Feasibility/Alternatives Analysis Report

Montgomery Dam, Meganticook River Camden, ME

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Prepared for:

Town of Camden,
Maine

Prepared by:

PO Box 236
Damariscotta, ME 04543

59 Union St., Unit 1
Camden, ME 04843

Executive Summary

The Montgomery Dam is located near the outlet of the Megunticook River at the head of Camden Harbor, in Camden, Maine. A dam has been in place at this location for approximately two centuries. The current structure controls a small impoundment upstream of the dam, within which a modest amount of fine sediment (~300 cubic yards) has accumulated. The accumulated sediment contains some potential pollutants of note, though the sediment quality is not markedly different than those found within the Camden Harbor. Several structures are located directly adjacent to or within the impoundment, with a range of conditions associated with structural elements that interact with the river. The dam presently does not serve other functions such as flood control, water supply or power generation.

Montgomery Dam is a low hazard structure in a degrading condition, requiring repair or management to address its structural deficiencies. The dam influences upstream flooding patterns, and requires frequent management by Town staff to control the potential for flooding impacts to upstream structures. There is evidence of a historical population of sea-run fish in the river, but there is no fish passage presently available at the site. A series of additional dams fragment the Megunticook River watershed between Montgomery dam and headwater areas including Megunticook Lake.

This study provides a detailed feasibility assessment of options to manage the dam to achieve objectives that have been identified for the site. These objectives include addressing the structural deficiencies of the dam, reducing the operation and maintenance requirements associated with the dam, reducing the potential for upstream flooding, providing restored fish passage for the native sea-run fish population, facilitating ecological recovery of the Megunticook River watershed, and enhancing the public amenity provided by the river and the site.

Three dam management options were evaluated, including full reconstruction of the dam spillway, partial reconstruction of the spillway (lowering the spillway elevation 4.5 feet), or full removal of dam. A series of fish passage solutions were evaluated for each of the dam management options, including channel restoration, nature-like fish passage, and technical fishways (fish ladders).

The full dam removal option combined with channel restoration or a pool and weir fishway would provide the greatest benefits in terms of reducing operation and maintenance requirements and reducing upstream flooding impacts, while also providing the most advantageous fish passage conditions and greatest benefits in terms of ecological recovery of the watershed. This option would result in the most substantial change to the current status of the site. This option may require selected countermeasures to address changed ambient conditions for the structures located directly adjacent to or within the impoundment, but will also reduce the regular interaction of the river with these structures due to the reduced water levels, resulting in a net benefit.

The full spillway reconstruction option would result in the least amount of change to the site as it exists today, but would not provide flood control benefits and would continue to require operation and maintenance, and periodic capital investments and repairs by the Town. The full spillway reconstruction option would also provide the most challenging fish passage restoration condition, limited to technical fish passage solutions (fish ladders), and would provide the least notable benefits to overall ecological recovery in the watershed. This option would not change the ambient conditions for the structures located directly adjacent to or within the impoundment, but will also not reduce the regular interaction of the river with these structures.

The partial spillway reconstruction option would also continue to require operation and maintenance, and periodic capital investments and repairs by the Town. The flood control benefits with this option are less than the full dam removal option downstream of Main Street, but similar upstream of Main Street due to the influence of the Main Street bridge. Eventual replacement of the Main Street bridge may alter this balance of flood control benefits upstream of the bridge.

With the partial spillway reconstruction option, the fish passage solutions are less challenging than the full spillway reconstruction option, but are still limited to technical fish passage solutions (fish ladders), and are more challenging than the full dam removal option. Similarly, the potential for overall ecological recovery of the watershed is greater than the full spillway reconstruction option, but less than the full dam removal option. This option may require selected countermeasures to address changed ambient conditions for the structures located directly adjacent to or within the impoundment, but will also reduce the regular interaction of the river with these structures due to the reduced water levels, resulting in a net benefit, though not to the same degree as the full dam removal option.

All of the options considered can be configured to provide increased public amenity at the site. Each of these options will include construction activities of notable magnitude, with near-term construction costs of generally similar magnitude. Over the long-term, the full dam removal option will result in the lowest lifespan costs in terms of operation and maintenance, and capital investment. In contrast, the full spillway reconstruction option will result in the greatest life span costs over the long term. Lastly, the full dam removal option is most likely to draw support from external funding sources associated with ecological recovery and infrastructure resiliency initiatives, particularly if included as a component of a comprehensive program to address the aging dams, habitat fragmentation, and ecological recovery of the overall Megunticook River watershed.

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1. Introduction

The Megunticook River has long been a cultural, ecological, and economic centerpiece of the historic Camden region. The Town of Camden owns four of the six remaining intact dams on the Megunticook River. Three of the dams located upstream of the downtown area (East and West Megunticook, and Seabright) are classified as high hazard potential dams. The fourth dam (Montgomery) is a low hazard small dam located in downtown Camden at the top of a ledge outcrop near the head of the Camden Harbor (GEI Consultants 2015). In addition, Seabright dam is part of the Federal Energy Regulatory Commission Seabright Hydroelectric Project (FERC No. 8640-ME), although this facility is not presently generating power and the process of decommissioning the facility is nearly complete.

The Town maintains and manages the dams for a variety of objectives, including aesthetic and recreational considerations. At the same time, the dams influence flooding patterns, create fish passage barriers, and interrupt ecological processes in the river basin. There is a plethora of ecological processes that are disrupted in a watershed fragmented by dams such as the case with the Megunticook River. These factors include connectivity of habitats for fish and other wildlife, impacts to water quality, and impacts to sediment processes, which in turn influence coastal resiliency to changing climate conditions.

As part of broader sustainability and public use initiatives, the Town is exploring options to manage the dams to balance these considerations. Communities around the country are contemplating similar cases, due to the state of aging infrastructure and resources required to maintain it, and growing awareness of the impacts of dams that may have outlasted their intended uses. There are many potential community benefits to be derived from watershed revitalization.

Montgomery dam is presently in a degrading condition and has been assessed to require active maintenance, which may require partial reconstruction. Sitting where the river enters the harbor, many buildings and businesses are clustered around and over the small impoundment behind the dam. The dam also appears to have a notable effect on flood elevations during major storm events in the downtown area and requires active management of levels throughout the year based on river flows and predicted precipitation. During storms, the outflow of the dam has overtopped the dinghy dock in the harbor.

Due to the current need to maintain Montgomery Dam, and in light of the other considerations discussed above, the Town in interested in exploring the full range of options for managing this dam. The Town commissioned a feasibility study to review the options for managing the dam before embarking on the maintenance activity. This report summarizes the results of the feasibility study.

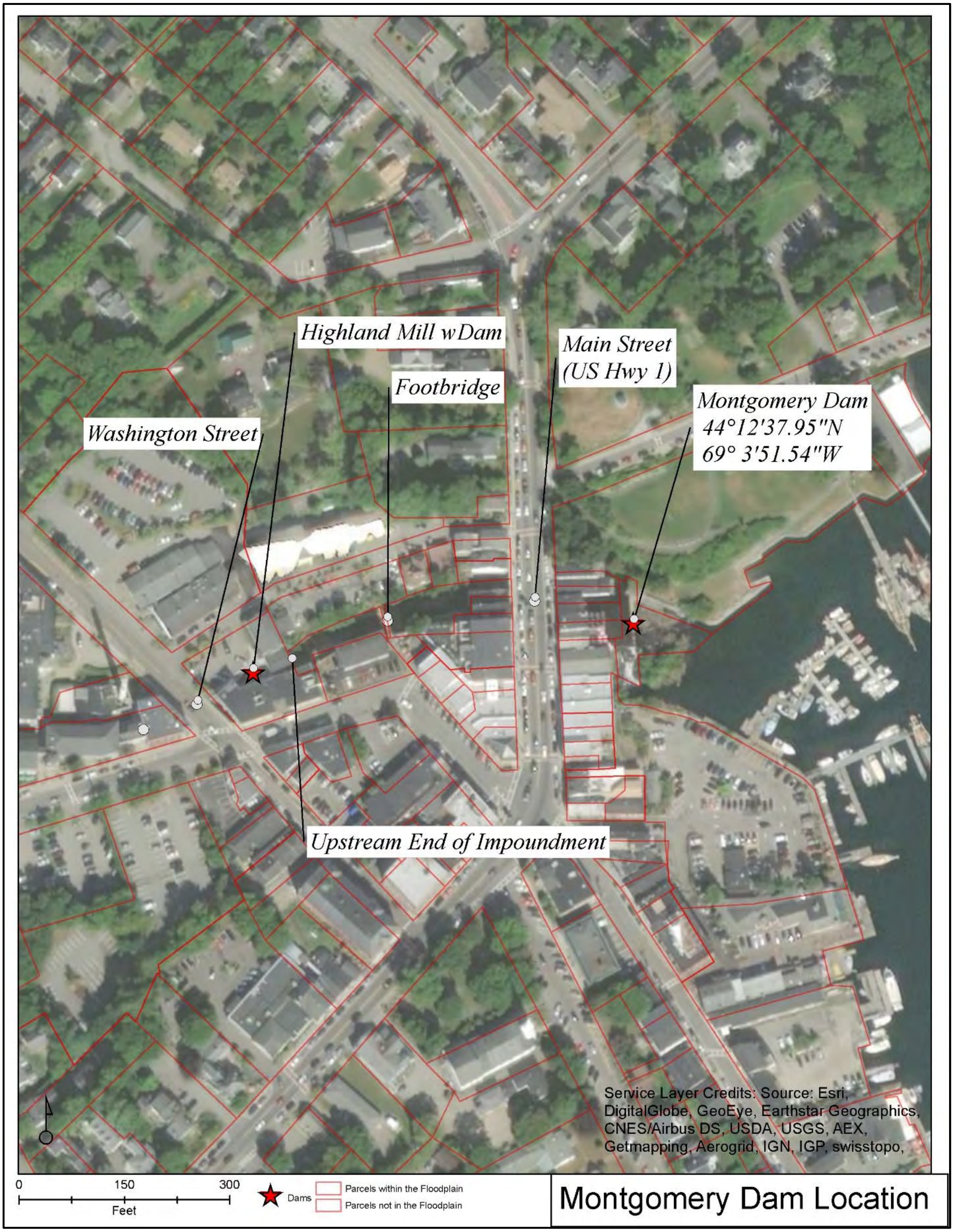

Figure 1. Aerial view of Montgomery Dam and impoundment location.

Figure 2. Aerial view of Montgomery Dam and lower impoundment location. Main Street (Route 1) is located at left of the image. Harbor Park is located north of the dam. The Camden Public Landing is located south of the dam. Date of photo June 22, 2014, low tide condition. Source: Google Earth.

2. Goals & Objectives

The Town's general goal for this project is to manage the dam in a way that limits risk and promotes ecological health of the watershed, while addressing other community concerns.

During the initiation phase of the project, a study kickoff meeting was held (April 23, 2018) to explore specific objectives for managing the site. Participants included interested community members and Town representatives.

A common thread throughout the feedback at the meeting was a desire to improve fish passage and the overall health of the river. Other concerns that were contributed included maintaining the scenic and historical qualities of riverfront and harbor area, and reducing flood risk.

The ultimate goal of this study is to identify options to balance the Town's infrastructure, ecological, and management goals while at the same time honoring the historical significance of the site and enhancing public amenities. The successful project will be collaborative, combining scientific reasoning with the input of the community.

3. Site History

Prior to European settlement, the river's diadromous fish runs were likely staples of the Native American subsistence way of life, as was typical along the Maine coast. European settlers arrived in the area in the 1760s and shortly thereafter began to harness the river by constructing a series of dams that powered mills along its banks. The growth of the local economy was largely made possible by the power generated by dams on the Megunticook, which at one point numbered 11 (Figure 3). Many other changes to the area have occurred. The inner harbor was dredged substantially in the late 1800s (Figure 4 and Figure 5). Fill has been placed on the north side of the river both upstream of Main Street (now a parking lot) and downstream of the dam (now Harbor Park).

An unfortunate consequence of these dams and other changes was the elimination of the diadromous fish run. A warrant article from an 1806 town meeting proposed a fish passage requirement for the dams. Town residents voted to form a committee that would study the issue and potentially petition the state legislature to require it. However, it appears that changes to result in fish passage on the river did not result from this initiative (McKellar 2018).

The dam has supported many uses over its life, including powering the Camden Grist Mill. The last functional application of the dam was for small-scale hydropower production in the 1980s (MEMA 2018).

Figure 3. Historical image of the Montgomery Dam, date unknown. Source: Camden Public Library, Walsh History Center.

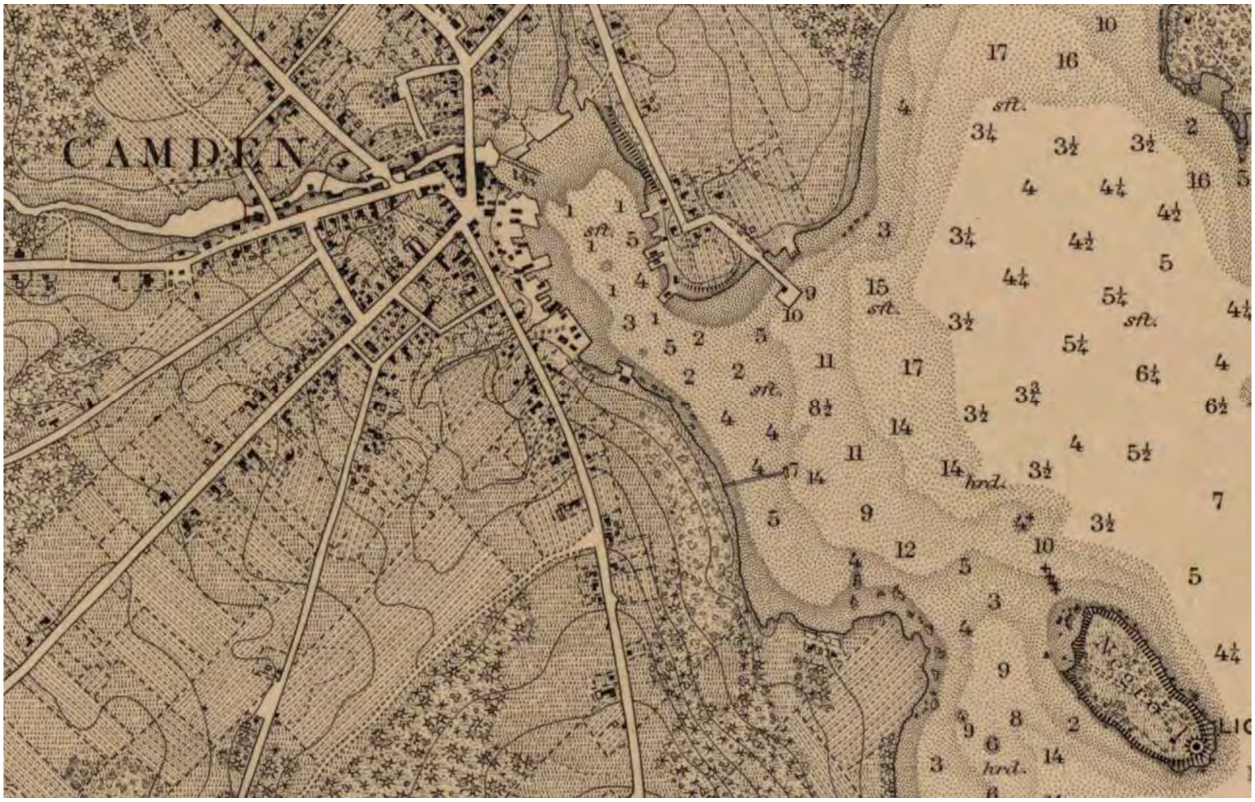

Figure 4. Excerpt from 1864 US Coast Survey map showing shallow depths and mudflats in the inner harbor. Source: American Geographical Society.

Figure 5. Historical image showing shallow depths and mudflats in the harbor, date unknown. Source: Camden-Rockport Historical Society.

4. Site Conditions

The study area for this project extends from the head of the Camden Harbor, through the impoundment formed behind Montgomery Dam, upstream to Washington Street. Following review of available background information, Inter-Fluve and Gartley & Dorsky conducted site investigations in June 2018. The investigations included a survey of the river channel and adjacent infrastructure, a geomorphic and habitat assessment of the river channel in the study reach, sampling of accumulated sediment in the impoundment, and structural assessment of the buildings near the dam. The following paragraphs provide an overview of the existing conditions at the site.

4.1 SITE CONTEXT

The Montgomery Dam is located in downtown Camden at the mouth of the Megunticook River, just above its entrance to Camden Harbor. The river drains a 30.9 square mile watershed that extends from the harbor into the hills and mountains surrounding the town (Figure 6). Elevations within the watershed range from sea level to 1376 feet. The watershed receives 49.5 inches of precipitation annually, on average (PRISM 2014). The watershed is mostly forested, with deciduous, conifer, or mixed forest making up 69% of landcover (Figure 7). Open water, such as Megunticook Lake, also makes up a notable portion (8%) of the watershed. The remaining area is a mix of headwater streams and ponds, wetlands, fields, and developed space (focused around downtown Camden).

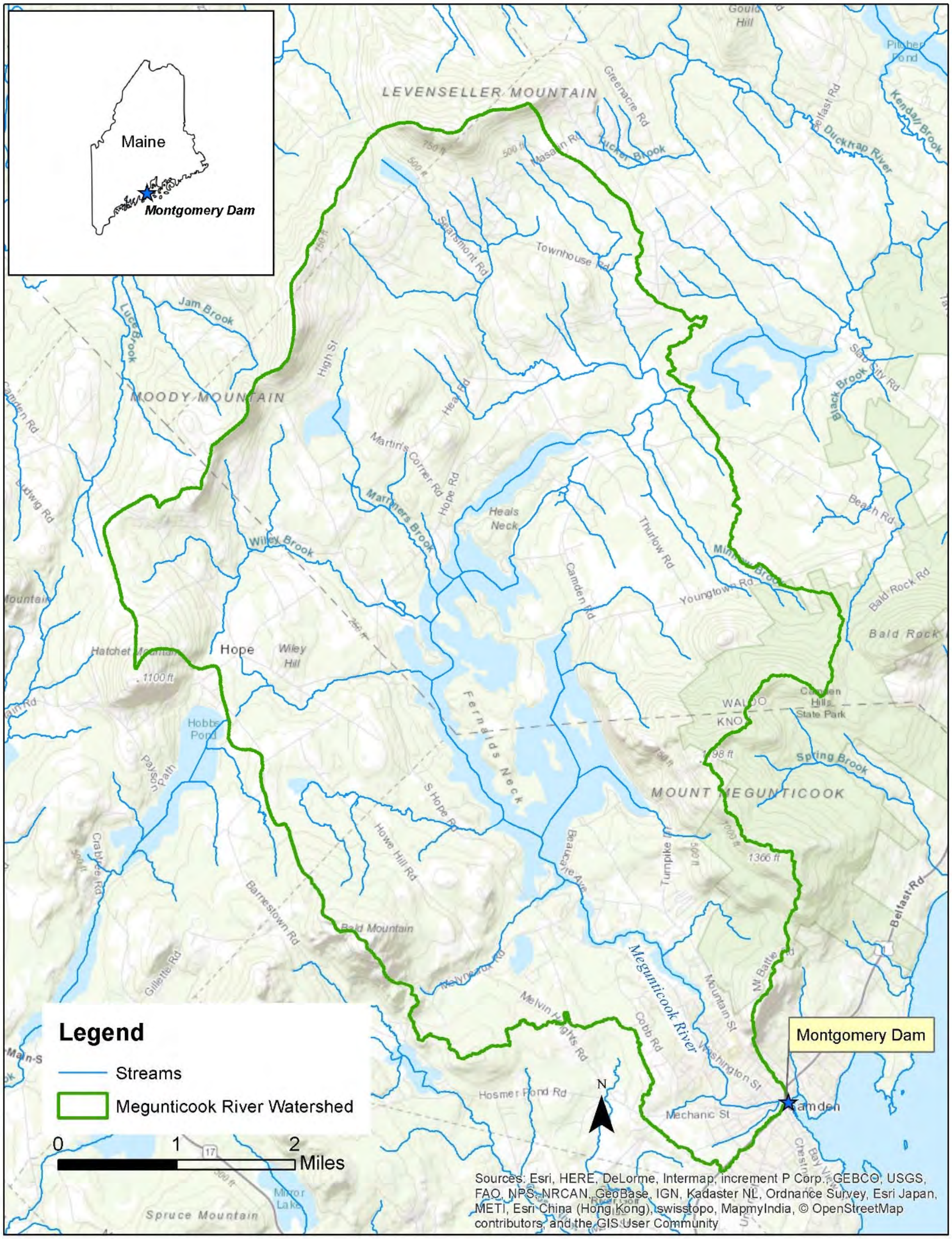

Figure 6. Topographic map with site location and outline of the Megunticook River watershed.

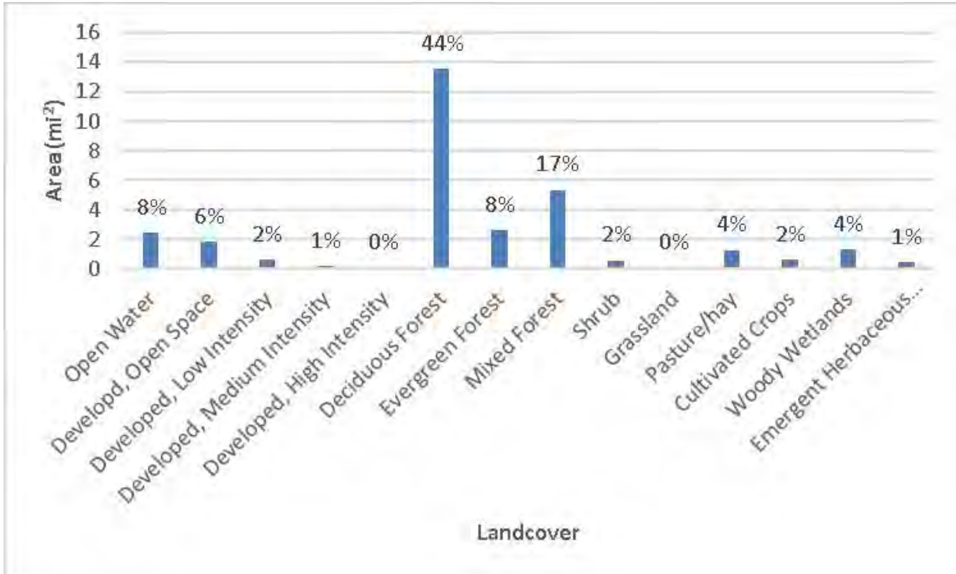

Figure 7. Landcover of the Megunticook River Watershed (NLCD, 2011)

From the dams at the outlet of Megunticook Lake, the river drops 138 feet before emptying into Camden Harbor. From the upper watershed, the river passes over six intact dams (plus at least one relict, degraded dam), with Montgomery being the furthest downstream. Clearly, the river profile is dominated by the series of dams, appearing more similar to a stepped cascade than the typical asymptotic curve of a natural river (Figure 8).

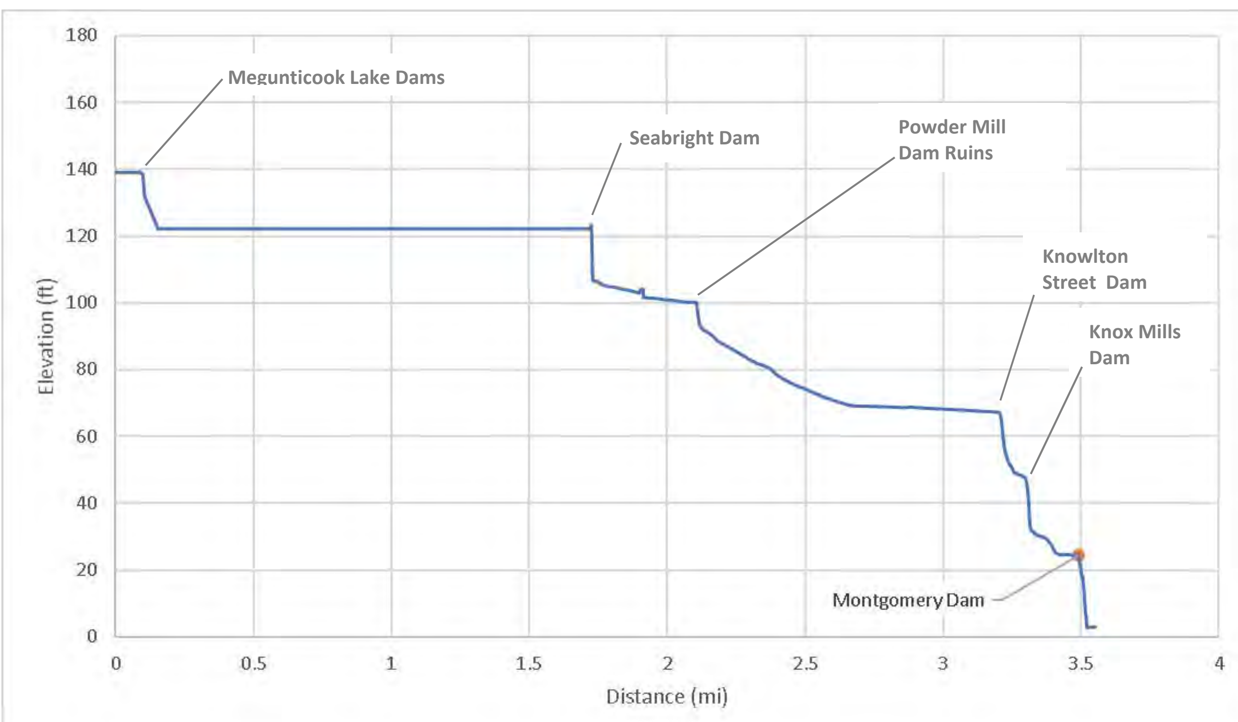

Figure 8. Elevation profile of the Megunticook River, from Megunticook Lake to Camden Harbor.

The Megunticook watershed is underlain primarily by granite and mid- to high-grade metamorphic rock, with some outcrops of limestone (Caldwell 1998). The watershed is a heavily glaciated landscape, still bearing the marks of the Labrador ice sheet that flowed over the region from approximately 75,000 to 15,000 years ago. The erosive power of the ice sheet rounded the peaks of the Camden Hills and carved U-shaped valleys that parallel the flow of the ice, roughly trending southeast/northwest. The Megunticook River flows from Megunticook Lake to Penobscot Bay through one of these valleys.

The region's history of glaciation is also evident in the widespread coverage of glacial till, a poorly sorted mix of sediment ranging from fine silt to boulders. The Megunticook River has spent the last 15,000 years forming in this heterogeneous substrate, which explains the wide variation in grain size along the channel bed and banks.

More locally, glacial striations (parallel grooves) in the bedrock are still highly evident on the bedrock at present day Megunticook Falls (Figure 9). These striations record the direction of ice flow (to the south-southeast), as they were etched by loose rocks dragged along the bottom of the flowing ice sheet.

Figure 9. Glacial striations on the bedrock surface of Megunticook Falls. Red arrows indicate the direction of ice flow ~15,000 years ago.

4.1.1 Channel Alignment

In the current configuration of the site, the Megunticook River flows over a bedrock outcrop over which the L-shaped dam embankment was constructed. The river drops approximately 17 feet from the dam spillway to the highest annual tide (HAT) elevation in Camden harbor (Figure 10 to Figure 13). The dam itself and Megunticook Falls pose barriers to fish passage.

Figure 10. View from head of harbor looking upstream at ledge outcrop and Montgomery dam, May 8, 2018. The seawall is shown in the right foreground.

Figure 11. View of north end of spillway, the stone outflow culvert, and ledge outcrop, May 8, 2018. The seawall and Harbor Park are at the right of the image.

Figure 12. View east from spillway at ledge outcrop, May 8, 2018. The outflow culvert, seawall and Harbor Park are at the left of the image.

Figure 13. View of south end of spillway and ledge outcrop, May 8, 2018.

During the course of project discussions, there has been consideration of whether the current alignment is the historical alignment of the river. Because the Town was settled in the 18th century, with significant manipulation of the river since that time, there are no maps or images that show in precise detail the unaltered course of the river. Our analysis of historic aerial imagery and topographic maps dating back to 1906 shows the river in its current alignment. Information prior to that time (e.g., Locke 1859) suggests a prior alignment shifted slightly to the north of the current alignment, through the lower part of Harbor Park (Figure 14).

Figure 14. A 1930 photo of the area behind the sea wall looking upstream towards the dam, showing evidence of a historical relict channel in this area. The area was converted to Harbor Park in 1930. Photo courtesy of the National Park Service, Olmstead Archives, Frederick Law Olmsted National Historic Site, Brookline, Massachusetts.

The current course of the river near the spillway is an unlikely one as it traverses over an erosion resistant, locally high spot in the topography. As rivers evolve, they gravitate towards the lowest, least erosion resistant alignment in the landscape, always seeking the path of least resistance as they flow from the upper watershed to meet the sea. If the river had been flowing over the ledge outcrop through the period since glaciation (for the past 15,000 years) as it does today, the striations in the bedrock described above would likely have been polished away by the river, similar to what is seen in other coastal rivers that flow over ledge. The fact that these striations are so well preserved today suggests that the river naturally flowed along a different alignment historically.

During the settlement of Maine, it was a common practice to move the alignment of rivers to opportunistically utilize bedrock outcrops in dam construction. By forcing the rivers to flow over the bedrock outcrops which are relatively higher in elevation, the amount of power that could be harnessed was increased, while resulting in more modest dam construction effort. It is suspected that this practice occurred with the Megunticook River.

While it is clear that the river alignment in downtown Camden is not the pre-disturbance alignment, the full detail of the historical course is less obvious. It is likely that the natural channel would have flowed down the more gently sloped approaches to the harbor that surround the bed rock outcrop. Mapping from early in the settlement of the Town and early photographs collected by McKellar (2018) indicate a channel to the north of the bedrock outcrop, aligned through what is now the Harbor Park area, below the bluff. The Harbor Park area was filled and developed in 1930 (Figure 15 and Figure 16) in conjunction with reconstruction of the dam, discussed in Section 4.2. The High Street National Historic District was expanded in 1999 to include the park area developed in 1930. The extent of fill in the lower park and on the adjacent bluff has not been investigated with field exploration. Additional evidence could be obtained in subsequent design phases through geophysical exploration or borings in this area, to determine the nature of the below ground conditions and the depth to bedrock.

Historical flow may have also partially split around the bedrock to the south, aligned with the low point in the ledge on the public landing side of the dam. This location coincides with the historical outflow from former mill in the Marriner's building and along the area that is now the public landing, discussed below. Water was funneled from the impoundment through the basement of the Marriner's building, and the portal that diverted flow from the Montgomery dam impoundment can still be observed today. However, evidence of extensive modification of the ledge including blasting in this area is also observable today, so the historical condition in this area is also difficult to conclude.

Downstream of the river mouth, the inner harbor has been dredged on multiple occasions, and has been modified from the historical condition. The condition prior to dredging in the late 1800s was much more shallow than the conditions today (Figure 4 and Figure 5). The history of disturbance in the harbor also limits clues of the historical condition of the river mouth as it flowed into the sea.

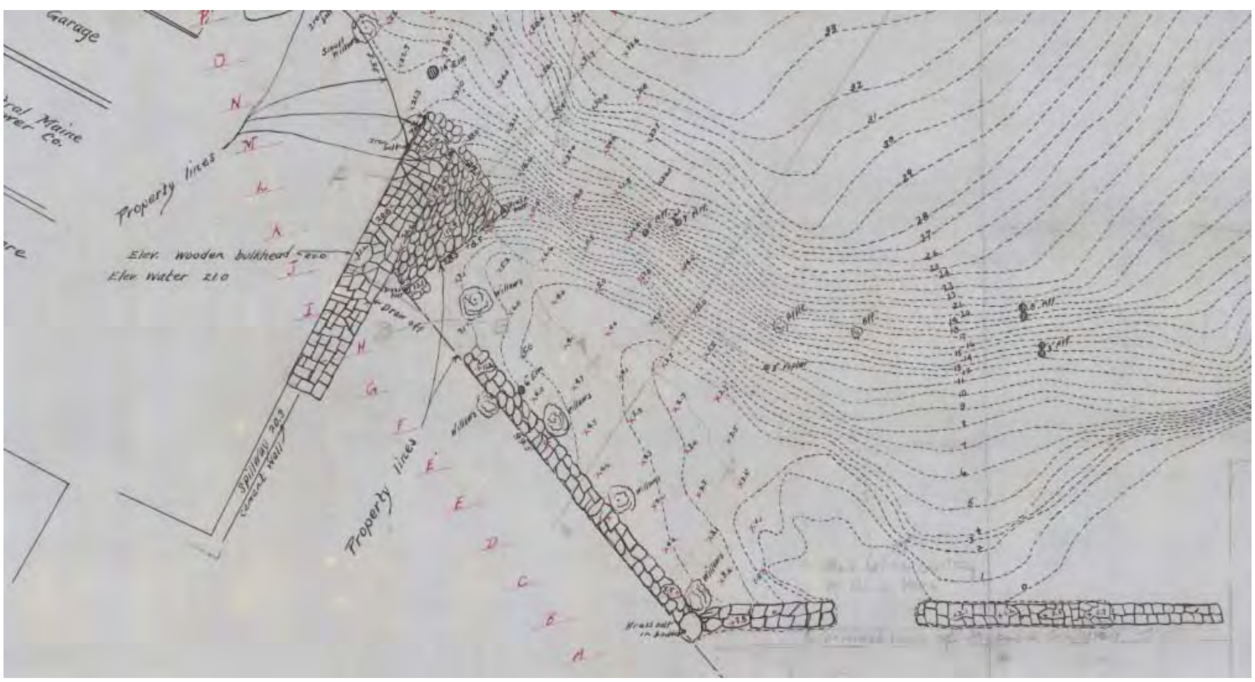

Figure 15. Excerpt of a 1929 topographical map of the site showing evidence of a historical channel north of the seawall as it existed at that time. The low-lying area was filled in conjunction with development of the Harbor Park area in 1930. Map courtesy of the National Park Service, Olmstead Archives, Frederick Law Olmsted National Historic Site, Brookline, Massachusetts.

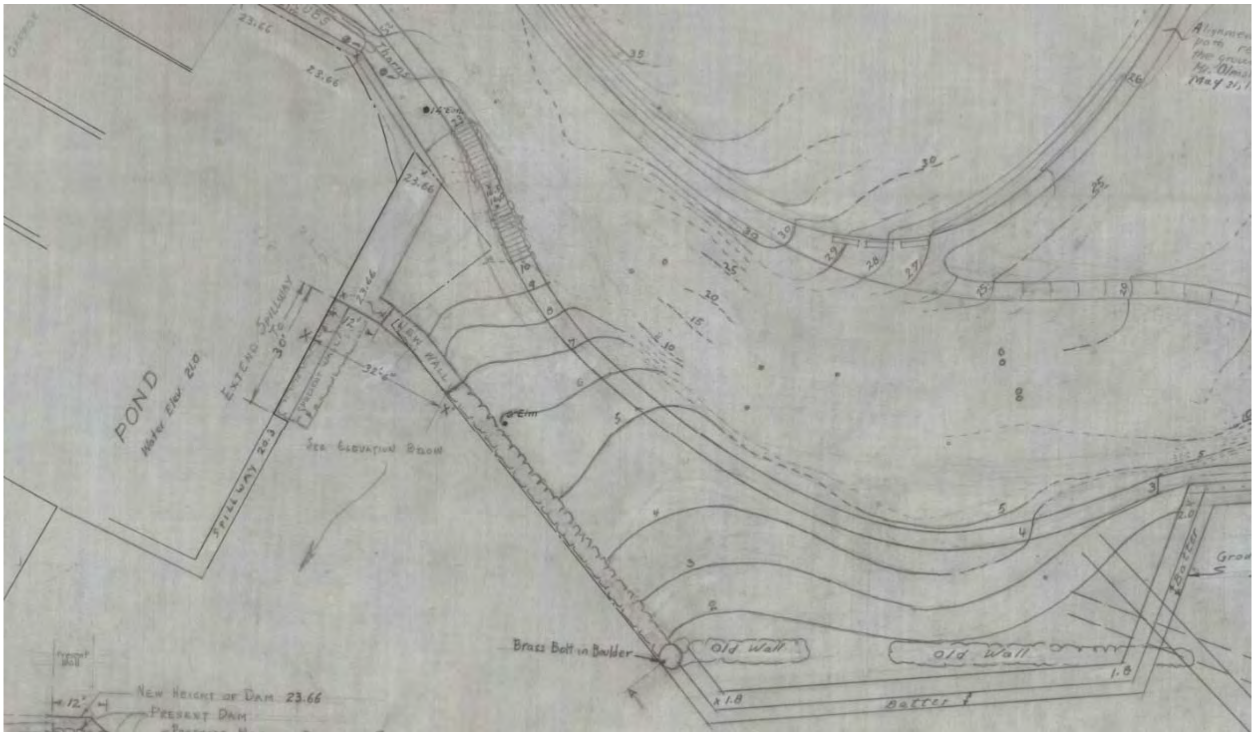

Figure 16. Excerpt of a 1930 plan showing grading and fill and new seawall in the Harbor Park area. Map courtesy of the National Park Service, Olmstead Archives, Frederick Law Olmsted National Historic Site, Brookline, Massachusetts.

4.2 DAM AND IMPOUNDMENT

The dam has undergone changes since it was first constructed. A survey map from 1912 indicates a second spillway located in the outlet channel that runs along the public landing (Figure 17). The second spillway can be observed in historical photos and evidence of it can be observed at the site, but it no longer exists (Figure 18).

Figure 17. 1912 map of Camden Grist Mill property (Source: Town of Camden archives).

Figure 18. Historical photo of Montgomery Dam showing second spillway downstream of grist mill, cropped stereographic image taken between 1869 and 1880, from the collection of Robert N. Dennis (Source: New York Public Library).

Water from the Montgomery dam impoundment was diverted through the former Camden Grist Mill (now the Marriner's restaurant) into the small impoundment behind the second spillway. Water from the lower impoundment was then diverted through the anchor factory that existed at the current location of the public landing. The dam was reconstructed in 1930 in conjunction with the development of the lower Harbor Park area (Figure 19 and Figure 20). Montgomery dam was given to the Town in 1992 by the Montgomery family.

Figure 19. 1930 Photo of the dam as it existing prior to reconstruction in 1930. Photo courtesy of the National Park Service, Olmstead Archives, Frederick Law Olmsted National Historic Site, Brookline, Massachusetts.

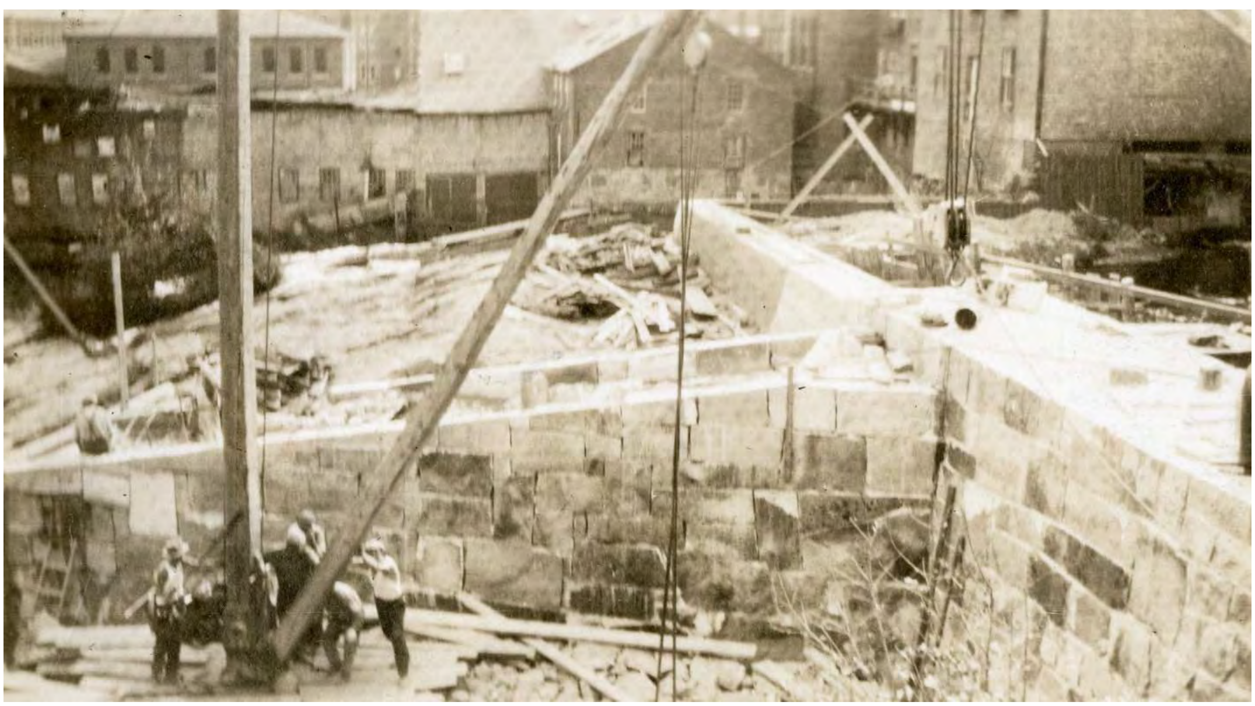

Figure 20. 1930 photo of the dam under reconstruction in 1930. Photo courtesy of the National Park Service, Olmstead Archives, Frederick Law Olmsted National Historic Site, Brookline, Massachusetts.

As it exists today, Montgomery dam is a mass gravity, cut-stone and concrete dam, founded on bedrock. The primary spillway forms a right angle and discharges in two directions down a bedrock cascade directly to Camden Harbor. The height of the dam varies between 12 feet at the low-level outlet control structure and 3 feet at the river right (west) side of the spillway. The primary spillway is a 2-foot wide, broad-crested weir 75 feet in length along the long face (south) and 25 feet in length along the short face (west). The spillway section is in a degrading condition, with the concrete/bedrock foundation interface considered to be in poor condition (GEI Consultants 2015).

A 40-foot long non-overflow segment forms the left abutment, located to the north of the spillway. The low-level outlet located in the left abutment is controlled by a vertical gate (Figure 21). The gate is operable (2018) and is used to draw down the impoundment as needed for maintenance to to limit inundation of the upstream buildings during periods of high flow or in anticipation of significant precipitation events. Under normal conditions, it is left in the closed position. Discharge through the low-level outlet flows through a 50-foot long stone culvert (approximate dimensions 3 feet wide, 4 feet tall) to the middle of the ledge outcrop along the cut stone seawall, flowing over bedrock to the harbor.

Figure 21. View of lower impoundment in drawn down condition, May 8, 2018. Non-overflow portion of dam and headgate at left half of image, spillway at right half of image. Normal pool elevation at spillway crest.

Presently, the dam backwaters a small impoundment which forms an approximate 50-foot wide, 100-foot long pool behind the Main Street businesses. The backwater influence of the dam at spillway elevation extends upstream beneath the businesses and through the Main Street bridge, to a point approximately 350 feet upstream of the bridge (Figure 22). There are presently no fish passage facilities at the site. Additional descriptions of the river upstream of the dam and of the influence of the dam are found in subsequent sections of the report.

Figure 22. View of upper impoundment looking downstream from Brewster building in drawn down condition, May 8, 2018. Stain lines on large boulder at left, and concrete wall at right indicate normal pool elevation. The ground to the left of the channel is comprised of urban fill.

4.3 FISHERIES OVERVIEW

The pre-settlement condition of the river and the status of the sea-run fish community that existed at that time are not conclusively known. However, there are lines of evidence which suggest that the river conditions supported sea-run fish, including the ability for the fish to ascend from the harbor upstream through the watershed to the headwater lakes (Kircheis, et al. 2004, McKellar 2018). The Maine Stream Habitat Viewer (2019) suggests that there is evidence that an alewife run existed historically. In particular, the headwater lakes and ponds provide promising potential reproduction habitat for a substantial alewife run. Presently, viable upstream passage for sea-run fish is not available at the site, due to the presence of the dam and outflow over the ledge outcrop.

Based on consultation with Maine Department of Marine Resources, the primary sea run fish that might reoccupy the Megunticook River watershed following restoration are alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American eel (*Anguilla rostrata*), sea lamprey (*Petromyzon marinus*), and sea-run brook trout (*Salvelinus fontinalis*). With substantial recovery of their populations, Atlantic salmon (*Salmo salar)* and rainbow smelt (*Osmerus mordax*) could also be expected to utilize habitat in the Megunticook watershed. If unobstructed safe, timely and effective fish passage were established all of the way to the headwater lakes including Megunticook Lake, MDMR (2018) suggested the potential for an alewife population of at least 300,000 fish based on the acreage of the potential habitat present in the watershed. Sketches of these fish are included in Figure 23.

The species designated in this list have shown a marked decline in abundance throughout the Atlantic region. This decline is attributed in large part to loss of habitat, especially relating to dam installation (Limburg and Waldman 2009). The Megunticook River reflects the experience of many rivers in the region, where insufficient fish passage contributed to a decline in diadromous species upstream of the dams.

The Megunticook River watershed is within the Penobscot salmon habitat recovery unit (SHRU) for Atlantic salmon and the Penobscot Habitat Focus Area under NOAA's Habitat Blueprint. The watershed also contains modeled potential Atlantic salmon rearing habitat (Maine Stream Habitat Viewer 2019). Recovery of sea-run fish that are co-evolved with Atlantic salmon such as river herring would support the goals of the recovery plan for the endangered salmon (U.S. Fish and Wildlife Service and NMFS 2018).

River herring (alewife and blueback herring) and American eel are attracted to the Megunticook River mouth during the spring migration, suggesting plausible restoration of the runs for these fish if effective fish passage were established. Bioperiod estimates for the fish considered in the study were subsequently derived from consultation with MDMR, which indicate the anticipated upstream migration timing of these species, were sufficient passage to be provided (Table 1).

Table 1. Estimated bioperiods for potential upstream migration of diadromous fish species on the Megunticook River (MDMR 2018).

Species	**Bioperiod**
	Upstream Migration
Alewife	**May - June**
Blueback Herring	**May – July 15**
American Eel	**May - July**
Sea Lamprey	**May -June**
Sea Run Brook Trout	**September - December**
Rainbow Smelt	**March-May**
Atlantic Salmon	**May - July**

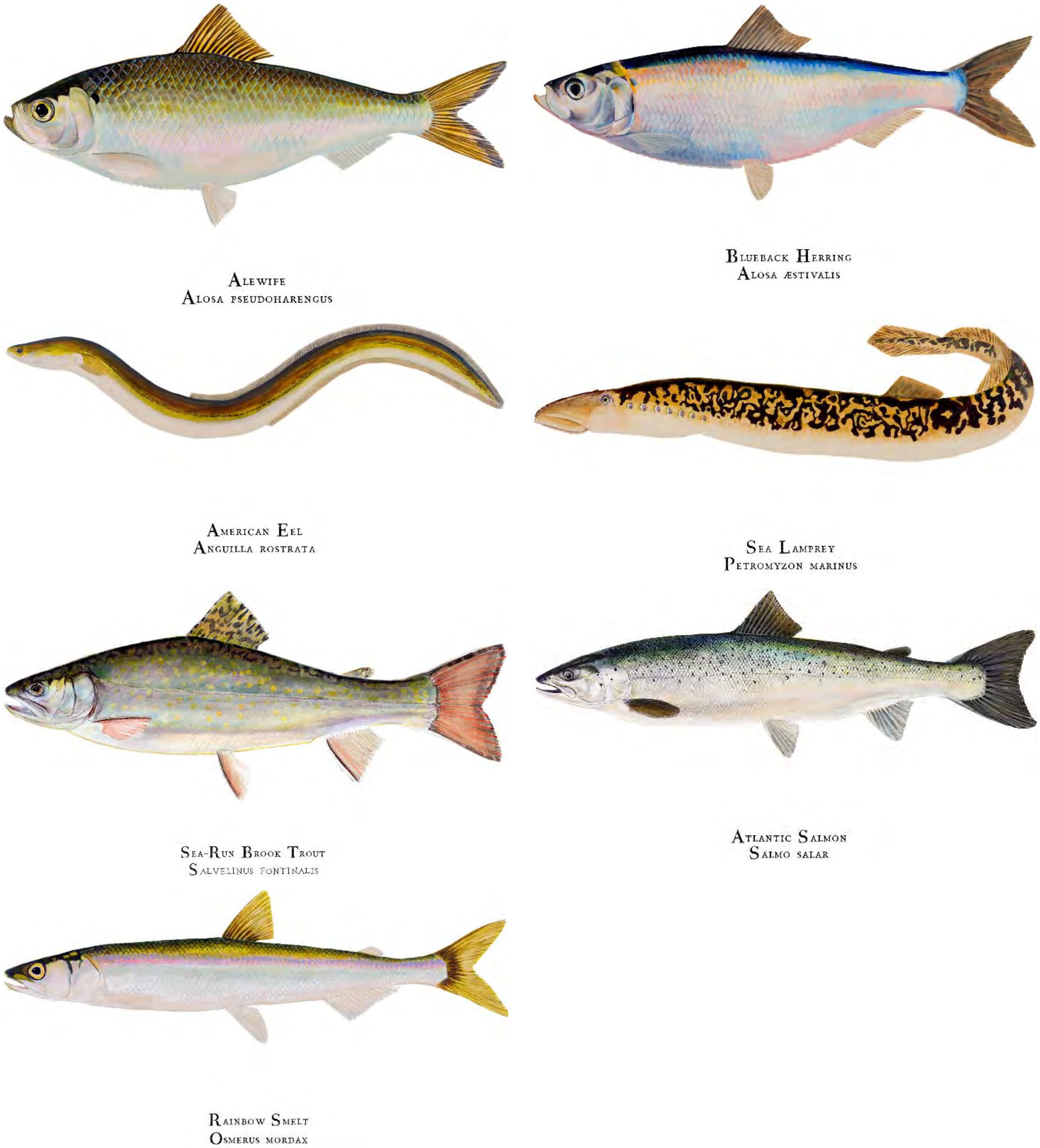

Figure 23. Sketches of the native sea-run fish that may utilize the Megunticook River watershed following restoration of fish passage in the river (Artwork by Karen Talbot, www.karentalbotart.com).

4.4 RIVER CHANNEL CONDITIONS

The Megunticook River through the study reach exhibits the traits of a highly altered stream. Typically, the impoundment from Montgomery dam extends upstream through the Main Street bridge, to a location just downstream of the Brewster building (approximately 350 feet upstream of Main Street). In the condition with the river impounded by the dam, this reach has the characteristics of a channelized, urban stream, that lacks aquatic habitat quality or diversity. The channel is walled on either side, with no natural floodplain.

During the field investigation, the impoundment was drawn down, which afforded a view of the condition of the stream in the study reach if the dam were lowered. Immediately upstream of the dam, the channel concentrates in the vicinity of the existing head gate between ledge outcrops under a shallow mantle of accumulated sediment. During the field assessment, an abandoned relict tank was observed in the lower impoundment on the south side of the channel (Figure 24). The origin and purpose of the tank is unknown, but observations by Town of Camden staff suggest that the tank is empty. In conjunction with sediment testing, a composite sediment sample was retrieved from the tank area. See Section 4.5.1 for more details.

Figure 24. View of lower impoundment and north end of spillway in drawn down condition, May 8, 2018. Relict tank is located in the vicinity of the survey tripod at the left of the image.

From a location approximately 35 feet upstream of the dam to the downstream edge of the Main Street bridge (approximately 100 feet upstream of the dam), the river flows under multiple commercial buildings with various supports and structural elements either landing in or adjacent to the river channel. Flow under Main Street (MDOT# 2497) is split between parallel 14 foot-wide spans

68 feet in length. Multiple piped utilities cross beneath the bridge deck above the river and appear to be in various states of maintenance need (Figure 25). The river bed through the bridge is coarse-grained (gravel, cobbles and small boulders with some bricks).

Figure 25. View downstream through north span of Main Street bridge in drawn down condition, May 8, 2018. Stain lines indicate normal pool elevation.

At the downstream end of the bridge, the flow concentrates around ledge and large boulders to create a pair of hydraulic drops totaling 2.7 to 3.0 feet in water surface level change over approximately 20 feet of stream length (Figure 26). This area is backwatered when the dam impounds the river. If the selected project approach led to reduction of the impoundment level, fish passage through this transition at Main Street would need to be managed.

Figure 26. View upstream at Main Street bridge in drawn down condition, May 8, 2018. Hydraulic drop at downstream bridge opening in center of photo. Stain lines apparent on posts indicate normal pool elevation.

Immediately upstream of the bridge, additional commercial structures extend over one half of the river for approximately 60 feet. In the drawn down condition, the channel exhibits geomorphic sequences of a natural stream over the next 275 feet (Figure 27). Gravel bars, riffles, and pools are all present through this section. A clear span footbridge crosses the river in the middle of this reach, but does not influence the river hydraulics. The river bed through this reach is also coarse-grained (gravel, cobbles and a few small boulders, with some bricks). The area upstream of the Main Street bridge exhibits a depositional pattern, in response to backwater during high flows.

Figure 27. Looking upstream from Main Street with impoundment drawn down, May 8, 2018. In addition to infrastructure in the river, natural features such as boulders, mid-channel bars, riffles, and pools are all present through this reach.

The effective end of the Montgomery dam impoundment is located approximately 350 feet upstream of the bridge, and 525 feet upstream of the dam. From this point upstream to Washington Street, the river again flows under residential and commercial buildings, including the Brewster building, the site of a former mill. A relict water wheel and a line of weirs extend across the channel beneath this building, creating a hydraulic drop of approximately 1 foot (Figure 28). These features were not assessed to be a full fish passage barrier, but modest management of the conditions beneath the building would enhance full fish passage potential.

Figure 28. Looking downstream beneath Brewster building, May 8, 2018. Relict water wheels and weirs between pier footings visible in images.

Lastly, the river flows under the Washington Street ('Bakery') Bridge (MDOT# 2981) approximately 500 feet upstream of Main Street. The super structure of the clearspan bridge was replaced in 2017. Beneath the bridge, a concrete-encased sewer pipe creates an approximate 9 inch to 12 inch hydraulic drop, which was also not assessed to be a full fish passage barrier (Figure 29).

Figure 29. View across channel beneath Washington Street bridge, May 8, 2018. Concrete sewer line encasement creates hydraulic drop of approximately 9 inches.

4.5 IMPOUNDED SEDIMENT

Downstream of Main Street, the impoundment is approximately 115 feet wide at the widest point along the upstream face of the dam. At two or three times the width of the river, this area of the lower impoundment is prone to modest fine sediment (sand and silt) accumulation (Figure 30). The lower impoundment near the head gate was previously dredged in 2013, removing an estimated 30 years of sediment accumulation at that time (Pen Bay Pilot 2013).

The site investigation included a depth of refusal survey, which entails surveying the surface of the impounded sediment and also probing through this layer and surveying the ledge or coarse sediment that made up the pre-dam surface. These survey points are used to estimate the volume of sediment trapped behind the dam and provides clues to what the site may look like if the dam were not in place.

The results of the survey suggest that the thickness of fine sediment trapped behind the dam is between 0 and 4 feet (Figure 31). This amounts to approximately 250 to 300 cubic yards of fine sediment across the impoundment. The sediment has been deposited along the low-velocity margins of the impoundment. The middle of the impoundment appears to be scoured to the underlying coarse layer as a result of occasional drawdown events.

Figure 30. The impoundment with the water level drawn down. A modest volume of fine-grained sediment is trapped behind the dam. May 8, 2018. Relict tank location is immediately below and several feet downstream of the purple French doors in the image.

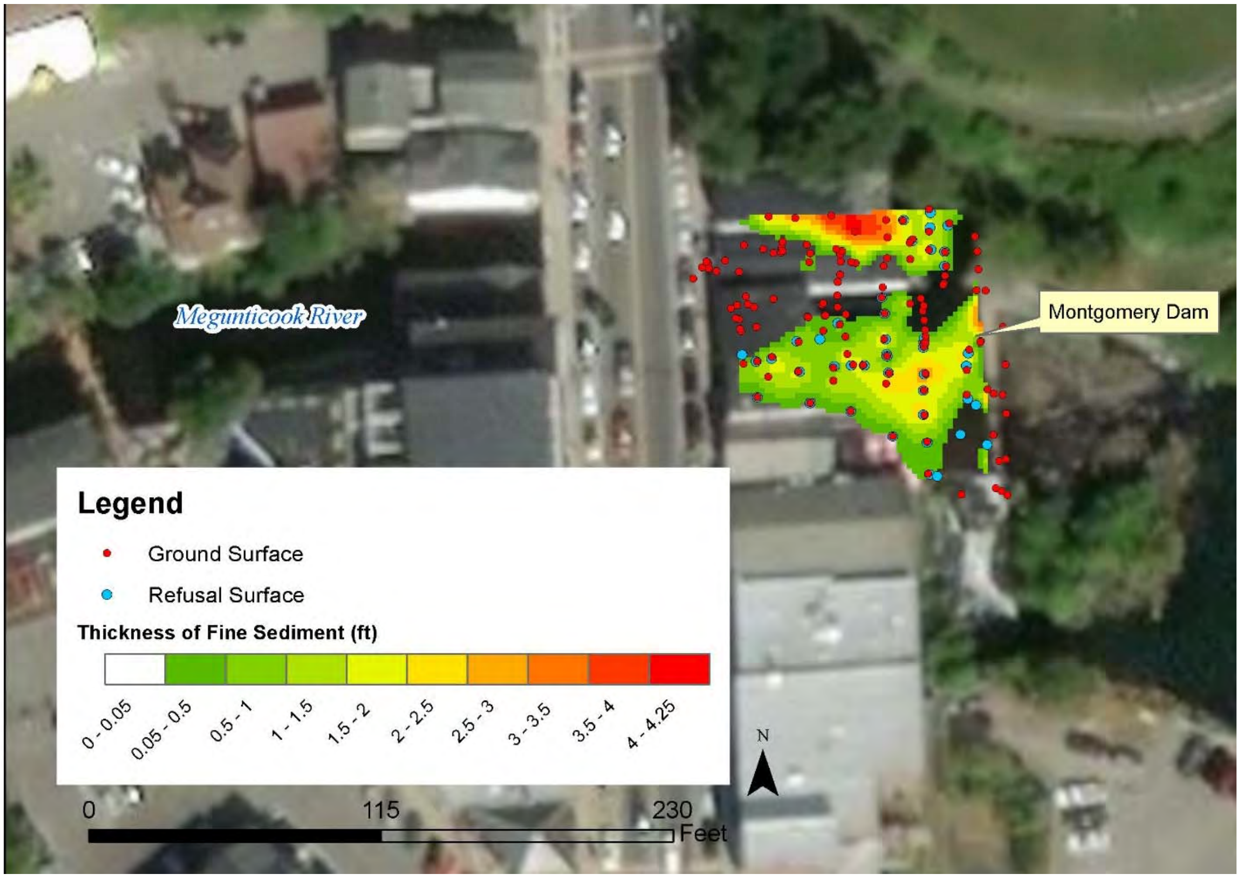

Figure 31. Estimated thickness of fine sediment trapped behind the dam.

4.5.1 Impounded Sediment Quality

Sediment impounded behind a dam can potentially bear the legacy of contamination from past or present upstream land or industrial uses, including urban runoff. Management of impounded sediment is an important consideration when contemplating dam management activities. Based on the industrial legacy of the river, the urban setting, and the presence of the sediment, samples of the accumulated sediment were collected to screen for the presence of potential pollutants. As discussed above, the Montgomery dam impoundment was dredged in 2013, and parts of the Camden harbor were most recently dredged in 2013 and 2003 (Pen Bay Pilot 2013). Sediment testing may have occurred in association with those dredging events, but any associated results were not available at the time of report preparation.

For this study, three sediment samples were collected in the dam impoundment. The locations included one sample on each side of the impoundment, and one directly in the vicinity of the relict tank that was observed in the impoundment. In addition, one "background" sample of sediment was collected from the head of Camden Harbor for comparison to the sediment in the impoundment. Typically, sediment management decisions are made based both on the level of potential pollutants in the impoundment samples, but also the level of potential pollutants in the sediment of the receiving water body.

The samples were analyzed by Alpha Analytical, a testing laboratory in Portsmouth, NH. Results of the testing were then screened against standard criteria that are used to evaluate accumulated sediment in impoundments in New England. These criteria are defined by the consensus-based sediment quality guidelines (MacDonald et al. 2000). These guidelines set thresholds for concentrations of potential pollutants that might result in marginal effects (TEC, TEL) and probable effects (PEC, PEL) to organisms living in freshwater and marine ecosystems. These criteria are typically used to assess whether sediment is clean enough to allow it to pass downstream, to reuse the sediment on a project site, or whether it is advisable to remove the sediment from the project location and prevent further exposure.

Complete results of the sediment testing program can be found in Appendix A. Selected results exceeded screening levels, predominantly for metals and semi-volatile organic compounds. In general, within the impoundment, the highest concentrations were found immediately adjacent to the tank. In some cases, the harbor sample had higher concentrations of a given analyte, which would indicate that releasing the impounded sediment would not increase the concentration of that analyte in the harbor.

Two points of comparison for the sediment testing results were obtained from other studies. First, a comparison for the harbor sample comes from sediment testing carried out for a proposed dredging project at Lyman-Morse Boatbuilding located within the harbor (Lyman-Morse Boatbuilding 2018). A review of the associated results indicated that they are in close agreement with the analysis of the harbor sample presented in this report. Testing carried out in the early 1990s in the impoundment upstream of Knowlton Street dam (Kimball Chase Company 1991, Town of Camden 2019) revealed similar results as were detected in the impoundment samples.

In general, the same analytes were detected in both the harbor and impoundment samples and at similar orders of magnitude. One notable exception to this trend is mercury, which was detected at a high concentration immediately adjacent to the tank, but below thresholds in the harbor sample. In addition, chromium was substantially higher in the impoundment samples than the harbor sample, which was below the associated thresholds. The general similarity between the results in the harbor and in the impoundment leads to the interpretation that harbor has been receiving sediment from the Megunticook River historically, and that the overall sediment quality upstream and downstream of the dam is not markedly different, with some noted exceptions.

Typically, reuse or release options for impounded sediment are discussed and negotiated with state regulatory bodies at the beginning of a detailed design phase. As a result, it is not presently known whether release of the accumulated sediment would be permitted. However, given the modest volume of sediment, a safe assumption for current project evaluation and planning purposes would be that sediment release will not be permitted, and that the sediment will be required to be removed from the impoundment and disposed at an offsite location.

4.6 STRUCTURAL CONDITION ASSESSMENT

The site investigation also included a qualitative structural condition assessment (performed by Gartley & Dorsky) to observe and document the existing structure foundations along the river from the dam upstream to 25 Mechanic Street (Brewster Building), located just downstream of the Washington Street bridge. The assessment included the portions of the existing foundations visible during the site visit, including building piles, bracing, bridge abutments and building foundations. Observations of the Main Street (Route 1) bridge abutments and the Tannery Lane Footbridge abutments were also made. The conditions assessment aimed to provide a general understanding of the existing condition of the building foundations at the time of the inspection.

Although many of the building foundation elements were found to be structurally sound, an array of forms and types of degradation or deficiency were observed. Several notable potential deficiencies were also observed beneath the Main Street bridge, including the condition of the stormwater lines suspended across the channel. The bridge was last inspected by MDOT in 2016, who observed similar conditions, although the MDOT inspection occurred during a period of high water.

The above conditions of the observed structures would be present regardless of modification to the dam, but form a baseline against which to compare effects that might result from dam modification. The subsequent potential effects of dam modification on the existing structural conditions are discussed in Section 6.1.2 of the report. The assessment report is included in Appendix B.

4.7 HYDROLOGY AND HYDRAULICS

As part of this project, Inter-Fluve evaluated the hydrologic characteristics of the Megunticook River and the contributing watershed, and hydraulic patterns near Montgomery Dam.

4.7.1 Hydrologic Analysis

This section of the report describes the methods used to estimate low-flow, seasonal flow, and peak flood flows into and out of the Montgomery Dam impoundment. Three separate methods were used to derive flow estimates.

First, Inter-Fluve reviewed the results of the historical hydrologic and hydraulic analysis for the Megunticook River reported in the May 4, 1988 Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) report. This historical study was performed by Stone and Webster Engineering Corporation, with the work completed in April 1986. The 1988 FIS was subsequently integrated into the 2016 county-wide Knox County FIS (FIS Number 23013CV000A; FEMA 2016).

Second, we used the U.S. Geological Survey Streamstats tool to estimate surface water inflows to the Montgomery Dam impoundment for a suite of typical flows and a suite of peak flood flows. The StreamStats tool is a web-based user interface that estimates the hydrologic characteristics of watersheds and then implements the USGS regression equation methods for estimating flows. After the user selects the discharge point for the area of interest, the web-based tool delineates the contributing area using the National Elevation Dataset and the National Hydrography Dataset, calculates characteristics of the land within the contributing area, and uses the characteristics to implement the regression equation methods.

Lastly, in 2014 Maine DOT performed a hydrologic analysis to evaluate the performance of the Washington Street Bridge (Bakery Bridge). The Maine DOT study referred to the same regression equations used by the StreamStats tool. Table 2 summarizes the peak flow estimates for these three alternate sources, while Table 3 summarizes estimates of the typical flows to the impoundment.

Table 2. Peak Flood Flows Discharging to the Montgomery Dam Impoundment

Average Return Period (Years)	Annual Exceedance Probability (%)	Discharge (MEDOT) (ft^3/s)	Discharge (USGS) (ft^3/s)	Discharge (FEMA) (ft^3/s)
1.1		375		
2	50%	720	724	
5	20%	1,090	1,090	
10	10%	1,360	1,360	1,095
25	4%	1,710	1,710	
50	2%	1,980	1,980	1,710
100	1%	2,270	2,270	2,030
500	0.2%	2,980	2,980	2,920

Table 3. Typical Flows Discharging to the Montgomery Dam Impoundment

	Discharge (ft^3/s)	
Month	**mean**	**median**
January	50	27
February	63	36
March	91	90
April	111	92
May	130	110
June	58	39
July	20	7
August	11	3
September	12	3
October	47	14
November	85	54
December	75	48
Annual flow	63	28
Summer low-flow (7Q10)		1.3

4.7.2 Hydraulic Analysis

The river hydraulics in the vicinity of the dam were previously analyzed to support the 1988 FEMA FIS, integrated as described above in the 2016 county-wide FIS (FEMA 2016). The profile from the FIS in the study area suggests the influence of the dam on flood levels extends to a location just downstream of the Brewster building (the former Brewster Mill, labeled as the Highland Mill on the profile figure; Figure 32). The hydraulic analysis that supported the 1988 FIS was used to establish the FEMA regulatory floodplain (Figure 33). The regulatory floodplain extends onto as many as 15 private and 2 public properties along the Montgomery Dam impoundment.

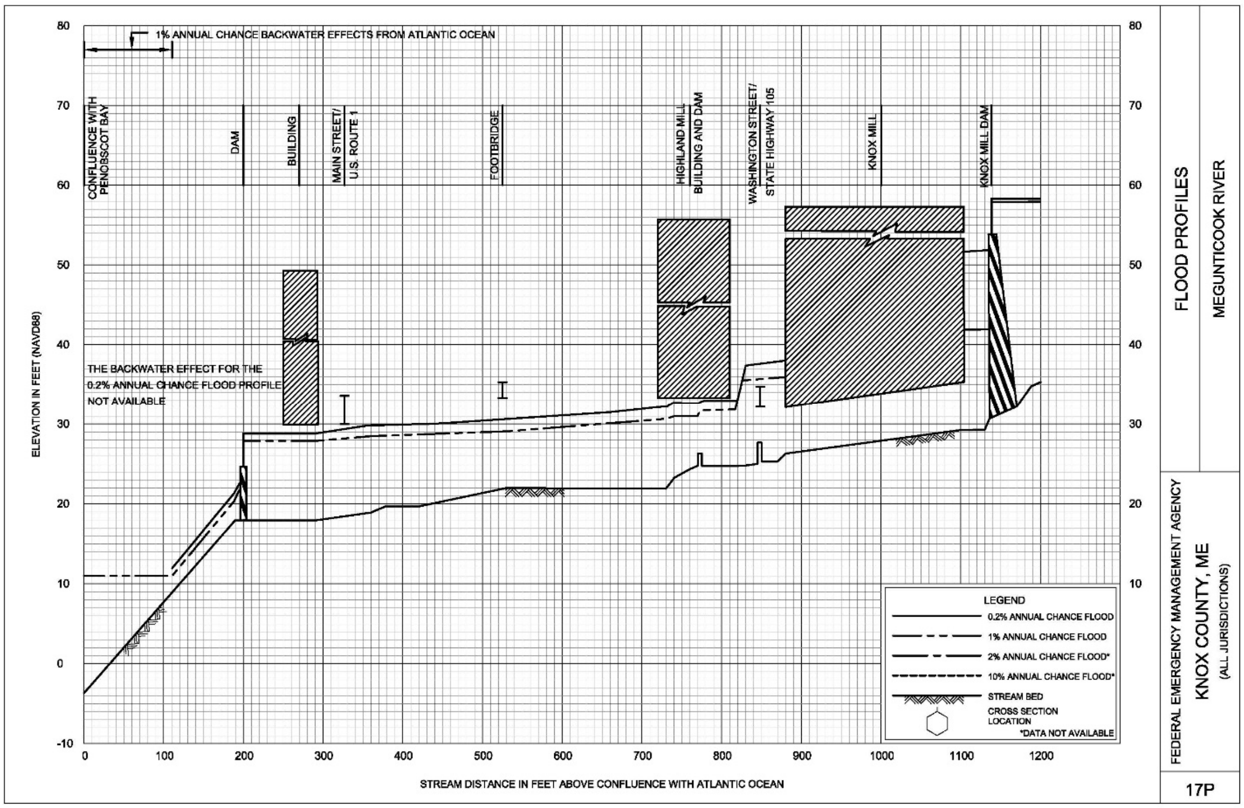

Figure 32. Flood profiles in the study reach from 1988 FIS (FEMA2016).

Inter-Fluve developed an updated one-dimensional, step-backwater model of the subject reach to represent current conditions. We also used this model to simulate the effect of modifying the dam and outlet structures on low- and high-flow water surface profiles of the Megunticook River, discussed in Section 6.1.1. We developed the model using the U.S. Army Corps of Engineers Hydraulic Engineering Center River Analysis System (HEC-RAS v 4.1). We developed the model in a GIS environment using site-specific topographic and bathymetric survey data collected by Gartley and Dorsky and Inter-Fluve in May 2018. We routed peak flows (Table 2) and typical seasonal flows (Table 3) through the model geometry.

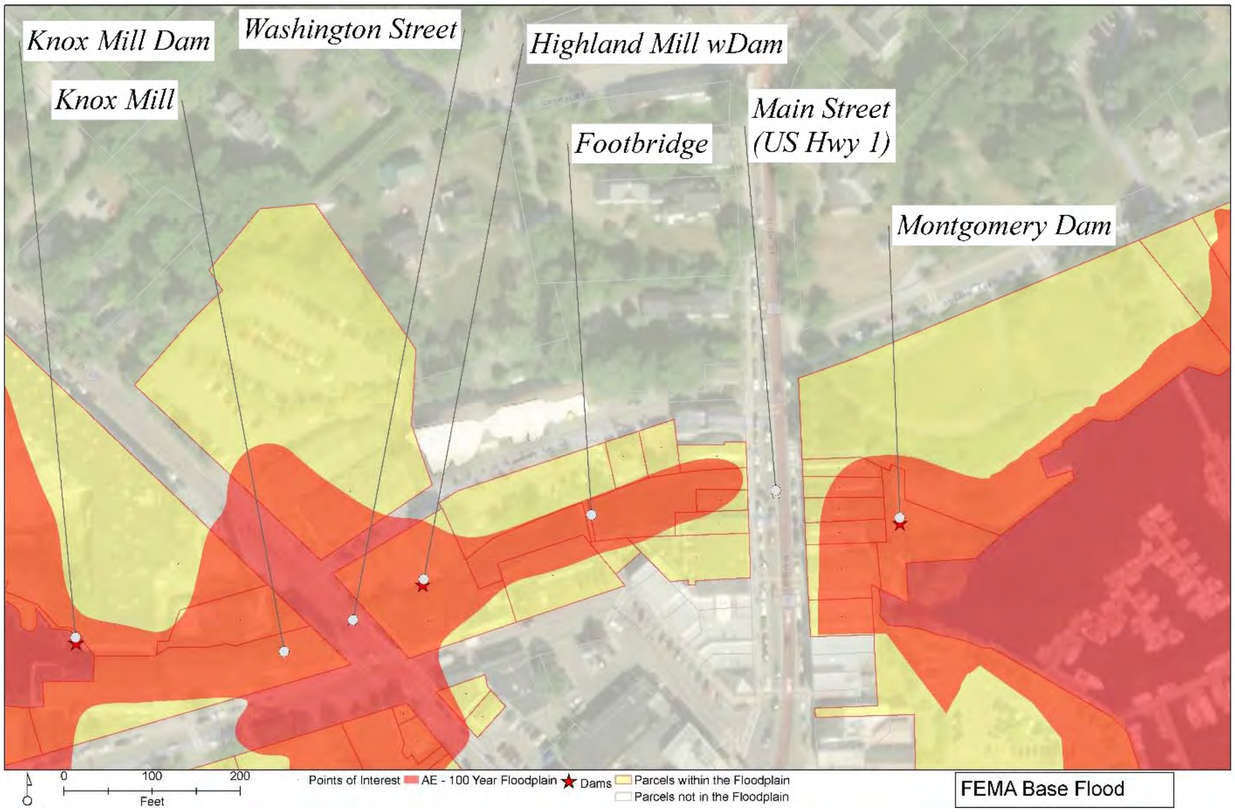

Figure 33. FEMA-mapped floodplain in the study reach from 1988 FIS (FEMA2016).

Figure 34 illustrates the model assumptions for the existing condition, while simulated flood profiles for existing conditions are shown in Figure 35. The estimated effects of dam modification on flood water profiles are discussed in detail in Section 6.1.1.

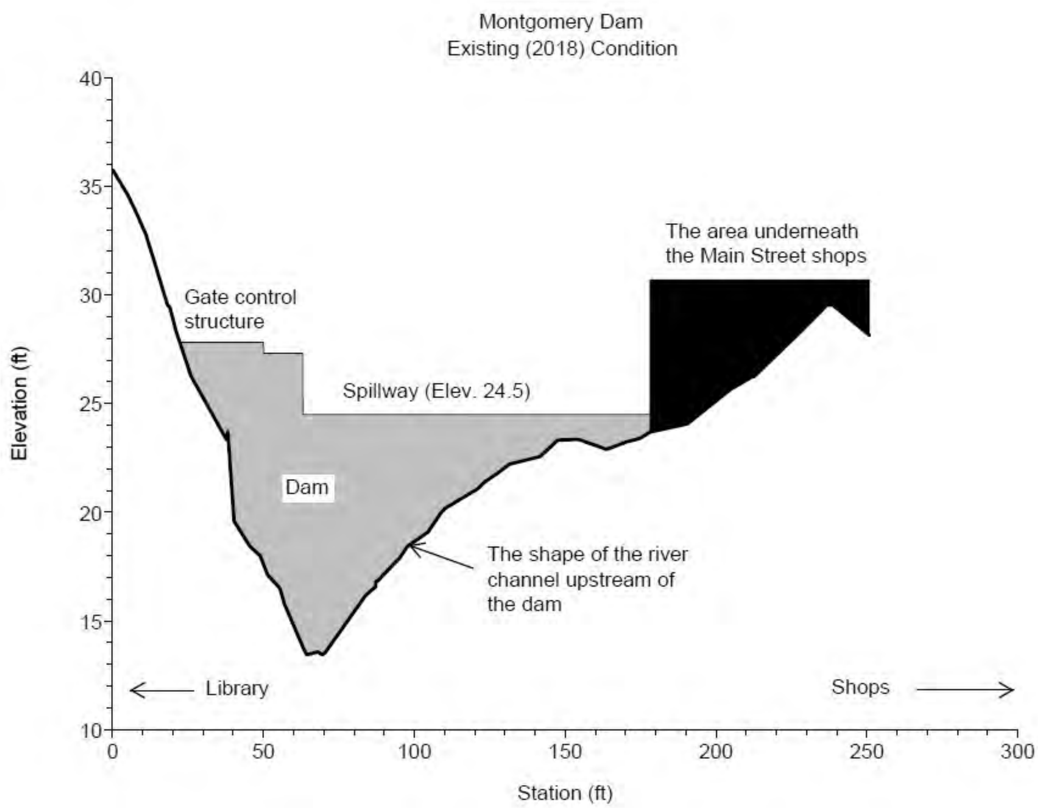

Figure 34. Dam Geometry, Existing Condition.

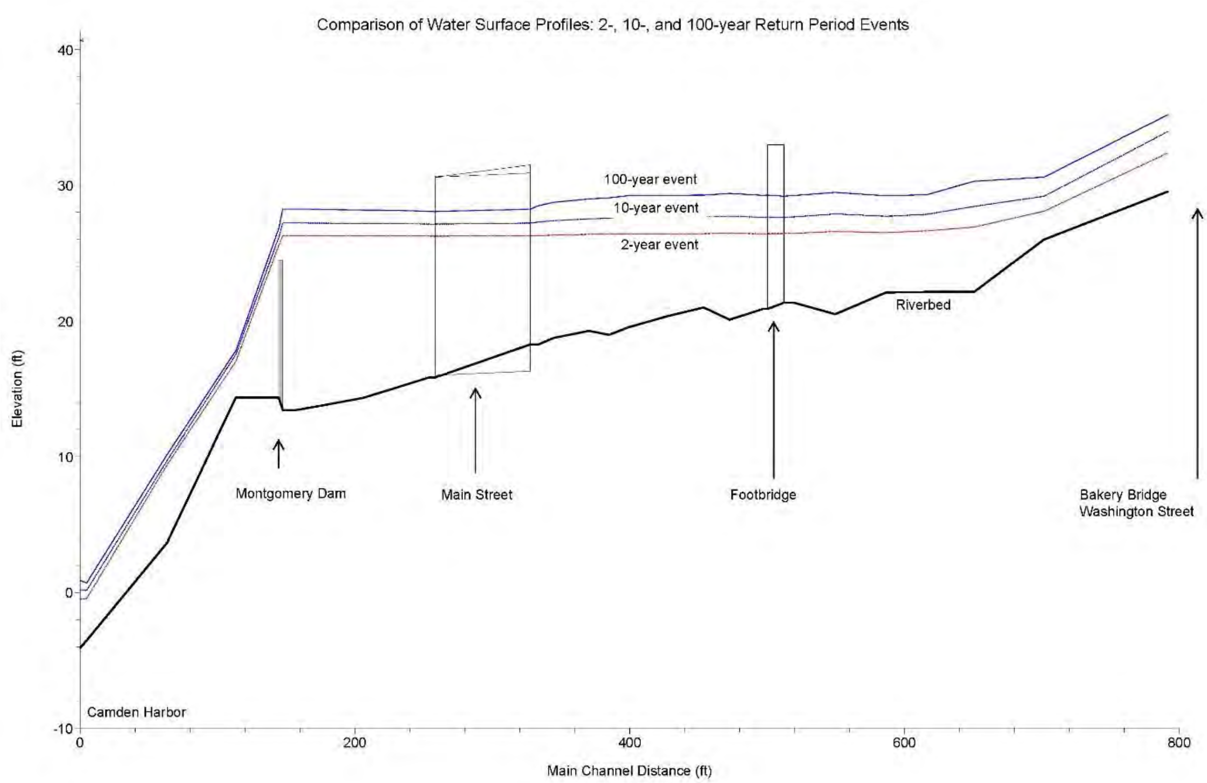

Figure 35. Simulated flood profiles for existing condition.

5. Potential Constraints

5.1 ENVIRONMENTAL AND HISTORICAL CONSTRAINTS

Dam modification, while potentially net-beneficial to existing infrastructure and ecosystems, can impose short term impacts on the environment during the construction phase of a project and disrupt species that had adapted to presence of the dam. Dam removals can also have cultural impacts if the dam or impoundment is adjacent to historically significant features. To identify sensitive ecological and cultural resources in the project area, Inter-Fluve submitted initial inquiries to various state and federal agencies. Responses from the Maine Natural Areas Program (MNAP), US Fish and Wildlife Service (USFWS), Maine Department of Inland Fisheries and Wildlife (MDIFW), and Maine Historic Preservation Commission (MHPC) are discussed below. There are no delineated wetlands in the vicinity of the potential project area, hence potential regulatory wetland impacts are not anticipated.

5.1.1 MNAP

The MNAP searched its data system and inquired with local experts for documentation of rare or unique botanical features in the vicinity of the project area. The results of the search indicate that no such features were documented in the project area.

5.1.2 USFWS

A federal threatened and endangered species review was conducted using the USFWS "Information for Planning and Consultation" system. The inquiry produced a potentially-present list that included two species: The Northern long-eared bat *(Myotis septentrionalis)* and the Atlantic salmon (*Salmo salar).* However, there were no critical habitats included listed within the project area. The potential presence of these two species will be factored into the project planning, but are not expected to be a constraint on project actions.

Typical considerations for the long-eared bat include removal of trees greater than 3 inches in diameter. In Maine, the typical implication is simply that USFWS is notified if trees of this size must be removed as a result of project actions, and may require the trees to be removed before the start of the regional nesting season (prior to April 1). Atlantic salmon are present in Penobscot Bay, but are not anticipated in the Megunticook River due to the site characteristics under the present condition. Federal permitting for a potential project may require informal consultation with USFWS or NOAA, but the likely impact to project planning relates to construction period sediment, erosion and pollution controls.

5.1.3 MDIFW

The MDIFW found no indication of State endangered, threatened, or special concern species in the project area. Furthermore, no essential or significant wildlife habitat were mapped in the project area.

5.1.4 MHPC

Based on their review of the site and potential project actions, MHPC determined that historical consultation would be required as the dam was found to be eligible for listing on the National Register of Historic Places as a part of a historic district if an associated historic district were to be established. Presently, the dam is not within an established historic district. The dam is not listed on the national register, and is not included in the nearby national historic districts. The adjacent Harbor Park area is included in the High Street National Historic District.

Based on the selected proposed project, formal consultation with MHPC would be initiated through the U.S. Army Corps of Engineers permitting process. A range of actions could be required, from documentation of potentially affected structures or resources, to avoidance and preservation in the extreme case. Based on prior project experience on fish passage restoration projects at historical dams in Maine and elsewhere in New England, these are not considered to be a hard project constraint. However, these considerations should be carefully integrated into ongoing project planning. The information regarding reconstruction of the dam and development of the Harbor Park in 1930, and the 1999 inclusion of the park area in the High Street historic district, were not known at the time of consultation with MHPC, and were not identified through the consultation. MHPC should be consulted regarding this information early in future project phases.

5.1.5 Project Permitting

For the likely range of project actions considered, regulatory permits that may be required include the following:

- Maine Department of Environmental Protection, Natural Resources Protection Act Permit
- US Army Corps of Engineers Individual Permit, with associated ESA consultations
- Maine Historic Preservation Commission (Section 106) Memorandum of Agreement
- Town of Camden Development Act or Shoreland Zoning Permit

5.2 INFRASTRUCTURE CONSIDERATIONS AND POTENTIAL CONSTRAINTS

5.2.1 Main Street Bridge

The Main Street bridge was constructed in 1931, with several potential deficiencies observed both by MDOT (2016) and through the structure condition assessment performed to support this study (Appendix B), including the condition of utility pipes that cross the river suspended beneath the bridge deck (Figure 25). Plans for bridge replacement, if any, are not known at the time of report preparation. The bridge is included in the MDOT work plan for 2019 for preliminary engineering of bridge improvements. As indicated in Section (4.4), the river is split between two parallel spans divided by a center pier.

Presently, a combination of boulders and ledge hold the channel bed grade at the downstream end of the bridge, while the channel bed within the bridge consists of coarse substrate (Figure 26). Maintained in the present condition, detrimental incremental scour beneath the bridge is not anticipated as a result of potential dam modifications. The boulders and ledge create a hydraulic drop that would not be considered a complete fish passage barrier if typical water levels in the impoundment were lowered, but would likely require some adaptation and management to enhance fish passage potential at this location.

Eventual bridge replacement, if considered, should include proactive considerations to optimize fish passage potential through the bridge, possibly including a transition to a clear span opening over the river, and management of the river bed to provide more optimal passage conditions.

5.2.2 Utilities and other public infrastructure

There are few known public utilities in the area of potential project actions. There is a water valve under a metal valve cover in the lawn in the Harbor Park which is no longer in use according to the Town. If a potential project were to impact the location, the valve would need to be investigated to determine whether it is connected to the Town water system, and disconnected appropriately if that were the case. In addition, there is assumed to be a buried electrical line which delivers power to the lamp posts along the walkway in Harbor Park. In addition, there are several utilities in the Main Street corridor. Unless the Main Street bridge were subject to modification, these utilities would not be affected by potential project actions.

Additionally, the cut-stone seawall which retains the lawn in the waterfront park is integrated with the non-overflow portion of the dam, and a portion of outflow from the dam runs along the wall as it cascades to the harbor (Figure 11 to Figure 12). Town representatives have indicated that the wall presently requires maintenance and repair, partially due to the interaction with outflow from the dam. In particular, spray from the dam spillway builds up as ice on the wall, leading to degradation. The wall is also overtopped during significant high tide and storm events. Potential effects on the sea wall will need to be considered in conjunction with potential project actions, as should opportunities to address the conditions of the wall in conjunction with a proposed fish passage project.

5.2.3 Private infrastructure

As indicated in Section 4 of the report, several buildings along Main Street include structural or other components that are have foundations in or are directly adjacent to the Montgomery dam impoundment. Implications of project actions for these features are a critical component of project evaluations. The effect of potential project actions on these features are discussed in detail in Section 6 of the report.

5.3 AESTHETICS

The mouth of the Megunticook River and the associated area is a unique and dramatic setting that is that is integral to the daily life and commerce in the downtown area. At the same time, visitors are drawn to the area to experience the contrasts and beauty of the harbor and the natural environment at the interface of the mountains and the sea. The aesthetic quality of any potential project actions will be a paramount consideration in evaluation of project alternatives.

6. Site Modification Approaches and Effects

To address the goal and objectives that were established for the project (Section 2), the primary potential project actions include two main action types, 1) dam modifications, and 2) fish passage enhancements. Because multiple combinations of each of these main actions are plausible, the following paragraphs first describes the range of options for these two categories individually. Subsequently, possible combinations of these main action types that result in complete project alternatives are discussed.

As the purpose of this report is to focus on proposed actions to be taken at the Montgomery dam site, the focus of this section is on the primary activities at the site itself. However, implicit in the range of options presented is the fact that improvement of the ecological constraints associated with the dam would extend far beyond the dam itself. As the first critical link in recovery of the watershed, the effects of the dam modifications could extend far upstream in terms of flood management and species and ecological recovery, and out into Penobscot Bay and beyond as a result of positive impacts to native sea-run fish and other ecological processes.

6.1 DAM MODIFICATION APPROACHES AND POTENTIAL EFFECTS

A total of four potential dam modification approaches were identified and evaluated. Three of these four approaches are action opportunities:

- **No Action**: No immediate action would be taken.
- **Spillway Reconstruction**: This option would re-create the existing spillway with new construction. The appearance of the dam, spillway, and pool would remain essentially unchanged.
- **Partial Spillway Reconstruction**: This option would reconstruct the spillway at an elevation that is 4.5 feet lower than the current spillway elevation. In doing so, the south spillway wall would be eliminated, and the east spillway wall would be shortened by approximately 50%. During typical conditions, the pool behind the dam would be approximately two-thirds the size of the current pool.
- **Dam Removal**: This option would remove the entirety of the dam and spillway, including the masonry non-overflow portion at the north end of the dam, which includes the head gate. The pool upstream of the current dam would revert to a flowing stream over the underlying ledge.

The 'No Action' alternative would result in ongoing degradation of the dam structure, with periodic capital expenditures to maintain the current condition. Without sustained maintenance, the structure would eventually degrade to a condition where the impoundment and pool would drain freely due to leakage through the spillway, and possibly result in dam failure during a high flow event. Presently, the dam collects sediment that is delivered from the upstream watershed, as well as debris, and at times appears to suffer poor water quality. The dam is a low hazard structure, with the risk of catastrophic damages resulting from dam failure considered to be low. However, this option does not meet the range of goals and objectives set for the project with a sustainable solution, and is not considered in detailed evaluations.

The other options achieve, to varying degrees, the project goals of reducing risk and reducing influence on infrastructure and flood profiles, while also promoting fish passage and ecological recovery of the watershed. They are characterized by a range of cost, effort, and effectiveness.

6.1.1 Hydraulic Effects of Dam Modification Approaches

To evaluate the potential hydraulic effect of the dam modification approaches, we used the hydraulic model (Section 4.7.2) to simulate peak flows (Table 2) and typical seasonal flows (Table 3) for the existing/reconstruction condition and for two alternative geometry scenarios, including:

- Spillway Reconstruction/Existing Condition: control elevation 24.5 feet NAVD88
- Partial Spillway Reconstruction: control elevation 20.0 feet NAVD88
- Dam Removal: control elevation 13.4 feet NAVD88

The Spillway Reconstruction condition model assumes the same geometry for the dam and river channel as the existing condition model (Section 4.7.2). Hence, the existing condition model is used to represent the Spillway Reconstruction condition.

The Partial Spillway Reconstruction condition model simulates the geometry of the river channel assuming that the concrete, stone, and wood associated with the primary spillway is removed down to elevation 20.0 feet NAVD. Figure 36 illustrates the model assumptions for this condition.

The Dam Removal condition model simulates the geometry of the river channel assuming that the dam fill material, including stone, masonry, and wood is completely removed from the river channel. Figure 37 illustrates the model assumptions for the Full Dam Removal condition.

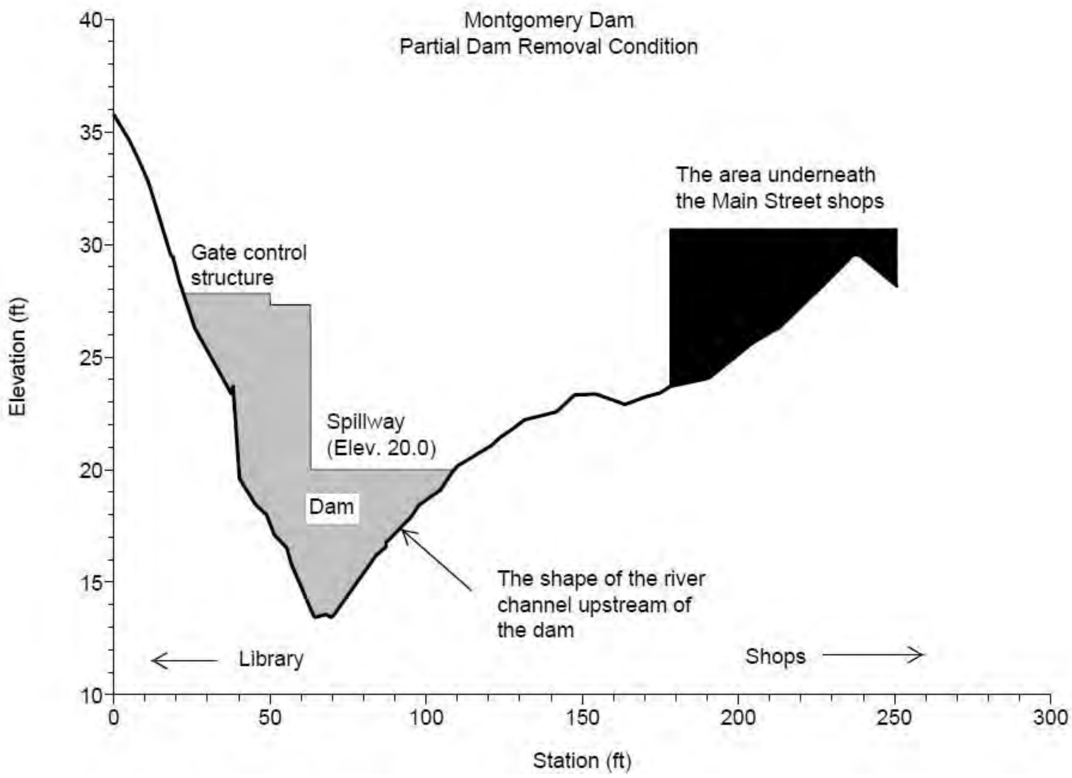

Figure 36. Dam Geometry, Partial Spillway Reconstruction, looking downstream.

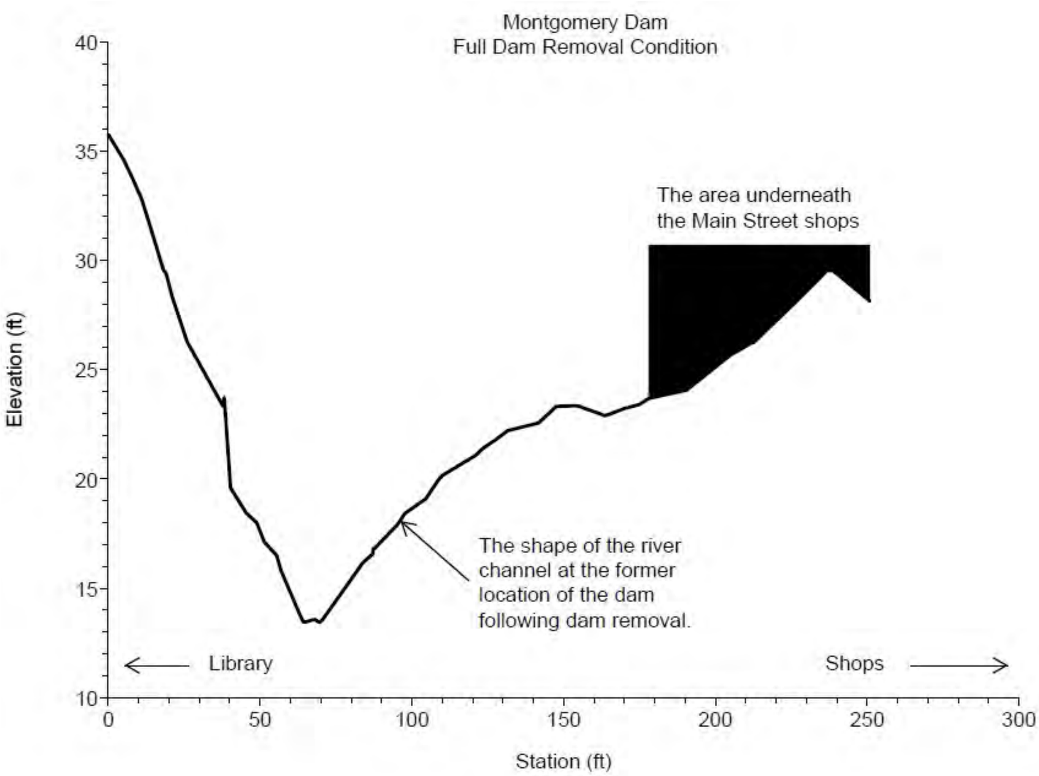

Figure 37. Dam Geometry, Dam Removal, looking downstream.

Model results indicate that both the Partial Spillway Reconstruction and Dam Removal alternatives will reduce the profile of the Megunticook River as compared to the Reconstruct Spillway/Existing condition. The effect of lowering or removing the dam will not extend upriver beyond Washington Street.

Figure 38 illustrates the impact of the partial reconstruction and dam removal conditions on the flood profile of the Megunticook River during the 2-year return period event. The 2-year return period event represents a minor high-flow event.
Table 4 summarizes the results at key locations along the river. Model results indicate that:

- Partial reconstruction reduces the elevation of the flood profile at the dam by 3.5 feet.
- Full removal reduces the flood profile at the dam by 8.8 feet.
- Approximately 40 feet upstream of the Main Street Bridge, the difference between the partial reconstruction and dam removal flood profiles diminishes to 0.1 feet. At this location, the 2-year flood profile is estimated to be reduced by 3.0 and 3.1 feet respectively, as compared to existing/full spillway reconstruction conditions.
- Approximately 100 feet downstream of the Washington Street Bridge, the difference between the existing condition and the proposed alternative flood profiles diminishes to zero.

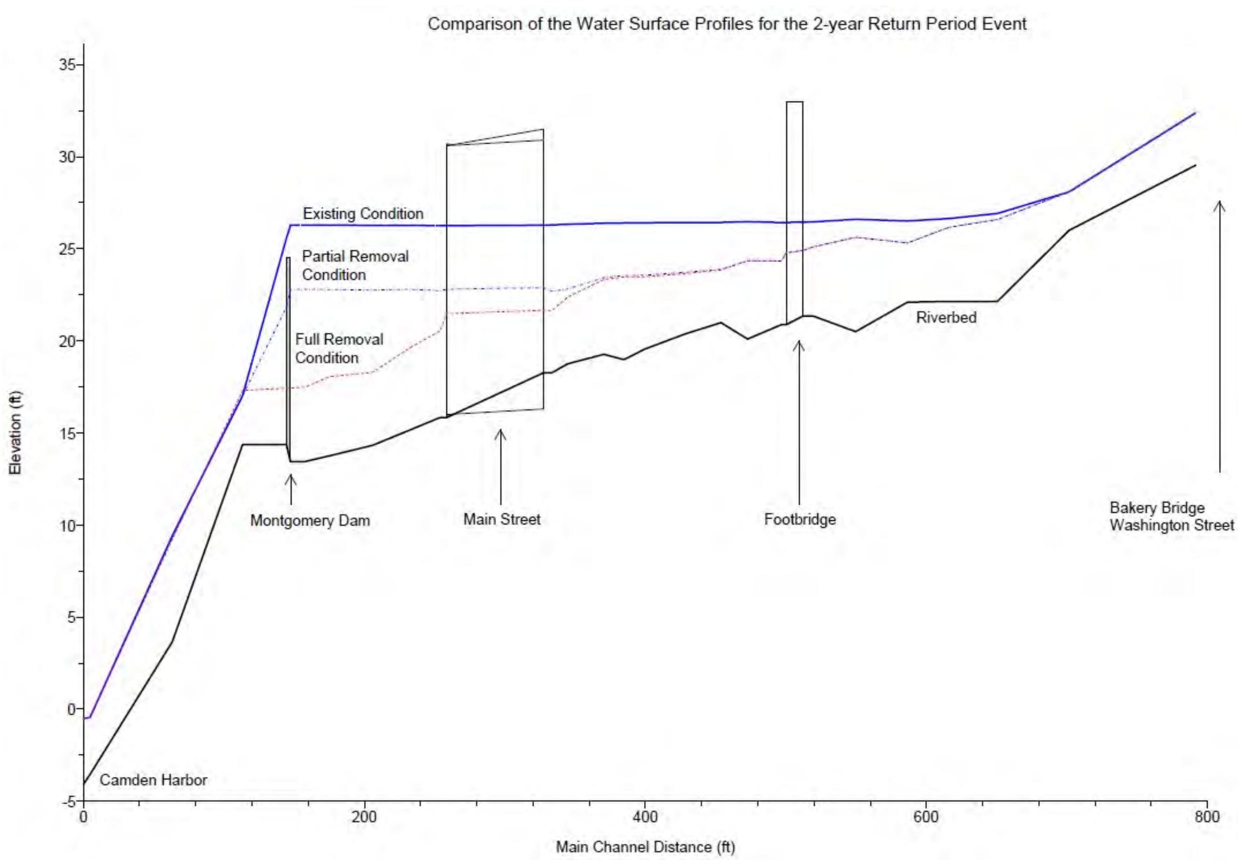

Figure 38. Profile, Model results for the 2-year flood event.

Table 4. Comparison of Water Surface Elevations along the Megunticook River, 2-year Return Period Event.

Location	Model XS	2-Year Event			Difference	
		Existing	Partial Reconstruction	Full Removal	Partial	Full
		[1]	[2]	[3]	[2]-[1]	[3]-[1]
10 feet Upstream of the Dam	173	26.3	22.8	17.5	-3.5	-8.8
40 feet upstream of Main Street Bridge	390	26.4	23.4	23.3	-3.0	-3.1
Downstream of 25 Mechanic Street Building	679	26.9	26.6	26.6	-0.3	-0.3
Downstream of Washington Street	818	32.4	32.4	32.4	0.0	0.0

Figure 39 illustrates the impact of the partial reconstruction and dam removal conditions on the flow profile during the average day in June (which also coincides with the upstream fish migration window). This flow represents a typical early summer day. Table 5 summarizes the results at key locations along the river. Model results show that:

- Partial reconstruction reduces the elevation of the flow profile at the dam by 4.2 feet.
- Dam removal reduces the flow profile at the dam by 9.6 feet.
- Approximately 40 feet upstream of the Main Street Bridge, the difference between the partial reconstruction and dam removal flow profiles diminishes to 0.2. At this location, the average June flow profile is estimated to be reduced by 4.1 and 4.3 feet respectively, as compared to existing/full spillway reconstruction conditions.
- Approximately 100 feet downstream of the Washington Street Bridge, the difference between the existing condition and the proposed alternative flood profiles is zero.

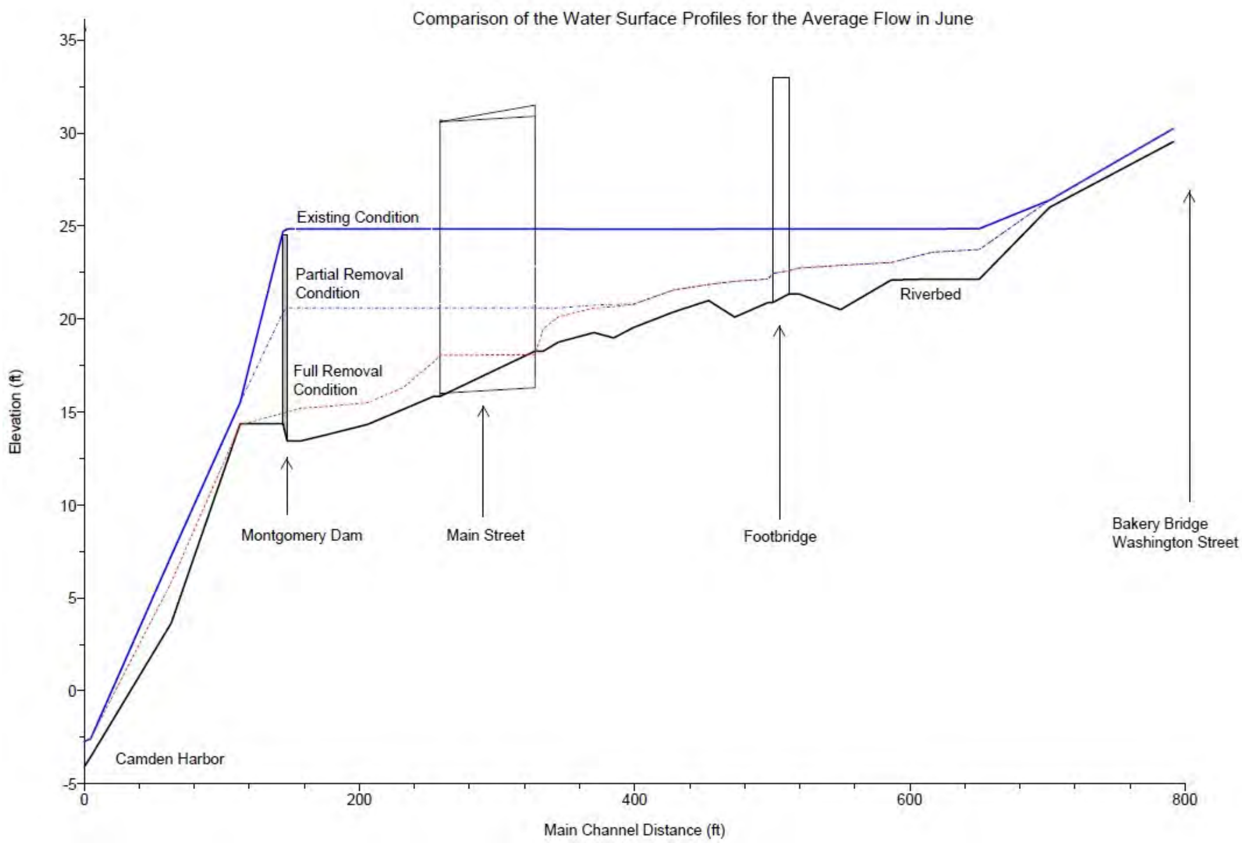

Figure 39. Profile, Model results for Mean Flow (June)

Table 5. Comparison of Water Surface Elevations along the Megunticook River, Average Flow in June.

Location	Model XS	Average flow in June			Difference	
		Existing	Partial Reconstruction	Full Removal	Partial	Full
		[1]	[2]	[3]	[2]-[1]	[3]-[1]
10 feet Upstream of the Dam	173	24.8	20.6	15.2	-4.2	-9.6
40 feet upstream of Main Street Bridge	390	24.8	20.7	20.6	-4.1	-4.3
Downstream of 25 Mechanic Street Building	679	24.9	23.7	23.7	-1.1	-1.1
Downstream of Washington Street	818	30.2	30.2	30.2	0.0	0.0

Figure 40 illustrates the impact of the partial reconstruction and dam removal conditions on the flood profile during the regulatory base flood event (the 100-year average return period event). This flow represents a significant flood event, which is typically used to determine eligibility for flood insurance under FEMA's National Flood Insurance Program. Table 6 summarizes the results at key locations along the river. Model results show that:

- Partial reconstruction reduces the elevation of the flood profile at the dam by 3.2 feet.
- Dam removal reduces the flood profile at the dam by 8.4 feet.
- Approximately 40 feet upstream of the Main Street Bridge, the difference between the partial reconstruction and dam removal flood profiles diminishes to zero. At this location, the 100-year flood profile is estimated to be reduced by 2.1 feet, as compared to existing/full spillway reconstruction conditions.
- Approximately 180 feet downstream of the Washington Street Bridge, the difference between the existing condition and the proposed alternative flood profiles diminishes to zero.

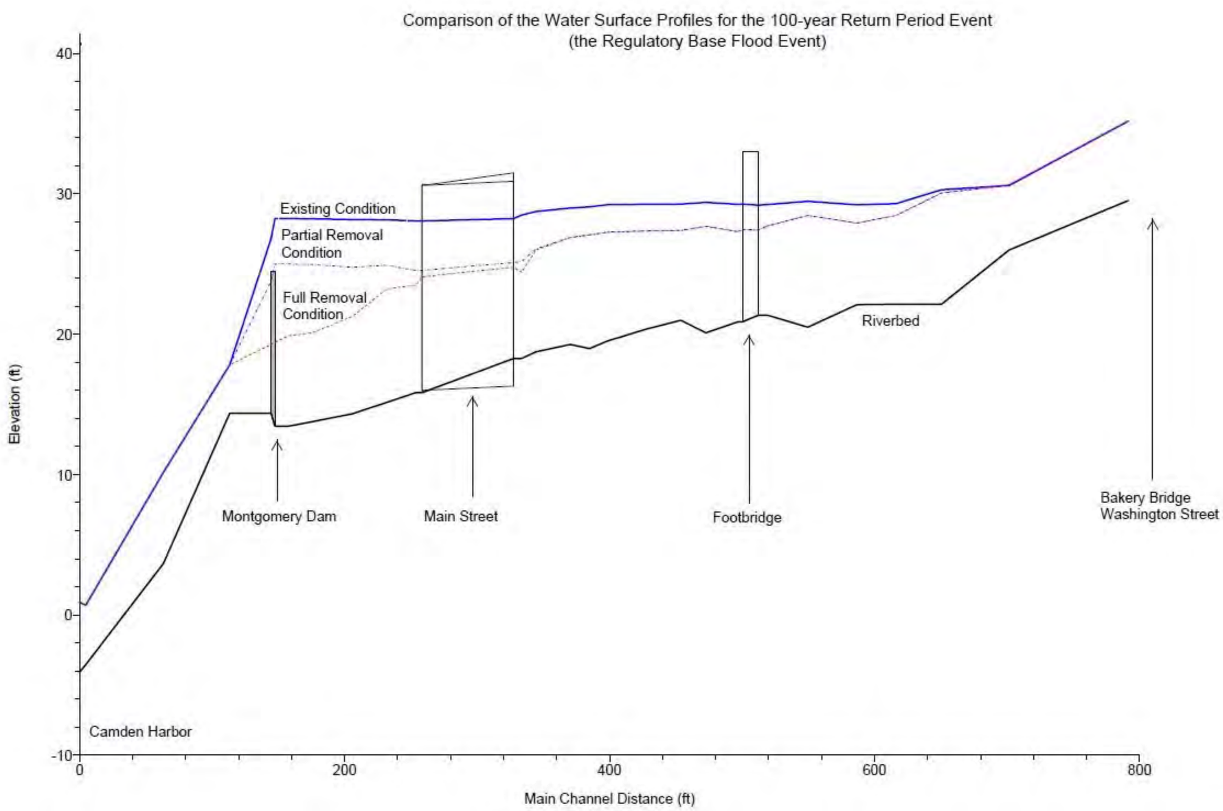

Figure 40. Profile, Model results for the 100-year flood event.

Table 6. Comparison of Water Surface Elevations along the Megunticook River, 100-year Return Period Event

Location	Model XS	100-Year Event			Difference	
		Existing	Partial Removal	Full Removal	Partial	Full
		[1]	[2]	[3]	[2]-[1]	[3]-[1]
10 feet Upstream of the Dam	173	28.2	25.0	19.9	-3.2	-8.4
40 feet upstream of Main Street Bridge	390	29.0	26.9	26.9	-2.1	-2.1
Downstream of 25 Mechanic Street Building	679	30.3	30.1	30.1	-0.2	-0.2
Downstream of Washington Street	818	35.2	35.2	35.2	0.0	0.0

Summary of Hydraulic Effects of Dam Modification Approaches

As indicated by the model results summarized above, both the partial spillway reconstruction and dam removal options are estimated to reduce flow levels through the impoundment as compared to existing/full spillway reconstruction conditions. The dam removal option results in notably greater reduction than the partial spillway construction option in the lower impoundment downstream of Main Street. Upstream of Main Street, the flow level reductions estimated for these two options are similar. Overall, the indicated flow level reductions are significant. Among other factors, Town staff presently operate the dam frequently to lower levels in anticipation of precipitation events in order to not inundate the buildings between the dam and Main Street.

Overall, for the 100-year return period flood, downstream of the bridge the estimated reductions range from 3.2 to 8.4 feet, and 2.1 feet immediately upstream of the bridge, to negligible in the vicinity of the Brewster building. For the 2-year return period flood, downstream of the bridge the estimated reductions range from 3.5 to 8.8 feet, and approximately 3.1 feet immediately upstream of the bridge, to negligible in the vicinity of the Brewster building.

The trends indicated above also highlight the effect of the Main Street bridge on flow elevations, if the current condition of the Main Street bridge were maintained in conjunction with the dam modification options. This is in part due to the hydraulic characteristics and capacity of the bridge itself, and also the effect of the ledge and boulder accumulations at the downstream end of the bridge. If either of these factors were changed in the future, it would be expected that the net reductions resulting from the partial spillway reconstruction and dam removal options would show more difference upstream of Main Street than the above results suggest. As indicated in Section 5.2.1, the bridge is in the MDOT work plan for 2019 for preliminary engineering studies. It is unknown what improvements may be made to the bridge in the near future.

6.1.2 Potential Effects of Dam Modification Approaches on Existing Structures

Sixteen private and public structures are located within, over, or immediately adjacent to the Montgomery dam impoundment. As described previously (Section 4.6), many of the building foundation elements were found to be structurally sound. However, an array of forms and types of degradation or deficiency were also observed for selected structural elements. These conditions would be present regardless of modification to the dam. The observed existing conditions of these building features constituted the baseline condition against which the effects of dam modifications were assessed. The assessment of effects described below specifically focuses on the potential incremental changes to the structures that might occur as a result of dam modification.

Structural Risk Factors Associated with Dam Modification

Both partial spillway reconstruction and dam removal are projected to alter the water surface profile from the existing dam location upstream to approximately 25 Mechanic Street (Brewster Building). Projected changes to water surface elevations are presented in the preceding section of the report (Section 6.1.1) to illustrate variation in water levels for key locations for various flow levels. Generally, most structures in the study area would benefit from the reduced elevation of water flows and flood protection associated with dam breach or dam removal. At least one of the structures requires ongoing management of the impoundment level by the Town in order to prevent inundation of the bottom of the structure.

It is challenging to specifically assess the impact of the projected water surface profiles on the structures within the river due to a variety of unknowns, including the unknown conditions and construction below grade. Original construction, existing conditions, frost and ice are considered to be the primary factors affecting whether and how the proposed water surface profile alterations may impact structures within and surrounding the river.

In general, the partial spillway reconstruction and dam removal alternatives will lower the water levels. Reduced water levels would typically be a favorable change structurally, although there are plausible scenarios where it could worsen unique situations. The most plausible unfavorable conditions to result from reduced water levels at this location include the potential reduction in frost protection, and the possible direction of debris and ice toward a different elevation on foundation elements.

Frost: It is anticipated that water in the river seeps through soils below and/or directly adjacent to the river bed, which minimizes frost penetration in these areas. As such, increased frost penetration may occur in select areas if water levels are reduced and flow is no longer present near foundation elements. The impact of frost penetration depends largely on the depth of the foundation below grade and the bearing conditions. Foundations which bear on ledge are not susceptible to heaving from frost; foundations on soils are susceptible to frost to varying degrees depending on the soil characteristics, moisture, and other factors. Foundations which extend at least 4-feet below grade typically provide adequate protection from frost locally. Within the project area, neither the depth of foundation nor the bearing conditions are exposed in most cases.

Ice: Local ice formation may be reduced with lowered water levels, due to reduced surface area of the river and fewer slow-moving stretches of river relative to existing conditions. However, the interaction with ice supplied from upstream or forming locally may occur at a different elevation than previously. Local ice conditions have been observed periodically during the period January to March 2019, with very little ice accumulation in the project area. This likely resulted from the ongoing need to manage the impoundment level in response to river flows, to avoid flooding impacts to the building upstream of the dam.

Soil Support: An additional consideration, not directly related to the water surface profiles, is possible accumulated sediment removal. Some foundation piers, particularly precast piers, may rely on the surrounding soil for lateral stability. Within the impoundment, because the amount of accumulated sediment present is a transient feature, it is unclear to what degree this may have been considered in design for supports in this category within the project area. Supports that include precast piers should be evaluated in more detail to assess whether the accumulated sediment was relied upon in the stability design.

Scour: Lastly, with reduced backwatering from the dam, selected foundation elements located adjacent to erodible streambed materials could be susceptible to increased scour. With a few exceptions, most of the areas within the impoundment have coarse -grained channel bed materials located upstream of erosion resistant features that control the bed elevation. If substantial changes to the Main Street bridge or the river bed beneath it were planned in the future, potential scour effects upstream of Main Street should be evaluated in more detail.

Projections of Potential Structural Impacts Associated with Dam Modification

Based on the simulated water surface profiles and the observed conditions in the field, preliminary projections of possible impacts were identified (See Appendix B). These projections are specific to potential impacts from change in ambient water levels and altered flood hydraulics upstream of the dam resulting from partial spillway reconstruction, or full dam removal. In some cases, the impacts are the same or very similar between these two cases, particularly upstream of 32 Main Street where the partial spillway reconstruction and dam removal scenarios have similar water surface profiles. It should be noted that these projections are based on only the conditions that were observed above the ground surface. Following selection of a project alternative, it is recommended that more in-depth evaluations be made at the selected locations which appear most susceptible. For example, this may include exploration below grade to establish actual susceptibility to frost-related issues.

Summary of Projected Potential Structural Impacts Associated with Dam Modification

In summary, general projections for key considerations of impact include the following:

- Flows: As stated above, most structures in the study area would benefit from the reduced elevation of water flows associated with dam breach or dam removal. In several cases, foundation elements will no longer be exposed to regular water flows or will be exposed to water of reduced depth, which has the benefit of typically inducing lessened hydraulic forces on the structures.

- Frost: The majority of the structures have at least one foundation element which may have increased exposure to frost, although the tangible consequences of this exposure are not identifiable due to unknown conditions below grade. It is probable that the majority of the foundations bear on ledge, which negates most concerns with frost penetration.

- Ice: Due to the change in water surface elevation, ice formation will occur at a different elevation than it does in the existing conditions. Although we have noted where altered ice flows may occur, we do not anticipate significant new problems to arise. We are unaware of significant ice formation issues in the present configuration. As indicated above, little ice accumulation has been observed over the period January to March 2019.

- Flood: Most, if not all structures in the study, and perhaps others in the vicinity would benefit from increased flood protection associated with the lower water surface profiles for dam breach or dam removal.

- Sediment: Sediment removal may only affect the two properties with precast concrete piers in the impoundment. However, as noted above, the extent to which the design of the piers relied on the surrounding accumulated sediment is not presently known.

- Other: Much of the observed material degradation on the structural supports is most severe near the normal water level, although as indicated above frequent management of the dam to prevent inundation of the upstream building causes frequent fluctuations in the pool level. For wood elements, this is likely due to the repeated drying and wetting that occurs at this elevation, which is likely exacerbated by the frequent draw down of the impoundment for maintenance or to accommodate precipitation events. For concrete elements, this is likely due to spalling from water flows and ice/debris traveling along the surface of the river. It is probable that altering the elevation of the water flow and any associated ice formation may allow for new material degradation to occur near the new normal water elevation on susceptible elements. However, with reduced need to manage the levels in the impoundment, fluctuations and associated wetting and drying may be reduced.

- Countermeasures: Countermeasures to mitigate the above projected potential effects are available, though would be determined for each site based on the actual needs. Once a dam modification alternative is selected, additional exploration below grade at selected sites would facilitate the development of countermeasure approaches.

6.2 POTENTIAL FISH PASSAGE RESTORATION APPROACHES

Discussed previously in the report, the present outflow of Montgomery dam is modified from the historical outlet of the river. The fish passage that existed prior to the construction of the dam and development of the mills in the downtown area was eliminated through these modifications. McKellar (2018) found evidence in the Town archives of an 1806 initiative to re-establish effective fish passage for the sea-run fish population that ultimately did not result in restored passage for sea-run fish.

Around this same time (1807), a similar initiative led to the re-establishment of fish passage at Damariscotta Mills after a century of disruption. After the Damariscotta Mills fish ladder had fallen into disrepair, it has been successfully restored over the last 15 years, resulting in a restored river herring population (as many as 1 million fish returning annually) in the Damariscotta River system (Damariscotta Mills Fish Ladder Restoration 2018).

While undoubtedly the Damariscotta Mills case study represents conditions that vary from the Megunticook River, it is a one local example of a fish passage restoration success story that bears similar characteristics. The Damariscotta Mills case represents arguably a more challenging site-specific passage condition (elevation drop of roughly 2 times that of Megunticook Falls), but more notable upstream challenges are present in the Megunticook River due to the presence of the upstream dams.

There are numerous other case studies around the region where sea-run fish populations are being restored with complex projects involving multiple dams, including on the Outlet Stream that leads from China Lake to the Sebasticook River, on the Sheepscot River, and in many other river systems throughout New England. Often, these efforts will include a range of fish passage technologies within a single river system, ranging from dam removal to nature-like bypass channels, and technical fish passages. The solution at each site is tailored to the particular opportunities and constraints present at each location. These projects all contribute to recovery of native sea-run fish populations within the Gulf of Maine. They also have innumerable collateral benefits to ecological health and environmental quality in each watershed and in the ocean, to management of aging infrastructure and flooding, and to community engagement and education.

The primary factors considered in development of a successful fish passage facility are the hydraulic height and effective gradient of the passage site, fish attraction, and biological capacity. The hydraulic height and gradient are determined by the site characteristics, and dictate the types of fish passage technologies that can be considered at a site. In general, for a similarly constrained site, the level of difficulty and cost increases with increasing hydraulic height and effective gradient.

Fish attraction refers to the ability to enable ascending fish to find the entrance to the fish passage facility, and is primarily attributed to a dominant flow velocity, orientation and position near the entrance to the facility. Generally, attraction cues are more effective with increasing amounts of water flowing through the fish passage. Typically, the goal is to put as much water down the fish passage as possible, subject to the hydraulic limitations of each passage technology.

Biological capacity refers to the physical space available within the fish passage facility to allow the population to ascend the barrier without unnecessary delay due to overcrowding. Extended delay of fish in their upstream migration can lead to mortality due to energy expenditure and predation, and/or degraded condition when fish ultimately do reach spawning grounds, which in turn may lead to reduced reproductive success.

MDMR (2018) provided a preliminary opinion of the potential alewife population in the Megunticook River system of at least 300,000 fish, represented primarily by the habitat available in Megunticook Lake. They suggested this might be a conservative estimate based on a rule-of-thumb population estimate factor that considers the acreage of the lake. With time, evaluation of other potential habitats in the tributaries upstream of the lake may result in even greater population estimates. In addition, several local examples suggest that the rule-of-thumb population factor may run notably low. At Blackman Stream in Bradley, the restored alewife population represents roughly double that which was estimated based on the rule-of-thumb factor. Overall, MDMR acknowledged the potential for a restored river herring run in the Megunticook to be significant in terms of regional fisheries recovery. At the same time, they acknowledged the steep challenges to restore the run, due to the characteristics of this site, and the subsequent challenges represented by restoration of passage at the upstream barriers that exist presently.

6.2.1 Fish Passage Site Characteristics

Of the above factors, the hydraulic height and effective gradient represent the primary constraints on establishing fish passage at the site as it exists today, or as potentially modified in the future by the dam modification options. A preliminary analysis of these factors for the dam modification options is summarized in Table 7. In the table, the length refers to the longest flow path that could be reasonably achieved for each scenario, without switchbacks. It should be noted that the mean tide level in the harbor was assumed as the base level for this analysis. For reference, high and low water conditions at the site are shown in Figure 41 and Figure 42. The following section of the report (Section 6.2.2) summarizes the available fish passage technologies, and compares their limits to basic characteristics reported below.

Table 7. Basic hydraulic heights and effective gradients for the three dam modification options. Water levels are in ft-NAVD88.

Location	Water Level at Dam Location	Water Level in Harbor	Hydraulic Height (ft)	Length (ft)	Effective Gradient
Flow Condition	May Median Flow	Mean Tide			
Case					
Spillway Reconstruction	25.1	-0.45	***25.6***	160	***16%***
Partial Spillway Reconstruction	21	-0.45	***21.5***	160	***13%***
Dam Removal, with channel down ledge outcrop	15.1	-0.45	***15.6***	160	***10%***
Dam Removal, with channel restoration through Harbor Park	15.1	-0.45	***15.6***	260	***6%***

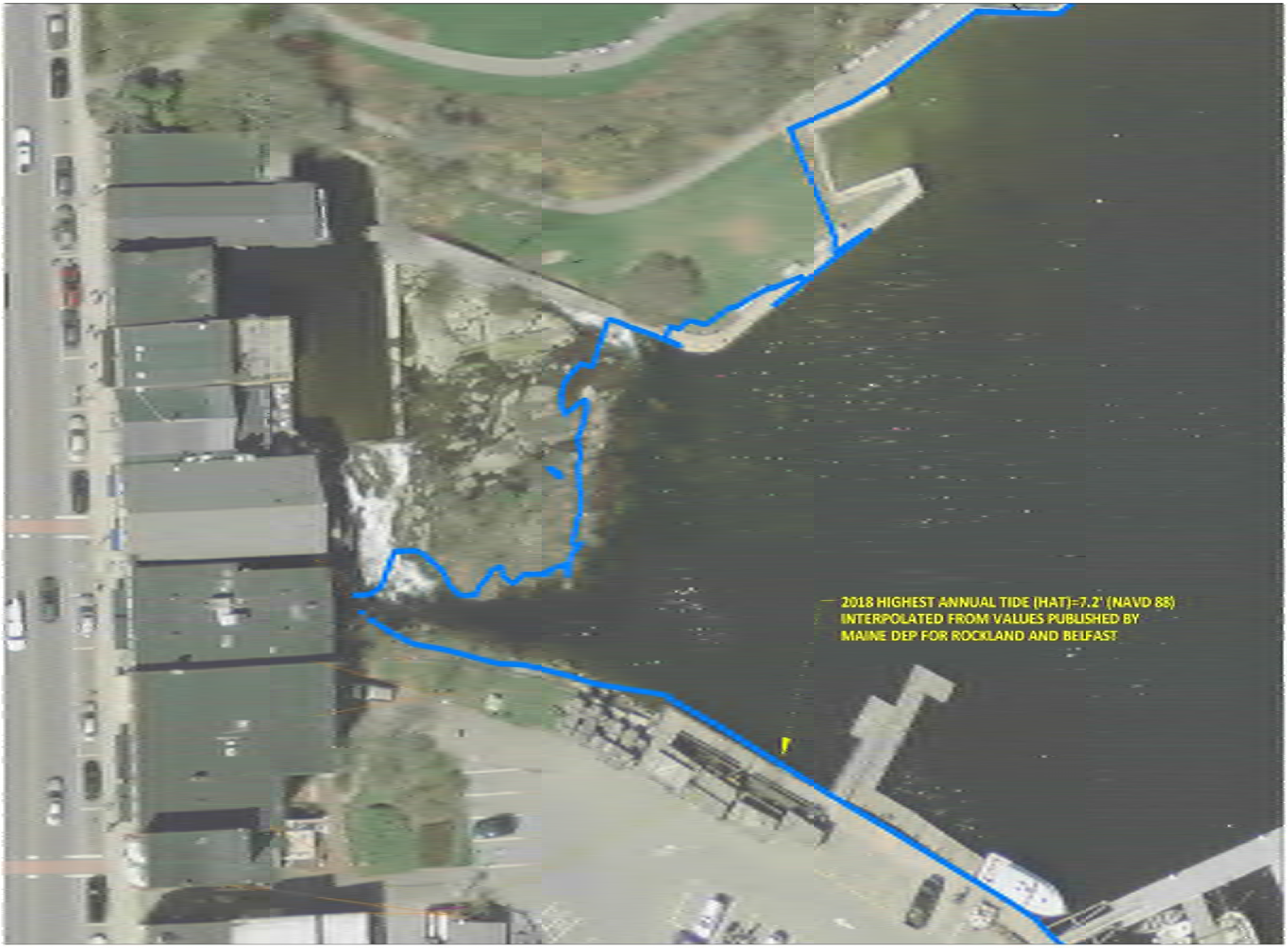

Figure 41. 2013 aerial view of Megunticook Falls and Camden Harbor showing a high tide condition (source: Maine GIS). Extreme high tides extend into the Harbor Park area over the footpath.

Figure 42. 2014 aerial view of Megunticook Falls and Camden Harbor showing a low tide condition (source: Google Earth).

6.2.2 Available Fish Passage Technologies

In natural streams, sustained gradients that the anticipated fish species negotiate are typically less than approximately 3% to 5%, though there are instances where native sea-run fish are able to utilize steeper gradients for short distances in naturally functioning streams in Maine. Comparison of this gradient range to the gradients summarized in Table 7 suggests that simply removing the dam may not lead to fully effective fish passage, and that proactive channel restoration or construction of an applied fish passage facility would be required.

Full dam removal with channel restoration can lead to favorable passage conditions. As indicated in Table 7, for full dam removal at this site, with a restored channel along the alignment of a historical channel location through Harbor Park, the resulting channel slope would be steep relative to the typical range that is seen in natural channels. However, the restoration of a channel that can effectively allow fish to pass may be feasible, but would require very careful design consideration and also additional knowledge of the ledge that may be found under the fill placed historically in the Harbor Park area. In actuality, channel restoration would employ design approaches similar to those used for nature-like fish passage described below.

Aside from dam removal, applied fish passage technologies generally fall into two main categories. 'Nature-like fish passage' or 'nature-like fishway' refers to construction which emulates the flow patterns and appearance typical of a naturalized stream channel and incorporates the landscape and naturalized materials (Figure 43). By emulating natural flow patterns, it is reasoned that fish are able to more intuitively ascend the passage. These features are easily scaled for the available flow and biological needs. Nature-like technologies accommodate the broadest range of fish species, including those considered for restoration at this site.

'Technical fish passage' or 'technical fishway' refers to a structure where concrete or metal construction is essential. These features are commonly called a fish ladder, and are typically more geometric in shape. There are many examples of technical fishways that incorporate pleasing aesthetic enhancements, such as at Damariscotta Mills (Figure 44) and Blackman Stream (Figure 45). Technical fish passage designs are manipulated to result in specific hydraulic patterns that foster fish passage. These solutions are able to be constructed at steeper effective gradients than nature-like passages. There are multiple styles of technical fish passage, with variability among these options in terms of flow and biological capacity. The different technologies are typically most effective for varying subsets of fish species.

Figure 43. Examples of constructed nature-like fish passage (photo credits: Matt Bernier).

Figure 44. Pool and weir fishway at Damariscotta Mills.

Figure 45. Pool and weir fishway at Blackman Stream (photo credit: Maine Sea Grant).

Based on the site characteristics, Table 8 summarizes the basic characteristics of fish passage technologies considered for this site. Of the technologies shown, there is a general gradient of preference among resource agencies, regulators, and funders in the region. Dam removal that does not require additional fish passage construction is by far the most preferred approach, followed by dam removal that requires proactive channel restoration. The next preference is for nature-like approaches as the flatter gradients and naturalized flow patterns are considered to provide very good fish potential passage conditions for the broadest range of fish.

Among the technical passage approaches, the pool and weir approach (Figure 44 to Figure 45) is generally favored on the basis of performance and reduced constraints relative to Denil fishways (Figure 46). Pool and weir ladders are typically also easier to add aesthetic enhancements too. The Damariscotta Mills ladder is an example of this. In addition, options that would create fish passage by excavating pools into the existing ledge outcrop have been suggested during the course of project discussions. This type of approach would also generally fit into the pool and weir approach. However, pool and weir fishways tend to be more expensive than Denil ladders.

Lastly, Denil fishways are typically the least preferred approach. Although they can be very effective for river herring and salmonids if sited and designed properly, they are constrained by biological and flow capacity. Typically, standard Denil fish passage designs are considered to have biological capacity for approximately 300,000 river herring. They possess greater sensitivity to operating conditions, particularly flow conditions at the entrance and exit, can be susceptible to debris clogging, and the flow limitation may limit the attraction signal in some instances. This is especially true at locations where competing flow signals may occur, such as dispersed flow over ledge outcrops.

Yet, Denil fishways are often the least cost technical fishway option due to simpler construction and relatively smaller footprint. They are more utilitarian in nature, and although it is possible to add flourishes such as masonry veneer, they tend to be less pleasing aesthetically. There are many Denil fishways in Maine, with varying degrees of performance and success, from sites with highly efficient passage for river herring and trout, to sites that perform poorly and are presently subject to removal. With Denil fish passage facilities, typically a separate eel passage structure is required, although at this site eel may be able to partially ascend the ledge if suitable flow exists with a substantially lowered dam.

Figure 46. Example of a Denil fishway.

A summary of the fish passage approaches considered in this study is included in Table 8. They are ordered in a hierarchy of likely fish passage effectiveness and general preference from a fish passage perspective.

Table 8. Available fish passage technologies considered for this study.

Type	Maximum Recommended Gradient	Flow Capacity	Biological Capacity	Species Effectiveness
Dam Removal with Channel Restoration	Natural channel gradient, <5% preferred[1]	Full river flow, Scalable	Scalable	All anticipated
Nature-Like Fishway	5%[2]	Scalable	Scalable	All anticipated
Pool & Weir (Technical)	10%[3]	Scalable	Scalable	Possible limitation for American Eel
Denil (Technical)	16%[4]	~40 cfs	~200,000 to 300,000 river herring	Limitation for American eel and possibly Sea lamprey. Capacity may be limiting for river herring with fully restored fish population

6.2.3 Feasibility of Available Fish Passage Technologies

This section of the report compares the available fish passage technologies to the dam modification options to identify the feasible pairings of the two primary project elements.

Dam Removal with Channel Restoration

For the dam removal option, an acceptable gradient would not be feasible for alignments that are constrained to the area of the ledge outcrop, downstream of the present dam location, inside the existing sea wall. An alignment through the Harbor Park area could be found that would be close to the recommended gradient range (Figure 47). In addition to disturbance to the Harbor Park area, a primary consideration with this alignment would be careful design to create an effective attraction signal at the entrance to the fishway.

This alignment would extend through the park and enter the harbor through the current alcove in the seawall used for wading. To meet the recommended gradient range, the restored channel would need to also extend approximately 15 feet upstream of the present dam location, to a point just

[1] Turek et al. 2016
[2] Turek et al. 2016
[3] USFWS 2016
[4] USFWS 2016

downstream of the first building. The approximate gradient for this alignment is 5.5%. This gradient is not optimal for this technology, but examples of natural channels in this slope range that pass fish do exist in Maine. Therefore, *dam removal with channel restoration through Harbor Park is considered feasible.*

Nature-like Fishway Feasibility

Based on the hydraulic height and basic gradient characteristics summarized in Table 7, *nature-like passage is not feasible for the full and partial spillway reconstruction options*. The elevation differences between the estimated water levels behind the dam and the mean tide line in the harbor is too great to provide a gradient that is in the acceptable range for this technology within the site constraints.

For the dam removal option, the nature-like approach with an alignment through Harbor Park is essentially equivalent to the channel restoration approach described above. Therefore, these alternatives are considered the same alternative for the balance of the report.

Pool and Weir Fishway Feasibility

Based on the hydraulic height and basic gradient characteristics summarized in Table 7, *pool and weir fish passage is feasible for the dam removal option.* A variety of alignments could be considered for this case, including those which are constrained to the existing ledge downstream of the dam location, or along an alternate alignment which traverses the harbor park area (Figure 48). See comments in the preceding section about design considerations as relate to fish attraction to the fishway entrance with the Harbor Park alignment.

For the full and partial spillway reconstruction options, the basic gradients represented in Table 7 exceed the recommended range for this technology. However, it is possible with this technology to create additional length along the passageway through switchbacks, resulting in a serpentine alignment down the ledge outcrop. A similar example can be seen at Damariscotta Mills, where the straight-line gradient is about 11%, with locally steeper segments along the ladder. The gradient is brought into an acceptable range through switchbacks in a portion of the fish ladder. One constraint within this type of approach is that due to space limitations, the ability to construct pools to match the full biological capacity of the watershed may be constrained. Detailed layout in subsequent project phases would be required to fully assess the potential limitation.

The ability to compensate for the higher gradient with switchbacks within the footprint of the ledge is more feasible for the partial spillway reconstruction option than for the full spillway reconstruction option (Figure 49). With both options, the acceptable slope range could be attained by utilizing the longer potential pathway through the Harbor Park (Figure 50). Therefore, *pool and weir fish passage is feasible for the partial spillway reconstruction option along alignments within the ledge outcrop, or along an alternate alignment through harbor park. Pool and weir fish passage is feasible for the full spillway reconstruction option only along the alternate alignment through Harbor Park.*

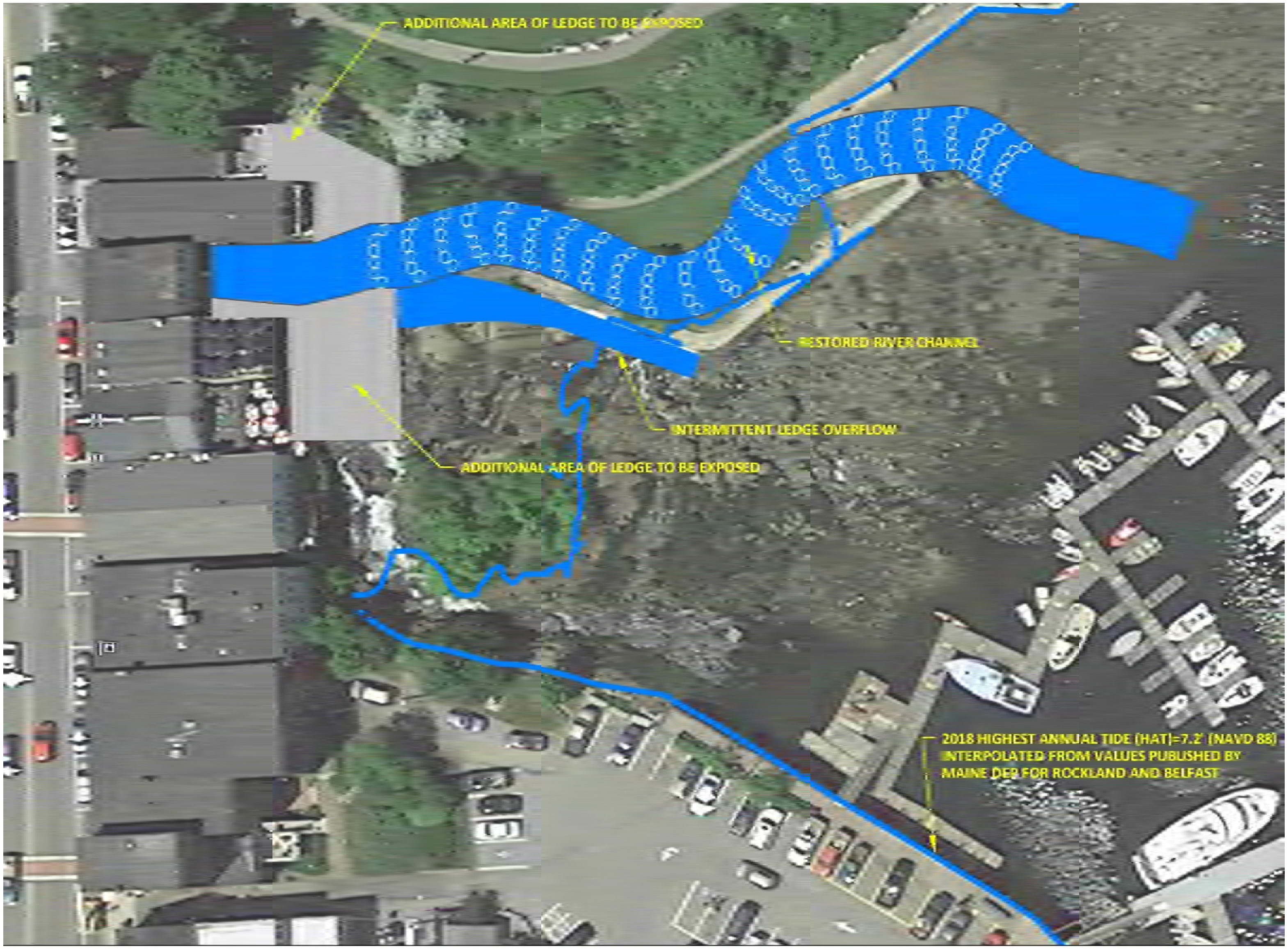

Figure 47. Schematic drawing of dam removal with restored river channel along a conceptual alignment through Harbor Park. Imagery shown represents low tide condition (imagery source: Google Earth).

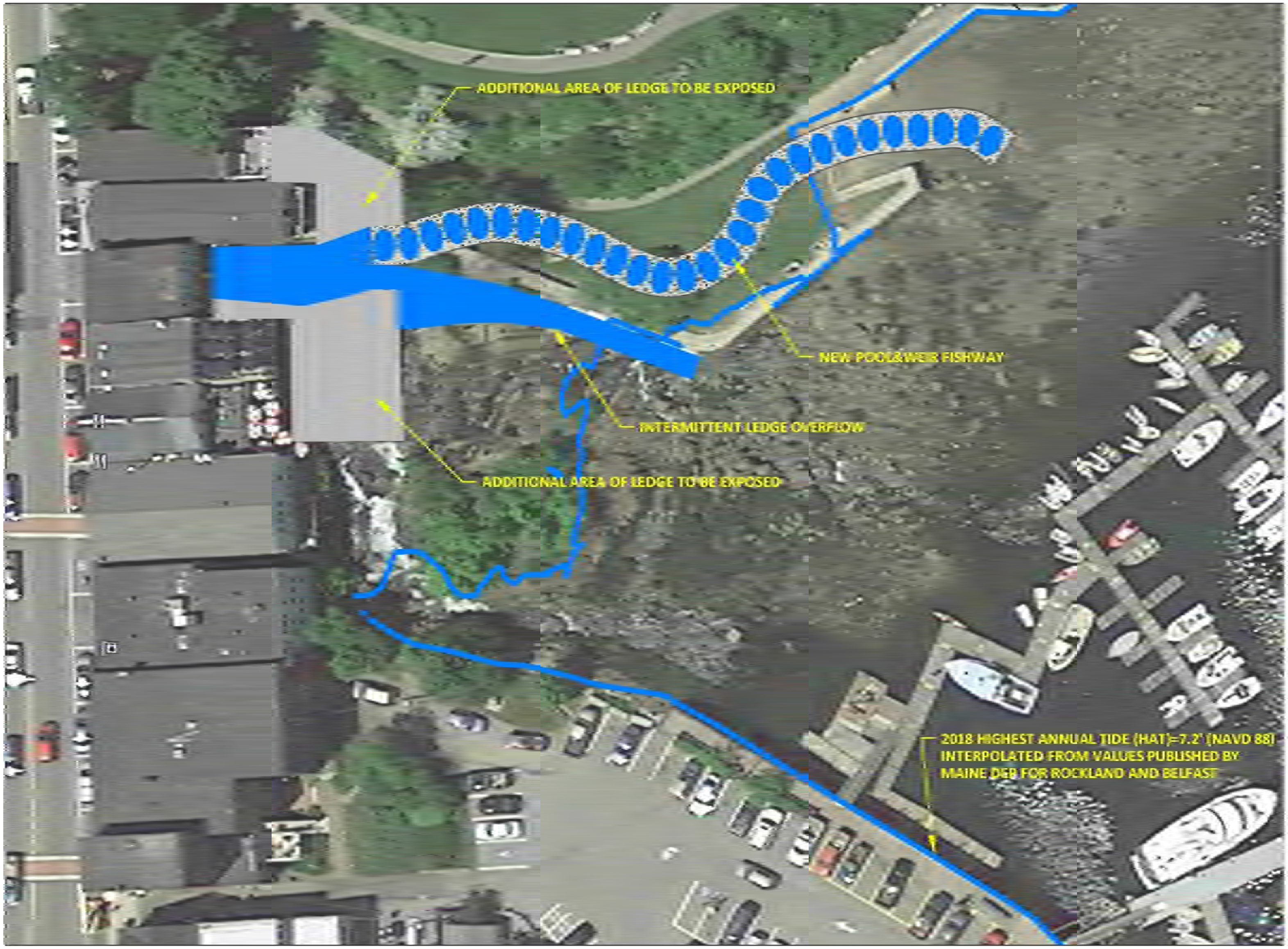

Figure 48. Schematic drawing of dam removal with pool and weir fishway along a conceptual alignment through Harbor Park. Imagery shown represents low tide condition (imagery source: Google Earth).

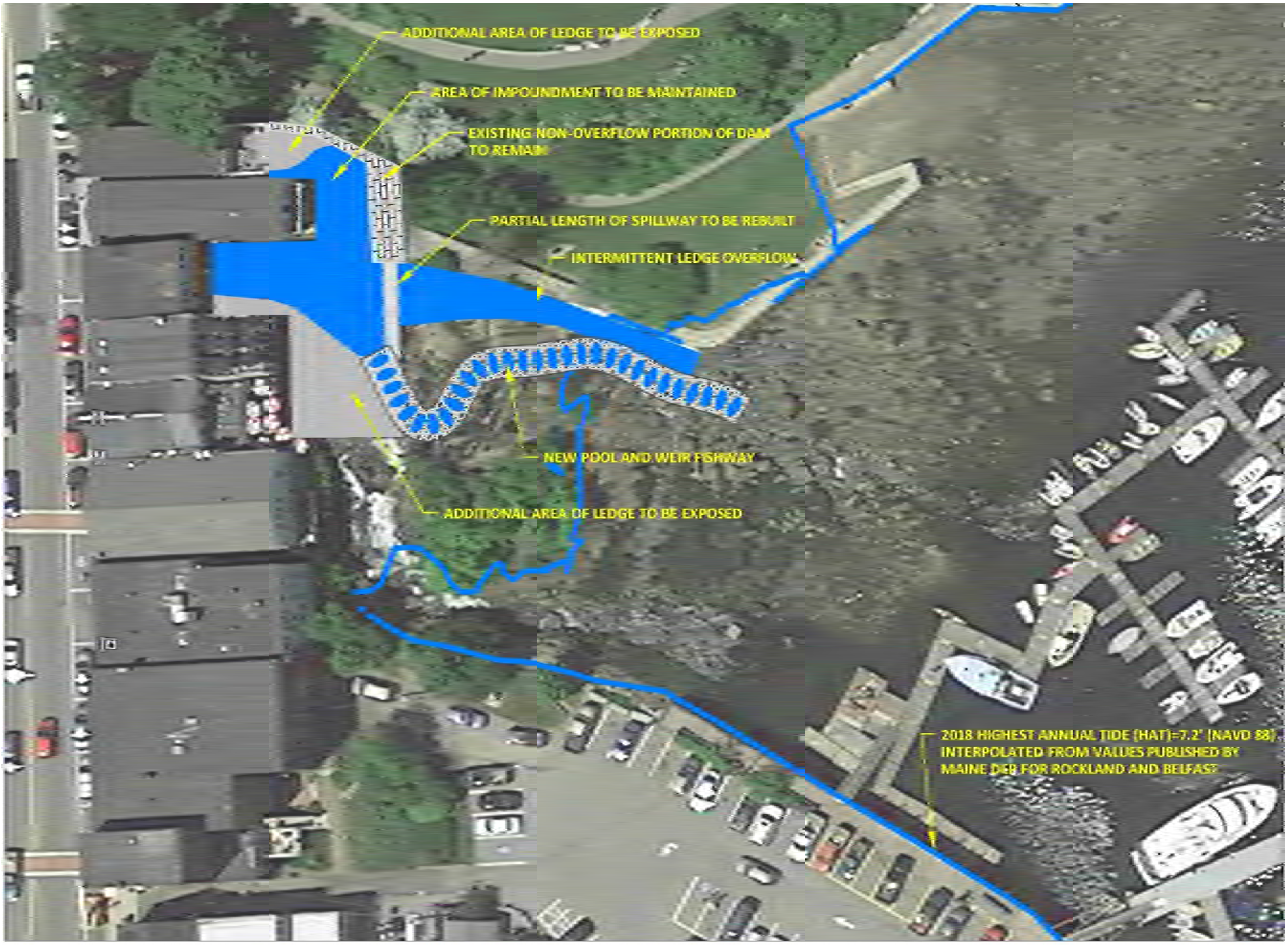

Figure 49. Schematic drawing of partial spillway reconstruction with pool and weir fishway along a conceptual alignment over the ledge outcrop. Imagery shown represents low tide condition (imagery source: Google Earth).

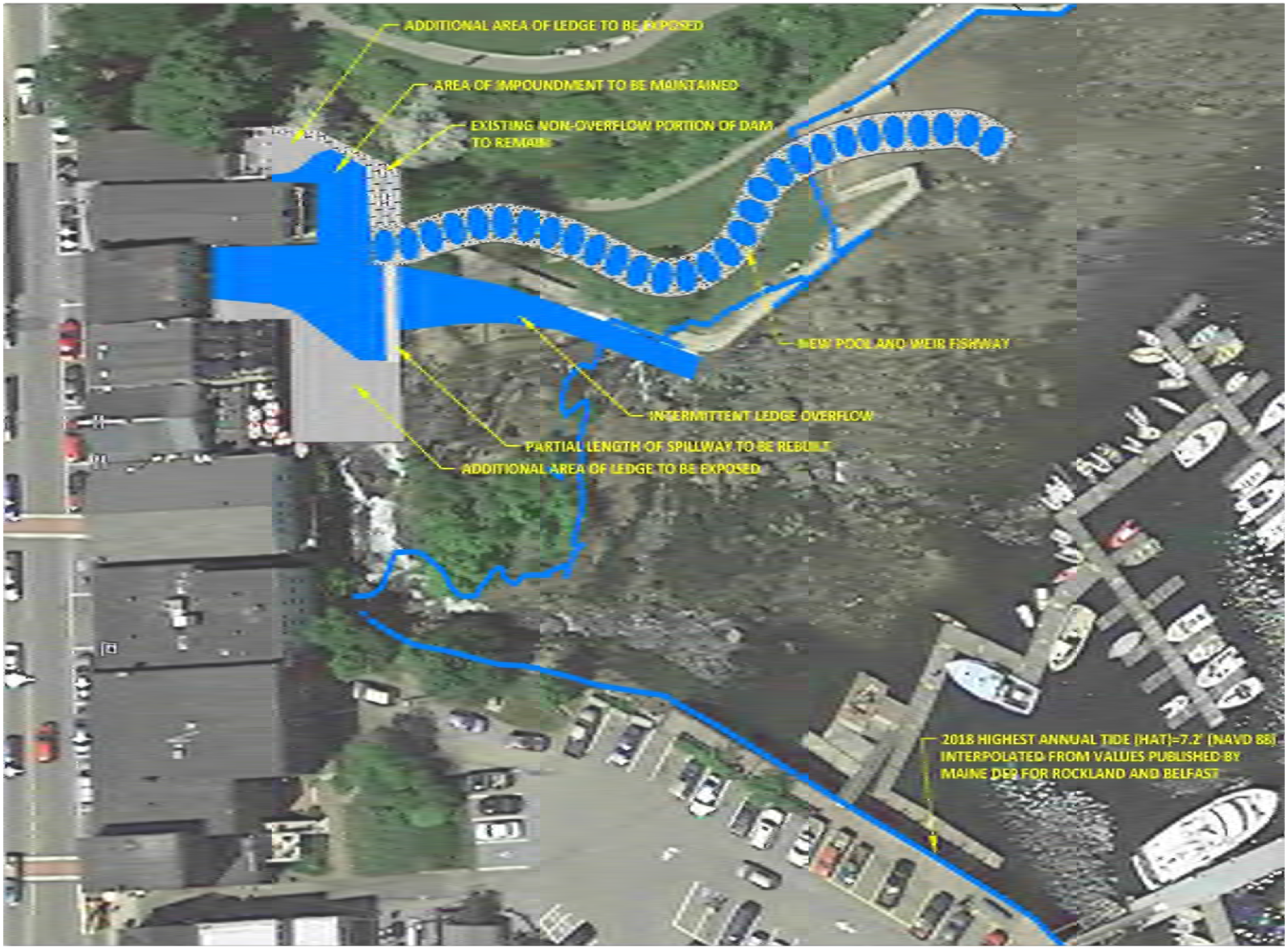

Figure 50. Schematic drawing of partial spillway reconstruction with pool and weir fishway along a conceptual alignment through Harbor Park. Imagery shown represents low tide condition (imagery source: Google Earth).

Denil Fishway Feasibility

Based on the hydraulic height and basic gradient characteristics summarized in Table 7, *Denil fish passage is feasible for all three dam modification options.* As indicated earlier in the report, standard Denil fish passage designs are considered to have biological capacity of approximately 300,000 river herring. If the sea-run fish restoration is highly successful, it is conceivable that a single Denil fishway could begin to limited the population size, and a second ladder could be required to meet the full biological capacity of the watershed.

A variety of Denil alignments could be considered, but would make most sense constrained to the area of existing ledge downstream of the dam location. In particular, installation of a Denil fishway aligned with the outflow culvert and seawall would provide an advantageous alignment for this technology (Figure 51). Alternatively, for the full spillway reconstruction option, an additional alignment would include exiting the impoundment through the south arm of the spillway down the ledge outcrop, then turning into the outflow channel along the public landing. It should be noted that for every 6 to 9 feet of rise in a Denil fishway, a larger resting pool is required. Detailed design would optimize the alignment of the ladder, but after the resting pool(s) are incorporated, the Denil approach may also need to incorporate a switchback alignment to stay within the acceptable slope range.

Hybrid Fish Passage Approaches

In addition to the fish passage options described above, two hybrid options that would combine segments of varying fish passage technologies in a single solution are feasible. First, with the dam removal option, a hybrid of pool and weir and channel restoration/nature-like approaches along an alignment through harbor park (Figure 47) would eliminate the need to extend the fish passage facility upstream of the current dam location.

Second, with the partial spillway reconstruction option, it would be feasible to install a pool and weir type installation through the existing outflow culvert, coupled with a Denil fishway downstream of the culvert. The primary limitation of this approach would be biological capacity within the culvert itself. Additionally, covered fish passages are typically not recommended. Lastly, hydraulic conditions potential sediment accumulation at the headgate structure would need to be assessed in more detail if interest in this option were advanced. However, this approach could result in a less intensive fish passage solution.

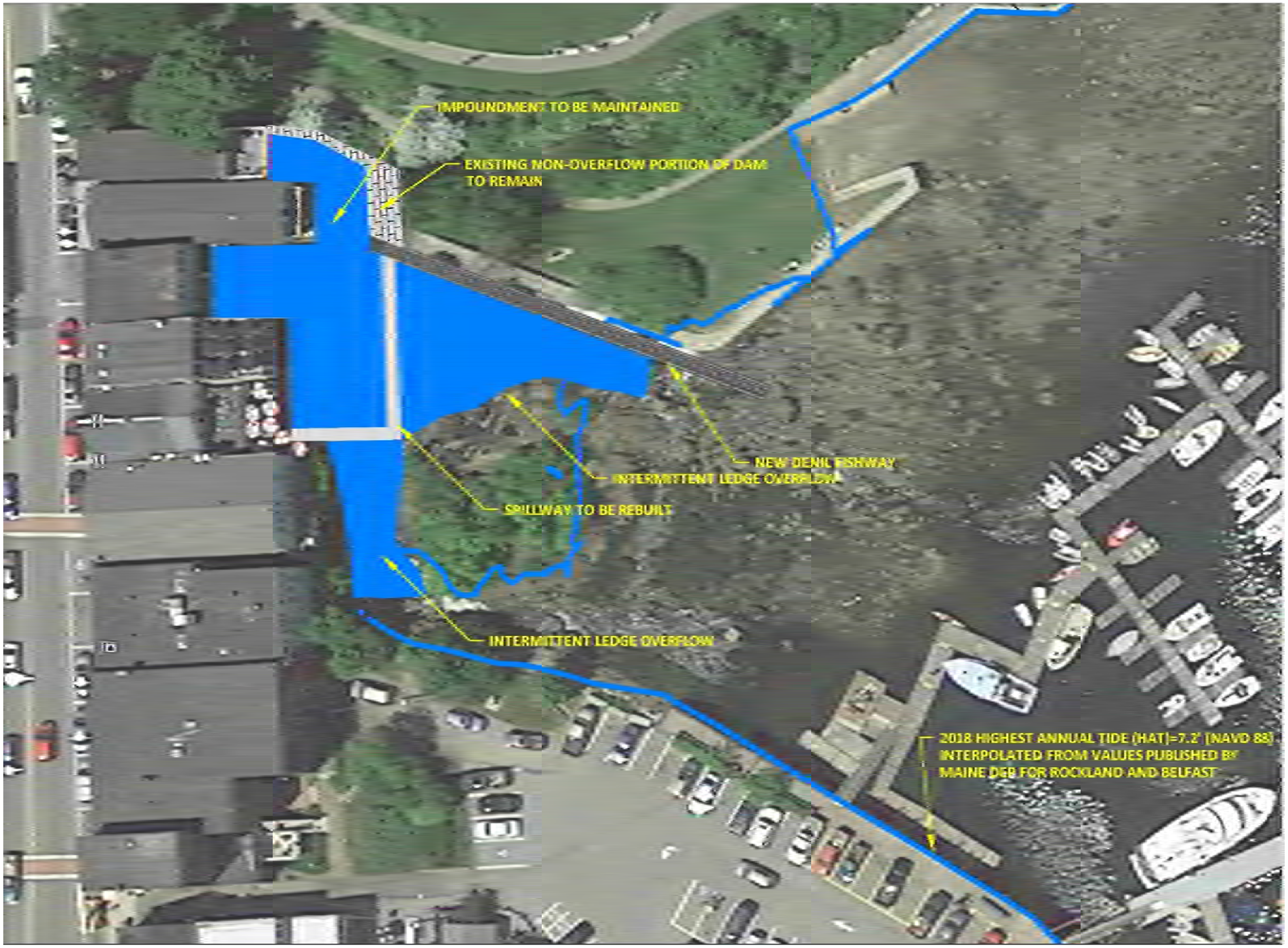

Figure 51. Schematic drawing of full spillway reconstruction with Denil fish passage along a conceptual alignment over the ledge outcrop. Imagery shown represents low tide condition (imagery source: Google Earth).

6.2.4 Summary of Fish Passage Options

Based on the site characteristics, a series of potential fish passage solutions were identified for the three dam modification options discussed in the report. The various combinations that are considered feasible are summarized in Table 9. These various combinations are evaluated against the project objectives in Section 1 of the report.

Table 9. Summary of feasible fish passage options for each dam modification option.

	Fish Passage Options			
Dam Modification Options	***Channel Restoration/ Nature-like***	***Pool & Weir***	***Denil***	***Hybrid***
Full Spillway Reconstruction	None	Harbor Park Alignment	Multiple Alignments	None
Partial Spillway Reconstruction	None	Multiple Alignments	Multiple Alignments	Culvert Alignment
Dam Removal	Harbor Park Alignment	Multiple Alignments	Multiple Alignments	Harbor Park Alignment

6.3 AESTHETIC CONSIDERATIONS

The aesthetic qualities of the site and setting are revered by Camden residents and visitors alike. One example of this is the flow of the river over the ledge outcrop commonly referred to as Megunticook Falls. With the dam modification and fish passage options considered, the aesthetic qualities of the area would be maintained, enhanced, and/or modified to varying degrees, discussed below.

6.3.1 Flow over Ledge Outcrop

With all of the dam modification alternatives, it will be feasible to maintain some degree of flow over the ledge outcrop. Because the full spillway reconstruction option generally maintains the current impoundment condition, this option provides the greatest flexibility to supply water to both the east and south areas of the ledge.

With the partial spillway reconstruction, it will be more challenging to supply flow to the south end of the ledge outcrop, although with modification of the ledge it may be feasible to supply nominal flow to this area. With the dam removal option, it will be challenging to supply flow to the south end.

With the addition of fish passage to the site, it will be important to divert substantial flow to the new fish passage during the period of fish migration (Section 4.3) to facilitate attraction to the fishway entrance with all of these options. Due to this, the amount of flow over the ledge may be reduced during those periods. However, the aesthetic attributes of a well-design restored channel or fish passage may replace this, with cascading flow through the channel.

6.3.2 Pool Behind Dam

Based on conversations with project stakeholders, some regard the pool behind the dam as contributing to the aesthetic quality of the area, while others have expressed reservations about the apparent poor water quality and the tendency of the pool to collect debris. The full spillway reconstruction option would generally maintain the current impoundment condition. With the partial spillway reconstruction option, the pool is estimated to shrink to approximately 50 percent of the present condition. The dam removal option would effectively eliminate the pool.

While these options may modify the existing pool condition to varying degrees, the aesthetic quality of the fish passage would likely offset changes associated with pool reduction. Both the Damariscotta Mills and Blackman Stream projects resulted in sites with notable aesthetic qualities, and the marvel of the restored fish runs draw crowds of visitors to each site annually.

6.3.3 Harbor Park and Adjacent Areas

In conjunction with the project alternatives, there are many options to maintain and enhance the visitor experience in the Harbor Park area. In particular, elements that augment interpretation of the historical role of the site, and the ecological role of a restored fish run would be viable enhancements.

As noted above, selected fish passage options may incorporate routing fish passage facilities through the Harbor Park area. The park area and the relict channel that existed there were filled in conjunction with the development of the park in 1930 (Figure 15 and Figure 16). Given the directly adjacent pedestrian access, restored fish passage in this area could be established in a way to provide a very pleasing visitor experience with notable potential for interpretive and public use elements, and a key element of revitalization of the area. While this may be viewed as an impact to the current condition, it could also be viewed as an enhancement for the future. There is an ongoing dialog in the Town on reimagining the area, to address the degrading condition of the seawall and the current inundation of the area during high water events. Combining these initiatives may result in a long-term enhancement for the Town.

7. Summary of Alternatives

A summary of the highlights and constraints of each opportunity is included in Table 10. The table also contrasts the opportunities against the project objectives for purpose of alternatives evaluation. Note that the hybrid options discussed in Section 6.2.3 are omitted from Table 10, but should be considered as potential refinements that could be evaluated in detailed design if the associated primary alternative is advanced as the selected project alternative. In addition, for contrast to the alternatives which address the combined project objectives of dam modification and fish passage restoration, an alternative is included at the end of Table 10 which solely reconstructs the spillway, but does not re-establish fish passage. This alternative is included for comparison purposes only, and is not considered a viable alternative to meet the goals and objectives established for the project.

Dam Maintenance and Flooding Benefits

The alternatives which reduce the overall hydraulic height of the dam either through dam removal or partial spillway reconstruction will yield the greatest flood relief benefits. Of these, the dam removal option will result in incrementally greater flood management benefits, and will also result in the least amount of long-term dam management, maintenance and repair. Full spillway reconstruction will not change the current configuration at the site. This option will replace the failing spillway with a new spillway resulting in reduced near term maintenance needs, but will still require operation by the Town and will not yield flood reduction benefits.

Fish passage and Ecological Recovery Benefits

The dam removal with channel restoration option will result in the best opportunity for successful fish passage and make the greatest contribution to recovery of ecological health in the watershed. This would include improvement of water quality at the site itself. This option would be followed by the dam removal with pool and weir fishway options, and then the other dam removal options.

The partial spillway reconstruction alternatives also provide potential for successful fish passage, but do not provide the same full potential for ecological benefits. Of the partial spillway reconstruction options, the pool and weir alignment through Harbor Park would provide the best potential for successful fish passage.

The full spillway reconstruction alternatives also provide potential for successful fish passage, but at the greatest complexity and cost. The ecological benefits resulting from full spillway reconstruction are the lowest between the alternatives.

Historical/Aesthetic Qualities and Public Amenity

All of the alternatives could be accomplished in a manner to preserve the aesthetics and acknowledge the historical attributes of the site, while enhancing the public use and educational components of the area. The dam removal alternatives will provide the most dramatic change to the site, while the full spillway reconstruction alternatives will most closely preserve the current condition.

Structural Implications

The dam removal alternatives would result in the greatest change to the current condition for the existing structures, with the potential for selected required countermeasures. However, these alternatives would also reduce the interaction of the river with these structures, which should yield a long-term positive outcome. Conversely, the full dam reconstruction alternatives change the ambient conditions around the structures the least, or not at all. With these alternatives, near-term countermeasures may not be required to account for the change induced by the project, but it should be noted that the current condition does contribute to the observed degraded conditions due to the ongoing interaction of the structures with the river.

Table 10. Alternatives assessment table.

ID	Dam Modification Option	Fish Passage Option	Dam Condition/Maintenance	Fish Passage Efficiency	Fish Passage Attraction	Biological Capacity	Flood Benefits	Impoundment Pool	Flow Over Ledge	Historical/Public Amenity/Aesthetics	Structural Implications	Harbor Park Implications	Total Cost ($)[1]
F1	Full Spillway Reconstruction	• Pool & Weir • Harbor Park Alignment	• Spillway is reconstructed • O&M required	• Good	• Maximize flow for success	• Scalable	• Limited	• Maintained	• East and south paths possible for periods of year	• Enhancements integrated in design • Passage aesthetics good	• Maintain existing conditions	• Park changes	• 2,384,800
F2	Full Spillway Reconstruction	• Denil • Outflow Culvert or South Channel Alignments	• Spillway is reconstructed • O&M required	• Moderate • separate eel passage	• Maximize flow for success	• 300,000	• Limited	• Maintained	• East and south paths possible for periods of year	• Enhancements integrated in design • Passage aesthetics moderate	• Maintain existing conditions	• Maintain Existing	• 2,097,400
P1	Partial Spillway Reconstruction	• Pool & Weir • Harbor Park Alignment	• Spillway is partially reconstructed • O&M required	• Good	• Maximize flow for success	• Scalable	• Second best	• Reduced to 60% of Existing	• Predominantly east path • south path with ledge modification	• Enhancements integrated in design • Passage aesthetics good	• Countermeasures may be required	• Park changes	• 1,994,600
P2	Partial Spillway Reconstruction	• Pool & Weir • Ledge Alignment	• Spillway is partially reconstructed • O&M required	• Moderate to Good	• Good	• Scalable, may be constrained by space limitations	• Second best	• Reduced to 60% of Existing	• Predominantly east path • south path with ledge modification	• Enhancements integrated in design • Passage aesthetics good	• Countermeasures may be required	• Maintain Existing	• 1,645,700
P3	Partial Spillway Reconstruction	• Denil • Outflow Culvert Alignment	• Spillway is partially reconstructed • O&M required	• Moderate • separate eel passage	• Good	• 300,000	• Second best	• Reduced to 60% of Existing	• Predominantly east path • south path with ledge modification	• Enhancements integrated in design • Passage aesthetics moderate	• Countermeasures may be required	• Maintain Existing	• 1,668,500
DR1	Dam Removal	• Nature-like • Harbor Park Alignment	• Structure removed • O&M limited to fish passage	• Best	• Maximize Flow for success	• Scalable	• Best	• Limited	• East path possible	• Enhancements integrated in design • Passage aesthetics good	• Countermeasures may be required	• Park changes	• 1,326,300
DR2	Dam Removal	• Pool & Weir • Harbor Park Alignment	• Structure removed • O&M limited to fish passage	• Good	• Maximize Flow for success	• Scalable	• Best	• Limited	• East path possible	• Enhancements integrated in design • Passage aesthetics good	• Countermeasures may be required	• Park changes	• 1,784,300
DR3	Dam Removal	• Pool & Weir • Ledge Alignment	• Structure removed • O&M limited to fish passage	• Moderate to Good	• Good	• Scalable, may be constrained by space limitations	• Best	• Limited	• East path possible	• Enhancements integrated in design • Passage aesthetics good	• Countermeasures may be required	• Maintain Existing	• 1,471,200
DR4	Dam Removal	• Denil • Ledge Alignment	• Structure removed • O&M limited to fish passage	• Moderate • separate eel passage	• Good	• 300,000	• Best	• Limited	• East path possible	• Enhancements integrated in design • Passage aesthetics good	• Countermeasures may be required	• Maintain Existing	• 1,433,100
SR1[2]	Full Spillway Reconstruction	• None	• Spillway is reconstructed • O&M required	• None	• None	• None	• Limited	• Maintained	• East and south paths possible for periods of year	• Current Condition Maintained	• Maintain existing conditions	• Maintain Existing	• 1,362,700[3]

[1] Includes construction cost and lifespan cost, plus estimated project delivery costs of $200,000 for project management, permitting, design, construction management and construction observation. Rounded up to nearest hundred.

[2] Included for contrast to the alternatives which meet the combined project objectives of dam modification and fish passage restoration. However, as no fish passage improvements are included in this alternative it is not considered a viable alternative.

[3] Includes construction cost and lifespan cost, plus estimated project delivery costs of $40,000 for project management, permitting, design, construction management and construction observation. Rounded up to nearest hundred.

8. Cost Analysis

Opinions of probable cost were developed for each of the alternatives discussed in Sections 6 and 7. These cost opinions are intended at the present juncture primarily to enable relative comparison between alternatives, with additional design development recommended to result in cost opinions that are suitable for advanced planning.

According to the definitions developed by the American Association of Cost Engineering (AACE 2016), the goal for the cost analysis fits in the range of Class 4 estimates. The cost analysis includes design, permitting, construction, and estimated operation and maintenance costs for a fifty-year planning horizon.

The cost opinions have been developed based on review of construction costs for similar items in past projects and applicable reference cost data. The actual implemented cost may vary from these estimates, based on market factors, detailed design development and possible optimization, and other factors.

8.1 ASSUMPTIONS

Several assumptions were required to facilitate preparation of the cost analysis, discussed below.

Sediment management associated with dam removal

As noted in Section 4, a modest amount of accumulated sediment is present behind the dam. It was assumed in the cost opinions that sediment in the lower impoundment would be excavated and disposed

Mitigation of potential infrastructure impacts associated with dam removal

Potential infrastructure impacts associated with dam management were reviewed in Section 5 and Section 6. Preliminary potential costs for mitigation of impacts to infrastructure that may result from dam management were included in the cost analysis. Follow-up analyses of selected impacts will be required in future phases of project planning.

Seawall retrofits

As reviewed in Section 6, the alternatives will result in varying degrees of interaction with the existing seawall, and as discussed general objectives for the seawall are under review by the Town. Placeholder costs for seawall retrofit were included in the cost analyses for each alternative scaled to the degree to which the alternative is likely to interface with the wall. Follow-up analyses of objectives and design for the seawall will be required in future design phases.

Capitalization of Lifespan Costs

Annual operation and maintenance costs and periodic inspection and repair costs were included in the cost analysis. These lifespan costs were applied to both the dam and the fishway for the enhancement alternatives which retain the dam or result in new built structures. Compared to the nature-like fishway, the technical fishways were assessed to have greater annual operation and maintenance costs, and greater periodic inspection and repair costs. Similarly, compared to partial spillway reconstruction, full spillway reconstruction was assessed to have greater annual operation and maintenance costs, and greater periodic inspection and repair costs.

Lifespan costs were capitalized over a 50-year planning horizon, assuming a 3% rate of inflation. This rate of inflation was selected based on review of average rates of inflation over the 50-year period 1986-2015-. Over this period, inflation in the Consumer Price Index calculated by the U.S. Bureau of Labor Statistics was 2.67 for the nation and 2.89 for the northeast region. These rates were compared to inflation in the RS Means Heavy Construction Index (RS Means 2016) over the same period (3.15), to result in the selected value of 3.0.

8.2 COST ANALYSIS SUMMARY

The results of the cost analysis are summarized in Table 11. In general, the initial construction costs were estimated at similar magnitudes, although the estimated costs for the pool and weir fishways were greater than for the other fish passage approaches. This trend is consistent with expectations. In terms of lifespan costs, the estimated costs for the full spillway reconstruction alternatives were the greatest, followed by the partial spillway reconstruction alternatives. The dam removal alternatives were estimated to have the lowest life span costs of the alternatives that were considered. Lastly, the full dam removal options are most likely to draw support from external funding sources associated with ecological recovery and infrastructure resiliency initiatives, particularly if included as a component of a comprehensive program to address the aging dams, habitat fragmentation, and ecological recovery of the overall Megunticook River watershed. Conversely, the availability of external funding to reconstruct the spillway to maintain the current condition with no fish passage will likely be limited.

Table 11: Summary of cost analysis, rounded to nearest $100.

Alternative	Construction Cost* ($)	Lifespan Cost (50 years) ($)	Total Cost** ($)
Full Spillway Reconstruction			
Pool & Weir Fishway	1,084,000	1,100,800	2,384,800
Denil Fishway	796,600	1,100,800	2,097,400
Partial Spillway Reconstruction			
Pool & Weir Fishway	1,098,300	696,300	1,994,600
Shaped Ledge Fishway	749,400	696,300	1,645,700
Denil Fishway	772,200	696,300	1,668,500
Dam Removal			
Restored Channel/ Nature-Like Fishway	745,100	381,200	1,326,300
Pool & Weir Fishway	1,033,900	550,400	1,784,300
Shaped Ledge Fishway	720,800	550,400	1,471,200
Denil Fishway	682,700	550,400	1,433,100
*Full Spillway Reconstruction with No Fish Passage****			
Full Spillway Reconstruction with No Fish Passage***	185,900	1,100,800	1,326,700****

*Includes 30% design and construction contingency.

**Includes construction cost and lifespan cost, plus estimated project delivery costs of $200,000 for project management, permitting, design, construction management and construction observation.

***Included for contrast to the alternatives which meet the combined project objectives of dam modification and fish passage restoration. However, as no fish passage improvements are included in this alternative it is not considered a viable alternative.

****Includes construction cost and lifespan cost, plus estimated project delivery costs of $40,000 for project management, permitting, design, construction management and construction observation.

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Appendix A - Sediment Sampling Results

				LOCATION		1-HARBOR	2-RR	3-RL	4-TNK
				SAMPLING DATE		6/28/2018	6/28/2018	6/28/2018	6/28/2018
				SAMPLE TYPE		SOIL	SOIL	SOIL	SOIL
	NOAA-FPEC	NOAA-FTEC	NOAA-MPEL	NOAA-MTEL	Units	Results	Results	Results	Results
Total Metals									
Lead, Total	128000	35800	112000	30240	ug/kg	198000	122000	67000	141000
Mercury, Total	1060	180	700	130	ug/kg	<98	229	133	3610
Nickel, Total	48600	22700	42800	15900	ug/kg	14000	15000	15100	20900
Silver, Total			1770	730	ug/kg	<623	<651	<581	<841
Thallium, Total					ug/kg	<1250	<1300	<1160	<1680
Antimony, Total					ug/kg	<3120	<3250	<2900	<4200
Arsenic, Total	33000	9790	41600	7240	ug/kg	9620	17000	7830	8940
Beryllium, Total					ug/kg	<312	410	<290	<420
Cadmium, Total	4980	990	4210	680	ug/kg	766	950	976	1320
Chromium, Total	111000	43400	160000	52300	ug/kg	25500	1460000	98300	600000
Copper, Total	149000	31600	108000	18700	ug/kg	20000	40100	30500	73200
Zinc, Total	459000	121000	271000	124000	ug/kg	70400	120000	106000	165000
Selenium, Total					ug/kg	<1250	<1300	<1160	<1680
Semivolatile Organics by GC/MS-SIM									
Hexachlorobenzene					ug/kg	<10	<56	<9.6	<14
Anthracene	845	57.2	245	46.9	ug/kg	2000	680	190	2300
Pyrene	1520	195	1398	153	ug/kg	5300	3900	1200	8100
Benzo(ghi)perylene					ug/kg	1000	720	310	1600
Indeno(1,2,3-cd)Pyrene					ug/kg	1200	830	350	1800
Benzo(b)fluoranthene					ug/kg	3400	2800	970	5500
Fluoranthene	2230	423	1494	113	ug/kg	6100	4500	1400	9400
Benzo(k)fluoranthene					ug/kg	960	1100	350	1900
Acenaphthylene			128	5.87	ug/kg	730	270	190	430
Chrysene	1290	166	846	108	ug/kg	3500	2300	810	5500
Benzo(a)pyrene	1450	150	763	88.8	ug/kg	2600	2000	730	4500
Dibenzo(a,h)anthracene		33	135	6.22	ug/kg	320	200	97	500
Benzo(a)anthracene	1050	108	693	74.8	ug/kg	3400	2000	710	5500
Hexachloroethane					ug/kg	<10	<56	<9.6	<14
Acenaphthene			88.9	6.71	ug/kg	980	340	51	1100
Phenanthrene	1170	204	544	86.7	ug/kg	7000	3000	750	8500
Fluorene	536	77.4	144	21.2	ug/kg	1300	330	76	1300
Hexachlorobutadiene					ug/kg	<10	<56	<9.6	<14
Pentachlorophenol					ug/kg	<40	<220	<38	<57
1-Methylnaphthalene					ug/kg	520	82	17	320
Naphthalene	561	176	391	34.6	ug/kg	1600	270	48	1400
2-Methylnaphthalene			201	20.2	ug/kg	670	97	22	500
2-Chloronaphthalene					ug/kg	<10	<56	<9.6	<14
Semivolatile Organics by GC/MS									
4-Nitroaniline					ug/kg	<250	<280	<240	<360
4-Nitrophenol					ug/kg	<350	<390	<340	<500
Benzyl Alcohol					ug/kg	<250	<280	<240	<360
4-Bromophenyl phenyl ether					ug/kg	<250	<280	<240	<360
Azobenzene					ug/kg	<250	<280	<240	<360
2,4-Dimethylphenol					ug/kg	<250	<280	<240	<360
1,4-Dichlorobenzene					ug/kg	<250	<280	<240	<360
4-Chloroaniline					ug/kg	<250	<280	<240	<360
3-Methylphenol/4-Methylphenol					ug/kg	<360	<400	<340	<520
Bis(2-chloroisopropyl)ether					ug/kg	<300	<330	<290	<430
Phenol					ug/kg	<250	<280	<240	<360
Pyridine					ug/kg	<270	<300	<260	<390
Bis(2-chloroethyl)ether					ug/kg	<230	<250	<220	<320
Bis(2-chloroethoxy)methane					ug/kg	<270	<300	<260	<390
Bis(2-ethylhexyl)phthalate			2647	182	ug/kg	<250	<280	<240	<360
Di-n-octylphthalate					ug/kg	<250	<280	<240	<360
1,2,4-Trichlorobenzene					ug/kg	<250	<280	<240	<360
2,4-Dichlorophenol					ug/kg	<230	<250	<220	<320
2,4-Dinitrotoluene					ug/kg	<250	<280	<240	<360
Dimethyl phthalate					ug/kg	<250	<280	<240	<360
Dibenzofuran					ug/kg	1000	<280	<240	890
2,4-Dinitrophenol					ug/kg	<1200	<1300	<1200	<1700
4,6-Dinitro-o-cresol					ug/kg	<660	<720	<620	<930
1,3-Dichlorobenzene					ug/kg	<250	<280	<240	<360
p-Chloro-m-cresol					ug/kg	<250	<280	<240	<360
2,6-Dinitrotoluene					ug/kg	<250	<280	<240	<360
Aniline					ug/kg	<300	<330	<290	<430
n-Nitrosodimethylamine					ug/kg	<510	<560	<480	<720
n-Nitrosodi-n-propylamine					ug/kg	<250	<280	<240	<360
Benzoic Acid					ug/kg	<820	<900	<780	<1200
4-Chlorophenyl phenyl ether					ug/kg	<250	<280	<240	<360
Hexachlorocyclopentadiene					ug/kg	<720	<790	<680	<1000
Isophorone					ug/kg	<230	<250	<220	<320
Diethyl phthalate					ug/kg	<250	<280	<240	<360
Di-n-butylphthalate					ug/kg	<250	<280	<240	<360
Butyl benzyl phthalate					ug/kg	<250	<280	<240	<360
NDPA/DPA					ug/kg	<200	<220	<190	<290
Carbazole					ug/kg	1200	350	<240	1200
2,4,6-Trichlorophenol					ug/kg	<150	<170	<140	<210
2-Nitroaniline					ug/kg	<250	<280	<240	<360
2-Nitrophenol					ug/kg	<550	<600	<520	<770
3,3'-Dichlorobenzidine					ug/kg	<250	<280	<240	<360
Biphenyl					ug/kg	<580	<630	<550	<820
Benzidine					ug/kg	<840	<920	<790	<1200
2-Methylphenol					ug/kg	<250	<280	<240	<360
1,2-Dichlorobenzene					ug/kg	<250	<280	<240	<360
2-Chlorophenol					ug/kg	<250	<280	<240	<360

Inter-Fluve
PO Box 236
Damariscotta, ME 04543

					LOCATION	1-HARBOR	2-RR	3-RL	4-TNK
					SAMPLING DATE	6/28/2018	6/28/2018	6/28/2018	6/28/2018
					SAMPLE TYPE	SOIL	SOIL	SOIL	SOIL
	NOAA-FPEC	NOAA-FTEC	NOAA-MPEL	NOAA-MTEL	Units	Results	Results	Results	Results
2,4,5-Trichlorophenol					ug/kg	<250	<280	<240	<360
Nitrobenzene					ug/kg	<230	<250	<220	<320
3-Nitroaniline					ug/kg	<250	<280	<240	<360
Volatile Organics by GC/MS-5035									
Ethylbenzene					ug/kg	<1	<1.3	<1.1	<1.4
Styrene					ug/kg	<1	<1.3	<1.1	<1.4
cis-1,3-Dichloropropene					ug/kg	<0.52	<0.65	<0.55	<0.72
trans-1,3-Dichloropropene					ug/kg	<1	<1.3	<1.1	<1.4
n-Propylbenzene					ug/kg	<1	<1.3	<1.1	<1.4
n-Butylbenzene					ug/kg	<1	<1.3	<1.1	<1.4
p-Chlorotoluene					ug/kg	<2.1	<2.6	<2.2	<2.9
1,4-Dichlorobenzene					ug/kg	<2.1	<2.6	<2.2	<2.9
1,2-Dibromoethane					ug/kg	<1	<1.3	<1.1	<1.4
1,2-Dichloroethane					ug/kg	<1	<1.3	<1.1	<1.4
Acrylonitrile					ug/kg	<4.2	<5.2	<4.4	<5.8
Vinyl acetate					ug/kg	<10	<13	<11	<14
4-Methyl-2-pentanone					ug/kg	<10	<13	<11	<14
1,3,5-Trimethylbenzene					ug/kg	<2.1	<2.6	<2.2	<2.9
Bromobenzene					ug/kg	<2.1	<2.6	<2.2	<2.9
Toluene					ug/kg	<1	<1.3	<1.1	<1.4
Chlorobenzene					ug/kg	<0.52	<0.65	<0.55	<0.72
Tetrahydrofuran					ug/kg	<4.2	<5.2	<4.4	<5.8
1,4-Dichlorobutane					ug/kg	<10	<13	<11	<14
trans-1,4-Dichloro-2-butene					ug/kg	<5.2	<6.5	<5.5	<7.2
1,2,4-Trichlorobenzene					ug/kg	<2.1	<2.6	<2.2	<2.9
Dibromochloromethane					ug/kg	<1	<1.3	<1.1	<1.4
Tetrachloroethene					ug/kg	<0.52	<0.65	<0.55	<0.72
Xylenes, Total					ug/kg	<1	<1.3	<1.1	<1.4
sec-Butylbenzene					ug/kg	<1	<1.3	<1.1	<1.4
1,3-Dichloropropane					ug/kg	<2.1	<2.6	<2.2	<2.9
cis-1,2-Dichloroethene					ug/kg	<1	<1.3	<1.1	<1.4
trans-1,2-Dichloroethene					ug/kg	<1.6	<1.9	<1.6	<2.2
Methyl tert butyl ether					ug/kg	<2.1	<2.6	<2.2	<2.9
p/m-Xylene					ug/kg	<2.1	<2.6	<2.2	<2.9
1,2-Dichloroethene, Total					ug/kg	<1	<1.3	<1.1	<1.4
1,3-Dichlorobenzene					ug/kg	<2.1	<2.6	<2.2	<2.9
1,3-Dichloropropene, Total					ug/kg	<0.52	<0.65	<0.55	<0.72
Carbon tetrachloride					ug/kg	<1	<1.3	<1.1	<1.4
1,1-Dichloropropene					ug/kg	<0.52	<0.65	<0.55	<0.72
2-Hexanone					ug/kg	<10	<13	<11	<14
2,2-Dichloropropane					ug/kg	<2.1	<2.6	<2.2	<2.9
Ethyl ether					ug/kg	<2.1	<2.6	<2.2	<2.9
1,1,1,2-Tetrachloroethane					ug/kg	<0.52	<0.65	<0.55	<0.72
Acetone					ug/kg	<10	**21**	**130**	**85**
Chloroform					ug/kg	<1.6	<1.9	<1.6	<2.2
Benzene					ug/kg	<0.52	<0.65	<0.55	<0.72
1,1,1-Trichloroethane					ug/kg	<0.52	<0.65	<0.55	<0.72
Bromomethane					ug/kg	<2.1	<2.6	<2.2	<2.9
Chloromethane					ug/kg	<4.2	<5.2	<4.4	<5.8
Dibromomethane					ug/kg	<2.1	<2.6	<2.2	<2.9
Bromochloromethane					ug/kg	<2.1	<2.6	<2.2	<2.9
Chloroethane					ug/kg	<2.1	<2.6	<2.2	<2.9
Vinyl chloride					ug/kg	<1	<1.3	<1.1	<1.4
Methylene chloride					ug/kg	<5.2	<6.5	<5.5	<7.2
Carbon disulfide					ug/kg	<10	<13	<11	<14
Bromoform					ug/kg	<4.2	<5.2	<4.4	<5.8
Bromodichloromethane					ug/kg	<0.52	<0.65	<0.55	<0.72
1,1-Dichloroethane					ug/kg	<1	<1.3	<1.1	<1.4
1,1-Dichloroethene					ug/kg	<1	<1.3	<1.1	<1.4
Trichlorofluoromethane					ug/kg	<4.2	<5.2	<4.4	<5.8
Dichlorodifluoromethane					ug/kg	<10	<13	<11	<14
1,2-Dichloropropane					ug/kg	<1	<1.3	<1.1	<1.4
2-Butanone					ug/kg	<10	<13	**21**	<14
1,1,2-Trichloroethane					ug/kg	<1	<1.3	<1.1	<1.4
Trichloroethene					ug/kg	<0.52	<0.65	<0.55	<0.72
1,1,2,2-Tetrachloroethane					ug/kg	<0.52	<0.65	<0.55	<0.72
1,2,3-Trichlorobenzene					ug/kg	<2.1	<2.6	<2.2	<2.9
Hexachlorobutadiene					ug/kg	<4.2	<5.2	<4.4	<5.8
Naphthalene	561	176	391	34.6	ug/kg	<4.2	<5.2	<4.4	<5.8
o-Xylene					ug/kg	<1	<1.3	<1.1	<1.4
o-Chlorotoluene					ug/kg	<2.1	<2.6	<2.2	<2.9
1,2-Dichlorobenzene					ug/kg	<2.1	<2.6	<2.2	<2.9
1,2,4-Trimethylbenzene					ug/kg	<2.1	<2.6	<2.2	<2.9
1,2-Dibromo-3-chloropropane					ug/kg	<3.1	<3.9	<3.3	<4.3
1,2,3-Trichloropropane					ug/kg	<2.1	<2.6	<2.2	<2.9
Ethyl methacrylate					ug/kg	<10	<13	<11	<14
tert-Butylbenzene					ug/kg	<2.1	<2.6	<2.2	<2.9
Isopropylbenzene					ug/kg	<1	<1.3	<1.1	<1.4
p-Isopropyltoluene					ug/kg	<1	<1.3	<1.1	<1.4
Polychlorinated Biphenyls by GC									
Aroclor 1260	676	59.8	189	21.6	ug/kg	<50.1	<55.3	<46.1	<69.4
Aroclor 1254	676		709	63.3	ug/kg	<50.1	**66.5**	<46.1	<69.4
Aroclor 1268	676	59.8	189	21.6	ug/kg	<50.1	<55.3	<46.1	<69.4
Aroclor 1221	676	59.8	189	21.6	ug/kg	<50.1	<55.3	<46.1	<69.4
Aroclor 1232	676	59.8	189	21.6	ug/kg	<50.1	<55.3	<46.1	<69.4
Aroclor 1248	676	59.8	189	21.6	ug/kg	<50.1	<55.3	<46.1	<69.4

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PO Box 236
Damariscotta, ME 04543

					LOCATION	1-HARBOR	2-RR	3-RL	4-TNK
					SAMPLING DATE	6/28/2018	6/28/2018	6/28/2018	6/28/2018
					SAMPLE TYPE	SOIL	SOIL	SOIL	SOIL
	NOAA-FPEC	NOAA-FTEC	NOAA-MPEL	NOAA-MTEL	Units	Results	Results	Results	Results
Aroclor 1016	676	59.8	189	21.6	ug/kg	<50.1	<55.3	<46.1	<69.4
PCBs, Total	676	59.8	189	21.6	ug/kg	<50.1	**66.5**	<46.1	<69.4
Aroclor 1262	676	59.8	189	21.6	ug/kg	<50.1	<55.3	<46.1	<69.4
Aroclor 1242	676	59.8	189	21.6	ug/kg	<50.1	<55.3	<46.1	<69.4
General Chemistry									
Solids, Total					%	**64.1**	**58.7**	**68.4**	**45.7**
Chlorinated Herbicides by GC									
Dichloroprop					ug/kg	-	<56.6	-	-
Dicamba					ug/kg	-	<56.6	-	-
Dalapon					ug/kg	-	<56.6	-	-
MCPP					ug/kg	-	<5660	-	-
2,4,5-TP (Silvex)					ug/kg	-	<283	-	-
2,4,5-T					ug/kg	-	<283	-	-
MCPA					ug/kg	-	<5660	-	-
2,4-D					ug/kg	-	<283	-	-
2,4-DB					ug/kg	-	<283	-	-
Organochlorine Pesticides by GC									
Heptachlor epoxide (B)	16	2.47	2.74		ug/kg	-	<1.62	-	-
Endosulfan sulfate					ug/kg	-	<0.811	-	-
Hexachlorobenzene					ug/kg	-	<1.62	-	-
Mirex					ug/kg	-	<0.811	-	-
Oxychlordane					ug/kg	-	**15.1**	-	-
Aldrin					ug/kg	-	**18.6**	-	-
alpha-BHC					ug/kg	-	<0.811	-	-
beta-BHC					ug/kg	-	<0.811	-	-
delta-BHC					ug/kg	-	<0.811	-	-
Endosulfan II					ug/kg	-	<0.811	-	-
2,4'-DDE					ug/kg	-	<0.811	-	-
trans-Nonachlor					ug/kg	-	**5.77**	-	-
4,4'-DDT	62.9	4.16	4.77	1.19	ug/kg	-	**6.03**	-	-
alpha-Chlordane					ug/kg	-	**4.52**	-	-
cis-Nonachlor					ug/kg	-	<0.811	-	-
gamma-Chlordane					ug/kg	-	**5.1**	-	-
2,4'-DDD					ug/kg	-	**22.3**	-	-
Endrin ketone					ug/kg	-	<0.811	-	-
Chlordane	17.6	3.24	4.79	2.26	ug/kg	-	<40.7	-	-
gamma-BHC					ug/kg	-	<0.811	-	-
Dieldrin	61.8	1.9	4.3	0.72	ug/kg	-	**142**	-	-
Endrin	207	2.22			ug/kg	-	<0.811	-	-
Methoxychlor					ug/kg	-	<8.11	-	-
4,4'-DDD	28	4.88	7.81	1.22	ug/kg	-	**58.7**	-	-
4,4'-DDE	31.3	3.16	374	2.07	ug/kg	-	**28.7**	-	-
Endrin aldehyde					ug/kg	-	<2.43	-	-
Heptachlor					ug/kg	-	<0.811	-	-
2,4'-DDT					ug/kg	-	**2.5**	-	-
Toxaphene				0.1	ug/kg	-	<40.7	-	-
Endosulfan I					ug/kg	-	<0.811	-	-

Detected analytes are reported in **bold**.
Analytes that were not detected are reported with a "<" followed by the detection limit of the analysis.
Results that exceed screening levels are highlighted in the color of the highest exceeded screening level.
NOAA-FPEC: NOAA Freshwater Sediment Probable Effect Concentration (PEC) SQuiRTs Criteria per 2008 Screening Quick Reference Tables.
NOAA-FTEC: NOAA Freshwater Sediment Threshold Effect Concentration (TEC) SQuiRTs Criteria per 2008 Screening Quick Reference Tables.
NOAA-MPEL: NOAA Marine Sediment Probable Effects Level (PEL) SQuiRTs Criteria per 2008 Screening Quick Reference Tables.
NOAA-MTEL: NOAA Marine Sediment Threshold Effects Level (TEL) SQuiRTs Criteria per 2008 Screening Quick Reference Tables.

Inter-Fluve
PO Box 236
Damariscotta, ME 04543

Appendix B - Structural Condition Assessment Report

MONTGOMERY DAM
MEGUNTICOOK RIVER
CAMDEN, MAINE

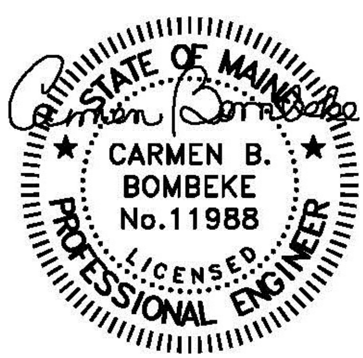
STRUCTURAL CONDITIONS ASSESSMENT

Prepared for
Inter-Fluve
Damariscotta, Maine

Prepared by

Gartley & Dorsky
ENGINEERING SURVEYING
59 Union Street Unit 1 P.O. Box 1031 Camden, ME 04843-1031
Ph (207) 236-4365 Fax (207) 236-3055 www.gartleydorsky.com

Report Issue Date: December 12, 2018
Engineer conducting the assessment: Carmen B. Bombeke, PE



12/12/2018

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1. INTRODUCTION & BACKGROUND

Montgomery Dam is located in Camden, Maine at the outlet of Megunticook River in Camden Harbor. The dam is situated east of Main Street (Route 1) behind several of the Main Street shops in downtown Camden. The dam is less than the minimum size for regulation, reportedly storing 10 acre feet at normal pool.

The dam is owned by the Town of Camden, however the pool and water flow affect several privately owned properties. Based on water surface profiles, the existing dam impacts flows upstream to approximately 25 Mechanic Street (Brewster Building), just east of the Washington Street (Route 105) bridge.

2. PURPOSE

This structural assessment is part of a larger study seeking to evaluate the physical, biological, ecological and engineering performance of the Montgomery Dam and fish passage alternatives. We understand discussions for the dam itself include the following possible options: 1) full dam removal, 2) partial dam lowering, and 3) dam reconstruction. Option 1 or 2 will modify the existing water flow. Assuming Option 3 reconstruction will match the existing dam configuration, existing flows and impacts will be maintained. This assessment aims to identity the potential impacts on existing structures due to the change in ambient water levels and altered flood hydraulics upstream of the dam resulting from dam modification, also referred to as dam breach, or dam removal.

3. SCOPE OF CONDITIONS ASSESSMENT

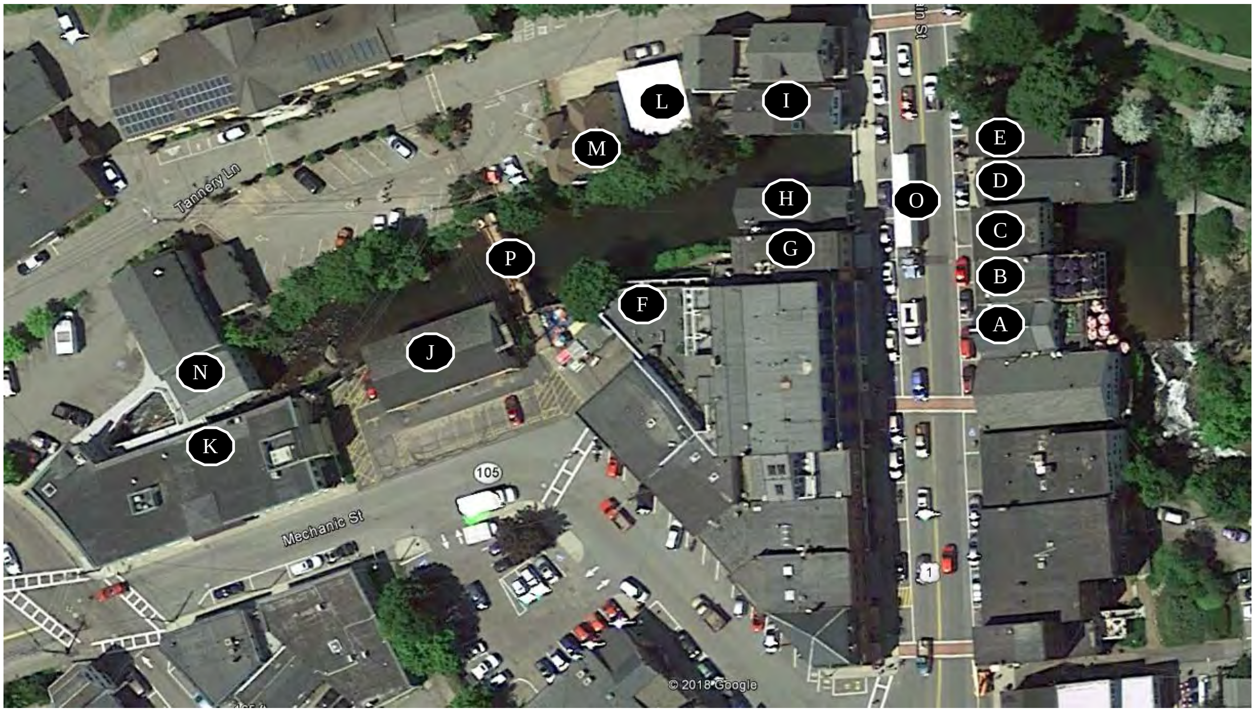
We conducted a site visit June 28, 2018 to observe and document the existing structure foundations from the dam impoundment upstream to 25 Mechanic Street (Brewster Building). We documented the visible portions of the existing foundations during our site visit, including building piles, bracing, bridge abutments and building foundations. The inspection was conducted by Carmen Bombeke, PE, Senior Engineer at Gartley & Dorsky Engineering & Surveying. Mike Burke of Inter-Fluve was also present at the site during part of the structural site visit.

The water flows had been lowered in the river the morning of the site assessment, however due to heavy rains during the day, the water flow and elevation continued to rise throughout the duration of the site visit.

This conditions assessment aims to provide a general understanding of the existing condition of the building foundations at the time of our inspection. We also observed the Main Street (Route 1) bridge abutments and the Tannery Lane Footbridge abutments. The assessment is based on qualitative observation of the structures and surrounding features only. This assessment does not include engineering calculations to determine the structural capacity and/or structural stability of any foundation elements observed and/or documented.

4. STRUCTURES & PROPERTIES LIST

The assessment included observation of the following buildings (or appurtenances to these buildings) and bridge abutment structures:



- A 35 Main Street
- B 37 Main Street
- C 39 Main Street
- D 41 Main Street
- E 43 Main Street
- F 26 Main Street
- G 30 Main Street
- H 32 Main Street
- I 34 Main Street
- J 21 Mechanic Street
- K 25 Mechanic Street
- L 4 Tannery Lane
- M 8 Tannery Lane
- N 14 Tannery Lane
- O Main Street (Route 1) bridge abutments
- P Tannery Lane Footbridge abutments

5. EXISTING CONDITIONS OBSERVATIONS

In this assessment we consider the existing conditions model as a benchmark that represents the current status quo and attempt to assess the impact of potential changes to the water surface profile with regard to the structures in the waterway. The starting point for assessing structural impacts is to understand the existing structural conditions. We conducted a site visit to observe the existing construction of the various structures/foundations in the river that may be affected by the project.

Existing Construction Types

Structures within the waterway have a variety of different construction materials and support conditions. Observed construction types include the following:

- Continuous cut granite foundations
- Continuous cast-in-place concrete foundations
- Round and square cast-in-place concrete piers
- Tapered precast concrete frost piers
- Precast concrete footing pads on grade
- Fieldstone foundation wall with cementitious parge coating
- Wood timber posts
- Wood diagonal bracing
- Steel pipe columns
- Steel cable/rod bracing

We also observed timber and masonry retaining walls along the waterway, although these were not necessarily part of a building foundation.

Material and Construction – Visual Assessment

Although many of the building foundation elements are structurally sound, we observations the following forms of degradation or deficiency in at least one location:

- Precast piers may rely on surrounding soil for lateral stability
- Some cast-in-place concrete piers are severely deteriorated
- Aggregate is exposed below normal water on some cast-in-place concrete piers
- Some steel barrels used as concrete forms are corroded and deteriorating
- Some concrete piers may encapsulate older wood piles
- Many of the cast-in-place concrete piers have limited to moderate spalling
- Footing pads on grade lack adequate frost protection
- Some repointing of cut stone foundations may be required
- Some stones have been displaced in fieldstone foundation walls
- Rebar is exposed at the surface of the concrete in some footings
- Some footings are undermined
- Some concrete support piers/beams have structurally significant cracks

- Some concrete footings are rotated out of plumb
- Some previous scour repairs have failed; severe scour is present at some locations
- The underside of the concrete bridge deck is severely deteriorated
- Efflorescence and crazed cracking is present on some foundation elements
- Remnants of previously failed support elements are present in the river in some locations
- Some steel pipe columns are severely deteriorated
- Some steel bracing elements are severely deteriorated
- Some wood posts are severely deteriorated
- Some wood bracing is severely deteriorated
- Unbraced wood posts may lack adequate structural capacity and connectivity
- Some galvanized metal connector products are deteriorated
- Mechanical connections and uplift restraint are not present at many locations
- Some deck support posts are out of plumb
- Some deck support posts are anchored with only mailbox post bases driven into soil
- At least one building has an enclosed area which appears susceptible to regular flooding
- Portions of some retaining walls are out of plumb and/or otherwise compromised
- Debris and materials under buildings and decks has fallen into resource
- Footings below grade are unknown

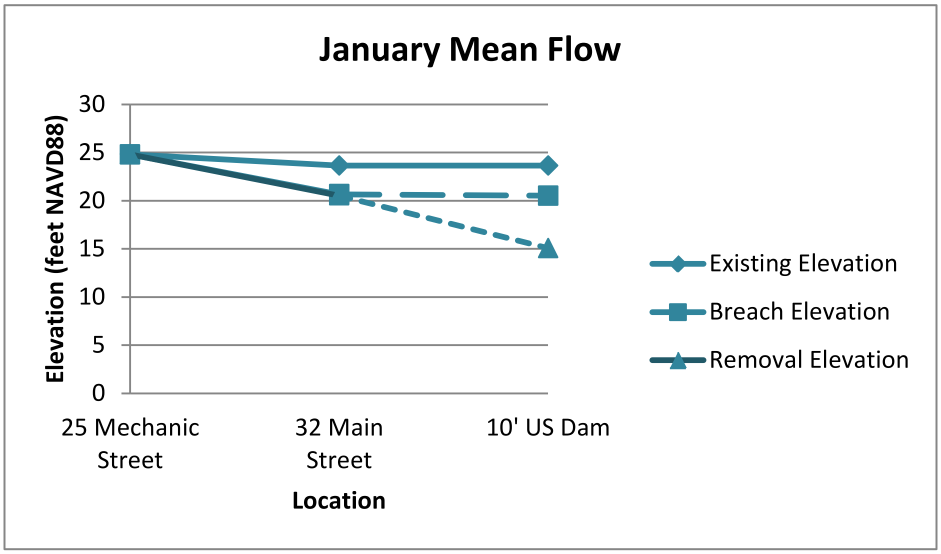
Note that there are a variety of structural deficiencies that are present regardless of modification to the dam. Although these conditions are reported herein and may be worthy of further exploration, developing recommendations to address existing structural deficiencies is not the purpose of this study. However, existing structural deficiencies may affect impacts to particular structures under certain proposed water surface profiles and are included herein for that reason.

6. POTENTIAL IMPACTS

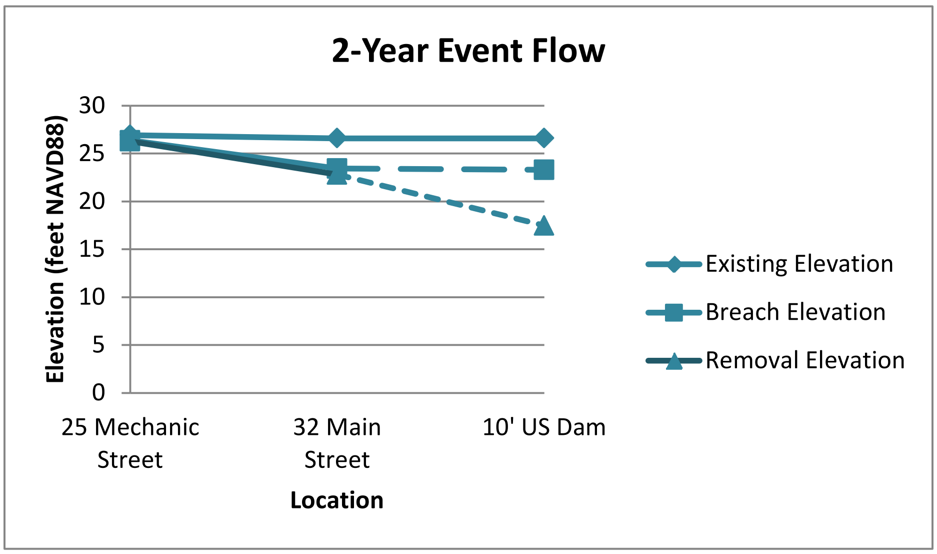
Inter-Fluve has simulated water surface profiles for three alternatives, including: 1) existing conditions, 2) dam breach which retains the head gate and masonry structure north of the headgate, but lowers the spillway south of the headgate by approximately 4.4 feet, and 3) full dam removal which includes removal of the head gate and masonry embankment down to the underlying ledge.

Both dam breach and dam removal are projected to alter the water surface profile from the existing dam location upstream to approximately 25 Mechanic Street (Brewster Building). In the dam breach scenario the water surface profile will decrease with the natural topography from 25 Mechanic Street to approximately the western end of 32 Main Street, where the water profile will begin to be affected by the dam. In the dam removal option the water surface profile will decrease with the natural topography from 25 Mechanic Street to the existing dam where water will flow freely over the existing ledge profile.

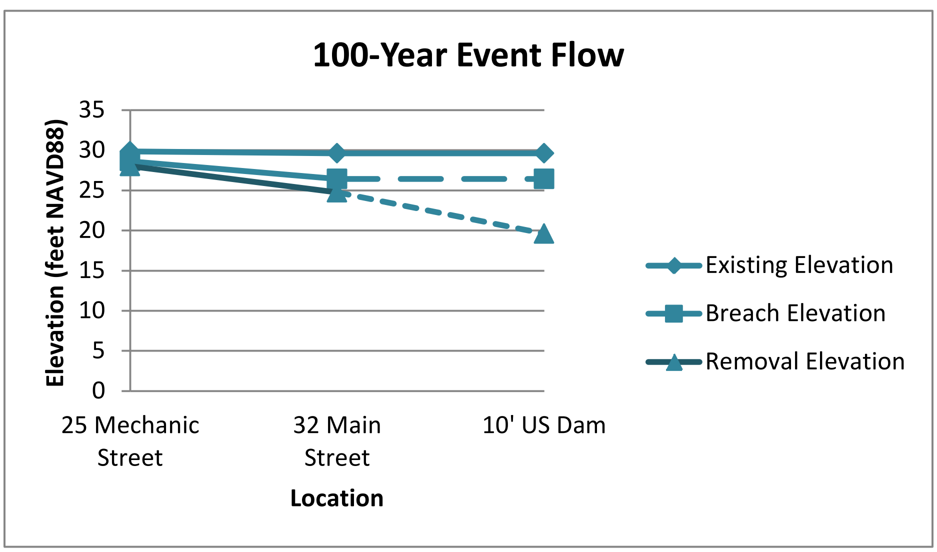
Projected water surface elevations are presented on the following page to illustrate projected water levels for key locations for January mean flow, as well as 2-year and 100-year high flow events.



January mean flows for the alternatives are shown at left for three locations. Breaching results in an estimated water level drop of 4.13' at 32 Main Street and 4.26' at the dam. Removal results in an estimated water level drop of 4.28' at 32 Main Street and 9.73' at the dam. (Data: Inter-Fluve)



2-year event flows for the alternatives are shown at left for three locations. Breaching results in an estimated water level drop of 2.95' at 32 Main Street and 3.48' at the dam. Removal results in an estimated water level drop of 3.08' at 32 Main Street and 8.80' at the dam. (Data: Inter-Fluve)



100-year event flows for the alternatives are shown at left for three locations. Breaching results in an estimated water level drop of 2.20' at 32 Main Street and 3.26' at the dam. Removal results in an estimated water level drop of 2.20' at 32 Main Street and 8.41' at the dam. (Data: Inter-Fluve)

It is challenging to assess the impact of the projected water surface profiles on the structures within the river due to a variety of unknowns, including perhaps most significantly the unknown conditions and construction below grade. Original construction, existing conditions, frost and ice are considered to be the primary factors affecting whether and how the proposed water surface profile alterations may impact structures within and surrounding the river. In general the breach and removal alternatives will lower the water levels. Reduced water levels would typically be a favorable change structurally, although there are plausible scenarios where it could worsen unique situations. The most plausible unfavorable conditions to result from reduced water levels at this location are a potential reduction in frost protection and the possible direction of debris and ice toward a different elevation on a foundation element.

It is anticipated that water in the river seeps through soils below and/or directly adjacent to the river bed and minimizes frost penetration in these area. As such, increased frost penetration may occur in select areas if water flow is no longer present near foundation elements. The impact of frost penetration depends largely on the depth of the foundation below grade and the bearing conditions. Foundations which bear on ledge are not susceptible to heaving from frost; foundations on soils are susceptible to frost to varying degrees depending on the soil characteristics, moisture, etc. Foundations which extend at least 4-feet below grade typically provide adequate protection from frost locally. Neither the depth of foundation nor the bearing conditions are exposed in most cases.

Local ice formation may be less due to less surface area of the river and fewer slow-moving stretches of river. However, the interaction with ice supplied from upstream or forming locally may occur at a different elevation than previously.

An additional consideration, not directly related to the water surface profiles, is possible sediment removal. Some foundation piers, particularly precast piers, may rely on the surrounding soil for lateral stability. In such cases sediment removal could affect the structural stability of the piers.

Based on the simulated water surface profiles and the observed conditions in the field, we make the preliminary projections identified in the following table for each property. These projections are specific to potential impacts from change in ambient water levels and altered flood hydraulics upstream of the dam resulting from dam breach or full dam removal. The center column identifies possible impacts from dam breach; the right column identifies possible impacts from dam removal. In some cases the impacts are the same or very similar, particularly upstream of 32 Main Street where the breach and removal scenarios have similar water surface profiles.

Table 1: Projected Possible Impacts to Structures – By Property

Key / Address	Dam Breach (Partial Removal)	Full Dam Removal
A 35 Main Street	1. Flows: Foundations will no longer be exposed to regular water flows 2. Frost: Foundations may have increased exposure to frost 3. Flood: Moderate increased flood protection 4. Sediment Removal: Reduced lateral stability of precast piers	1. Flows: Foundations will no longer be exposed to regular water flows 2. Frost: Foundations may have increased exposure to frost 3. Flood: Substantial increased flood protection 4. Sediment Removal: Reduced lateral stability of precast piers
B 37 Main Street	1. Flows: Foundations will no longer be exposed to regular water flows 2. Frost: Foundations may have increased exposure to frost 3. Flood: Moderate increased flood protection 4. Sediment Removal: Reduced lateral stability of precast piers	1. Flows: Foundations will no longer be exposed to regular water flows 2. Frost: Foundations may have increased exposure to frost 3. Flood: Substantial increased flood protection 4. Sediment Removal: Reduced lateral stability of precast piers
C 39 Main Street	1. Flows: Southern foundations will no longer be exposed to regular water flows 2. Frost: Southern foundations may have increased exposure to frost 3. Ice: Northern and interior foundations may experience altered exposure to ice flows on concrete piers that may be susceptible to degradation or damage 4. Flood: Moderate increased flood protection	1. Flows: Southern and interior foundations will no longer be exposed to regular water flows 2. Frost: Southern and interior foundations may have increased exposure to frost 3. Ice: Northern foundations may have altered exposure to ice flows on concrete piers that may be susceptible to degradation or damage 4. Flood: Substantial increased flood protection

Key / Address	Dam Breach (Partial Removal)	Full Dam Removal
D 41 Main Street	1. Flows: Foundations will remain largely in the waterway; elevation of water on piers will be lower 2. Flood: Moderate increased flood protection	1. Flows: Southern foundation will remain largely in the waterway; elevation of water on piers will be lower 2. Ice: Northern foundations may have altered exposure to ice flows near base of concrete piers that may be susceptible to degradation or damage 3. Flood: Substantial increased flood protection
E 43 Main Street	1. Flows: Northern foundations/pilings will no longer be exposed to regular water flows 2. Frost: Northern foundations/pilings may have increased exposure to frost 3. Ice: Southern and interior foundations/pilings may have altered exposure to ice flows on wood pilings that may be susceptible to degradation or damage 4. Flood: Moderate increased flood protection	1. Flows: Northern and interior foundations/pilings will no longer be exposed to regular water flows 2. Frost: Northern and interior foundations/pilings may have increased exposure to frost 3. Ice: Southern foundations/pilings may have altered exposure to ice flows on wood pilings that may be susceptible to degradation or damage 4. Flood: Substantial increased flood protection
F 26 Main Street	1. Flows: Deck foundations will no longer be exposed to regular water flows 2. Frost: Deck foundations may have increased exposure to frost 3. Flood: Moderate increased flood protection	⬅ Same as Dam Breach

Key / Address	Dam Breach (Partial Removal)	Full Dam Removal
G 30 Main Street	1. Flows: Base of north foundation wall will be exposed to regular water flows that may cause new scour 2. Flows: Most deck foundations will no longer be exposed to regular water flows 3. Frost: Foundation may have increased exposure to frost 4. Frost: Deck foundations may have increased exposure to frost 5. Flood: Moderate increased flood protection	1. Flows: Deck foundations will no longer be exposed to regular water flows 2. Frost: Foundation may have increased exposure to frost 3. Frost: Deck foundations may have increased exposure to frost 4. Flood: Moderate increased flood protection
H 32 Main Street	1. Flows: Most 8x8 wood posts will no longer be exposed to regular water flows 2. Ice: Concrete piers may experience altered exposure to ice flows and will form larger obstacles to ice movement 3. Flood: Moderate increased flood protection	1. Flows: South piers will no longer be exposed to regular water flows 2. Flows: 8x8 wood posts will no longer be exposed to regular water flows 3. Ice: North and interior concrete piers may experience altered exposure to ice flows and will form larger obstacles to ice movement 4. Flood: Moderate increased flood protection
I 34 Main Street	1. Flows: Fieldstone foundation wall will have reduced exposure to regular water flows 2. Flood: Moderate increased flood protection	1. Flows: Fieldstone foundation wall will no longer be exposed to regular water flows 2. Flood: Moderate increased flood protection

Key / Address	**Dam Breach (Partial Removal)**	**Full Dam Removal**
J 21 Mechanic Street	1. Flows: Foundation will no longer be exposed to regular water flows, or only at normal higher water levels 2. Frost: Foundation may have increased exposure to frost 3. Ice: Foundation may have altered exposure to ice flows 4. Flood: Limited increased flood protection	⬅ Same as Dam Breach
K 25 Mechanic Street	1. Flows: Western half of the building is beyond water surface flow impact area and will remain unchanged 2. Flows: Eastern half may experience slight decrease in surface levels at regular water flows 3. Flows: Select piers in eastern half of the building may no longer be exposed to regular water flows 4. Frost: Select piers may have increased exposure to frost 5. Flood: Limited to no increased flood protection	⬅ Same as Dam Breach
L 4 Tannery Lane	No foreseeable impact on structure	No foreseeable impact on structure
M 8 Tannery Lane	No foreseeable impact on structure	No foreseeable impact on structure

Key / Address	Dam Breach (Partial Removal)	Full Dam Removal
N 14 Tannery Lane	1. Frost: Continuous foundation may have increased exposure to frost 2. Ice: Intermediate support in south portion of building may have altered exposure to ice flows that may expedite ongoing degradation or damage 3. Ice: Masonry retaining walls forming north boundary of river at parking lot may have altered exposure to ice flows that may expedite ongoing degradation or damage 4. Flood: Limited to no increased flood protection	⬅ Same as Dam Breach
O Main Street (Route 1) bridge abutments	1. Ice: Abutments may have altered exposure to ice flows near bases which could cause increased scour 2. Flood: Moderate increased flood protection	⬅ Same as Dam Breach
P Tannery Lane Footbridge abutments	1. Flows: South abutment will no longer be exposed to regular water flows 2. Frost: North abutment may have increased exposure to frost 3. Ice: North abutment may have altered exposure to ice flows	⬅ Same as Dam Breach

7. PROJECTION SUMMARY

General projections for key considerations are summarized below:

FLOWS: Most structures in the study would benefit from the reduced elevation of water flows associated with dam breach or dam removal. In several cases, foundation elements will no longer be exposed to regular water flows or will be exposed to water of reduced depth, which has the benefit of typically inducing lessened hydraulic forces on the structures.

FROST: The majority of the structures have at least one foundation element which may have increased exposure to frost, although the tangible consequences of this exposure are not identifiable due to unknown conditions below grade. It is probable that the majority of the foundations bear on ledge, which negates most concerns with frost penetration.

ICE: Due to the change in water surface elevation, ice formation will occur at a different elevation than it does in the existing conditions. Although we have noted where altered ice flows may occur, we do not anticipate significant new problems to arise. We are unaware of significant ice formation issues in the present configuration.

FLOOD: Most, if not all structures in the study, and perhaps others in the vicinity would benefit from increased flood protection associated with the lower water surface profiles for dam breach or dam removal.

SEDIMENT: Sediment removal will likely only affect the two properties with precast concrete piers in the impoundment.

OTHER: Much of the observed material degradation is most severe near the normal water level. For wood elements, this is likely due to the repeated drying and wetting that occurs at this elevation. For concrete elements, this is likely due to spalling from water flows and ice/debris traveling along the surface of the river. It is probable that altering the elevation of the water flow and any associated ice formation may allow for new material degradation to occur near the new normal water elevation on susceptible elements.

8. RECOMMENDED NEXT STEPS

In order to determine the actual impact of the proposed alternatives on the structures in the study, further exploration and refinement is required. We recommend that once a project alternative is selected, impacts are re-assessed on a more detailed level. Of particular importance will be assessing frost impacts, which may require selective exploration to determine the depth of the existing foundations and bearing conditions. Identification of possible countermeasures to any concerning projections could be included at that time.

Although not part of this study, we also recommend remediation of existing structural deficiencies observed.

Appendix C - Detailed Cost Tables

Table F-1. Conceptual Cost Analysis for *Montgomery Dam, Dam Rebuild, Pool & Weir Fishway Alternative* .

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Direct Costs						
1	Mobilization	1	LS	$ 75,800.00	$ 75,800	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Erosion, Pollution & Water Control	1	LS	$ 20,000	$ 20,000	misc control activities
Site Work						
3	Dam Repair	1	LS	$ 75,000	$ 75,000	estimated, needs advanced design alignment to optimize
4	Sediment Excavation	300	CY	$ 100	$ 30,000	Excavate Sediment From Impoundment
5	Subgrade preparation & demolition	1	LS	$ 15,000	$ 15,000	Misc for installation of new fishway
6	P&W Fishway Concrete	210	CY	$ 1,500	$ 315,000	10' wide 260 feet long including 38 weirs
7	P&W Masonry Facing	2,600	SF	$ 80	$ 208,000	walls, 260 feet long, 5 feet deep
8	Gates, fencing, signage, and appurtenances	1	LS	$ 25,000	$ 25,000	estimated, needs advanced design alignment to optimize
9	Seawall Retrofit	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design alignment to optimize
Site Landscape & Restoration						
10	Site Enhancement	1	LS	$ 20,000	$ 20,000	Placeholder
			Construction Subtotal		$ 833,800	
			Contingency (30%)		$ 250,140	
			Project Contruction Total		**$ 1,083,940**	
Initial Project Delivery Costs						
Item					**Total Cost**	**Notes**
Project Management (estimated)					$20,000	
Permitting (estimated)					$25,000	
Engineering Design (estimated)					$100,000	
Construction Contract Administration (estimated)					$15,000	
Construction Observation (estimated)					$40,000	
Initial Project Delivery Costs Total					**$200,000**	
Total Initial Project Costs					**$1,283,940**	

Lifespan Costs - 50-year planning horizon					
Item	**Event Cost**	**Intervals**	**Interest**	**Total Cost**	**Notes**
Annual Operation and Maintenance	$8,000	50	3%	$902,375	Dam and Fishway, estimated $8000/annum (2019 dollars) for 50 years, 3% inflation
Repair and Rehabilitation (every 10 years)	$15,000	5	3%	$198,349	Assumed $15,000 (2019 dollars) renovation/repairs every 10 years, 3% inflation
Total Lifespan Costs				**$1,100,723**	

Table F-2. Conceptual Cost Analysis for *Montgomery Dam, Dam Rebuild, Denil Fishway Alternative*.

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Direct Costs						
1	Mobilization	1	LS	$ 55,700.00	$ 55,700	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Erosion, Pollution & Water Control	1	LS	$ 20,000	$ 20,000	misc control activities
Site Work						
3	Dam Repair	1	LS	$ 75,000	$ 75,000	estimated, needs advanced design to optimize
4	Sediment Excavation	300	CY	$ 100	$ 30,000	Excavate Sediment From Impoundment
5	Subgrade preparation & demolition	1	LS	$ 15,000	$ 15,000	Misc for installation of new fishway
6	Denil Fishway Concrete	125	CY	$ 1,200	$ 150,000	4' wide 1:6 standard design, 6 ft deep, 200 feet long including 2 resting pools, entrance and exit channel
7	Denil Masonry Facing	2,400	SF	$ 80	$ 192,000	walls, 200 feet long, 6 feet deep
8	Gates, fencing, signage, and appurtenances	1	LS	$ 25,000	$ 25,000	estimated, needs advanced design alignment to optimize
9	Eel passage	1	LS	$ 20,000	$ 20,000	estimated, needs advanced design alignment to optimize
10	Downstream Passage Enhancement	1	LS	$ 20,000	$ 20,000	300 SF pool, 5 ft ledge excavation plus new headgate and uniform acceleration weir
Site Landscape & Restoration						
11	Site Enhancement	1	LS	$ 10,000	$ 10,000	Placeholder
			Construction Subtotal		$ 612,700	
			Contingency (30%)		$ 183,810	
			Project Contruction Total		**$ 796,510**	
Initial Project Delivery Costs						
Item					**Total Cost**	**Notes**
Project Management (estimated)					$20,000	
Permitting (estimated)					$25,000	
Engineering Design (estimated)					$100,000	
Construction Contract Administration (estimated)					$15,000	
Construction Observation (estimated)					$40,000	
Initial Project Delivery Costs Total					**$200,000**	
Total Initial Project Costs					**$996,510**	

Lifespan Costs - 50-year planning horizon					
Item	**Event Cost**	**Intervals**	**Interest**	**Total Cost**	**Notes**
Annual Operation and Maintenance	$8,000	50	3%	$902,375	Dam and Fishway, estimated $8000/annum (2019 dollars) for 50 years, 3% inflation
Repair and Rehabilitation (every 10 years)	$15,000	5	3%	$198,349	Assumed $15,000 (2019 dollars) renovation/repairs every 10 years, 3% inflation
Total Lifespan Costs				**$1,100,723**	

Table P-1. Conceptual Cost Analysis for *Montgomery Dam, Partial Dam Rebuild, Pool & Weir Fishway Alternative*.

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Direct Costs						
1	Mobilization	1	LS	$ 76,800.00	$ 76,800	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Erosion, Pollution & Water Control	1	LS	$ 20,000	$ 20,000	misc control activities
Site Work						
3	Dam Repair	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design alignment to optimize
4	Building Retrofits	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design to optimize
5	Sediment Excavation	300	CY	$ 100	$ 30,000	Excavate Sediment From Impoundment
6	Subgrade preparation & demolition	1	LS	$ 15,000	$ 15,000	Misc for installation of new fishway
7	P&W Fishway Concrete	200	CY	$ 1,500	$ 300,000	10' wide 260 feet long including 32 weirs
8	P&W Masonry Facing	2,600	SF	$ 80	$ 208,000	walls, 260 feet long, 5 feet deep
9	Gates, fencing, signage, and appurtenances	1	LS	$ 25,000	$ 25,000	estimated, needs advanced design alignment to optimize
10	Seawall Retrofit	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design alignment to optimize
Site Landscape & Restoration						
11	Site Enhancement	1	LS	$ 20,000	$ 20,000	Placeholder
			Construction Subtotal		$ 844,800	
			Contingency (30%)		$ 253,440	
Project Contruction Total					**$ 1,098,240**	
Initial Project Delivery Costs						
Item					**Total Cost**	**Notes**
Project Management (estimated)					$20,000	
Permitting (estimated)					$25,000	
Engineering Design (estimated)					$100,000	
Construction Contract Administration (estimated)					$15,000	
Construction Observation (estimated)					$40,000	
Initial Project Delivery Costs Total					**$200,000**	
Total Initial Project Costs					**$1,298,240**	

Lifespan Costs - 50-year planning horizon					
Item	**Event Cost**	**Intervals**	**Interest**	**Total Cost**	**Notes**
Annual Operation and Maintenance	$5,000	50	3%	$563,984	Dam and Fishway, estimated $5000/annum (2019 dollars) for 50 years, 3% inflation
Repair and Rehabilitation (every 10 years)	$10,000	5	3%	$132,232	Assumed $15,000 (2019 dollars) renovation/repairs every 10 years, 3% inflation
Total Lifespan Costs				**$696,217**	

Table P-2. Conceptual Cost Analysis for *Montgomery Dam, Partial Dam Rebuild, Excavated Ledge/Pool&Weir Fishway Alternative* .

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Direct Costs						
1	Mobilization	1	LS	$ 52,400.00	$ 52,400	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Erosion, Pollution & Water Control	1	LS	$ 20,000	$ 20,000	misc control activities
Site Work						
3	Dam Repair	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design alignment to optimize
4	Building Retrofits	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design to optimize
5	Sediment Excavation	300	CY	$ 100	$ 30,000	Excavate Sediment From Impoundment
6	Selected Ledge Shaping for Fishway	200	CY	$ 300	$ 60,000	210 feet long, assume 1/2 directly in ledge
7	P&W Fishway Concrete	100	CY	$ 1,500	$ 150,000	10' wide 210 feet long including 32 weirs, assume 1/2 built
8	P&W Masonry Facing	1,300	SF	$ 80	$ 104,000	walls, 210 feet long, 5 feet deep, assume 1/2 built
9	Gates, fencing, signage, and appurtenances	1	LS	$ 25,000	$ 25,000	estimated, needs advanced design alignment to optimize
10	Seawall Retrofit	1	LS	$ 15,000	$ 15,000	estimated, needs advanced design alignment to optimize
Site Landscape & Restoration						
11	Site Enhancement	1	LS	$ 20,000	$ 20,000	Placeholder
			Construction Subtotal		$ 576,400	
			Contingency (30%)		$ 172,920	
			Project Contruction Total		**$ 749,320**	
Initial Project Delivery Costs						
Item					**Total Cost**	**Notes**
Project Management (estimated)					$20,000	
Permitting (estimated)					$25,000	
Engineering Design (estimated)					$100,000	
Construction Contract Administration (estimated)					$15,000	
Construction Observation (estimated)					$40,000	
Initial Project Delivery Costs Total					**$200,000**	
Total Initial Project Costs					**$949,320**	

Lifespan Costs - 50-year planning horizon					
Item	**Event Cost**	**Intervals**	**Interest**	**Total Cost**	**Notes**
Annual Operation and Maintenance	$5,000	50	3%	$563,984	Dam and Fishway, estimated $5000/annum (2019 dollars) for 50 years, 3% inflation
Repair and Rehabilitation (every 10 years)	$10,000	5	3%	$132,232	Assumed $15,000 (2019 dollars) renovation/repairs every 10 years, 3% inflation
Total Lifespan Costs				**$696,217**	

Table P-3. Conceptual Cost Analysis for *Montgomery Dam, Partial Dam Rebuild, Denil Fishway Alternative* .

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Direct Costs						
1	Mobilization	1	LS	$ 54,000.00	$ 54,000	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Erosion, Pollution & Water Control	1	LS	$ 20,000	$ 20,000	misc control activities
Site Work						
3	Dam Repair	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design to optimize
4	Building Retrofits	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design to optimize
5	Sediment Excavation	300	CY	$ 100	$ 30,000	Excavate Sediment From Impoundment
6	Subgrade preparation & demolition	1	LS	$ 15,000	$ 15,000	Misc for installation of new fishway
7	Denil Fishway Concrete	110	CY	$ 1,200	$ 132,000	4' wide 1:6 standard design, 6 ft deep, 175 feet long including 2 resting pools, entrance and exit channel
8	Denil Masonry Facing	2,100	SF	$ 80	$ 168,000	walls, 175 feet long, 6 feet deep
9	Gates, fencing, signage, and appurtenances	1	LS	$ 25,000	$ 25,000	estimated, needs advanced design alignment to optimize
10	Eel passage	1	LS	$ 20,000	$ 20,000	estimated, needs advanced design alignment to optimize
11	Downstream Passage Enhancement	1	LS	$ 20,000	$ 20,000	300 SF pool, 5 ft ledge excavation plus new headgate and uniform acceleration weir
12	Site Enhancement	1	LS	$ 10,000	$ 10,000	Placeholder
			Construction Subtotal		$ 594,000	
			Contingency (30%)		$ 178,200	
			Project Contruction Total		**$ 772,200**	
Initial Project Delivery Costs						
Item					**Total Cost**	**Notes**
Project Management (estimated)					$20,000	
Permitting (estimated)					$25,000	
Engineering Design (estimated)					$100,000	
Construction Contract Administration (estimated)					$15,000	
Construction Observation (estimated)					$40,000	
Initial Project Delivery Costs Total					**$200,000**	
Total Initial Project Costs					**$972,200**	

Lifespan Costs - 50-year planning horizon					
Item	**Event Cost**	**Intervals**	**Interest**	**Total Cost**	**Notes**
Annual Operation and Maintenance	$5,000	50	3%	$563,984	Dam and Fishway, estimated $5000/annum (2019 dollars) for 50 years, 3% inflation
Repair and Rehabilitation (every 10 years)	$10,000	5	3%	$132,232	Assumed $10,000 (2019 dollars) renovation/repairs every 10 years, 3% inflation
Total Lifespan Costs				**$696,217**	

Table DR-1. Conceptual Cost Analysis for *Montgomery Dam, Dam Removal, Channel Restoration/Nature-like Fishway Alternative* .

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Direct Costs						
1	Mobilization	1	LS	$ 52,100.00	$ 52,100	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Erosion, Pollution & Water Control	1	LS	$ 20,000	$ 20,000	misc control activities
Site Work						
3	Dam Removal	1	LS	$ 20,000	$ 20,000	estimated, needs advanced design alignment to optimize
4	Building Retrofits	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design to optimize
5	Sediment Excavation	300	CY	$ 100	$ 30,000	Excavate Sediment From Impoundment
6	Subgrade preparation & demolition	1	LS	$ 10,000	$ 10,000	Misc for installation of new channel/ fishway
7	Misc Grading/Excavation	1,200	CY	$ 30	$ 36,000	Harbor Park area
7	Channel Restoration	275	LF	$ 1,000	$ 275,000	25' wide 275 feet long
8	Fencing, signage, and appurtenances	1	LS	$ 10,000	$ 10,000	estimated, needs advanced design alignment to optimize
9	Seawall Retrofit	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design alignment to optimize
Site Landscape & Restoration						
11	Site Enhancement	1	LS	$ 20,000	$ 20,000	Placeholder
			Construction Subtotal		$ 573,100	
			Contingency (30%)		$ 171,930	
			Project Contruction Total		**$ 745,030**	
Initial Project Delivery Costs						
Item					**Total Cost**	**Notes**
Project Management (estimated)					$20,000	
Permitting (estimated)					$25,000	
Engineering Design (estimated)					$100,000	
Construction Contract Administration (estimated)					$15,000	
Construction Observation (estimated)					$40,000	
Initial Project Delivery Costs Total					**$200,000**	
Total Initial Project Costs					**$945,030**	

Lifespan Costs - 50-year planning horizon					
Item	**Event Cost**	**Intervals**	**Interest**	**Total Cost**	**Notes**
Annual Operation and Maintenance	$2,500	50	3%	$281,992	Fishway/Channel, estimated $2500/annum (2019 dollars) for 50 years, 3% inflation
Repair and Rehabilitation (every 10 years)	$7,500	5	3%	$99,174	Assumed $7,500 (2019 dollars) renovation/repairs every 10 years, 3% inflation
Total Lifespan Costs				**$381,166**	

Table DR-2. Conceptual Cost Analysis for *Montgomery Dam, Dam Removal, Pool&Weir Fishway Alternative* .

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Direct Costs						
1	Mobilization	1	LS	$ 72,300.00	$ 72,300	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Erosion, Pollution & Water Control	1	LS	$ 20,000	$ 20,000	misc control activities
Site Work						
3	Dam Removal	1	LS	$ 20,000	$ 20,000	estimated, needs advanced design alignment to optimize
4	Building Retrofits	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design to optimize
5	Sediment Excavation	300	CY	$ 100	$ 30,000	Excavate Sediment From Impoundment
6	Subgrade preparation & demolition	1	LS	$ 25,000	$ 25,000	Misc for installation of new fishway
7	P&W Fishway Concrete	190	CY	$ 1,500	$ 285,000	10' wide 260 feet long including 24 weirs
8	P&W Masonry Facing	2,600	SF	$ 80	$ 208,000	walls, 260 feet long, 5 feet deep
9	Gates, fencing, signage, and appurtenances	1	LS	$ 15,000	$ 15,000	estimated, needs advanced design alignment to optimize
10	Seawall Retrofit	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design alignment to optimize
Site Landscape & Restoration						
11	Site Enhancement	1	LS	$ 20,000	$ 20,000	Placeholder
			Construction Subtotal		$ 795,300	
			Contingency (30%)		$ 238,590	
			Project Contruction Total		**$ 1,033,890**	
Initial Project Delivery Costs						
Item					**Total Cost**	**Notes**
Project Management (estimated)					$20,000	
Permitting (estimated)					$25,000	
Engineering Design (estimated)					$100,000	
Construction Contract Administration (estimated)					$15,000	
Construction Observation (estimated)					$40,000	
Initial Project Delivery Costs Total					**$200,000**	
Total Initial Project Costs					**$1,233,890**	

Lifespan Costs - 50-year planning horizon					
Item	**Event Cost**	**Intervals**	**Interest**	**Total Cost**	**Notes**
Annual Operation and Maintenance	$4,000	50	3%	$451,187	Fishway, estimated $4000/annum (2019 dollars) for 50 years, 3% inflation
Repair and Rehabilitation (every 10 years)	$7,500	5	3%	$99,174	Assumed $7,500 (2019 dollars) renovation/repairs every 10 years, 3% inflation
Total Lifespan Costs				**$550,362**	

Table DR-3. Conceptual Cost Analysis for *Montgomery Dam, Dam Removal, Excavated Ledge Pool&Weir Fishway Alternative* .

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Direct Costs						
1	Mobilization	1	LS	$ 50,400.00	$ 50,400	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Erosion, Pollution & Water Control	1	LS	$ 20,000	$ 20,000	misc control activities
Site Work						
3	Dam Removal	1	LS	$ 20,000	$ 20,000	estimated, needs advanced design alignment to optimize
4	Building Retrofits	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design to optimize
5	Sediment Excavation	300	CY	$ 100	$ 30,000	Excavate Sediment From Impoundment
6	Selected Ledge Shaping for Fishway	200	CY	$ 300	$ 60,000	210 feet long, assume 1/2 directly in ledge
7	P&W Fishway Concrete	100	CY	$ 1,500	$ 150,000	10' wide 210 feet long including 24 weirs, assume 1/2 built
8	P&W Masonry Facing	1,300	SF	$ 80	$ 104,000	walls, 210 feet long, 5 feet deep, assume 1/2 built
9	Gates, fencing, signage, and appurtenances	1	LS	$ 25,000	$ 25,000	estimated, needs advanced design alignment to optimize
10	Seawall Retrofit	1	LS	$ 25,000	$ 25,000	estimated, needs advanced design alignment to optimize
Site Landscape & Restoration						
11	Site Enhancement	1	LS	$ 20,000	$ 20,000	Placeholder
			Construction Subtotal		$ 554,400	
			Contingency (30%)		$ 166,320	
			Project Contruction Total		**$ 720,720**	
Initial Project Delivery Costs						
Item					**Total Cost**	**Notes**
Project Management (estimated)					$20,000	
Permitting (estimated)					$25,000	
Engineering Design (estimated)					$100,000	
Construction Contract Administration (estimated)					$15,000	
Construction Observation (estimated)					$40,000	
Initial Project Delivery Costs Total					**$200,000**	
Total Initial Project Costs					**$920,720**	

Lifespan Costs - 50-year planning horizon					
Item	**Event Cost**	**Intervals**	**Interest**	**Total Cost**	**Notes**
Annual Operation and Maintenance	$4,000	50	3%	$451,187	Fishway, estimated $4000/annum (2019 dollars) for 50 years, 3% inflation
Repair and Rehabilitation (every 10 years)	$7,500	5	3%	$99,174	Assumed $7,500 (2019 dollars) renovation/repairs every 10 years, 3% inflation
Total Lifespan Costs				**$550,362**	

Table DR-4. Conceptual Cost Analysis for *Montgomery Dam, Dam Removal, Denil Fishway Alternative*.

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Direct Costs						
1	Mobilization	1	LS	$ 47,740.00	$ 47,740	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Erosion, Pollution & Water Control	1	LS	$ 20,000	$ 20,000	misc control activities
Site Work						
3	Dam Removal	1	LS	$ 20,000	$ 20,000	estimated, needs advanced design to optimize
4	Building Retrofits	1	LS	$ 50,000	$ 50,000	estimated, needs advanced design to optimize
5	Sediment Excavation	300	CY	$ 100	$ 30,000	Excavate Sediment From Impoundment
6	Subgrade preparation & demolition	1	LS	$ 15,000	$ 15,000	Misc for installation of new fishway
7	Denil Fishway Concrete	90	CY	$ 1,200	$ 108,000	4' wide 1:6 standard design, 6 ft deep, 140 feet long including 2 resting pools, entrance and exit channel
8	Denil Masonry Facing	1,680	SF	$ 80	$ 134,400	walls, 140 feet long, 6 feet deep
9	Gates, fencing, signage, and appurtenances	1	LS	$ 25,000	$ 25,000	estimated, needs advanced design alignment to optimize
10	Eel passage	1	LS	$ 20,000	$ 20,000	estimated, needs advanced design alignment to optimize
11	Downstream Passage Enhancement	1	LS	$ 20,000	$ 20,000	300 SF pool, 5 ft ledge excavation plus new headgate and uniform acceleration weir
11	Seawall Retrofit	1	LS	$ 25,000	$ 25,000	estimated, needs advanced design alignment to optimize
Site Landscape & Restoration						
12	Site Enhancement	1	LS	$ 10,000	$ 10,000	Placeholder
			Construction Subtotal		$ 525,140	
			Contingency (30%)		$ 157,542	
			Project Contruction Total		**$ 682,682**	
Initial Project Delivery Costs						
Item					**Total Cost**	**Notes**
Project Management (estimated)					$20,000	
Permitting (estimated)					$25,000	
Engineering Design (estimated)					$100,000	
Construction Contract Administration (estimated)					$15,000	
Construction Observation (estimated)					$40,000	
Initial Project Delivery Costs Total					**$200,000**	
Total Initial Project Costs					**$882,682**	

Lifespan Costs - 50-year planning horizon						
Item	**Event Cost**	**Intervals**	**Interest**	**Total Cost**	**Notes**
Annual Operation and Maintenance	$4,000	50	3%	$451,187	Fishway, estimated $4000/annum (2019 dollars) for 50 years, 3% inflation
Repair and Rehabilitation (every 10 years)	$7,500	5	3%	$99,174	Assumed $7,500 (2019 dollars) renovation/repairs every 10 years, 3% inflation
Total Lifespan Costs				**$550,362**	

Table SR1. Conceptual Cost Analysis for *<u>Montgomery Dam, Spillway Reconstruction, No Fish Passage</u>* .

Initial Project Costs						
Construction Cost Items						
No.	**Item**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes**
Direct Costs						
1	Mobilization	1	LS	$ 13,000.00	$ 13,000	10% of other items; includes clearing and grubbing; traffic control as necessary
2	Erosion, Pollution & Water Control	1	LS	$ 10,000	$ 10,000	misc control activities
Site Work						
3	Dam Repair	1	LS	$ 75,000	$ 75,000	estimated, needs advanced design to optimize
4	Sediment Excavation	300	CY	$ 100	$ 30,000	Excavate Sediment From Impoundment
5	Gate Replacement/Repair	1	LS	$ 15,000	$ 15,000	Update/replace gatesystem as needed, placeholder
			Construction Subtotal		$ 143,000	
			Contingency (30%)		$ 42,900	
			Project Contruction Total		**$ 185,900**	
Initial Project Delivery Costs						
Item					**Total Cost**	**Notes**
Project Management (estimated)					$5,000	
Permitting (estimated)					$10,000	
Engineering Design (estimated)					$15,000	
Construction Contract Administration (estimated)					$5,000	
Construction Observation (estimated)					$5,000	
Initial Project Delivery Costs Total					**$40,000**	
Total Initial Project Costs					**$225,900**	

Lifespan Costs - 50-year planning horizon					
Item	**Event Cost**	**Intervals**	**Interest**	**Total Cost**	**Notes**
Annual Operation and Maintenance	$8,000	50	3%	$902,375	Dam, estimated $8000/annum (2019 dollars) for 50 years, 3% inflation
Repair and Rehabilitation (every 10 years)	$15,000	5	3%	$198,349	Assumed $15,000 (2019 dollars) renovation/repairs every 10 years, 3% inflation
Total Lifespan Costs				**$1,100,723**	