

To:	Andy Hrycyna	From:	Matt Lajoie
	Mystic River Watershed Association		Stantec Consulting Services Inc.
Project/File:	203402558	Date:	June 28, 2024

Reference: Alewife Brook Hydraulic and Stream Improvement Study – Conceptual Design

1 Project Background

The Mystic River Watershed Association (MyRWA), the “Client,” and their partners from the Save the Alewife Brook (StAB) have vested interest in stewardship, planning, monitoring, and improving the Alewife Brook stream corridor, located between East Arlington and West Somerville, Massachusetts. The Client has identified problematic flooding of adjacent properties, and seeks to pursue measures to reduce flooding risk, while improving stream conditions. Stantec was contracted to conduct a Hydraulic and Stream Improvement Study (Project), which included two-dimensional (2D) hydraulic modeling of Alewife Brook, field assessment of existing conditions, and conceptual development of three potential improvement projects, as described herein. The study area included an approximately 8,000 LF portion of Alewife Brook, extending from CSO outfall CAM401A to the Mystic River confluence (**Figure 1**).

Potential improvement projects were presented to the Client during a Post-Fieldwork Review Meeting on April 21, 2024. This meeting successfully engaged with the Client’s historical knowledge of Alewife Brook and the Mystic River, and concurrence was gained for the four initiatives discussed herein. This memorandum discusses conceptual projects separately; however, the Client may choose to combine alternatives or their components to best meet organizational funding, goals, and objectives.

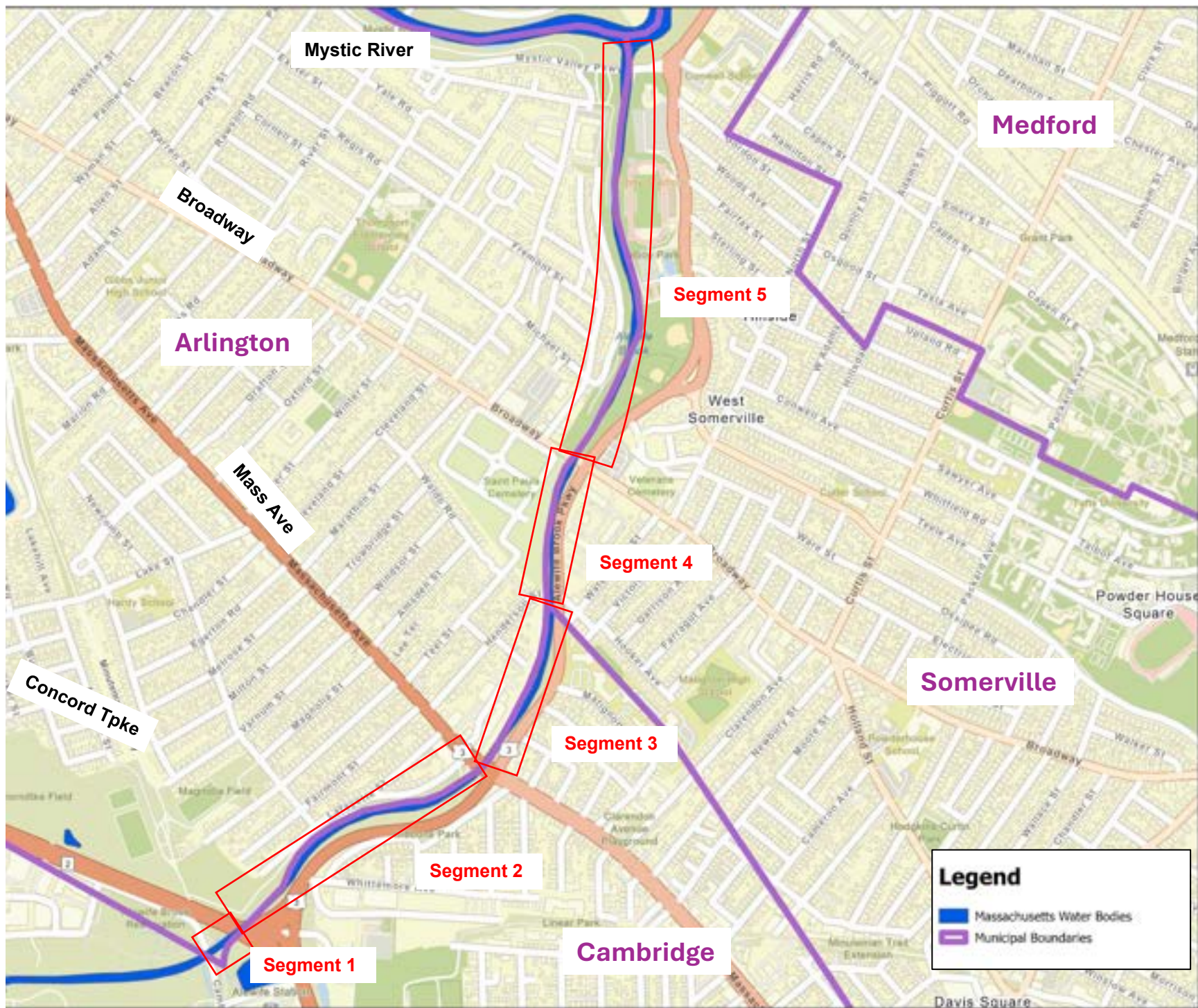


Figure 1. Alewife Brook Site Location Map

2 Existing Conditions

During the week of March 25, 2024, Stantec performed site reconnaissance and geomorphic assessment of an approximately 8,000 linear foot study reach along Alewife Brook. The study reach began at CSO outfall CAM401A, near Alewife Station in Cambridge, and extended downstream to the confluence with the Mystic River. The purpose of the existing conditions evaluation was to characterize onsite conditions, to classify the stream channel within the Rosgen Classification System, and to gather information that may be pertinent to potential improvement projects.

2.1 Stream Channel Characteristics

A total of three cross sections were surveyed within the project area, representative of unique channel characteristics within their respective segments of Alewife Brook. Photographic documentation of existing conditions is provided in **Appendix E** (cross sections: Photos 31 to 42). Although bankfull indicators were not present at the time of the survey, due to the hardened nature of the streambanks, the top of bank represents the maximum capacity conveyed within the existing channel, and this elevation is the basis of measurement. Based on field observations, the study reach of Alewife Brook can be broken into five segments with unique channel characteristics, as described below and shown in **Figure 1. Table 1** summarizes the extents of each stream segment evaluated in this study along with average water surface slopes.

Table 1. Stream Segment Summary

Segment ID	Extents	Average Water Surface Slope
1	CSO Outfall CAM401A to Concord Turnpike	0.40%
2	Concord Turnpike to Massachusetts Avenue	0.01%
3	Massachusetts Avenue to Henderson Bridge	0.03%
4	Henderson Bridge to Broadway	0.06%
5	Broadway to Mystic River Confluence	0.03%

Cross sections XS1 through XS3 (**Appendix D**) are representative of Segments 2, 3, and 4.

Segment 1: CSO Outfall CAM401A to Concord Turnpike

The Project's study reach originates at the outfall from CSO CAM401A. The receiving channel is ditched; however, the banks are natural and vegetated through a scrubby forested area parallel to the Alewife Station Access Road. Fine sediment and sand are present in the bed, but there are no signs of erosion nor substantial deposition. The channel is well-connected to its floodplain and conditions appear to be stable, although floodplain vegetation had been trampled by members of a recent homeless encampment. At the

Reference: Alewife Brook Hydraulic and Stream Improvement Study

time of the site visit, the camp had been demolished and trash and debris littered the floodplain. Moving downstream, the outfall channel passes under a steel pedestrian bridge and meets its confluence with Little River immediately upstream of the Alewife Station Access Road stream crossing. Downstream of the crossing, the channel is broad, without well-defined banks, and is characterized as an inundated section of flat water with a large wetland area contributing from its right bank. The broad adjacent floodplain and wetland depression provide flood storage for the confined area between the access road bridge crossing and the box culvert conveying flow under Concord Turnpike. Riparian buffer in the vicinity is densely vegetated with shrub cover and sparse canopy.

Segment 2 (XS1): Concord Turnpike to Massachusetts Avenue

This stream segment is characterized by trapezoidal channel geometry with hardened banks, via the historical placement of cast concrete slabs. Substantial sediment accumulation and aggradation in the bed was present at the time of the survey, which is captured in XS1 as the existing surface. The immediate riparian buffer is well-developed with full canopy, shrub, and herbaceous layers throughout the stream corridor, with the exception of the Alewife Greenway Bike Path along the left bank. The bike path takes foot and bicycle traffic on a regular basis; however, dense vegetation screens the path from Alewife Brook and does not promote access or foot traffic beyond the established route.

Segment 3 (XS2): Massachusetts Avenue to Henderson Bridge

Similar to Segment 1, this portion of Alewife Brook is also trapezoidal in geometry and is lined with cast concrete slabs, constraining the channel from natural adjustment through geomorphic processes. Deposition of fine sediments and sand were observed here as well, but generally not to the depths observed upstream in Segment 1. The immediate riparian buffer is well-developed with full canopy, shrub, and herbaceous layers throughout the stream corridor, with the exception of the Alewife Greenway Bike Path on the left bank. The bike path diverges from the stream at Henderson Bridge.

Segment 4 (XS3): Henderson Bridge to Broadway

The stream channel widens downstream of Henderson Bridge and is characterized by high, vertical retaining walls on both banks. The channel has a rectangular shape, generally with a flat bottom across its width, and deposition of fines and sand present throughout the segment. Segment 3 does not have access to its floodplain, which is by design to protect Saint Paul's Cemetery along its left bank and the boardwalk along Alewife Brook Parkway on its right bank. There is little to no riparian buffer throughout this segment. The cemetery is mowed and maintained up to the edge of the channel's left bank, and the Alewife Brook Parkway abuts the right bank retaining wall for most of its length.

Segment 5: Broadway to Confluence with Mystic River

The natural channel downstream of Broadway, could not be surveyed due to water depths at the time of the field visit; however, the channel was observed to be wider than upstream hardened segments, and no armoring was present on the banks. The densely vegetated banks generally remained stable with localized areas of erosion in the vicinity of two outfalls on the left bank. Sediment deposition was present throughout the reach, especially as lateral bars, and is likely caused primarily by backwater effects of the Mystic River during elevated storm events. Some transport from upstream is occurring; however, it is limited by the low slopes throughout the study reach of Alewife Brook.

Reference: Alewife Brook Hydraulic and Stream Improvement Study

Table 2 summarizes channel morphology at each surveyed cross section. Max and mean depths are based on the cross sectional geometry at the specific locations that were surveyed, representative of their respective stream segments. The measurements are based on the existing bed elevation, including existing sediment. Cross section locations are depicted in the detailed site map provided in **Appendix A**.

Table 2. Channel Characteristics at Maximum Channel Capacity - Existing

Cross Section	Area (sf)	Width (ft)	Max Depth (ft)	Mean Depth (ft)	Width/Depth	Entrenchment Ratio	Reachwide Average Slope	Stream Type (Rosgen)
XS1	78.7	33.9	3.9	2.3	14.6	>2.2	0.01%	C
XS2	99.0	27.3	4.8	3.6	7.5	>2.2	0.03%	E
XS3 ¹	142.2	29.3	5.6	4.9	-	1.0	0.06%	F ²
¹ XS3 is an entrenched rectangular channel with vertical retaining walls on both banks. No geomorphic bankfull indicators were present; therefore, maximum capacity does not represent the bankfull discharge at this location. ² Stream type is assigned based on the bankfull discharge, not maximum channel capacity. As no geomorphological features were present at this location, the F stream type is assumed due to the high, vertical retaining walls, presumably extending above the flood prone area (>2 times maximum bankfull depth).								

2.2 Stream Crossing Structures

During the field assessment, stream crossing structures (culverts, bridges, etc) were visually evaluated and measured for verification of input parameters in the 2-dimensional ICM. **Table 3** summarizes the results of the evaluation.

Reference: Alewife Brook Hydraulic and Stream Improvement Study

Table 3. Crossing Structure Summary

Crossing Street	Structure Type	Span (ft)	Height of Opening (ft)	Freeboard (ft)	Material	Condition	Blockage Description
Pedestrian/Bike Path	Pedestrian Bridge	75	9	0.75	Steel	Good	None. Soft bed sediments.
Alewife Station Access Road	Bridge	54	6.5	3	Concrete	Good	None. Soft bed sediments.
Alewife Brook Parkway/ Concord Turnpike	Open Bottom Box Culvert with Wing Walls	16	7.8 at inlet (behind blockage), 7.0 at outlet	3.5	Concrete	Good	Woody debris and trash on inlet. Sediment deposition at outlet. Minor blockage currently but may cause backwater during flood flows.
Massachusetts Avenue	Arch Bridge (historical)	15	11.0 at inlet, 9.0 at outlet	3.5	Quarry Stone and Brick	Good	Woody debris and trash on inlet. Minor blockage but unlikely to clear. Bricks, quarry stone, and concrete slab immediately below outlet.
Cross Street (Henderson Br)	Arch Bridge	30	12.25	2	Concrete	Good	None. Soft bed sediments with some coarser cobble/gravel.
Broadway	Arch Bridge	14.8	16.5	6.5	Lower Cast Concrete, Upper Quarry Stone	Good/ Moderate	Some woody debris under bridge. No significant blockage. Note: minor erosion along bottom portion of concrete.
Mystic Valley Parkway	Arch Bridge	40	15.3	3.5	Concrete	Good	Fine sediment deposited from Mystic River Backwater. No blockage.

Partial blockages were observed at two inlet locations: upstream of the Concord Turnpike crossing and upstream of the Massachusetts Avenue crossing. Deposition of fine sediments and sand were noted throughout the study area, including minor deposition through crossing structures; however, no other significant blockages were observed. The only crossing structure that exhibited degradation was at the arch bridge at Broadway, in which minor scour of the concrete was apparent along the lower walls. It does not appear to be an imminent concern. Aperture measurements were consistent with the data included in the model.

Reference: Alewife Brook Hydraulic and Stream Improvement Study

3 Hydraulic Modeling

The hydraulic analysis of Alewife Brook was completed by adapting a previously developed region-wide Mystic Regional Model, a two-dimensional (2D) model built by Stantec for the Mystic River Watershed in 2020 using InfoWorks ICM 2021.9 software. The Mystic Regional Model (Model) includes Alewife Brook and the Mystic River, and storage arrays for Spy Pond and Fresh Pond. The model was expanded in 2022 to include the Belmont stormwater network, Clay Pit Pond, and Little Pond. The model includes bridges and other river crossings to evaluate any potential restrictions. The model includes a 2D surface built from a Digital Elevation Model (DEM) to simulate overland flow when the collection system or rivers flood. The ponds, bridges, sewers, and 2D surface are critical in simulating the impacts of flood flows during large rain events. Ponds, bridges, and rivers are modeled as 1D model elements and are connected to the 2D surface by banks. 'Banks' are a component of the ICM, expressed as lines with varying surface elevations, which are assigned using the DEM. They allow flow to travel in both directions between the river and the ground surface within the model. For example, when the Alewife Brook accesses its floodplain, it floods onto the 2D surface via banks.

The existing model was reviewed and updated, using field-collected and verified data, to create a representative *Existing Conditions* model scenario. Subsequently, this would be used as the basis for the improvement project analysis, presented in **Section 4**.

As described in **Section 2.1**, cross sections were surveyed in the field, and significant sediment and debris build up were identified during the investigation. The model cross sections matched the surveyed cross sections well; however, depositional sediment and debris were not reflected. To capture this element, the model was modified using sediment depth measurements collected at surveyed cross sections and stream crossing structures to incorporate observed sediment and bridge obstructions.

Models such as this are calibrated to evaluate peak flows that have the most impact to flooding. This *Existing Conditions* model was validated using the August 8th, 2023 storm to confirm the model accurately predicts water depth in Alewife Brook. Flooding was observed on Alewife Greenway Bike Path on August 8th and thus was deemed an effective validation event. The event consisted of 2.0-inches of rain with a peak hourly intensity of 1.6-inches/hour over 6.25-hours. The USGS gauge 01103025 measured depth at the Broadway bridge was compared to the model results for August 8th, 2023. The model and observed maximum water depth was the same, 4.35-feet. **Figure 2** shows a depth comparison for the storm duration. The model predicts the peak depth and timing accurately, but the model depth recedes slower than observed at first and then faster than observed. **Figure 3** shows the flood extent in blue, highlighted within the red boxes. Alewife Greenway Bike Path flooding is outlined in red. Based on the August 8th event, the model replicates peak depth and flood extent accurately.

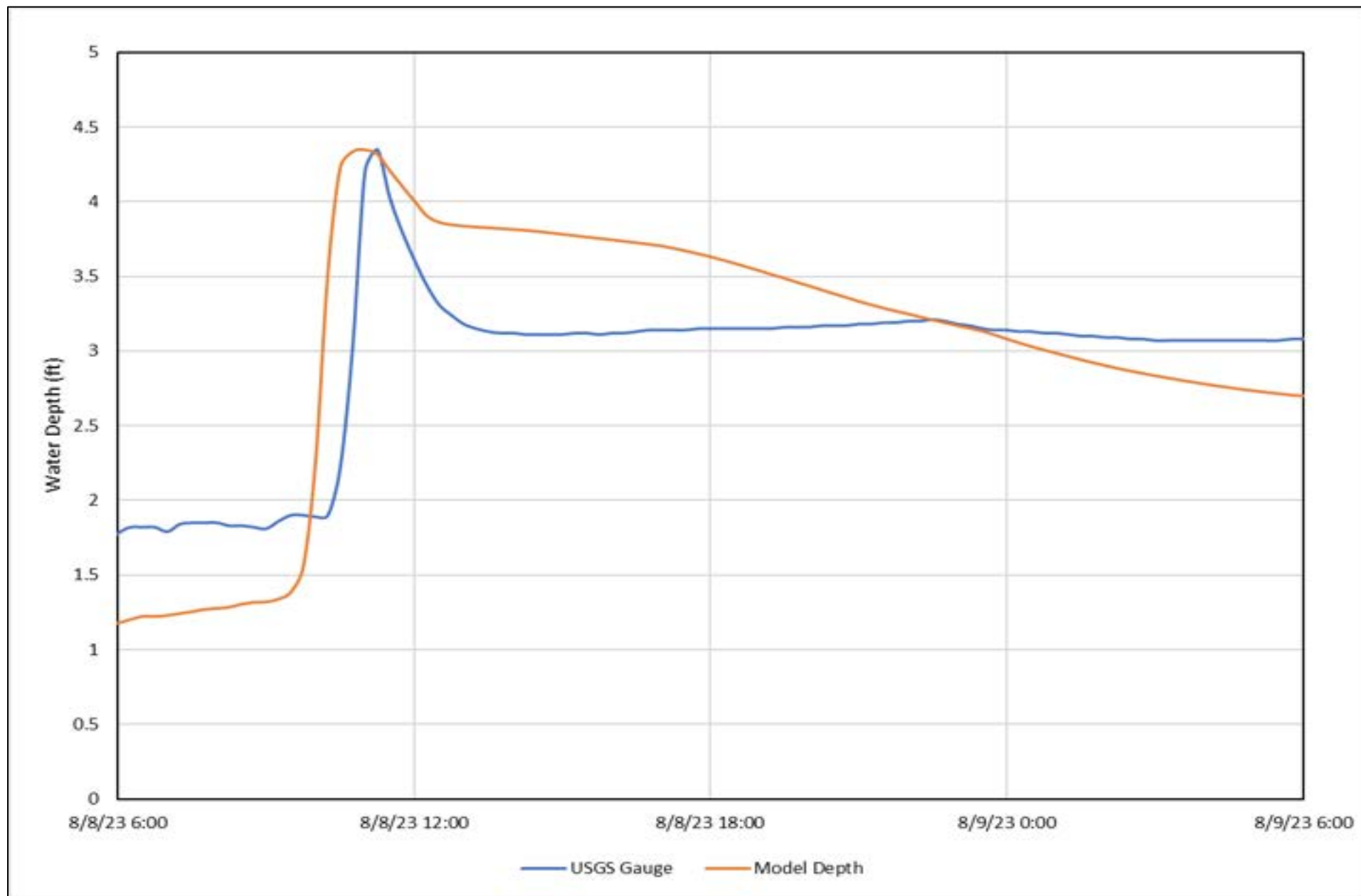


Figure 2. August 8th, 2023 Model to USGS Gauge Depth Comparison, Broadway



Figure 3. Existing Conditions Flood Extent Map – August 8th, 2023

Reference: Alewife Brook Hydraulic and Stream Improvement Study

The *Existing Conditions* model was used as a base for all potential improvement scenarios that require modeling. All scenarios were run for two design storms: 5-year 24-hour present and 25-year 24-hour present, including the *Existing Conditions* model. The 5-year and 25-year storms consist of 4-inches of rain with peak hourly intensity of 1.1-inches/hour and 6.2-inches of rain with peak hourly intensity of 1.6-inches/hour, respectively. In both design storms, the *Existing Conditions* shows flooding outside of Alewife Brook onto the Alewife Greenway Bike Path, by Lafayette Street and Sunnyside Avenue.

Figure 4 shows the *Existing Conditions* 5-year storm flood extent map with flooding locations outlined in red for reference. Additionally, the 5-yr storm event used in this evaluation is similar to the 2050 2-yr storm event being proposed in the CSO update Plan, currently under development by others, so these data may be applicable to planning for climate change. **Figure 5** shows the *Existing Conditions* hydraulic profile 5-year storm results from the Alewife Station Access Road River Crossing (left) to the Mystic River (right). The brown represents earth, and the blue represents the water. The bridges are labelled for context.

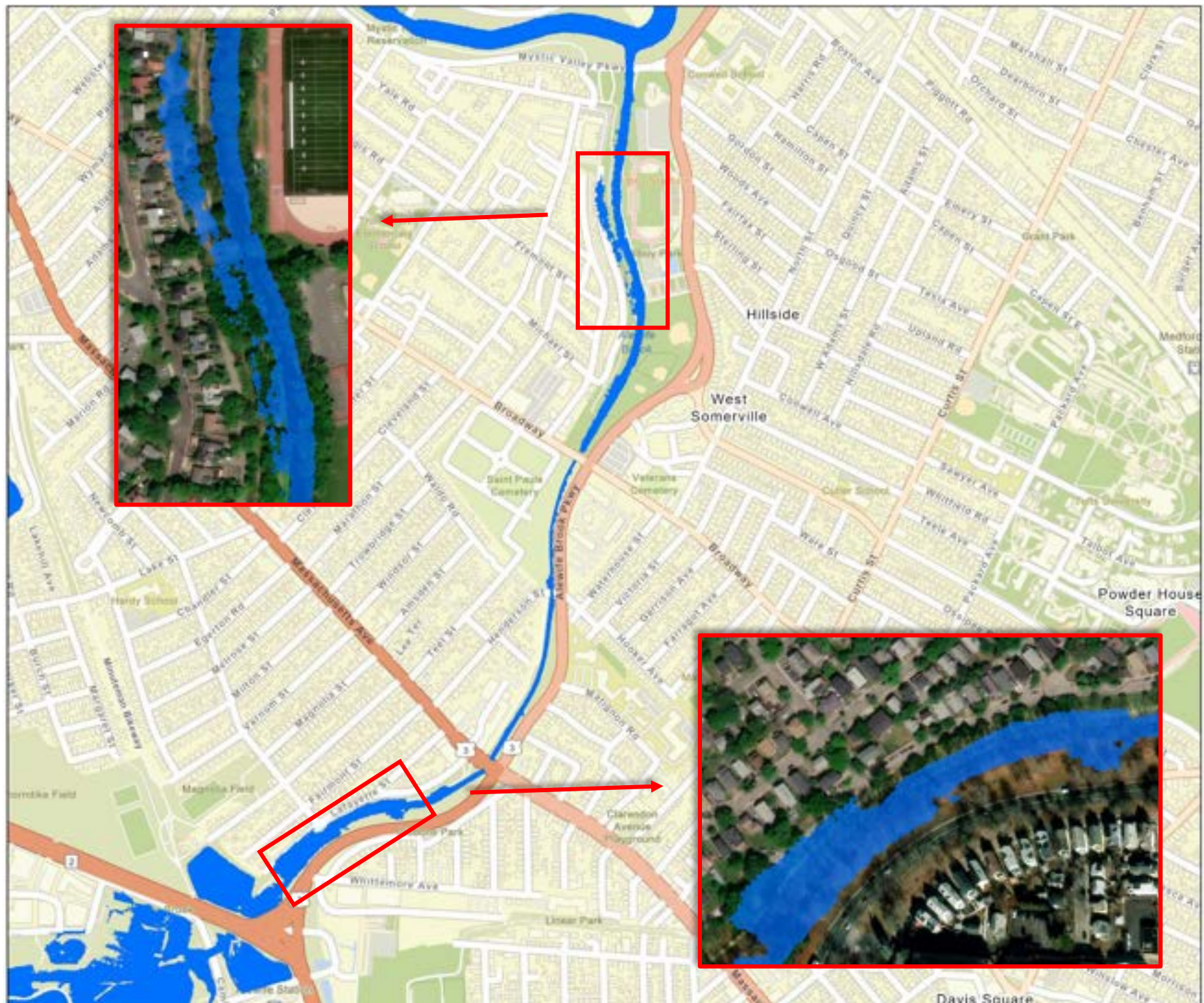


Figure 4. Existing Conditions Flood Extent Map – 5-Year 24-Hour Storm

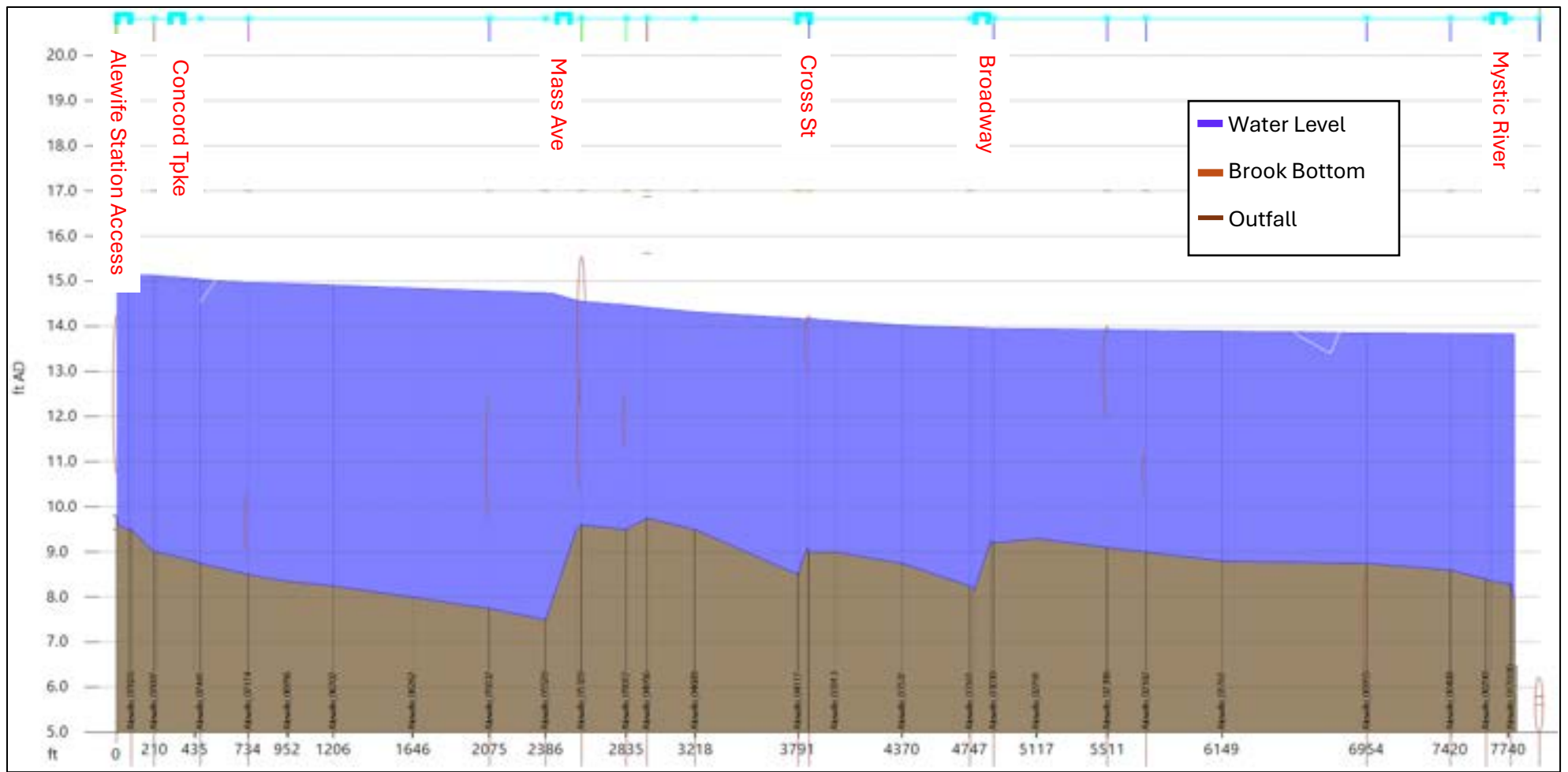


Figure 5. Existing Conditions Alewife Brook Hydraulic Profile – 5-Year 24-Hour Storm

Reference: Alewife Brook Hydraulic and Stream Improvement Study

4 Potential Improvement Projects – Conceptual

An overview of the conceptual approach, objectives, considerations, and net benefits of potential improvement projects are described in this section. While the primary goal is to protect infrastructure, many of these potential projects also seek to enhance ecological value of the resource. The four alternatives selected for this study collaboratively with the Client, include the following:

1. Channel Clean-Out: Dredging and/or Debris Removal
2. Riparian Wetland Creation and Enhancement
3. Crossing Structure Replacement (Alewife and/or Mystic River)
4. Draw-downs – Dam Controls

Alternative improvement projects 1, 3, and 4 were analyzed using the hydraulic model to evaluate how they may affect flood risk. A model was built for each project using the *Existing Conditions* model as a base. The 5-year and 25-year design storms were run for each scenario and results were compared to the *Existing Conditions* results to determine the projects' hydraulic benefit. Model results and maps showing flooding extents are provided in **Appendix C**. Proposed conditions are depicted in blue for each scenario overlaying the *Existing Conditions* flood extents in pink for both the 5-year and 25-year storms. Therefore, the visible pink area represents the improvement scenario flood extent reduction. **Appendix C** includes hydraulic profiles for both storms. Riparian Wetland Creation and Enhancement (Alternative 2) was not included in the hydraulic analysis, as more detailed study would be required to determine feasibility, specific locations and positioning, sizing, and wetland type selection before storage can be quantified and the influence on flooding can be evaluated. Note that all of the Greenway land is owned by the Department of Conservation and Recreation (DCR) with the exception of a small area near Magnolia owned by Arlington. As such, DCR is the responsible entity and Arlington has stormwater responsibility.

4.1 Alternative 1 - Channel Clean-Out

4.1.1 CONCEPTUAL APPROACH

Fine sediment and sand deposition is prevalent throughout Alewife Brook. The consistently low slope of the channel limits sediment transport and does not provide adequate stream power to effectively flush debris. This is exacerbated by the presence of woody material and trash that has formed partial channel restrictions intermittently throughout the study reach. As the debris catches sediment and the sediment, in turn, holds the debris in place, these debris jams tend to become embedded and grow over time, increasing restrictions to flow. Sediment accumulation in the bed effectively reduces channel capacity as it aggrades, which may affect flooding frequency and floodwater extents, especially during overbank flood flows near bankfull discharge (approximately 1-yr recurrence interval in urban environments). Segments of Alewife Brook with trapezoidal concrete linings appear to be undersized under existing conditions (See Dredging section below), and because they are constrained from natural geomorphic adjustment to accommodate

Reference: Alewife Brook Hydraulic and Stream Improvement Study

peak flows, bed aggradation has the greatest potential to reduce capacity and increase flooding in these areas.

The Channel Clean-out alternative involves two components: in-channel debris removal and dredging to increase channel capacity. As these initiatives require different levels of effort and cost, they will be discussed separately in the forthcoming sections; however, they are related and have been combined as a “Clean-Out Scenario” for modeling purposes (see **Section 4.1.2**).

Debris Removal

As discussed, debris accumulation has the potential to increase sediment deposition within the channel and tends to worsen constrictions over time, once established. Debris blockages at stream crossing inlets can also become impediments to flow, causing backwater effects and further deposition upstream. To avoid this, debris jams generally may be removed by hand with minimal equipment and manpower. Permitting would likely not be required to perform this initiative. Additionally, mobilization of a work force could be done rapidly with a relatively low level of planning effort and for a relatively nominal cost.

During site reconnaissance, Stantec identified 11 locations of debris jams within the channel and partial blockages of two stream crossings (see **Table 3** and **Appendix A**). The box culvert inlet at Concord turnpike and the arch bridge at Massachusetts Avenue are both partially obstructed by woody debris and trash. There are bricks, quarry stone, and concrete slab building materials below the outlet of the Massachusetts Avenue stream crossing. Under this Alternative 1 project, hand removal of debris is likely feasible; however, a chainsaw may be necessary to remove larger wood, and hoists, winches, or other lifting equipment may be required for removal of the stone and concrete, especially if embedded. While the existing debris jams do not currently appear to be significant obstructions to flow, maintenance removal is recommended as needed. Addressing in-channel debris early will make removal much easier, and regular clearing is important, as natural stream flow is not able to effectively flush the channel.

Debris removal has the lowest cost among the alternatives and can be implemented at many different levels, including utilizing team members from the MyRWA and StAB to provide labor; however, DCR would likely be responsible as the landowner. If DCR were to hire a contractor to perform removal of the 11 observed debris jams and two blockages at road crossings, this would require approximately 160 person hours, including mobilization and offsite disposal. It is assumed that a 4-person team could perform the work within one week as a conservative estimate. This could vary substantially depending on the selected contractor, however. Municipal assistance may be an option as part of stormwater maintenance, and coordination with Arlington, Cambridge, and Somerville is recommended if this alternative is pursued.

Dredging (with removal of channel lining)

As discussed, sediment deposition within Alewife Brook is widespread and has reduced channel capacity from bed aggradation. This is particularly relevant in Segments 2 and 3, where the trapezoidal concrete lining has confined the channel and does not allow it to adjust through geomorphic processes. Segment 1 (upstream) and Segment 5 (downstream) both have natural bed and bank conditions and they remain generally stable, indicating that their cross sectional areas are not undersized, and their geometry is appropriate to accommodate peak flows. Segment 4, a rectangular channel confined by high, vertical retaining walls, may be feasible to dredge; however, it maintains a larger capacity within the constraints of the channel compared to the trapezoidal channel segments upstream. This was by design, as discharge

Reference: Alewife Brook Hydraulic and Stream Improvement Study

onto the floodplain would inundate the St. Paul's Cemetery abutting the left bank. The right bank retaining wall is positioned at a higher elevation, directly below the raised Alewife Greenway Bike Path with Alewife Brook Parkway immediately beyond it. As such, modification of the channel geometry by grading is not feasible throughout this segment. Access for dredging the channel bed in Segment 4 may also be challenging with the proximity of these features.

For these reasons, channel dredging and removal of the concrete lining is recommended in Segments 2 and 3 only, between Concord Turnpike and Henderson Bridge. As shown in the comparative cross sections provided in **Appendix B**, the confined channel in these segments is undersized to convey the 1-year storm event, roughly equivalent to the bankfull discharge in an urban setting. Bankfull discharge is the "channel forming flow" that drives channel evolution through erosion, aggradation, and re-stabilization to resize unconfined channels naturally. As such, removal of the concrete lining would likely destabilize the channel unless grading was performed to achieve adequate capacity and stable geometry. Note that dredging and/or re-grading will effectively remove all existing debris without separate effort, with the exception of maintenance clearing which should be performed under all levels of implementation.

Stantec has developed preliminary typical cross sections to illustrate the grading concept upon removal of the concrete lining (**Appendix B**). Based on the nearly flat slope of the channel, less than 0.03%, we recommend implementing a low bankfull width/mean depth ratio (W/D) C-type geometry. According to the Rosgen Stream Classification System, a C-type channel is characterized by a W/D greater than 12 with access to a broader floodplain (entrenchment ratio greater than 2.2) and with a slope less than 2%. To promote bank stability, no steeper than 3:1 side slopes are recommended, as shown in the section views. **Table 4** compares the existing, target, and preliminary proposed channel dimensions.

Table 4. Channel Characteristics Summary

Parameter	Stream Segment 2 (XS1)			Stream Segment 3 (XS2)		
	Existing	Proposed	Target (1-year RI)	Existing	Proposed	Target (1-year RI)
Discharge (cfs)			116			149
Bankfull Area (sf)	79	124	118	99	144	142
Bankfull Width (ft)	33.9	39.0		27.3	42.0	
Max Depth (ft)	3.9	5.5		4.8	6.0	
Mean Depth (ft)	2.3	3.2		3.6	3.4	
W/D	14.6	12.3		7.5	12.4	
Stream Type (Rosgen)	C	C		E	C	

As summarized above, the existing bankfull cross sectional area is undersized for both Stream Segments 2 and 3, due to the constraints of the channel lining. Based on area calculations from the 2D model, the proposed typical sections (**Appendix B**) are sized to convey the 1-year discharge. A low W/D for target C-type morphology (near 12) was selected to minimize channel widening and to avoid extensive grading into adjacent areas.

Reference: Alewife Brook Hydraulic and Stream Improvement Study

Figures 6 and 7 are output from the ICM 2D model, demonstrating that the elevation of the 1-year discharge is at or near top of bank, confirming that the 1-year recurrence interval approximates bankfull discharge.

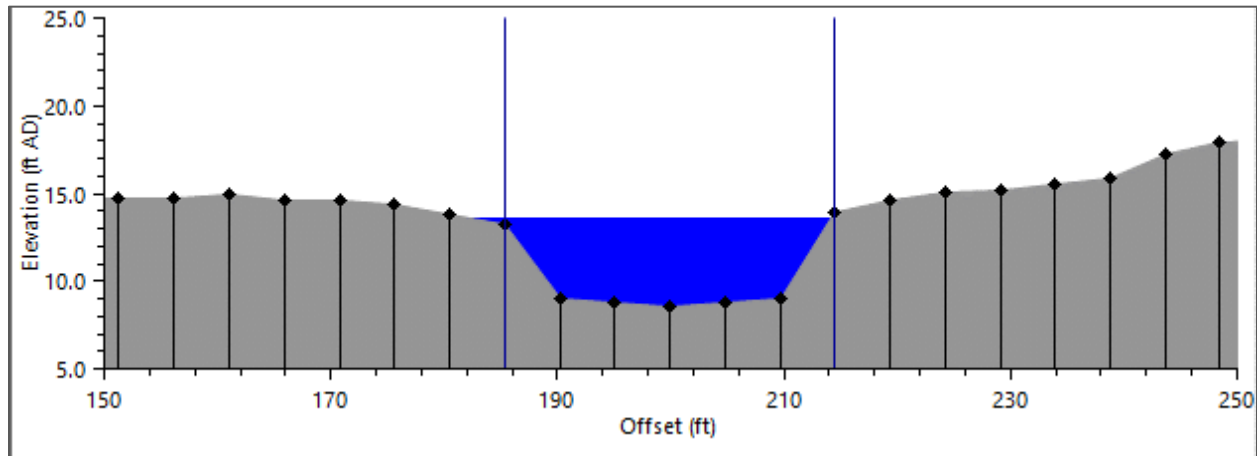


Figure 6. 1-yr Discharge to Channel Downstream of Concord Turnpike – Stream Segment 2

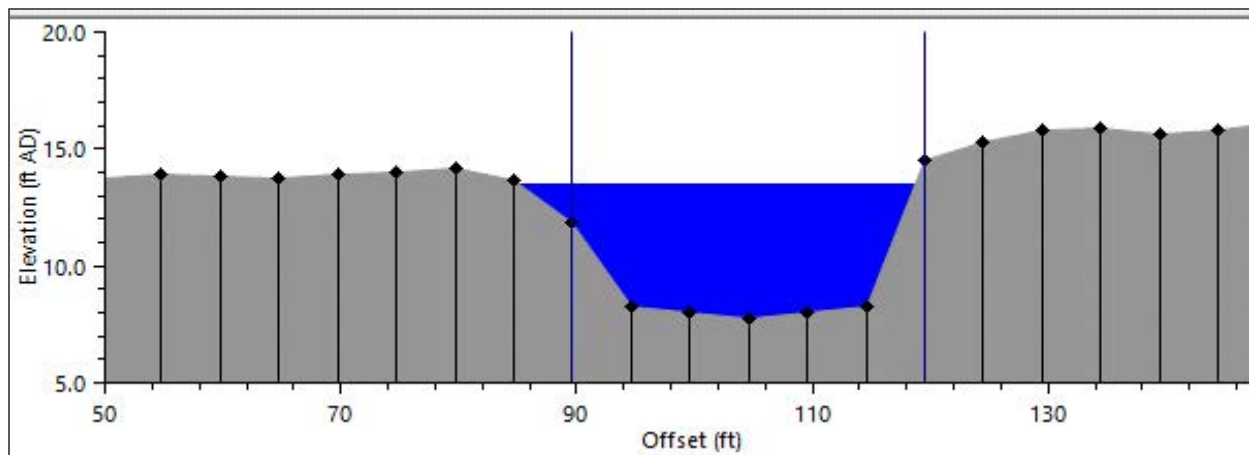


Figure 7. 1-yr Discharge to Channel Downstream of Massachusetts Avenue – Stream Segment 3

Permitting, schedule, and cost for a dredge project as described in this section may depend greatly on the level of implementation. If channel lining removal is desired, the necessary channel grading would require detailed modeling, development of engineering construction plans, and substantially higher construction cost compared to sediment removal with the lining in place. Construction would also require extensive clearing with buffer reestablishment, and a large scale invasive species removal effort would be important to facilitate establishment of native plantings. Given the setting, permitting may be challenging, particularly as a result of the necessary tree clearing. Additionally, flow diversion would be required for construction to take place “in the dry” and may be challenging given the tight stream corridor and adjacent development. The location and length of the channel lining (approximately 3,500 LF) also make this project relatively expensive to construct, likely costing between \$3.5M and \$5M. The cost of sediment and concrete disposal

Reference: Alewife Brook Hydraulic and Stream Improvement Study

would be significant, and due to the substrate composition primarily of sand and fine particles, import of reinforced bed material would likely be necessary along the entire length of the project.

A major consideration for pursuing dredging under this alternative is related to long term value. Due to the very low slope throughout the study area, the amount of sediment contributed by closed stormwater systems, and the tendency to form debris obstructions, deposition is likely to continue after clean-out and the dredged/graded channel may again aggrade. Maintenance dredging may be required, as the relative elevation of the Mystic River downstream does not allow increases in longitudinal profile slope of the channel that would increase transport and flushing. A narrow bottom width may help with this to some extent if the channel geometry can be adjusted through bank grading, as described above. Given the cost and level of effort associated with this alternative, the risk of channel re-filling should be carefully considered.

If the lining is allowed to remain, it may be possible to partner with Arlington, Cambridge, and Somerville to perform the work under their municipal stormwater maintenance permits. This version of the alternative would be substantially less costly, the timeline could be condensed, and design and planning would be far less involved. To determine feasibility, further municipal coordination would be necessary.

4.1.2 MODEL EVALUATION FOR CLEAN-OUT SCENARIO

The *Clean Out* scenario consists of the *Existing Conditions* model with the sediment and debris removed from Alewife Brook. Hypothetically, clearing the brook of sediment and debris blockages would increase capacity through the channel and culverts under roadway crossings. However, model results show no reduction in maximum flood water depth or flood extent in the 5-year or 25-year recurrence intervals. This suggests Alewife Brook flooding is not significantly due to a hydraulic restriction within the channel caused by sediment and debris build up. Instead, the water level is driven by the Mystic River water level downstream. This is apparent when observing the flat hydraulic grade line (HGL) through the downstream half of the Alewife Brook in the hydraulic profiles in **Appendix C**. The Mystic River level prevents the Alewife from freely discharging flow, forcing the Alewife to act as storage for stormwater until the Mystic River level recedes.

Alewife Brook is nearly flat with a reach-wide average slope of approximately 0.03%. The slope is not consistent throughout the reach, however. Instead, there are several locations with negative slope, the majority of which are under river crossings. Negative slopes will result in sediment build up in deeper portions of the channel. For example, in **Figure 5**, just upstream of the Massachusetts Avenue stream crossing, sediment builds up in the deepest portion of the channel. Although clearing sediment from here may increase capacity of the short length of channel upstream of the bridge, the negative slope under the bridge results in an increase in channel bottom level of 2-feet. Even if the sediment and debris were cleared out upstream of the bridge, the channel bottom under the bridge would continue to restrict flow and cause ponding in the upstream section of Alewife Brook where the sediment was cleared. Hydraulic profiles are shown in **Appendix C** that illustrate the negative slope at the Massachusetts Avenue bridge.

The hydraulic profiles show an increased HGL slope through the Massachusetts Avenue stream crossing, which means the crossing currently restricts flow due to the negative slope under the bridge. Clearing the crossing's blockage slightly increases the capacity through the crossing, which does reduce the HGL upstream, but by less than 0.1-feet during the 5-year storm and even less during the 25-year storm.

Reference: Alewife Brook Hydraulic and Stream Improvement Study

Although this is negligible, it does illustrate the flow restriction at Massachusetts Avenue. It also suggests that if debris is not cleared and builds up over time, the flow capacity reduction could cause increased flooding upstream of Massachusetts Ave. Although debris removal will not impact flooding, removal would reduce risk of increasing flooding in the future.

4.2 Alternative 2 – Riparian Wetland Creation and Enhancement

4.2.1 CONCEPTUAL APPROACH

Based on field reconnaissance, several areas were identified for potential wetland creation within the Alewife Brook riparian corridor. Creating depressional areas in the floodplain provides additional flood storage when the river reaches overbank stage during higher discharge events.

As previously noted, Alternative 2 could not be modeled at this conceptual stage of design; however, the additional floodplain storage may be effective in reducing the extents of flooding in key locations where flood waters are most likely to encroach on residential and commercial properties as well as trail limits. In addition to capturing flood flows from the river, constructed depressions can slow the rate at which overland flows re-enter the stream channel, increasing infiltration and improving groundwater recharge. Implementation can take various forms that range from BMP-like emergent wetland basins to more natural forested wetland complexes with diverse vegetative communities; however, the density and extent of invasive species in the stream corridor may be limiting to successful establishment of native species and species richness. Creation of new wetland areas and/or the expansion of existing wetland features also offers increased functions and values, such as sediment capture and reduction from entering Alewife Brook, toxicant and nutrient removal/uptake, groundwater recharge, and ecological habitat enhancement for aquatic and riparian organisms. There is also opportunity for public engagement and education provided by wetland creation projects, as schools and organizations may find interest in the natural communities and biodiversity supported by this initiative. Such engagement may help to foster support for the project.

Four (4) potential wetland creation and enhancement areas are depicted on the Detailed Site Map in **Appendix A**. Photographs of existing conditions in these areas are provided in **Appendix E** (Photos 43-52).

WL-1 is located within flat upland areas of between Alewife Brook and the existing dirt bike path along its left bank. Similar conditions on the opposite side of the foot path may also provide a suitable location for wetland creation and may be implemented with a hydraulic connection under the dirt path to increase flood storage and treatment functions. This stream segment (Concord Turnpike to Massachusetts Avenue) was noted as an area of particular concern by the client, as the bike path is positioned completely within the river's floodplain and is subject to frequent flooding. Due to its position roughly at bankfull elevation and depressed below it along some of its length, flooding is likely to continue during the 1-yr discharge and larger storm events. However, creation of wetland flood storage may help to reduce the duration and/or frequency of flooding on the path, by allowing positive drainage into the wetland cells as in-channel flows recede. Further study would be required to determine the feasibility of extending the proposed wetlands farther along Stream Segment 2, approaching Massachusetts Avenue. An existing gas pipeline running parallel to Alewife Brook complicates site layout and may preclude excavation. Should this alternative be pursued, precise mapping of the pipeline will be necessary.

Reference: Alewife Brook Hydraulic and Stream Improvement Study

WL-2, WL-3 and WL-4 are located downstream of the Broadway stream crossing, on the opposite stream bank from the Dilboy ball fields, extending to Dilboy Stadium. Throughout the length of this area, the Alewife Greenway Bike Path parallels Alewife Brook, close to the left bank. Its position at the front of the floodplain makes it susceptible to frequent inundation during storm events above bankfull discharge. The bike path near WL-2 is sand and gravel, and it has formed depressions along its length that hold water after flooding recedes. The bike path near WL-3 and WL-4 has been raised on a wooden boardwalk, presumably as a result of frequent flood flows accessing lower areas of the floodplain. See 'Additional Considerations' section below for further discussion regarding potential bike path improvements.

A row of residential structures line the outer limits of the floodplain at a marginally higher elevation for the entire length of the area containing WL-2, WL-3, and WL-4. As such, these homes are also at risk of flooding, and the ICM model shows that flood flows will likely reach them at the 25-year recurrence interval (**Figure 4**). Existing wetland depressions were observed intermittently between the bike path and the residences in this vicinity. They are generally heavily vegetated with *Phragmites* sp. and other invasive species, and the shallowness of the depressions does not provide much additional flood storage. The boundaries of WL-2, WL-3, and WL-4, shown in **Appendix A**, are approximate and have been mapped where space and site conditions appear to be most suitable for excavation to create new wetland cells and/or expand existing depressions to create greater storage capacity. With more detailed study, it may be possible to create hydraulic connections to link these areas or to expand them further. As observed upstream, the gas pipeline continues through the floodplain, which may present a challenge to design and implementation, should this alternative be pursued. It is important to note that the left bank floodplain is owned and managed by DCR, up to the residential drive in front of the homes. Coordination or partnership with the municipality will be necessary to pursue this initiative; however, ownership by DCR simplifies the permitting process by avoiding easement acquisition.

Conceptual details are provided in **Appendix B** as an example of wetland creation implementation. Note that wetland design will need to be tailored to the existing site conditions, will require detailed hydrologic and hydraulic modeling of existing and proposed conditions, and must be adjusted to existing constraints, such as property limits, utilities, and infrastructure. Detailed wetland delineation will be required to reduce impacts to existing wetland features. Additionally, it is important to note that construction of new wetland features will require clearing of existing mature vegetation to facilitate grading. Given the urban setting, tree clearing will likely meet opposition at the municipal and state levels, and it will be critical to minimize to the greatest extent practicable. The locations selected by Stantec generally correspond with low shrub areas and existing depressions, as well as the margins of other existing wetlands; however, some tree clearing will be unavoidable.

The cost of wetland creation in the urban environment is expected to be higher than average due to site constraints, permitting challenges, access, logistics, and labor rates; however, the specific type of implementation will vary dramatically both construction and design costs. In 2012, the Alewife Reservation Constructed Wetland project was implemented in Cambridge on Massachusetts Department of Conservation and Recreation (DCR) lands. The total construction cost of the project was approximately \$12M for a total of approximately 3.2 AC of wetland creation. This equates to approximately \$3.5M per acre, not including design fees or permitting costs. Given the current economic environment, it may be expected that a similar project in 2024 would cost roughly twice as much as it would in 2012. With this considered, simpler, smaller constructed wetland projects, extended detention ponds, or other stormwater basins, would be less expensive and would still provide flood storage and other functions and values to benefit Alewife Brook. Construction of simple bioretention basins may be expected to cost roughly \$20-30 per square foot, or about \$1M/acre of development. Based on similar work Stantec has performed in the

Reference: Alewife Brook Hydraulic and Stream Improvement Study

urbanized Capital Region (Fairfax, VA), construction cost was estimated on volume of storage. Constructed wetlands averaged approximately \$2,500/cubic yard, extended detention ponds averaged \$60/cubic yard, and manufactured BMP systems (hydrodynamics) averaged approximately \$100/cubic yard. There are many more specific options for implementation of this alternative, but smaller, simpler projects may be more feasible for cost and space constraints.

Additional Considerations – Alewife Brook Greenway Bike Path

In conjunction with the Wetland Creation and Enhancement Alternative or as a stand-alone project, reducing flooding on the Alewife Brook Greenway Bike Path may be worth pursuing.

As the constrained channel in Stream Segments 2 and 3 accesses the floodplain below the 1-year recurrence interval, the Mystic River Greenway Bike Path is prone to flooding under existing conditions. Even with the potential project alternatives implemented, its position at the front edge of the floodplain puts lower portions of the path at risk during any overbank flows. Inundation of the bike path with urban stormwater and potentially CSO may be a risk to public health for pedestrian and bike traffic. To address this, Stantec recommends raising the elevation of the Mystic River Greenway Bike Path in the most susceptible areas, although flooding would not be reduced as a result. **Figure 8** illustrates where the path would need to be raised to maintain passage up to the 5-year storm. The raised path would require an elevation of approximately 1560-feet. Without modification to the existing channel, 5-year discharge results in a maximum depth of 1.8 feet of water on the floodplain. Accordingly, where shown directly across from Whittemore Ave, the path should be raised two feet above its current elevation to span these flood flows. This concept provides a feasible way to protect public health and maintain passage during more frequent storm events. If this project is pursued, coordination with DCR would likely be required, and there is potential for wetland impacts associated with installation of footers for the structure. A wetland delineation would be necessary to evaluate potential impacts and to determine permitting requirements. Due to the relatively low construction cost and the benefit to the community, the raised bike path would likely be worth evaluating further.

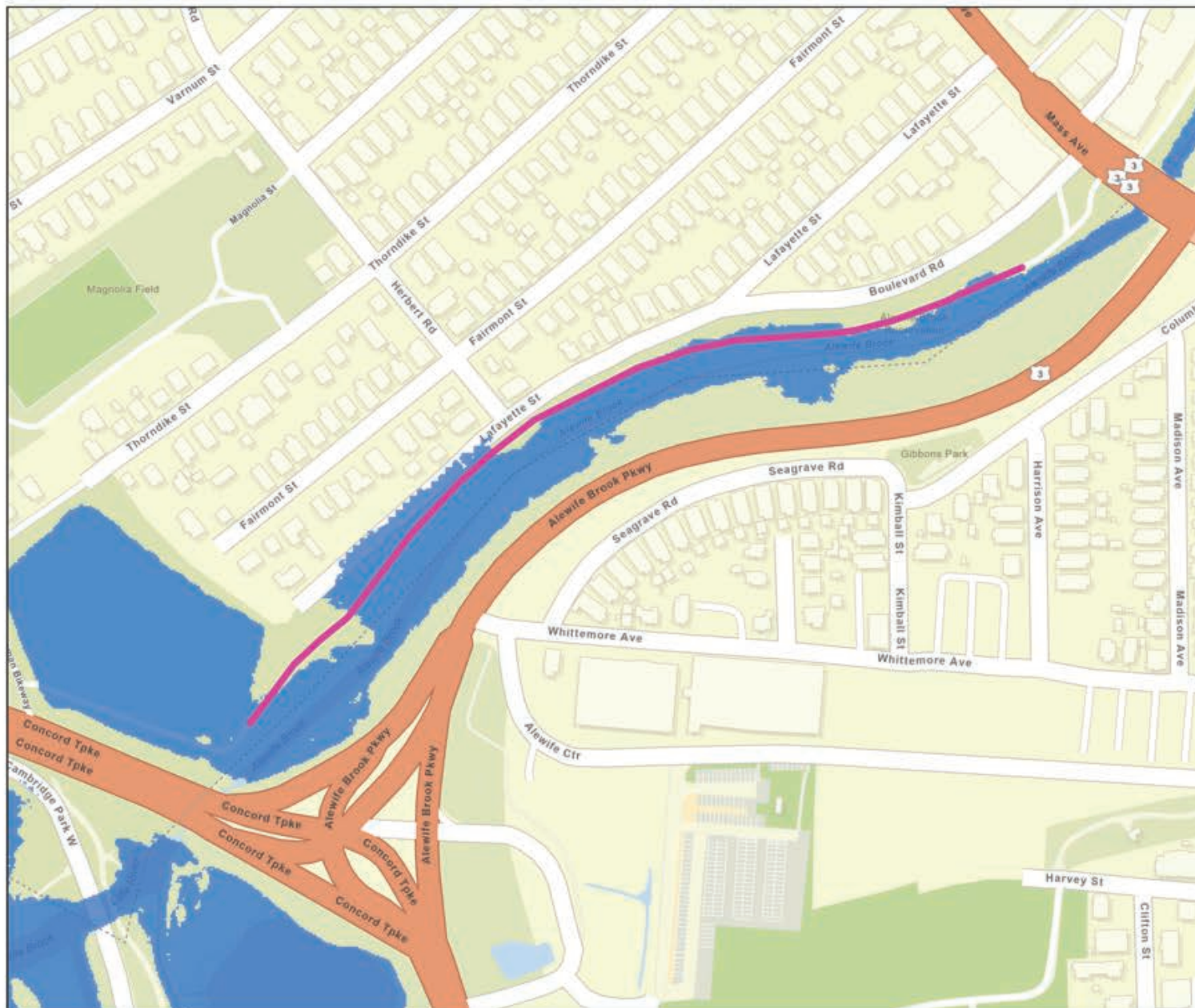


Figure 8. Segment of Alewife Brook Greenway Bike Path to be Raised

Title

Alewife Brook Project Area

**Proposed Raised Alewife Greenway Bike Path
Existing Conditions, 5-Year 24-Hour Storm**

Client/Project

Mystic River Watershed Association

Map Revised: June 2024

Project Location

Alewife Brook, MA

Legend

- Proposed Raise Bike Path
- Existing Conditions Flood Extent, 5-Year Storm

Reference: Alewife Brook Hydraulic and Stream Improvement Study

4.3 Alternative 3 - Crossing Structure Replacement

4.3.1 ALEWIFE BROOK MODEL EVALUATION

Using the ICM 2D model, Stantec evaluated each of the stream crossing structures over Alewife Brook to determine whether they are causing obstruction to flow and backwater effects that lead to flood risk. The *Existing Conditions* hydraulic profile shows a hydraulic restriction at Massachusetts Avenue. None of the other Alewife Brook crossings reflect restrictions. The Massachusetts Avenue crossing is listed as a preserved historical resource, and therefore cannot be removed or reconstructed. Stantec modeled the system with all crossings removed. This scenario representing the channel with no crossing restrictions cumulatively had very little effect on water level or flooding compared to existing conditions with Mass Ave (and other crossings) in place. Therefore, addressing the restriction at Massachusetts Avenue would have negligible effects on upstream water levels and, by extension, flooding. Replacement of this crossing structure was not conceptualized for improvements due to its infeasibility and lack of influence on upstream flood elevations.

4.3.2 MYSTIC RIVER MODEL EVALUATION

The water depth in Alewife Brook is driven by the Mystic River water level. The Mystic River *Existing Conditions* results were examined to determine if any Mystic River crossing structure restricts flow, causing the water level to rise at the Alewife discharge point. **Figure 9** shows a hydraulic profile of the Mystic River from the Alewife Brook (left) to the Amelia Earhart Dam (right) for the 5-year storm. The river crossing structure at Mystic Valley Parkway is shown to restrict flow, resulting in a water level increase of 1.0-feet across the crossing structure.

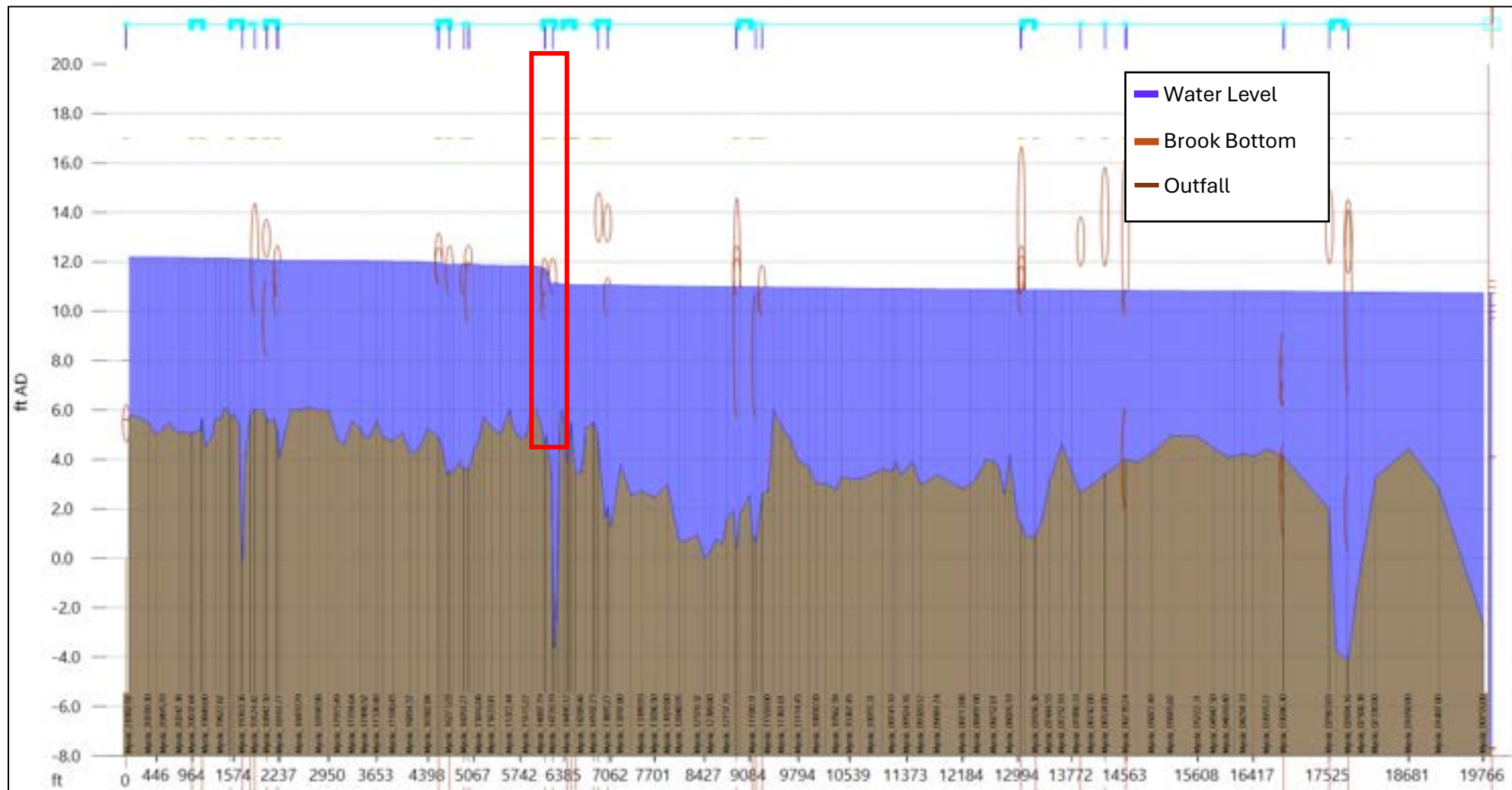


Figure 9. Existing Conditions Mystic River Hydraulic Profile – 5-Year 24-Hour Storm

Reference: Alewife Brook Hydraulic and Stream Improvement Study

For the *Crossing Structure Replacement* scenario, the Mystic Valley Parkway crossing was removed from the model to represent an alternative crossing structure with adequate capacity that would not limit flow. As shown in **Figure 10**, the existing crossing is outlined in black and has varying width from 75-feet to 60-feet. If the opening was widened to approximately 93-feet with an opening height of at least 9-feet, the opening would not restrict flow (see also **Appendix B concept exhibit**). The widened opening is shown in red below. The blue lines represent existing channel limits, and the red box illustrates the approximate sizing of a replacement structure at Mystic Valley Parkway. This red box also corresponds to the location shown in red in **Figure 9** above. Under this scenario, the river bottom would not require dredging and the height of the opening would not need to be increased.

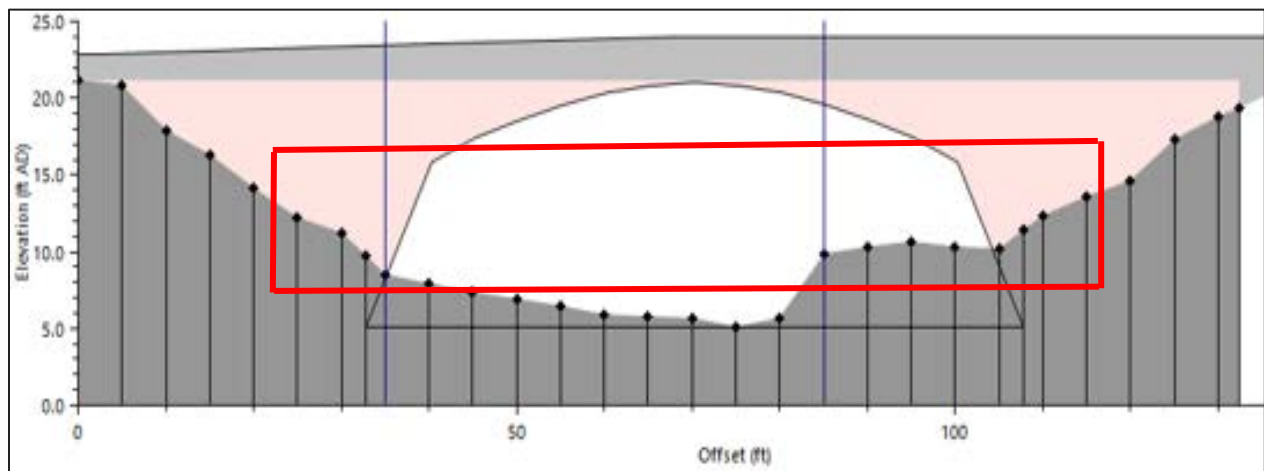


Figure 10. Mystic Valley Parkway Crossing Structure Opening and Expansion

Using this condition would test for a resulting reduction in HGL in Alewife Brook to determine its ability to reduce flooding. Based on the ICM 2D results for the 5-year storm event, removing the Mystic Valley Parkway crossing would reduce the HGL approximately 0.5-feet at the downstream end of Alewife Brook and approximately 0.3-feet at Broadway. For the 25-year storm event, the HGL is reduced by approximately 0.7-feet at the downstream end of Alewife Brook and approximately 0.3-feet at Broadway. Upstream of Massachusetts Avenue, there is no HGL reduction for either storm event. Although this improvement project does not result in flood extent reduction upstream of Massachusetts Avenue, affecting Lafayette Street, it would reduce flooding on Sunnyside Avenue. To compare flood extent, **Figure 11** shows the *Existing Conditions* (pink) and *Crossing Structure Replacement* flooding extents (blue) for the 5-year recurrence interval. A map for this condition and for the 25-year storm are also provided in **Appendix. C**. The flood extent comparison shows almost total elimination of flooding outside of the channel downstream of Broadway; however, there is no flood reduction in the channel upstream of Massachusetts Avenue.

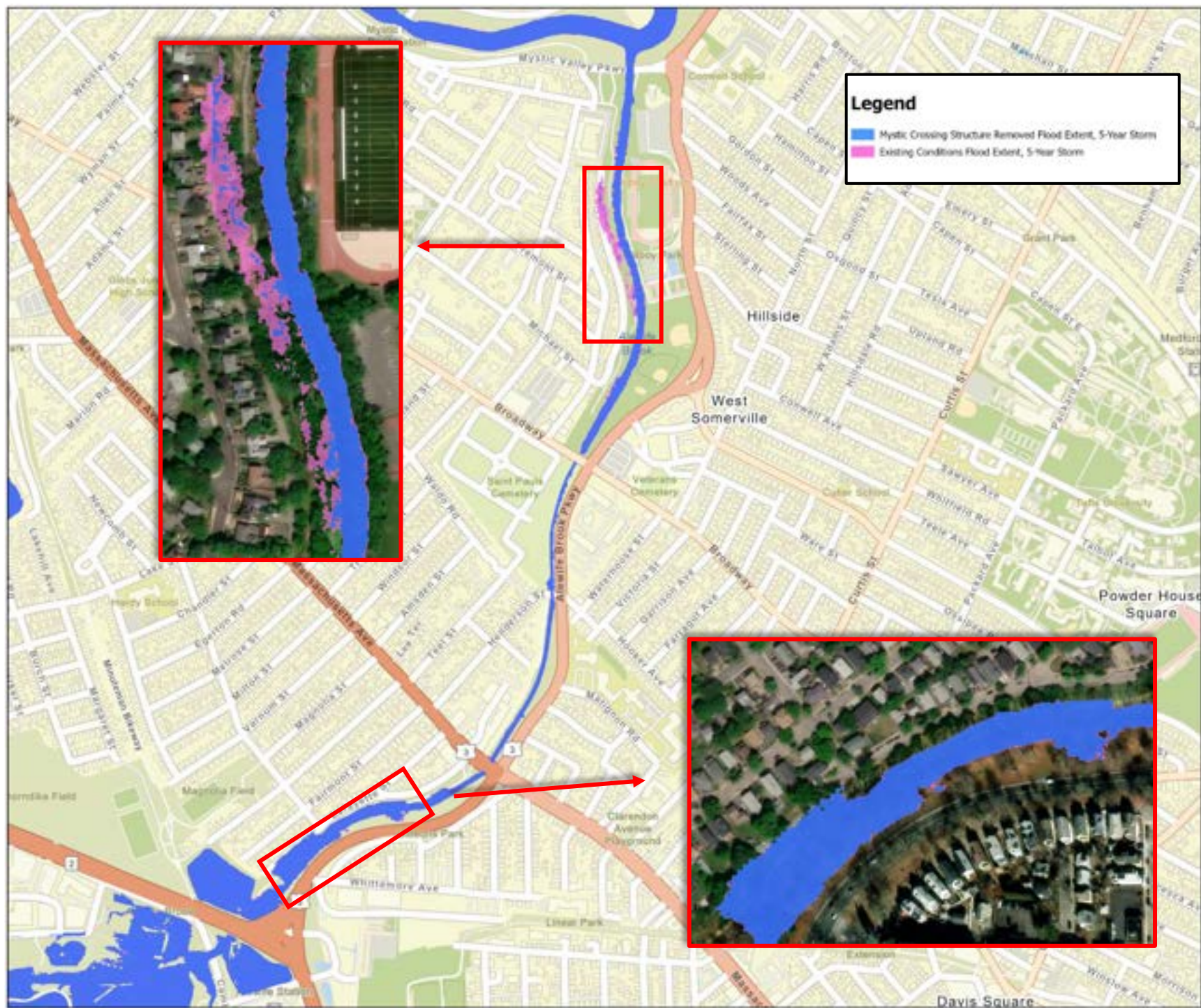


Figure 11. Crossing Structure Replacement Flood Extent Map – 5-Year 24-Hour Storm

Reference: Alewife Brook Hydraulic and Stream Improvement Study

This concept reduces flooding in the Alewife Brook downstream of Broadway by lowering the water surface elevation in the Mystic River at the Alewife Brook discharge point. However, the water surface elevation reduction does not propagate to upstream of Massachusetts Avenue, a location where Alewife Brook flooding has been observed. Still if the Mystic Valley Parkway stream crossing structure required rehabilitation in the future, this concept could be considered. A replacement of an existing crossing structure of this scale would be very expensive, relatively complex to design and implement, and may encounter permitting and buy-in challenges. Coordination would be required with both Somerville and Medford to obtain necessary permits which would be a lengthy process. The project would most likely cost at least \$50 million. It could be done if significant benefit to water level upstream was observed; however, the observed benefit most likely does not outweigh the cost and project complexity.

4.4 Alternative 4 - Draw Down via Dam Control

4.4.1 CONCEPTUAL APPROACH AND MODEL EVALUATION

Stantec evaluated the feasibility of downstream dam controls to effectively draw down water levels during flood flows in Alewife Brook. As previously described, the Mystic River water level is the Alewife Brook downstream boundary condition. The Mystic River downstream boundary condition is the Amelia Earhart Dam operating level and the harbor level. **Figure 12** shows the Alewife Brook, Mystic River, and Amelia Earhart Dam to show their relative locations. Dam operations maintain a water level of 10-feet upstream of the dam. Operating the dam to maintain a lower level may reduce the HGL from the dam upstream to the Alewife Brook, which could propagate upstream to the Alewife Brook. The *Draw Down – Dam Control* model consists of the *Existing Conditions* with the dam operating to maintain an 8-foot water level, 2-feet lower than existing operations. The harbor level is based on tides and cannot be changed; therefore, the dam downstream condition must remain the same.

Reference: Alewife Brook Hydraulic and Stream Improvement Study

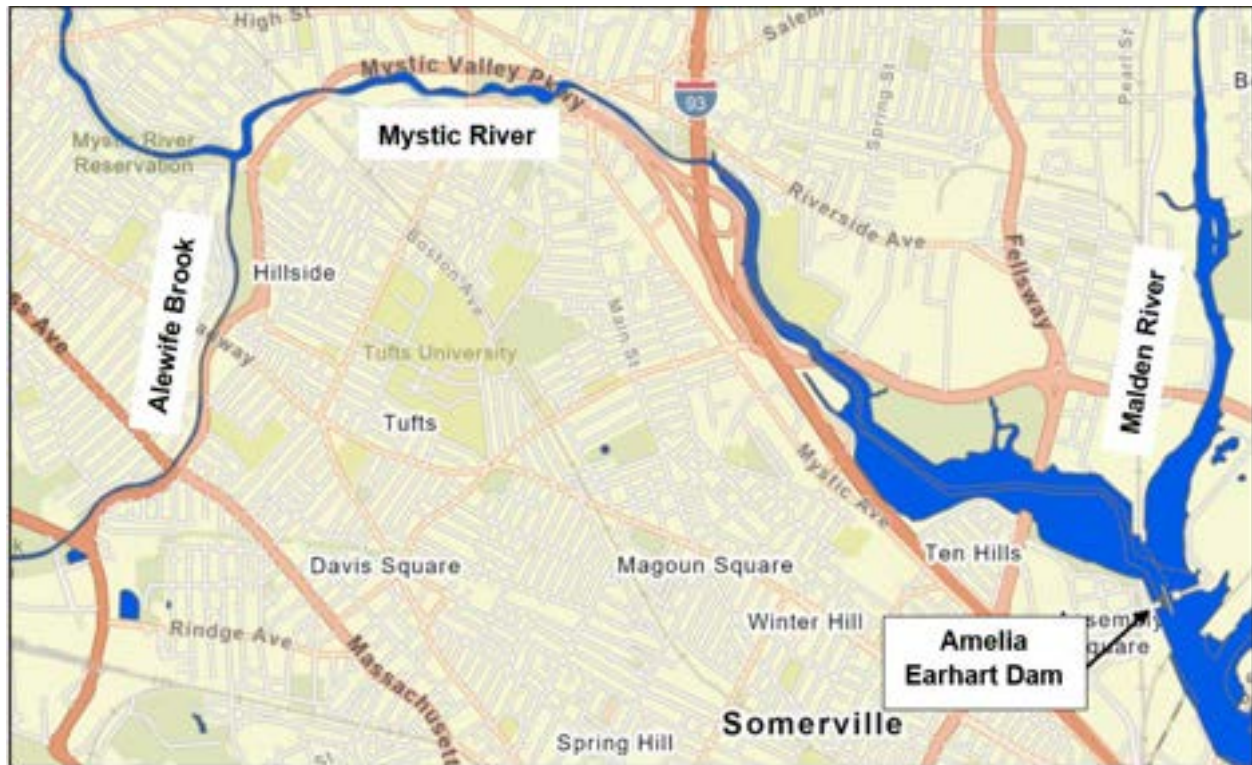


Figure 12. Draw Down – Dam Control Concept Area

The *Draw Down – Dam Control* model results show almost no reduction in HGL in the Alewife Brook. During wet weather, Mystic River water level is not reduced by the altered dam operation due to the consistent downstream condition and the way in which the dam operates. The dam operation includes pumping flow from the river to the harbor when the harbor level is higher than the river level. When the harbor level is lower than the river level and the river level reaches a certain elevation, sluice gates open to allow flow to freely discharge to the harbor. The rate at which flow can discharge through the gates far exceeds the pump flow rates, lowering the Mystic River level quickly. At the start of the storm, the *Draw Down – Dam Control* river level is lower than the *Existing Conditions* but once the river reaches its maximum level, in both conditions, the sluice gate is open and the water levels are the same due to the unchanged harbor downstream condition.

Regardless of water level reduction, altering the Amelia Earhart Dam operation is not feasible. This scenario was reviewed to gain an understanding of the dam operation's impact on the Alewife Brook water level. Changing the dam operation does not have the desired effect on the Mystic River level.

Reference: Alewife Brook Hydraulic and Stream Improvement Study

5 Prioritization and Summary of Recommendations

The potential project alternatives described in this memorandum are prioritized below with consideration for effect on flooding, feasibility, practicality, and cost. For the purpose of the following recommendations, the Channel Clean-Out scenario (Alternative 1) has been separated into two parts: debris removal only and full-clean-out with dredging and lining removal. While both are feasible, they require dramatically different levels of effort and may be implemented together or individually, depending on Client goals, objectives, and resources. Four of the five listed prioritization alternatives are feasible but have significantly different costs and potential challenges that may affect whether they are pursued by the Client.

Prioritization

1. Debris Removal Only
 2. Wetland Creation and Enhancement
 3. Full Clean-Out Scenario (Dredging, Lining Removal, Grading)
 4. Structure Replacement
 5. Draw-Down via Dam Control (Not feasible)
-
1. Under existing/current conditions, debris removal alone may have minimal effects on flood elevation; however, if debris is left in place, progressive development of channel blockages, especially at road crossings, could result in substantial backwater effects and ultimately more severe flooding. For this reason, it is recommended to address woody debris and trash accumulations in the channel as early as possible. Likewise, debris removal will reduce the tendency to hold onto sediment that will further aggrade in the streambed and will further decrease channel capacity. As the nearly flat channel slope does not provide the stream power to effectively transport and flush, progressive shrinking of the channel would lead to greater frequency and magnitude of flooding over time.

Removing debris in the early stages of accumulation would also avoid the chance for it to be carried downstream during higher discharge events to block road crossing structures (bridges and culverts). This alternative would have the lowest cost, lowest planning effort, fewest requirements, and can be implemented most rapidly. As suggested, municipal partnerships may further reduce cost and extend resources to perform debris removal activities. The importance of proactive management through early action and regular maintenance clearing makes this alternative a top priority project for mitigating future flood risk.
 2. The Wetland Creation and Enhancement alternative has the potential to reduce flooding by providing storage in targeted areas where residential and commercial properties are positioned close to the Alewife Brook floodplain. While this is difficult to quantify at the conceptual stage, larger wetland features would have a larger benefit, but they tend to be very expensive to implement, and space within the corridor could be limiting. Smaller detention basin-style wetlands or emergent pocket wetlands

Reference: Alewife Brook Hydraulic and Stream Improvement Study

positioned toward the back of the Alewife Brook floodplain may be more feasible from a cost standpoint and could be implemented in phases. Additionally, creating hydraulic connections between smaller wetland cells may be considered to distribute storage and protective effects over a larger area. This would also provide more flexibility for site layout, given constraints associated with the urban setting. Additionally, implementation of the wetland creation alternative would promote drainage to reduce the duration of inundation in low-lying areas and along the Alewife Greenway Bike Path. It could also help manage overland flows heading toward the brook. Clearing for wetland excavation could be met with opposition, which would complicate permitting, so expanding existing wetland features to provide more storage or by connecting these existing features to smaller, newly created cells may maximize the benefit with the least disturbance. Invasive species dominate the existing riparian wetlands, so some dredging to increase their flood storage capacity may be partially justified as invasive species management and native community reestablishment.

As part of this alternative, Stantec evaluated raising a portion of the the Alewife Brook Greenway Bike Path between Concord Turnpike and Massachusetts Avenue to avoid frequent flooding during storm events slightly above bankfull discharge, due to its position at the front edge of the floodplain. As discussed, stormwater containing CSO could contaminate the existing structure and may be a risk to human health. Inundation would also make the path impassable for pedestrian and bike traffic, which may take extended periods to recede from the lower elevations on the path. The recommended implementation of a raised boardwalk could be done in concert with wetland creation to promote drainage or as a separate project. Compared to most of the other alternatives, raising the bike path would be a relatively inexpensive initiative on its own and may have meaningful benefits to the community.

3. The 'full clean-out' scenario constitutes stream restoration due to its scope, with concrete lining removal, sediment excavation, channel geometry improvements, and riparian buffer re-establishment. While this alternative increases channel capacity and would be designed to promote stability without the hardened concrete lining, modeling results show that – even if this work were to be accomplished – there would be no significant reduction in maximum flood water depth or flooding extents that would reach adjacent properties at the 5-year and 25-year recurrence intervals. Cost and complexity of this full clean-out alternative could be preclusive, if the only driver were the protection of adjacent properties and infrastructure from higher discharge events.

The stream improvements, on the other hand, would serve to keep lower flood flows contained within the channel, which would reduce frequency of flooding near the bankfull (1-year) discharge and reduce inundation along the Alewife Greenway Bike Path in the floodplain, areas currently owned and managed by DCR.

Dredging alone (even without removing the concrete lining) would provide additional capacity to address current localized flooding of the Alewife Brook Greenway Bike Path.

4. Investigation for a structure replacement project found that the only restricted stream crossing on Alewife Brook was at Massachusetts Avenue; however, its effect on flooding is minimal and it cannot be considered for this alternative. The crossing structure itself is a listed historical resource that must be preserved. Regardless, flooding on Alewife Brook is much more controlled by the downstream elevation of the Mystic River.

Reference: Alewife Brook Hydraulic and Stream Improvement Study

As previously described, a hydraulic restriction was observed at the Mystic Valley Parkway river crossing, located on the Mystic River itself. Under the preliminary resizing of this structure on the Mystic River that would be needed to remove the restriction, flooding risk would be reduced in the lower reaches of Alewife Brook along Sunnyside Avenue.

The 5- and 25-year flood elevations upstream of Massachusetts Avenue would be unaffected by the project. While there is some benefit, this approach does not address the areas of greatest concern, as expressed by the Client, such as flooding upstream of Massachusetts Avenue. Additionally, a bridge replacement project such as this would be costly and would involve significant complexity, public involvement, permitting, and design effort. It is unlikely to be approved as long as the existing structure is in good condition and flooding does not dramatically worsen. Should the river crossing structure at Mystic Valley Parkway require rehabilitation in the future, this alternative may be worth putting forward for consideration, given the evidence of its impact on the lower reaches of Alewife Brook.

5. Evaluating the feasibility of floodwater drawdowns by regulating discharge, Stantec investigated potential downstream controls at the Amelia Earhart Dam. As previously discussed, this was found to be impossible due to the tidal influence on the dam's downstream condition. Because it cannot be changed, discharge regulation is not a viable option for flood reduction in Alewife Brook.

The intent of this technical memorandum has been to provide preliminary planning and consideration of possible flood reduction initiatives that have additional ecological benefits to the Alewife Brook stream corridor and to the surrounding communities. More detailed evaluations will likely be required to advance conceptual projects to subsequent design phases, if pursued; however, the information contained herein should assist with decision-making, budgeting, and in support of internal prioritizations for the MyRWA and StAB.

If you have questions about the information contained herein, please feel free to contact us.

Sincerely,

STANTEC CONSULTING SERVICES INC.

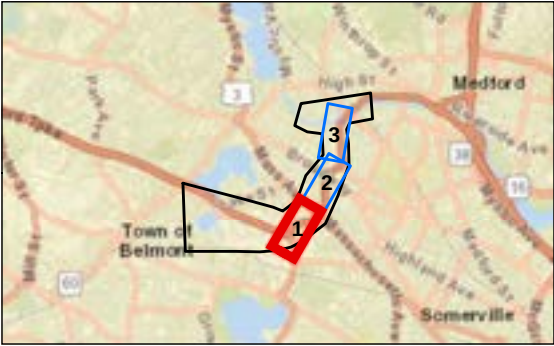


Matt Lajoie
Associate, Senior Project Manager
Phone: (603) 731-9688
matt.lajoie@stantec.com



David VanHoven, P.E.
Senior Principal, Senior Water Resources Engineer
Phone: (617) 935-5588
david.vanhoven@stantec.com

Appendix A – Detailed Site Map



Notes
1. Coordinate System: NAD 1983 CORS96 StatePlane Massachusetts Mnlid FIPS 2001 FtUS
2. Data Sources:
3. Background: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

- Study Corridor
- Sheet
- 2-ft Contours (LiDAR)
- Stream - NWI
- Wetland - NWI
- Pond - NWI
- Stream Crossing
- Approximate Riparian Planting Area
- Wetland Creation Opportunities - Approximate Limits
- Cross Sections
- CSO Outfall
- Arch Structure

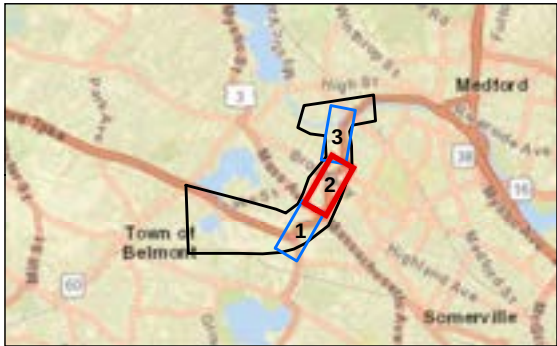
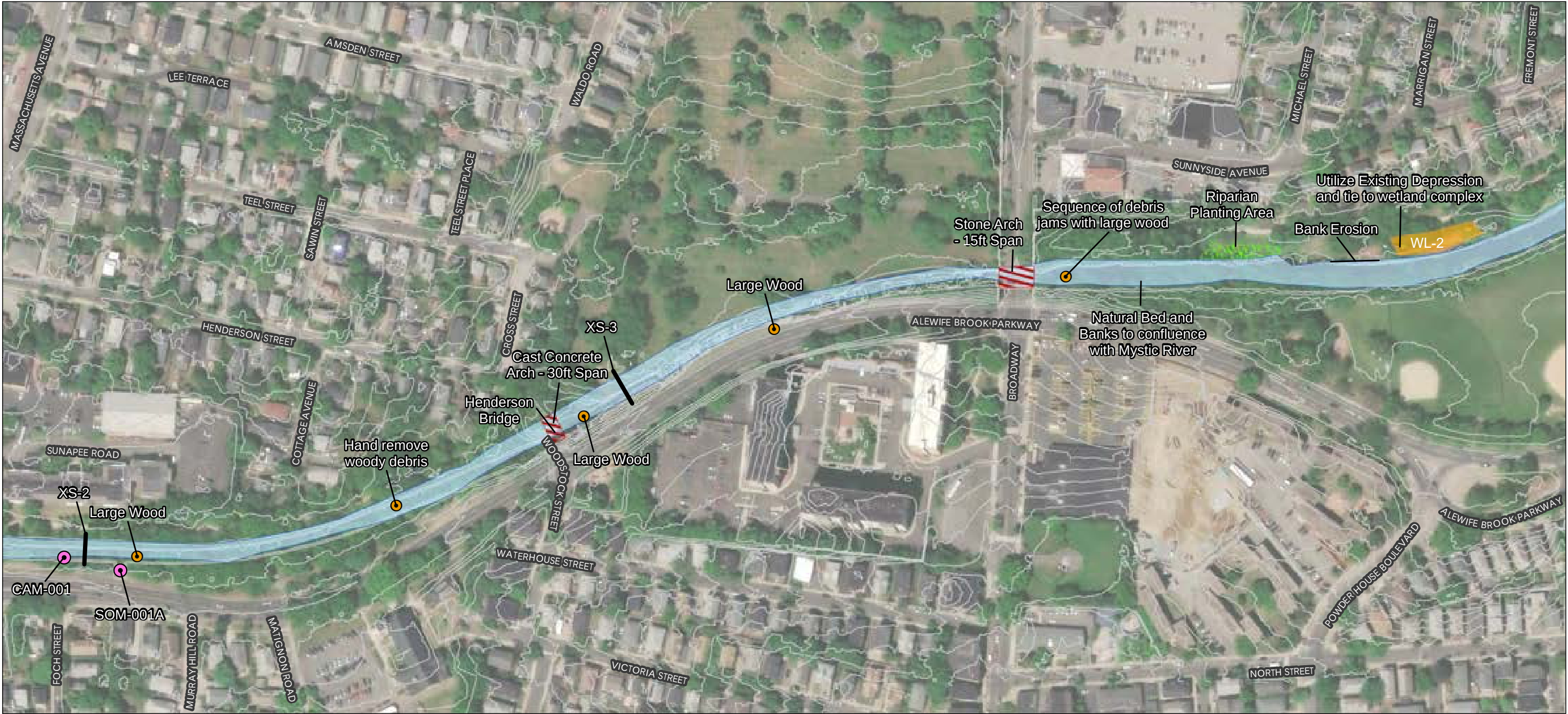
- Box Culvert
- Bridge Structure
- Woody Debris/Obstruction
- General Collection

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Project Location
T11N, R12E, S05
T. of Dane, Dane Co., WI
Client/Project
Mystic River Watershed Association
Alewife Brook Hydraulic and Stream Improvement Study
Prepared by ABC on 2019-01-01
TR by ABC on 2019-01-01
IR Review by ABC on 2019-01-01
XXXXXXXX-XXXX REV A

Sheet No.
1
Title
Alewife Brook Base Map



Notes
1. Coordinate System: NAD 1983 CORS96 StatePlane Massachusetts Mnlid FIPS 2001 FtUS
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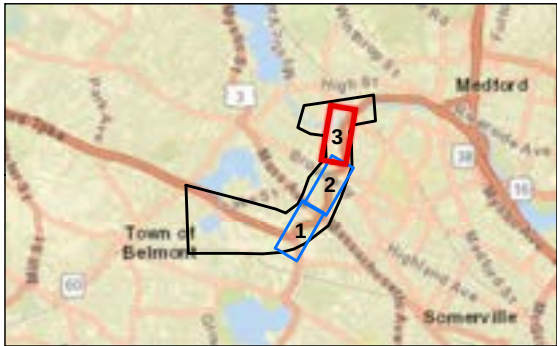
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Project Location
T11N, R12E, S05
T. of Dane, Dane Co., WI
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Alewife Brook Hydraulic and Stream Improvement Study

Sheet No.
2
Title
Alewife Brook Base Map



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1. Coordinate System: NAD 1983 CORS96 StatePlane Massachusetts Mnlid FIPS 2001 FIPS
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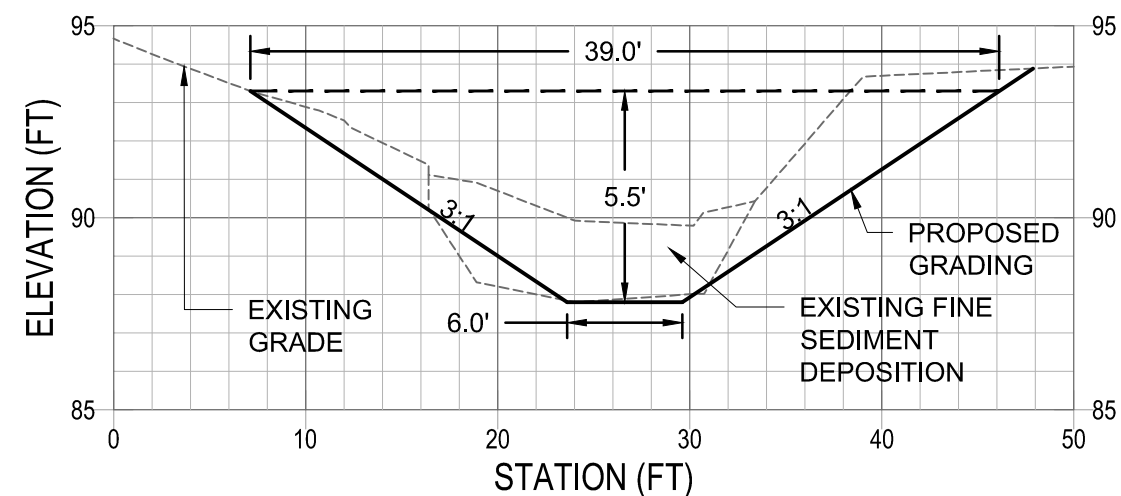
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Mystic River Watershed Association
Alewife Brook Hydraulic and Stream Improvement Study
Prepared by ABC on 2019-01-01
TR by ABC on 2019-01-01
IR Review by ABC on 2019-01-01
XXXXXXXXXX-XXXX REV A

Sheet No.
3
Title
Alewife Brook Base Map

June 28, 2024
Andy Hrycyna

Reference: Alewife Brook Hydraulic and Stream Improvement Study

Appendix B – Conceptual Design Drawings

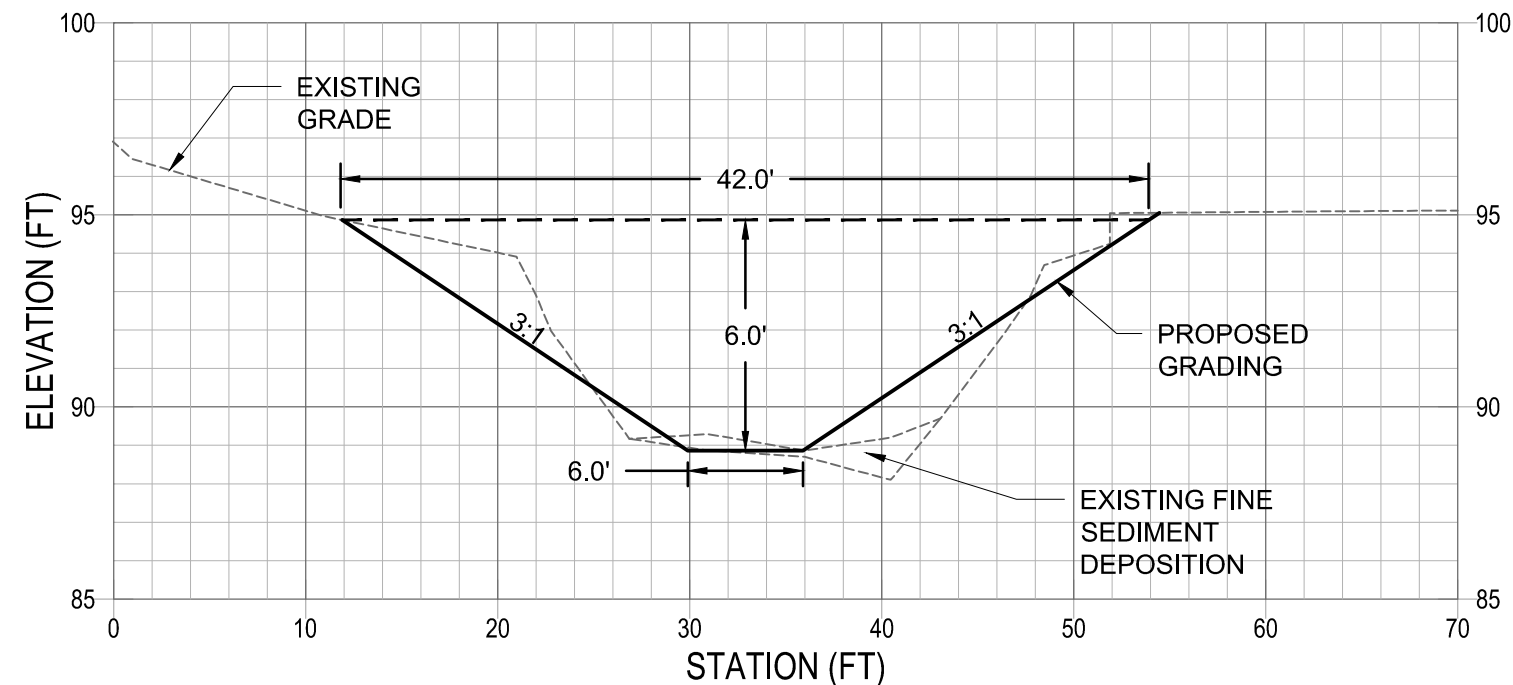


CROSS SECTION 1 - STREAM SEGMENT 2

VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 10'

Note: Remove existing concrete lining panels and dispose of properly offsite.

BANKFULL PARAMETERS		
	EXISTING	PROPOSED
AREA	78.7 SF	123.8 SF
WIDTH	33.9 FT	39.0 FT
MAX DEPTH	3.9 FT	5.5 FT
MEAN DEPTH	2.3 FT	3.2 FT
WIDTH/DEPTH	14.6	12.3



CROSS SECTION 2 - STREAM SEGMENT 3

VERTICAL SCALE: 1" = 5' HORIZONTAL SCALE: 1" = 10'

Note: Remove existing concrete lining panels and dispose of properly offsite.

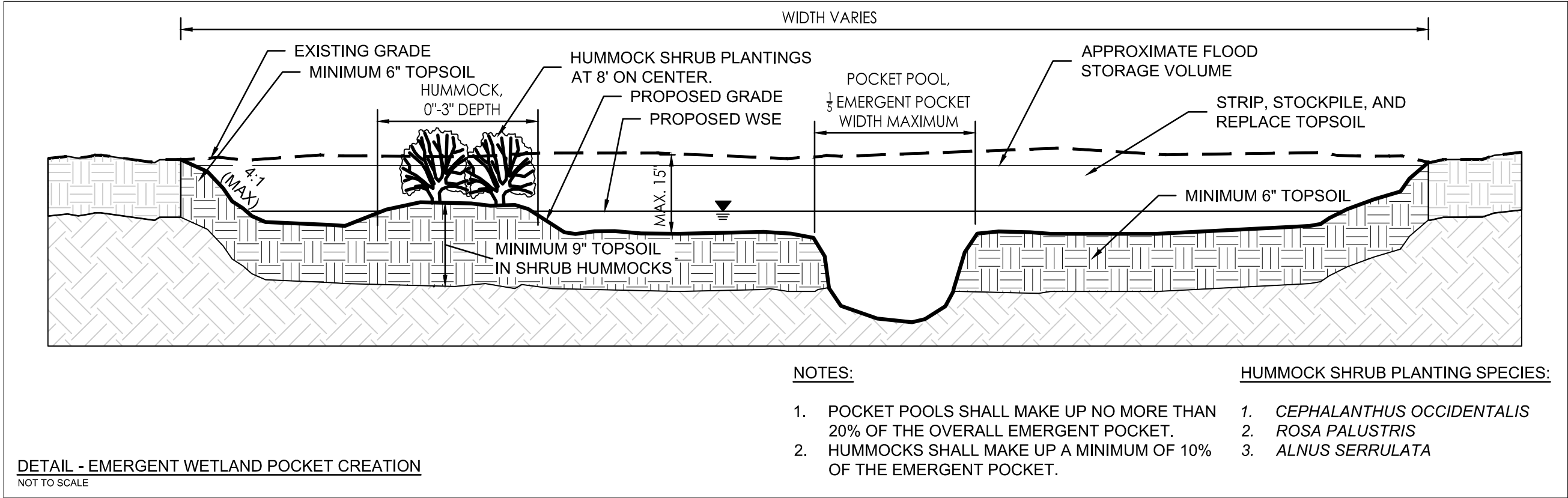
BANKFULL PARAMETERS		
	EXISTING	PROPOSED
AREA	99.0 SF	144.0 SF
WIDTH	27.3 FT	42.0 FT
MAX DEPTH	4.8 FT	6.0 FT
MEAN DEPTH	3.6 FT	3.4 FT
WIDTH/DEPTH	7.5	12.4

Alternative 1: Channel Clean-Out Scenario with Concrete Lining Removal and Bank Grading

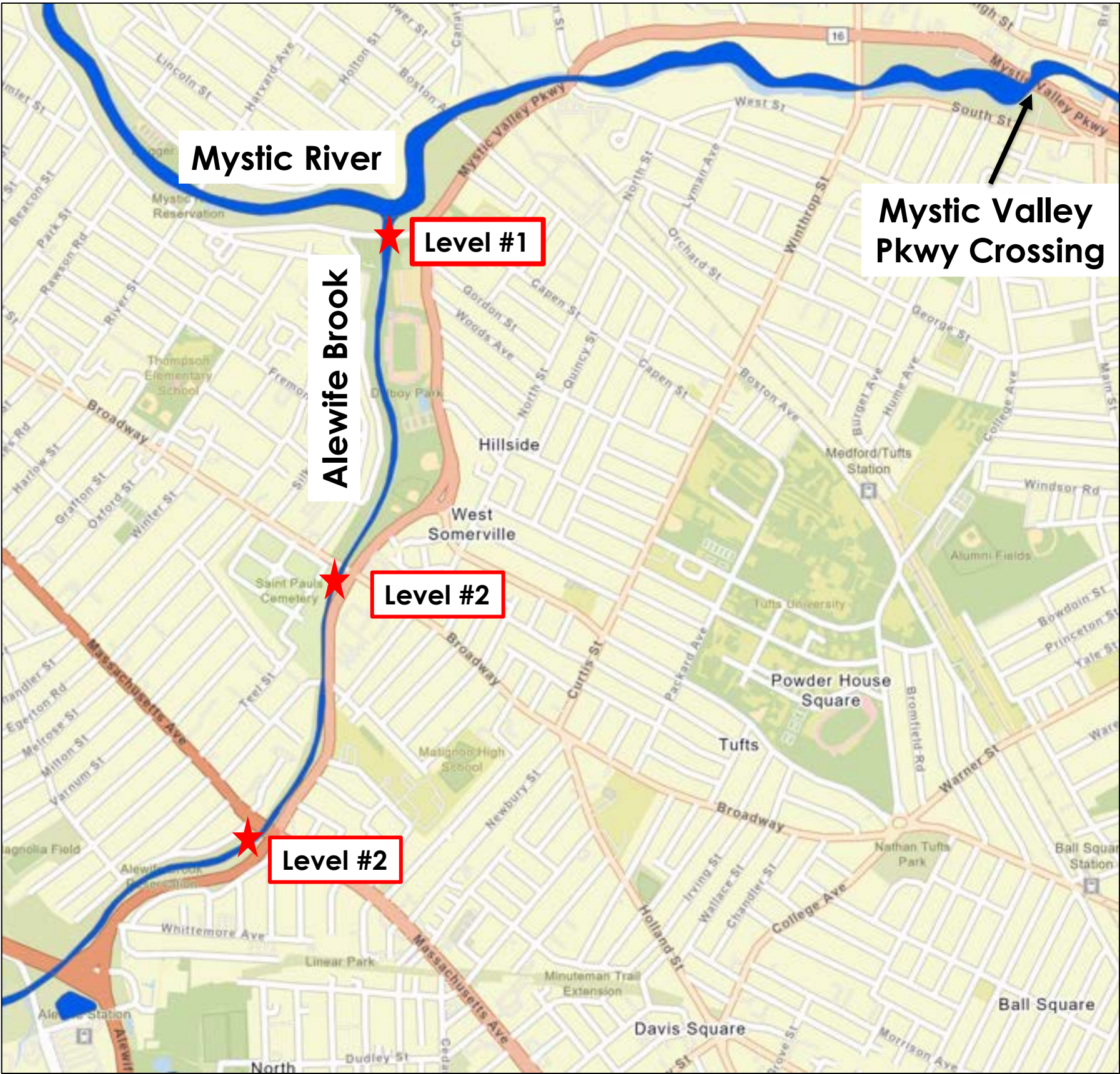
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Client/Project	MALEWIFE BROOK HYDRAULIC MODELING AND STREAM IMPROVEMENT STUDY MARLINGTON AND SOMERVILLE, MASSACHUSETTS
Title	TYPICAL CROSS SECTIONS

Alternative 2: Wetland Creation and Enhancement



Alternative 3: Crossing Structure Replacement/Resizing



Concept Description: Mystic Valley Pkwy Crossing restricts flow through the Mystic River which increases the hydraulic gradeline upstream in the Mystic and Alewife Brook.

The existing opening width varies from 75-ft to 60-ft. It was widened to a 93-ft opening.

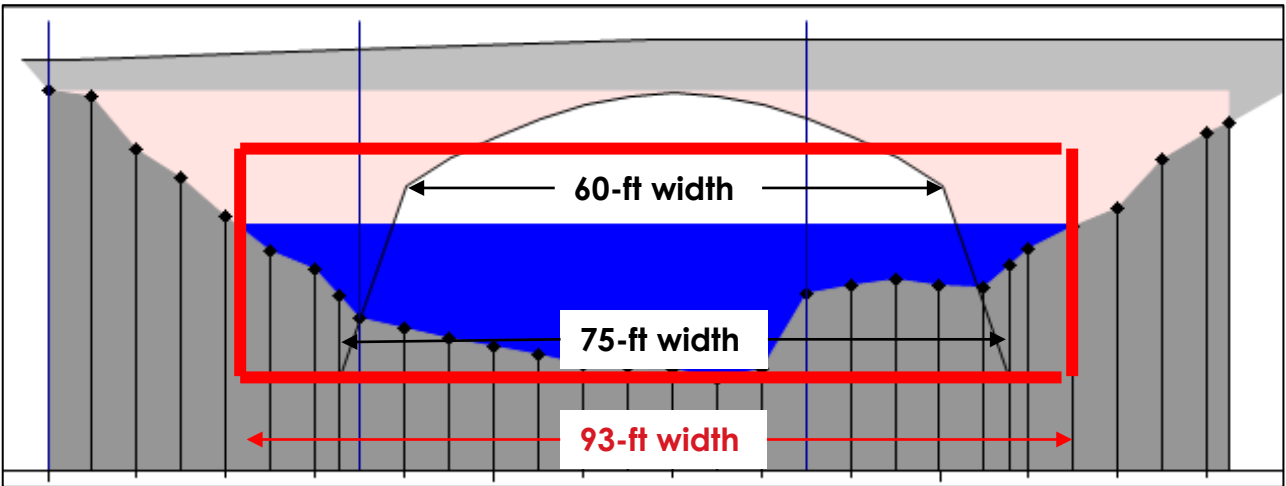
Water level is reduced by a maximum of 0.5-ft and 0.3-ft during the 5-yr and 25-yr storms, respectively.

Project Cost: >\$50M

Water Level (ft AD)

Location	Existing Conditions		Concept #3	
	5-Yr 24-Hr Present	25-Yr 24-Hr Present	5-Yr 24-Hr Present	25-Yr 24-Hr Present
Level 1	13.8	14.8	13.3	14.1
Level 2	14.0	15.1	13.5	14.8
Level 3	14.7	16.3	14.7	16.3

Bridge Opening Profile – 25-Yr 24-Hr Present

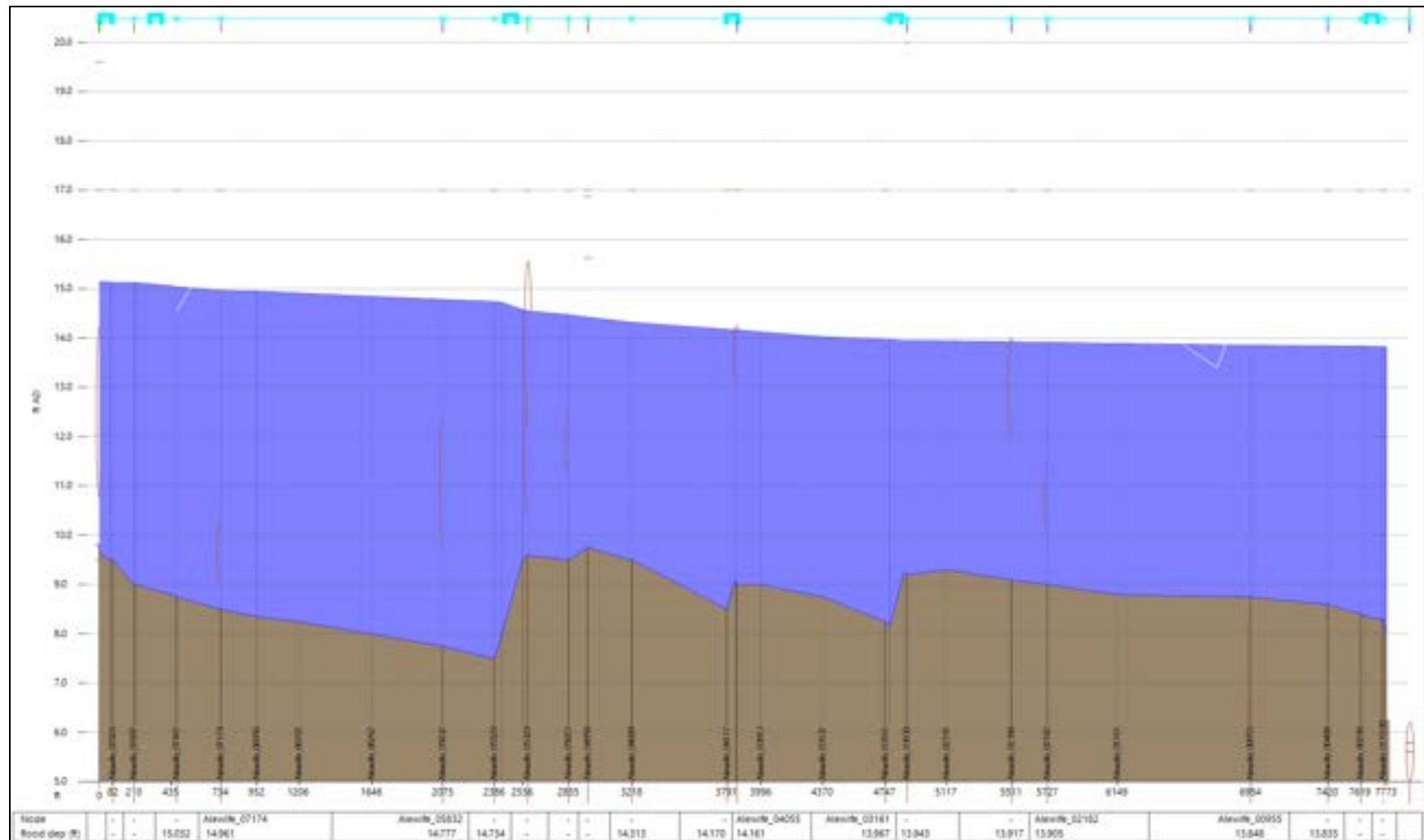


Appendix C – Hydrologic Modeling Data

Alewife Brook Hydraulic and Stream Improvement Study – Conceptual Design

Appendix C Part 1

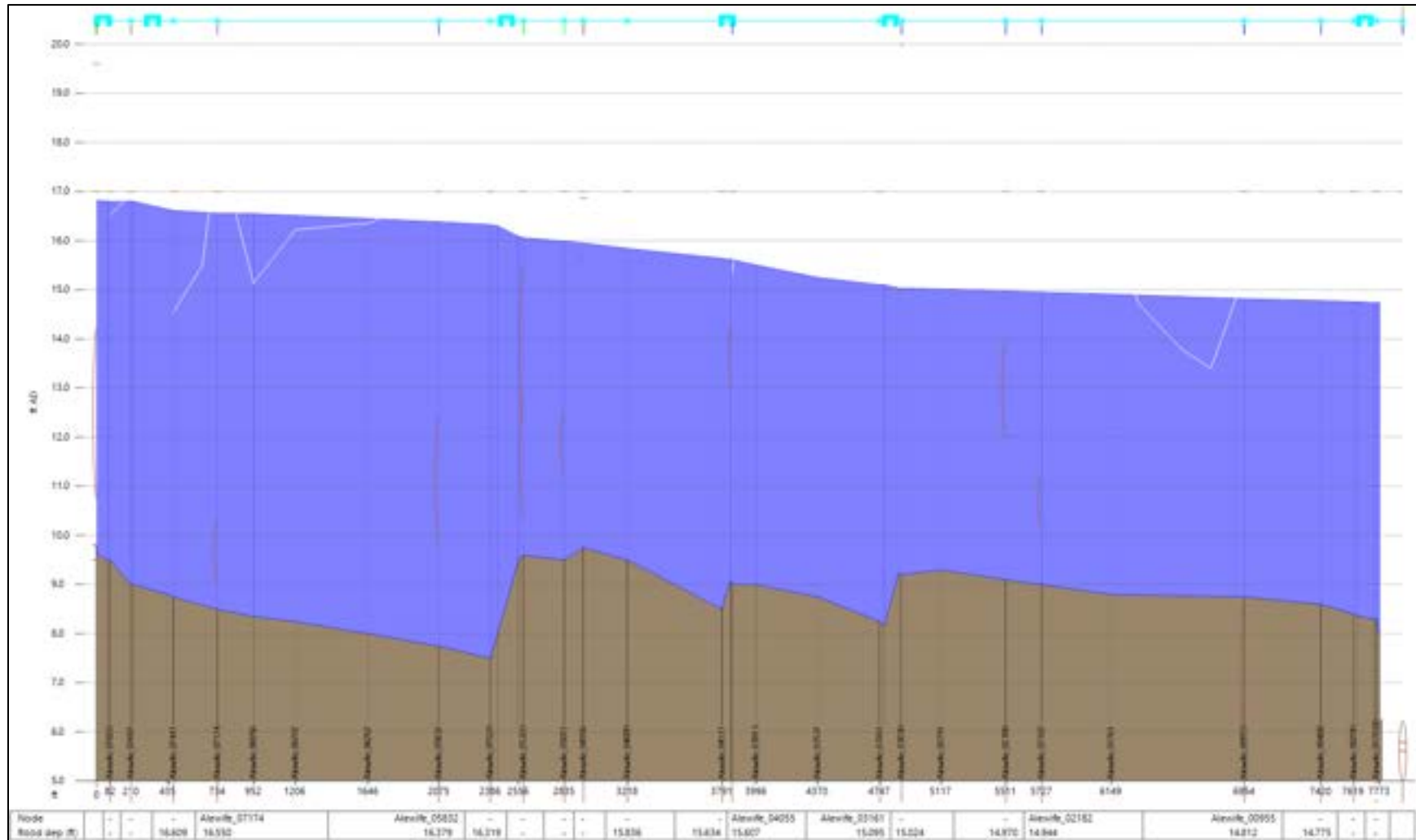
Existing Conditions – 5-Year 24-Hour Present



Alewife Brook Hydraulic and Stream Improvement Study – Conceptual Design

Appendix C Part 1

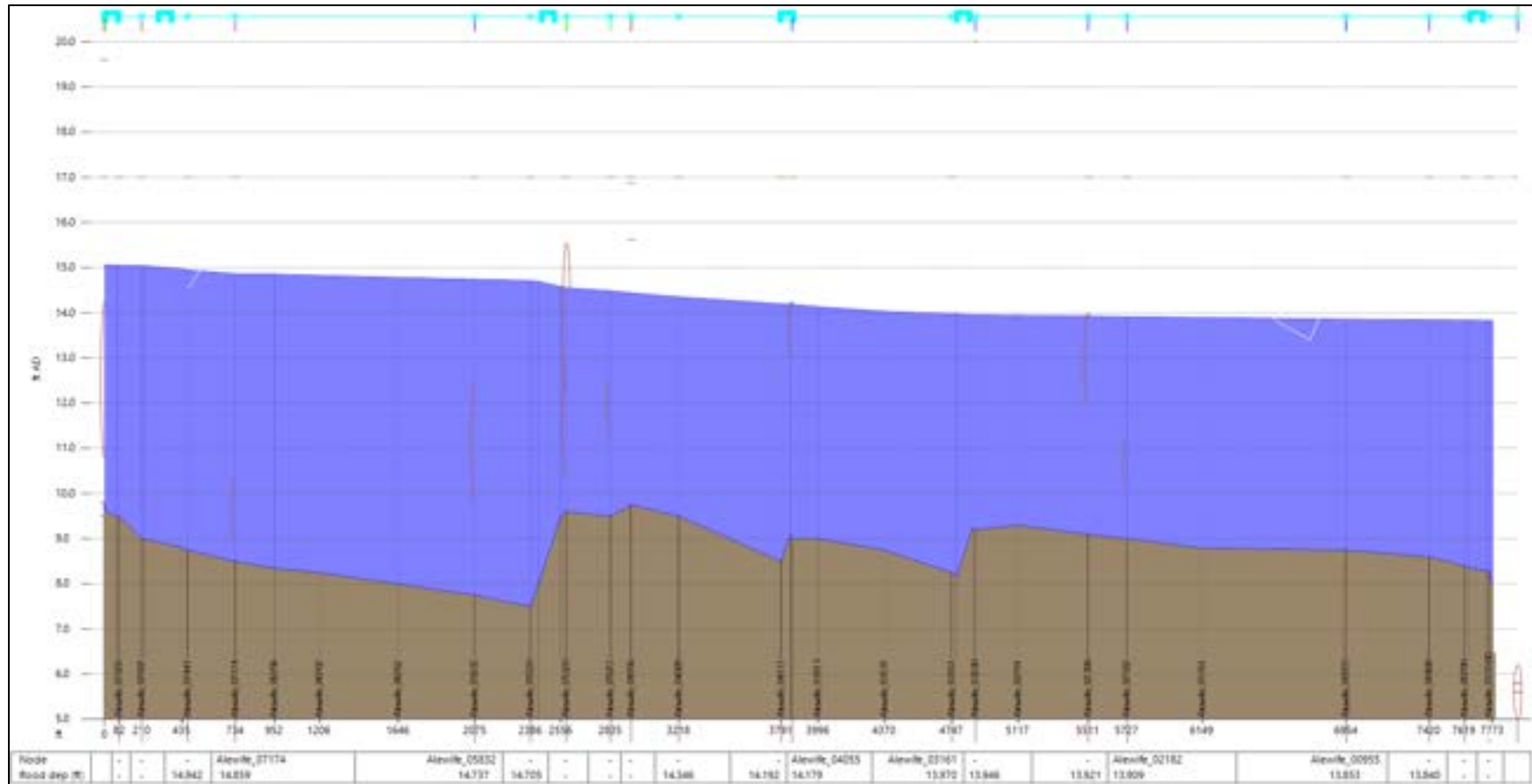
Existing Conditions – 25-Year 24-Hour Present



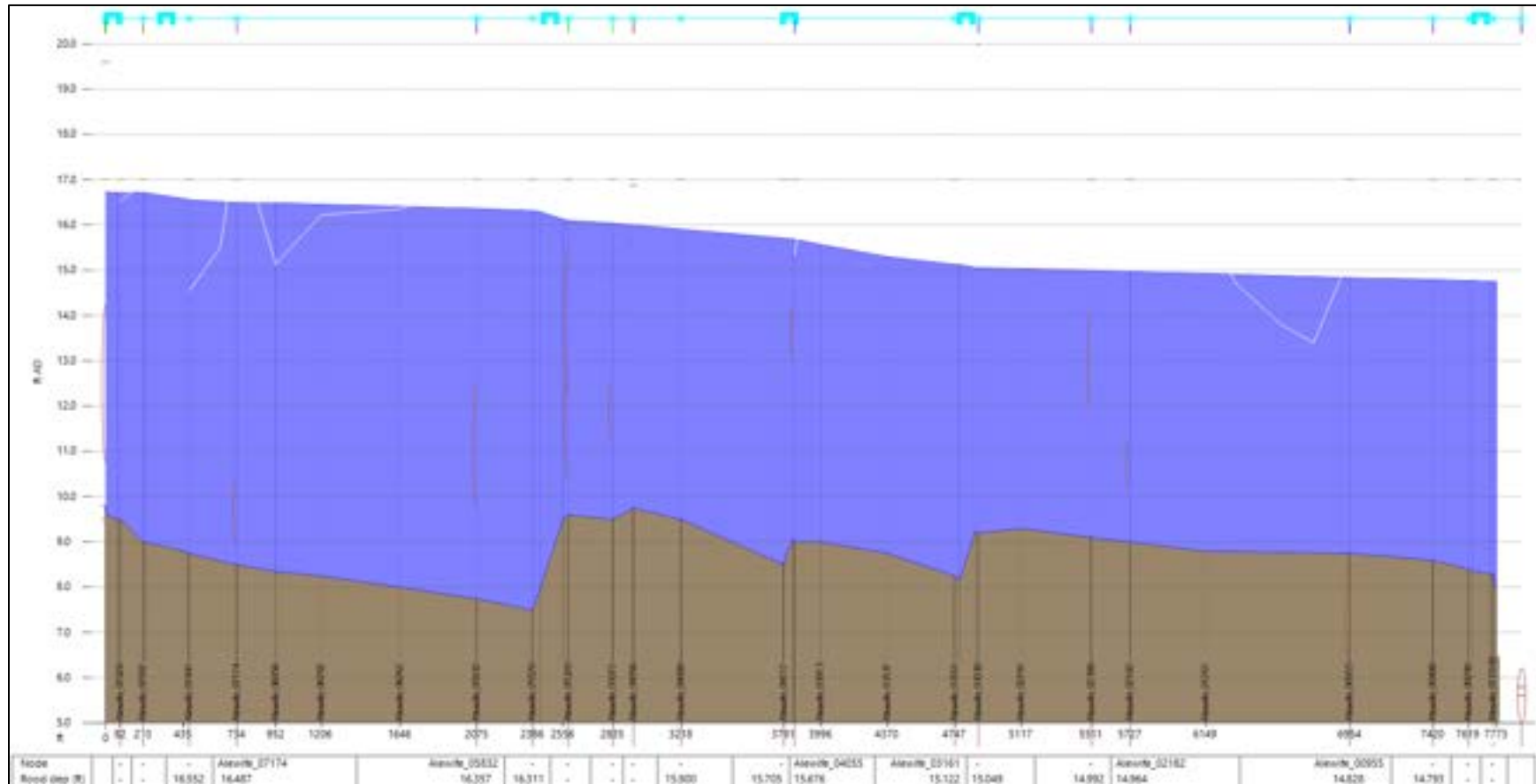
Alewife Brook Hydraulic and Stream Improvement Study – Conceptual Design

Appendix C Part 1

Cleaned Out – 5-Year 24-Hour Present



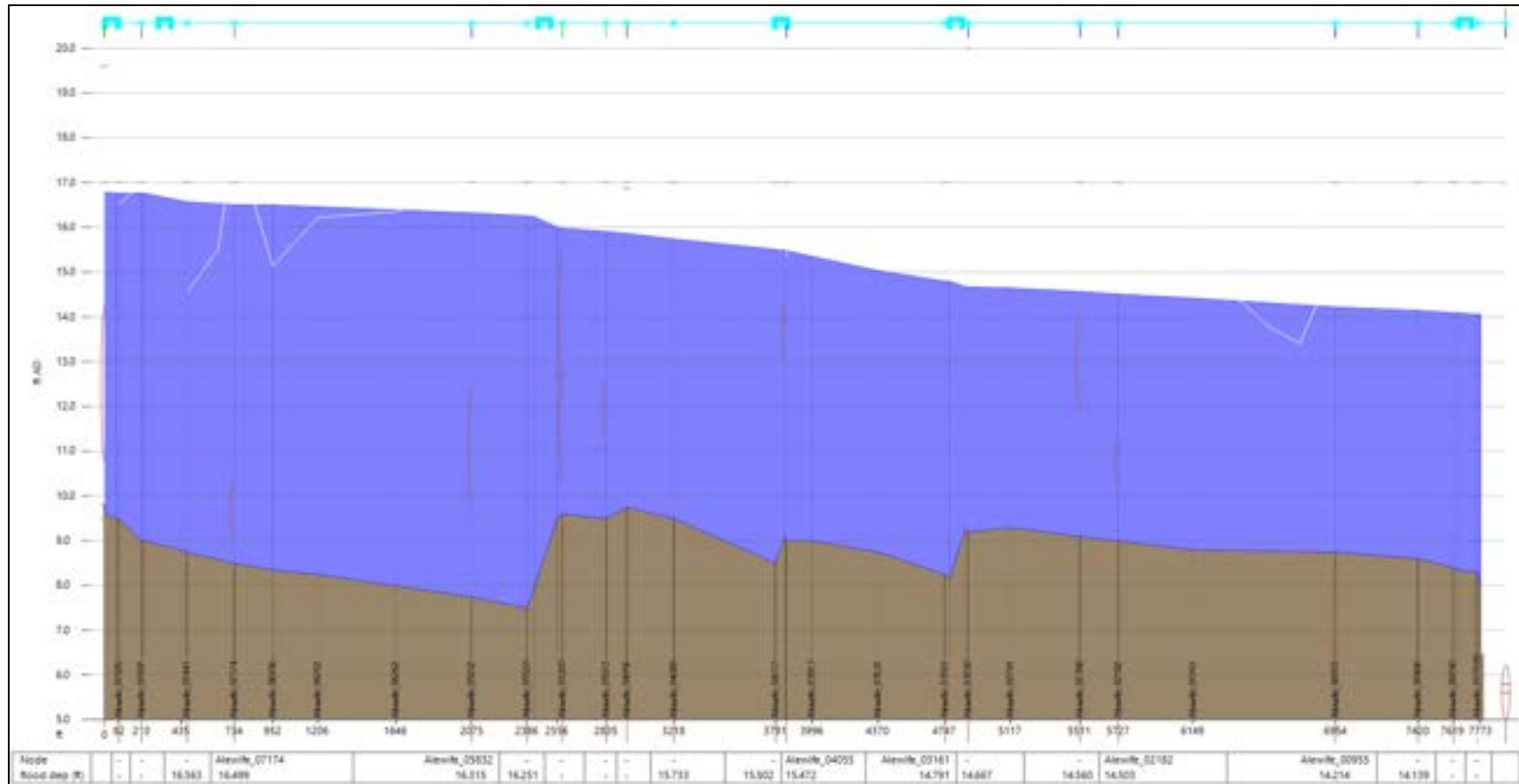
Cleaned Out – 25-Year 24-Hour Present



Mystic Crossing Structure Removed – 5-Year 24-Hour Present

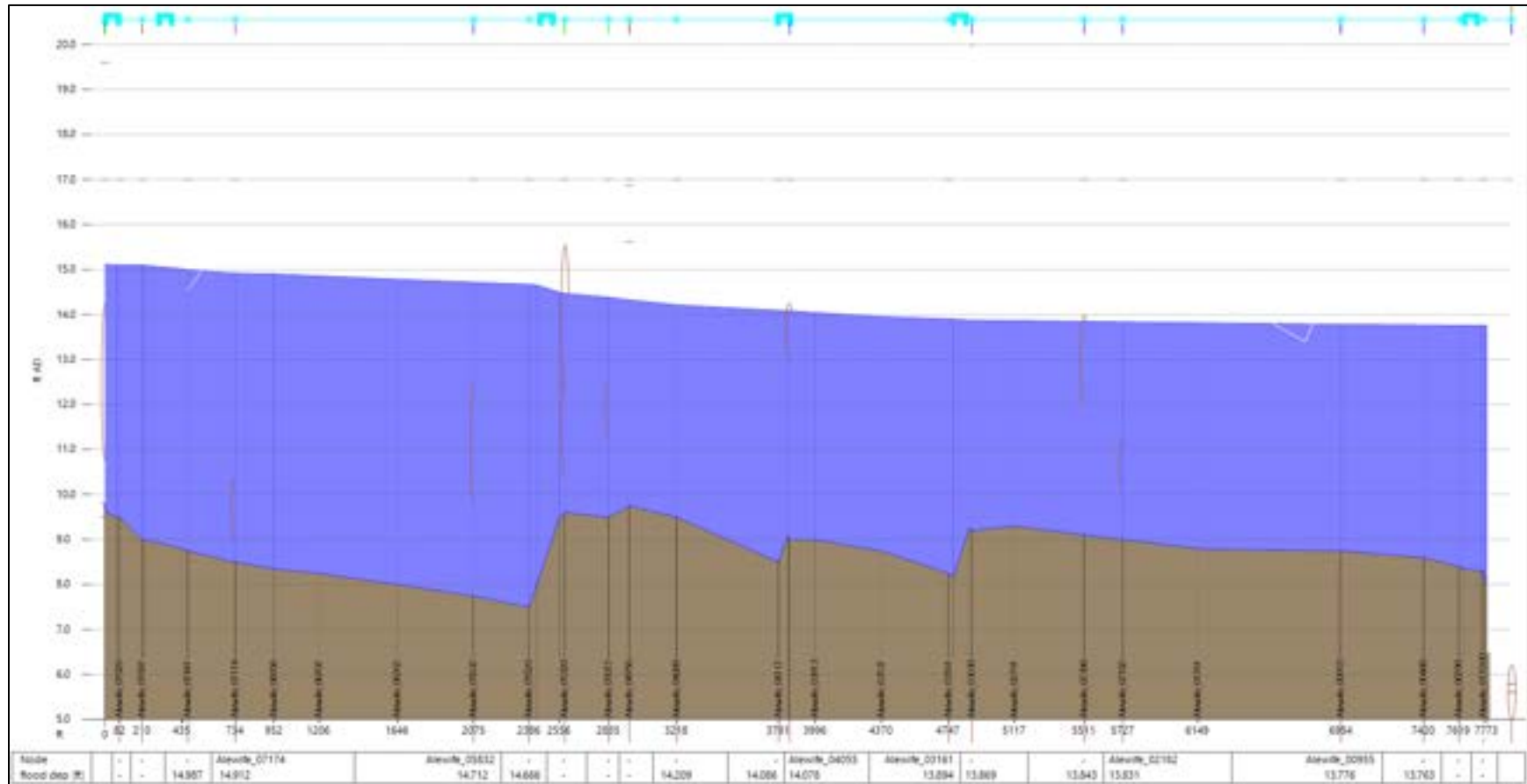
Alewife Brook Hydraulic and Stream Improvement Study – Conceptual Design
Appendix C Part 1

Mystic Crossing Structure Removed – 25-Year 24-Hour Present



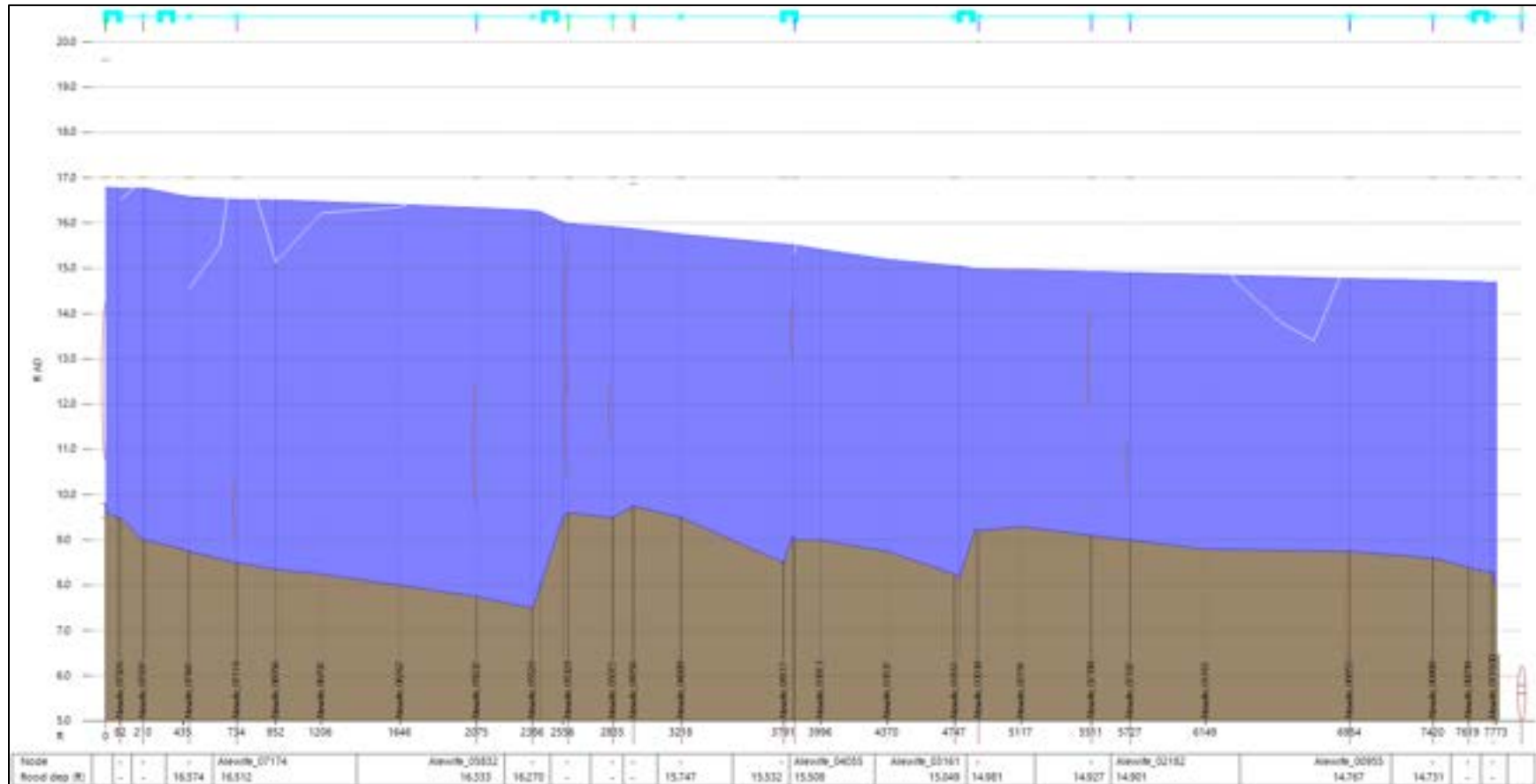
Alewife Brook Hydraulic and Stream Improvement Study – Conceptual Design Appendix C Part 1

Draw Down – Dam Controls – 5-Year 24-Hour Present



Alewife Brook Hydraulic and Stream Improvement Study – Conceptual Design Appendix C Part 1

Draw Down – Dam Controls – 25-Year 24-Hour Present



Title

Alewife Brook Flood Extent Map

**Existing Conditions
5-Year 24-Hour Present**

Client/Project

Mystic River Watershed Association

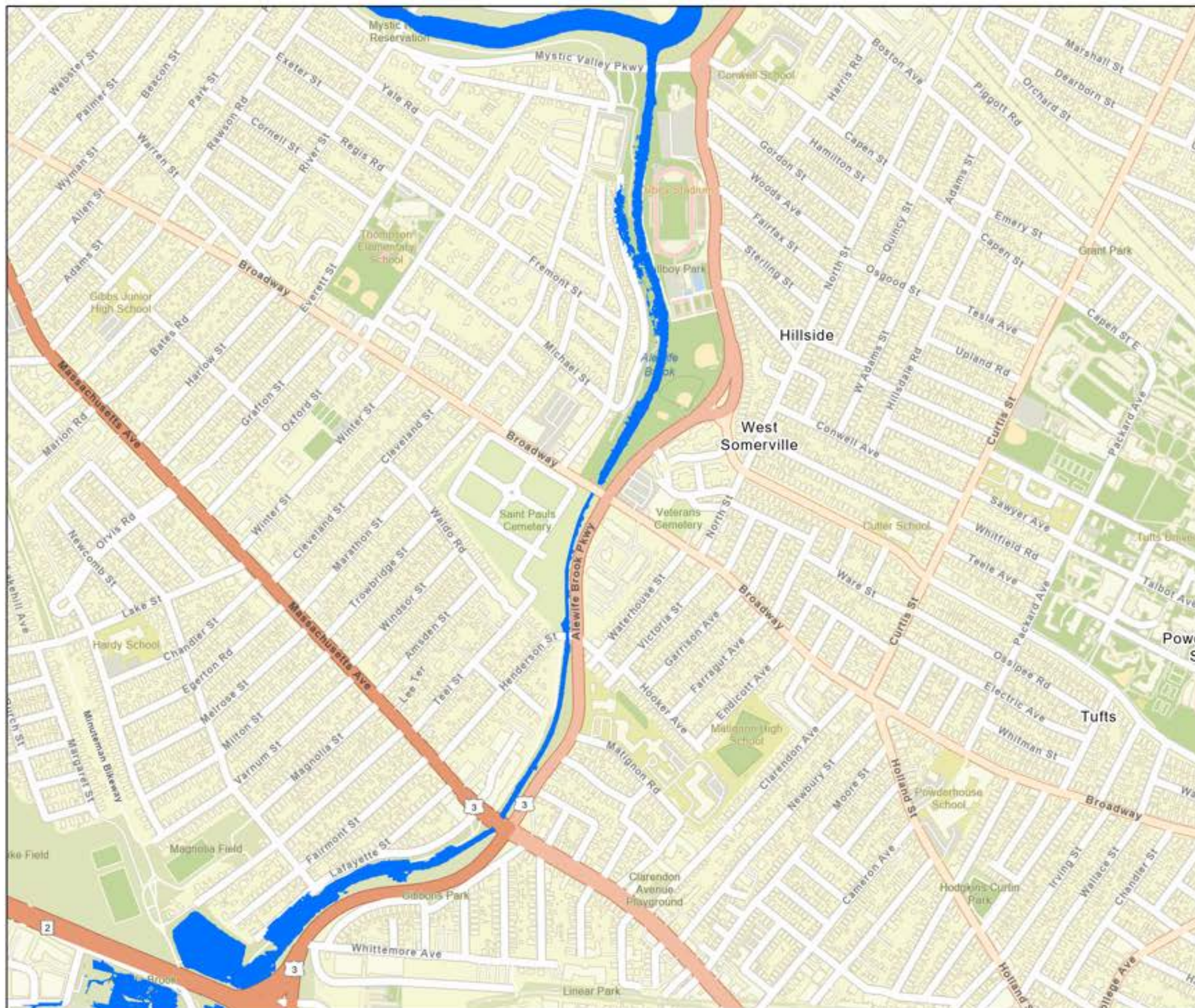
Map Revised: May 2024

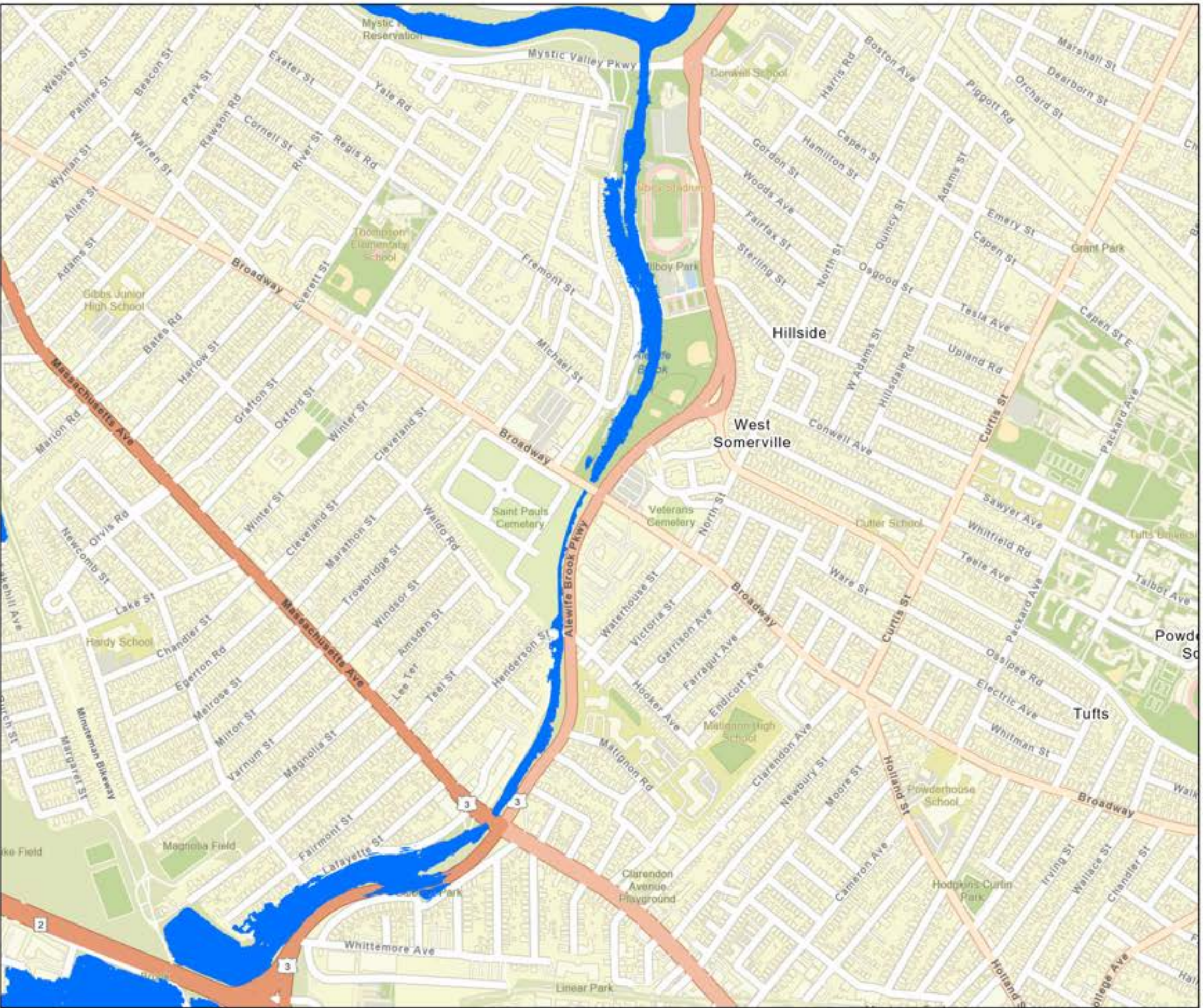
Project Location

Alewife Brook, MA

Legend

 Existing Conditions Flood Extent, 5-Year Storm





Title

Alewife Brook Flood Extent Map

Existing Conditions

25-Year 24-Hour Present

Client/Project

Mystic River Watershed Association

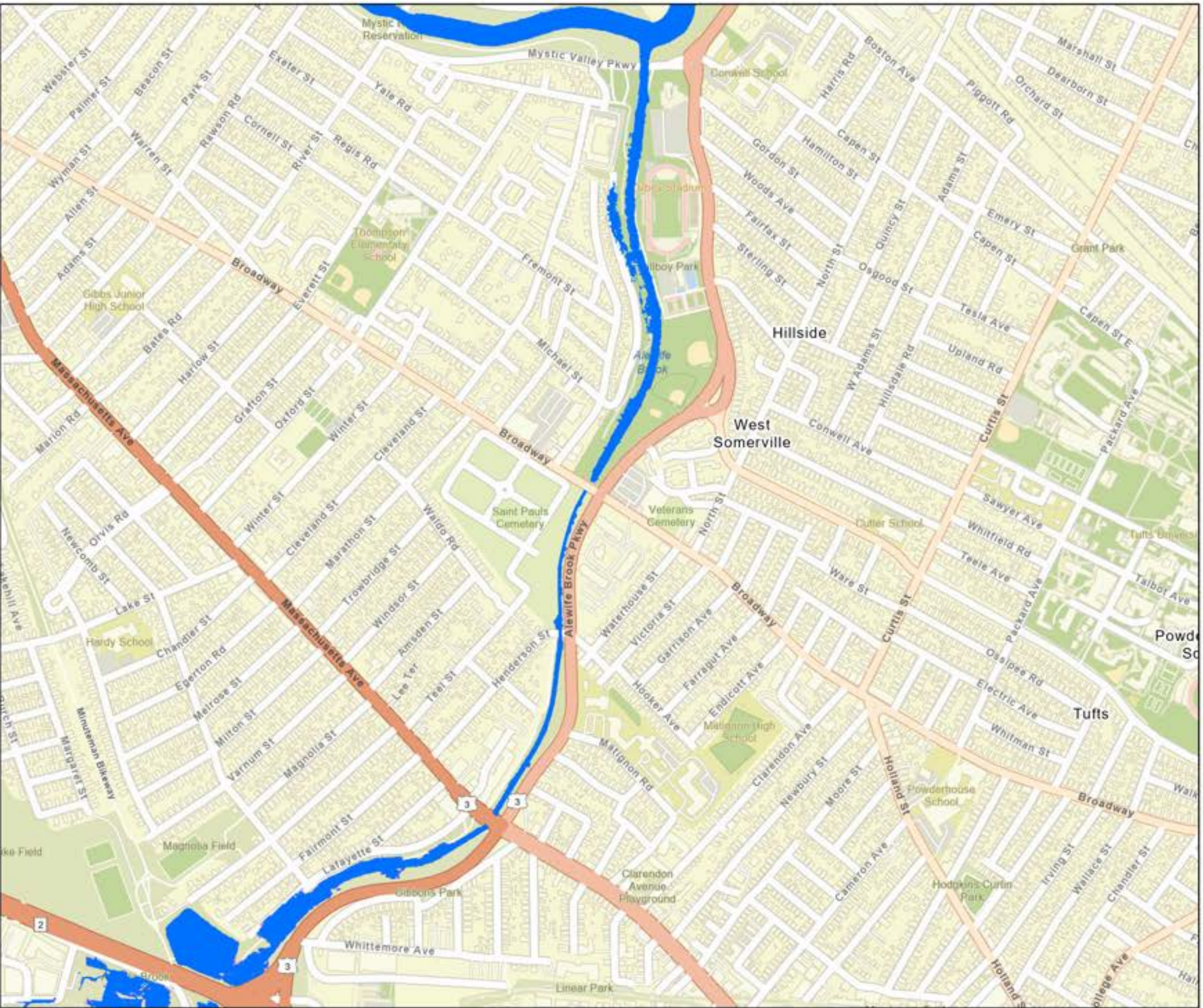
Map Revised: May 2024

Project Location

Alewife Brook, MA

Legend

Existing Conditions Flood Extent, 25-Year Storm



Title
Alewife Brook Flood Extent Map

Cleaned Out
5-Year 24-Hour Present

Client/Project
Mystic River Watershed Association
Map Revised: May 2024

Project Location
Alewife Brook, MA

Legend
Cleaned Out Flood Extent, 5-Year Storm
Existing Conditions Flood Extent, 5-Year Storm

Title

Alewife Brook Flood Extent Map

**Cleaned Out
25-Year 24-Hour Present**

Client/Project

Mystic River Watershed Association

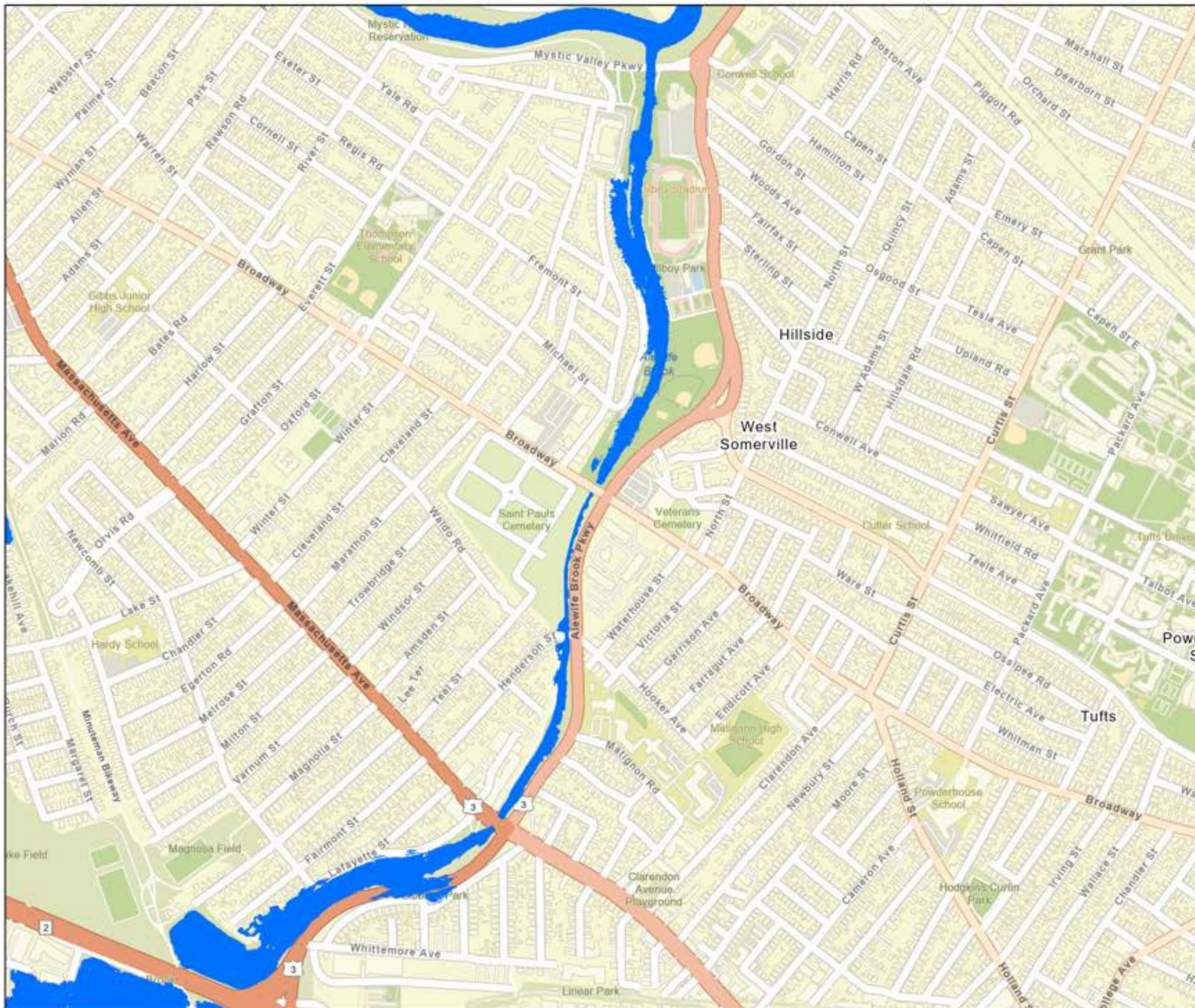
Map Revised: May 2024

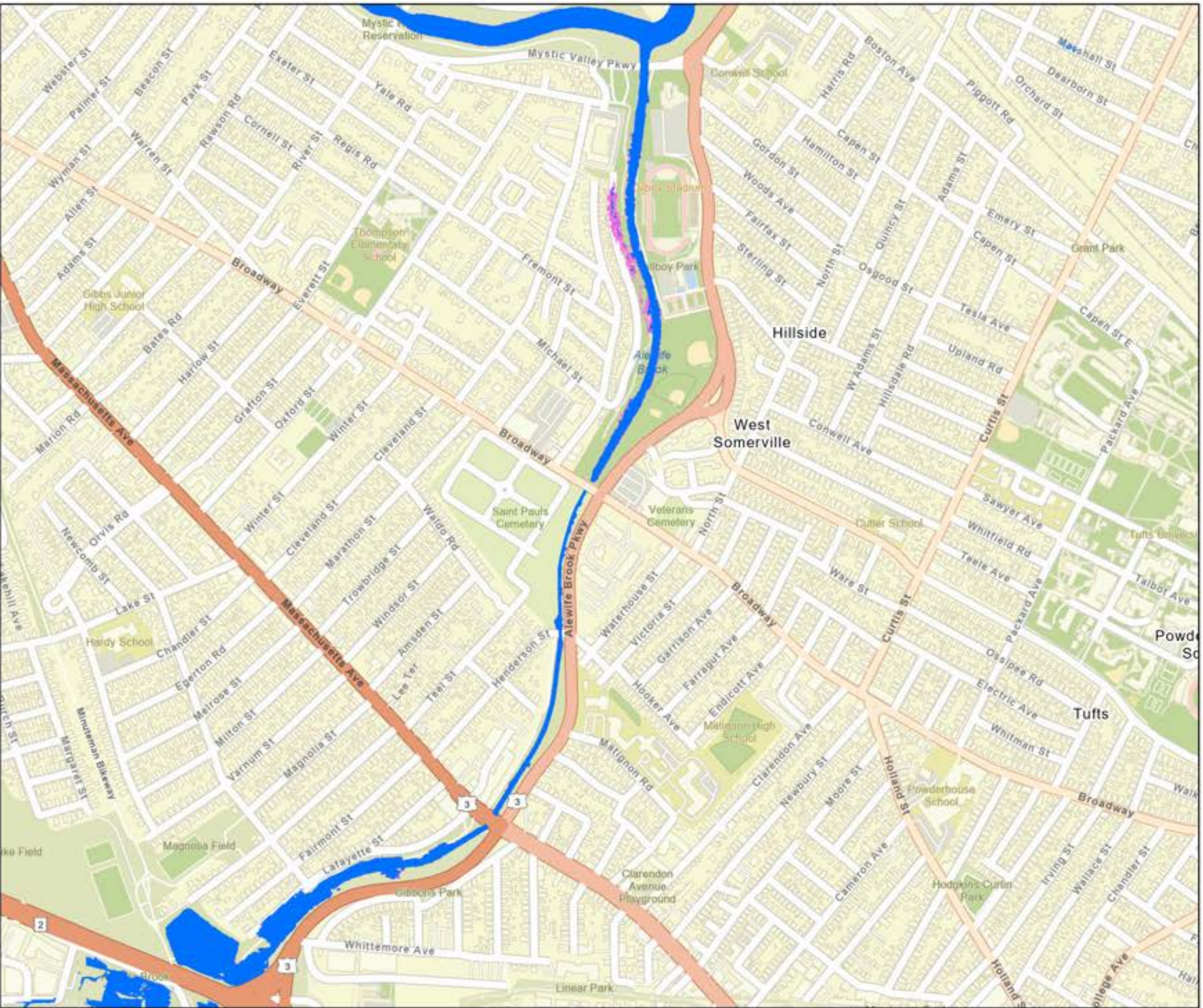
Project Location

Alewife Brook, MA

Legend

-  Cleaned Out Flood Extent, 25-Year Storm
-  Existing Conditions Flood Extent, 25-Year Storm





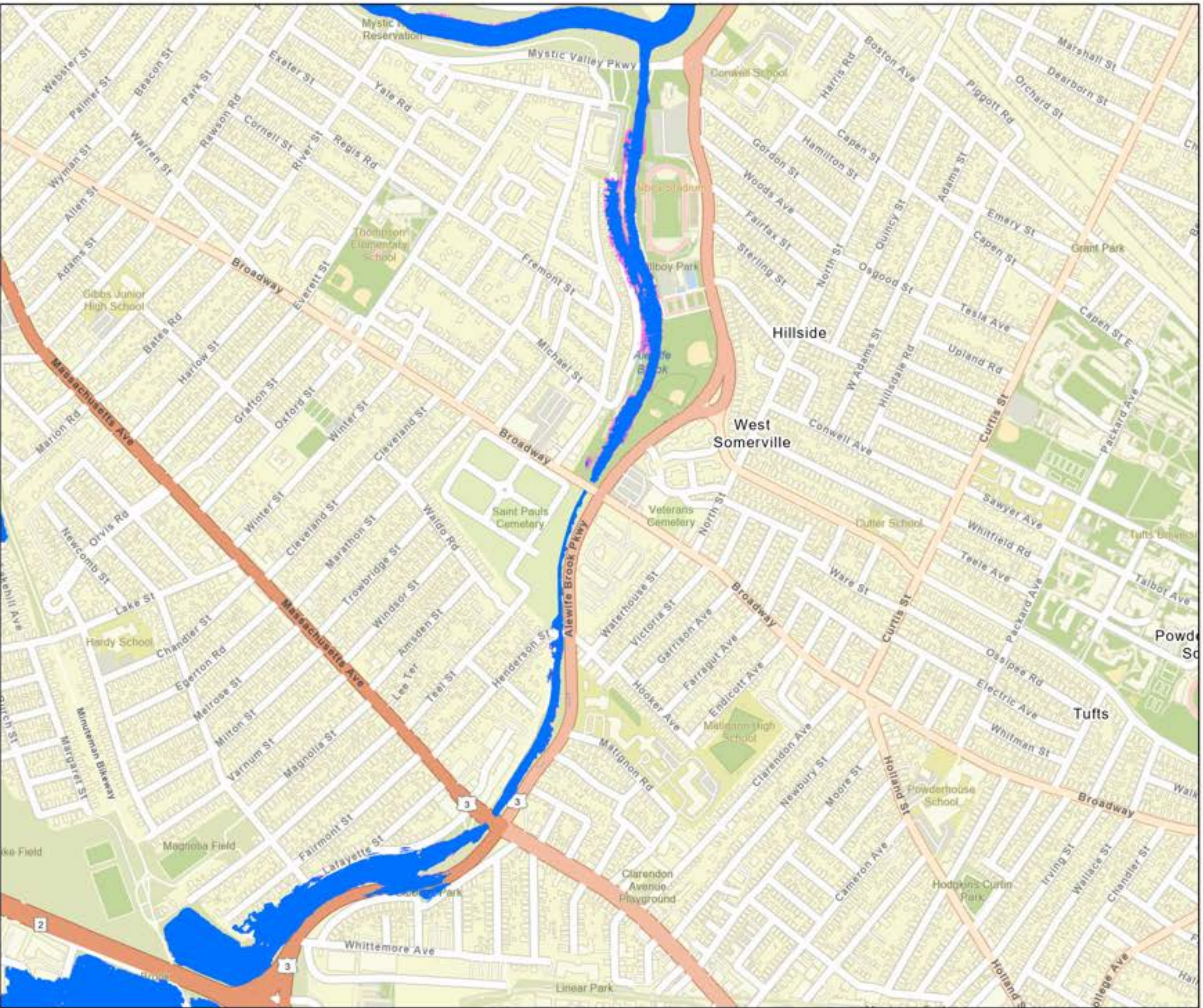
Title
Alewife Brook Flood Extent Map

**Mystic Crossing Structure Removed
5-Year 24-Hour Present**

Client/Project
Mystic River Watershed Association
Map Revised: May 2024

Project Location
Alewife Brook, MA

Legend
■ Mystic Crossing Structure Removed Flood Extent, 5-Year Storm
■ Existing Conditions Flood Extent, 5-Year Storm

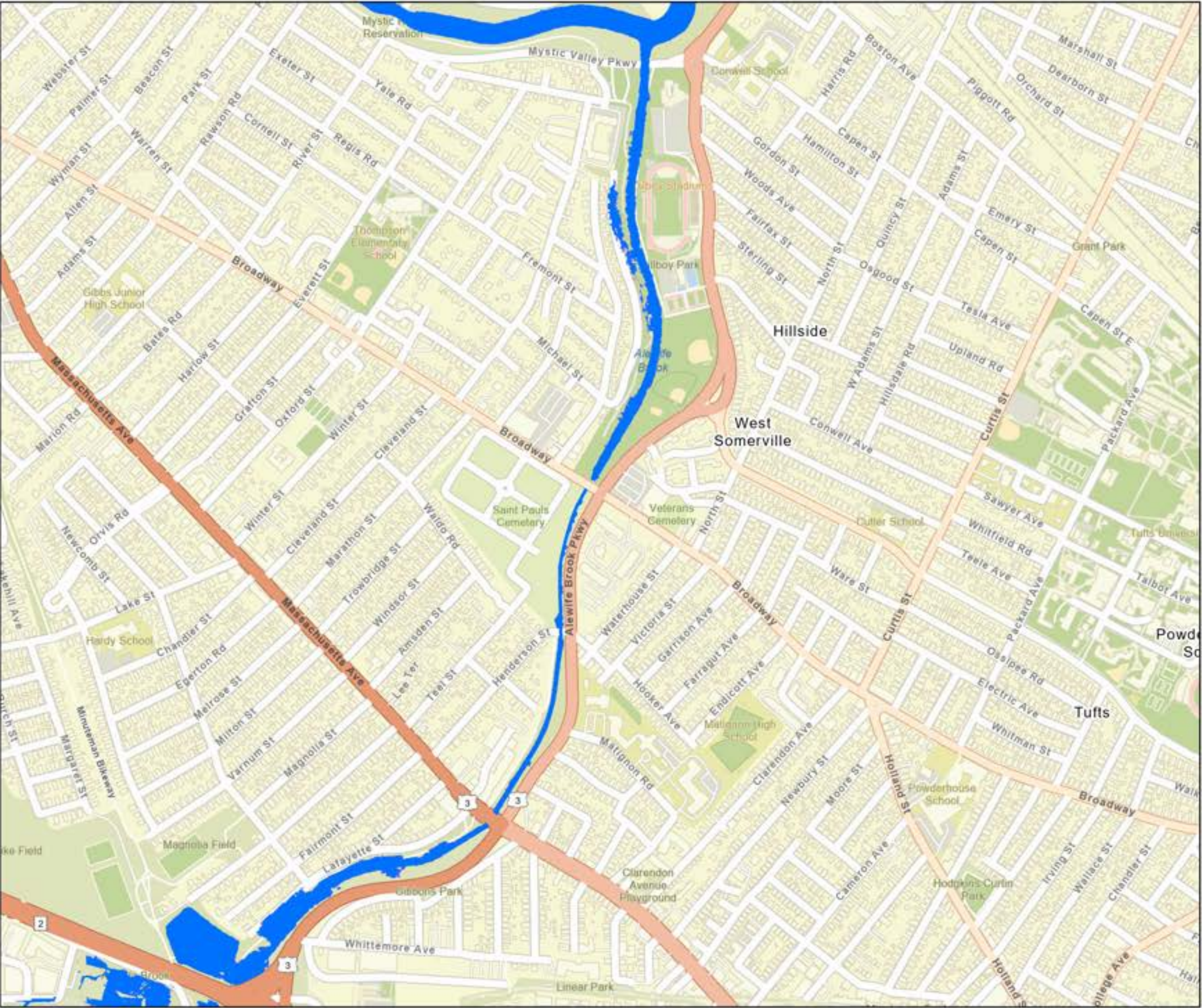


Title
Alewife Brook Flood Extent Map
Mystic Crossing Structure Removed
25-Year 24-Hour Present

Client/Project
Mystic River Watershed Association
Map Revised: May 2024

Project Location
Alewife Brook, MA

Legend
Blue: Mystic Crossing Structure Removed Flood Extent, 25-Year Storm
Pink: Existing Conditions Flood Extent, 25-Year Storm



Title
Alewife Brook Flood Extent Map

Draw Down - Dam Controls
5-Year 24-Hour Present

Client/Project
Mystic River Watershed Association
Map Revised: May 2024

Project Location
Alewife Brook, MA

- Legend**
- Draw Down - Dam Controls Flood Extent, 5-Year Storm
 - Existing Conditions Flood Extent, 5-Year Storm

Title

Alewife Brook Flood Extent Map

**Draw Down - Dam Controls
25-Year 24-Hour Present**

Client/Project

Mystic River Watershed Association

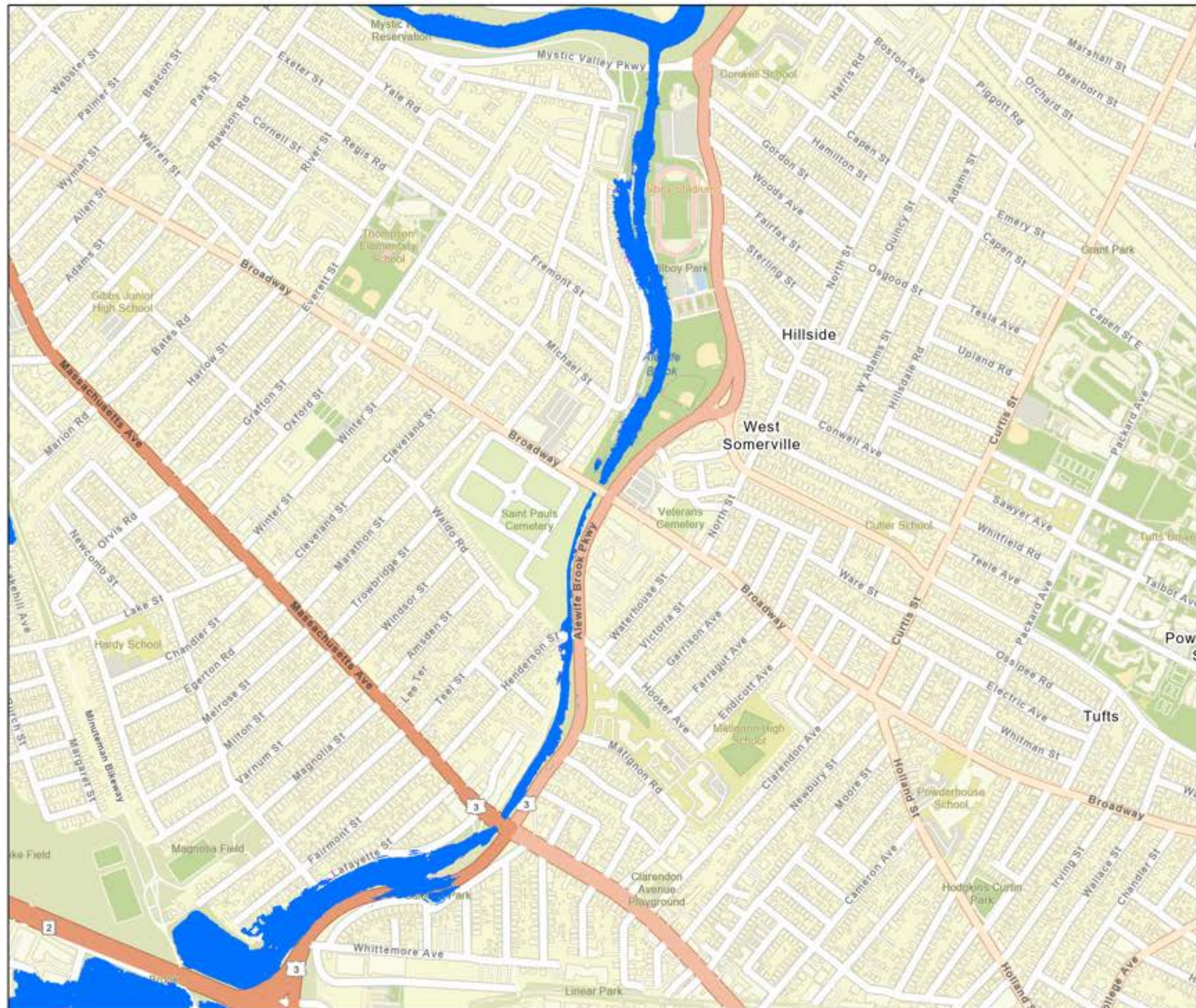
Map Revised: May 2024

Project Location

Alewife Brook, MA

Legend

-  Draw Down - Dam Controls Flood Extent, 25-Year Storm
-  Existing Conditions Flood Extent, 25-Year Storm



June 28, 2024
Andy Hrycyna

Reference: Alewife Brook Hydraulic and Stream Improvement Study

Appendix D – Surveyed Cross Sections and Field Data

XS1

○ Ground Points

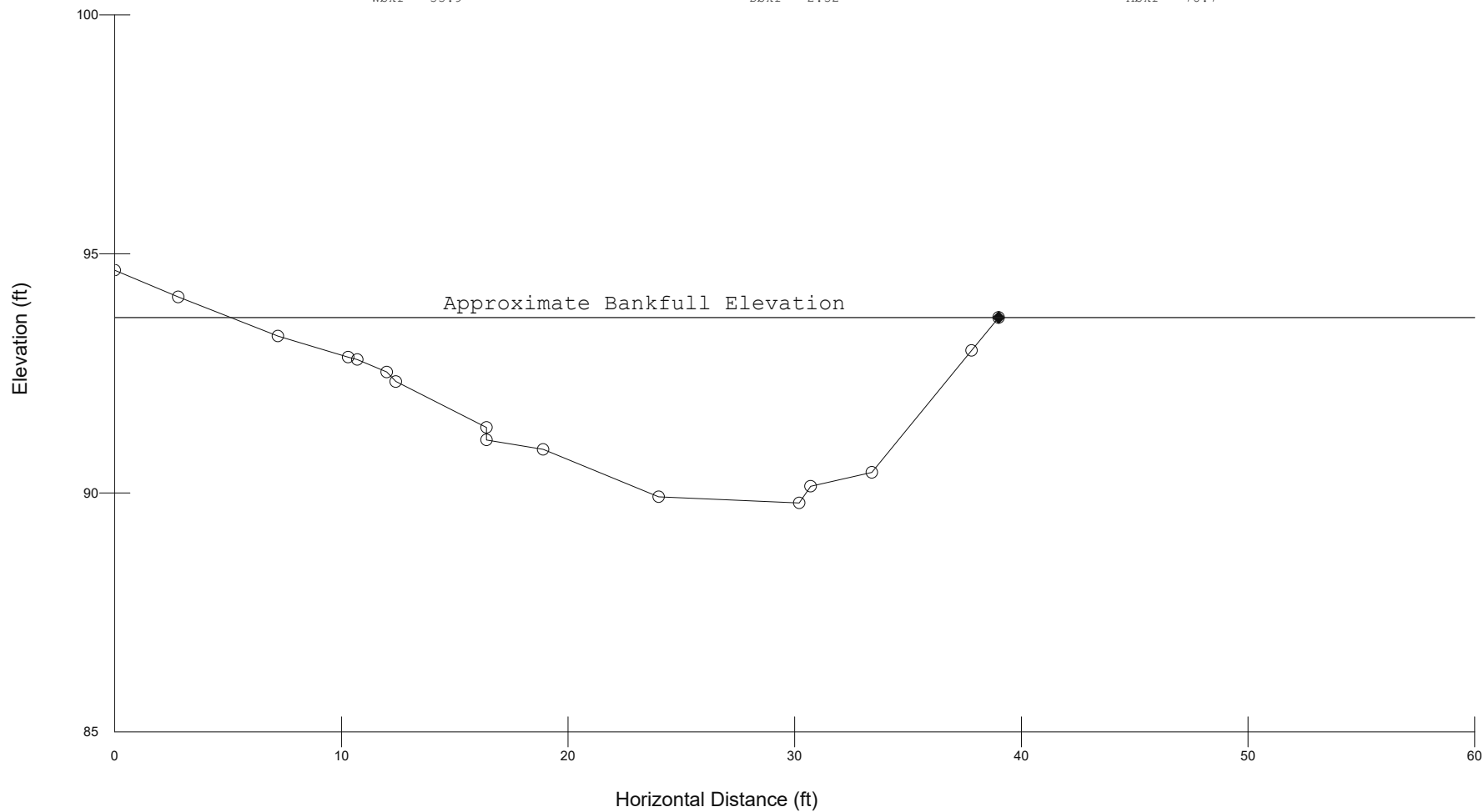
Wbkf = 33.9

◆ Bankfull Indicators

Dbkf = 2.32

▼ Water Surface Points

Abkf = 78.7



XS2

○ Ground Points

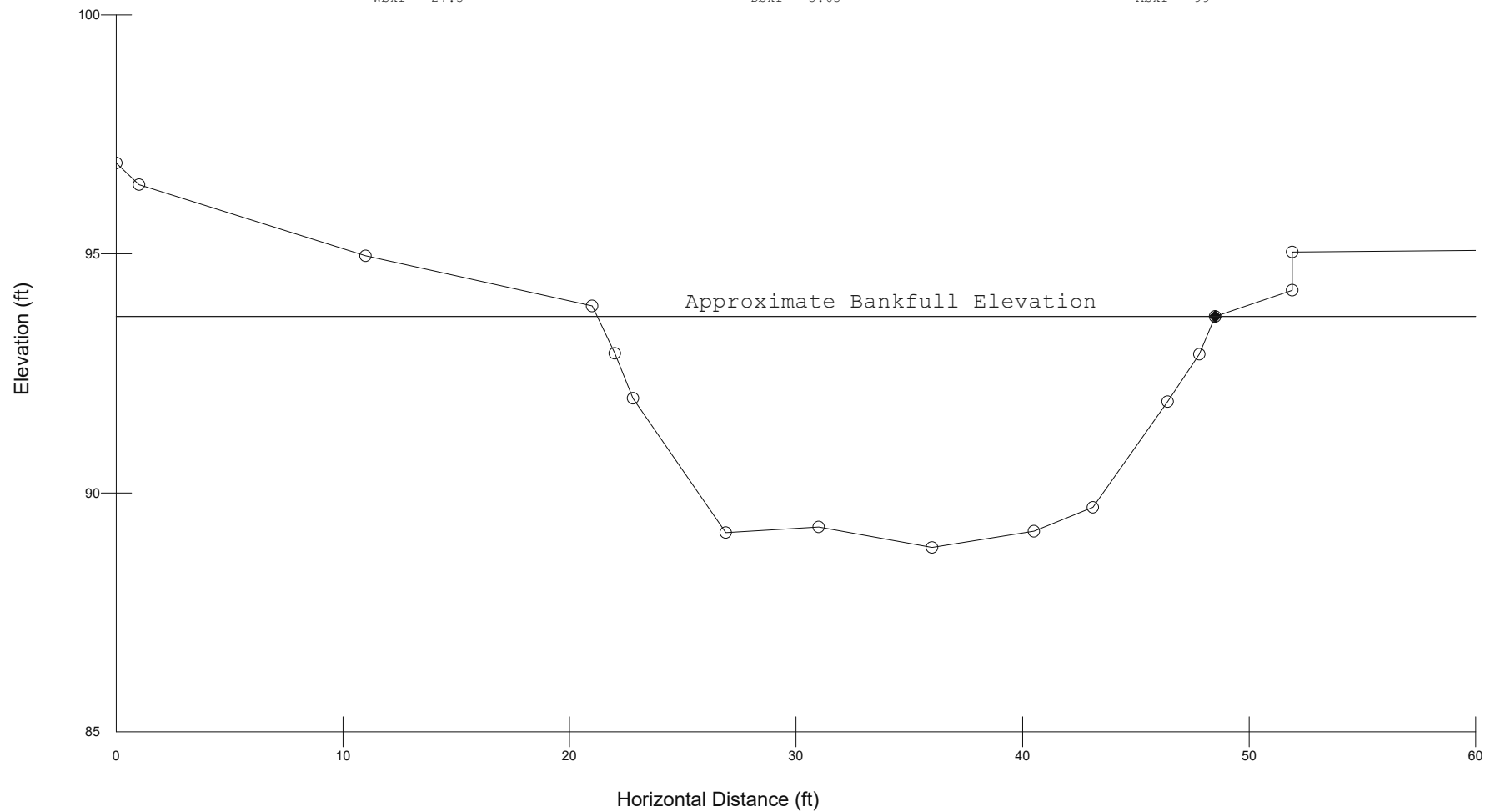
Wbkf = 27.3

◆ Bankfull Indicators

Dbkf = 3.63

▼ Water Surface Points

Abkf = 99



XS3

○ Ground Points

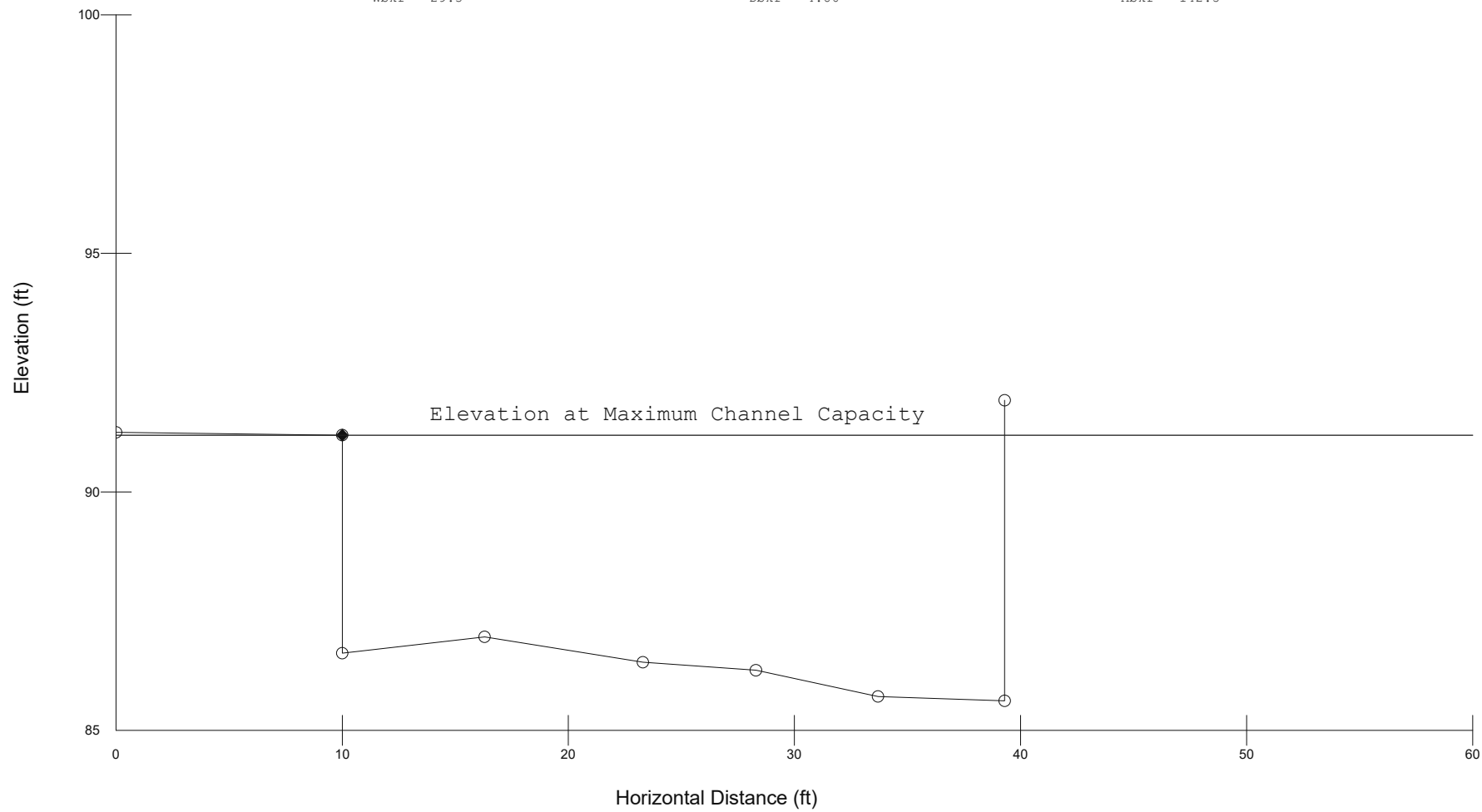
Wbkf = 29.3

◆ Bankfull Indicators

Dbkf = 4.86

▼ Water Surface Points

Abkf = 142.5



June 28, 2024
Andy Hrycyna

Reference: Alewife Brook Hydraulic and Stream Improvement Study

Appendix E – Site Photographs



Photo 1. CSO Outfall CAM-401A at upstream extent of study area.



Photo 2. Looking downstream from CSO Outfall CAM-401A.



Photo 3. Pedestrian bridge looking downstream along CAM-401A outfall drainage channel.



Photo 4. Looking upstream at Alewife Station Access Road crossing structure.



Photo 5. Looking downstream from Alewife Station Access Road toward Concord Turnpike.



Photo 6. Looking upstream from Concord Turnpike toward Alewife Station Access Road.



Photo 7. Concord Turnpike inlet at crossing structure, with debris jam



Photo 8. Concord Turnpike debris jam at inlet of crossing structure.



Photo 9. Concord Turnpike outlet of crossing structure.



Photo 10. Typical debris jam in Stream Segment 2.



Photo 11. Massachusetts Avenue inlet of crossing structure, with debris jam.



Photo 12. Debris jam at Massachusetts Avenue inlet.



Photo 13. Massachusetts Avenue outlet of crossing structure.



Photo 14. CSO outfall CAM-002 downstream of Massachusetts Avenue.



Photo 15. Looking upstream from Massachusetts Avenue at Stream Segment 2.



Photo 16. Looking downstream from Massachusetts Avenue at Stream Segment 3.



Photo 17. Typical debris jam in Stream Segment 3.



Photo 18. Henderson Bridge inlet of crossing structure.



Photo 19. Looking upstream from Henderson Bridge at Stream Segment 3.



Photo 20. Henderson Bridge outlet of crossing structure.



Photo 21. Looking downstream from Henderson Bridge at Stream Segment 4.



Photo 22. Typical debris jam in Stream Segment 4.



Photo 23. Broadway inlet of crossing structure.



Photo 24. Looking upstream from Broadway at Stream Segment 4.



Photo 25. Looking downstream through Broadway crossing structure.



Photo 26. Broadway outlet of crossing structure.



Photo 27. Looking downstream from Broadway at typical debris jams in Stream Segment 5.



Photo 28. Looking downstream toward Mystic Valley Parkway inlet of crossing structure.



Photo 29. Looking upstream from Mystic Valley Parkway at Stream Segment 5.



Photo 30. Looking downstream from Mystic Valley Parkway toward Mystic River.



Photo 31. XS1 (Stream Segment 2) looking upstream.



Photo 32. XS1 (Stream Segment 2) looking downstream.



Photo 33. XS1 (Stream Segment 2) looking toward left bank.



Photo 34. XS1 (Stream Segment 2) looking toward right bank.



Photo 35. XS2 (Stream Segment 3) looking upstream.



Photo 36. XS2 (Stream Segment 3) looking downstream.



Photo 37. XS2 (Stream Segment 3) looking toward left bank.



Photo 38. XS2 (Stream Segment 3) looking toward right bank.



Photo 39. XS3 (Stream Segment 4) looking upstream.



Photo 40. XS3 (Stream Segment 4) looking downstream.



Photo 41. XS3 (Stream Segment 4) looking toward left bank.



Photo 42. XS3 (Stream Segment 4) looking toward right bank.



Photo 43. Wetland Creation Area WL-1 (Stream Segment 2).



Photo 44. Wetland Creation Area WL-2 (Stream Segment 5).



Photo 45. Wetland Creation Area WL-2 (Stream Segment 5), looking east.



Photo 46. Wetland Creation Area WL-3 (Stream Segment 5).



Photo 47. Wetland Creation Area WL-3 (Stream Segment 5).



Photo 48. Wetland Creation Area WL-3 (Stream Segment 5).



Photo 49. Wetland Creation Area WL-4 (Stream Segment 5), upstream portion.



Photo 50. Wetland Creation Area WL-4 (Stream Segment 5), upstream portion.



Photo 51. Wetland Creation Area WL-4 (Stream Segment 5), downstream portion.



Photo 52. Wetland Creation Area WL-4 (Stream Segment 5), downstream portion.