approximately 75 ft long. Low-flow sluiceways are cast into either end of the spillway and are controlled by removable weir planks.

Figure 3: Bridge Street Dam & Fish Passage, Royal River, Yarmouth, Maine

The Bridge Street Dam was originally constructed in 1870 to provide low-head water to the adjacent Sparhawk Mill through a metal penstock (**Figure 4**). The Sparhawk Mill Hydropower plant was a Federal Energy Regulatory Commission (FERC) operated dam until 2019 when it was decommissioned. The intake structure and 200-ft-long welded steel penstock from the original hydroelectric plant, are still in place.

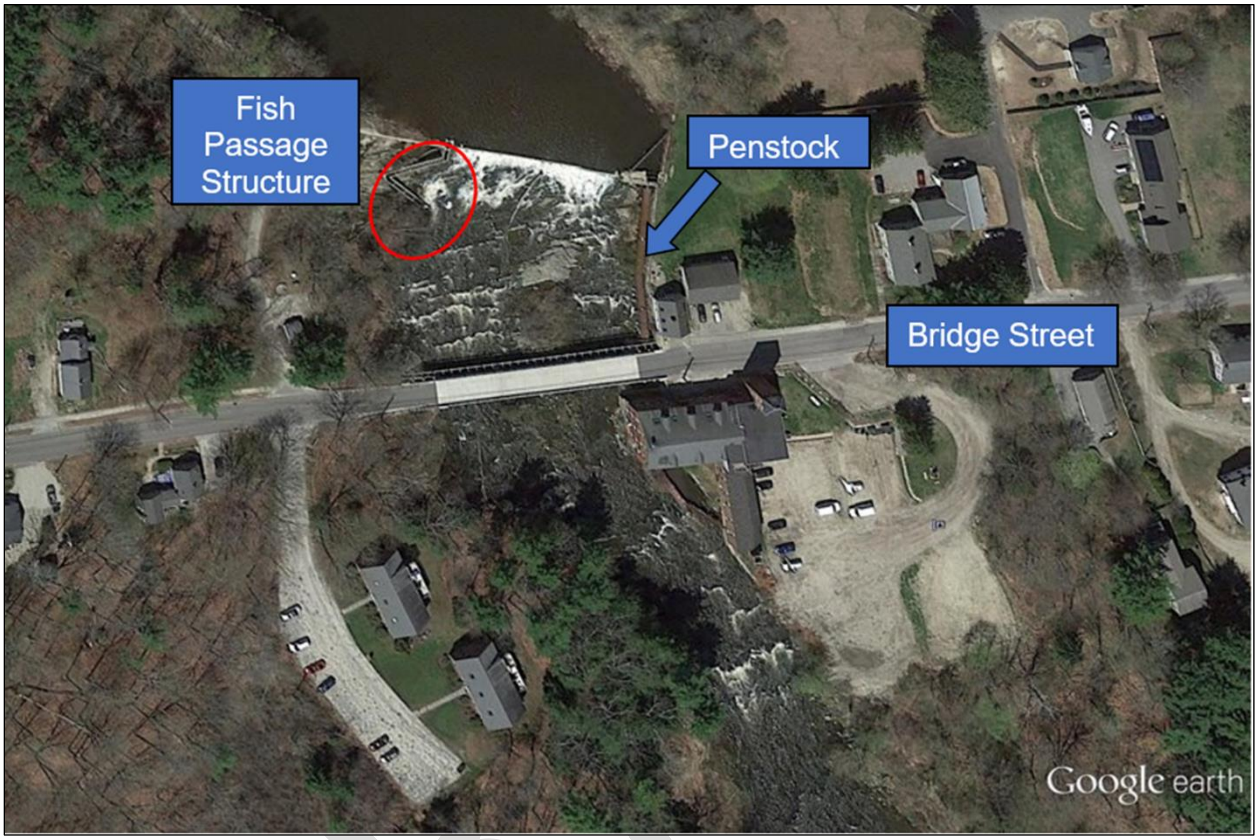

Figure 4: Aerial View of the Bridge Street Dam

The most recent inspection of the Bridge Street Dam took place in December 2014 (Johnson, 2014). At that time, the dam was described as being in generally good condition. The report recommended a number of minor repairs, including replacing mortar overlay on the downstream face and repairing eroded spillway construction joints, that if done in a timely manner, would "minimize future, significantly more costly repairs". No leaks were observed in the dam structures, "however clear water was observed flowing out of a hole in the bedrock just downstream of and adjacent to" a section of missing concrete noted on the right end of the spillway, which abuts the sluice bay. The report estimated that the leakage rate was approximately 10 gallons per minute. No repairs to the dam or ongoing operations and maintenance (O&M) to the Bridge Street Dam have occurred since this inspection.

In an effort to improve fish passage, a concrete Denil-type fish ladder was built into the southwest end of the dam's spillway in 1974 (**Figure 5**). The fishway consists of two 3-ft-wide concrete segments with 19 baffles each and "a 13-ft long, 120 degree turning pool" that separates the two segments. The design of the fish ladder does not meet current fish passage needs. The design is suitable for alewife but is problematic for the passage of other native anadromous species (Inter-Fluve, 2018).

The effectiveness of the structure is dependent on many conditions including water flow, regular maintenance, and debris removal. For many years, the fish passage structure was inoperable due to damage and lack of maintenance. In recent years, a local group of volunteers have repaired the fish ladder. Their efforts have shown some success, as they have filmed fish moving through the fish ladder in 2024, though fish passage is measured in tens of fish instead of thousand that were recorded moving up the river in the past (Royal River Fish Passage, 2024).

Figure 5: Denil-Type Fish Ladder at the Bridge Street Dam

The dam and fish ladder are currently owned by the town of Yarmouth.

The impoundment above the Bridge Street Dam extends from the dam upstream to the Middle Falls, a distance of 2000 ft. The surface area of the impoundment at normal pool level is approximately nine acres, with a maximum depth of 15 ft (Stantec, 2015).

2.1.2 Middle Falls

Middle Falls, also known as Mill Street Falls, is a natural barrier to fish passage that is located between the Bridge Street and East Elm Street Dams (**Figures 6 & 7**). This feature is 2,000 ft upstream of Bridge Street Dam. “At this site, the river bifurcates around Factory Island with the main channel (and falls) on river right and a small side channel on the east side of Factory Island that also connects the head and tailwaters of the falls” (USFWS, 2017).

Figure 6: The Middle Falls Site with the Remnants of the Forest Paper Company Mill

Figure 7: Aerial View of Middle Falls

The area was formerly the site of the Forest Paper Company Mill, which spanned the river from the south shore to Factory Island (**Figure 8**). Prior to 2012, remnants of the mill complex encroached into the river channel, including a stone structure spanning the channel to the north of Factory Island and large granite blocks blocking the side channel. The 2010 report written by Stantec suggested that this encroachment into the river channel likely impacts fish passage at this site.

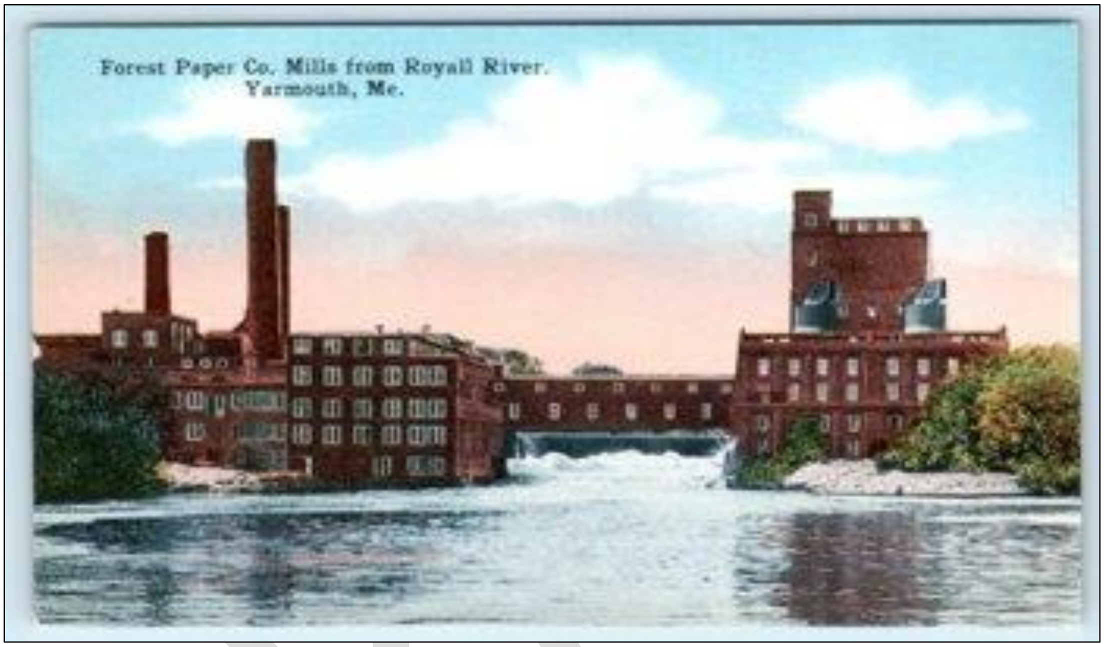

Figure 8: The Forest Paper Company Mill Located on the Royal River at the Middle Falls site

In 2012, the town of Yarmouth led an effort to clear the remnants of the mill structure from the side channel to partially or substantially improve passage through that section of the river. Dozens of granite blocks, weighing approximately 6,000 pounds, were pulled out of the river channel. In total, approximately 70 tons of rock was removed from the river channel, improving fish passage in a 0.9 miles section of the Royal River (Maine Rivers, 2012).

During the summer of 2017, the U.S. Fish and Wildlife Service (USFWS) surveyed the bypass to assess the potential of fish passage in this side channel. In a letter written by the agency describing their findings, the agency indicated that “the side channel appears passable over most of its length though water depths were shallow at the time of this survey. Two locations that may hinder fish movement were identified.” There are no records that describe any modifications of the side channel during the construction of the Mill. However, one of the locations mentioned by the USFWS is a rock ledge which stands out from the surrounding features and might not be an original feature of the channel. The agency suggested that these impediments could be removed and that:

"Significant improvements to the passage conditions at these sites might be accomplished through alternations to the ledge outcroppings and/or movement of large rocks. This work might be accomplished in 3 to 5 days by a small crew with access to a generator, compressor, pneumatic hammer, and grip hoists. These enhancements would be relatively low cost and should be considered viable alternative." (USFWS, 2017)

2.1.3 East Elm Street Dam

The East Elm Street Dam is located approximately a half mile upstream of the Bridge Street Dam and 0.23 miles upstream of Middle Falls. The area is also known as the Fourth Falls and Gooch's Falls. The dam is a stone, run-of-river, gravity-type structure approximately 250 ft in length (including abutments), with a 12-ft structural height (**Figure 9**). The dam is built on a bedrock outcropping that is an extension of Gooch Island, immediately east of the dam. The structure of the dam consists of "a loose-laid, large-granite-block structure, a sloping concrete overlay on the upstream side, and a concrete overlay on portions of the downstream side." (Powers, 2009)

Figure 9: East Elm Street Dam, Royal River, Yarmouth, Maine

Gooch Island splits the Royal River into a main channel (west of Gooch Island), and a narrower back channel (east of Gooch Island) (**Figure 10**). The entire length of the dam serves as a spillway, which has a granite block crest (Stantec, 2010).

Figure 10: Aerial View of the East Elm Street Dam

In 1979, a concrete Denil-type fishway was built by the Maine Department of Marine Resources at the southern end of the dam (**Figure 11**). The fishway has a 1:6 slope and includes a concrete chute with slanted wooden baffles, trash racks and a slide control gate at the upstream inlet (Petrovsky, 2019). The structure is 3-ft wide with three segments. The first and second segments are separated by "a 16-ft long, 90 degree turning pool", while the second and third segments are separated by a 180-degree turning pool. The structure allows a 11-ft rise from entrance to exit. Assessments of the fish ladder find that the design does "not meet current design standard for the target community" (Inter-Fluve, 2018). Similar to the Bridge Street fish passage structure, the structure at East Elm Street Dam eventually fell into disrepair and was not functional. In recent years, a local group of volunteers have repaired the fish ladder.

The dam and fish ladder are currently owned by the town of Yarmouth.

The impoundment above the East Elm Street Dam extends from the dam upstream approximately 6 river miles to Baston Park/State Route 9 (**Figure 2**). The dam has minimal effects on river flows for an additional 5,000 and 12,000 ft beyond the park. As described by Stantec in their 2013 report, the impoundment is highly sinuous and meandering. Pools within the impoundment can be as deep as 20 ft during low flows.

Bank heights vary, but “the banks appear considerably higher than the annual flood level…” (Stantec, 2013a). Comparing present conditions with a topographic map developed in 1941 shows that the river channel has not significantly changed position in over 80 years. Due to its slow moving, calm nature, the impoundment is used for a wide variety of recreational activities including flat-water boating, swimming and ice skating during the winter.

Figure 11: Denil-type Fish Ladder Near the East Elm Street Dam

The last inspection of the East Elm Street Dam commissioned by the town of Yarmouth occurred December 2009 (Powers, 2009). At that time, the dam was described to be in generally good condition. The inspection recommended safety improvements around the dam and fish ladders that would limit public access to the area. The report also suggested removal of vegetation from the right non-overflow section, repair of the deteriorating downstream face of the non-overflow section near the fish ladder, and the repair of two areas where the crest stones and/or concrete were displaced. In the bypass channel, the inspector also suggested stabilizing the old spillway, initiating repairs to the stone retaining wall downstream of the old spillway and installing fencing to limit public access to the bypass channel.

In 2019, a private business owner commissioned MBP Consulting to assess the condition of the dam (Petrovsky, 2019). The inspection report concluded that the dam “…appears to be in stable, but deteriorating condition.” The inspector supported their conclusions by referencing the “lack of up-keep measures, unchecked vegetation growth, accumulation of debris in water conveying structures, abandoned fishway and numerous signs of deterioration." Numerous measures were suggested to improve the condition of the dam including removal of large woody debris, installation of a log boom, removal of dense vegetation, replacement of the sluice stoplogs, installation of a service platform, repair of the downstream toe of the sluice, permanent sealing of the north and south ends of the spillway, repair of the northern section of the spillway and installation of warning signage.

2.2 ENVIRONMENTAL RESOURCES

2.2.1 Aesthetics & Recreation

The Royal River, its estuary and open water areas are valuable ecological resources that are utilized by the public for recreational shellfishing and fishing, boating, hiking, and swimming.

The Royal River is a very popular area for flat water boating, such as canoeing and kayaking. The river is generally too narrow and shallow for motorized boating, though some sections of the East Elm Street impoundment allow very small motorized jon boats. The river has been designated as the Royal River Water Trail from Sabbathday Lake to Casco Bay. The most popular stretches of the river for paddling are located upstream of the East Elm Street dam. Very few boaters paddle the river below the East Elm Street Dam to navigate the lower section of the river. From East Elm Street to the Yarmouth Harbor there are four significant barriers to recreational boating, the East Elm Street Dam, Middle Falls, Bridge Street Dam, and the falls at Grist Mill Park. Upstream of East Elm Street Dam there are several put-in locations for recreational boaters including the Yarmouth Historic Center, Wescustogo Park, Route 9, and Penney Road. The impoundment of the East Elm Street Dam extends approximately 6 miles upstream and is a valued area for beginner and novice paddlers for its aesthetic value and ease of navigation.

The Royal River is well known for its fishing opportunities. Currently, anglers can catch alewife, shad (*Alosa sapindissima*), brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), rainbow smelt (*Osmerus mordax*), and American eel (*Anguilla rostrata*). Atlantic salmon (*Salmo salar*) were historically found in the Royal River, but the original population has been extirpated due to loss of access to habitat.

In addition to water sports on the Royal River, people also enjoy spending time in the forests and parks surrounding the river. Birding, hunting, fiddlehead harvesting, hiking and picnicking are popular activities that occur around the river. Local residents also enjoy winter sports on the Royal River, including snowmobiling and ice skating.

The largest public park in the study area is the Royal River Park, which is located in the town center and runs from the East Elm Street Dam to the Bridge Street Dam on the right descending bank of the river. This park is owned and managed by the town. The park includes a paved walking path, pedestrian bridges, picnic areas and manicured lawns. The park includes the site of the historic Yarmouth Paper Company. Informational signs that describe the industrial history of the area and granite stones from the original buildings of the mill are located in the park. The park also includes the Beth Condon Pathway, which his part of the East Coast Greenway, a 3,000-mile trail system that links Calais, Maine to Key West, Florida.

Aesthetics encompass the visual resources and the quality of the overall visual perception of the environment, which includes buildings, landscapes and open areas. Aesthetic features consist of unique or prominent natural or man-made attributes, or several small features that, when viewed together, create a whole that is visually interesting or appealing. The aesthetic scenery provided by the areas not only benefit the residents of the coastal communities but attracts tourists from around the world. The study area provides a wide variety of aesthetic resources. From the head of tide to the East Elm Street Dam, the area includes both natural and man-made features including scenic views of the river, including natural cascades and falls, urban parkland, historic buildings, and historic dams. Further upstream, the study area includes views of the river, forests and natural landscapes.

2.2.2 Physical Environment

2.2.2.1 Air Quality

Air quality is defined by ambient air concentrations of specific pollutants determined by the U.S. Environmental Protection Agency (USEPA) to be of concern related to the health and welfare of the public and the environment. The Clean Air Act (CAA) of 1970, as amended, is the primary federal statute governing air quality. Under authority of the CAA, the USEPA sets the National Ambient Air Quality Standards (NAAQS), which are the maximum acceptable concentration for specific pollutants that may impact the health and welfare of the public. NAAQS have been established for six principal pollutants: Carbon Monoxide, Lead, Nitrogen Dioxide, Ozone, Particle Pollution including particulate matter equal to or less than 2.5 microns in diameter, and particulate matter equal or less than 10 microns in diameter, and Sulfur Dioxide.

The USEPA classifies the air quality in an air quality control region (AQCR) or its subareas. The areas designated for each of the six pollutants under an ACQR are as either "attainment," "nonattainment," or "unclassified." Attainment means that the air quality within an area is better than the NAAQS; nonattainment indicates that one or more of the six principal pollutants exceed the NAAQS; and unclassified means that there is not enough information for the area to be classified. If an area is designated as being in attainment status for all criteria pollutants, the project is in compliance with the CAA and a conformity determination is not required.

Cumberland County, ME currently meet the NAAQS air quality standards and is in attainment (USEPA, 2022). The primary mobile sources of emissions in the vicinity of the project include private, commercial and government vehicles being operated in the roadways that border the project area and small combustion engines (e.g., lawn mowers, leaf blowers) used by the local private landowners.

2.2.2.2 Water Quality

The Royal River is designated as a Class A river system from Sabbathday Lake in New Gloucester, ME to where it is joined by Collyer Brook north of the Depot Road Crossing in East Grey, ME. However, from this crossing to the estuary the section of the Royal River in the study area is designated as a Class B River system. The designated uses for Class B waters are habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation.

Where designated, Class B waters are suitable as a source of public water supply with appropriate treatment. They are suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters have consistently good aesthetic value. Dissolved oxygen levels are not less than 6.0 milligrams/liter in cold water fisheries nor less than 5.0 mg/l in warm water fisheries unless background conditions are lower; temperature does not exceed 83°F (28.3°C) in warm water fisheries. Water pH levels are in the range of 6.5 through 8.3 standard units and not more than 0.5 units outside of the background range. Fecal coliform bacteria levels do not exceed a geometric mean of 200 organisms per 100 milliliter (ml) in any representative set of samples, and more than 10% of the samples do not exceed 400 organisms per 100 ml. These waters are free from floating, suspended and settleable solids in concentrations and combinations that would impair any use assigned to this class, that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

The Royal River estuary is rated Class SB. The designated uses for Class SB waters include providing habitat for fish, other aquatic life, and wildlife and can be used for primary and secondary contact recreation. In approved areas, they are suitable for shellfish harvesting with depuration (Restricted Shellfish Areas). These waters have consistently good aesthetic value, and dissolved oxygen levels are not less than 5.0 mg/l unless background conditions are lower; temperature does not exceed 85°F (29.4°C). Water pH is in the range of 6.5 through 8.5 standard units and not more than 0.2 units outside of the normally occurring range. Waters approved for restricted shellfishing do not exceed a fecal coliform median or geometric mean most probable number (MPN) of 88 per 100 ml, and no more than 10% of the samples exceed an MPN of 260 per 100 ml. These waters are free from floating solids, suspended and settleable solids in concentrations or combinations that would impair any use assigned to this class that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom.

2.2.2.3 ***Hydrology & Hydraulics***

The Royal River Watershed (**Figure 1**) is in the Presumpscot Basin (HUC-8 watershed 01060001), which is in the Saco River Basin (HUC-4 watershed 0106). The Hydrologic Unit is located entirely in Water Resource Region (i.e., HUC-2 watershed) number 01, the New England Region. The entire Royal River Watershed drains an area of 142 square miles and flows 39 miles predominately north to south from headwaters at Sabbathday Lake in New Gloucester, ME to its mouth at Callen Point in Casco Bay (Atlantic Ocean).

The total fall in the Royal River from Sabbathday Lake to the ocean is approximately 300 ft, or an overall average of 7.7 ft per mile; however, approximately 70 ft of the drop is accounted for in the mile above the head of tide that includes four sets of rapids.

There are eight dams within the Royal River Watershed that restrict fish passage. The Royal River receives input from several natural springs such as:

- Unnamed springs in Northern New Gloucester, bordering on Poland, ME, which are partly regulated by the Jordan Mill Dam and natural bedrock, approximately 24 miles upstream of East Elm Street in Yarmouth
- Meadow Brook, 19.7 miles upstream of East Elm Street in Yarmouth
- Stevens Brook, approximately 19 miles upstream of East Elm Street (inflows from Stevens Brook are regulated at one unnamed dam)
- Bear Brook, 16.6 miles upstream of East Elm Street
- Collyer Brook, 11.9 miles upstream of East Elm Street, partly regulated by the Pownal State School Dam, and an unnamed dam on the Eddy Brook tributary.
- Chandler River, 6.0 miles upstream of East Elm Street, partly regulated by Florida Lake on the Collins Brook tributary, and partly regulated by Runaround Pond Dam on the Alder Brook tributary.

To establish a basis of existing hydrologic and hydraulic conditions, it was necessary to determine stream flows over the range of natural variability for the Royal River through the reach of interest near Bridge Street Dam and the East Elm Street Dam. The U.S. Geological Survey (USGS) has recorded flows on the Royal River at a gage (gage #01060000) in Yarmouth, ME, from 1949 to 2023, with a gap from 2004-2019. The gage has been located at, or near, the head of tide at First Falls, located approximately at the East Main Street /Route 88 Bridge in Yarmouth, (**Figure 2**) for this period of record.

Daily average stream flow data for the USGS gage from the previous 59 years (October 1949-September 2004; October 2019-September 2023) were assessed to determine flow-duration statistics for representative 'normal' (Annual Median Flow) conditions, and low flow (i.e., drought) conditions (7Q10 - the lowest 7-day average flow that occurs on average once every 10 years), as well as monthly means and duration exceedances. **Figure 12** below depicts the duration hydrograph showing the 2024 Royal River flows recorded at the USGS gage along with historical streamflow percentiles.

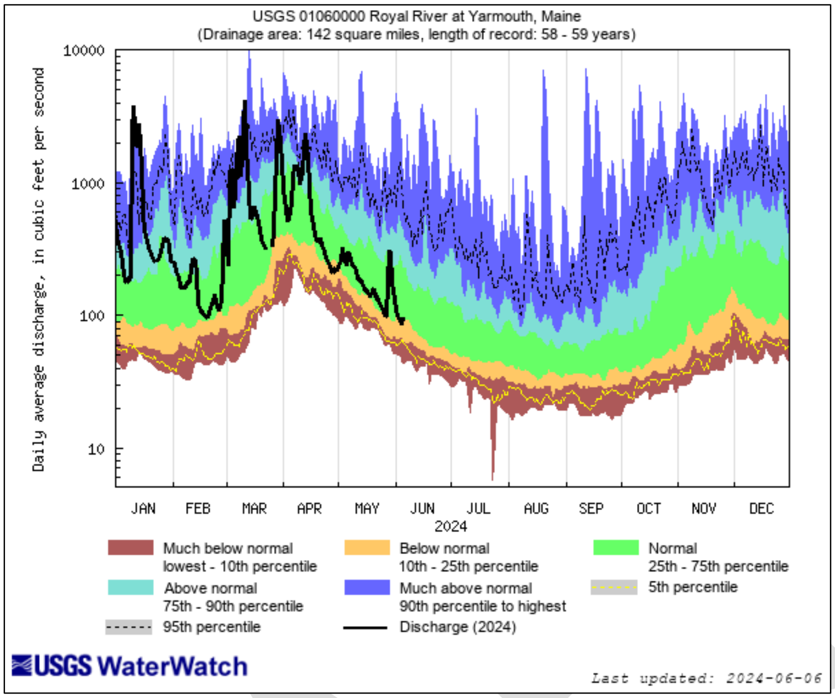

Figure 12: Daily Average Flow Duration Curve

The 7Q10 (drought condition) and annual median flows for the USGS gage were 25 cubic feet per second (cfs) and 120 cfs, respectively. Similarly, for Mid-May to Mid-June, the peak season for alewife upriver passage, the Royal River flows for low (95% duration exceedance), average (50%), and high (5% duration exceedance) are 62 cfs, 144 cfs, and 641 cfs, respectively. The full May-June upriver migration period values are similar: 53 cfs, 149 cfs, and 706 cfs, respectively.

The discharges described in the previous paragraph were compiled for use in a hydraulic model of existing conditions in order to provide a basis for the evaluation of low-flow, normal flow, and fish passage scenarios. The USACE Hydrologic Engineering Center's (CEIWR-HEC) River Analysis System (HEC-RAS) model was utilized for this analysis, given the software's capability for two-dimensional unsteady flow calculations. HEC-RAS version 6.1 was initially utilized for terrain and initial model development at the beginning of the study, with version 6.4.1 utilized for model finalization and computations. The modeling effort is described fully in **Appendix C**.

Flood flows were also a necessary input for the hydraulic model, to serve as a basis for flood levels, depth of flow, and the range of velocity/shear stresses currently experienced along the Royal River. Peak flows were obtained from the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS), but only for the 10-, 50-, 100-, and 500-yr annual recurrence interval (ARI) events (a.k.a. the 10%, 2%, 1%, and 0.2% annual exceedance probability [AEP]). The hydrologic calculations supporting the FEMA FIS were completed in the 1980s. As such, an updated flood frequency analysis was completed utilizing modern methods with the entire period of record at the Yarmouth

USGS gage. The updated flood frequency analysis is included in **Appendix C.** The FIS peak flows support the updated analysis flows, which were then adopted for purposes of this study, as summarized in **Table 1**. As with the daily flows, USGS gage data was utilized directly without adjusting for slight increase in drainage area between the USGS gage and the upstream study limits.

Table 1: Flood Frequency Analysis

Annual Chance Exceedance	Average Recurrence Interval (year)	Computed Curve (Flow, cfs)	Confidence Limits (Flow, cfs)		USGS StreamStats Flows (cfs)	FEMA FIS Flows (cfs)		Adopted Flows (cfs)
			0.05	0.95		At USGS gage 01060000	At Route 9 in North Yarmouth	
0.2	500	13,415	20,997	10,530	14,300	14,540	13,820	----
0.5	200	11,678	16,867	9,522	----	----	----	----
1	100	10,419	14,189	8,729	11,000	10,530	10,020	10,419
2	50	9,200	11,841	7,903	9,710	9,060	8,850	----
5	20	7,639	9,174	6,751	----	----	----	----
10	10	6,480	7,447	5,820	6,780	6,085	6,540	6,480
20	5	5,314	5,924	4,824	5,540	----	----	----
50	2	3,643	3,998	3,321	3,740	----	----	3,643
80	1.25	2,506	2,758	2,253	----	----	----	----
90	1.11	2,063	2,293	1,803	----	----	----	----
95	1.05	1,759	1,984	1,475	----	----	----	----
99	1.01	1,305	1,551	975	----	----	----	----

Below the head of tide, the Royal River descends to an estuary in the form of a long, broad river mouth. The estuary is bounded by the head of tide at lower falls and winds toward Casco Bay. The mean tide range in Casco Bay at the National Oceanic and Atmospheric Administration (NOAA) Portland observation station (8418150) is 9.1 ft, with a Mean Lower Low Water (MLLW) elevation of –5.3 ft North American Vertical Datum of 1988 (NAVD88).

2.2.2.4 Floodplains

Executive Order (EO) 11988 requires that federal agencies avoid, to the extent possible, adverse effects associated with the occupancy and modification of floodplains and to avoid support of floodplain development wherever there is a practicable alternative. The riparian areas along the Royal River at the project site are designated as Zone "AE" under the FEMA National Flood Insurance Program. This area has a 1% chance of flooding (100-year flood) (MDEP, 2020). Flood hazard areas are identified in **Figures 13 & 14**. The FEMA flood hazard areas were used for relative comparison to existing conditions hydraulic model results (**Appendix C**), that serve as a basis for flood levels, depth of flow, and the range of velocity/shear stresses currently experienced along the Royal River.

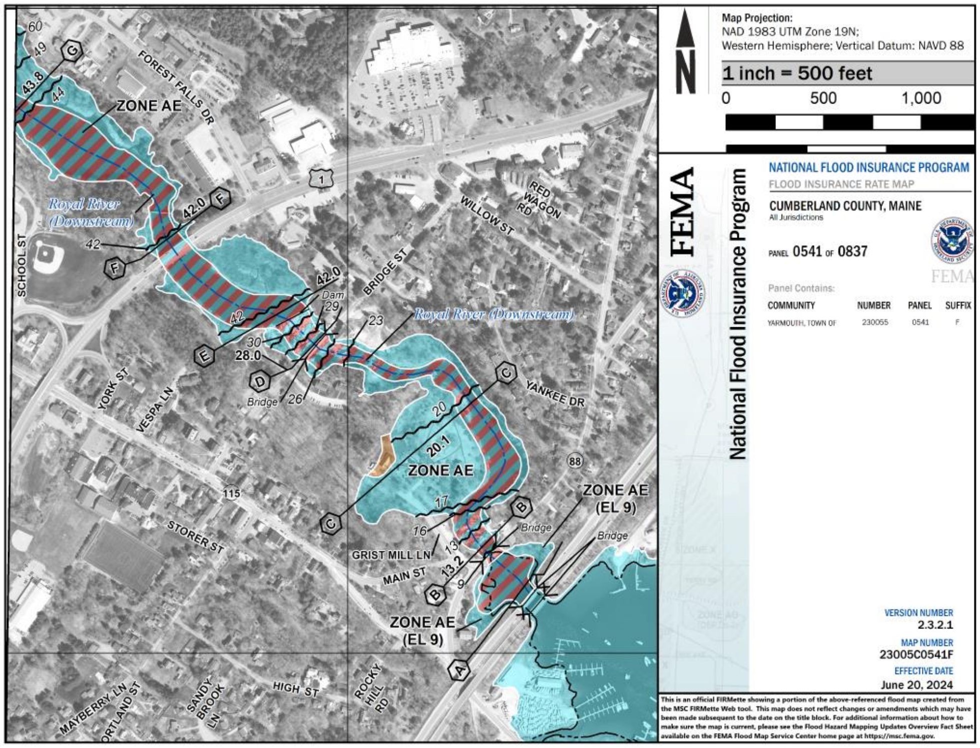

Figure 13: Town of Yarmouth Flood Hazard Map – Downtown Yarmouth

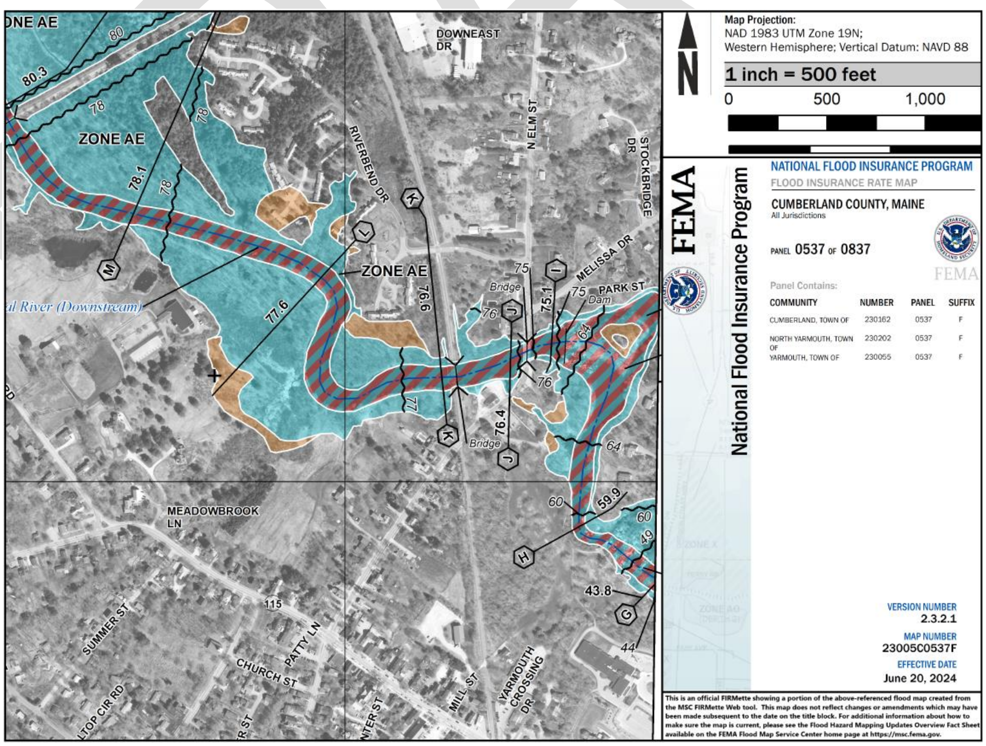

Figure 14: Town of Yarmouth Flood Hazard Map – East Elm Street.

2.2.2.5 *Geology and River Sediment*

Geologic mapping identifies the riverbanks as Stream Alluvium and River Terraces consisting of sand and silt with minor amounts of gravel in the Alluvium and significant gravel and cobbles in the river terraces (Retelle, 1999). Adjacent and underlying is the Presumpscot formation of fine-grained marine mud consisting of silt and clay with occasional sand (Retelle, 1999). The bedrock in the watershed consists of undifferentiated metamorphic rock of uncertain Silurian or Ordovician age with frequent intrusions of varying age (West and Hussey, 2018). Much of the Royal River is scoured streambed where the bottom substrate is bedrock.

The New England District completed a sediment sampling and testing effort in October 2023. The purpose of this investigation was to determine river bottom conditions and screen for contaminants. The effort was focused on characterizing the sediments in the East Elm Street Dam impoundment and delineating the extent and level of metal contamination downstream of the Bridge Street Dam, which had been identified in previous sampling and testing conducted by Stantec for the town of Yarmouth in 2009. Maps of the areas sampled in 2023 can be found in **Appendix B**.

Results of grain size analysis are provided in **Table 2**. The riverbed was found to consist of primarily scoured bedrock and coarse substrate with a fringe of sediment along portions of each bank. Soil samples were collected primarily from the riverbanks due to the near absence of sediment on the river bottom. Bank sediments erode and accrete on the Royal River, as is common on flowing rivers subject to seasonal flow variation.

Table 2: Summary of Grain Size Analysis Conducted by USACE, 3-4 October 2023

Sample ID	% Cobble	% Gravel	% Sand	% Fines	Soil Type
BS23-01	57.2	26.6	15.8	0.5	Gravel
BS23-02	0.0	1.2	49.7	49.0	Sand
BS23-03	0.0	0.7	31.8	67.4	Fines
BS23-05	49.7	42.6	7.3	0.4	Gravel
BS23-05-1	0.0	0.2	18.5	81.4	Fines
ES23-01	0.0	33.1	66.1	0.9	Sand
ES23-02	0.0	0.2	46.5	53.3	Fines
ES23-03	0.0	1.4	36.8	61.7	Fines
ES23-04	0.0	1.9	19.8	78.3	Fines
ES23-05	0.0	0.7	67.9	31.4	Sand
ES23-06	0.0	0.0	32.8	67.2	Fines
ES23-07	0.0	0.6	68.9	30.6	Sand
ES23-08	0.0	0.1	36.2	63.7	Fines
ES23-10	0.0	0.0	23.0	77.0	Fines
ES23-11	0.0	0.7	58.6	40.7	Sand

The chemical concentrations in the sediment samples were found to be very low. There were no traces of elevated mercury concentrations below the Bridge Street Dam, as documented in a single sample from the Stantec 2009 sampling effort. PAHs, pesticides, and lead measured within a subset of the samples from isolated depositional areas above the East Elm Street Dam were present at concentrations above Threshold Effect Concentrations (TEC) screening values for freshwater sediments but were below (typically well below) the associated Potential Effect Concentrations (PEC) value.

Threshold Effect Concentration (TEC):
A concentration of a hazardous substance in sediment below which adverse effects on sediment-dwelling organisms are unlikely to occur.

Potential Effect Concentrations (PEC):
A concentration of a hazardous substance in sediment above which adverse effects on sediment-dwelling organisms are likely to be

USACE's evaluation of the sediments in the study areas above the East Elm Street Dam and below the Bridge Street Dam aligns with Maine's Department of Environmental Protection's (Maine DEP) evaluation of a 2015 Stantec sampling and testing effort performed for The Nature Conservancy in the Bridge Street Dam impoundment. A November 20, 2017, memo released by The Nature Conservancy documents that:

> "The DEP's review supports Stantec's conclusion of minimal potential risk to aquatic life related to impounded sediments at the Bridge Street Dam. Moreover, the Department concluded that overall, the site is clean and is in fact cleaner than sediment tested prior to the harbor dredge in winter 2015-2016."

The isolated nature and comparatively low volume of the sediments in question led the Maine DEP to conclude that the total average concentrations were low. Individual PAH and metals concentrations documented by the 2015 Stantec effort were higher than those documented in the upstream and downstream areas by USACE in 2023.

The town of Yarmouth developed a Royal River Restoration Project in conjunction with their contractor, Stantec. Although improved fish passage was a stated objective of the restoration project, there was also concern over sedimentation and dredging needs in the Yarmouth, ME harbor. Phase II of the restoration project was released in 2013 (Stantec, 2013a). The 2013 report noted, based on chemical sampling performed at the time, that sediments, which might be released due to the removal of the East Elm Street and Bridge Street Dams, were unlikely to create risk of adverse effects to aquatic life. A subsequent report from GZA (2018) also discussed sedimentation and dredging.

Two sampling efforts were performed in 2023 to assess the quantities of sediment currently present in the study area. The first is the previously described sampling effort completed by the USACE in October 2023. During that sampling effort the riverbed downstream of the Bridge Street Dam (between the dam and First Falls) was found to be composed of exposed bedrock with areas of boulder and cobble substrate. The riverbed in the East Elm Street Dam impoundment was also composed primarily of bedrock. The only portion of this study reach with any significant accumulation of sediment was located along the banks.

Later in 2023, Stantec contracted with the Town of Yarmouth to collect data of sediment depth and characterization in the Royal River upstream from the Elm Street and Bridge Street Dams. The study reaches included an approximately 1,800 ft section upstream from Bridge Street Dam and approximately 500 ft section upstream of Elm Street Dam. Six profiles were collected at each sampling location. The profile collected approximately 50 ft upstream of East Elm Street Dam (**Figure 15**) is shown as an example of the data collected by Stantec. The dashed line represents bedrock, while the solid line defines the river bottom. The area (represented in blue) in between the two lines represents the sediment layer. The complete Stantec report can be found in **Appendix B**.

The conclusions from the sediment profile effort were consistent with USACE's October 2023 sampling effort. The river bottom was found to have little to no sediment and consists primarily of bedrock/cobble. When erodible sediment was present, the material was mostly found along riverbanks. The full report developed by Stantec can be found in **Appendix B.**

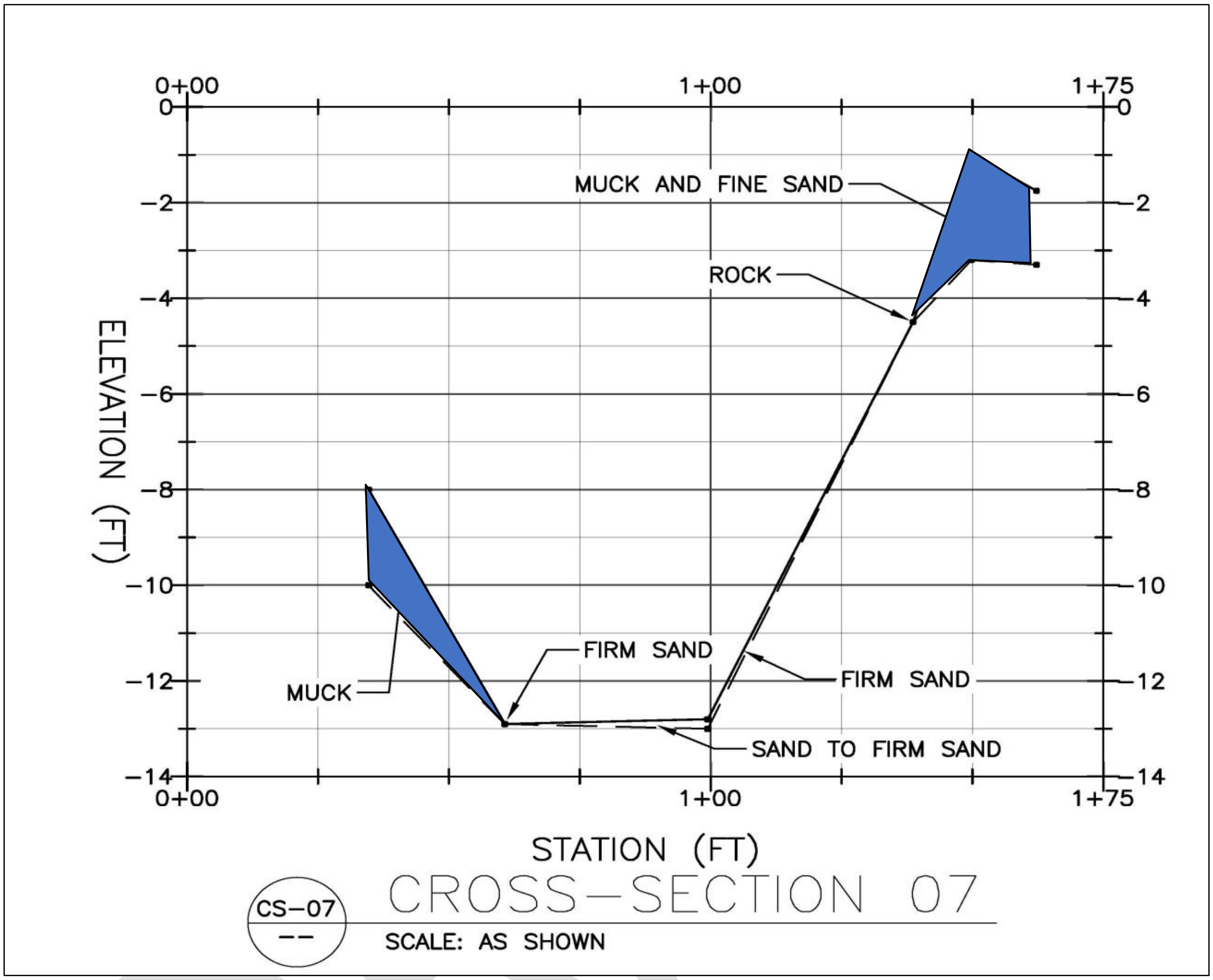

Figure 15: Sediment Profile Collected Approximately 50 ft Above East Elm Street Dam During December 2023 by Stantec Consulting Services, Inc.

2.2.2.6 ***Estuary***

Downstream of the head of tide and the northbound Interstate-295 bridge, is a 2-mile-long estuary that ranges from 300 ft to 1,200 ft in width. A federal channel has ensured navigation access from Casco Bay to this vicinity since at least the 1870s. This channel was enlarged in the 1960's along with creation of an 8-acre anchorage, collectively identified as the Federal Navigation Project (FNP) (**Figure 16**). Private interests also operate several commercial marinas in the estuary.

When the FNP was constructed, approximately 200,000 cy of sediment were removed to create the anchorage and to enlarge the existing channel. Approximately half of the sediment was taken from the channel, while the other half came from the anchorage. Water depths in the anchorage ranged from 0 ft to 4 ft Mean Low Water (MLW) prior to construction and met or exceeded 6 ft MLW after construction. Depths of excavation ranged from 2 ft to 6 ft throughout most of the anchorage. The average depth of excavation was nearly 4 ft. Removing this sediment altered the natural balance that had existed between the velocity of water and erosion and deposition processes. As a result of the excavation, river sediments shoal[1] in the FNP as the river rebalances back toward the natural condition that existed prior to dredging. The same general concept is true for the adjacent marinas that rebalance toward their natural condition by shoaling.

Figure 16: Royal River Federal Navigation Project.
(The blue shading represents the current design of the FNP and anchorage.)

2.2.2.7 Greenhouse Gas Emissions

According to the CEQ's NEPA Guidance on Consideration of Greenhouse Gas (GHG) Emissions and Climate Change (Federal Register, Vol. 88, No. 5, January 9, 2023), climate change is a defining national and global environmental challenge of this time, threatening broad and potentially catastrophic impacts to the human environment. Global atmospheric GHG concentrations are substantially affecting the Earth's climate, and the dramatic observed increases in GHG concentrations since 1750 are unequivocally caused by human activities including fossil fuel combustion (IPCC, 2021). Rising GHG levels are causing corresponding increases in average global temperatures and in the frequency and severity of natural disasters including storms, flooding, and wildfires (NASA, 2021). CEQ directs agencies to quantify GHG emissions of proposed actions, place GHG emissions in appropriate context, disclose relevant GHG emissions and relevant climate impacts, and identify alternatives and mitigation measures to avoid or reduce GHG emissions in NEPA reviews.

The Royal River project is located in Maine, which had gross greenhouse gas emissions in 2021 of 16.11 million metric tons of CO_2 equivalent (MMTCO2e).

[1] Shoaling is the process of deposition of sediment.

2.3 CULTURAL RESOURCES

As an agency of the federal government, the USACE has certain responsibilities concerning the protection and preservation of historic properties. Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, and its implementing regulations, the Advisory Council on Historic Preservation's Procedures for the Protection of Historic and Cultural Properties (36 CFR 800), and EO 11593 direct federal agencies to take into account the effect of any undertaking on historic properties included on, or eligible for, the National Register of Historic Places (NRHP). NEPA requires that federal agencies consider whether an action will have significant environmental effects including effects to historic and cultural resources. In particular, under NEPA, environmental review includes a description of the human environment and the environmental consequences of the proposed action on that environment, which includes aesthetic, historic, and cultural resources. The American Indian Religious Freedom Act (1978), the Presidential Memorandum "*Government to Government Relations with Native American Tribal Government* (1994), the Native American Graves Protection and Repatriation Act (1990), and EO 13175 "*Consultation and Coordination with Tribal Governments*" (2000) direct federal agencies to consult and to consider the effects of any proposed undertaking on the tribes.

2.3.1 Pre-Contact Context

Yarmouth's location where the Royal River empties into Casco Bay was an attractive area for the Wabanaki native peoples, with access to hunting, fertile lands, water and transportation, and later to Europeans who first came to the area in the 17th Century. The town was originally called North Yarmouth, to differentiate it from the town on Cape Cod and settled in the 1630's and later again, in the 1679 (Yarmouth Historic Context Statement 2023).

According to Dr. Arthur Spiess, Maine State Archaeologist, there are no recorded archaeological sites in the Maine Historic Preservation Commission's inventory from East Elm Street south to below the Bridge Street Dam to the head of tide falls. There is the potential for undiscovered pre-Contact archaeological sites; however, no evidence has been identified on the surface in exposed soils along riverside paths downstream of the East Elm Street Dam (Dr. Arthur Spiess, personal communication August 25, 2023).

Woodland Period (2,800 to 500 years ago) Native American sites are possible on or near the banks of the Royal River one to two kilometers upstream of the East Elm Street Dam according to Dr. Spiess. Several upstream areas in North Yarmouth have received professional archaeological survey and these areas are noted south of Baston Park. There is only one known pre-Contact archaeological site known from this stretch of river – site number 14.159, a small (several square meters) scatter of stone debitage with one calcined bone fragment on or near the riverbank, that was identified by survey for a subdivision in 1996 (Dr. Arthur Spiess, personal communication September 1, 2023).

2.3.2 Historic Context

The Royal River Watershed in Yarmouth has been known historically as a series of falls where the waterpower was harnessed for industrial purposes with the construction of dams and mills in the 19th Century. Beginning in the north, Fourth Falls is located at East Elm Street and was originally the location of a flour mill, sawmill, and paper mill. A fish passage structure was later added to the dam. The Third Falls (or Middle Falls) area south of East Elm Street was the site of the Forest Paper Company, dating from 1874, and used in the production of soda pulp products. The Forest Paper Company was located on both banks of the Royal River with a wooden bridge spanning the river to the east in the Middle Falls (Factory Island) area. A fire in 1931 spread from the west side (the current site of Royal River Park) over the river along the bridge to the 10-story digester building on the east side, effectively destroying the mill complex. Bridge abutments are located on both sides of the stream here and the Middle Falls area was used for the disposal of waste products from the mill until 1923. Black ash up to 30 ft deep from the fire is said to compose the Shaw’s Grove area on the east side of Middle Falls, which had been acquired by the Forest Paper Company for waste disposal (Yarmouth History Center exhibit collections).

South of the Middle Falls area is the location of the former Royal River Manufacturing Company and the Sparhawk Mill on Bridge Street, also known as Second Falls. A cotton mill was first established on this site in the late 1840’s. Following its reconstruction after a fire in 1855, the mill was purchased in 1857 by the Royal River Manufacturing Company, which used it as a textile mill for the production of fine yarns and seamless grain bags. The mill complex included the dam, which provided waterpower for the machinery, along with offices and worker housing (Yarmouth History Context Statement 2020, 3-4). The company later manufactured twine for lobster traps in the 1950’s and was known as Yale Cordage in 1970, before being redeveloped into office space in the 1990’s (Landmarks Observer – Sep/Oct 1981).

The area known as First Falls is the location of a former saw and grist mill today known as Grist Mill Park, a scenic town recreation area. However, the First Falls area is not part of the current ecosystem restoration project.

No National Register (NR)-listed properties are located within the Area of Potential Effect (APE). The Bridge Street Dam is eligible for listing on the NR, as a contributing element of the proposed Royal River Manufacturing Company historic district, which dates from 1857-1917. The original penstock, which is a pipe that transfers water from the intake structure to turbines within the mill, runs alongside the dam and was destroyed during a 1981 storm and replaced in 1986. In addition to the dam itself, the proposed NR listing includes: the Sparhawk Mill (circa 1857), a cotton textile mill at 81 Bridge Street, an office and associated barn (80 Bridge Street), a house and barn (100 Bridge Street) built by mill owner Phillip Kimball, and boarding houses for the mill workers (107 and 109 Bridge Street). The mill was redeveloped into office space in 1992 and is currently in use today (Gaertner 2018, 22).

2.4 BIOLOGICAL ENVIRONMENT

2.4.1 Fishery Resources

The Maine Department of Inland Fish and Wildlife (MDIF&W) has documented that the Royal River Watershed supports a variety of freshwater, marine, anadromous (fish that migrate up-river from salt water to spawn in freshwater), and catadromous (fish what live in freshwater, but travel to saltwater to spawn) fisheries. Anadromous fish in the watershed include alewife, smelt , and American shad. Game fish in the watershed include brown trout, brook trout, yellow perch (*Perca flavescens*), chain pickerel (*Esox niger*), smallmouth bass (*Micropterus dolomiteu*), largemouth bass *(Micropterus salmoides*), and striped bass (*Morone saxatilis*) and bluefish (*Pomatomus saltatrix*) in the tidal waters. Other species of fish include the golden shiner (*Notemigonus crysoleucas*), common shiner (*Luxilus cornutus*), northern redbelly dace (*Chrosomus eos*), blacknose dace (*Rhinichthys atratulus*), creek chub (*Semotilus atromaculatus*), lake chub (*Couesius plumbeus*), fallfish (*Semotilus corporalis*), nine spine stickleback (*Pungitius pungitius*), white sucker (*Catostomus commersonii*), brown bullhead (*Ameiurus nebulosus*), pumpkinseed sunfish (*Lepomis gibbosus*), and American eel.

The Royal River was home to a commercial American shad and alewife fishery as early as 1887. Shad and alewife are anadromous species that use the river to migrate to historic spawning grounds in lakes and lentic waters upstream. In 1974 the Maine Department of Marine Resources (MDMR) began an anadromous fish restoration plan focused on alewife and American shad. Gravid alewife were stocked into Sabbathday Lake and Runaround Pond and adult Shad were stocked above the East Elm Street Dam under this plan, but no permanent migratory run was established for either species.

The National Marine Fisheries Service (NMFS) has designated specific aquatic areas as Essential Fish Habitat (EFH) in accordance with the Magnuson-Stevens Fishery Conservation Act, as amended by the Sustainable Fisheries Act of 1996. The Sustainable Fisheries Act includes requirements for evaluating fish habitat loss and protection of fisheries identified as essential fisheries. EFH are those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (50 CFR Part 600).

The study area is broken out into two EFH areas. The first runs from the mouth of the Royal River and ends 0.1 miles upstream of the railroad crossing at river mile 3.7, This location is approximately 0.8 river miles upstream of the East Elm Street Dam and includes both the Bridge Street and East Elm Street Dams. The second EFH reach starts north of the railroad crossing to a site approximately 6.3 river miles upstream from the mouth of the Royal River. **Table 3** below summarizes essential fish habitat designations in Casco Bay and the two EFH reaches located in the Royal River.

Table 3: Summary of Essential Fish Habitat Designations Summary of Essential Fish Habitat Designations (NMFS, 2024)

Species	Eggs	Larvae	Juveniles	Adults
Acadian Redfish (*Sebastes fasciatus*)		A B C		
American Plaice (*Hippoglossoides platessoides*)	A B	A B	A B	A B
Atlantic Butterfish (*Peprilus triacanthus*)			A	A B
Atlantic Cod (*Gadus morhua*)	A B	A B	A B	A B
Atlantic Herring (*Clupea harengus*)		A B	A B	A B
Atlantic Mackerel (*Scomber scombrus*)			A B	A B
Atlantic Sea Scallop (*Placopecten magellanicus*)	A B	A B	A B	A B
Atlantic Wolffish (*Anarhichas lupus*)	A B	A B	A B	A B
Bluefin Tuna (*Thunnus thynnus*)				A
Bluefish (*Pomatomus saltatrix*)			A B	A B
Haddock (*Melanogrammus aeglefinus*)			A B C	
Little Skate (*Leucoraja erinacea*)			A B	A B
Monkfish (*Lophius americanus*)	A B		A B C	A B C
Ocean Pout (*Zoarces americanus*)	A B		A B	A B
Pollock (*Pollachius virens*)			A B	
Red Hake (*Urophycis chuss*)	A B	A B	A B	A B
Silver Hake (*Merluccius bilinearis*)	A B	A B		A B
Smooth Skate (*Malacoraja senta*)			A B	
Thorny Skate (*Amblyraja radiata*)			A B	
White Hake (*Urophycis tenuis*)		A	A B	A B
Windowpane Flounder (*Scophthalmus aquosus*)	A B	A B	A B	A B
Winter Flounder (*Pseudopleuronectes americanus*)	A B	A B	A B	A B
Winter Skate (*Leucoraja ocellata*)			A B	
Yellowtail Flounder (*Limanda ferruginea*)	A B	A B	A B	A B

A = Casco Bay
B = The mouth of Royal River to 3.7 miles upstream
C = River mile 3.7 to river mile 6.3 river miles

The segment of the Royal River from the mouth of the river to the rail crossing has also been included as part of the proposed EFH designation for Atlantic Salmon. 30 river systems in the New England Region are designated Atlantic Salmon EFH. This area includes rivers, bays and estuaries that have a direct connection to the ocean and exhibit the environmental conditions for freshwater spawning and rearing habitats for the species (NMFS, 2017).

2.4.2 Wildlife

The MDIF&W collects and provides information on the wildlife found in the state. Maine contains significant amounts of rural, forested lands, which support a wide variety of animal species. The state includes three ecological regions: Warm Continental Mountains, Warm Continental Division and the Hot Continental Division. It is also located close to the Subarctic Division this is found in Canada. This diversity in ecological regions allows the state to support a wide variety of wildlife species. 58 species of mammals, excluding marine mammals and domesticated species, are found in Maine. The most well know species include American black bear (*Ursus americanus*), moose (*Alces alces*), Canada lynx (*Lynx canadensis*) and white-tailed deer (*Odocoileus virginianus*). Furbearing mammal species found in Maine include American beaver (*Castor canadensis*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), raccoons (*Procyon lotor*), and Virginia opossum (*Didelphis virginiana*). While small mammal species found in the state include eastern chipmunk (*Tamias striatus*), eastern gray squirrel (*Sciurus carolinensis*), New England cottontail rabbits (*Sylvilagus transitionalis*), woodchuck (*Marmota monax*) and North American porcupine (*Erethizon dorsatum*). Maine also has 292 bird species, seven turtles, nine snakes and 18 amphibian species, which include nine frogs and toads, eight native salamanders and one exotic salamander (MDIF&W, 2024).

There are over 16,000 invertebrate species, including both terrestrial and freshwater organisms. These include butterflies, mayflies, snails, and spiders. Freshwater mussels are one of the most studied invertebrate groups, due to the loss of habitat and dramatic decline in populations. Of the 300 species found in the United States, "more than a third have already vanished or are in danger of extinction and over 75% are listed as Endangered, Threatened, or Special Concern on the state level." There are ten native freshwater mussel species found in Maine. Three (Yellow Lampmussel (*Lampsilis cariosa)*, Tidewater Mucket (*Atlanticoncha ochracea)* and the Brook Floater (*Alasmidonta varicosa*) are listed as state threatened, while the Creeper (*Strophitus undulatus*) is a species of state concern (MDIF&W, 2024).

A review using the USFWS's Information for Planning and Consultation (IPaC) system indicates there are no federally identified critical habitats or habitats of concern located in the project area for wildlife, birds, or herptiles (USFWS, 2024c). Migratory birds identified by the USFWS that may potentially occur within the project area are listed in **Table 4**. Birds of Conservation Concern (BCC) are migratory and non-migratory bird species that represent the USFWS's highest conservation priorities (USFWS, 2022). The probability of these species' presence is not high for the project area; however, surveys of birds within the study area have not been completed (USFWS, 2022).

Table 4: Migratory Birds Found in the Study Area

Common Name	Scientific Name	Breeding Season
Bald Eagle	*Haliaeetus leucocephalus*	December 1 to August 31
Black Guillemot	*Cepphus grylle*	May 15 to September 10
Black Scoter	*Melanitta nigra*	Breeds Elsewhere
Black-Billed Cuckoo*	*Coccyzus erythropthalmus*	May 15 to October 10
Black-legged Kittiwake	*Rissa tridactyla*	Breeds Elsewhere
Bobolink*	*Dolichonyx oryzivorus*	May 20 to July 31
Canada Warbler*	*Cardellina canadensis*	March 15 to August 25
Cape May Warbler	*Setophaga tigrina*	June 1 to July 31
Chimney Swift*	*Chaetura pelagica*	March 15 to August 25
Common Eider	*Somateria mollissima*	June 1 to September 30
Common Loon	*Gavia immer*	April 15 to October 31
Eastern Whip-poor-will	*Antrostomus vociferus*	May 1 to August 20
Evening Grosbeak	*Coccothraustes vespertinus*	May 15 to August 10
Hudsonian Godwit	*Limosa haemastica*	Breeds Elsewhere
Lesser Yellowlegs	*Tringa flavipes*	Breeds Elsewhere
Long-tailed Duck	*Clangula hyemalis*	Breeds Elsewhere
Olive-sided Flycatcher	*Contopus cooperi*	May 20 to August 31
Prairie Warbler*	*Dendroica discolor*	May 1 to July 31
Purple Sandpiper	*Calidris maritima*	Breeds Elsewhere
Razorbill	*Alca torda*	June 15 to September 10
Red-breasted Merganser	*Mergus serrator*	Breeds Elsewhere
Red-throated Loon	*Gavia stellata*	Breeds Elsewhere
Ring-billed Gull	*Larus delawarensis*	Breeds Elsewhere
Surf Scoter	*Melanitta perspicillata*	Breeds Elsewhere
Thick-billed Murre	*Uria lomvia*	April 15 to August 15
White-winged Scoter	*Melanitta fusca*	Breeds Elsewhere
Willet	*Tringa semipalmata*	April 20 to August 5
Wood Thrush*	*Hylocichla mustelina*	May 10 and August 31

*Indicates BCC status.

Bald Eagles are protected under the Bald Eagle Golden Eagle Protection Act. In 2018, the MDIF&W conducted a statewide survey of the inventory of nesting bald eagles. The survey found 834 intact bald eagle nests and 734 nesting pairs. Eagle populations in all 16 Maine counties had increased. In Cumberland County, 26 nesting pairs were identified, which was a 23.8% increase since the last survey completed in 2013. Bald Eagle nesting sites in Maine are shown in **Figure 17**.

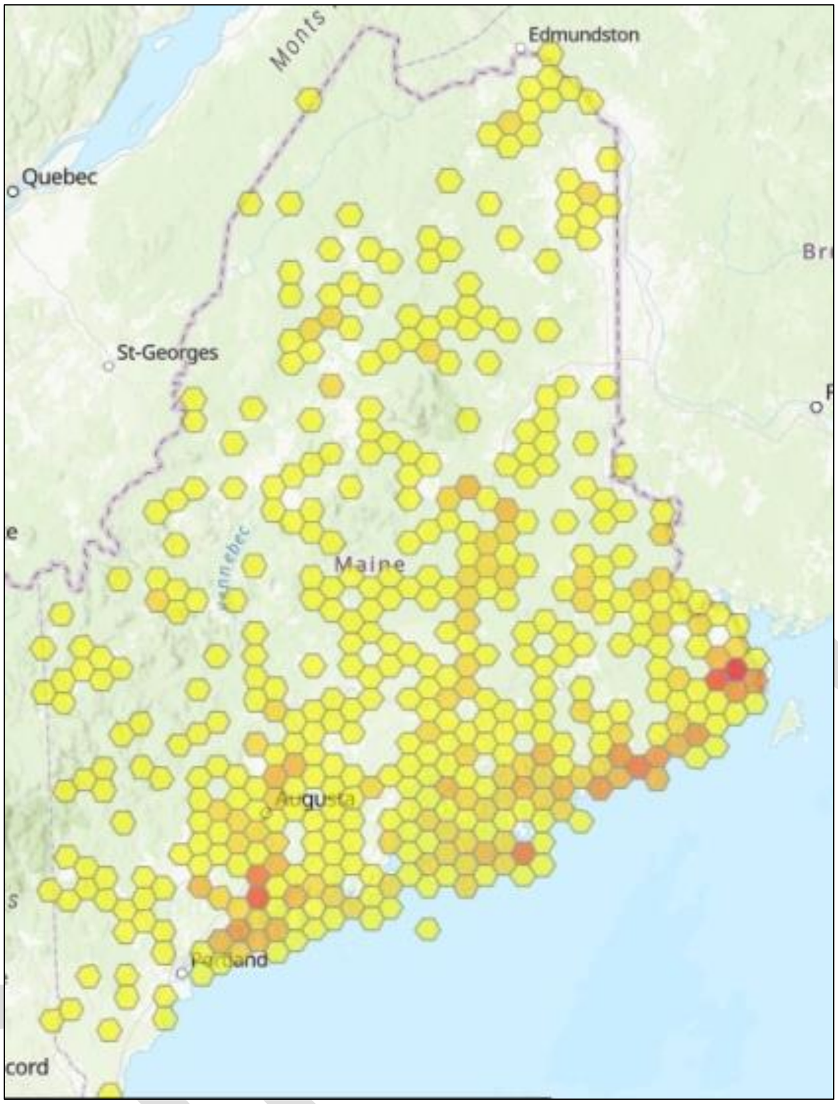

Figure 17: Bald Eagle Nesting Sites in Maine

2.4.3 Threatened and Endangered Species

The USFWS identified the northern long-eared bat (NLEB) (*Myotis septentrionalis*), which is currently listed as endangered under the Endangered Species Act (ESA), as potentially present in the proposed project area (**Figure 18**) (USFWS, 2024c). The NLEB is found across much of the eastern and north central United States and all Canadian provinces from the Atlantic coast west to the southern Northwest Territories and eastern British Columbia. NLEB populations have declined in the Northeast due to white-nose syndrome, a fungal disease known to affect bats. Population levels have declined by up to 99 percent from pre-white-nose syndrome levels at many hibernation sites (USFWS, 2015).

During summer months, NLEBs roost singly or in colonies underneath bark, in cavities, or in crevices of both live and dead trees. Males and non-reproductive females may also roost in cooler places, like caves and mines. NLEBs emerge at dusk to fly through the understory of forested hillsides and ridges feeding on moths, flies, leafhoppers, caddisflies, and beetles, which they catch while in flight using echolocation. Breeding begins in late summer or early fall when males begin swarming near hibernacula. Most females within a maternity colony give birth around the same time, which may occur from late May or early June to late July, depending on where the colony is located within the species' range (USFWS, 2015).

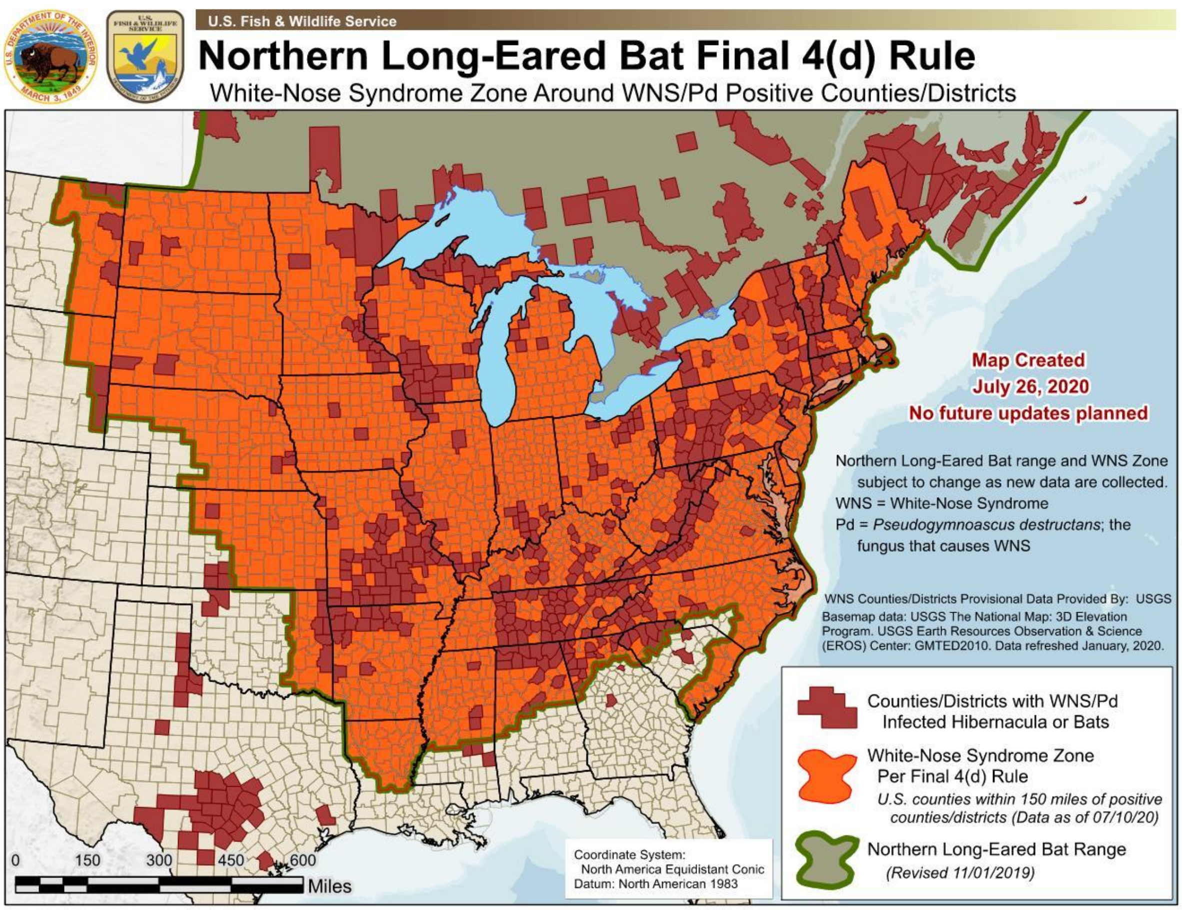

Figure 18: Northern Long-Eared Bat White-Nose Syndrome Infected Hibernacula Map (USFWS, 2020)

The proposed federally endangered tri-color bat (*Perimyotis subflavus*) was also identified as potentially present within the project area (USFWS, 2024). Tri-color bats were once a common species present in most of the eastern and central U.S. During active months these bats roost among clusters of leaves on deciduous trees. Much like the previously mentioned NLEB, tri-color bats hibernate in caves during the winter months and have suffered a great reduction in their abundance due to white-nose syndrome (USFWS, 2024b).

The USFWS also identified roseate tern (*Sterna dougallii dougallii*), which is currently listed as endangered under the ESA, as potentially present in the proposed project area (USFWS, 2024a). Roseate terns can be found worldwide but are divided into two geographically distinct subspecies. The northern population, which may be present in the project area, has extremely limited numbers of breeding colonies. About 90% of the members of this subspecies are restricted to three breeding colonies in Long Island Sound and Buzzard's Bay Massachusetts (USFWS, 2024a). This decline is attributed to the combined negative impacts from sea level rise, predation, and human development.

There are currently 26 inland fish and wildlife species listed as Endangered and 31 listed as Threatened under Maine's Endangered Species Act, some of which are also listed under the U.S. ESA. Species potentially present in the project area can be found in **Table 5.**

Table 5: State Listed Threatened and Endangered Species Potentially Present in the Study Area.

State Listed Endangered		State Listed Threatened	
Bird			
Black-crowned Night Heron	*Nycticorax nycticorax*	Arctic Tern	*Sterna paradisaea*
Grasshopper Sparrow	*Ammodramus savannarum*	Atlantic Puffin	*Fratercula arctica*
Least Bittern	*Ixobrychus exilis*	Bank Swallow	*Riparia riparia*
Least Tern	*Sterna antillarum*	Blackpoll Warbler	*Setophaga striata*
Peregrine Falcon*	*Falco peregrinus*	Cliff Swallow	*Petrochelidon pyrrhonota*
Piping Plover	*Charadrius melodus*	Common Gallinule	*Gallinula chloropus*
Roseate Tern	*Sterna dougallii*	Great Cormorant*	*Phalacrocorax carbo*
Saltmarsh Sparrow	*Ammodramus caudacutus*	Harlequin Duck	*Histrionicus histrionicus*
Sedge Wren	*Cistothorus platensis*	Razorbill	*Alca torda*
-----	-----	Short-eared Owl*	*Asio flammeus*
-----	-----	Upland Sandpiper	*Bartramia longicauda*
Fish			
Redfin Pickerel	*Esox americanus americanus*	Swamp Darter	*Etheostoma fusiforme*
Invertebrates			
Cobblestone Tiger Beetle	*Cicindela marginipennis*	Salt Marsh Tiger Beetle	*Ellipsoptera marginata*
Ashton's Cuckoo Bumble Bee	*Bombus ashtoni*	Twilight Moth	*Lycia rachelae*
Hessel's Hairstreak	*Callophrys hesseli*	-----	-----
Mammals			

State Listed Endangered		State Listed Threatened	
Little Brown Bat	*Myotis lucifugus*	Eastern Small-footed Bat	*Myotis leibii*
New England Cottontail	*Sylvilagus transitionalis*	Tri-colored Bat	*Perimyotis subflavus*
Northern Long-eared Bat	*Myotis septentrionalis*	-----	-----
Reptiles			
Black Racer	*Coluber constrictor*	Spotted Turtle	*Clemmys guttata*

2.4.4 Vegetation and Wetlands

Land cover over the Royal River Watershed is largely dominated by second growth mixed forest and farmland. The riverbanks bordering the Royal River generally have a natural vegetation buffer, except in the locations of the Bridge Street and East Elm Street Dams. Areas surrounding the East Elm Street Dam and downstream of the dam on right descending bank are highly developed; mostly consisting of a large town-managed park. In the areas near the dams, vegetation and riparian buffers are minimal and include maintained lawns, ornamental gardens, and sporadic tree cover. In less developed areas, including the East Elm Street Dam impoundment and the left descending bank from the East Elm Steet Dam to the head of tide, there is a continuous riparian buffer. Although this corridor is undisturbed, it varies in width within the study area. Trees found in the riparian zone is mostly comprised of common hardwood and softwood species like red maple (*Acer rubrum*), birch species (*Betula sp*.), white oak (*Quercus alba*), black oak (*Quercus velutina*), American beech (*Fagus grandifolia*), Eastern white pine (*Pinus strobus*), green alder (*Alnus alobetula*), green ash (*Fraxinus pennsylvanica*), and Eastern hemlock (*Tsuga canadensis*). The shrub layer includes raspberry (*Rubus indaeus*), staghorn sumac (*Rhus typhina*), green alder, saplings, and sensitive fern (*Onoclea sensibilis)*, and northern lady fern (*Athyrium angustum*). The riparian buffer[2] is composed of emergent vegetation like pickerel weed (*Pontederia cordata*) and broadleaf arrowhead (*Sagittaria latifolia*) before abruptly transitioning to an upland environment occupied by mature trees like red maple, hemlock, and white oak.

Several invasive species have colonies along the banks of the Royal River. Japanese knotweed (*Polygonum cuspidatum*), oriental bittersweet (*Celastrus orbiculatus*), multiflora rose (*Rosa multiflora*), common buckthorn (*Rhamnus cathartica*), Japanese barberry (*Berberis thunbergii*) and Morrow's honeysuckle (*Lonicera morrowii*) can be found in the riparian buffers and wetlands.

According to the USFWS's National Wetlands Inventory (NWI) mapping, wetlands are located within the study area. **Figure 19** illustrates the wetlands located within the entire study area, from the head of tide to the upstream limit of the East Elm Street Dam Impoundment. While **Figure 20** focuses entirely on the East Elm Street Dam Impoundment. There are sporadic freshwater forested/shrub wetlands found along the Royal River within the study area, instead of a continuous wetland corridor. There is only

[2] Area adjacent to a river.

one area of emergent freshwater wetlands, found upstream of the Bridge Street Dam, within the study area.

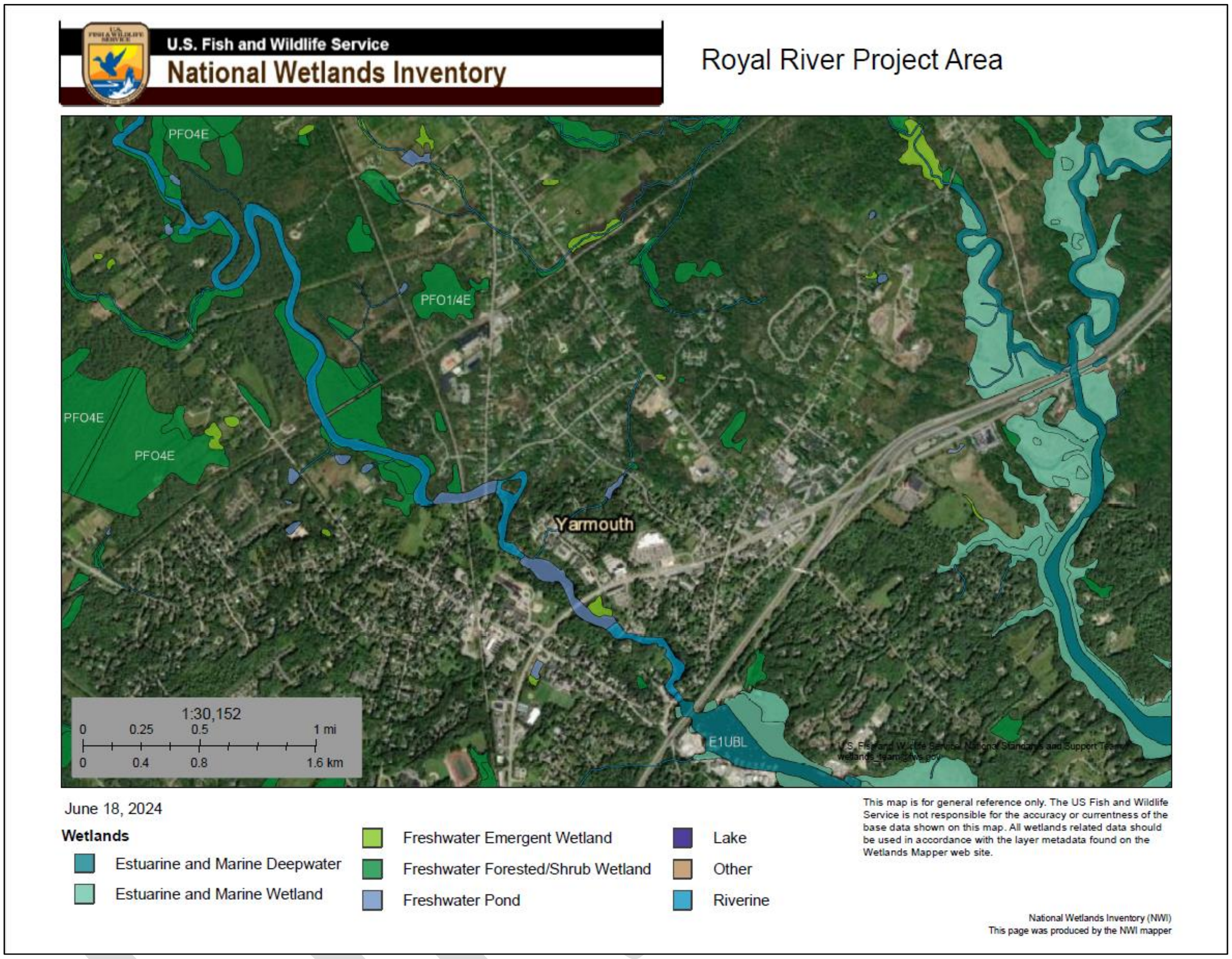

Figure 19: NWI Mapped Wetlands Located Within the Study Area.

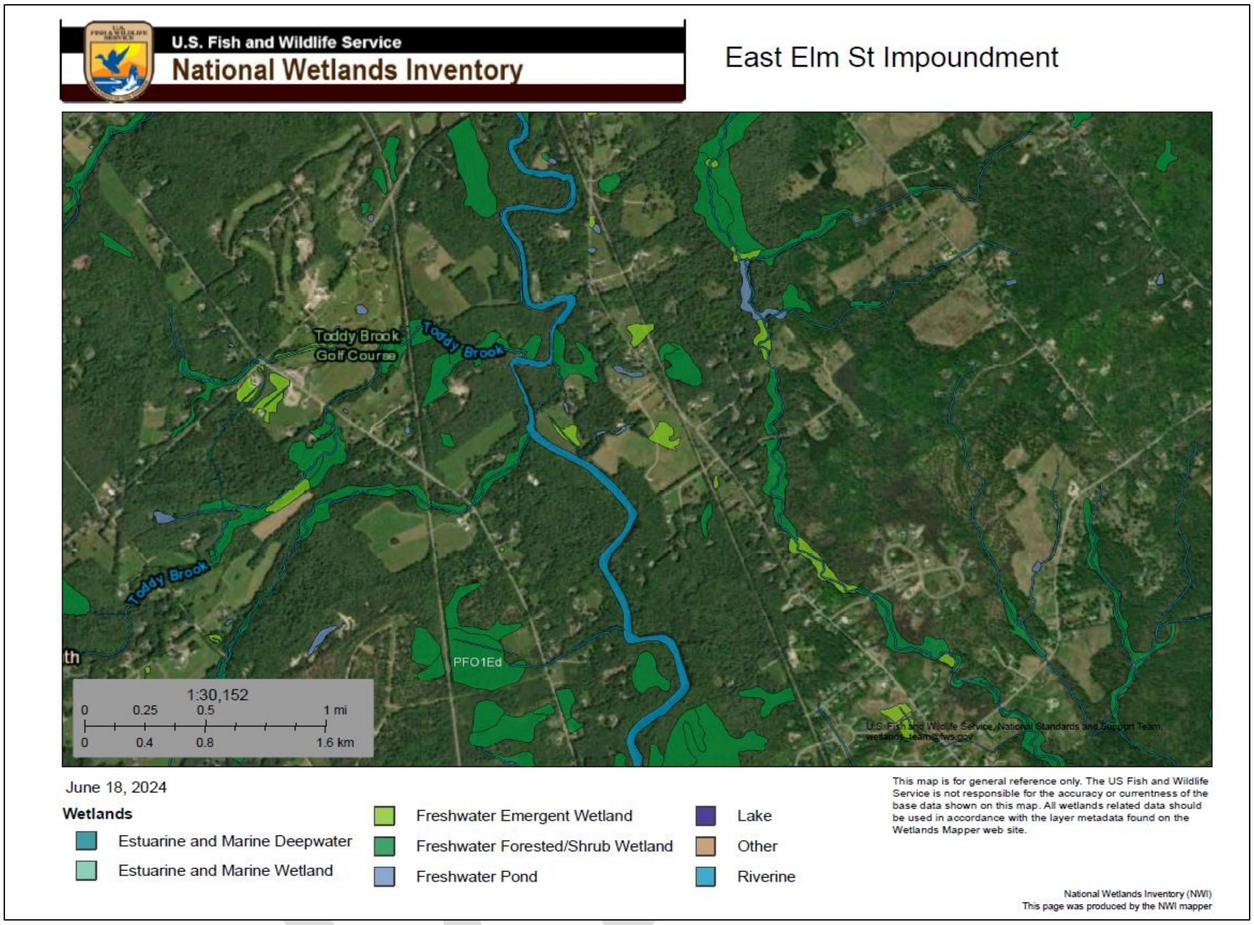

Figure 20: NWI Mapped Wetlands Located Within the East Elm Street Dam Impoundment

In July 2024, USACE completed a vegetation survey of the wetland located immediately upstream of the Bridge Street Dam on the left descending bank. This area is approximately 2.9-acre in size. **Table 6** provides a list of the 36 identified species present in the wetland.

Table 6: Plant Species Observed in Wetland Upstream of the Bridge Street Dam

Common Name	Scientific Name	Wetland Indicator Status
American bur-reed	*Sparganium americanum*	OBL
Bayonet Rush	*Juncus militaris*	OBL
Black willow	*Salix nigra*	OBL
Broadleaf arrowhead	*Sagittaria latifolia*	OBL
Broadleaf cattail	*Typha latifolia*	OBL
Common buckthorn*	*Rhamnus cathartica*	FAC
Common horsetail	*Equisetum arvense*	FAC
Common waterweed	*Elodia canadensis*	OBL

Common Name	Scientific Name	Wetland Indicator Status
Creeping yellow loosetrife	*Lysimachia nummularia*	FACW
Curled pondweed	*Potomogeton crispus*	OBL
Eelgrass	*Valisinaria americana*	OBL
Flowering raspberry	*Rubus odoratus*	N/A
Fringed Sedge	*Carex crinata*	O
Green alder	*Alnus viridis*	FAC
Green ash	*Fraxinus pennsylvanica*	FACW
Japanese barberry*	*Berberis thunbergii*	FACU
Jewelweed	*Impatiens capensis*	FACW
Marsh marigold	*Caltha palustris*	OBL
Morrow's honeysuckle*	*Lonicera morrowii*	FACU
Multiflora rose*	*Rosa multiflora*	FACU
Narrow-leaf cattail	*Typha latifolia*	OBL
Canada goldenrod	*Solidago altissima*	FACU
Multiflora rose*	*Rosa multiflora*	FACU
Oriental bittersweet*	*Celastrus orbiculatus*	FACU
Queen Anne's lace	*Daucus carota*	UPL
Red maple	*Acer rubrum*	FAC
Red Osier Dogwood	*Cornus sericea*	FACW
Riverbank grape	*Vitis riparia*	FAC
Royal fern	*Osmunda spectabilis*	OBL
Sallow sedge	*Carex lurida*	OBL
Sensitive fern	*Onoclea sensibilis*	FACW
Soft-stemmed bulrush	*Schoenoplectus tabernaemontani*	OBL
Spotted Joe Pye Weed	*Eutrochium maculatum*	OBL
Swamp milkweed	*Asclepias incarnata*	OBL
Sweet fern	*Comptonia peregrina*	N/A
Switchgrass	*Panicum virgatum*	FAC
White willow	*Salix alba*	FACW

*Indicates invasive species

WETLAND PLANT INDICATORS

Obligate (OBL) – Occurs almost always (>99%) under natural conditions in wetlands.

Facultative Wetland (FACW) – Usually occurs in wetlands (67 – 99%), but occasionally found in non-wetlands.

Facultative (FAC) – Equally likely to occur in wetlands or non-wetlands (34% - 66%)

Facultative Upland (FACU) – Usually occurs in non-wetlands (67 - 99%), but occasionally found in wetlands (1 – 33%)

Upland (UPL) – Occurs almost always (>99%) under natural conditions in non-wetlands.

The wetland is relatively flat and transitions from a 10-20 ft wide area of emergent pants such as narrow-leaf cattail (*Typha angustifolia)* and broadleaf arrowhead (*Sagittaria latifolia)* at the river edge to a diverse riparian wetland displaying more facultative upland and upland plants as the elevation gradually increases. The section of the wetland closest to Bridge Street Dam is slightly higher in elevation displaying dryer soils and was primarily inhabited by Canada goldenrod (*Solidago altissima*) and multiflora rose. The elevation gradient changes approximately 50 ft from the northeastern border to become very steep and characterized by facultative upland and upland plants. Several animals were identified as utilizing the wetland through direct observation and observation of signs of occupation such as white-tailed deer, North American beaver, American robin (*Turdus migratorius*), ruby-throated hummingbird (*Archilochus colubris*), song sparrow (*Melospiza melodia*), American bullfrog (*Lithobates catesbeianus*), and Northern raccoon.

2.5 NOISE

Noise is defined as unwanted or disturbing sound. Sound becomes unwanted when it either interferes with normal activities such as sleeping or conversation or disrupts or diminishes one's quality of life. The effects of noise are determined mainly by the duration and level of the noise, but they are also influenced by the frequency. Long-lasting, high-level sounds are the most damaging to hearing and generally the most annoying. High-frequency sounds tend to be more hazardous to hearing and more annoying than low-frequency sounds. The way sounds are distributed in time is also important, in that intermittent sounds are typically less damaging to hearing than continuous sounds, because of the ear's ability to regenerate during the intervening quiet periods.

The typical noise environment in the project area consists of noise from vehicles traversing the bridges, and typical noise associated with a riverine environment (i.e., wildlife, water movement, and air movement).

2.6 HAZARDOUS, RADIOACTIVE, & TOXIC WASTE (HTRW)

Hazardous materials include hazardous and toxic substances (biological, chemical, and/or physical) and waste, and any materials that pose a potential hazard to human health and the environment due to their quantity, concentration, or physical and chemical properties. Hazardous waste is characterized by its ignitability, corrosivity, reactivity, and toxicity. Hazardous materials and wastes, if not controlled, may either (1) cause or significantly contribute to an increase in mortality, serious irreversible illness, or incapacitating reversible illness, or (2) pose a substantial threat to human health or the environment. The primary relevant federal regulations for hazardous material and waste include those promulgated under the Resource Conservation and Recovery Act (RCRA) of 1974 and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 (commonly known as Superfund), which are administered by the USEPA.

The assessment of hazardous materials and wastes located in and around the study area was completed. This assessment focused on information gathered from USEPA and state databases, including the following:

- Superfund Enterprise Management System. This database lists hazardous waste sites under the Superfund Program, a federal program to clean up the most hazardous sites throughout the U.S (current as of August 2024). Sites include abandoned warehouses, manufacturing facilities, processing plants, and landfills.

- RCRA Information. This is a national program management and inventory system about hazardous waste handlers.

- Toxics Release Inventory (TRI). This is an information system about toxic chemicals that are being used, manufactured, treated, transported, or released into the environment (current as of 2022).

- Solid Waste Facilities. List of solid waste facilities in Maine, sorted by county.

CERCLA/Superfund Sites

The National Priorities List (NPL) includes those sites in the Superfund program that are listed as a national priority among the hazardous waste sites and receive funding from the Trust Fund for remedial action. Currently, the USEPA includes 11 active sites in Maine, two are located in Cumberland County on the NPL. None are located in Yarmouth or are in the vicinity of the project site.

There are also five NPL sites that have been deleted from the list. One of these sites is located in Cumberland County. This site is the McKin Superfund site located in Grey, ME. It is a 7-acre site that originally opened in 1965 for the disposal of liquid wastes. In 1972, the facility was expanded to accommodate waste generated when an industrial fuel tanker ran aground spilling 100,000 gallons of fuel. In 1973, residents reported odors in well water and the USEPA confirmed contaminated groundwater from this site was the source. Cleanup of the superfund site began in the 1980s. The USEPA implemented final remedial action and the site was delisted in 2022.

No other significant source of HRTW is present on the Royal River.

RCRA Sites

Facilities that generate, transport, treat, store, or dispose of hazardous waste are required to report their activities under the RCRA. There are 16 RCRA sites located in Yarmouth and 2 sites in North Yarmouth.

Toxics Release Inventory (TRI)

31 facilities in Cumberland County have had toxic releases reported to the TRI in the last 10 years. Five of these facilities are located in Yarmouth.

Solid Waste Facilities

There are two solid waste facilities located in Yarmouth, ME. These include a landfill and a recycling transfer facility. These two facilities are located approximately 1.5 miles from the closest point on the Royal River.

Brownfield Sites

Brownfield is a term used to describe land formerly used for industrial or commercial purposes. Expansion, redevelopment or reuse of these properties may be complicated by the presence of potential hazardous substances, pollutants, or contaminants, but do not rise to the level of a Superfund site. The USEPA runs a program to clean up these sites for reinvestment. There is one Brownfield site located in the vicinity of the project site.

2.7 SOCIOECONOMIC

EO 12898 "*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"* requires federal agencies to examine proposed actions to determine whether they will have disproportionately high and adverse human health or environmental effects on minority or low-income populations. Royal River is largely bounded by residential areas in the vicinity of both Bridge Street and East Elm Street Dams. Residential neighborhoods to the East of Royal River are in the 73rd percentile for the National Low-Income standard, but there is no specific low-income housing within the bounds of the project area.

Table 7 provides a summary of the socioeconomic composition of the town of Yarmouth. According to U.S. Census 2020 data, the town of Yarmouth had an estimated population of 6,125 and roughly 82% of the population was over 18 years of age. Most of the population was white (95.6%), 1.4% were black or African American, 2% were Asian, and about 4.4% identified as two or more races. The percentage of individuals living below the poverty level was 16.5% which was higher than the national average (11.6%) for 2021. The median household income for Yarmouth was $136,605 that year (U.S. Census Bureau, 2022). The town of Yarmouth is not identified as being disadvantaged by the CEQ Climate and Economic Justice Screening Tool.

Table 7: Socioeconomic Composition of Yarmouth, ME.

Demographic	Yarmouth, ME
Total Population	6,125
Percent Male	45.1%
Percent Female	54.9%
Percent Under 5 Years Old	4.5%
Percent Over 65 Years Old	14.5%
Percent White	95.6%
Percent Black or African American	1.4%
Percent American Indian, Alaska Native	0.3%
Percent Asian	2.0%
Percent Some Other Race	0.8%
Percent Reporting 2 or more races	4.4%
Percent Hispanic or Latino	2.3%
Percent of Individuals Below Poverty	16.5%
Median Household Income	$136,605

EO 13045 "*Protection of Children from Environmental Health Risks and Safety Risks*" seeks to protect children from disproportionately incurring environmental health risks or safety risks that might arise as a result of Army Policies, programs, activities, and standards. Environmental health risks and safety risks include risks to health and safety attributable to products or substances that a child is likely to come into contact with or ingest.

Currently, the areas around the East Elm Street and Bridge Street Dams and their associated fish ladders do not have any safety features, such as fencing, gates or signage, to keep the public away from the structures. Low head dams are particularly known for the safety risk to people boating and swimming in their vicinity. The right descending bank of the East Elm Street Dam and the left descending bank of the Bridge Street Dam consists of public parks. Although, there has not been a recorded incident of injury due to the dams or fish ladders, the areas present safety risks to children who frequent the recreational areas.

2.8 TRANSPORTATION AND INFRASTRUCTURE

The river is too narrow and shallow within the study area for commercial use, such as the transportation of goods, and is instead utilized primarily by recreational boaters in small personal, non-motorized watercraft. Boat launches in the study are located upstream of the East Elm Street Dam behind the Yarmouth Historical Society. The Royal River estuary, downstream from the project area, contains a Federal Navigation Channel, managed by USACE, the Yarmouth Boat Landing and privately owned marinas. This area is also mostly navigated by recreational boaters. However, vessels using the area are both motorized and non-motorized.

Nine bridges traverse the Royal River in the vicinity of the project. They range from Interstate 295 downstream of lower falls in the estuary up to Route 9 near Dunns. Of the bridges available in the Maine Department of Transportation (DOT) database, all were constructed with foundations on bedrock, which will not be impacted by the removal of the dams. The Beth Condon Foot bridge was not noted in the database, but it is constructed on existing abutments that likely also penetrate to bedrock.

Of the nine crossings, there are also two railroad bridges. One is owned by the St. Lawrence and Atlantic Railroad and appears abandoned. The other carries Amtrak and remains an active service rail line at high conventional speeds. The rail bridges are also presumed to penetrate to bedrock given the very small tolerances to settlement or vibration necessary for railroad structures. Since all bridges are situated on bedrock their foundations will not be altered by removal of the dams.

Near the upstream limits of the Elm Street Dam impoundment in North Yarmouth, Baston Park and the Memorial Highway (Route 9) bridge effectively represent the upstream study limits (**Figure 21**). the Route 9 bridge infrastructure includes a dry hydrant for rural fire fighting. The dry hydrant allows fire crews to draw water directly from Royal River, which could potentially be sensitive to changes in water levels.

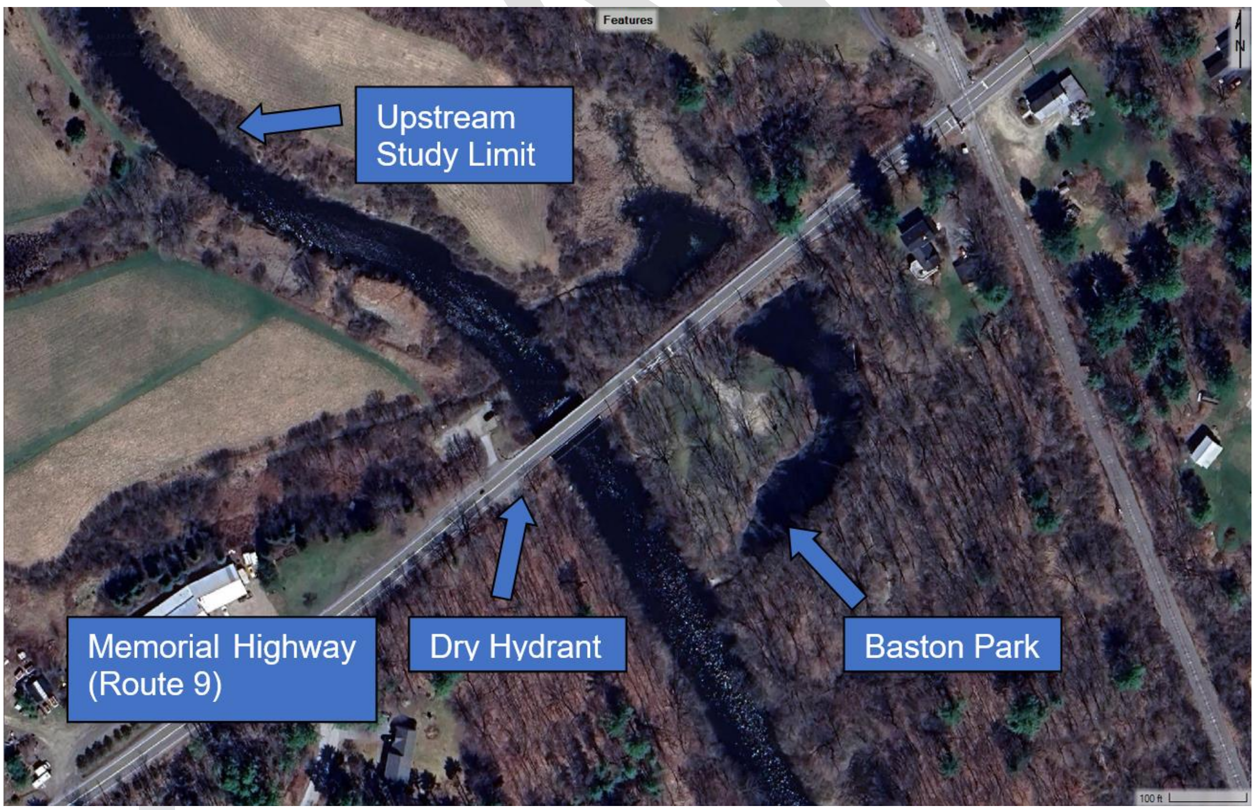

Figure 21: The Upstream Limit of the Aquatic Restoration Study at Baston Park and Memorial Highway (Route 9)

2.9 HEALTH AND SAFETY

The East Elm Street and Bridge Street Dams pose a risk to public safety. These sites are surrounded by parklands, which are heavily utilized by the community, including children. There are no gates or fences in place to keep people from climbing onto the dams and fish ladder structures or signage to warn of the danger. In previous dam inspections reports of the East Elm Street Dam (Petrovsky, 2019; Powers, 2009), the inspectors recommended the installation of safety features. In the 2009 Inspection Report, HDR Engineering, Inc. recommended that “the services of a qualified security and safety expert be retained immediately to be sure that the public is properly protected from the hazards of the dam and bypass” and that “the Town install temporary barriers and signage immediately around the East Elm Street Dam”.

Additionally, the dams are deteriorating with age and pose a potential safety concern for persons recreating on the river. With continued lack of O&M and repair spending, the condition of the dams will continue to deteriorate. There is potential in the future for the dams to fail with a large storm event and cause large granite blocks to fall downriver and release the water held in the impoundment at an unexpected time.

2.10 FUTURE WITHOUT PROJECT CONDITIONS

The future without project condition is the most likely condition expected to exist in the future in absence of a proposed ecosystem restoration project. The future without project condition provides the basis from which alternative plans are formulated; from which all benefits are measured; and against which all effects are assessed. These effects were estimated over a 50-year period of analysis from 2028-2078.

Future without project conditions are forecasted to include no alterations to the reach of the Royal River that runs through Yarmouth, ME, from the Bridge Street Dam to Baston Park, and are based on the continuing existing aquatic ecosystem conditions.

Habitat conditions immediately upstream of each dam will remain as lentic, or lake-like, impoundments. This condition interrupts the natural flow of the river by slowing the water velocity.

Fish passage will remain almost completely blocked and will continue to segregate existing populations to their current reaches of the Royal River. Spawning runs will remain impossible for alewives and other migratory species. The existing fish ladders have been made operable due to the funding and efforts of a local volunteer group. Although the group plans to continue their efforts, future funding is not guaranteed. If the volunteer group continues their work on the fish ladders, some fish will be able to move upstream. However, the number of fish recorded to successful utilize the fish ladder are in the tens of individuals.

As the dams continue to age, they will require funding to support O&M activities and small repairs. Eventually, the dams will need to be replaced completely. In the past, the town of Yarmouth has not been able to support these costs. If O&M and repair actions are not taken, the condition of the dams are expected to deteriorate.

Finally, each dam and fish ladder would continue to pose a public safety risk because there are no fences in place to keep the public from accessing the dams or the fish ladders. Also, there is no warning signage to warn the public of the danger.

3.0 PLAN FORMULATION

Plan formulation is the iterative process resulting in the development, evaluation, and comparison of alternative plans to address the identified study problems. To facilitate the plan formulation process, the methodology outlined in the Corps' Engineering Regulation 1105-2-103 "*Planning Policy for Conducting Civil Works Planning Studies*" and Engineering Pamphlet 1105-2-58 *"Continuing Authorities Program*". The steps in this methodology are summarized below:

1. Identify the study problems, opportunities, objectives, and constraints that relate to the primary project purpose.

2. Formulate management measures to achieve planning objectives and avoid planning constraints, where measures are the building blocks of alternative plans.

3. Formulate, evaluate, and compare an array of alternative plans to achieve the primary National Ecosystem Restoration (NER) purpose and identify cost effective plans. This is achieved by evaluating the alternatives through each discipline on the Project Delivery Team (PDT) for their engineering feasibility and effects, as well as through the metrics of an alternatives' completeness, effectiveness, efficiency, and acceptability.

4. Perform an effects assessment following CEQ and NEPA guidelines to identify and disclose potential impacts to environmental and cultural resources. (Detailed in **Section 4.0**)

5. Identify and analyze benefits in total and equally across a full array of benefit categories including NER, Regional Economic Development (RED). Environmental Quality (EQ), and Other Social Effects (OSE).

6. Identify the NER plan, which is synonymous with the TSP or preferred plan.

3.1 PROBLEMS AND OPPORTUNITIES

Step 1 in the plan formulation process, outlined above, is to identify the study problems, opportunities, objectives, and constraints that relate to the primary project purpose. This is the creation of a plan for aquatic ecosystem restoration opportunities on the Royal River.

3.1.1 Problems

Impediments to fish passage are present in the Royal River. These impediments include two dams that occur within the lower reach of the Royal River, the Bridge Street Dam and East Elm Street Dam, which restrict the upriver migration of migratory fish species. Denil-like fish ladders were originally installed adjacent to each dam in the 1970s to support the commercial alewife and blueback herring (*Alosa aestivalis*) fisheries. The existing fish passage structures (*e.g*., ladders) do not efficiently pass fish upriver towards the headwaters of the Royal River. In addition to the man-made structures, the Middle Falls area is a naturally occurring impediment to fish passage.

The Royal River ecosystem is sub-divided into four segments. These segments exist because the two low-head dams and Middle Falls interrupt the natural flow of the river. Prior to 19th Century human activity, unobstructed fish passage was possible over 32 miles of the main stem of the Royal River, that stretched from the headwaters of the river at Sabbathday Lake to the river's confluence with Casco Bay. Many additional miles of riverine habitat were provided by tributaries that run into the main stem. As the area surrounding the river developed and the dams were built, the population and diversity of the river species were negatively impacted. Reaches of habitat became confined to river segments that are defined by the dams.

While the dams were originally constructed to support commercial businesses, they are no longer needed for industry. The final commercial use of the Bridge Steet Dam ended in 2019 when the Sparhawk Mill Hydropower plan was decommissioned by FERC.

Additionally, given the age of these structures and lack of repairs and upkeep, the condition of the dams has deteriorated, and they pose a wash out risk under high-flow flood scenarios.

Specific problems relating to the primary project purpose are:

- The current dam and fish ladder configurations limit the upriver migration of migratory fish.
- The current configuration of Middle Falls partially or completely blocks fish passage.
- The existing dams cause ecological impairment including:
    - Loss of riverine and riparian continuity
    - Conversion of riverine to lacustrine habitat
    - Loss of associated resources, and
- Continued O&M and repair requirements in addition to eventual replacement costs for the dams are a financial burden that the town of Yarmouth has had difficulty meeting.

3.1.2 Opportunities

Given the problems identified above, a range of potential opportunities have been identified in the study area that address aquatic ecosystem restoration:

- Facilitate the passage of migratory anadromous and catadromous fish species.
- Increase connectivity within the Royal River
- Restore riverine habitat with natural temperature and flow regimes.
- Enhance the overall productivity of the Royal River ecosystem.
- Restore scenic falls and riffles.
- Increase safety around the dam sites and reduce town liability.
- Reduce O&M, repair and replacement costs associated with the dams.

3.2 PLANNING OBJECTIVES AND CONSTRAINTS

3.2.1 Planning Objectives

Planning objectives are the desired results of the planning process that will solve the identified problems and typically result in the desired changes between the without- and with- project conditions. Planning objectives serve to eliminate from consideration alternatives and considerations that will not solve the identified problem.

The primary objective of this project is to restore the aquatic ecosystem of the Royal River and return it to a healthy, self-sustaining river system. This result would aid the native species that rely on riverine habitats for their existence and reproduction. Other objectives include:

- Improve aquatic passage for all species within the Royal River Watershed over the study period of analysis,
- Restore habitat and reconnect disjointed biomes within the Royal River Watershed over the study period of analysis,
- Reduce the significant risk costs of O&M, repair, and replacement of the dams, and
- Improve public safety within Yarmouth over the study period of analysis.

3.2.2 Planning Constraints

Planning constraints are any policy, technical, environmental, economic, local, regional, social, and institutional factors that act to restrict the planning process. There are no constraints for this study.

3.2.3 Planning Considerations

In addition to constraints, there are also considerations such as, time, money, uncertainty of the future, policy.

Other planning considerations include:

- Surveying near the dams and the Middle Falls area pose a risk to project team safety and team safety must be considered.
- During this feasibility phase, the study area has received high levels of precipitation resulting in consistent high-water levels on the river. As a result, these conditions have restricted the number of opportunities for in-water data collection efforts.
- This concern has been studied extensively since the 1990s and there is significant public interest in the outcome of this study. The PDT must be impartial when studying the Royal River, yet be considerate and respectful to all stakeholders, including the public, local business owners, private property owners and local organizations.
- Avoid causing scour or negatively impact critical infrastructure including bridges and other river crossings.
- Avoid negative impacts to the Federal Navigation Channel and privately owned marina located at the mouth of the Royal River.

3.3 MEASURES TO ACHIEVE PLANNING OBJECTIVES*

The second step in the planning process is to formulate management measures to achieve planning objectives and avoid planning constraints. Measures are features or activities that can be implemented at a specific geographic location to address all or a portion of the identified planning objectives.

There are natural, nature-based, and structural measures being considered for alternative development. The following measures have been frequently used in past restoration projects within the USACE. Measures are building blocks in the formulation process and are mixed and matched to build the alternatives.

3.3.1 Preliminary Structural Measures

The following table lists the measures considered to restore and create hydrogeomorphic setting(s) for native riverine communities at each project location.

Table 8: Restoration Measures Considered

Measure	Bridge Street Dam	East Elm Street Dam	Middle Falls
Dam Modification / Notching	Considered	Considered	N/A
Dam Demolition	Considered	Considered	N/A
Fish Ladder (Repair)	Considered	Considered	N/A
Fish Ladder (New/Replacement)	Considered	Considered	Considered

Measure	Bridge Street Dam	East Elm Street Dam	Middle Falls
Naturalized Fish Bypass Channel	Considered	Considered	Considered
Main Channel Modification	N/A	N/A	Considered
Diversion to Side Channel	N/A	N/A	Considered

3.3.1.1 Dam Modification / Notching

This measure was considered at both dam locations and involved creating a bypass section within the dam, which would allow unobstructed stream flow, benefitting the natural habitat and recreation. This notch could be rectangular or V-shaped. The measure would allow most of the structure to remain in place. The dam foundation would not need to be completely removed. The design of the modification would be required to promote fish passage, maintain the structural integrity of the dam and provide adequate river flow conditions.

3.3.1.2 Dam Demolition

The second measure involves dam removal at the two dam sites. Dam removal would need to consider such factors as mobilization/ demobilization, demolition technique, equipment used, construction site plan, lay down areas, material hauling, access, safety, temporary and/or permanent embankment stabilization techniques, and water control measures.

The extent of demolition will be designed with consideration to construction costs, ecosystem benefits, safety, operations, maintenance, and feasibility. The scope of demolition currently proposed at each dam is described below.

Demolition of the Bridge Street Dam would include demolition of the dam structure on the right-descending bank, fish ladder and spillway. The Bridge Street Dam penstock and associated intake structure are not included in this measure. The design team determined that the demolition of these components would be expensive, complex and would not provide a benefit to fish passage. Additionally, the penstock is located on private property and is not owned by the town of Yarmouth.

The demolition of the East Elm Street Dam measure will include demolition of the dam structure on the right-descending side of the river, including the fish ladder. This dam can be removed with access only from the right-descending bank.

The demolition of the East Elm Street Dam measure does not include demolition of the dam structure on the left-descending side of the river. Demolition of this structure would require additional access and staging from the left-descending bank of the river, adding considerable cost to the measure. This access and work area would be on private property and require additional real estate action. Additionally, the left-descending bank structure cannot be completely removed as it is integrated with the foundation of the adjacent residence. Demolition of this structure would need to be carefully designed and executed to maintain the structural integrity of the home's foundation. Most importantly, our analysis did not show additional fish passage benefit associated with removal of the left-descending bank structure. In fact, by keeping the structure in place, more water is directed to the main channel, improving fish passage in the main channel.

During the design phase, engineers will reevaluate the design scope with additional survey data, technical expert advice and stakeholder input.

3.3.1.3 Fish Ladder (Repair)
The Bridge Street Dam and East Elm Street Dam have existing fish ladders. This measure includes the repair and modification of the existing fish ladders to restore their design function. This measure would improve fish passage and connectivity, but not restore riverine habitat, address safety concerns, or reduce O&M, repair, and replacement costs.

3.3.1.4 Fish Ladder (New/Replacement)
At the Bridge Street and East Elm Street Dam sites, this measure includes the complete removal of the existing fish ladders (**Figures 4** and **10**) and replacement with a modern metal and/or concrete fish ladder structure to pass fish over or around the side of the dam. This measure would improve fish passage and connectivity, but not restore riverine habitat, address safety concerns, or reduce O&M, repair, and replacement costs.

At the Middle Falls site, this measure would include the construction of a new structure. This measure would improve fish passage and connectivity past the Middle Falls area; however, it would not restore riverine habitat, address safety concerns, or reduce O&M, repair, and replacement costs.

3.3.1.5 Naturalized Fish Bypass Channel
This measure was considered at both dam sites. It includes the excavation and disposal of material for creation of a bypass channel around the dam structure **(Figure 23**). This measure would achieve connectivity objectives and improve fish passage.

Figure 22: Example of a By-Pass Channel for Fish Passage

3.3.1.6 Main Channel Modification

Main channel modification was considered at the Middle Falls site. Because the majority of water in the river travels through the main channel, fish passage through the falls was investigated. Rock chipping to channelize the flow into a contiguous running water pathway would be required. These modifications would provide a direct route for fish to swim up the river, channeling low flow conditions to provide adequate depth during dry years and providing a deep-water path through the falls at higher flows. This measure only improves fish passage at Middle Falls. In order to reestablish fish passage throughout the study area, this measure must be paired with other measures at East Elm Street Dam and Bridge Street Dam, such as repair of the fish ladders or removal of the dams.

3.3.1.7 Diversion to Side Channel

This measure was considered at the Middle Falls site and includes the placement of large boulders in the main channel to enhance flows through the side channel, especially for low flow conditions. This modification must be designed to provide adequate volume and velocities through the side channel to produce attractive flows at the downstream confluence. This measure may also include relocation of in-stream obstacles to eliminate vertical barriers to fish passage as part of an adaptive management plan. This measure only improves fish passage at Middle Falls. In order to reestablish fish passage throughout the study area, this measure must be paired with other measures at East Elm Street Dam and Bridge Street Dam, such as repair of the fish ladders or removal of the dams.

3.3.2 Screened Measures

Prior to forming alternatives plans for evaluation (Step 3 in the planning process), each of the above planning measures were sorted based on how well they achieved the project objective and how feasible they were. Only those measures that would completely meet the project objectives and were also determined to be feasible were carried forward into the array of alternatives. All but two measures relating to the Bridge Street and East Elm Street Dams were screened out. At the Middle Falls site, only the diversion to the side channel was carried forward. Even though it does not meet the project objective, the No Action plan was carried forward into the final array as it is a requirement of NEPA. **Table 9** shows the summary of this process. The nine screened out measures are summarized in the following paragraphs.

Table 9: Screening of Measures

Measure	Objectives				Feasible?	Carry Forward
	1	2	3	4		
	Fish Passage	Restore Habitat/ Improve Connectivity	Reduce Future Costs	Improve Safety		
No Action	No	No	No	No	Yes	Yes
Dam Modification/Notching: Bridge St.	Yes	No	No	No	Marginal	No
Dam Modification/Notching: E. Elm St.	Yes	No	No	No	Marginal	No
Dam Demolition: Bridge St.	Yes	Yes	Yes	Yes	Yes	Yes
Dam Demolition: E. Elm St.	Yes	Yes	Yes	Yes	Yes	Yes
Fish Ladder (Repair): Bridge St.	Marginal	Marginal	No	No	Yes	No
Fish Ladder (Repair): E. Elm St.	Marginal	Marginal	No	No	Yes	No
Fish Ladder (Replacement): Bridge St.	Yes	Marginal	No	No	Yes	Yes
Fish Ladder (Replacement): E. Elm St.	Yes	Marginal	No	No	Yes	Yes
Fish Ladder (New): Middle Falls	Yes	No	No	No	Yes	No
Natural Fish Bypass: Bridge St.	Yes	Yes	No	No	Marginal	No
Natural Fish Bypass: E. Elm St.	Yes	Yes	No	No	Marginal	No
Natural Fish Bypass: Middle Falls	Yes	Marginal	No	No	No	No
Main Channel Modification: Middle Falls	Yes	Marginal	No	No	Marginal	No
Diversion to Side Channel: Middle Falls	Yes	Marginal	No	No	Yes	Yes

3.3.2.1 Dam Modification / Notching (Bridge Street Dam, East Elm Street Dam)

Dam modifications would preserve the majority of the existing structure. The main benefit of this measure over a partial demolition of the dam is that it provides the option to leave the dam foundation in place. However, the dams under study have shallow foundations, so this benefit is marginal. This marginal benefit is likely offset by additional construction complication with the selective demolition required to create a notch or weir structure.

This measure presents a dam safety risk and risk to the streambed subsurface. Forces introduced by a rectangular or wide V-shaped weir may lead to structural instability of overturning, sliding or rotation. The original structures were not designed to account for these load conditions. The reduced channel width causes an increase in the stream flow rates entering and exiting the removed section. In the event of increased flow rates, hydrodynamic loading against the dam will create unique forces and stresses in the structure. Continual erosion of the stream bed will undermine and scour the remaining dam foundation, leading to instability and increasing the risk of a potential failure mode (sliding or overturning). Additionally, the downstream would experience greater hydraulic jumps, turbidity, and reverse rollers. Due to the hydrodynamic loading against and over the dam, unique forces and stresses are developed in the structure. Given the reduced weight of the structure, the forces may lead to sliding or overturning situation.

Design of a modification or notch that meets minimum safety and stability requirements is technically challenging and perhaps infeasible. The benefits provided by this measure do not exceed the benefits of other, feasible measures. Therefore, this measure has been screened out.

3.3.2.2 Fish Ladder Repair (Bridge Street Dam, East Elm Street Dam)

Repair of the existing fish ladders was a measure that was initially considered but was screened early in the study process. Drawing from an existing analysis completed by Inter-Fluve in 2017, the team concluded that other measures would be more cost efficient in improving fish passage. The Inter-Fluve study assessed fish passage capabilities of the ladders at both the Bridge Street and East Elm Street Dams. The report identified and compared costs for alternatives that could improve fish passage at each site, including repair of the fish ladders, fish ladder replacement and dam removal. The passage of migratory fish species, including alewife, American eel, American shad, blueback herring, sea-run brook trout, rainbow smelt, sea lamprey (*Petromyzon marinus*), and striped bass were considered. The study evaluated potential costs of rebuilding the fishways to accommodate targeted species versus installing new fishways. The study concluded that constructing a new fishway was less expensive than rehabilitating the existing fishway at both the Bridge Street and East Elm Street Dams.

Repair of the fishways would not meet three of the study objectives. This measure only marginally improves connectivity and does not restore lost habitat. Additionally, the measure does not improve safety or reduce O&M, repair, and replacement costs. Therefore, this measure was screened from consideration.

3.3.2.3 New Fish Ladder (Middle Falls)

Building a new fish ladder at the Middle Falls site will improve fish passage but is not the most efficient measure available to achieve this goal and was screened early in the planning process. As described previously in the report, the USFWS surveyed the side channel of Middle Fall during 2017 in order to assess the potential of fish passage in this side channel.

The agency suggested that fish passage could be significantly improved by making "…alternations to the ledge outcroppings and/or movement of large rocks. This work might be accomplished in 3 to 5 days by a small crew with access to a generator, compressor, pneumatic hammer, and grip hoists. These enhancements would be relatively low cost and should be considered viable alternative (USFWS, 2017)."

To confirm the information provided by the USFWS, the PDT completed a site visit to Middle Falls during the summer of 2024. The team concluded that the less expensive and less intrusive measure proposed by the USFWS would improve fish passage through the side channel.

3.3.2.4 Natural Fish Bypass (Bridge Street Dam, East Elm Street Dam, Middle Falls)

A natural fish bypass was considered at both dam sites and Middle Falls. This measure would involve numerous technical and legal challenges. For example, naturalized bypasses would require a large footprint that are unavailable without extensive vegetation clearing and regrading. To further explore this option, a design and cost for a natural fish bypass and costs were developed for the Middle Falls site. To construct this measure, an access road, which would run down the left descending bank, would be essential. The road would require acquisition of private property and the clearing and grading of a forested riverbank on an extreme slope. This road would be a permanent structure and would also require future maintenance by the NFS. Given the high bedrock, a naturalized bypass may not be constructable and would require extensive study to plan. This design was determined to be significantly more expensive and invasive than other measures being considered. It was also found to be only marginally feasible to construct.

The bypass at any of the sites would meet Objective 1, improving fish passage. This measure would also meet Objective 2 (improve connectivity/restore habitat) at East Elm Street and Bridge Street Dams, but only marginally successful at meeting this objective at Middle Falls. The measures would not meet the other two objectives. Instead, the bypass would require regular maintenance and would increase the O&M, repair, and replacement costs of the NFS. This measure was eliminated from consideration because it did not meet all of the study objectives, is expensive, and marginally feasible.

3.3.2.5 Main Channel Modification (Middle Falls)

Modifying the main channel to improve fish passage was considered during the initial formulation of measures; however, this measure was quickly eliminated from consideration due to the constructability challenges that are posed by this measure. The main channel of Middle Falls is part of the "Yarmouth Cascades" and consists entirely of steep drops or cascades over exposed bedrock. Alteration of the main channel would require a significant dewatering effort before work can begin. With the information provided by the USFWS and site visits, this measure was not found the most efficient way available to achieve the objective.

In addition to the constructability challenges posed by this measure it also does not meet all of the study objections. Although it would theoretically improve fish passage between the Bridge Street and East Elm Street dams, there is uncertainty alteration of the main river channel would create conditions that would allow passage. For example, it is uncertain that the water speed would be slow enough to allow fish to migrate past the falls. This measure only marginally meets Objective 2 by potentially increasing connectivity, but it would not improve habitat. The measure does not address public safety or reduce O&M, repair, or replacement costs. This measure was removed from consideration.

3.4 FORMULATION AND COMPARISON OF ALTERNATIVES

Step 3 in the planning process involves formulating, evaluating, and comparing an array of alternative plans to achieve the primary NER purpose and identify cost effective plans. The first part of this step is to formulate alternative plans.

The purpose of ecosystem restoration measures is to restore the aquatic resources, specifically increasing riverine aquatic resource value and fish passage, of an affected section of river. The construction of dams has had an adverse ecological impact on the Royal River. From the screened measures listed above, the study team combined the restoration measures to produce eighteen alternatives (**Table 10**). This list includes the No Action Alternative and represents a range of combinations.

Table 10: Array of Alternatives

Alternative	East Elm Street Dam	Bridge Street Dam	Middle Falls
1	No Action	No Action	No Action
2	Dam Demolition	Dam Demolition	Diversion to Side Channel
3	Dam Demolition	Dam Demolition	No Action
4	Fish Ladder Replacement	Fish Ladder Replacement	Diversion to Side Channel
5	Fish Ladder Replacement	Fish Ladder Replacement	No Action
6	Fish Ladder Replacement	Dam Demolition	Diversion to Side Channel
7	Fish Ladder Replacement	Dam Demolition	No Action
8	Dam Demolition	Fish Ladder Replacement	Diversion to Side Channel
9	Dam Demolition	Fish Ladder Replacement	No Action
10	No Action	Dam Demolition	Diversion to Side Channel
11	No Action	Dam Demolition	No Action
12	No Action	Fish Ladder Replacement	Diversion to Side Channel
13	No Action	Fish Ladder Replacement	No Action
14	Dam Demolition	No Action	Diversion to Side Channel
15	Dam Demolition	No Action	No Action

Alternative	East Elm Street Dam	Bridge Street Dam	Middle Falls
16	Fish Ladder Replacement	No Action	Diversion to Side Channel
17	Fish Ladder Replacement	No Action	No Action
18	No Action	No Action	Diversion to Side Channel

3.4.1 Alternative 1 - No Action Alternative

No alterations to the dams and fish ladders located on the Royal River in Yarmouth, ME would be performed. Additionally, no actions would occur at Middle Falls. The presence of each dam and the Middle Falls will continue to block passage for fish species and will segregate existing populations to their current reaches of the Royal River. Existing development and usage patterns surrounding the dams will remain the same.

3.4.2 Alternative 2: East Elm Street and Bridge Street Dam Demolition + Middle Falls Diversion to Side Channel

Alternative 2 includes the following measures:

- Removal of a 120 linear foot (LF) section of the East Elm Street Dam and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- Removal of Bridge Street Dam across the entire width of the river, which includes the 275 LF structure and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- Installation of diversion structure at the top of Middle Falls to divert streamflow into the side channel. Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

3.4.3 Alternative 3: East Elm Street and Bridge Street Dam Demolition

Alternative 3 comprises the following measures:

- Removal of Bridge Street Dam across the entire width of the river, which includes the 275 LF structure and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- Removal of a120 LF section of the East Elm Street Dam and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- No action at the Middle Falls

3.4.4 Alternative 4: Bridge Street and East Elm Street Fish Ladder Replacement + Middle Falls Diversion to Side Channel

Alternative 4 includes:

- Removal of the existing Denil-type fish passage structure at the Bridge Street Dam and construction of a new, modern fish passage structure on the right descending bank.

- Removal of the existing Denil-type fish passage structure at the East Elm Street Dam and construction of a new, modern fish passage structure on the right descending bank.
- Installation of diversion structure at the top of Middle Falls to divert streamflow into the side channel. Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

3.4.5 Alternative 5: Bridge Street and East Elm Street Fish Ladder Replacement

Alternative 5 comprises the following measures:

- Removal of the existing Denil-type fish passage structure at the Bridge Street Dam and construction of a new, modern fish passage structure on the right descending bank.
- Removal of the existing Denil-type fish passage structure at the East Elm Street Dam and construction of a new, modern fish passage structure on the right descending bank.
- No action at the Middle Falls

3.4.6 Alternative 6: East Elm Street Fish Ladder Replacement + Bridge Street Dam Demolition + Middle Falls Diversion to Side Channel

Alternative 6 includes:

- Removal of the existing Denil-type fish passage structure at the East Elm Street Dam and construction of a new, modern fish passage structure on the right descending bank.
- Removal of Bridge Street Dam across the entire width of the river (275 LF), and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- Installation of diversion structure at the top of Middle Falls to divert streamflow into the side channel. Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

3.4.7 Alternative 7: East Elm Street Fish Ladder Replacement + Bridge Street Dam Demolition

Alternative 7 includes:

- Removal of the existing Denil-type fish passage structure at the East Elm Street Dam and construction of a new, modern fish passage structure on the right descending bank.
- Removal of Bridge Street Dam across the entire width of the river (275 LF), and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- No action at the Middle Falls

3.4.8 Alternative 8: East Elm Street Dam Demolition + Bridge Street Fish Ladder Replacement + Middle Falls Diversion to Side Channel

The elements of Alternative 8 includes:

- Removal of a 120 LF section of the East Elm Street Dam and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- Removal of the existing Denil-type fish passage structure at the Bridge Street Dam and construction of a new, modern fish passage structure on the right descending bank.
- Installation of diversion structure at the top of Middle Falls to divert streamflow into the side channel. Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

3.4.9 Alternative 9: East Elm Street Dam Demolition + Bridge Street Fish Ladder Replacement

Alternative 9 comprises the following measures:

- Removal of a 120 LF section of the East Elm Street Dam and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- Removal of the existing Denil-type fish passage structure at the Bridge Street Dam and construction of a new, modern fish passage structure on the right descending bank.
- No action at the Middle Falls

3.4.10 Alternative 10: Bridge Street Dam Demolition + Middle Falls Diversion to Side Channel

Alternative 10 includes:

- No action at the East Elm Street Dam
- Removal of Bridge Street Dam across the entire width of the river (275 LF), and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- Installation of diversion structure at the top of Middle Falls to divert streamflow into the side channel. Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

3.4.11 Alternative 11: Bridge Street Dam Demolition

Alternative 11 includes:

- No action at the East Elm Street Dam
- Removal of Bridge Street Dam across the entire width of the river (275 LF), and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- No action at the Middle Falls

3.4.12 Alternative 12: Bridge Street Fish Passage Structure Replacement + Middle Falls Diversion to Side Channel

The elements of Alternative 12 includes:

- No action at the East Elm Street Dam
- Removal of the existing Denil-type fish passage structure at the Bridge Street Dam and construction of a new, modern fish passage structure on the right descending bank.
- Installation of diversion structure at the top of Middle Falls to divert streamflow into the side channel. Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

3.4.13 Alternative 13: Bridge Street Fish Ladder Replacement

Alternative 13 includes:

- No action at the East Elm Street Dam
- Removal of the existing Denil-type fish passage structure at the Bridge Street Dam and construction of a new, modern fish passage structure on the right descending bank.
- No action at the Middle Falls

3.4.14 Alternative 14: East Elm Street Dam Demolition + Middle Falls Diversion to Side Channel

Alternative 14 comprises the following measures:

- Removal of a 120 LF section of the East Elm Street Dam and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- No action at the Bridge Street Dam
- Installation of diversion structure at the top of Middle Falls to divert streamflow into the side channel. Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

3.4.15 Alternative 15: East Elm Street Dam Demolition

Alternative 15 includes:

- Removal of a 120 LF section of the East Elm Street Dam and the Denil-type fish passage structure located on the right descending bank of the Royal River.
- No action at the Bridge Street Dam
- No action at the Middle Falls

3.4.16 Alternative 16: East Elm Street Fish Ladder Replacement + Middle Falls Diversion to Side Channel

Alternative 16 comprises the following measures:

- Removal of the existing Denil-type fish passage structure at the East Elm Street Dam and construction of a new, modern fish passage structure on the right descending bank.
- No action at the Bridge Street Dam
- Installation of diversion structure at the top of Middle Falls to divert streamflow into the side channel. Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

3.4.17 Alternative 17: East Elm Street Fish Ladder Replacement

Alternative 17 includes:

- Removal of the existing Denil-type fish passage structure at the East Elm Street Dam and construction of a new, modern fish passage structure on the right descending bank.
- No action at the Bridge Street Dam
- No action at the Middle Falls

3.4.18 Alternative 18: Middle Falls Diversion to Side Channel

Alternative 18 includes:

- No action at the East Elm Street Dam
- No action at the Bridge Street Dam
- Installation of diversion structure at the top of Middle Falls to divert streamflow into the side channel. Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

3.5 EVALUATION AND COMPARISON OF ALTERNATIVE PLANS

Continuing Step 3, each of the above alternatives was evaluated by each discipline on the project team for how it met the study objectives and what would be the resulting effect on the ecosystem of the Royal River if implemented.

3.5.1 Environmental Evaluation of Benefits

It is necessary to estimate the ecosystem restoration benefits or outputs of each of the viable alternatives to assess their cost effectiveness and determine their incremental costs. The purpose of this project is to restore aquatic ecosystem functions and values to the Royal River. The project will restore habitats within the riverine channel and, for the dam removal alternatives, within the impoundments behind the two dams. The study team determined that the project effect with the greatest overall value would be the restoration of anadromous fish populations because of their relative scarcity and selected a model to distinguish among the alternatives on this basis.

Although the model focuses on fish passive effectiveness, it also provides a good indicator of the relative value of each alternative with respect to overall aquatic ecosystem health. The environmental model used to assess environmental benefits was based on the Upper Mississippi River System Fish Connectivity Index. The Upper Mississippi River System Fish Connectivity Index itself was too large in scope to adequately assess the connectivity of the Royal River; however, the passage index values for individual measures were applicable. The model assesses the proportion of fish that will be able to pass the project area by assigning a percentage of the total population that will be able to successfully navigate each of the three obstructions. This is done using the equation:

$$p = k*b*f*e$$

Where p = estimated number of passed fish
Where k = carrying capacity of the project area and upstream reaches
Where b = Bridge Street Dam passage index
Where f = Middle Falls passage index
Where e = East Elm Street Dam passage index

Values for the percent passage index can be found below in **Table 11** and a complete copy of the model can be found in **Appendix A**.

Table 11: Percent Passage Index by Measure

Measure	% Passage
Dam Removal	100
Natural Bypass	70
Fish Ladder	50
No Action	5

The model analyzed the passage of 18 alternatives summarized in **Table 12**. The alternative that returned the highest number of passing fish was Alternative 2: removal of both dams and diversion to the Middle Falls side channel with a result of 25,880 fish. This number does not represent the immediate benefit to the system, but the maximum expected annual passage through the system.

Table 12: Environmental Model Results Sorted by Habitat Units.

Results	Habitat Units
Alt 2: Bridge Street Dam Demolition, Middle Falls Diversion, East Elm Street Dam Demolition	**25,880**
Alt 4: Bridge Street Fish Ladder Replacement, Middle Falls Diversion, Elm Street Dam Demolition	**12,940**
Alt 6: Bridge Street Dam Demolition, Middle Falls Diversion, East Elm Street Fish Ladder Replacement	**12,940**
Alt 8: Bridge Street Fish Ladder Replacement, Middle Falls Diversion, East Elm Street Fish Ladder Replacement	**6,470**

Results	Habitat Units
Alt 3: Bridge Street Dam Demolition, Middle Falls No Action, East Elm Street Dam Demolition	1,849
Alt 14: Bridge Street No Action, Middle Falls Diversion, East Elm Street Dam Demolition	1,294
Alt 10: Bridge Street Dam Demolition, Middle Falls Diversion, East Elm Street No Action	1,294
Alt 9: Bridge Street Fish Ladder Replacement, Middle Falls No Action, East Elm Street Dam Demolition	924
Alt 15: Bridge Street No Action, Middle Falls No Action, East Elm Street Dam Demolition	924
Alt 7: Bridge Street Dam Demolition, Middle Falls No Action, East Elm Street Fish Ladder Replacement	924
Alt 16: Bridge Street No Action, Middle Falls Diversion, East Elm Street Fish Ladder Replacement	647
Alt 12: Bridge Street Fish Ladder Replacement, Middle Falls Diversion, East Elm Street No Action	647
Alt 5: Bridge Street Fish Ladder Replacement, Middle Falls No Action, East Elm Street Fish Ladder Replacement	462
Alt 11: Bridge Street Dam Demolition, Middle Falls No Action, East Elm Street No Action	92
Alt 18: Bridge Street No Action, Middle Falls Diversion, East Elm Street No Action	65
Alt 17: Bridge Street No Action, Middle Falls No Action, East Elm Street Fish Ladder Replacement	46
Alt 13: Bridge Street Fish Ladder Replacement, Middle Falls No Action, East Elm Street No Action	46
Alt 1: Bridge Street No Action, Middle Falls No Action, East Elm Street No Action	5

3.5.2 Cost Effectiveness & Incremental Cost Analysis

Cost effectiveness and incremental cost analysis (CE/ICA) are two distinct analyses that must be conducted to evaluate the effects of alternative plans according to USACE policy. First, it must be shown through cost effectiveness analysis that a restoration plan's output cannot be produced more cost effectively by another alternative. Cost effective means that, for a given level of non-monetary output (e.g., number of fish), no other plan costs less and no other plan yields more output at a lower cost. Subsequently, through incremental cost analysis, a variety of alternatives and various-sized alternatives are evaluated to arrive at a best level of output within the limits of both the sponsor's and the USACE's capabilities.

The subset of cost-effective plans is examined sequentially (by increasing scale and increment of output) to ascertain which plans are most efficient in the production of environmental benefits. Those most efficient plans are called best buys. As a group of measures, they provide the greatest increase in output for the least increase in cost. They have the lowest incremental costs per unit of output. In most analyses, there will be a series of best buy plans, in which the relationship between the quantity of outputs and the unit cost is evident. As the scale of best buy plans increases (in terms of output produced), average costs per unit of output and incremental costs per unit of output will increase as well. The incremental analysis by itself will not point to the selection of any single plan.

The results of the incremental analysis must be synthesized with other decision-making criteria (i.e., significance of outputs, acceptability, completeness, effectiveness, risk and uncertainty, reasonableness of costs) to help the study team select and recommend a particular plan.

Eighteen alternative plans (**Table 13**), including the No Action Plan, were created using measures that were not screened. The Institute of Water Resources (IWR)-Planning Suite II was used to complete a CE/ICA analysis of these alternatives. The analysis identified eight cost effective plans (Alternative 1, 2, 3, 8, 10,11, 15 and 18) and ten plans that were not cost-effective (4, 5, 6, 7, 9, 12, 13, 14, 16 and 17). Non-cost effective means another plan(s) provided the same benefits or more at a lesser cost.

Two best buy plans were identified. The No Action Plan is always considered a best buy. One other plan was identified as a best buy. Alternative 2, which includes the demolition of the dam and fish ladder at both East Elm Street and Bridge Street and diversion to the side channel at Middle Falls. This Alternative has an average cost of $8.76 per habitat unit gained (**Table 13** & **Figure 23**).

Table 13: Alternative Plan Cost Effectiveness

Alternative Plan	Annual Average Cost ($1000)	NAAHU's	Cost Effective	Cost per Habitat Units
1	**$0.00**	**0**	**Best Buy**	**$0.00**
2	**$226.63**	**25,880**	**Best Buy**	**$8.76**
3	$166.95	1,849	Cost Effective	$90.29
4	$242.96	12,940	Non-Cost Effective	$18.78
5	$180.79	462	Non-Cost Effective	$391.32
6	$253.36	12,940	Non-Cost Effective	$19.58
7	$191.04	924	Non-Cost Effective	$206.75
8	$219.10	6,470	Cost Effective	$33.86
9	$157.25	924	Non-Cost Effective	$170.18
10	$144.30	1,294	Cost Effective	$111.51
11	$85.42	92	Cost Effective	$928.48
12	$134.05	647	Non-Cost Effective	$207.19
13	$75.17	46	Non-Cost Effective	$1,634.13
14	$146.02	1,294	Non-Cost Effective	$112.84
15	$87.15	924	Cost Effective	$94.32
16	$169.57	647	Non-Cost Effective	$262.09
17	$114.45	46	Non-Cost Effective	$2,488.04
18	$63.94	65	Cost Effective	$983.69

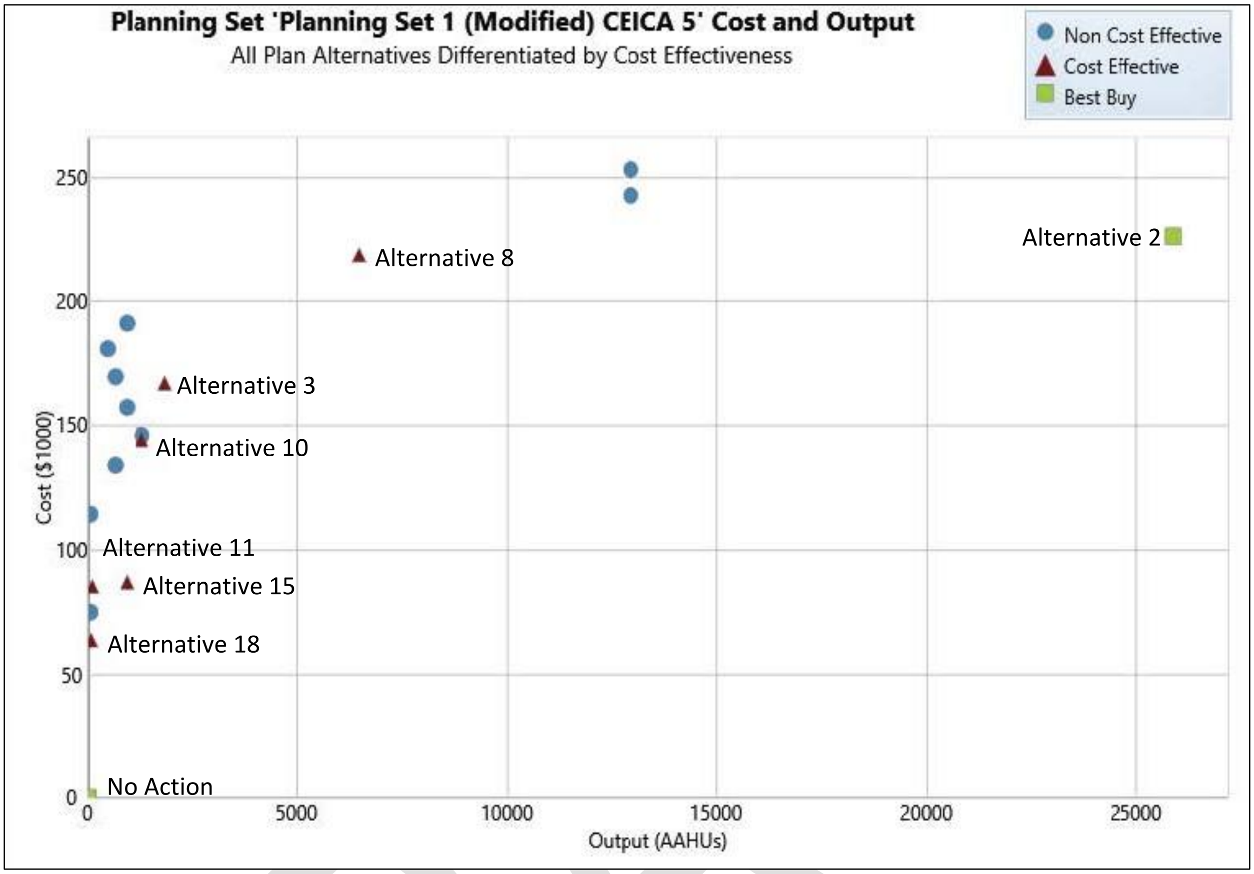

Figure 23: Cost Effectiveness Analysis for All Alternatives.
(Best Buy and Cost-Effective plans are labeled)

3.5.3 Comparison of Alternative Plans

After the comprehensive evaluation of each of the 18 alternatives, the project team completed Step 3 in the planning process by comparing them across a standard list of four evaluation criteria (ER 1105-2-103). These criteria are defined below:

1. Completeness is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities.
2. Effectiveness is the extent to which the alternative plans contribute to achieving the planning objectives.
3. Efficiency is the extent to which an alternative plan is the most cost-effective means of achieving the objectives.
4. Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations and public policies.

For easier comparison, the table below (**Table 14**) ranks each of the 18 alternatives of this study according to how well they meet the above criteria while considering the planning objectives. Each alternative is ranked on the following scale:

- Meets Criteria – The alternative meets the criteria fully or almost fully.
- Partially Meets Criteria – The alternative partially meets the criteria or has the potential to meet it in the future.
- Does Not Meet Criteria – The alternative does not meet the criteria or has no potential to meet the criteria in the future.

Table 14: Alternatives Comparison by the Four Standard Evaluation Criteria

Alt Plan	Completeness	Effectiveness	Efficiency	Acceptability
1	Does Not Meet Criteria	Does Not Meet Criteria	Does Not Meet Criteria	Meets Criteria
2	Meets Criteria	Meets Criteria	Meets Criteria	Meets Criteria
3	Partially Meets Criteria	Meets Criteria	Meets Criteria	Meets Criteria
4	Partially Meets Criteria	Partially Meets Criteria	Does Not Meet Criteria	Meets Criteria
5	Partially Meets Criteria	Partially Meets Criteria	Does Not Meet Criteria	Meets Criteria
6	Partially Meets Criteria	Meets Criteria	Does Not Meet Criteria	Meets Criteria
7	Partially Meets Criteria	Meets Criteria	Does Not Meet Criteria	Meets Criteria
8	Partially Meets Criteria	Meets Criteria	Meets Criteria	Meets Criteria
9	Partially Meets Criteria	Meets Criteria	Does Not Meet Criteria	Meets Criteria
10	Partially Meets Criteria	Partially Meets Criteria	Meets Criteria	Meets Criteria
11	Partially Meets Criteria	Partially Meets Criteria	Meets Criteria	Meets Criteria
12	Partially Meets Criteria	Partially Meets Criteria	Does Not Meet Criteria	Meets Criteria
13	Partially Meets Criteria	Partially Meets Criteria	Does Not Meet Criteria	Meets Criteria
14	Partially Meets Criteria	Partially Meets Criteria	Does Not Meet Criteria	Meets Criteria
15	Partially Meets Criteria	Partially Meets Criteria	Meets Criteria	Meets Criteria
16	Partially Meets Criteria	Partially Meets Criteria	Does Not Meet Criteria	Meets Criteria

Alt Plan	Completeness	Effectiveness	Efficiency	Acceptability
17	Partially Meets Criteria	Partially Meets Criteria	Does Not Meet Criteria	Meets Criteria
18	Partially Meets Criteria	Does Not Meet Criteria	Meets Criteria	Meets Criteria

Completeness – Only Alternative 2 meets the completeness planning objective fully as it provides for all necessary investments to ensure the realization of all four planning objectives (1. improving fish passage, 2. increasing connectivity and restoring habitat, 3. reducing O&M, repair, and replacement costs and 4. improving safety). Alternatives 3 through 18 addresses some of the planning objectives and, therefore, partially meet the completeness criteria. Alternative 1 meets none of the planning objectives and does not meet this criterion.

Effectiveness – Alternatives 2, 3, 6, 7 and 8 fully or partially address the four planning objectives. Therefore, these alternatives meet the effectiveness criteria. Alternatives 4, 5, 10, 11, 12, 13, 14, 15, 16 and 17 address some of the planning objectives and only partially meet the effectiveness criteria. Alternatives 1 and 18 meet none of the planning objectives and do not meet this criterion.

Efficiency – As previously described in **Section 3.5.2**, an CE/ICA analysis was completed to assess the cost effectiveness of each alternative. The analysis identified eight cost effective plans (Alternative 1, 2, 3, 8, 10,11, 15 and 18). These plans met the efficiency criterion. While ten plans (4, 5, 6, 7, 9, 12, 13, 14, 16 and 17) are not efficient as they are not a cost-effective option.

Acceptability - All Alternatives meet the definition of acceptability because they follow all applicable laws, regulations, and public policies.

3.6 EVALUATION OF THE FOUR ACCOUNTS

Step 5 in the planning process begins once alternative formulation is complete and initial evaluations have identified acceptable plans. This step is to identify and analyze benefits equally across a full array of benefit categories including:

- National Ecosystem Restoration (NER) - The non-monetary benefits to society which are gained through the improvement or restoration of wildlife and ecosystem.
- National Economic Development (NED) - This category describes monetary changes the economic value of the national output of goods and services.
- Regional Economic Development (RED) - This category includes benefits to the regional economy not already accounted for in the national economic assessment.

- Environmental Quality (EQ) - The EQ benefit category includes both positive and negative benefits to the environment.
- Other Social Effects (OSE) – The OSE benefits measure social well-being factors that influence personal and group definitions of satisfaction, well-being, and happiness. The distribution of resources; the character and richness of personal and community associations; the social vulnerability and resilience of individuals, groups, and communities; and the ability to participate in systems of governance are all elements of the OSE benefit category.

These four accounts encompass all potential significant beneficial effects of a plan on the human environment as required by NEPA (42 U.S.C. 4321 et seq.) and social well-being as required by Section 122 of the Flood Control Act of 1970 (Pub. L. 91-611, 84 Stat. 1823). The January 5, 2021 "*Memorandum for Commanding General, U.S. Army Corps Of Engineers, Policy Directive – Comprehensive Documentation of Benefits in Decision Documents"* supplements the guidance provided in ER 1105-2-103 (formally known as the Planning Guidance Notebook) by requiring comprehensive consideration of total project benefits including economics, environmental, and social categories. Study teams must identify and analyze benefits in total and equally across a full array of benefit categories. The level of the analysis will vary based on the magnitude of the change, its relevance to decision-making, and the availability of data, tools, and procedures to quantify or monetize the benefit or impact.

Consistent with the goal of an ecosystem restoration study, the New England District's objective is to recommend a NER plan. This NER recommendation is discussed following the evaluation of the alternatives through the RED, EQ, and OSE accounts. NED benefits, which identify the economic value of the plan to the nation, are discussed below but were not the objective of the study. While the project is expected to have positive NED benefits, plan formulation did not specifically target NED benefits because of the NER study objectives.

3.6.1 National Economic Development Account

The NED account details any changes the economic value of the national output of goods and services. While not required, a brief discussion of NED benefits is included to comply with the 2021 Commanding Memorandum on Comprehensive Benefits as the alternatives studied will provide small benefits to NED in the form of the reduction of O&M, repair, and replacement costs. Future costs were not developed for this study. However, in their 2010 report, Stantec provided estimates for O&M, repair, and replacement costs for both the Bridge Street and East Elm Street Dams and the fish ladders associated with each dam. These costs were not developed through detailed economic modeling or analysis but were estimated cost ranges based on similar regional projects. Using these estimates, **Table 15** provides a qualitative representation of future O&M, repair and replacement costs. Alternatives with high future costs include continued O&M and repair costs for both dams and fish ladders and the eventual replacement of both dams. Alternatives with moderate level costs typically include O&M and repair costs for one dam and one or both fish ladders. And finally, alternatives with low future costs only include the continued O&M, repair, and replacement of part of the East Elm Street Dam.

Table 15: Summary of Future O&M, Repair and Replacement Costs

Alternative	Future Costs	Cost Breakout
Alt 1	High	-Continued O&M/repair of both dams & fish ladders -Full replacement of both dams
Alt 2	Low	-Continued O&M/repair for remaining section of E. Elm Street Dam -Replacement of the remaining section of E. Elm Street Dam
Alt 3	Low	-Continued O&M/repair for remaining section of E. Elm Street Dam -Replacement of the remaining section of E. Elm Street Dam
Alt 4	High	-Continued O&M/repair of both dams & fish ladders -Full replacement of both dams
Alt 5	High	-Continued O&M/repair of both dams & fish ladders -Full replacement of both dams
Alt 6	Moderate	-Continued O&M/repair of the E. Elm Street Dam & both fish ladders -Full replacement of the E. Elm Street Dam
Alt 7	Moderate	-Continued O&M/repair of the E. Elm Street Dam & both fish ladders -Full replacement of the E. Elm Street Dam
Alt 8	Moderate	-Continued O&M/repair of the Bridge Street Dam & both fish ladders -Full replacement of the Bridge Street Dam
Alt 9	Moderate	-Continued O&M/repair of the Bridge Street Dam & both fish ladders -Full replacement of the Bridge Street Dam
Alt 10	Moderate	-Continued O&M/repair of the E. Elm Street Dam & fish ladder -Full replacement of the E. Elm Street Dam
Alt 11	Moderate	-Continued O&M/repair of the E. Elm Street Dam & fish ladder -Full replacement of the E. Elm Street Dam
Alt 12	High	-Continued O&M/repair of both dams & fish ladders -Full replacement of both dams
Alt 13	High	-Continued O&M/repair of both dams & fish ladders -Full replacement of both dams
Alt 14	Moderate	-Continued O&M/repair of the Bridge Street Dam & fish ladder -Full replacement of the Bridge Street Dam
Alt 15	Moderate	-Continued O&M/repair of the Bridge Street Dam & fish ladder -Full replacement of the Bridge Street Dam
Alt 16	High	-Continued O&M/repair of both dams & fish ladders -Full replacement of both dams
Alt 17	High	-Continued O&M/repair of both dams & fish ladders

Alternative	Future Costs	Cost Breakout
		-Full replacement of both dams
Alt 18	High	-Continued O&M/repair of both dams & fish ladders -Full replacement of both dams

There is no regulated commerce along the Royal River. Existing traffic on the river is entirely recreational based. There are no rental outfitters along this stretch of the river; however, the entire Royal River has been identified as a water trail, offering "paddling experiences and public water access points for paddling, swimming…" (Royal River Conservation Trust, 2024). Additionally, there are private marinas/boat yards located at the mouth of the river. This project is not expected to reduce access to the water trail or financially impact businesses located near the Royal River.

No flood risk management benefits are predicted to be gained by the TSP.

3.6.2 Regional Economic Development

The RED account identifies changes in the distribution of regional economic activity that result from each alternative plan. USACE policy allows a scaled analysis of comprehensive benefits analysis commensurate with the size of the project. In this case, a qualitative summary of RED benefits, instead of a full RED analysis, is included in this report.

Each alternative included in the final array will provide regional economic benefits, though the amounts of those benefits vary between alternatives. During construction, RED benefits include money spent by the construction company and workers in the town of Yarmouth and will positively impact the local economy. These benefits will be temporary and will end when construction has been completed. Long-term RED benefits are not expected to change significantly because the project is not expected to alter the nature or access to recreational opportunities. If the fish runs are reestablished, they may increase fishing opportunities, and alteration of the dams may increase white water boating opportunities; but, on a whole these changes are not expected to produce changes to RED benefits.

Table 16 provides a qualitative summary of RED benefits that would be produced by each alternative in comparison to the other alternatives included in the array. Alternatives predicted to have "High RED benefits involve large amounts of construction (i.e., removal of in-stream structures), meaning that the period of construction will be longer and will require more workers, whose spending will add to the local economy. While those alternatives with "Low" levels of RED benefits involved less construction time and therefore, will contribute less to the local economy.

Table 16: A Qualitative Summary of RED Benefits for the Array of Alternatives

Alternative	RED Benefits	Alternative	RED Benefits
Alt 1	Low	Alt 10	Moderate
Alt 2	High	Alt 11	Moderate
Alt 3	Moderate	Alt 12	Moderate
Alt 4	High	Alt 13	Low
Alt 5	High	Alt 14	Moderate
Alt 6	High	Alt 15	Moderate
Alt 7	High	Alt 16	High
Alt 8	High	Alt 17	Moderate
Alt 9	Moderate	Alt 18	Low

3.6.3 Environmental Quality

A summary of EQ benefits (**Table 17**) is provided to help readers evaluate whether the condition of the resources affected by the alternatives are improved or not. The environmental quality benefits of the alternatives analyzed may be considered as non-supportive = 0; partial support = 1; or most supportive = 2.

Table 17: Environmental Quality and Other Social Effects Benefits for Each Alternative

Alternatives	EQ				OSE	Total
	Improve Fish Passage/Connectivity	Restore Riverine Habitat	Improve Productivity	Supports Native River Species	Improve Human Safety	
Alt 1: Bridge Street No Action, Middle Falls No Action, East Elm Street No Action	0	0	0	0	0	**0**
Alt 2: Bridge Street Dam Demolition, Middle Falls Diversion, East Elm Street Dam Demolition	2	2	2	2	2	**10**
Alt 3: Bridge Street Dam Demolition, Middle Falls No Action, East Elm Street Dam Demolition	1	2	1	2	2	**8**
Alt 4: Bridge Street Fish Ladder Replacement, Middle Falls Diversion, Elm Street Dam Demolition	2	0	1	1	0	**4**
Alt 5: Bridge Street Fish Ladder Replacement, Middle Falls No Action, East Elm Street Fish Ladder Replacement	1	0	1	1	0	**3**
Alt 6: Bridge Street Dam Demolition, Middle Falls Diversion, East Elm Street Fish Ladder Replacement	2	1	2	1	1	**7**
Alt 7: Bridge Street Dam Demolition, Middle Falls No Action, East Elm Street Fish Ladder Replacement	1	1	1	1	1	**5**
Alt 8: Bridge Street Fish Ladder Replacement, Middle Falls Diversion, East Elm Street Fish Ladder Replacement	2	1	1	1	1	**6**
Alt 9: Bridge Street Fish Ladder Replacement, Middle Falls No Action, East Elm Street Dam Demolition	1	1	1	1	1	**5**
Alt 10: Bridge Street Dam Demolition, Middle Falls Diversion, East Elm Street No Action	1	1	1	1	1	**5**
Alt 11: Bridge Street Dam Demolition, Middle Falls No Action, East Elm Street No Action	0	1	1	1	1	**4**
Alt 12: Bridge Street Fish Ladder Replacement, Middle Falls Diversion, East Elm Street No Action	1	0	1	1	0	**3**
Alt 13: Bridge Street Fish Ladder Replacement, Middle Falls No Action, East Elm Street No Action	0	0	1	1	0	**2**
Alt 14: Bridge Street No Action, Middle Falls Diversion, East Elm Street Dam Demolition	1	1	1	1	1	**5**
Alt 15: Bridge Street No Action, Middle Falls No Action, East Elm Street Dam Demolition	1	1	1	1	1	**5**

Alt 16: Bridge Street No Action, Middle Falls Diversion, East Elm Street Fish Ladder Replacement	1	0	0	1		0	**2**
Alt 17: Bridge Street No Action, Middle Falls No Action, East Elm Street Fish Ladder Replacement	0	0	0	1		0	**1**
Alt 18: Bridge Street No Action, Middle Falls Diversion, East Elm Street No Action	0	0	0	1		0	**1**

Alternative 2 provides the most EQ Benefits, followed by Alternatives 3, 6 and 8. Each of these alternatives involves either demolition of the dam and fish ladder or replacement of the fish ladder at both dam sites and constructing a diversion to the Middle Falls side channel. The EQ benefits are higher for these alternatives because fish passage is improved at each site that has been identified as being an impediment to migration. Alternative 4 also improves fish passage at both dam sites through the replacement of the fish ladders and diversion to the Middle Falls side channel, although it does not address restoration of riverine habitat and therefore, provides lower EQ benefits. All other alternatives provide partial solutions to aquatic ecosystem restoration, by only addressing one dam site or not improving passage at the Middle Falls side channel.

3.6.4 Other Social Effects

The OSE account evaluates project alternatives in respect to key human needs. The Bridge Street and East Elm Street Dams and associated fish ladders pose a risk to public safety. These structures are not equipped with safety precautions, such as fencing, gates or signage, to keep the public away from the structures. Currently, members of the public can climb onto the concrete structures and potentially could be injured by a fall or could drown if they fall into the water. Each alternative was evaluated for their effect on human health and safety. **Table 17** above summarizes the reduction of risk to human safety. The OSE benefits of the alternatives analyzed may be considered as non-supportive = 0; partial support = 1; or most supportive = 2.

Alternatives 2 and 3 provide the most OSE benefits because they involve the removal of both low-head dams and removal of the existing fish ladder structures. As a result, these alternatives improve safety for the public who frequent the dam sites.

3.6.5 National Ecosystem Restoration

ER 1105-2-103 states that “for aquatic ecosystem restoration projects, a plan that reasonably maximizes aquatic ecosystem restoration benefits compared to the costs, consistent with the Federal objectives and Guiding Principles, must be identified.” USACE guidance also states that the plan must be shown to be cost effective to achieve that desired level of output. To identify this plan, initial costs were developed for each of the measures carried forward through the screening process. These initial costs were used to develop initial cost estimates for each alternative in an additive manner.

Table 18 shows the monetary investment layout and benefits gained towards the federal objective. Carried forward from the initial array of measures, dam and fish ladder demolition at both sites plus constructing a diversion to the Middle Falls side channel maximizes benefits towards the federal objective and requires no operations and maintenance since the alternative restores the natural feature by removing a man-made structure and returning riverine processes.

Table 18: Summary of Costs and NER Benefits of the Final Array of Alternatives

	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Alt 8	Alt 9	
Total Project First Costs ($)	5,954,000	4,386,000	6,383,000	4,815,000	6,656,000	5,088,000	5,756,000	4,188,000	
Interest During Construction ($)	164,488	121,170	176,340	65,909	183,882	69,646	159,018	57,326	
Total Gross Investment ($)	6,118,488	4,507,170	6,559,340	4,880,908	6,839,882	5,157,646	5,915,018	4,245,326	
Average Annual Cost of Total Gross Investment ($)	226,634	166,950	242,964	180,793	253,356	191,044	219,098	157,251	
Annual OMRR&R [3] Cost ($)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Average Annual Costs ($)	226,634	166,950	242,964	180,793	253,356	191,044	219,098	157,251	
Total NER Benefits (AAHU's[4])	25,880	1,849	12,940	462	12,940	924	6,470	924	
Cost Per Habitat Unit ($1000)	8.76	90.29	18.78	391.32	19.58	206.75	33.86	170.18	
CE/ICE Cost Effective	Yes	Yes	Yes	No	No	No	Yes	No	

	Alt 10	Alt 11	Alt 12	Alt 13	Alt 14	Alt 15	Alt 16	Alt 17	Alt 18
Total Project First Costs ($)	3,843,000	2,275,000	3,570,000	2,002,000	3,889,000	2,321,000	4,516,000	3,048,000	1,703,000
Interest During Construction ($)	52,604	31,141	48,867	27,404	53,234	31,771	61,816	41,722	7,713
Total Gross Investment ($)	3,895,604	2,306,141	3,618,867	2,029,404	3,942,234	2,352,771	4,577,816	3,089,722	1,710,713
Average Annual Cost of Total Gross Investment ($)	144,297	85,422	134,046	75,171	146,024	87,149	169,567	114,446	63,366
Annual OMRR&R Cost ($)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Average Annual Costs ($)	144,297	85,422	134,046	75,171	146,024	87,149	169,567	114,446	63,366
Total NER Benefits (AAHU's)	1,294	92	647	46	1,294	924	647	46	65
Cost Per Habitat Unit ($1000)	111.51	928.48	207.19	1634.13	112.84	94.32	262.09	2,488.04	983.69
CE/ICE Cost Effective	Yes	Yes	No	No	No	Yes	No	No	Yes

[3] OMRR&R – Operations, Maintenance, Repair, Replacement and Rehabilitation
[4] AAHU – Average Annual Habitat Unit

All monetary values are in Fiscal Year 2024 price levels. All annualized values are discounted using a Fiscal Year 2024 Federal discount rate of 2.75%: 50-year period of analysis.

3.6.6 Summary Evaluation of the Four Accounts

To complete the analysis of the four accounts as a part of Step 5 of the planning process, the summary table below (**Table 19**) shows the various evaluation criteria used to compare the 18 alternatives under the accounts. These are sorted by their respective account as well as the initial criteria mentioned above as a part of Step 3: their completeness, effectiveness, efficiency, and acceptability.

NER factors gauged included the number of habitat units created by the alternative and the economic efficiency of the alternative when compared to the group at large. This metric follows the results of the CE/ICA analysis from **Section 3.5.2**. Alternative 2 has significantly higher habitat unit totals and is the only identified best buy plan that maximizes efficiency.

The only NED factor that was considered was the reduction of future O&M, replacement and repair costs. Alternatives 2 and 3 provided the greatest NED benefits. RED benefits will stem from project construction. Alternatives 2, 4, 5, 6, 7, 8 and 16 exhibited high RED outputs, largely due to the benefits of construction accrued from demolition of the dam and fish ladder structures or replacement of the fish ladders.

Of the EQ factors used by the study team to evaluate the alternatives array, alternatives 2, 3, 6 and 8 stood out for having a higher impact on stream connectivity/fish passage, river productivity, support of native fish species and the restoration of riverine habitat.

Alternatives 2 and 3 demonstrated the largest OSE benefits when considering human safety.

Based on the analyses presented in this section (Plan Formulation), and **Section 4.0 – Environmental Consequences of the Alternatives**, the NER plan would be Alternative 2: East Elm Street and Bridge Street Dam and Fish Ladder Demolition + Middle Falls Diversion to Side Channel. This is supported by analyses addressing problems and meeting planning objectives. Other than the No Action Plan (Alternative 1), Alternative 2 is only best buy plan. Therefore, it is recommended over all the other cost-effective plans.

Table 19: Comprehensive Benefits Analysis Summary

P&G Criteria	Effectiveness	Efficiency	Effectiveness	Effectiveness	Effectiveness	Effectiveness	Effectiveness	Effectiveness	Completeness	Completeness	Acceptability
Benefit Category	National Ecosystem Restoration (NER)		RED Benefits	Environmental Quality				Other Social Effects	Contribution to Planning Objectives		
	Adds Habitat Units to Royal River Ecosystem	Maximize Efficiency of Habitat Unit Creation	RED activity Generated by construction	Improves Fish Passage/ Connectivity	Restores Riverine Habitat	Improves Productivity	Supports Native River Species	Improves Human Safety	Meets Project Objectives	Avoids Constraints	USACE Policy Compliant
No Action	None	N/A	None	No Improvement	No Improvement	No	No	No	No	Yes	Yes
Alt 2	25,880	Best Buy	High	High Improvement	High Improvement	Yes	Yes	Yes	Yes	Yes	Yes
Alt 3	1,849	Cost Effective	Moderate	Partial Improvement	High Improvement	Partial	Yes	Yes	Yes	Yes	Yes
Alt 4	12,940	Not Cost Effective	High	High Improvement	No Improvement	Partial	Partial	No	Partial	Yes	Yes
Alt 5	462	Not Cost Effective	High	Partial Improvement	No Improvement	Partial	Partial	No	Partial	Yes	Yes
Alt 6	12,940	Not Cost Effective	High	High Improvement	Partial Improvement	Partial	Partial	Partial	Partial	Yes	Yes
Alt 7	924	Not Cost Effective	High	Partial Improvement	Partial Improvement	Yes	Partial	Partial	Partial	Yes	Yes
Alt 8	6,470	Cost Effective	High	High Improvement	Partial Improvement	Partial	Partial	Partial	Partial	Yes	Yes
Alt 9	924	Not Cost Effective	Moderate	Moderate Improvement	Moderate Improvement	Partial	Partial	Partial	Partial	Yes	Yes
Alt 10	1,294	Cost Effective	Moderate	Moderate Improvement	Moderate Improvement	Partial	Partial	Partial	Partial	Yes	Yes
Alt 11	92	Cost Effective	Moderate	No Improvement	Moderate Improvement	Partial	Partial	Partial	Partial	Yes	Yes
Alt 12	647	Not Cost Effective	Moderate	Moderate Improvement	Moderate Improvement	Partial	Partial	No	Partial	Yes	Yes
Alt 13	46	Not Cost Effective	Low	No Improvement	No Improvement	Partial	Partial	No	No	Yes	Yes
Alt 14	1,294	Not Cost Effective	Moderate	Moderate Improvement	Moderate Improvement	Partial	Partial	Partial	Partial	Yes	Yes
Alt 15	924	Cost Effective	Moderate	Moderate Improvement	Moderate Improvement	Partial	Partial	Partial	Partial	Yes	Yes

Table 19: Comprehensive Benefits Analysis Summary (cont'd)

P&G Criteria	Effectiveness	Efficiency	Effectiveness	Effectiveness	Effectiveness	Effectiveness	Effectiveness	Effectiveness	Completeness	Completeness	Acceptability
Benefit Category	National Ecosystem Restoration (NER)		RED Benefits	Environmental Quality				Other Social Effects	Contribution to Planning Objectives		
	Adds Habitat Units to Royal River Ecosystem	Maximize Efficiency of Habitat Unit Creation	RED activity Generated by construction	Improves Fish Passage/ Connectivity	Restores Riverine Habitat	Improves Productivity	Supports Native River Species	Improves Human Safety	Meets Project Objectives	Avoids Constraints	USACE Policy Compliant
Alt 16	647	Not Cost Effective	High	Moderate Improvement	No Improvement	No	Partial	No	No	Yes	Yes
Alt 17	46	Not Cost Effective	Moderate	No Improvement	No Improvement	No	Partial	No	No	Yes	Yes
Alt 18	65	Cost Effective	Low	No Improvement	No Improvement	No	Partial	No	No	Yes	Yes

3.7 TENTATIVELY SELECTED PLAN DESCRIPTION

This project is federally funded under Section 206 of the CAP; a plan that best meets national interests must be identified under USACE regulations (ER 1105-2-100). This national plan, the NER Plan, reasonably maximizes environmental benefits, is cost effective, and provides aquatic habitat restoration benefits that are in the national interest. The NER plan must meet planning objectives and constraints and reasonably maximize environmental benefits while passing tests of cost effectiveness, significance of outputs, acceptability, completeness, cost efficiency, and effectiveness. If it does, then Step 6, the final step in the plan formulation process is complete. USACE regulations allow federal funding to be contributed to support the project to the maximum allowed when the NER plan is chosen as the proposed plan.

Alternative 2 is a best buy plan. It is recommended over the other cost-effective plans. Based on its superior environmental benefits and supporting evidence discussed above, the New England District recommends Alternative 2 for implementation. The TSP includes the following elements:

Bridge Street Dam Demolition

- Removal of the entire fish ladder and dam structure on the right descending bank structure
- Removal of the entire spillway and stop log structures
- No impact to the penstock
- Modification and repair of the intake structure where the stop log structure has been removed

East Elm Street Dam Demolition

- Removal of the entire fish ladder and dam structure on the right descending bank structure
- Removal of 120 LF of spillway on the right descending bank
- Protection of the spillway on the left descending bank.

Middle Falls Diversion to Side Channel

- Installation of diversion structure at the top of Middle Falls to divert streamflow into the side channel.
- Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

3.8 RISK AND UNCERTAINTY

3.8.1 Abbreviated Risk Analysis

An Abbreviated Risk Analysis (ARA) was developed relying on local District staff to provide expertise and information gathering. The cost engineer facilitated a risk assessment meeting on February 7, 2024, with the PDT in addition to a qualitative analysis to produce a risk register that served as the framework for the risk analysis. Risk Mitigation was conducted through an ARA of the project as it is currently presented in addition to the acknowledgement of risk in the scope and estimated quantities of material. The New England District has taken an approach to mitigate this risk through a conservative approach to the project duration, equipment and crews necessary to construct the project. The amounts included in the project cost provide an amount that the PDT is confident will provide substantive costs to mitigate issues. The New England District will continue to monitor and include all risks in continuing assessment of contingency and amend as necessary as an essential element to the continued development of the project. The key cost risk drivers identified through formal risk and sensitivity analysis were access of crews and equipment, riverine rock removal operations and native plant ecological restoration.

The ARA assumed the Project Development Stage is “Alternative Formulation” with a “Low Risk” risk category based on the experience of the cost engineer and vetted with the study team. The resultant overall contingencies are 28% for the Total Construction Estimate, 28.0% for Cultural Resource Preservation, 15% for Lands and Damages, 20% for Total Planning, Engineering & Design, and 16.0% for Total Construction Management. These contingency percentages were then utilized in the Total Project Cost Summary. More detailed information can be found in **Appendix E** “*Cost Engineering, Section 5.0 Abbreviated Risk Analysis”*.

3.8.2 Climate Change Assessment

An assessment was performed to identify existing and future vulnerabilities of the Royal River to climate change. The assessment was conducted in accordance with USACE Engineering Construction Bulletin (ECB) 2018-14, *Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects*, revised August 19, 2022. The assessment included a literature search and a review of existing information. In addition, the Climate Hydrology Assessment Tool (CHAT) was used to model trends in annual streamflow, precipitation, and temperature to predict future river conditions resulting from climate change. The complete analysis can be found in **Appendix F**.

Recent climate literature indicates that there is evidence of increasing mean air temperature trends in the study region. Winter temperatures may be increasing faster than in other seasons. The literature points to an increasing trend in the number and temperature of extreme heat days. The fourth National Climate Assessment (NCA4) in Dupigny-Giroux et al. (2018) projected that mean temperatures are projected to rise by 5.3 to 9.1 °F by the end of the 21st century.

Total precipitation, especially winter precipitation, is expected to increase. Whitehead et al. (2023), in the fifth National Climate Assessment (NCA5), noted increasing frequencies of 2-inch through 5-inch precipitation days per annum from 1958 to 2022 (49 to 103% increases). Two studies (Janssen et al., 2016; Thibeault and Seth, 2014) pointed to an increase during the 21st century in winter precipitation of 1 inch per month for the months of December to April. Although drier summers were expected to lead to lower summer stream flows and more frequent drought conditions (NCA4, Dupigny-Giroux et al., 2018). The occurrence of extreme storm events is predicted to increase over time. One study (Rawlins et al., 2012) predicted an 80% increase in high-intensity storm frequency (almost an effective doubling of the storm frequency). Snowmelt and spring thaws of lake ice have been observed to occur earlier in the year. Stream flows are expected to increase in the fall, winter, and spring, but decrease marginally in the summer months. The literature synthesis findings are summarized in **Figure 24**.

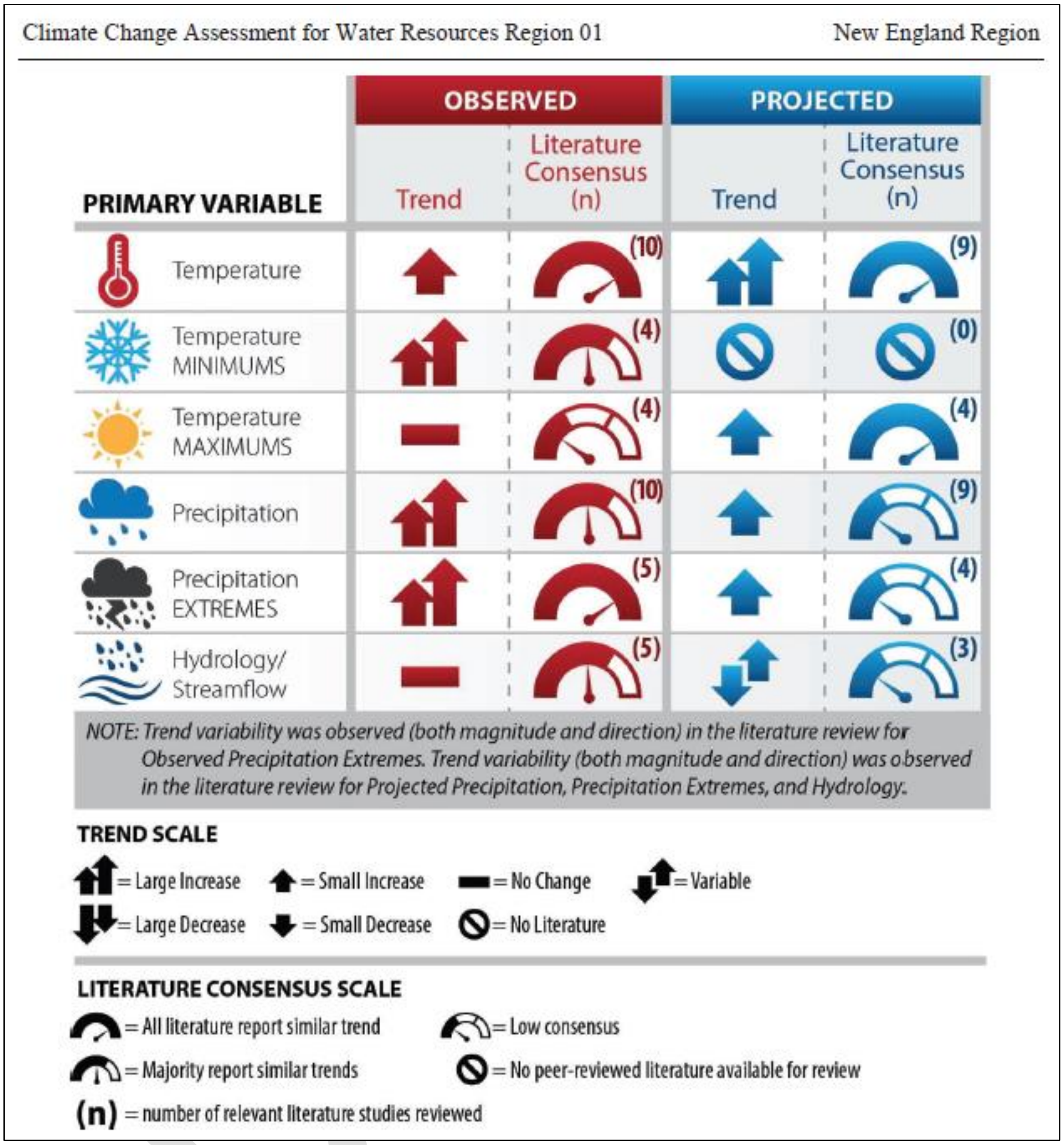

Figure 24: Summary of Observed and Projected Climate Change from Existing Literature.

The change in climate may impact the restoration of the aquatic ecosystem and fish passage within the study area. Elements of climate change that were considered include change in sea level, increase in temperature, changes to rainfall and snowfall patterns, and changes in stream flow.

Sea level is known to be rising, although there is not yet consensus about the rate of change.

The range of potential sea level changes in Portland, ME through 2130 is shown in **Figure** . The extension of the record through 2024 is likely to translate into increases in sea level of 2 to 8 ft by 2130. Greater detail is included in the climate change appendix (**Appendix F**).

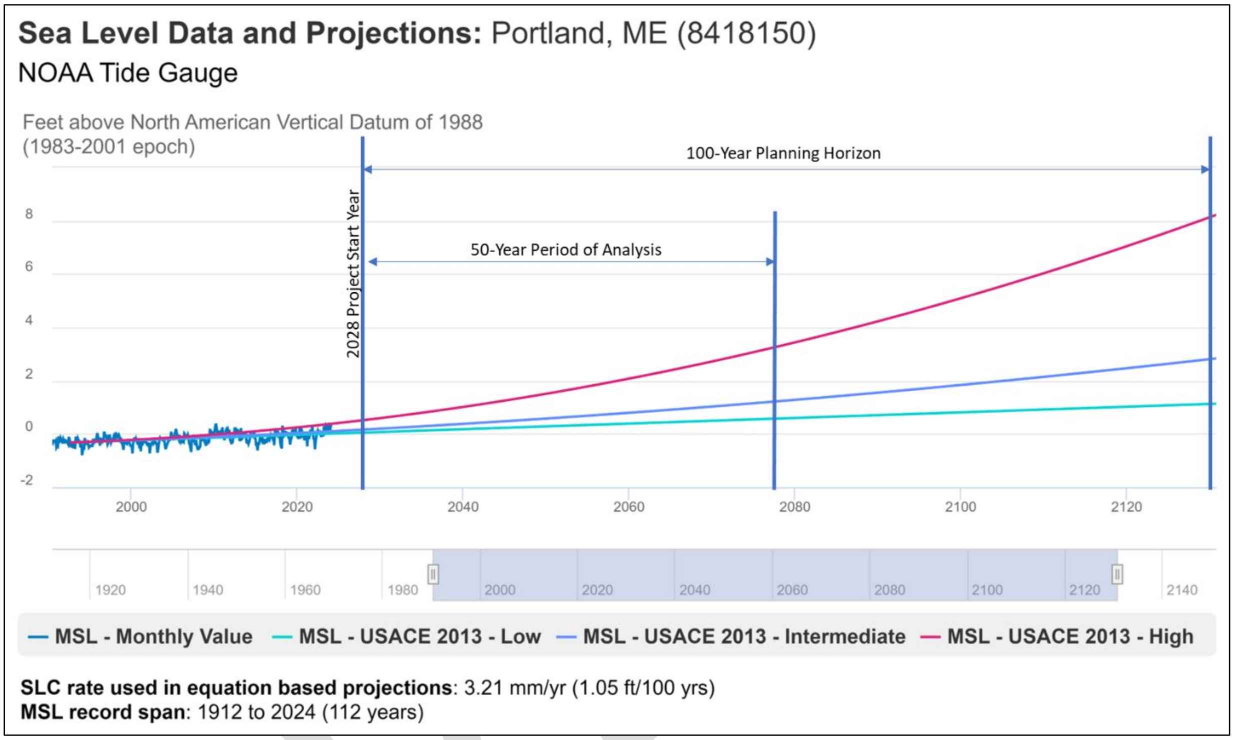

Figure 25: USACE Sea Level Projections for Portland, ME

Higher sea levels result in additional risks to vulnerable infrastructure; however, the higher relative sea level for this ecosystem restoration project would have positive impacts on fish passage. First, higher sea levels may promote fish passage from the Atlantic Ocean to upstream spawning locations.

Higher sea levels may assist non-native species, including fish, shellfish and aquatic plants, entering the watershed. Removal of dams in the river system could serve to increase flow velocities thereby limiting ingress of non-native, non-migratory species. If non-native species become established in the Royal River system, they may compete with the target species for habitat within the river system.

Average temperatures may increase due to climate change. Warmer weather will result in increased water temperatures, which could have negative environmental impacts. Warmer water usually has lower dissolved oxygen concentrations than colder water. Low dissolved oxygen concentrations could stress fish and other aquatic species, leading to increased levels of disease and quicker fatigue. It is anticipated that alewife will adapt well to the warmer temperatures, but some trout species will be stressed in the warmer environment. The change in water temperature could also change the timing of migrations, with younger fish arriving at the river before they are strong enough for the upstream migration. The negative impacts of increased water temperatures are expected to be buffered by infiltration of groundwater into the river and the higher water velocities that are expected to occur when the dams are removed. Additionally, lower water levels in the impoundments will create/expose areas of riffles and cascades, which will introduce more oxygen into the faster-moving parts of the river.

Climate change may lead to changes in precipitation patterns. The region may experience more intense storms and faster river flows. Snowmelt and spring flows may happen earlier in the upstream migration season, while lower amounts of rain will fall during the summer. These changes in rain and snow patterns could impact fish passage:

- Greater water velocities could make upstream migration more difficult.
- Change the timing of migration.
- Low rainfall in summer leads to reduced dissolved oxygen concentrations.

Changes in stream flow may be the result of climate change. Annual peak flows, which typically occur during the upstream migration season, are expected to increase. While summer flows are expected to decrease.

Changes to the spring migration season could increase the difficulty of swimming upstream due to higher velocities. Higher water temperatures and lower dissolved oxygen during the downstream migration season will impact young growing fish, which are more vulnerable to extreme environmental conditions. It is anticipated that alewife would adapt well to the warmer temperatures, but some trout species will be stressed in the warmer environment.

3.9 ESTIMATE PROJECT COSTS AND SCHEDULE

After the TSP was chosen, the project design was refined to better reflect project scope and work limits. Also, an adaptive management plan which includes seeding the exposed banks of the East Elm Street Dam impoundment and other elements, was added to the TSP. The project cost estimate was updated to incorporate those changes to represent current dollar first costs and fully funded costs.

The project first cost estimate was approximately $5,100,000 based on October 1, 2023 price levels. The fully funded Total Project Cost is estimated to be $5,718,000 of which 65% (roughly $3,717,000) is the responsibility of the Federal Government per the cost-share requirements of the Section 206 authority. The NFS must pay 35% (roughly $2,001,000) of the total cost of the TSP. The non-federal share of project costs can be offset by the value of Lands, Easements, Rights-of-Way, Relocations, and Disposal Areas (LERRDs) for which they are responsible. The NFS has indicated they have the financial capability to cover their cost responsibilities required by under a future PPA.

Table 20 below provides the schedule for the feasibility study and the Design and Implementation (D/I) phases for the Royal River Section 206 project.

Table 20: Feasibility Study and Implementation Schedule

Project Task	Milestone Code	Current Scheduled Date
Federal Interest Determination	CW170	Apr 2020 (A)
Execute Feasibility Cost Share Agreement	CW130	Sep 2021 (A)
Tentatively Selected Plan Meeting	CW190	Apr 2024 (A)
Agency Technical Review		Oct 2024
Final Report Submittal to NAD	CW150	Mar 2025
NAD approves Final DPR/EA	CW170	May 2025
Execute Project Partnership Agreement	CW130	Aug 2025
Final ROW Drawings Submitted to Real Estate		Feb 2026
Approve Plans & Specs	CW330	Sep 2026
Contract Award	CC800	Mar 2027
Project Physical Completion	CW450	Oct 2028
Project Fiscal Closeout	CW470	Dec 2028
Notice of Project Completion	CW480	Jul 2028

3.10 BENEFITS PROVIDED BY THE TENTATIVELY SELECTED PLAN

In addition to the modeled alewife passage benefits described in **Section 3.5.1**, the TSP will provide other benefits to the study area and the entire Royal River Watershed. These benefits include:

- Increases connectivity, providing unhindered upstream (and downstream) fish passage (32 miles on the main stem and 176 miles of tributaries). **Figure 26** is a map that was developed by the USFWS for a report by Maine Rivers and illustrates the river miles that currently restrict fish passage due to the presence of dams. The area in light and dark green represents the river miles that would become accessible to fish passage if the TSP was implemented. The study area is indicated by the red circle.

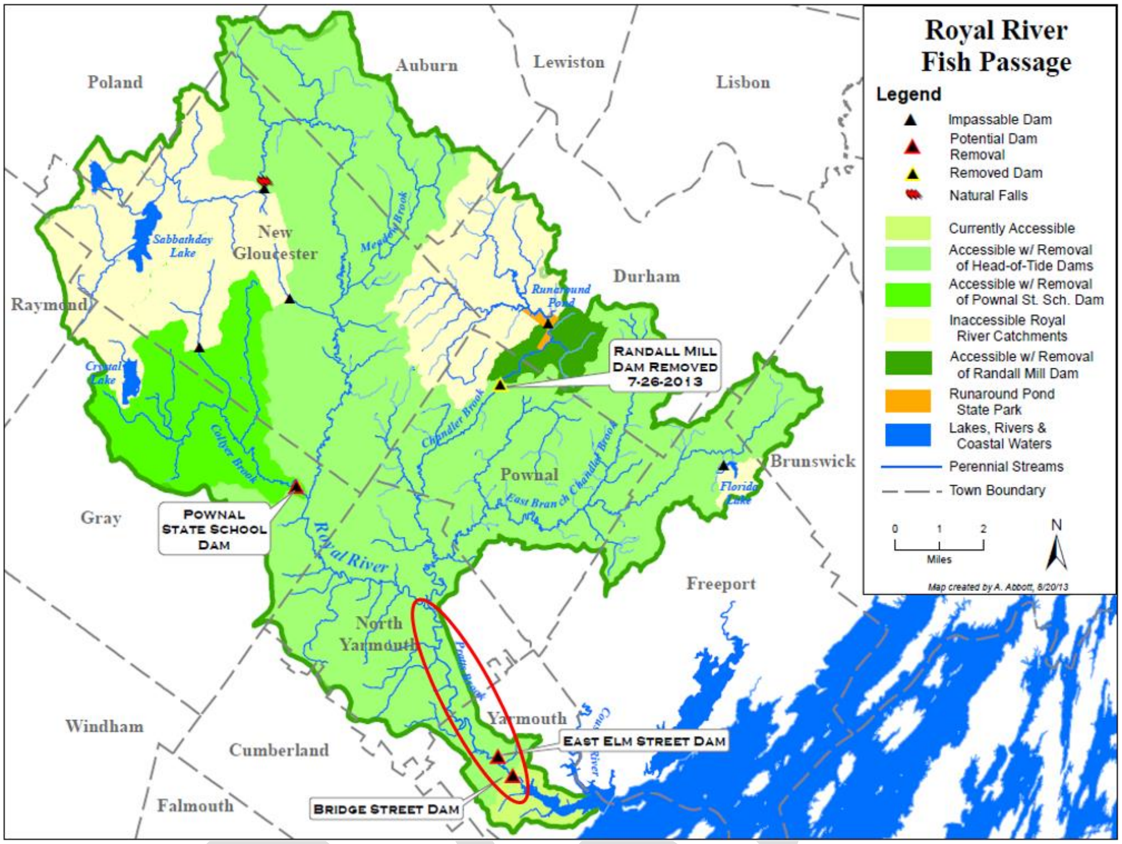

Figure 26: River Miles on the Royal River that would be Opened to Fish Passage of the East Elm Street and Bridge Street Dams
(Source: Gulf of Maine Coastal Program, U.S. Fish and Wildlife Service, 2013)

- Restoration of approximately six miles of impounded reaches upstream of the Elm East and Bridge Street Dams to more natural river habitat.
- Reestablishment of fish runs would increase river productivity.
- Restore natural river cascades.
- In addition to mitigatory species, the TSP will benefit other native fish species, such as white sucker, sea lamprey, brook trout.
- Elimination of millions of dollars in future O&M, repair, and replacement costs.
- Improved safety and reduction of liability for the Town.

4.0 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES*

The proposed Royal River project would reduce three physical barriers within the Royal River Watershed. Removing or reducing the effects of these barriers would restore connectivity to the 32 miles of main stem of the Royal River upstream of the physical barriers and in turn, restore habitat for alewife, American Shad and other diadromous fishes upstream of Bridge Street Dam. The No Action Alternative would have no effect on the physical barriers within the Royal River. Seven alternatives, including the No Action Alternative, are cost effective and implementable. These plans consist of measures that include removal of the Bridge Street and East Elm Street Dams, replacement of the fish ladders at both dams, and improvements to the Middle Falls diversion. The effects of these measures are discussed in the sections that follow.

4.1 HYDROLOGIC & HYDRAULIC EVALUATION

A hydraulic model was used to simulate the range of water surface elevation and velocity that would result from the implementation each of each alternative. The model was also used to develop the conception designs for bank stabilization and in-stream structures. The USACE HEC-RAS model was used for this analysis. HEC-RAS Version 6.1 was initially used to develop the terrain and initial model at the beginning of the study, then Version 6.4.1 was used for model finalization, computations, and alternative evaluation.

As described previously in this report, the model assessed a variety of different river conditions, including high, low, and normal flow conditions. “Normal” flows are referred to as “Annual Median Flow”. This flow is developed using the USGS stream gage at First Falls, which records the flow in the Royal River every 15-minutes. This information is used to develop an average daily flow for every day the gage has been recording. The daily average values were ranked, and the median (50-percentile) annual value is identified. The median is the value where half of the daily average flows in a year are the same or lower, and half of the daily average flows in a year are the same or higher. **Table 21** lists each river condition that was modeled, and the water flow experienced during each condition. Additional information about the modeling can be found in **Appendix C**.

Table 21: The River Conditions Assessed with Hydraulic Modeling

River Condition	Water Flow (CFS)
Drought (7Q10)	25 cfs
Annual Median Flow (Normal)	120 cfs
2-Year Flood Event (50% AEP)	3,643 cfs
10-Year Flood Event (10% AEP)	6,480 cfs
100-Year Flood Event (1% AEP)	10,419
Fish Passage Low Flow (95% percentile)	62 cfs
Fish Passage High Flow (5% percentile)	641 cfs

Model results indicate that water velocities and river depths will remain relatively unchanged during high flow events. Although, some areas may experience within bank flow depth increases, particularly areas downstream of the dams. Changes to the river character are expected to occur during normal and low flow conditions. During these conditions, that river is expected to become shallower and narrower than the existing condition. These changes will be more pronounced in areas upstream of the dams, between Bridge Street and Middle Falls, and also between the East Elm Street Dam / Royal River Park and State Route 9 /Baston Park. Information on projected river depth and water velocity for all modelled conditions can be found in **Appendix C**. The modeling results presented in this main report will focus on the changes to the Royal River that are projected to occur at "normal" or annual median flow unless specifically indicated.

Figure 27 illustrates projected change in river depths throughout the study area at "normal" Annual Median flows. Current river conditions are identified by a gray line, with predicted river heights if the TSP is implemented in blue. The bathymetry of the river bottom is represented with the green line. Sites of interest on the river are identified with labels. The predicted change in river height between the existing conditions and the TSP will vary within the study area. Callen Point and Yarmouth Harbor would not see any change in river height. Above the Bridge Street Dam, river levels are expected to drop 4 ft. While at the US Route 1 crossing, the river is predicted to drop by 2 ft. Above the East Elm Street Dam, the river is predicted to be lowered by 4 ft. Impacts to locations within the impoundment upstream of the East Elm Street Dam will vary. Near the canoe launch behind the Yarmouth History Center, the river is expected to drop by 4 ft. Moving upstream, the magnitude of impacts to the water level will become less, with a predicted drop at the US Route 9 bridge of approximately 2 ft.

Figure 28 presents a comparison of water velocity between the existing condition (gray line) and after the TSP has been completed (blue line) at "normal" Annual Median flows. Water velocity is predicted to remain relatively unchanged from East Elm Street Dam to the North Yarmouth town line. Between the East Elm Street Dam and Bridge Street, velocities are expected to generally increase, with areas downstream of Bridge Street expected to be primarily unchanged. Upstream of the North Yarmouth town line, there are sites that are projected to experience marginally higher water velocities.

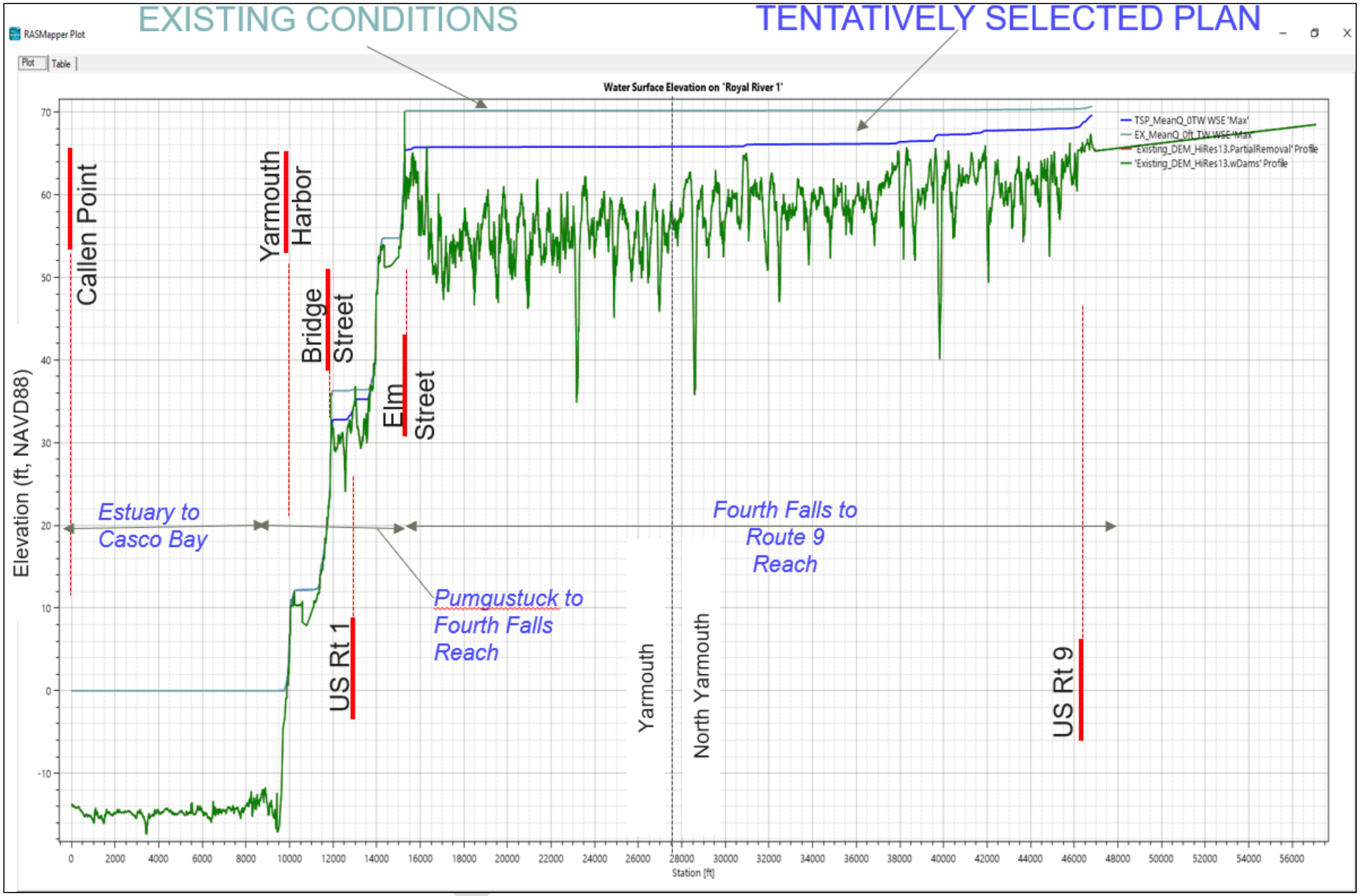

Figure 27: Water Surface Profile Comparison at the Annual Median Flow in the Study Area

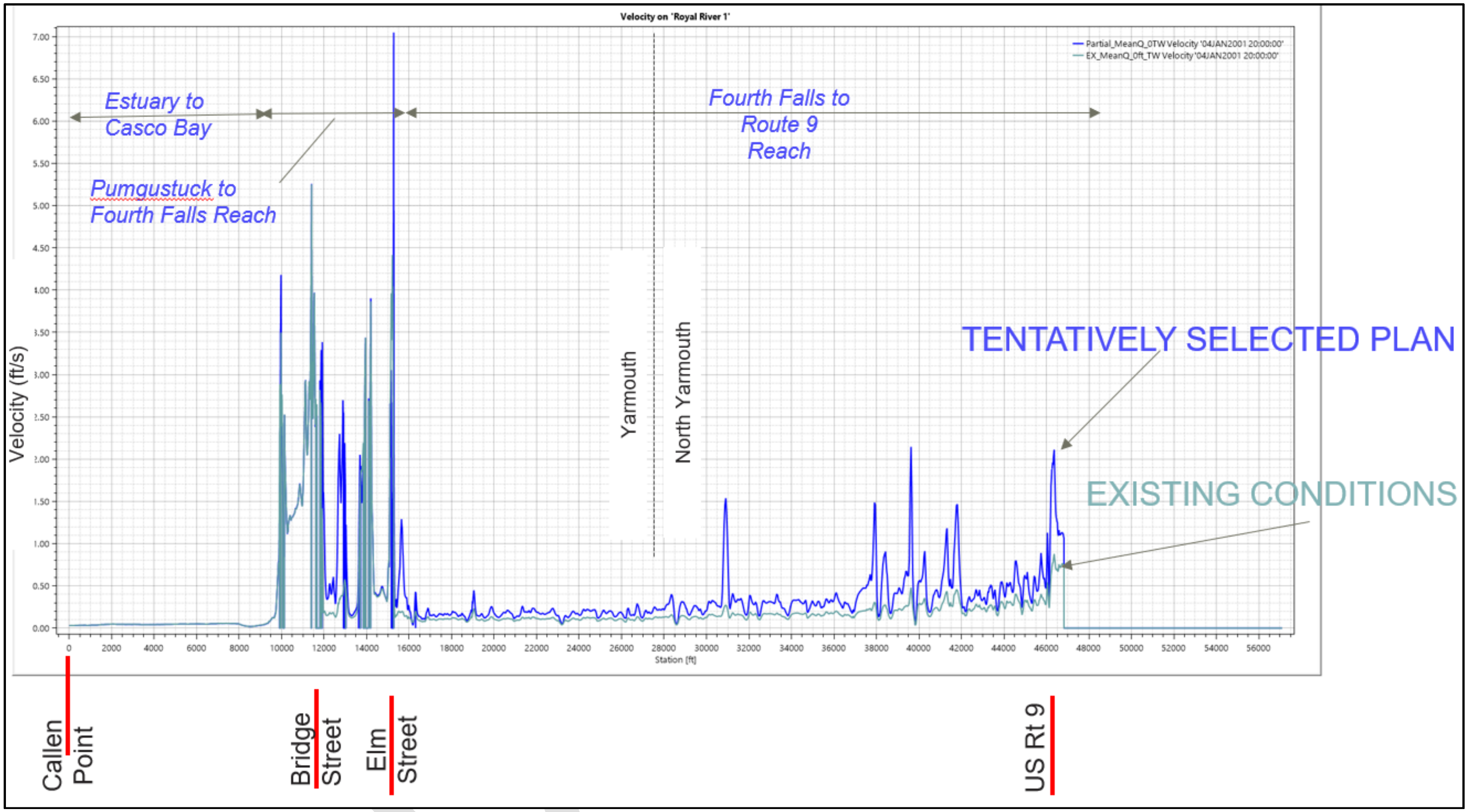

Figure 28: Water Velocity Profile Comparison at the Annual Median Flow in the Study Area

Figure 29 illustrates the projected changes in water depth at annual median flow between the Yarmouth Harbor and East Elm Street Dam. There are no projected changes to water depth from First Falls to the mouth of the river. Upstream of the Bridge Street Dam, the river is expected to become shallower and narrower, as seen immediately upstream of the Bridge Street Dam (**Figure 30**). Additionally, it is predicted that the main current of the river will move towards the center of the channel at the Bridge Street Dam site.

Upstream of Bridge Street at the Beth Condon Foot bridge, the river is projected to drop between 2.0 and 2.5 ft, exposing a rock ledge and creating new cascades (**Figure 31**). The yellow lines across the river channel in **Figures 30 and 31** correspond to the inset river profiles, with the light blue line representing the existing conditions and the dark blue line showing the projected condition.

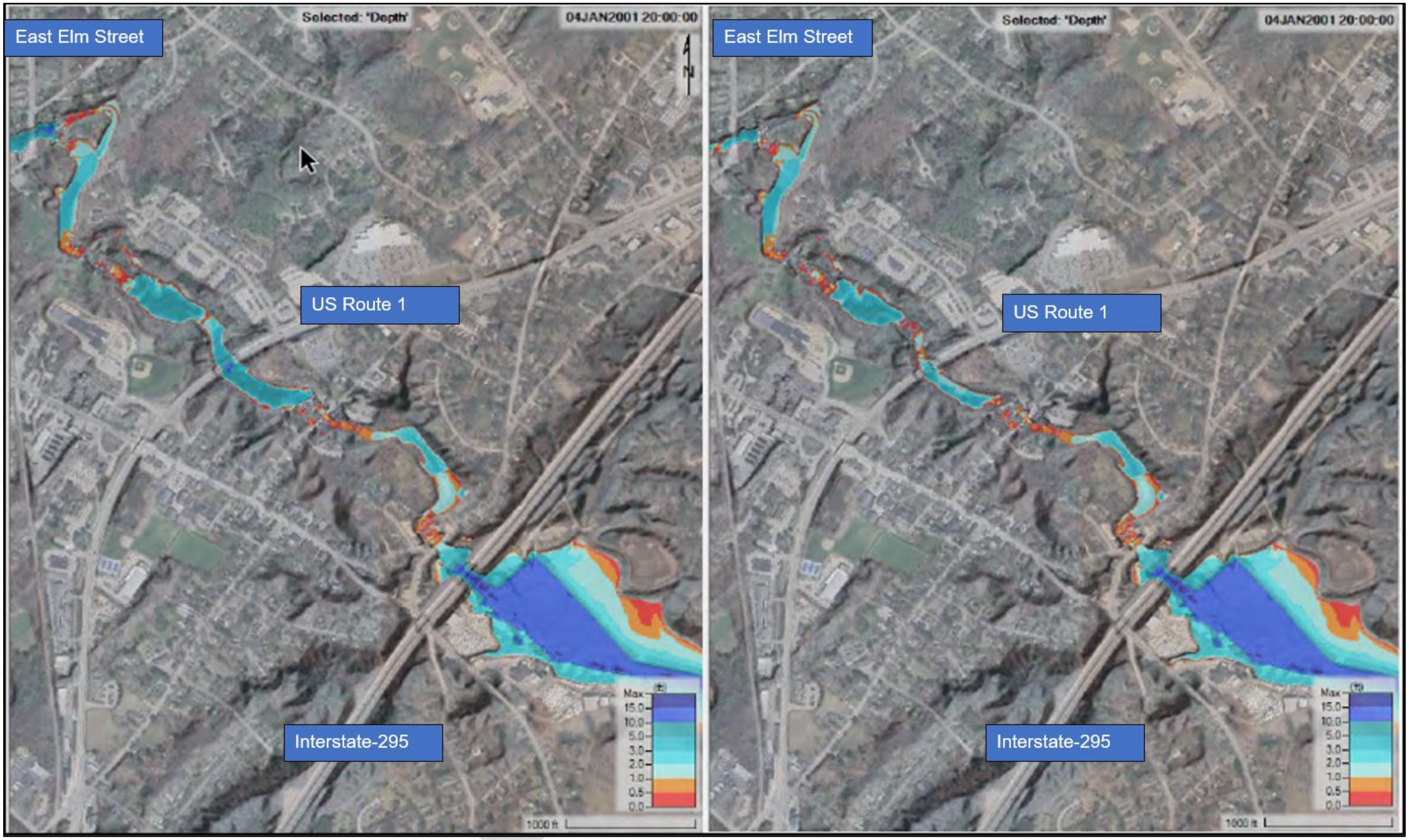

Figure 29: Comparison of Existing (left) and Projected (right) River Depths at Annual Median Flows Between the Bridge Street and East Elm Street Dams.

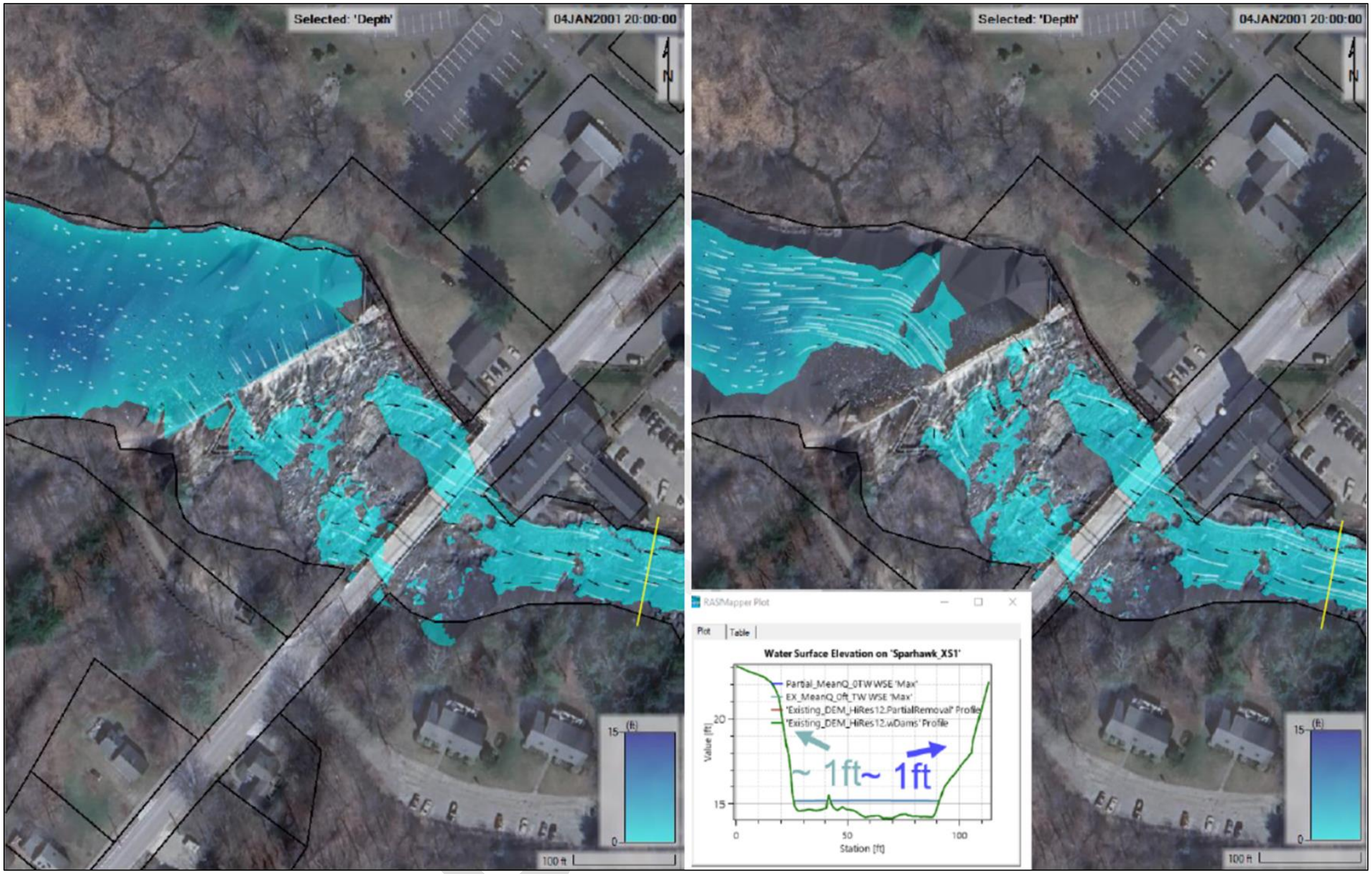

Figure 30: Depth Comparison Existing (left) and Projected (right) River Depths at Annual Median Flows at the Bridge Street Dam

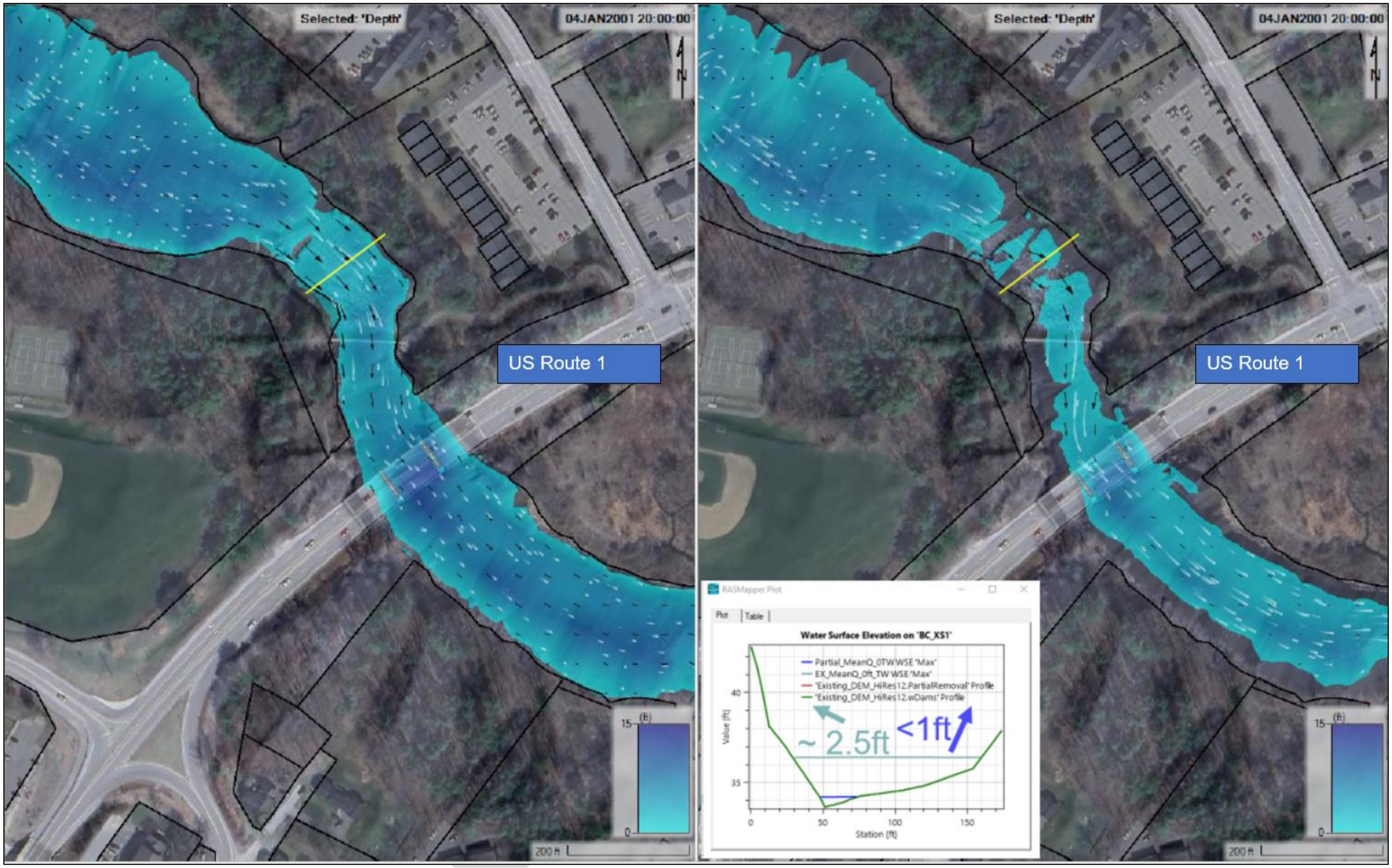

Figure 31: Depth Comparison Existing (left) and Projected (right) River Depths at Annual Median Flows at the Beth Condon Foot Bridge.

No significant changes to the depth or width of the river are projected to occur at Middle Falls. Both the main and side channel should remain similar to existing conditions. The TSP would result in an increase in the volume of water flowing through the side channel.

Dam removal would affect the northern branch of the river that passes around Gooch Island. The partial removal would leave in place the northern section (left descending bank) of the dam, diverting the water down the cascade at the southern end except in larger storm events. This area is further highlighted in **Figures 32 and 33** depicting predicted changes in depths and inundation limits**.**

The East Elm Street partial dam removal would also affect the Foundry Channel, which is depicted in **Figure 32**. Foundry Channel is historic mill race that allows water to bypass the East Elm Street Dam, flow through Royal River Park, and rejoin the main stem Royal River at a point between Gooch Island and Middle Falls. Predicted lower water levels upstream of East Elm Street would reduce the depth and velocity of water flowing through this reach of the river except during larger flow events.

Projected changes to the Royal River upstream of the East Elm Street Dam are discussed in detail in the next section of the report, **Section 4.2, Aesthetics & Recreation.** In addition to results of the various modeled river conditions, information on model development, data sources, assumptions and simplifications, sources of uncertainty, and sensitivity analyses can be found in **Appendix C**. That appendix also includes potential future efforts to refine the hydrologic and hydraulics in the D/I phase which include:

- Refine the evaluation/design of Middle Falls project elements for aquatic organism passage criteria, including acquisition of survey throughout Factory Channel, if required.
- Extend Royal River hydraulic model upstream to Wescustogo Park and along Chandler Brook to the first railroad crossing, or further upstream, as relevant, to evaluate the full upstream limits of potential drawdown effects.
- Further refine collective understanding of bathymetric surface and bottom conditions at immediate vicinity of dams, as relevant.
- Collect additional bathymetry in the Gooch Island back channel to enhance the definition of the hydraulic response in this area, if appropriate.
- Enhance 2D computation mesh at areas of enhanced interest especially around dam removals and aquatic organism passage projects.
- Establishment of a stream gage, or similar instrumentation at the State Route 9 bridge could help provide a more complete understanding of channel hydraulics when used with the current USGS stream gage. This would allow enhanced model calibration for normal, and any flood flows experienced during its operation, reducing uncertainty and providing improved understanding of both With and Without Project conditions.
- Develop a plan for post-construction validation of aquatic organism passage that can be integrated into the Adaptive Management Plan, if appropriate

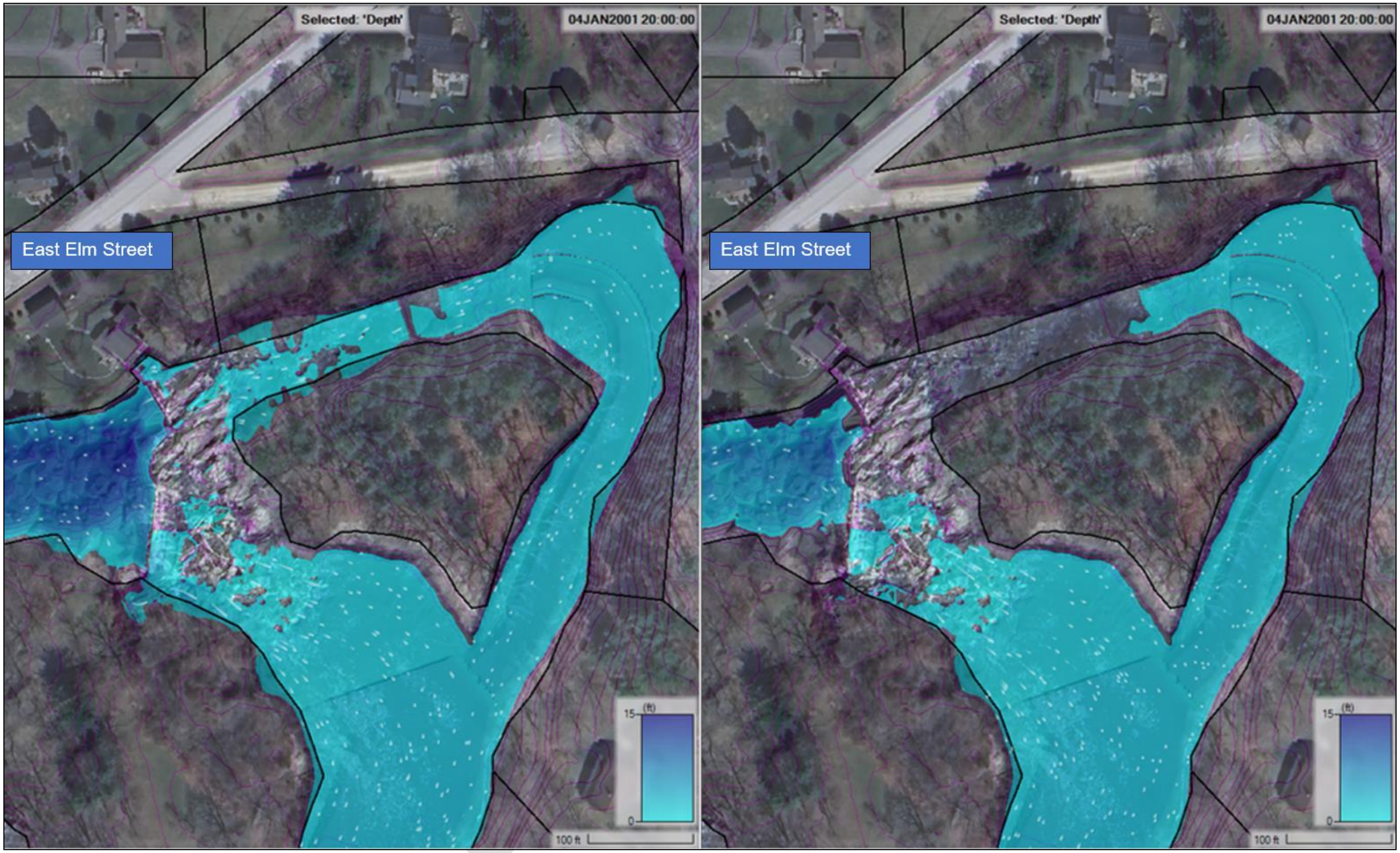

Figure 32: Depth/Inundation Comparison of Current (left) and Projected (right) Annual Median Flow Downstream of East Elm Street Dam

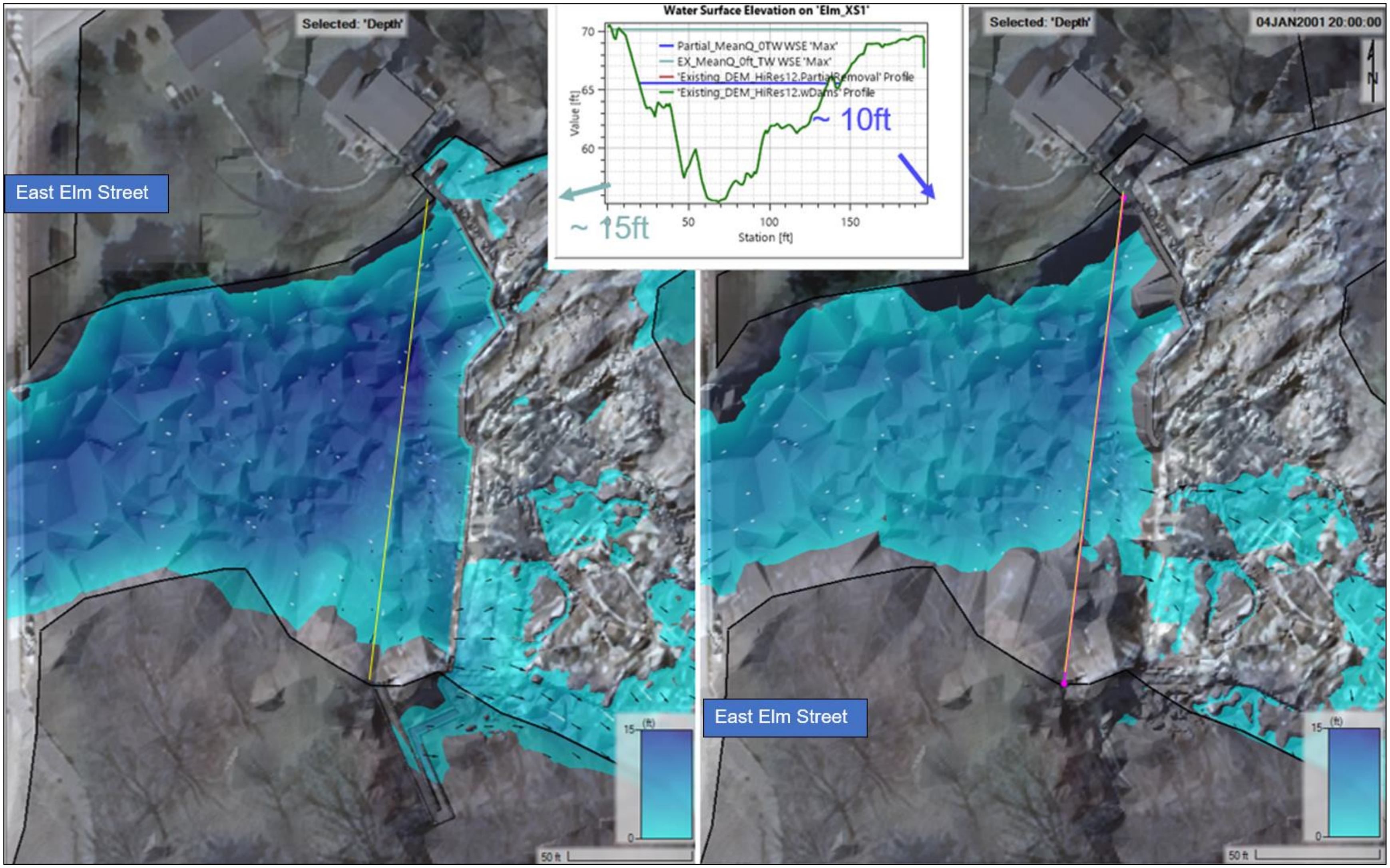

Figure 33: Depth Comparison Existing (left) and Projected (right) River Depths at Annual Median Flows at the East Elm Street Dam

4.2 AESTHETICS & RECREATION

Minor impacts to recreation in the area would occur as a result of construction activities. Recreational boating would be restricted in the areas where construction is taking place. The canoe launch behind the Yarmouth History Center and parking lot may be limited for use during periods of construction. Advanced notification would be issued to minimize impacts to recreational users of the project area.

The Royal River is an extremely important resource for recreation and the potential impact of having the water level lower upstream of East Elm Street Dam has been a concern for stakeholders. To ease these concerns, hydraulic modeling was performed to estimate this impact. The modeling results indicate that there would be minor impacts to recreational activities on the river. Although the partial removal of the East Elm Street Dam would result a narrowing of the river channel and the reduction of water depth, the opportunity to canoe, kayak, swim and paddleboard in the area upstream of the East Elm Street Dam are expected to remain available to the public with the alternatives that include dam removal. Side-by-side images (**Figures 35 - 41**) from the Bridge Street Dam to Baston Park illustrate the differences between existing water depths to projected water depth are provided in the next section of the report. These comparisons help to assess potential impacts on recreational boating and other recreational activities. The condition of the impoundments would remain unchanged for the alternatives that include fish ladder construction.

The removal of the East Elm Street Dam would reduce the water depth between the East Elm Street Dam and the Yarmouth History Center canoe launch (**Figure 34**). This would remove the barrier to passage by kayaks and other small watercraft created by the East Elm Street Dam but change the nature of the waterbody for activities like stand-up paddleboarding that may benefit from the slower moving water in the impoundment. The East Elm Street Dam currently serves as a barrier that prevents recreational boaters from going down the cascade, which is mostly exposed rock and fast-moving water. With the removal of the dam, a bedrock ridge, located approximately 300 ft upstream of the dam, would be exposed and would act as barrier during Annual Median flows, potentially keeping boaters from floating downstream to the falls at the current location of East Elm Street Dam. There is potential that the cascade will begin at this bedrock ridge and continue through the East Elm Street Dam. The installation of signage and other safety precautions are recommended at the canoe launch.

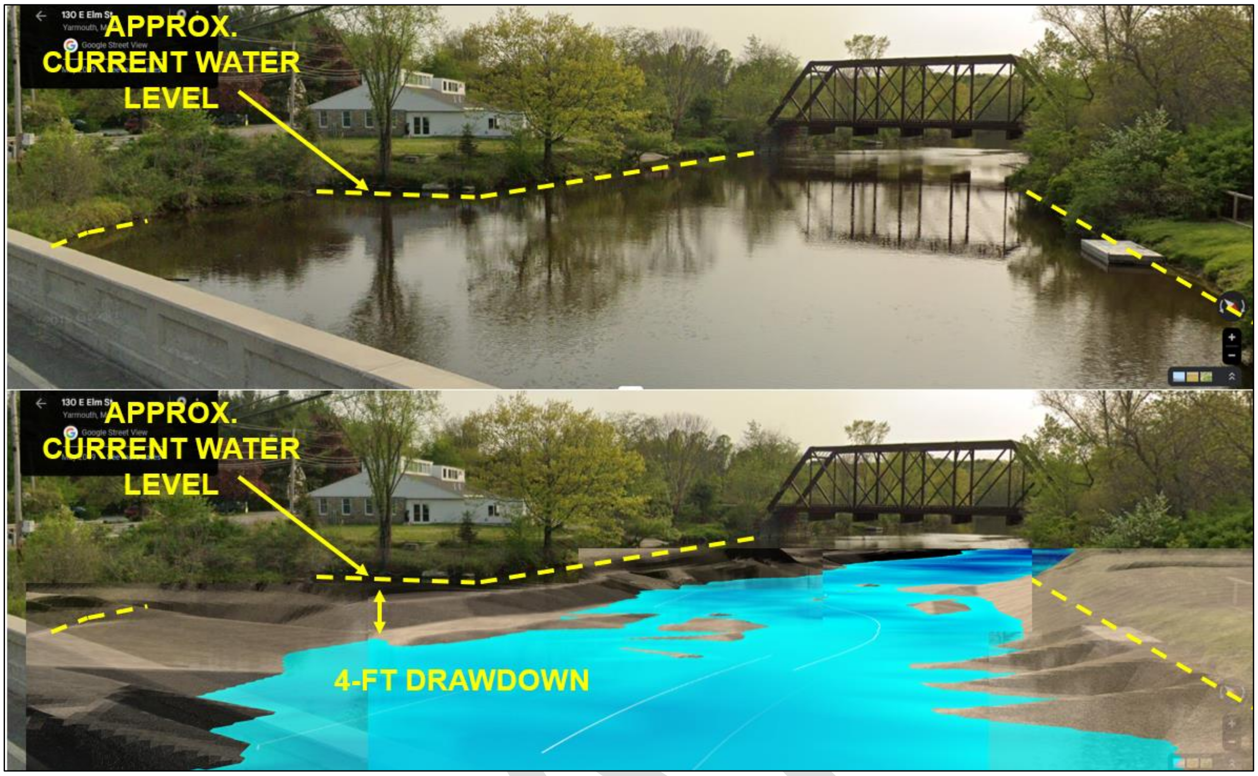

Figure 34: Comparison of existing (top) and projected (bottom) river conditions at Annual Median flows looking upstream of East Elm Street toward the canoe launch.

The bedrock ridge would also impact river depths upstream of the canoe launch. This ridge would reduce the impacts of partial dam removal on water level and current speed. **Figures 35** provides a comparison between the existing water levels at Annual Median flows and projected water levels near the canoe launch. For most of the East Elm Street Dam impoundment, at Annual Median flows, water depths will remain deep enough to allow flat water boating. Only four points in the impoundment are expected to have water depths of 1.5 ft or less. The first site is located upstream of the Maine Central Railroad Bridge (**Figure 38**). While the other three sites are found near Toddy Brook where there are two significant bends in the river. These sites are predicted to become narrower and shallower, although the central channel of the river is predicted to remain passable (**Figure 40**). The uppermost extent of the East Elm Street impoundment is unlikely to see significant changes in paddle depth (**Figure 41**). Water velocities are not predicted to increase significantly.

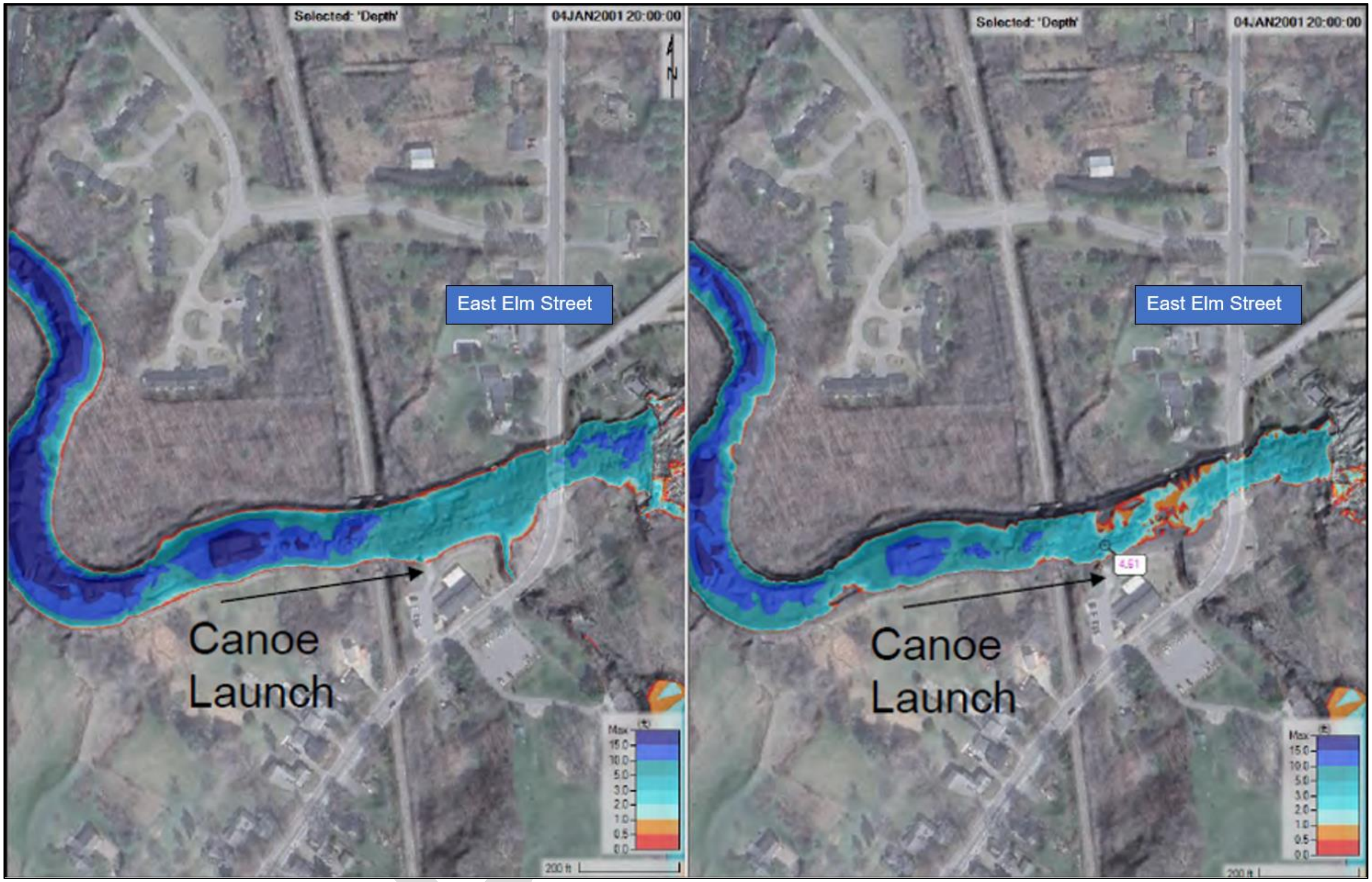

Figure 35: Comparison of Existing (left) and Projected (right) River Depths at Annual Median Flows Immediately Upstream of the East Elm Street Dam

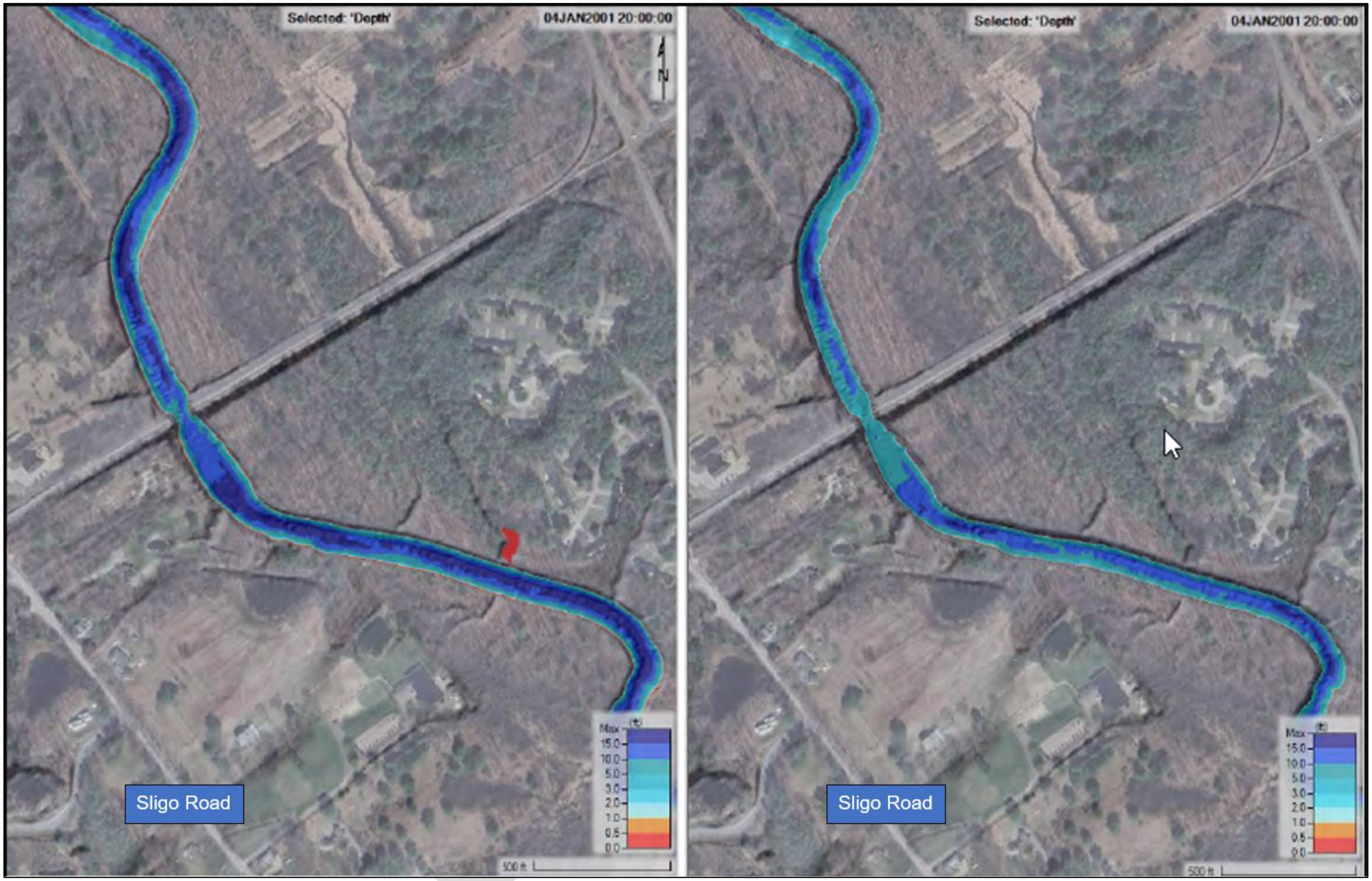

Figure 36: Comparison of Existing (left) and Projected (right) River Depths at Annual Median Flows Upstream of the East Elm Street Dam, Near the Maine Central Railroad Bridge

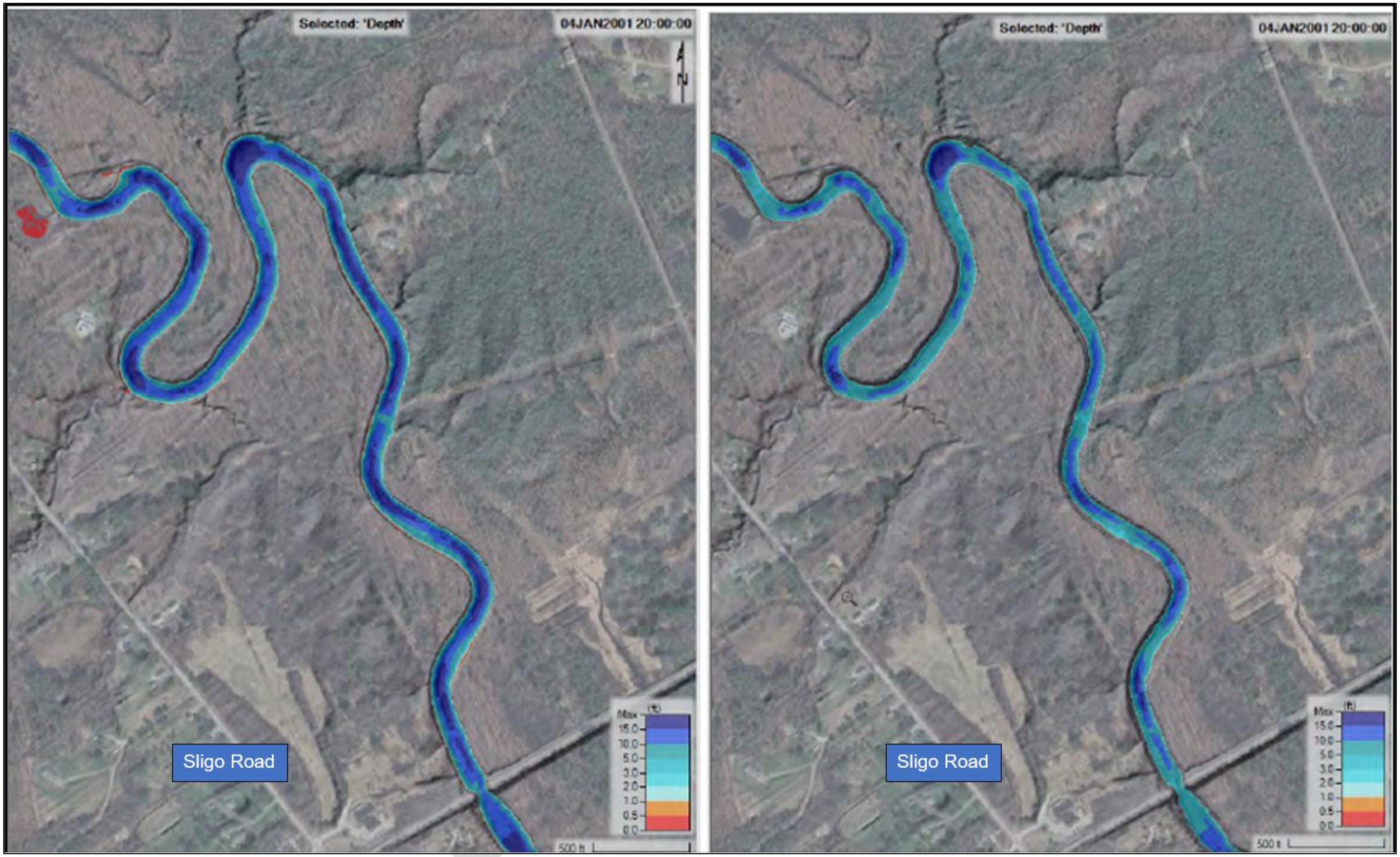

Figure 37: Comparison of Existing (left) and Projected (right) River Depth at Annual Median Flows Upstream of the East Elm Street Dam, Upstream of the Maine Central Railroad Bridge

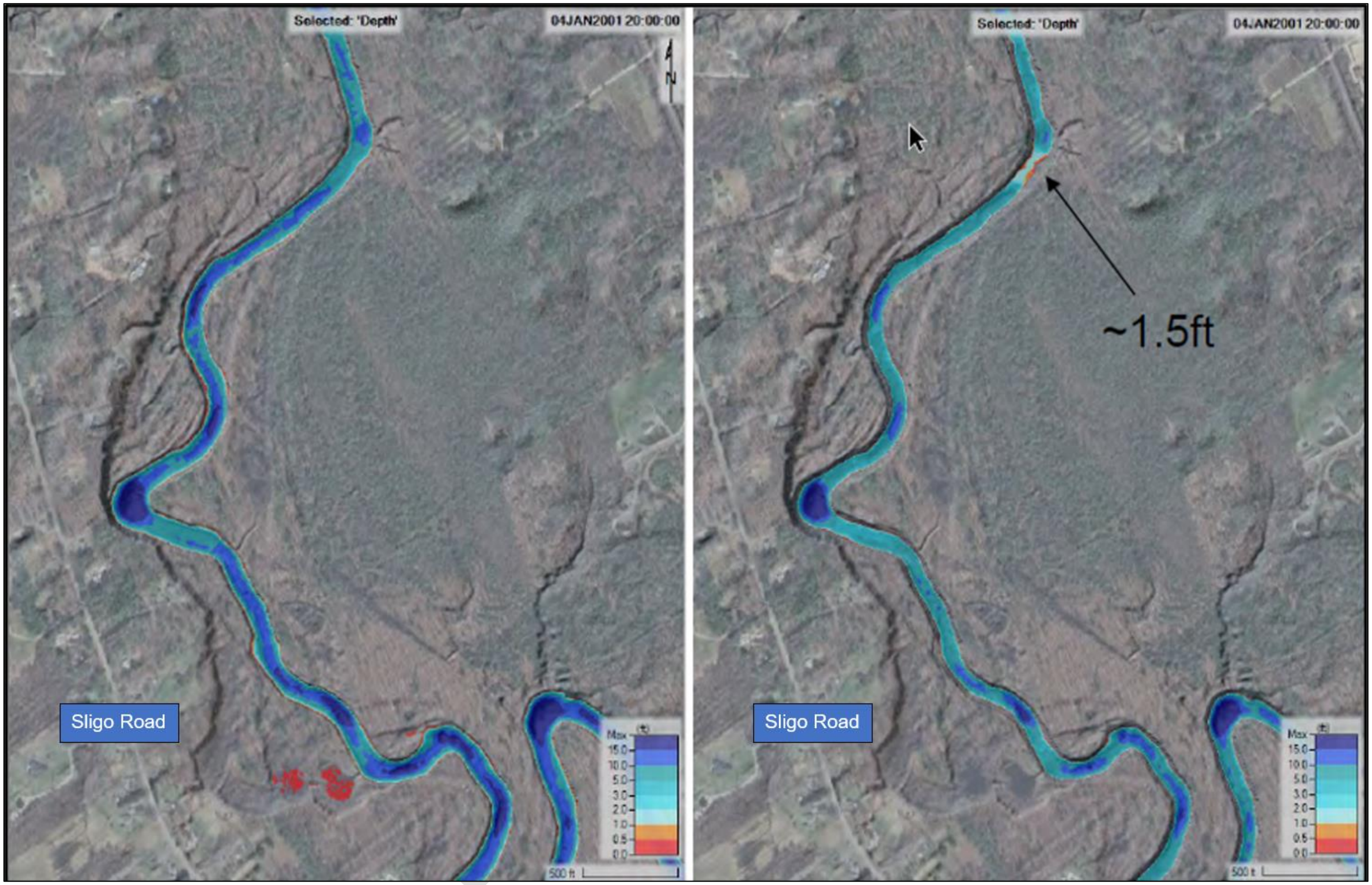

Figure 38: Comparison of Existing (left) and Projected (right) River Depth at Annual Median Flows Upstream of the East Elm Street Dam, Further Upstream of the Maine Central Railroad Bridge

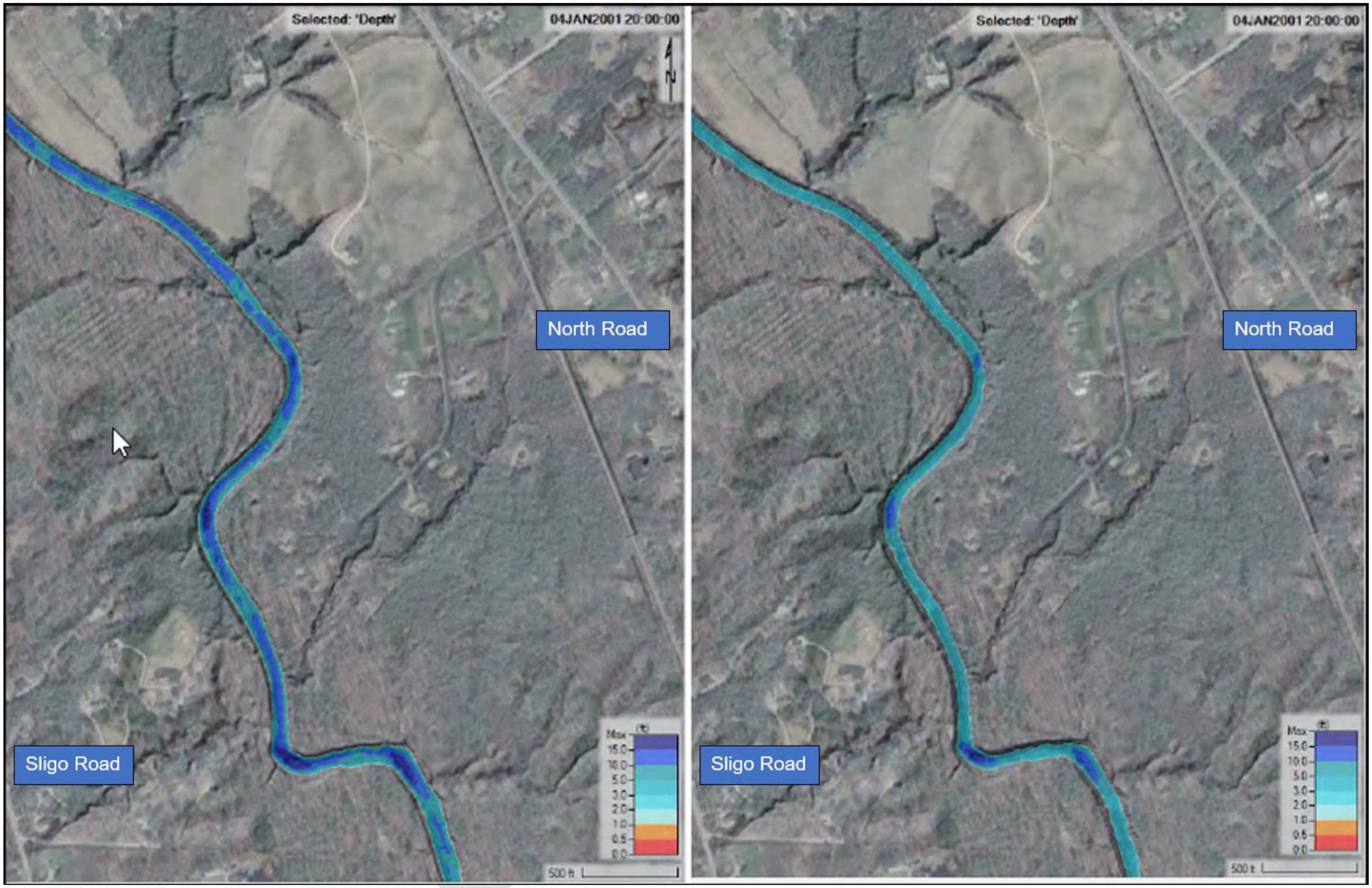

Figure 39: Comparison of Existing (left) and Projected (right) River Depth at Annual Median Flows Upstream of the East Elm Street Dam, Upstream of the Maine Central Railroad Bridge

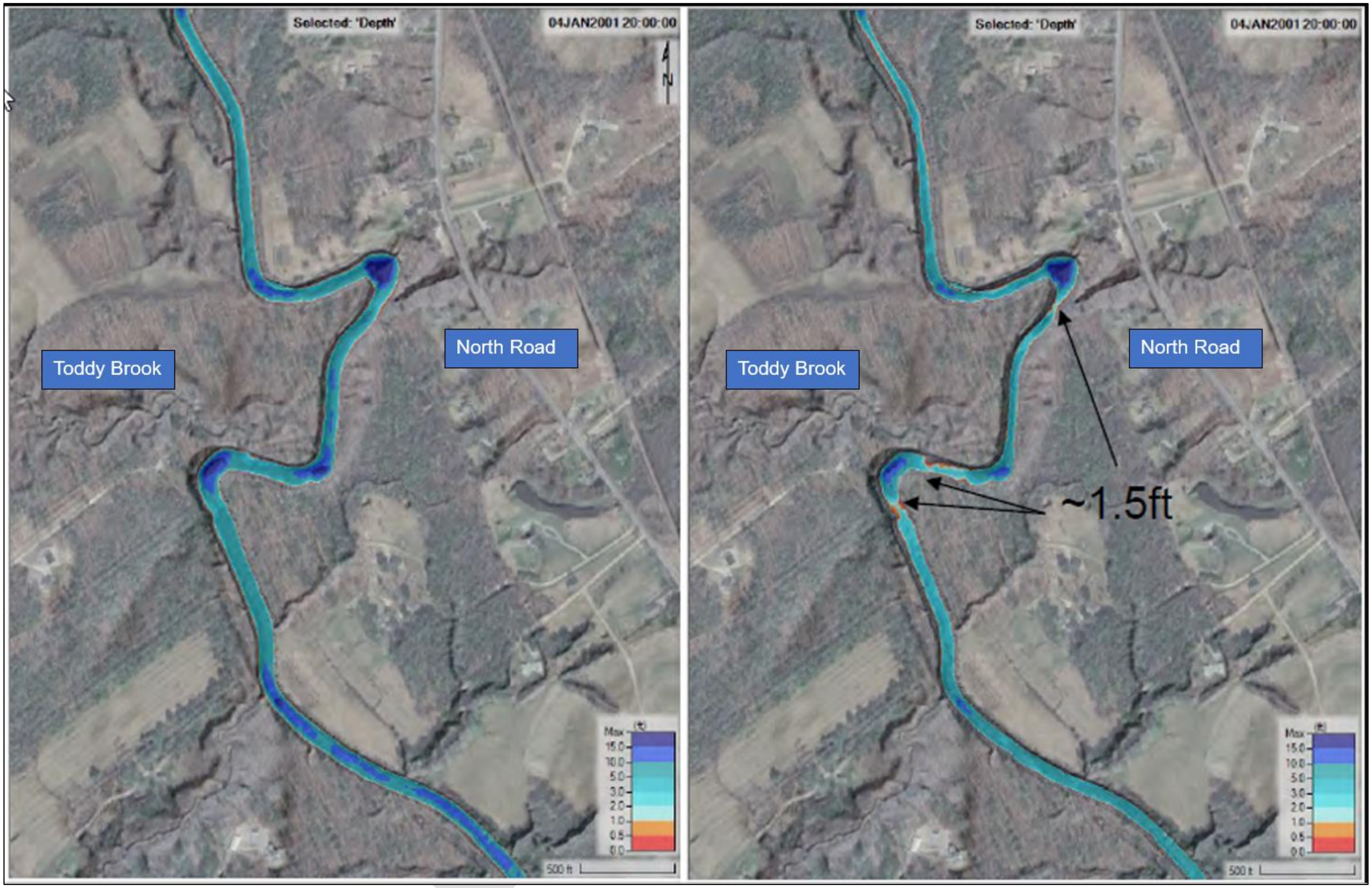

Figure 40: Comparison of Existing (left) and Projected (right) River Depth at Annual Median Flows Upstream of the East Elm Street Dam, Near Toddy Brook

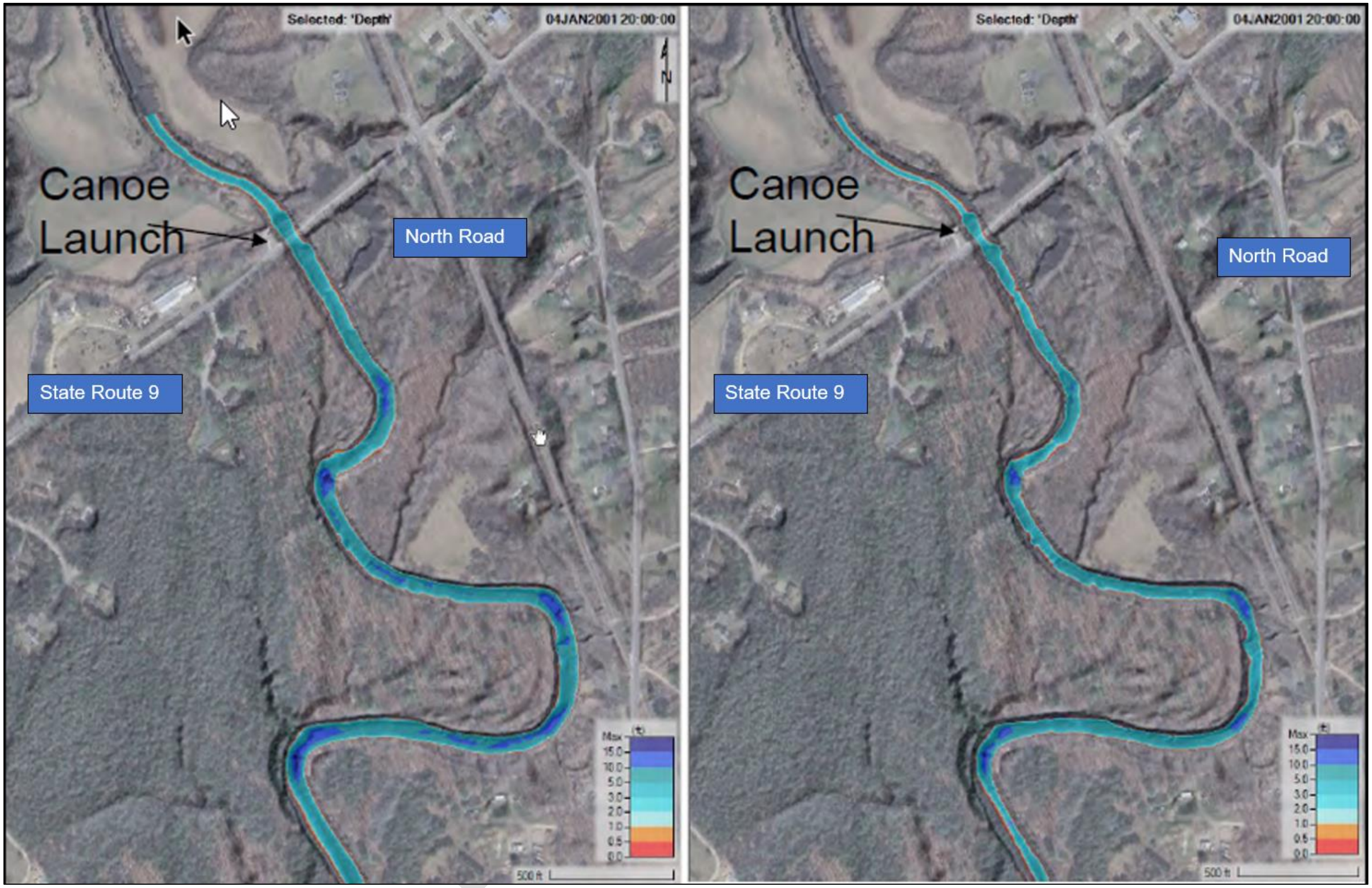

Figure 41: Comparison of Existing (left) and Projected (right) River Depth at Annual Median Flows Upstream of the East Elm Street Dam, at Baston Park

Hydraulic modeling projects there will be some changes in inundation below the East Elm Street Dam. The partial dam removal will train water away from the northern channel around Gooch Island and into the main branch of the river. Water is still predicted to backflow up the eastern portion of the channel but a reach of approximately 200 LF will be dewatered under normal conditions (**Figure 32**). This channel is approximately 1 ft deep under normal conditions and is poorly suited to recreation. Under conditions of a 10 year or greater flooding event, the remaining portion of the dam will act as a spillway and inundate the dewatered channel. It is likely that this portion of the channel will begin to fill with sediment from storm runoff over time and convert into a new section of wetland. No impacts are anticipated for Gooch Island itself.

Winter sports, such as ice skating and snowmobiling, are also important recreational activities enjoyed in the East Elm Street impoundment. Dam removal would result in the narrowing of the river channel and increase the water velocity so that ice skating would be unlikely. In addition, the four points on the river where the river depth will be 1.5 ft may be too narrow to allow passage of snow mobiles.

The Royal River is highly prized by recreational anglers for its brook trout, brown trout, American eel, rainbow smelt, catfish and smallmouth bass. The dam removal options would change the nature of the fish resources and the angling experience. The warm-water impoundments would be eliminated and replaced by a cold-water fishery. Dam removal would enhance the fishery by reestablishing a large annual migration of alewife, which would increase the productivity of the river. Adult alewife, their eggs, and their juveniles serve as a substantial food source for many game and non-game species and will result in healthier, more robust fish for anglers to target.

The alewife run would provide a significant recreational opportunity. Across the State of Maine local organizations and municipalities celebrate the returning alewife with a variety of events and festivals. In Pembroke, ME, the Pennamaquan Alewife Festival gives locals and guests alike a chance to witness the spectacle of the run, taste freshly smoked alewife, engage with biologists on the role alewife play in the local ecosystem, and several other events to drive recreation and community involvement (Quintal-Snowman, 2024).

Alternatives that include fish ladder replacement would maintain the warmwater impoundments with increased anadromous fish populations, but at lower population levels than the dam removal options.

The No Action Alternative would have no effect on the recreational uses of the Royal River.

Aesthetic value can often be subjective, depending on the values and opinions of each person experiencing the study area. In the case of this study, alternatives that include fish ladders would not affect the aesthetics of the study area. The two dams would remain in place, resulting in no change in river height or characteristics from the existing conditions. For alternatives that include removal of the dams, the appearance of the river would change in some locations. With the removal of the historic dams, the river would become shallower and narrower, developing a profile of a more natural waterway. Riverbanks would become exposed and new cascades would become evident. The value of these changes, whether negative or positive, could vary from person to person.

The No Action Alternative would have no effect on the aesthetic value of the Royal River.

4.3 PHYSICAL ENVIRONMENT

4.3.1 Air Quality

The project would have no long-term impacts on air quality. During construction, equipment operating on the site would emit pollutants including nitrogen oxides that can lead to the formation of ozone. In order to minimize air quality effects during construction, construction activities would comply with applicable provisions of the Maine Air Quality Control Regulations pertaining to dust, odors, construction, noise, and motor vehicle emissions.

A conformity analysis is not required for this project as it is located in an attainment area for all air quality pollutants noted in **Section 2.2.2.1**. This project, therefore, conforms to the federal requirements for activities under the CAA within the Maine State Implementation Plan.

The No Action Alternative would have no effect on the air quality in the vicinity of the Royal River.

4.3.2 Water Quality

Dam removal and the Middle Falls channel diversion would have negative short-term impacts on the water quality of the Royal River. During the construction phase, water turbidity would increase around the dams and Middle Falls. However, this increase would be temporary and would not change the long-term water quality of the river. Removal of the dams would allow sediment that accumulates behind the structures to move downstream. Placement of stone in the river at Middle Falls could also result in minor increases to turbidity. To assess the potential impacts of this project, two investigations focusing on river sediment were completed in 2023. The first, led by the New England District, focused on the physical and chemical composition of river sediment. The study also characterized site conditions. This effort found that the riverbed "consisted primarily of scoured bedrock and course substrate, with a fringe of sediment along portions of each bank." The second sampling effort was completed by Stantec in December 2023. The objective of this study was to collect sediment profiles immediately upstream of both the East Elm Street and Bridge Street dams. The six profiles collected by Stantec supported the conclusions of the USACE effort. The river channel was found to be scoured to bedrock with areas of fine sediment located on the riverbanks. The reports from each study effort can be found in **Appendix B**.

These two investigations support the conclusion that although turbidity would increase during construction as the dams are removed, the increase will be short-term and will not significantly alter the water quality of the system. Larger sediment, i.e., sand, would fall quickly out of the water column to be transported as bedload, while smaller sediment would remain in the water column and move downstream. Water clarity would return to normal levels once construction has been completed.

Once the dams have been removed, the Royal River system may take many years to establish a new steady state. This is particularly true of the movement of sediment through the system. The movement of sediment that is currently present in the impoundments may result in increased turbidity during high water events. However, it may be difficult to identify turbidity caused by sediment already in the channel and turbidity caused by new material entering the system.

The dam removal alternatives would include measures to reduce turbidity resulting from the project. At the construction sites, material from the banks will be stopped from entering the river through sediment and erosion control measures, native plantings, and landscaping. These measures will be implemented along the north and south banks, both upstream and downstream of the Bridge Street Dam and at the East Elm Street Dam on the north and south banks downstream of the existing Elm Street bridge to the existing spillway location. To reduce sediment from entering the water column in the East Elm Street Dam Impoundment, the riverbank exposed due to the lowering of the water level will be seeded with a New England wetland seed mix to promote the growth of native wetland species. Vegetated stream banks reduce erosion and stabilized sediment, thus reducing the amount of material entering the river and ultimately moving downstream.

The chemical composition of river sediment released during construction is also not predicted to affect water quality of the Royal River. “PAHs, pesticides and lead were present within a subset of the samples from isolated dispositional areas above East Elm Street Dam at concentrations above the TEC screening values for freshwater sediment” (Stantec, 2013a). The USACE evaluation of the sediment in the study area aligned with previous studies that concluded that impounded sediments posed minimal risk to aquatic life due to the isolated nature of the contamination and low volume of sediments in the river.

The proposed project is not anticipated to change the water quality classification of the proposed project area noted in **Section 2.2.2.2** or contribute to any long-term impacts to the water quality of the project area. The No Action Alternative would have no effect on the water quality within the Royal River.

4.3.3 Floodplains

The hydraulic model for the reach of interest anticipates some impact to the riverine wetlands located in the East Elm Street Impoundment. The effect comes from the lowering of the water levels throughout the impoundment, which is estimated at 4 ft. These effects are most pronounced in the section of the impoundment directly behind the East

Elm Street Dam (**Figure 43**). During the sediment sampling survey conducted by USACE it became apparent the banks of the river were the primary location of sediment in an otherwise mostly hard bottom river. It is therefore anticipated hydroseeding of the newly exposed sediment will stabilize the banks and mitigate the impact to the existing riparian wetlands, giving the native seed bank an opportunity to expand and reform naturally.

Flood conditions will be generally identical or have slight reduction based on 50%, 10%, and 1% (2-, 10-, and 100-yr, respectively) storm events. These flood level reductions are most pronounced upstream of the proposed dam removals - estimated to be as much as 4.5 to 5.5 feet lower. However, there are some locations of water level increase during the 1% AEP (100-yr) storm event, as shown in **Appendix C**. Specifically, water levels are predicted to increase on average 0.1-ft between the estuary and Bridge Street, and average 0.2-ft increase between Bridge Street and the Bridge Street Dam site. Upstream of Bridge Street on the left side could experience a water level increase of 0.5-ft.; however, it is still expected to crest multiple feet below the retaining wall. Comparison at Middle Falls indicates that 1% AEP water surface levels could increase by up to 2.5-feet; however, the extents are limited to largely difficult-to-access areas with no predicted adverse impacts to existing structures.

The No Action Alternative would not affect the Royal River floodplain.

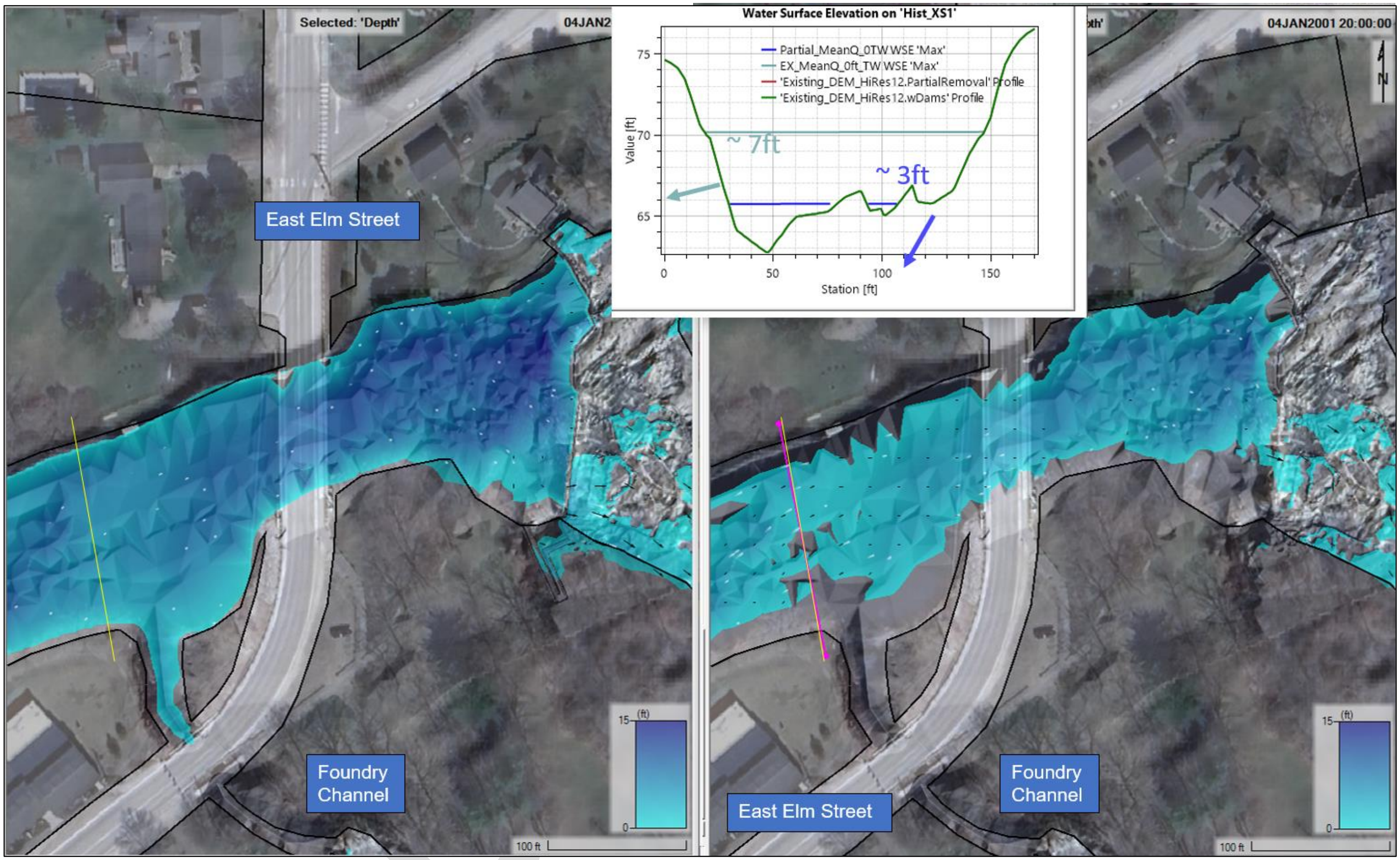

Figure 43: Comparison of the Anticipated Effect of East Elm Street Dam Removal on Inundation of the Riverbanks at East Elm Street Dam

4.3.4 Geology and River Sediment

4.3.4.1 Geology

The TSP and the No Action Alternative would have no effect on the geology of the Royal River.

4.3.4.2 Sediment Transport

Previous reports, including Stantec's two reports released in 2013, entitled "*Potential Impacts of Dam Removal on Sediment Projection and Sediment Transportation on the Royal River, ME*" and "*Royal River Restoration Project: Phase II Analysis and Reporting*", have discussed the potential for increased migration of contaminated sediment downstream due to the demolition of the East Elm Street and Bridge Street Dams. To further investigate this concern, the study team completed an assessment of these past study efforts that characterized sediment volume and composition within the study area. In addition, two new study efforts, described in **Section 2.2.2.5** with the full reports included in **Appendix B**, were also completed to evaluate sediment release with dam removal.

Sediment transport from dam removal and disposition within the estuary could result from two potential sources. The first source is the release of sediment present immediately upstream of the dams. Stantec (2024) completed a field study to assess this source on December 15, 2023. They collected sediment profiles to determine the sediment thickness and soil type upstream of Bridge Street Dam and Elm Street Dam. The sediment profiling effort demonstrated that erodible sediment was primarily identified along the riverbanks with little or no erodible sediment across most of the river bottom, which is consistent with USACE findings from the October 2023 sampling effort.

In general, gravels and cobbles only migrate downstream during major flood events. Sands and fine-grained sediments are most susceptible to erosion and are typically redeposited in downstream areas where velocities decrease, typically at river meanders or in broad, calm reaches. Some fine-grained sediment, particularly clay, can remain suspended in the water column under very mild flow conditions and may travel many miles before being redeposited.

The study team estimated the rough volume of sediment available to migrate downstream based on the depths of cores collected behind the two dams. It is estimated that there is approximately 5,400 cy immediately upstream of the dams. For comparison, the last maintenance dredging cycle for the FNP involved the removal of approximately 45,000 cy of material, and typical maintenance dredging volumes in the adjacent marina basins range from 5,000 to 18,000 cy of sediment. Several key points must be considered in relationship to this number:

1. Not all sediment would be expected to erode.
2. Not all eroded sediment would necessarily travel all the way to the estuary as some would likely be deposited elsewhere in the river.

3. Not all eroded sediment would be expected to arrive at the same time, the process will be gradual and would likely occur over many years.
4. Not all sediment that arrives at the estuary would necessarily be deposited within the FNP and marinas.

The second source of sediment is the production of sediment throughout the Watershed. This has been assessed by a research scientist from the USACE's Engineer Research and Development Center (ERDC). Based upon the geology, historic stability, tributary structure, and anticipated changes to the flow regime, there is limited potential for increases to riverine sediment production as a result of removing the dams.

The dam removal alternatives are expected to have negligible adverse impact on the amount of sediment that will move downstream into the estuary. A relatively small quantity of sediment is available to erode compared to the typical annual shoaling within the estuary, which is discussed in **Section 4.3.5** below. There is minimal risk of increased sediment movement downstream.

The No Action Alternative and fish ladder reconstruction alternatives would not impact amount of river sediment moving through the river system.

4.3.4.3 Sediment Contamination

Although not investigated during the study, it is believed that the source of contaminants in the sediment is road run-off. The project alternatives would not address current sources of contamination sources, so removal of the dams and construction of a diversion to the Middle Falls side channel would not change the amount or type of contamination found within the river sediment. However, review of the 2023 sediment data in comparison with the NOAA effects-range low (ERL) and effects-range median (ERM) Sediment Quality Guidelines used for marine sediments along with paired sediment chemistry and biological testing data (10-day toxicity and 28-day bioaccumulation studies) for dredging projects disposed of at the Portland Disposal Site suggest that the sediments from all study areas would be suitable for unconfined open water placement, even at the documented concentrations for the sediment in its current location. Based on the available information including the environmental setting, bulk chemical concentrations, and volumes of material that might be mobilized and transported downstream, USACE finds that the sediments from the study area pose minimal potential risk to the marine environment in the Royal River estuary and Casco Bay under any of the proposed restoration project alternatives.

The No Action Alternative and fish ladder reconstruction alternatives would not impact the chemical composition of river sediment moving through the river system.

4.3.5 Effects of Dam Removal on Downstream Sedimentation

Sediment accumulated in the estuary may come from upland sources, the Royal River, or the coastal marsh and beaches. Regardless of the source, this shoaling occurs under the existing conditions and is managed by routine dredging. The recurring maintenance dredging provides a broad measure of the movement of sediment down the river that is deposited in the estuary.

The USACE reviewed internal files to determine a typical shoaling rate at the FNP and the adjacent marinas. FNP dredge quantities published in the annual Chief's Report to Congress since initial construction were consulted. Dredge quantities for private marinas were determined from permit documents and regulatory filings. Private marina calculations included at least two dredge cycles. The FNP was found to shoal at an average rate of 5,300 cy per year (cy/yr). The sum of average shoaling rates at the commercial marinas was 4,200 cy/yr. This indicates a typical average shoaling rate within the estuary of 9,500 cy/yr.

The total quantity of sediment available to erode as a result of dam removal is approximately 5,400 cy, which is small compared to the 9,500 cy of sediment shoaling in the estuary each year. It is unlikely that the dam removal would result in measurable adverse shoaling within the estuary as a result of the erosion of sediment in the immediate vicinity of the dams.

The No Action Plan and the fish ladder construction alternatives would not change the sedimentation patterns within the estuary located at the mouth of the Royal River.

4.3.6 Green House Gases

The project would have minimal effects on GHG due to its small size and lack of energy intensive construction or operation requirements. The rough quantity of carbon dioxide equivalents (CO2eq) produced by the project construction is approximately 924,920.88 pounds (419.54 metric tons) or 0.0026% of the total metric tons of CO2eq produced in Maine in 2021 (State of Maine Priority Climate Action Plan, 2024) based on the following formula and anticipated equipment to be used in construction. Operation and maintenance of the project would have similarly negligible emissions.

CO2eq = X*CO2 + Y*N2O + Z*CH4

Where X = 100 Year Global Warming Potential for Carbon Dioxide = 1
Where Y = 100 Year Global Warming Potential for Nitrous Oxide = 298
Where Z = 100 Year Global Warming Potential for Methane = 25
*CFR Title 40 Chapter I Subchapter C Part 98: Table A-1 Global Warming Potentials

4.4 CULTURAL RESOURCES

The APE of this project consists of the locations for demolition of the East Elm Street and Bridge Street Dams and fish ladders at each impoundment; and at the Middle Falls area where an in-stream modification is proposed requiring construction access, staging, and possible ledge removal of the adjacent bank. Additionally, the APE would also include any impacts to surrounding historic properties, and in the event of a river drawdown, to the adjacent riverbank following dam removal.

Removal of the Bridge Street Dam would constitute an adverse effect upon a NR-eligible historic property, which is a contributing element of the proposed Royal River Manufacturing Company site. Additionally, removal of both the East Elm Street Dam (which was previously determined to be ineligible for the NR) and the Bridge Street Dam would result in a drawdown of the Royal River of approximately up to four ft in some areas, of the river, with the largest drawdown at the location of the dams and tapering to lesser amounts upstream. Native American archaeological sites that may be present along the banks of the Royal River beneath the current water level could potentially be exposed and subject to erosion and weathering processes along. Due to the paucity of archaeological data for the watershed and the presence of several sites upstream of the East Elm Street area, an archaeological monitoring and documentation survey will be conducted upon completion of the dam removals. Identified sites would be evaluated and documented in accordance with a Programmatic Agreement (PA) that will address how impacts to historic properties will be addressed in the D/I phase of the project.

The Middle Falls area, also known as Factory Island, is the location of proposed in-stream modification of the side channel that flows around the “island” before proceeding downstream. Due to the potential for historic archaeological sites and ruins from the former Forest Paper Company, ground disturbance activities would need to be proceeded by an archaeological assessment and survey during the D/I phase. This would include access and staging areas as well as any bank modification or ledge removal. Bridge abutments are located on both sides of the river at this location, on the west at Royal River Park where remains of the Forest Paper Company are located, and to the east at Middle Falls/Factory Island where the former digester building of the mill complex was located and where waste products from the pulp mill were deposited on the “island” and potentially along the surrounding banks.

4.5 BIOLOGICAL ENVIRONMENT

4.5.1 Fishery Resources

There will be both short-term and long-term impacts to the fishery resources of the Royal River resulting from the construction of the project. Fish will be temporarily disrupted during the removal of the dams, construction of fish ladders, and/or construction of a diversion at Middle Falls. The use of heavy equipment in the river would scare fish away from the construction sites. While most fish will be mobile enough to leave the immediate area, slow moving individuals or individual that don’t leave the area may be injured or killed. For those fish that move away from the dam sites, other reaches of the river will provide habitat for displaced wildlife. Additionally, dam removal would temporarily increase turbidity, which can negatively impact fish. Increased suspended solids can carry bacteria and irritate gills and can hinder visibility, reducing the ability to detect predators or hunt prey. These impacts would end when construction is complete, and a new species composition would develop in the area with species better adapted to a free-flowing river.

The long-term effect of dam removal on fish communities in the project area would be to increase the value of the habitat for species that prefer riverine habitats and, in particular, anadromous species.

Removal of the East Elm Street and Bridge Street dams, reconstruction of fish ladders, and the construction of a diversion to the side channel at factory island would restore access to 32 miles of main stem river and 176 miles of tributaries for diadromous fish. Beyond the access to reproductive and nursery habitat for these species, reestablishment of an annual alewife run would benefit the entire aquatic community. Fish that return upstream to spawn serve as an excellent food source for predatory fish like smallmouth bass and brook trout, while their prolific egg laying serves as a food source for many smaller species. Alewife do pose the threat of direct competition for food sources with resident species, but this risk is outweighed by the benefits of their reintroduction to the system. Environmental modelling predicted 25,880 alewife would be able to pass the existing obstructions annually under the proposed plan. Lesser numbers of alewife would return to the river under the fish ladder reconstruction alternatives.

Some fish species would be negatively affected by dam removal. The removal of the dams will result in a change of the characteristics of upstream impoundments. The impoundments will become shallower and narrower, with a faster current. Fish species that depend on slower, warmer water conditions like largemouth bass and chain pickerel would be less successful once river conditions have changed.

The No Action Alternative would have no effect on the fisheries resources within the Royal River.

4.5.2 Wildlife

The project should have no significant adverse impact on waterfowl or other wildlife occurring in the vicinity of the Royal River. Some wildlife (mainly birds) may be temporarily displaced during construction activities; however, they would be able to return to those areas once construction activities have ended. **Table 21** summarizes anticipated impacts to species partially or fully reliant on the Royal River ecosystem with a plus sign (+) denoting a positive impact, a zero (0) denoting a neutral impact and a minus sign (-) denoting a negative impact.

Table 21: Summary of Potentially Impacted Species in the Study Area

Common Name	Scientific Name	Fish Ladder	Dam Removal
American black bear	*Ursus americanus*	0	0
Ashton's Cuckoo Bumble Bee	*Bombus ashtoni*	0	0
Bald Eagle	*Haliaeetus leucocephalus*	+	+
Bank Swallow	*Riparia riparia*	0	0
Black Guillemot	*Cepphus grylle*	0	0
Black Racer	*Coluber constrictor*	0	0
Black Scoter	*Melanitta nigra*	0	-
Black-Billed Cuckoo	*Coccyzus erythropthalmus*	0	0
Black-crowned Night Heron	*Nycticorax nycticorax*	+	+
Black-legged Kittiwake	*Rissa tridactyla*	0	0
Blacknose dace	*Rhinichthys atratulus*	+	+
Blackpoll Warbler	*Setophaga striata*	0	0
Bobcat	*Lynx rufus*	0	0
Bobolink	*Dolichonyx oryzivorus*	0	0
Canada lynx	*Lynx canadensis*	0	0
Canada Warbler	*Cardellina canadensis*	0	0
Cape May Warbler	*Setophaga tigrina*	0	0
Chimney Swift	*Chaetura pelagica*	0	0
Cliff Swallow	*Petrochelidon pyrrhonota*	0	0
Cobblestone Tiger Beetle	*Cicindela marginipennis*	0	0
Common Eider	*Somateria mollissima*	0	0
Common Gallinule	*Gallinula chloropus*	0	0
Common Loon	*Gavia immer*	+	+
Coyote	*Canis latrans*	0	0
Eastern Small-footed Bat	*Myotis leibii*	0	0
Eastern Whip-poor-will	*Antrostomus vociferus*	0	0
Evening Grosbeak	*Coccothraustes vespertinus*	0	0
Grasshopper Sparrow	*Ammodramus savannarum*	0	0
Great Cormorant	*Phalacrocorax carbo*	+	+
Hessel's Hairstreak	*Callophrys hesseli*	0	0
Hudsonian Godwit	*Limosa haemastica*	0	0
Least Bittern	*Ixobrychus exilis*	+	+
Least Tern	*Sterna antillarum*	0	0
Little Brown Bat	*Myotis lucifugus*	0	0
Long-tailed Duck	*Clangula hyemalis*	+	+
North American beaver	*Castor canadensis*	0	0
North American porcupine	*Erethizon dorsatum*	0	0

Common Name	Scientific Name	Fish Ladder	Dam Removal
Northern Long-eared Bat	*Myotis septentrionalis*	0	0
Olive-sided Flycatcher	*Contopus cooperi*	0	0
Peregrine Falcon	*Falco peregrinus*	0	0
Prairie Warbler	*Dendroica discolor*	0	0
Purple Sandpiper	*Calidris maritima*	0	0
Raccoon	*Procyon lotor*	+	+
Razorbill	*Alca torda*	0	0
Red-breasted Merganser	*Mergus serrator*	+	-
Red-throated Loon	*Gavia stellata*	+	+
Ring-billed Gull	*Larus delawarensis*	+	+
Roseate Tern	*Sterna dougallii*	0	0
Salt Marsh Tiger Beetle	*Ellipsoptera marginata*	0	0
Saltmarsh Sparrow	*Ammodramus caudacutus*	0	0
Spotted Turtle	*Clemmys guttata*	0	0
Tri-colored Bat	*Perimyotis subflavus*	0	0
Twilight Moth	*Lycia rachelae*	0	0
Virginia opossum	*Didelphis virginiana*	0	0
White-tailed deer	*Odocoileus virginianus*	0	0
Willet	*Tringa semipalmata*	0	0
Wood Thrush	*Hylocichla mustelina*	0	0

Positive impacts to species listed in **Table 21** can be divided into two categories: habitat and forage. The reestablishment of an annual alewife migration would provide a substantial annual increase to animals like common loon, red-breasted merganser, and great cormorant that regularly feed on local fish. Animals that rely on wetland habitats associated with the river may see short-term negative impacts after the water level is reduced; however, as the reseeding takes root and the native seedbank expands the habitat will return. This will be most prominent in areas of sediment deposition in close proximity to the East Elm Street and Bridge Street Dams. Areas further from the dams in the impoundment will convert into exposed mudflat that will periodically flood following storm events.

The No Action Alternative would have no effect on the wildlife resources within the Royal River.

4.5.3 Threatened and Endangered Species

The USFWS IPaC Report identified the endangered NLEB, the proposed federally endangered tri-color bat and the federally endangered roseate tern are potentially present within the project area. The project alternatives would have no effect on the northern long-eared bat, tri-colored bat, roseate tern, their habitat, or any other fish and wildlife resource. USFWS concurrence was received on June 12, 2024, and can be found in **Appendix A**.

Federally threatened and endangered species under the jurisdiction of the National Marine Fisheries Service (i.e., whales, sea turtles, and fish) are not expected to occur in the project area. Therefore, no impacts to those species are expected.

The No Action Alternative would have no effect on any threatened or endangered species within the Royal River.

4.5.4 Vegetation, Wetlands, and Riparian Areas

The proposed project is not anticipated to significantly impact any vegetation within the Royal River. All in-water work is in areas without vegetation. Areas most impacted would be those where heavy equipment is needed for the dam removal or fish ladder construction. This impact would be temporary as the vegetation would recolonize the area once construction ends.

Dam removal would cause short-term and long-term effects to the wetlands associated with Royal River. The largest contiguous wetland associated with Royal River is located approximately 80 ft upstream of the Bridge Street Dam along the left descending bank. The wetland is approximately 2.9 acres in area and displays a composition of plants correlating to elevation, containing more wetland obligate species and fewer upland species as elevation decreases terminating in a buffer of emergent vegetation approximately 10 ft wide along the river edge. The decrease in water level from dam removal will be most pronounced in this area because of the proximity to Bridge Street Dam. The water level is predicted to decrease by 4 ft in this area which would change the frequency of inundation of the soils in this wetland. Short-term impacts due to this change will include exposure of approximately 0.5 acres of deposited river sediments and a reduction in the inundation of the soils in the existing wetland. The reduction in inundation will make the habitat less suitable for obligate wetland plants at the high end of the elevation range they currently occupy, shifting the composition in that range to less flood tolerant plants over time. Given the configuration of the wetland on a broad flat area at the base of a slope, it is likely that the area will remain a wetland over the long term, but most likely with a species composition more tolerant of less frequent flooding. The lower limit of the wetland could migrate from the currently occupied area into the newly exposed sediment over the long term. Other small creeks and surrounding wetlands along the portion of the Royal River that would be affected by dam removal similarly to the wetland upstream from Bridge Street Dam; they are likely to become less frequently flooded but remain as forested wetland.

The expected drawdown due to the removal of the Bridge Street and East Elm Street Dams would expose approximately five acres of riverbank along the six miles of river affected by the dams. This bank will be hydroseeded from the river with a Northeast Wetland Seed mix to revegetate and prevent the expansion of existing invasive species and stabilize exposed sediment as the natural succession occurs.

Existing riparian areas in the study area would be affected by dam removal. The existing riparian zone is primarily comprised of mature upland trees and shrubs with a sharply sloped bank down to the river's edge where emergent plants like cattails and pickerel weed line the channel, The impacted riparian areas are only found immediately upstream of the two dams of the dams. The lowered water level would result in less inundation of the emergent vegetation, exposing deposited sediment along the bank.

The No Action Alternative and fish ladder reconstruction alternatives would have no effect on vegetation within the Royal River.

4.6 NOISE

The operation of construction equipment (e.g., noise from crane motors, electrical generators, and workboats) would temporarily increase the volume of noise in the project area for the construction alternatives. Removal of material from the dams would also increase traffic noise along the route to their disposal or reuse site during the construction period. According to the American National Standards Institute (https://blog.ansi.org/2018/10/how-loud-is-construction-site-noise/), most construction noises are on the order of 80 to 90 decibels (dB). The sound level decreases at 6 dB for each doubling of distance from a source (https://www.osha.gov/otm/section-3-health-hazards/chapter-5#decibles); therefore, the construction noise levels would decrease to about 60 dB (about the level of conversation) at about 100 ft from the construction source. Over the long term, the removal of the dams would reduce the ambient noise associated with water dropping over the falls; however, the rock outcrops would ensure that some sounds from water flow would continue.

The No Action Alternative would have no effect on the noise environment of the Royal River.

4.7 HAZARDOUS, RADIOACTIVE, & TOXIC WASTE

The project alternatives and the No Action Alternative will have no effect on HTRW in the Royal River.

4.8 SOCIOECONOMIC

The project alternatives would not have any disproportionately high or adverse impacts on minority or low-income populations, or any adverse short or long-term environmental justice impacts because the project is not located near any areas with these populations. The project area in the Royal River is located in a state-owned waterway.

The No Action Alternative would have no effect on these populations.

The proposed project alternatives would not pose any significant or adverse short or long-term health and safety risks to children because access to the project area during construction would be limited as it would be occurring in the river and in undeveloped areas adjacent to the river.

The No Action Alternative would have no effect on children.

4.9 TRANSPORTATION & INFRASTRUCTURE

No significant impacts to transportation infrastructure are anticipated. The geology of the river necessitates the bridges be installed into bedrock, thus scour around the bridges is not a concern. Potential downstream impact to the FNP and marinas is limited due to the estimated volume of sediment discussed above.

The No Action Alternative would have no impact on transportation.

4.10 PUBLIC SAFETY

The dam removal alternatives would affect long term public safety. With the demolition of the dams and fish ladders, the public would no longer be able to assess the structures once they have been removed. This would reduce the public safety concerns at these locations. The only portion of the East Elm Street Dam that would remain in place could only be accessed by crossing private property. This would reduce the potential of the public to access this section of the dam.

Additionally, dam removal would mitigate the concerns of the East Elm Street and Bridge Street dams failing. The remaining portion of the East Elm Street Dam would not be subject to the stress the existing dams are and the likelihood of blocks coming loose and potentially harming recreators is reduced. Although, regularly scheduled O&M would be required to keep the structure in good condition.

The dam removal alternatives might result in new safety concerns. The first area of concern is located in the East Elm Street Impoundment. The rail bridge immediately upstream of the canoe launch at the Yarmouth Historic Society is used by local children to jump into the river and swim. The water level at that location is projected to decrease by 4 ft, which may increase the risk of this activity. Second, the implementation of the TSP would result in high water conditions that would support white water boating. This sport is an inherently risky activity. Signage and other safety measures should be considered by the NFS.

The No Action Alternative would not mitigate the safety risk.

4.11 CUMULATIVE EFFECTS ANALYSIS

Cumulative impacts are those resulting from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions. Past and current activities in the Royal River include the dredging of the navigation channel downstream of the project, recreational activities such as swimming, boating, ice skating, hiking, birdwatching, and fishing. The proposed dam removal and channel modification activities may result in the expansion of access and desirability of recreational fishing along the river. Reasonably foreseeable future actions include the continuation of monitoring of fish passage during their migration season.

Regionally, the improvement restoring historic connectivity to the project will assist the commercial fishery that exists in coastal Maine. The restoration will provide spawning ground and nursery habitat for currently impacted alewife and the reestablishment of a substantial annual migration. This would supplement the commercial alewife fishery that has been in decline over the last 20 years. The historic spawning grounds for alewife in the Royal River is in its headwaters at Sabbathday Lake in New Gloucester, ME. Passage to this spawning ground will still be obstructed at the conclusion of the project; however, increased alewife passage through the project area makes an alewife passage project to Sabbathday Lake viable and valuable to both the recreation and commercial fishery of Royal River. The cumulative impacts on marine resources from dam removal will be short-term and minimal and should not contribute to any loss of regional resources.

The change in hydrology will change the suitability of the ecosystem in the impoundment for fish that require a more lentic environment. Fish like largemouth bass and chain pickerel prefer warmer, slower moving water that is typically found in ponds and lakes. The reduction in suitability will drive these species to seek refuge in areas with naturally slower water, like eddies or in ponds connected to the system. Their prevalence in the study area will reduce overtime and the composition will shift towards riverine species like fallfish and smallmouth bass. The change in composition will not significantly impact recreation on the river and will create a more resilient and natural community.

The lower water level will expose deposited sediment near the Bridge Street and East Elm Street Dams and reduce the inundation of the wetlands in these two areas. The loss of inundation will make the existing wetlands unsuitable for the current vegetation composition. The upland plants already present at the northern end of the wetland will begin to establish in the dryer soils as the wetland plants begin to colonize the newly exposed sediment. The net result is a migration of the extant wetland to lower, more inundated soil, and an extension of the upland scrub/shrub ecosystem.

The Town of Yarmouth is considering the removal of the remaining section of the East Elm Street Dam separately after the TSP has been implemented. This action would allow a continuous flow of water through the back channel of Gooch Island and would eliminate future O&M costs to maintain the section of dam. The USACE does not believe that this action would affect the effectiveness of the recommended plan to improve fish migration in the Royal River.

Based on the impacts noted above, no significant cumulative impacts are anticipated as a result of the proposed project.

5.0 ENVIRONMENTAL COMPLIANCE*

5.1 ENVIRONMENTAL COMPLIANCE

The status of compliance with applicable Federal Statutes and EOs is summarized in the **Table 22**.

Table 22: Environmental Compliance Table

Federal Statutes	Citation	Compliance
Archaeological Resources Protection Act of 1979	54 U.S.C. 3001018 et seq.	Not applicable to this project.
American Indian Religious Freedom Act of 1978	42 U.S.C. 1996	This project will not impede access by Native Americans to sacred sites, possession of sacred objects, and the freedom to worship through ceremonials and traditional rites.
Bald and Golden Eagle Protection Act	16 U.S.C. 668 et seq.	No bald or golden eagles will be impacted by the proposed project.
Clean Air Act (CAA)	42 U.S.C. 7401 et seq.	Cumberland County, ME currently meet the NAAQS air quality standards and is in attainment
Clean Water Act (CWA)	33 U.S.C. 1251 et seq.	CWA coordination will begin upon completion of the draft EA and a 401 Water Quality Certification will be applied for.
Coastal Barrier Resources Act	16 U.S.C. 3501 et seq.	No properties within Coastal Barrier Resources Act Units have been identified for nonstructural measures.
Coastal Zone Management Act	16 U.S.C. 1451	Preliminary CZM consistency determination will begin upon completion of the draft EA.
Endangered Species Act (ESA) of 1973	16 U.S.C. 1531 et seq.	USFWS concurred with our ESA species determinations in an email dated 12 June 2024.
Estuarine Areas Act	16 U.S.C. 1221 et seq.	Not applicable.
Federal Water Project Recreation Act	16 U.S.C. 460l-12 et seq.	Public notice of availability to the project report to the National Park Service (NPS) and Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.
Fish and Wildlife Coordination Act	16 U.S.C. 661 *et seq*.	FWCA coordination will begin upon completion of a draft EA.
Land and Water Conservation Fund Act of 1965	54 U.S.C. 200301 et seq.	Public notice of the availability of this report to the National Park Service (NPS) and the Office of Statewide Planning relative to the Federal and State comprehensive outdoor recreation plans signifies compliance with this Act.
Magnuson-Stevens Act Fishery Conservation and Management Act	16 U.S.C. 1855	EFH Mapper Report was generated for the project area 12 March 2024. Coordination with NMFS will begin upon completion of draft EA.
Marine Mammal Protection Act of 1972	16 U.S.C. 1361-1407.	Not applicable.

Marine Protection, Research, and Sanctuaries Act of 1972	33 U.S.C. 1401 et seq.	Not applicable.
Federal Statutes	**Citation**	**Compliance**
Migratory Bird Treaty Act	16 U.S.C. 703-712 et seq.	Migratory birds will not be adversely impacted by the proposed project.
Native American Graves Protection & Repatriation Act	25 U.S.C. 3001-3013, 18 U.S.C. 1170	Not applicable to this project.
National Environmental Policy Act of 1969	42 U.S.C. 432 *et seq*.	Preparation and circulation of the Draft IFR/EA partially fulfills requirements of NEPA. Full compliance shall be noted at the time the FONSI is issued.
National Historic Preservation Act of 1966	54 U.S.C. 300101 et seq	USACE is conducting coordination with the Maine SHPO and ACHP. Compliance will be achieved through execution of a Programmatic Agreement in accordance with Section 106 and Planning Bulletin 2018-1(s)
Preservation of Historic and Archeological Data Act of 1974	54 U.S.C. 312501 et seq.	No historical or archaeological data will be irrevocably lost or destroyed by the project.
Rivers and Harbors Act of 1899	33 U.S.C. 401 et seq.	No requirements for projects or programs authorized by Congress. The proposed project is being conducted pursuant to the Congressionally approved authority.
Watershed Protection and Flood Prevention Act	16 U.S.C 1001 et seq.	Not applicable.
Wild and Scenic Rivers Act	16 U.S.C. 1271 et seq.	Not applicable.
National Invasive Species Act	16 U.S.C. 4701 et seq	The adaptive management plan developed for the project includes actions that will control the colonization of invasive plant species.
Executive Orders (EO)		
Protection and Enhancement of the Cultural Environment, 13 May 1971	EO 11593	Coordination with the State Historic Preservation Officer signifies compliance.
Floodplain Management, 24 May 1977	EO 11988 and amendments	See Section 4.2.4.
Protection of Wetlands, 24 May 1977	EO 11990	The project will avoid adverse impacts to wetlands. Circulation of this report for public and agency review fulfills the requirements of this order.
Environmental Effects Abroad of Major Federal Actions, 4 January 1979	EO 12114	Not applicable.
Environmental Justice, 11 February 1994	EO 12898	USACE performed an analysis and has determined that a disproportionate negative impact on minority or low-income groups in the community is not anticipated.
Accommodation of Sacred Sites, 24 May 1996	EO 13007	Access to and ceremonial use of Indian sacred sites by Indian religious practitioners will be allowed and accommodated. No adverse effects to the physical integrity of such sacred sites will occur.

Protection of Children from Environmental Health Risks and Safety Risks. 21 April, 1997	EO 13045	The project will not create a disproportionate environmental health or safety risk for children.
Federal Support of Community Efforts Along American Heritage Rivers	EO 13061, and Amendments	The project is not located along an American Heritage River.
Invasive Species	EO 13112, as amended by EO 13751	The project will not promote or cause the introduction or spread of invasive species.
Consultation and Coordination with Indian Tribal Governments, 6 November 2000	EO 13175	Consultation with Indian Tribal Governments, where applicable, and consistent with executive memoranda, DOD Indian policy, and USACE Tribal Policy Principles signifies compliance.
Responsibilities of Federal Agencies to Protect Migratory Birds	E.O. 13186	Migratory birds will not be adversely impacted by the proposed project.
Tackling the Climate Crisis at Home and Abroad	E.O. 14008	A Climate Change assessment was completed for this study. Additionally, an assessment of greenhouse gases was also completed. This project will not affect the Climate Crisis.
Executive Memorandum		
Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing NEPA, 11 August 1980	N/A	The project will not impact Prime or Unique Agricultural Lands.
White House Memorandum, Government-to-Government Relations with Indian Tribes 29 April 1994	N/A	Consultation with Indian Tribal Governments, where applicable, and consistent with executive memoranda, DOD Indian policy, and USACE Tribal Policy Principles signifies compliance.

5.2 PUBLIC INVOLVEMENT

5.2.1 Public Meetings

Throughout the feasibility phase of the study, meetings were held to keep the public and stakeholders informed of the progress of the feasibility study. **Table 23** provides the dates and purpose of each meeting. Additionally regular meetings were held with the NFS. Meeting notes were distributed to the Town Council and the public.

Table 23: Public Meetings Which Have Occurred During the Feasibility Phase

Date	Audience	Purpose
October 10, 2024	Private Property Owner that Abut the River	-Describe the real estate process -Address concerns of the property owners
October 9, 2024	General Public	-Provide an update on the study -Provide information about the public review
August 13, 2024	General Public	-Explained the H/H modeling results -Provided an update on the study
May 20, 2024	North Yarmouth, ME Select Board	-Provide a description of the Tentatively Selected Plan.
May 12, 2024	Yarmouth, ME Town Counsel	-Provide a description of the Tentatively Selected Plan.
February 13 ,2024	General Public	-Explain the Continuing Authorities Program. -Present the conclusions of the sediment studies. -Provide an update on the feasibility study.
March 17, 2023	General Public	-Present an update on the H/H modeling effort.

A public meeting will be held prior to the start of the 30-day public review period. The study team will provide an overview of the analysis and conclusions of the developed during the feasibility phase.

5.2.2 Agency Coordination

Invitations to the initial interagency coordination meeting were sent via email on August 17, 2023. The meeting occurred the morning of August 29, 2023. The meeting was attended by representatives of USEPA, USFWS, NOAA, Maine DIF&W, Maine DOT, Maine State Historic Preservation Officer (SHPO), and the Casco Bay Partnership. A coordinated site visit was conducted on November 7, 2023, with representatives from USEPA, USFWS, Maine DIF&W, the Town of Yarmouth, and the Casco Bay Partnership. Coordination communications can be found in **Appendix A**.

5.2.3 Cultural Resources Programmatic Agreement Coordination

Because USACE cannot fully determine how the project may affect historic properties prior to finalization of this feasibility study, an PA (36 CFR 800.14(b)(3)) has been prepared that will outline the process to identify and evaluate historic properties and avoid, minimize, and where possible, mitigate for any adverse impacts in accordance with Section 106 of the NHPA and implementing regulations 36 CFR 800. The PA will allow USACE to complete the necessary historic and archaeological surveys during the D/I phase of the project, once the final design for the TSP has been completed.

The PA, entitled "*Royal River Section 206 Aquatic Ecosystem Restoration Study. Yarmouth, Maine*" is in development; when complete, it will be submitted to the Maine SHPO, federally recognized Tribes, local interested parties, and any other identified consulting and concurring parties, for review and comment.

Therefore, pursuant to 36 CFR 800.4(b)(2), and 36 CFR 800.14(b)(1)(ii), USACE defers final identification and evaluation of historic properties until after project approval when additional funding becomes available during the D/I phase, and through execution of an approved PA. The Maine SHPO is expected to concur with this determination. The Advisory Council on Historic Preservation will also be contacted regarding development of the PA and whether they wish to participate in preparation of the PA. All coordination and the final approved PA will be included in the final DPR/EA.

5.2.4 Tribal Consultation

In accordance with the NHPA and 36 CFR 800 as well as the USACE Tribal Consultation Policy, New England District is coordinating with the five federally recognized Maine Tribes (Houlton Band of Maliseets, Mi'kmaq Nation, Passamaquoddy Tribe of Indian Township and Pleasant Point, and the Penobscot Indian Nation) to solicit their comments and concerns. Additionally, a local Wabanaki tribal group has been identified in the Town of Yarmouth that will also be contacted. Correspondence is available in **Appendix A.**

5.2.5 Public Comments Received and Responses

Throughout the feasibility phase, members of the public have provided comments and questions about the study. These inquiries have related to a few recuring topics. These include:

- Impacts to recreational opportunities on the Royal River
- Impacts to private property
- Impacts to private businesses
- Sediment movement and composition
- Changes to river levels at the upstream limit of the East Elm Street Dam
- Impacts to Gooch Island
- Coordination with the Wabanaki residents of Yarmouth, ME
- Cultural Resources coordination
- Impact to infrastructure.

A matrix that includes the record of the comments that have been received during the feasibility phase is included in **Appendix A**.

6.0 PLAN IMPLEMENTATION REQUIREMENT

6.1 FEDERAL RESPONSIBILITIES

The Federal government will be responsible for final design investigations, preparation of plans and specifications, contract advertisement and award, supervision and inspection of the work, management during design and construction, and post construction monitoring. The Federal government will be responsible for project compliance with Federal environmental laws and regulations, including the NEPA, consistency with the Coastal Zone Management Act, and compliance with the CWA. State coastal zone management consistency concurrence and WQC would be requested early in the design effort when more detailed project drawings become available. Discussions with both state agencies indicate no significant issues exist with the timely issuance of the required state approvals for the project.

6.2 MONITORING AND ADAPTIVE MANAGEMENT

Section 2039 of WRDA 2007, 33 U.S.C. § 2330a, directs the Secretary to ensure that when conducting a feasibility study for a project (or a component of a project) for ecosystem restoration that the recommended project can include a plan for monitoring the success of the ecosystem restoration for a period of up to ten years from completion of construction of an ecosystem restoration project.

A monitoring plan would be implemented for this project (**Appendix A**). The USACE, New England District would conduct monitoring in conjunction with the NFS to determine the success of the project. The principal goal of a resulting project is to restore stream connectivity and habitat to provide upstream migration for local fish and restore natural stream flows and processes. Baseline data for current conditions in the Royal River are detailed in this DFR/EA. The following specific monitoring objectives were established to determine the effectiveness of this project:

- Observe numbers of alewife successfully migrating through the study area.
- Reduce colonization of invasive plants on exposed riverbanks upstream of the East Elm Street Dam.
- Ensure water flow through Middle Falls to support fish passage through the side channel.

6.3 NON-FEDERAL RESPONSIBILITIES

For all aquatic habitat restoration projects funded by USACE, project costs must be shared between the local sponsor and USACE. This study was authorized by Section 206 of the Water Resources Development Act of 1996, Public Law 104-303, and by Section 210 of WRDA 1999, which modifies portions of the earlier law.

As the NFS, the town of Yarmouth, ME is required to provide 35% of total project costs relating to ecosystem restoration. The town is also responsible for 100% of operation and maintenance costs for the 50-year life of the project. The Federal share is 65% of total project costs relating to ecosystem restoration. Total project costs include the costs of developing the DPR and EA, creating plans and specifications, and completing construction. The NFS's 35% cost share obligation can be in the form of a cash contribution, in-kind services, or credit for LERRDs. The NFS is responsible for acquiring all LERRDs prior to any construction activity. Before signing the PPA, the NFS must have secured funds to complete the non-Federal cost-sharing portion.

This section includes some of the items of local cooperation required for projects authorized under Section 206 authority. The NFS must provide assurance that they intend to meet these items prior to project authorization. The PPA will detail these and other requirements of the Government and the Sponsor for implementation and future maintenance of the project.

6.3.1 Lands, Easements, Rights-of-Way, Relocations and Disposal Areas

The NFS will be responsible for the acquisition of all LERRDs without cost to the United States, necessary for completing and inspecting the project, and for operating, maintaining, repairing, rehabilitating, or replacing (OMRR&R) the project. The estimated project first cost for LERRD required for this project are estimated to be approximately $99,000.

Further details and maps pertaining to LERRDs may be found in the Real Estate Plan (**Appendix D**).

6.3.2 Operations, Maintenance, Repair, Replacement, and Rehabilitation

There are no foreseen O&M requirements for this project beyond the 5-year monitoring period from completion of the project but there be a need to reseed the exposed banks as needed by the NFS. Existing O&M agreements related to the remaining portion of the East Elm Street Dam between non-federal entities will not be affected by the project. No O&M requirements described in these agreements will be transferred to the USACE.

6.3.3 Additional Non-Federal Responsibilities

1. Hold and save the United States free from all damages arising from construction, operation, maintenance, repair, replacement, and rehabilitation of the project, except for damages due to the fault or negligence of the United States or its contractors.

2. Assume full responsibility for all non-Federal costs associated with the project. Current law requires that the NFS provide at least 35 percent of the first cost of design and construction.

3. Agree to be responsible for total project costs in excess of the Federal cost limit of $10 million in accordance with Section 206 of the River and Harbor Act, as amended.

4. Not use funds from other Federal programs, including any non-federal contribution required as a matching share therefore, to meet any of the non-Federal sponsor's obligations for the project unless the Federal agency

providing the funds verifies in writing that such funds are authorized to be used to carry out the project.

5. The NFS shall not use the project, or real property interests required for construction, operation, and maintenance of the project, as a wetlands bank or mitigation credit for any other project.

6. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function.

7. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the NFS has entered into a written agreement to furnish its required cooperation for the project or separable element.

8. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20.

9. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the CERCLA, 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the initial construction, operation and maintenance of the project.

10. Assume, as between the Federal government and the NFS, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way required for the initial construction, or operation and maintenance of the project.

11. Agree, as between the Federal government and the NFS, that the NFS shall be considered the operator of the project for the purpose of CERCLA liability.

12. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the placement of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

13. Comply with all applicable Federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "*Unlawful Discrimination on the Basis of Disability in Programs and Activities Receiving Federal Financial Assistance From or Conducted by the Department of the Army*" dated 10 March 2020; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)).

7.0 RECOMMENDATION

USACE has evaluated the data for the proposed Federal plan for improving the aquatic ecosystem in the Royal River. Alternative 2 is the TSP. This plan includes:

Bridge Street Dam Demolition

- Removal of the entire fish ladder and dam structure on the right descending bank structure
- Removal of the entire spillway
- Protection of the penstock and associated intake structure on the left descending bank

East Elm Street Dam Demolition

- Removal of the entire fish ladder and dam structure on the right descending bank structure
- Removal of 120 LF of spillway on the right descending bank
- Protection of the spillway on the left descending bank.

Middle Falls Diversion to Side Channel

- Installation of diversion structure at the top of Middle Falls to divert streamflow into the side channel.
- Flow in the side channel will be monitored for capacity to pass fish and additional interventions may be executed as part of an adaptive management plan.

The NER plan is justified due to the high environmental benefits that the nation will receive with the removal of the dams and fish ladders and the construction of a diversion to the Middle Falls side channel. Fish passage and habitat restoration will occur within the Royal River.

The total project costs are estimated to be $5,718,000.00. Federal costs represent 65% if this total: $3,717,000, while non-federal costs represent 35% of the total: $2,001,000. The Town of Yarmouth ME, acting as the NFS, would be responsible for acquiring real estate interest in behalf of the project.

We find substantial benefits to the environment are to be derived by removing the man-made and nature barriers to fish passage. The proposed Federal action was considered individually and cumulatively under the provisions of the NEPA and the action was determined not to have significant effects on the quality of the human environment. The proposed action also incorporates the provisions for protection and ensures compliance with other Federal environmental laws, regulations, EOs and Executive Memorandum such as, for example, the ESA, the FWCA, the NHPA, the CWA, etc.

The USACE has concluded that implementation of the proposed aquatic ecosystem improvements would cause a temporary disruption of the environmental resources present in the construction work area but no significant, negative long-term effects to most environmental resources are anticipated. The removal of the Bridge Street Dam would constitute an adverse effect upon a NR-eligible historic property. Additionally, removal of both the East Elm Street Dam (which was previously determined to be ineligible for the NR) and the Bridge Street Dam would result in a drawdown of the Royal River, which might result in the exposure of Native American archaeological sites that may be present along the banks of the Royal River. A PA is being developed to address how impacts to historic properties and archaeological resources will be addressed in the D/I phase of the project. Due to the significant environmental benefits to habitat any effects are considered to be offset by the improvement of the aquatic ecosystem in the Royal River.

Implementation of the recommendation contained in this report is subject to USACE review, approval and funding processes and sponsor participation, including execution of a PPA with the NFS, the Town of Yarmouth. Upon receiving project approval from NAD, the New England District would prepare plans and specifications prior to solicitation of bids and contract award. Construction of the restoration project could begin as soon as the summer of 2026.

The New England District recommends the approval of the Detailed Project Report and integrated Environmental Assessment to continue into the D/I Phase.

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9.0 LIST OF ACRONYMS AND ABBREVIATIONS

AAHU	Average Annual Habitat Units
ACQR	Air Quality Control Region
AEP	Annual Exceedance Probability
APE	Area of Potential Effect
ARA	Abbreviated Risk Analysis
ARI	Annual Recurrence Interval
BCC	Birds of Conservation Concern
CAA	Clean Air Act
CAP	Continuing Authorities Program
CE/ICA	Cost effectiveness and incremental cost analysis
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CHAT	Climate Hydrology Assessment Tool
CO2eq	Carbon Dioxide Equivalent
CWA	Clean Water Act
cy	Cubic Yards
cy/yr	Cubic Yards per Year
DEP	Department of Environmental Protection
D/I	Design and Implementation
DOT	Department of Transportation
DPR	Detailed Project Report
EA	Environmental Assessment
ECB	Engineering Construction Bulletin
EFH	Essential Fish Habitat
EO	Executive Order
EQ	Environmental Quality
ERDC	Engineer Research and Development Center (USACE)
ERL	Effects-Range Low

ERM	Effects-Range Median
ESA	Endangered Species Act
FEMA	Federal Emergency Management Act
FERC	Federal Energy Regulatory Commission
FIS	Flood Insurance Study
FNP	Federal Navigation Project
FONSI	Finding of No Significant Impact
FT	Feet/Foot
GHGs	Greenhouse Gases
HEC-RAS	Hydrologic Engineering Center's River Analysis System (USACE)
HRTW	Hazardous, Radioactive, and Toxic Waste
IPaC	Information, Planning and Consultation (USWFS)
IWR	Institute of Water Resources
LERRDs	Lands, easements, right-of-way, relocations, and disposal areas
LF	Linear Feet
MDIF&W	Maine Department of Inland Fish and Wildlife
MDMR	Maine Department of Marine Resources
ME	Maine
mg/l	Milligrams/liter
ml	Milliliter
MLW	Mean Low Water
MLLW	Mean Lower Low Water
MMTCO2e	million metric tons of CO_2 equivalent
MPN	Most Probable Number
NAAQS	National Ambient Air Quality Standards
NAVD88	North American Vertical Datum of 1988
NCA4	Fourth National Climate Assessment
NCA5	Fifth National Climate Assessment
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NFS	Non-Federal Sponsor

NHPA	National Historic Preservation Act
NLEB	Northern Long-Eared Bat
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Association
NPL	National Priorities List
NPS	National Park Service
NR	National Register
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
O&M	Operations & Maintenance
OMRR&R	Operating, Maintaining, Repairing, Rehabilitating, or Replacing
OSE	Other Social Effects
PA	Programmatic Agreement
PAHs	Polycyclic Aromatic Hydrocarbons
PDT	Project Delivery Team
PEC	Potential Effect Concentrations
PPA	Project Partnership Agreement
RCRA	Resource Conservation and Recovery Act
RED	Regional Economic Development
SHPO	State Historic Preservation Office
TEC	Threshold Effect Concentration
TRI	Toxics Release Inventory
TSP	Tentatively Selected Plan
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
WQC	Water Quality Certification
WRDA	Water Resources Development Act