Municipal Vulnerability Preparedness Program Action Grant Case Study

Municipality: Town of Andover
Project Title: Shawsheen River Nature-Based Flood Resilience
Award Year (FY): 2023
Grant Award: $ 271,705.00
Match: $ 91,350.00
Match Source: Town cash and in-kind town staff time, volunteer times, Gonzaga students and faculty time
One or Two Year Project: One Year
Municipal Department Leading Project: Community Development and Planning's Conservation Division, Public Works' Engineering Division, Information Technology's GIS Division and the Sustainability Department
Project Website URL:
https://experience.arcgis.com/experience/7f84651bc78f461680c5dd2990f306d0/page

Community Overview:

COMMUNITY SIZE AND LOCATION. The Town of Andover has a population of approximately 36,500 people and is located in Essex County, approximately 20 miles northwest of Boston.

ENVIRONMENTAL JUSTICE AND CLIMATE VULNERABLE COMMUNITIES. While Andover is one of Massachusetts' wealthier communities, as noted in the Town's Summary of Findings, 17.45% of Andover households (over 2,100 households in total) have incomes below $50,000. Andover also contains a large mapped environmental justice (EJ) community north of I-495. This EJ community has a median household income of $176,645 (well above the state median of $85,843) but is mapped as having a 48.3% minority population, with 20.9% of households with language isolation. Portions of this EJ community also overlap with the FEMA floodplains for the Merrimack River and Fish Brook. The EPA's EJScreen tool identifies additional areas in Andover as meeting demographic indicators of EJ communities. The neighborhood South of I-495 in Shawsheen Heights near the Shawsheen River is mapped as having 13% of its population under the age of 5, putting it at the 93rd percentile nationally for this vulnerable population. The EJScreen tool also indicates that the flood prone area along the Shawsheen River south of the Stevens Street bridge is mapped as having 29% of its population over the age of 64 (88th percentile); a similarly mapped area occurs just west of North Main Street along the Shawsheen (over 25% of residents over the age of 64; 82nd percentile). One additional area in the same vicinity (along High Street) is mapped as 8% linguistically isolated (82nd percentile).

There are three high-density, low-income housing communities along the Shawsheen River at an elevated risk from flooding: Andover Commons (50% of units are reserved for residents with incomes less than 50% of AMI), Marland Place (senior housing), and Frye Circle (a 96-unit Andover Housing Authority property that houses elderly and disabled residents). Marland Place, in particular, is recognized and categorized as having an extreme flood risk by the First Street Foundation's Flood Factor Tool.

Furthermore, resilientma.org indicates that the neighboring downstream City of Lawrence is mapped entirely as EJ communities based on the percentage of minorities, with many areas also mapped for English language isolation and/or income. The median household income for one mapped EJ community in the downtown Lawrence area is $18,882, with a 98.5% minority population, and 50.8% of households with language isolation.

UNIQUE TRAITS. Andover is an inland Town with significant waterbodies including the Shawsheen River, Fosters Pond, Pomps Pond, Haggetts Pond, and the Merrimack River forming the Northern border. Architecture found in Andover reflects the Town's historic past as a mill town, established in part with water power from the Shawsheen River. The region's first powder mill was established in Andover in 1775, and shortly after followed paper manufacturing and several textile mills. Andover is also known for being the home of Phillips Academy, one of the nation's oldest incorporated secondary schools.

Project Description and Goals.

LOCATION. The project was located along the Shawsheen River in Andover, extending into the neighboring City of Lawrence downstream.

CLIMATE IMPACT. The Town's MVP planning process in 2019 identified flooding as a particular hazard of concern following serious flooding events in May 2006 and March 2010. These major flooding events were triggered by heavy rainfall and caused many roads to close, schools to cancel classes, and residents to evacuate their homes. Climate projections analyzed during the prior year's project indicated total annual precipitation is expected to increase by 2.34 inches from 2020 to 2049 over historical averages from 1971-2000, while the annual days with precipitation greater than 2 inches are expected to increase by 23%.

GOALS AND TASKS. This phase of the MVP project focused on quantifying the flood mitigation benefits gained from future flood storage and/or restoration projects on high priority parcels of land along the Shawsheen River. Specifically, hydrologic and hydraulic (H&H) modeling was carried out to evaluate the existing and projected future flooding conditions. The project also included a multiday visioning workshop and design charrette held with community members to co-create nature-based conceptual restoration and flood storage projects along the Shawsheen River in the Town of Andover.

There were four major tasks and subtasks:

- Task 1: Project Kickoff, Management, and Reporting
    - 1.1 Kickoff Meeting
    - 1.2 Monthly Progress Reports
    - 1.3 Project Case Study
    - 1.4 Project Management
- Task 2: Public Involvement and Community Engagement
    - Print, Digital, and In-Person Engagement Activities

    - Community Liaison
    - Youth Climate Action
    - Equitable Engagement Enhancement
- Task 3: Modeling Nature-Based Solutions on the Shawsheen River
    - HEC-RAS Model Development
    - Modeling Nature-Based Solutions
    - Lawrence Desktop Screening
- Task 4: Visioning Workshop and Design Charrette
    - Design Charrette and Visioning Workshop

MEETING MVP GOALS. The project has met several goals described in the Town's application to the MVP Program. First, the project focused on using a science-based approach to incorporate nature-based solutions to address future climate-exacerbated flooding in the following ways:

- Quantifying current and future flooding impacts by developing a HEC-RAS model of the Shawsheen River that updates prior models with future climate projections;
- Developing novel nature-based project concepts for three high-impact sites along the Shawsheen River (Lower Shawsheen Soccer Field, Stevens Street Parcel, and the Sacred Heart Reservation) and quantifying the flood mitigation impacts of the planned nature-based solutions.

Second, the project addressed the goal of improving equitable outcomes for and fostering strong partnerships with EJ and other Climate Vulnerable Populations. This was accomplished by replicating the desktop site screen tool developed in the last phase of the Andover project and extending the work to identify flood mitigation project sites in the neighboring City of Lawrence, and by discussing the modeling work with residents of the Washington Park Condos who have suffered repeated flood loss events.

Third, the project provided regional benefits by A) enabling Abbott Lawrence High School students to take a class trip to the Ecology School in Saco, Maine to gain additional insights on how critical watersheds and river systems are to the health and safety of communities and protecting wildlife habitats, and B) establishing new connections to the Groundwork Lawrence and Essex County Greenbelt Association organizations through the planning and implementation of a multi-community public hiking and environmental educational event at the Den Rock Park reservation in Lawrence and Andover. Presenters and partners included the City of Lawrence residents, Lawrence Conservation Commission, Ground Work Lawrence, Andover Conservation Commission, Essex Greenbelt, the Merrimack River Watershed Council, the New England Flying Squirrel Network and the Andover High School Environmental Club.

Although four major successful outreach events were executed throughout the project this year (Resilience Workshop in April; Den Rock Hike and Public Walk-shop in May, and a virtual Community Design Debut in June) the project was not as successful as we would have liked in terms of recruiting a community liaison to further engage the City of Lawrence. The planned hiring of a bilingual student from the Greater Lawrence Technical School required undergoing a

formal hiring process through the Town of Andover. This required the creation of a position description by Human Resources, for which there was no prior Andover Town Meeting approval to support. Other attempts to identify an alternate community liaison outside of school setting were not successful.

In summary, all project deliverables were completed on time except for the community liaison task. The funding remains unspent.

Results and Deliverables:

The FY23 MVP project continues the progress made in identifying impactful parcels in the prior phase of the project and asks about the flood mitigation impact of deploying nature-based solutions on these parcels. To do so, a hydrologic and hydraulic (H&H) model was developed for the Shawsheen River to assess river flows within current climatic conditions as well as project conditions anticipated in 2030 and 2070, with the latter years incorporating more frequent and intense storm impacts brought on by climate change. The model was also calibrated using the USGS Balmoral Station stream gauge data that describe actual historic conditions from 2010 to the present.

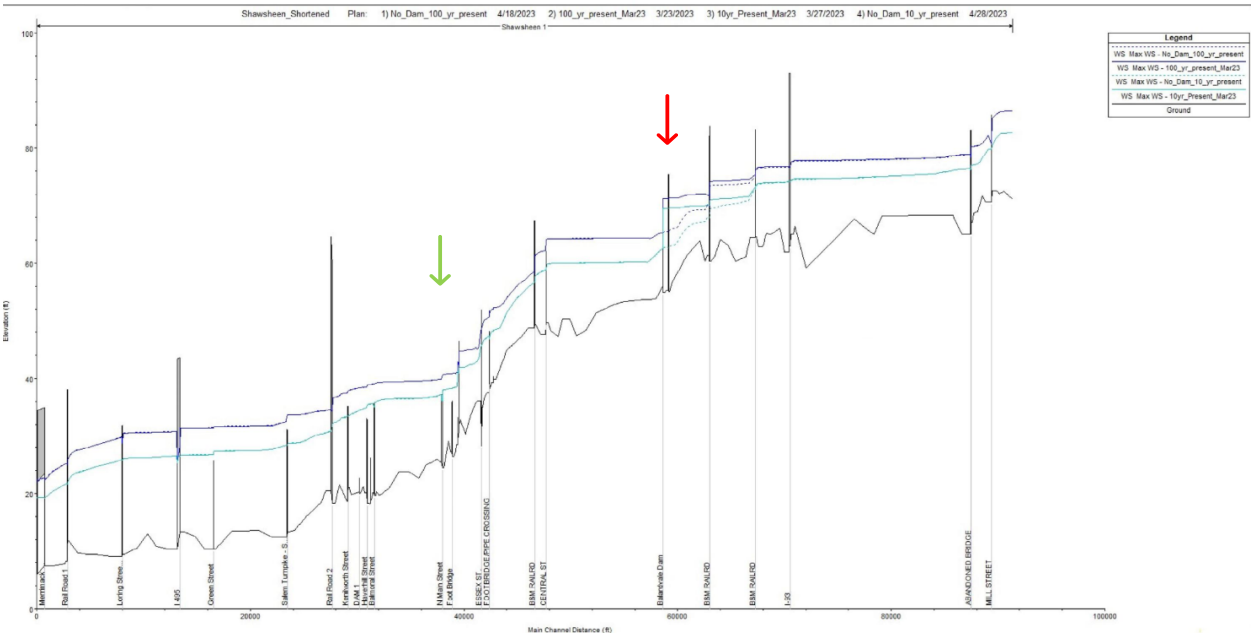
Three Andover land parcels abutting the Shawsheen River were chosen for further characterization: 56 York Street Parking Lot, Lower Shawsheen Field, and the Stevens Street parcels (listed from the northernmost to southernmost parcels). These parcels ranked among the most promising sites identified in last year's work, representing not only larger open areas with more room to store floodwaters but also proximity to populations vulnerable to flooding. Two of these parcels - York Street and Stevens Street - are privately held, and the Lower Shawsheen Field is owned by the Town of Andover.

The Stevens Street parcels not only have additional benefits in terms of ecological restoration but also are highly coveted by the Andover Open Space Task Force, which sees the parcels as a great opportunity to link adjoining protected lands. The York Street parcel is already marked as a flood-prone area but could be restored to reduce impervious pavement and flood storage. Last but not least, the Lower Shawsheen Field, - currently serving as a soccer field and track - would be ideal for river flow diversion and storage during intense storms, which may help to alleviate flooding on nearby residential properties.

Once these three top sites were identified, Fuss & O'Neill hosted a public "walk-shop" on May 22nd 2023 to gather community input that ultimately was incorporated into the final design and H&H modeling work. Each of these parcels was assessed separately. Of these parcels, the Stevens Street conceptual design was the most impactful. The new design involves raising the current Stevens Street Bridge by 3 feet and raising the road by 1 foot, in addition to incorporating nature-based solutions for river restoration and improving public access. The larger bridge opening allows the crossing to be sized for a 100-year storm in 2070 and reduced the 100-year flood depth by 1 foot between Stevens Street and Essex Street. The work would also involve adding stone cross vanes to support habitat creation and aeration of the river's

flows. Other amenities might include a river and wildlife viewing deck, a trail loop, and an access road with parking. The estimated cost of the Stevens Street concept is $8 million (without contingency), with the bridge elevation increase being the costliest component at $2.5 million.

A key question we sought to answer this year is whether the removal of the Ballardvale Dam, the sole obstacle to migrating aquatic wildlife that remains in the 25-miles long Shawsheen River, would impact future riverine flooding conditions. Disappointingly, we learned from the model that while removing the dam can lead to a difference in water depths at the dam's location, water levels 50 feet downstream of the dam and 2 miles upstream of the dam will remain within one inch of the initial conditions. The image below shows how the water depths change along the river. The dark blue lines represent a 100-year storm, and the light blue lines represent a 10-year storm. The solid lines are water surfaces with the dam in place, and the dashed lines are the water surfaces with the dam taken out.



At the location of the dam (red arrow), the model shows a decrease in water surface elevation of approximately 6 feet under all present-day storm events when the structure is removed. About 4,000 feet upstream of that, the change in water surface elevation is about 1 foot, and about 8,000 feet upstream of the dam, the difference is less than 2 inches. Downstream of the Balmoral Dam, in the North Main Street location where buildings are most prone to severe flooding (lime green arrow), the modeling shows virtually no difference between dam-in and dam-out conditions.

A key aspect of the work this year involved the addition of Gonzaga University professor, Dr. Sue Niezgoda and her four engineering students, Brooke Baker, Megan Fleming, Sydney Anyan, and Ryan Cooper who collaborated with the Fuss & O'Neill technical team to extend the desktop screening process developed earlier with the prior project to the City of Lawrence

parcels. The Gonzaga team's work required generating 15 maps within ArcGIS Pro and focused on parcels located within 100 meters of the 500-year FEMA floodplain. The mapping work took into account social and community assets (EJ priority areas and open space/recreational areas), as well as environment and ecology factors (landscape diversity, local connectivity, ecological integrity, etc). The Lawrence areas where multiple desktop site screening converge would yield high priority parcels to ground-truth in the future. The students also used H&H modeling to determine the projected peak flows at the Shawsheen and Merrimack River confluence, and were able to determine that 2070 conditions would increase peak flows from 3000 to nearly 5000 cfs, introducing new areas of at-risk properties in the future. These results will be shared with City of Lawrence Planner, Daniel McCarthy, by email.

Summary of Deliverables Attached

- Task 1: Project Kickoff, Management and Reporting
    - Kickoff meeting notes and sign-in
    - Monthly reports
    - Final case study report and slides
- Task 2: Public Involvement and Community Engagement
    - Print and digital materials, including website
    - Event memos and photos
    - Presentations
- Task 3: Modeling Nature-Based Solutions on the Shawsheen River
    - Flood assessment outcomes, including dam-in and dam-out conditions
    - Nature-based concepts and plan view graphics with cost estimates
    - Desktop screening maps of South Lawrence
- Task 4: Visioning Workshop and Design Charrette
    - Workshop document package summarizing process, community input and proposed vision

Lessons Learned

There were two major lessons learned during this project.

First, flood mitigation work in Andover is likely to consist of multiple nature-based solution implementations, as well as substantial gray infrastructure updates. The three sites examined during this project offered 1 foot or less of flood depth reduction by 2070, leaving many properties exposed to multiple flood losses. Removal of Ballardvale Dam also does not greatly alleviate downstream flood-prone properties, although its removal would lower the risk of additional harm associated with dam failure during storms. The modeling work shows that many Andover properties that are in the current 100-year flood plain will likely be in the future 10-year flood plain; de-risking flood impacts will require either substantial property elevations or in some cases, managed retreat.

Second, community liaison work in the City of Lawrence to raise awareness about Andover projects that impact the Lawrence community can best be done by a permanent staff of an established grassroots organization with experience working in local neighborhoods, as well as ideally established relationships with City of Lawrence officials. The concept of enlisting the assistance of a bilingual student at the Greater Lawrence Technical School to serve that role, born of our earlier successes in working with high school students, was ultimately unworkable. Full details of how to bring a student on board as a Town of Andover part-time staff were not disclosed before the application. Had those requirements (CORI, position description posting, interviews, desk space, and full-time supervision) been shared, the Town would have sought alternative avenues to fulfill that role. Unfortunately, multiple emails inviting City of Lawrence officials to attend events and workshops were not responded to.

That being said, we are optimistic that the new bonds forged with Ground Work Lawrence will be strengthened and lead to more robust cooperative projects in the future – including perhaps a bilingual project liaison.

Partners and Other Support:

- Town Departments- Grant Management
    - Engineering Division – Mily Puello, Joe Assenza, and Paul Gahinet (Bathymetric measurements)
    - Conservation Division- Bob Douglas, Ben Meade, Marisa MacDonald, and Lynn Viselli (Events, Coordination with Conservation Commission)
    - GIS Division- Jeff Cary (Storymap, Essex Tech coordination)
- Fuss & O'Neill- Technical Leads
    - Resilience Planner – Alex Maxwell
    - Hydrology and Engineering – Sarah Frisby, Lara Sup
    - Landscape Architects and Designers- Andrew Bohne, Jeffrey Dawson, Michael Frederik, Ian Law
- Groundwork Lawrence – Tennis Lilly, Eric Lundquist, Eddie Rosa; coordination on Den Rock Park community hike and watershed expo
- Essex County Greenbelt Association- Cathy Lanois and Mary Ellen Kelly; coordination on Den Rock community hike and watershed expo
- Becky Zawalski - Merrimack River Watershed Council; coordination on Den Rock Park community hike and watershed expo

Project Photos

1. Conceptual Design of Stevens St
2. Hydraulic Modeling
3. Public Site Walk
4. Den Rock Park Hike and Watershed Expo (Greenbelt Table)
5. Den Rock Park Pond and Wetland Lookout Deck

Photo 1: Screenshot of the Stevens Street Conceptual Design and Features Shared With Residents in June, 2023.

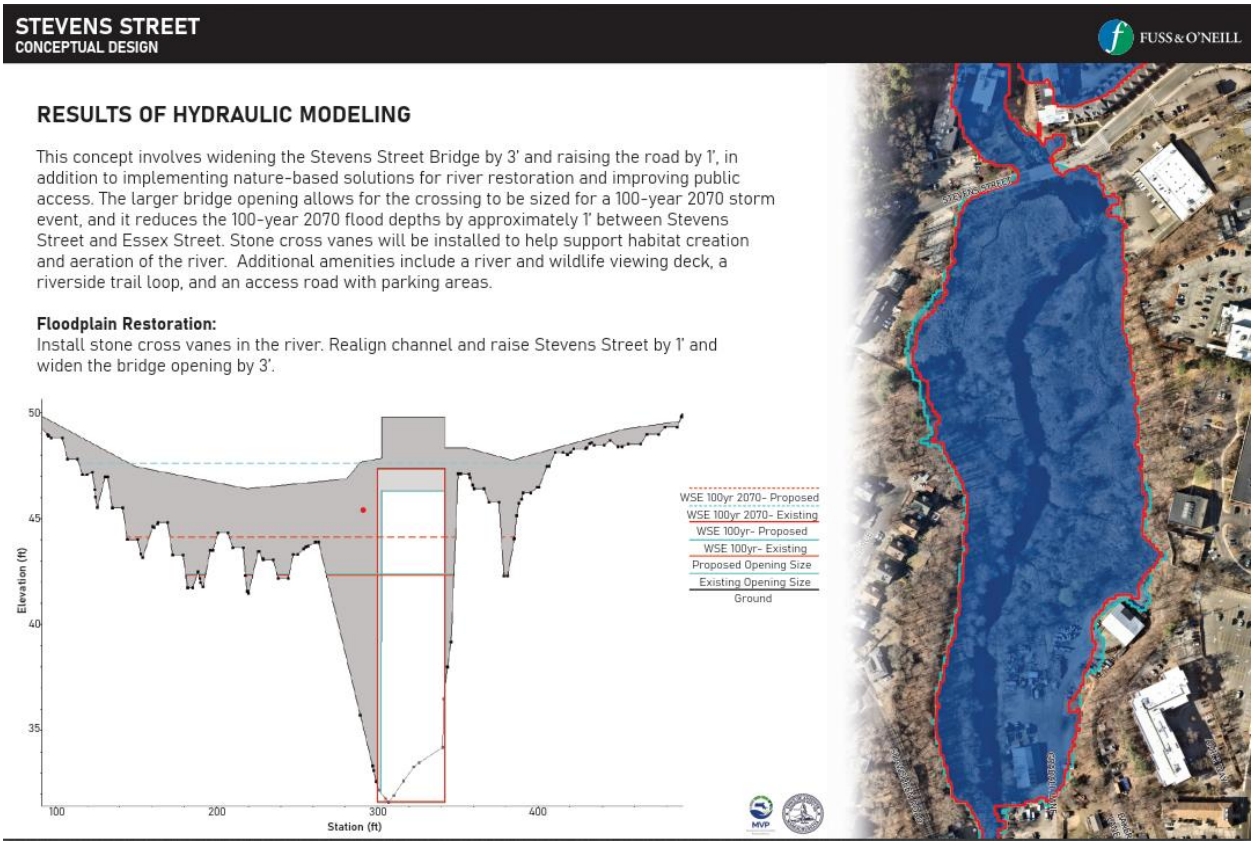


Photo 2: Screenshot of the Stevens Street Hydraulic Modeling and Flood Impact Shared With Residents in June, 2023.

Photo 3: Community Gathers for Public Walk-shop in Andover in May, 2023.

Photo 4: Essex County Greenbelt Display at the Den Rock Park Hike and Watershed Expo in Lawrence in May, 2023.

Photo 5: Andover Conservation Agent Explains Wetland Features in Den Rock Park Hike in Lawrence in May, 2023.