Town of Braintree Monatiquot River Watershed Study

A comprehensive study of Stormwater Management,
Water Quality Improvement & River Access and Recreation

May 31, 2011

Prepared for

Town of Braintree Massachusetts
Mayor Joseph C. Sullivan
Planning & Community Development Department

Prepared by

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EXECUTIVE SUMMARY

The Town of Braintree is of integral importance to the cultural history of New England. Its proximity to Boston, its historic figures, and industrial history make it a landmark unto itself in the great history of the United States. Monatiquot River has played an important role in the town's great history. Over time, people's relationship with the river has evolved from daily necessity and industrial utilitarian usage to scenery and recreational amenity. However, currently there is limited public physical access to the water and a lack of connection to regional greenway system. In addition, the extreme flood in March 2010 signified the prolonged urbanization impacts on floodplains and massive impervious surfaces in the watershed. Under the climate change effects, Braintree is likely to face more frequent and severe storms that affect safety and welfare of the increasing population of Braintree residents. Finally, water quality in Braintree has been a concern as a downstream community in the increasing urbanized watershed with missing links of riparian buffers along the river.

The main goals of this project therefore are to provide stromwater management strategies, improve water quality management and to evaluate accessibility and recreation opportunity of the Monatiquot River within the Town of Braintree.

This project underwent a series of data dredging and assessment through meetings with the members of the Planning & Community Development Department and Public Health Department, site observations, GIS data analysis and assessment at Weir subwatershed scale and town scale using a SWOT (Strength, Weakness, Opportunities, and Treats) analysis methodology, and a public community workshop. The studio then synthesized those findings in company with relevant case studies and developed planning and implementation strategies for each project goal.

The recommendations put forward in this report aim to enhance long term sustainability of the town. It is founded on research of sustainable urban design and sustainable community development principles. It is important to note that no single solution is the answer, but rather a network of infrastructure that maintains portions of the overall goals at all scales. For example, implementation of a rain garden on every residential and commercial property can have aggregated effect in managing stormwater and improve water quality in Braintree and the watershed as a whole. However, implementation of BMPs along does not free the community from flooding risks. A combination of short-term and long-term flood mitigation and risk management

in coping with extreme events should be integrated into long range planning process considering floodplain acquisition, floodplain and wetlands restoration, disaster preparedness, response and recovery plans, and climate change mitigation and adaptation plans.

Key recommendations indicated in this report include:

- Implement Best Management Practices at all scales (subwatershed, town, and site scales) on all land uses to reduce impervious areas, increase infiltration, and improve water quality.
- Establish continuous riparian buffers and restore ecological and hydrological functions for flood control and water quality improvement
- Develop long-term plans for acquisition of floodplain properties and restore hydrological functions of floodplains
- Provide access to the river through redevelopment of Armstrong Factory and Robert Salvaggio Recycling and enhancement of access facilities at existing golf course and the Route 3 rotary with future trail connections to Pond Meadow and Watson Parks
- Initiate a Monatiquot River Greenway System connecting both local and regional recreation systems
- Develop Monatiquot River Outreach and Education Programs that help to bring the awareness of watershed issues, facilitate BMPs implementation, and build a long term stewardship with the river

Braintree can achieve this grand vision through readily available public support. Strategies implemented at all levels of town structure, from neighborhood to governmental office, from primary school through high-school increase the knowledge and stewardship of each individual within Braintree. Connecting natural nodes and corridors encourages exercise, engagement with each other, and engagement with their ecological and cultural history. It allows for creating a sense of community that is strongly connected to their environment and history. Furthermore, a stronger social capital and an increase in economic capital can be gained as a result of long term stewardship with the river.

Braintree is now in a critical path to a sustainable future through comprehensive town planning processes. By reconnecting people to the Monatiquot River, Braintree will gain an invaluable asset to each person and the community as a whole.

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1. INTRODUCTION

The Town of Braintree (Braintree) is located ten miles south of Boston, Massachusetts, as part of the Boston Metropolitan Area. In March 2010, Braintree experienced a major flood event when the Monatiquot and Farm Rivers overflowed their banks after over nine inches of rain fell within three days. Braintree has concerns about flood mitigation as well as water quality improvement. Moreover, even though the Monatiquot River meanders through Briantree, there is limited public physical access to the water. Since the first settlement in 1634, Braintree has developed a close relationship with the Monatiquot River. Over time, people's relationship with the river has evolved from daily necessity and industrial utilitarian usage to scenery and recreational amenity. However, properties along the river are largely privately owned, which in turn limits the benefits of using the river as an asset. While Braintree is making efforts toward a more resilient and sustainable community, the main goals of this project are to provide stromwater management strategies, improve water quality management and to evaluate accessibility to the Monatiquot River within Braintree.

1.1 PROJECT RATIONALE: URBANIZATION IMPACT AND CLIMATE CHANGE

Primarily a residential suburban community, the population of Braintree has risen 5.2% in the last ten years according to Census 2010, continuing with the population trend from the past decades (Figure 1). The historical settlement patterns and current development practices have posed significant threats to stormwater management, as well as water quality. Assessment of conventional development patterns, current land use, existing ecological conservation and preservation initiatives as well as consideration to climate change concerns benefit the future health of the Monatiquot River.

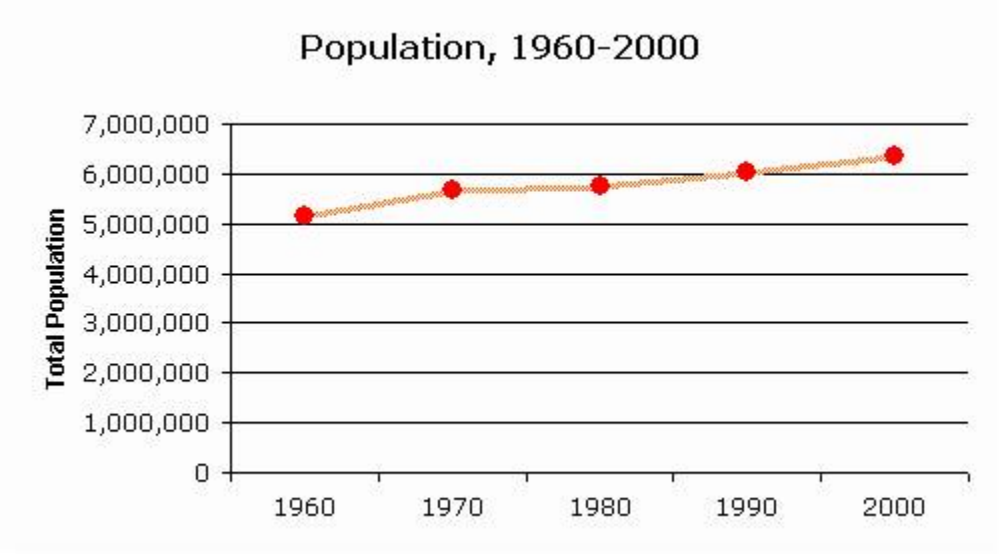

Figure 1: Massachusetts Population Trends. Source: Census 2000 analyzed by the Social Science Data Analysis Network (SSDAN). Accessed through http://www.censusscope.org/us/s25/chart_popl.html

The conventional development pattern alters hydrologic cycle as a result of impervious areas that include buildings, roads, parking lots, and any paved surfaces. The increasing impervious surface contributes to decreasing infiltration and increasing stormwater runoff (Figure 2). Consequently, the base flow for streams and rivers becomes flashy and the risk of *flash flood* (see Glossary) increases (Figures 3) in the urbanized areas.

In order to manage water quantity, an effective stormwater management system needs to be put in place at multiple levels (small, medium and large projects; short, medium and long-term goals). An effective stormwater management system and implementation of Best Management Practices (BMPs) can reduce stormwater surface runoff that is associated with *flash flood* risks (Figure 3). In addition, increased infiltration and use of wetland plants can reduce pollutants carried by runoff thus improving water quality.

From the climatic trends through the past five decades and projections throughout this century in the Northeast region, it is likely more frequent and severe storm events would occur in addition to earlier snow melt and longer summer (Figure 4). For example, the 100-year storm in the past may have a greater probability to become 25-year storms now and in the future. With the growing population in Braintree, it is likely more people will be affected and a greater damage to the town from extreme events will occur if urbanization and climate change impacts are to continue and become even more severe.

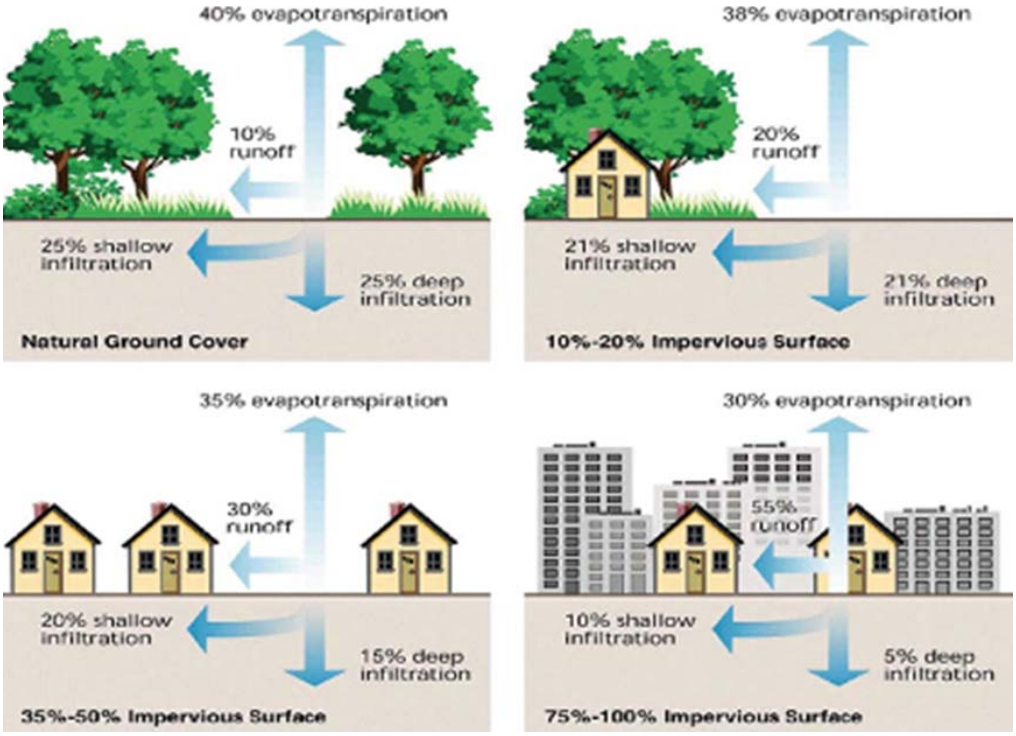

Figure 2: The increase of impervious surfaces as a result of urbanization process contributes to the increase of runoff and decrease of infiltration into the soils. The increasing runoff affects water quality through non-point source pollution and severity of flooding events. Source: EPA, 2003.

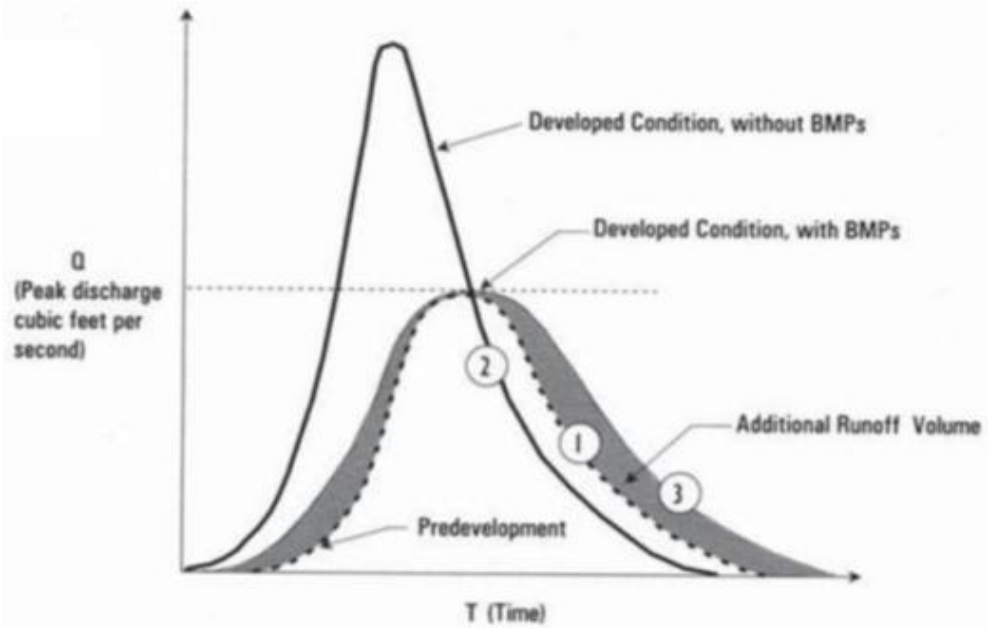

Figure 3: The hydrograph shows that under the developed condition without BMPs, stormwater runs off a higher level of impervious surfaces without having the opportunity to infiltrate into the soil. This raises peak flow and lowers base flow of the river. Source: MDEP, 2007.

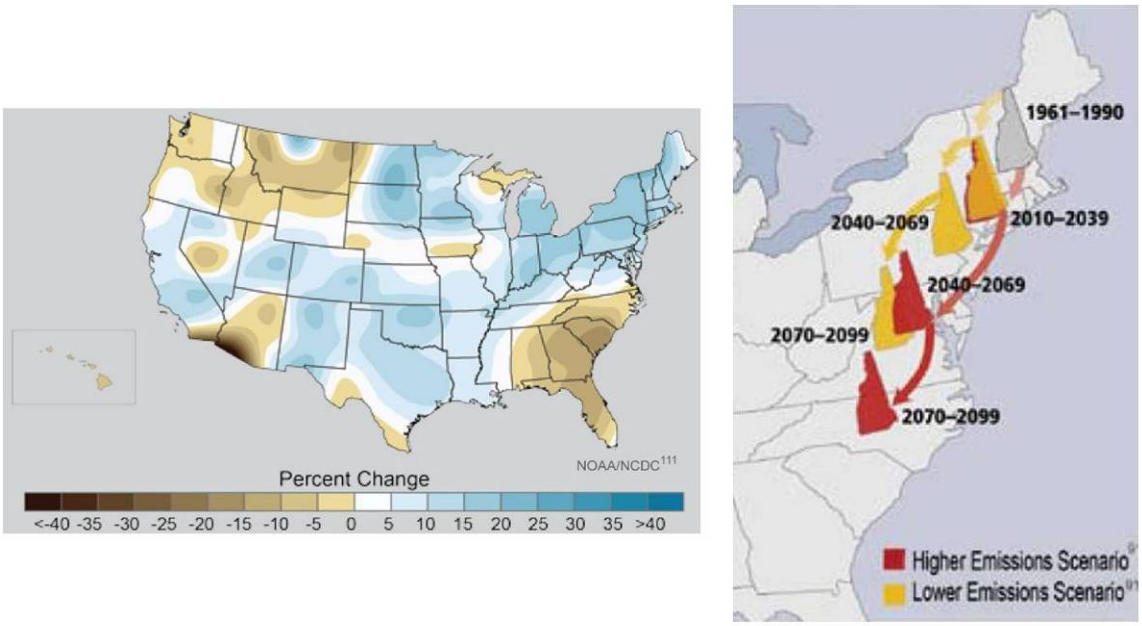

Figure 4: Climate change trends in the Northeast region. Left image shows observed changes in annual average precipitation from 1958-2008 indicating the region has increased precipitation. The right image shows projected changing summer in New Hampshire illustrating increased hot days are likely to occur in the region. Source: Global Climate Change Impacts in the United States, 2009.

1.2 PROJECT RATIONALE: REGIONAL CONNECTIVITY

Regional connectivity is a vital aspect to the strategies proposed here. This connection to surrounding communities including the Metro-Boston area promotes local tourism, investment, and pride with an overall recreational greenway system. This is also of beneficial consequence to natural functions: providing safe pathways for woodland animals, and creating extended vegetative communities that can share in groundwater filtration and carbon sequestering. A system that is connected throughout has a better chance of mitigating and surviving extreme weather pattern occurrences, allowing stormwater to be better controlled.

1.3 TOWN INITIATIVES AND PRECEDENT STUDIES

Braintree has taken several planning initiatives in improving the town's health and safety. These include: no new developments allowed on floodplains; no combined sewer overflow (CSO) systems; passing the Community Preservation Act (CPA) in 2002;

and a push to widen the river buffers. There have also been, and continued to be, ecological studies such as: Hazard Mitigation Plan (HMP); updated open space and recreation plans; Herring studies; and a Brownfield and Community Engagement Plan. These policies and studies provide a significant source of information that can be used to guide BMPs designs, and to guide future legislation. There have also been many successful BMPs implementation strategies created throughout the United States from which to draw ideas, and problem solving strategies.

1.4 PROJECT APPROACH

Braintree has already provided significant policies and data from which future planning can be based. The purpose of this study is to augment these efforts with comprehensive plans that address concerns in the short- and long-term. These plans will address issues of water quantity, water quality, and public access to the Monatiquot River on multiple scales (small scale sites through large scale town-wide and sub-watershed areas).

This document is the product of a process comprised of several distinct phases which built upon and informed each other.

Phase I: kick-off meeting and site visit. A meeting held on March 9, 2011, in Braintree with members of the Planning Department and Public Health Department provided data and insight into the current and historic flooding patterns of the Monatiquot River. Town Conservation Planner Kelly Phelan led a town-wide tour to visually access various areas of concern along the Monatiquot River.

Phase II: data inventory and assessment. The studio was divided into three teams, each concentrating on one of the three goals identified by the client. Initially, the teams undertook general exercises aimed at developing a familiarity with the use of GIS (Geographical Information System, computer-based data analysis and mapping software). This computer program provides the capability to categorize swaths of land based on criteria and indicators specific to issues to be addressed and then draw conclusions from the assessment. This was followed by more specific exercises which explained areas of information pertinent to the focus of each team. Each team then analyzed data using a planning assessment procedure to identify Strengths, Weaknesses, Opportunities and Threats (SWOT) relevant to respective project goal.

Phase III: community workshop. The studio then conducted a town-sponsored community workshop on the evening of April 6, 2011. Research of local and regional case studies and precedents was undertaken and used to develop recommendations presented at the workshop. This event was attended by about 40 residents, town officials and journalists. After a brief introduction, participants completed a written survey and joined each of three focus group discussions. Results and conclusions drawn from this meeting are discussed in this report and supporting materials are included in Appendices 12.1-12.4. The workshop clearly focused and directed the remainder of the project and final recommendations.

Phase IV: planning and implementation strategies development. The studio has analyzed information gathered from case studies, GIS mapping, and public participation surveys to propose planning and implementation strategies. The project and its results were presented to faculty, staff and the public at the University of Massachusetts Amherst prior to the final preparation of this report. The presentation helped to strengthen and clarify the final report.

1.5 ORGANIZATION OF THE REPORT

Throughout the entire project, each of the teams collaborated closely, sharing data, ideas and insights. We believe that comprehensive approaches provided in this report would allow Braintree to become more resilient to flooding, address water quality concerns, and provide accessibility along the river as well as the future creation of a greenway system that links Braintree to surrounding communities.

Chapter 2 summarized Braintree's history, overall context (geographic and cultural), and the history of the Monatiquot River followed by a vision statement (Chapter 3). Chapter 4 provides planning assessment results at sub-watershed scale. Chapter 5 through 7 detailed analyses at town scale and proposed strategies for stormwater management, water quality, and recreational access to the Monatiquot River respectively. During the planning processes, we feel strongly that public outreach and education is a key to the success of reaching the goals. A proposed outreach and education program for the town can be found in Chapter 8 followed by conclusions (Chapter 9).

Chapter 10 provides a glossary listing technical terms that are frequently used in this report. Chapter 11 is a list of reference and resources. Finally, Chapter 12 includes documents used for public workshop and a summary of stormwater BMPs tools.

2. BACKGROUND

2.1 TOWN HISTORY

Braintree was initially named Mount Wollaston after its founder in 1625. It was then renamed Merry Mount and subsequently named Braintree after the English town in 1640. The surrounding towns of Randolph, Quincy, Milton, and Holbrook were then split from Braintree into individual communities.

Braintree is home to notable births of influential people in the history of the United States including Presidents John Adams and John Quincy Adams, statesmen General Sylvanus Thayer, the founder of West Point Military Academy in New York, and John Hancock, noted signer of the Declaration of Independence. The retirement home of the co-founder of the telephone, Thomas Watson, is also located in Braintree.

Braintree is also home to the famous Sacco and Vanzetti Murders in 1920. Ferdinando Sacco and Bartolomeo Vanzetti were convicted of robbing the Slater-Morrill Shoe Company on Pearl Street and murdering the paymaster and security guard there. The murders are infamous for the controversial trial and series of appeals over a six-year period.

Figure 5: John Quincy Adams, John Adams, Ferdinando Sacco and Bartolomeo Vanzetti respectively. Sources: (left) http://millercenter.org/president/jqadams
(middle) http://www.ushistory.org/declaration/signers/adams_j.htm
(right) http://law2.umkc.edu/faculty/projects/ftrials/saccov/saccov.htm

2.2 TOWN CONTEXT

Braintree is a suburban community located ten miles south of the City of Boston, Massachusetts. Figure 6 shows the location of Braintree and the Weir sub-watershed in the context of the state of Massachusetts. Braintree is located in the Weir sub-watershed encompassing a 14.5 square mile area (Figure 7). Braintree also has a strong business culture. The South Shore Plaza Mall is one of the largest regional shopping centers in the Northeast. Braintree is situated adjacent to main travel arteries including Interstate 93 and Routes 3, 53, and 37 which make it an ideal location for easy travel to Boston or Cape Cod.

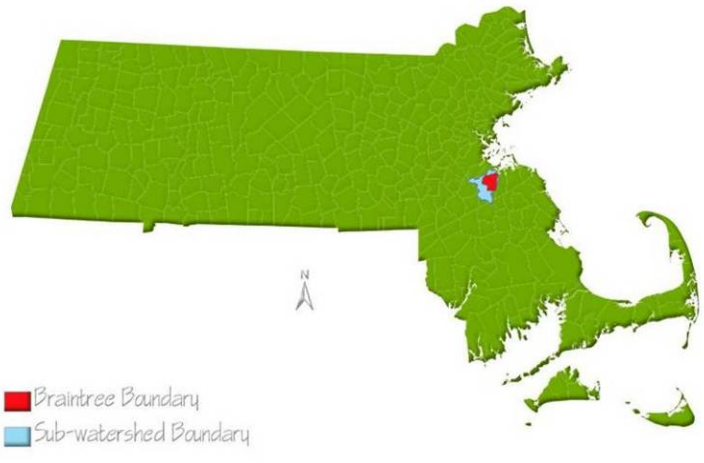

Figure 6: The location of Braintree with the sub-watershed and Massachusetts

Figure 7: Town of Braintree located in the Weir sub-watershed.

Braintree is home to a public 18-hole golf course. Popular water destinations are Sunset Lake and Smith Beach. Destinations include the DCR Blue Hills Reservation and its recreation trail system located in the surrounding communities of Quincy, Dedham, Milton and Randolph. Pond Meadow Park spans the towns of Weymouth and Braintree and is comprised of a 320 acre conservation area. The park provides several miles of walking trails as well as a two-mile stretch of paved bike paths. Trails pass through meadows, woodlands, marshes and past Smelt Brook and a 20 acre pond. The pond's dam provides flooding protection for Weymouth Landing. In addition, Braintree's Independence Day Celebration is held at Braintree High School every year with as many as 20,000 people in attendance.

The Massachusetts Bay Transportation Authority (MBTA) red line terminus and numerous bus lines provide public transportation to and from surrounding communities including the greater Metro-Boston area. The MBTA is beneficial to Braintree as it promotes connectivity.

Figure 8 illustrates that Braintree has a wide variety of land uses showing the extent of residential, commercial and industrial uses throughout Braintree. Braintree's forest land shown in Figure 9 offers potential areas for infiltration of water into the soil and access points to the Monatiquot River. Figure 10 illustrates a compilation of flood zone areas in Braintree showing the vulnerability of existing and future development within flood zones located along the Monatiquot River.

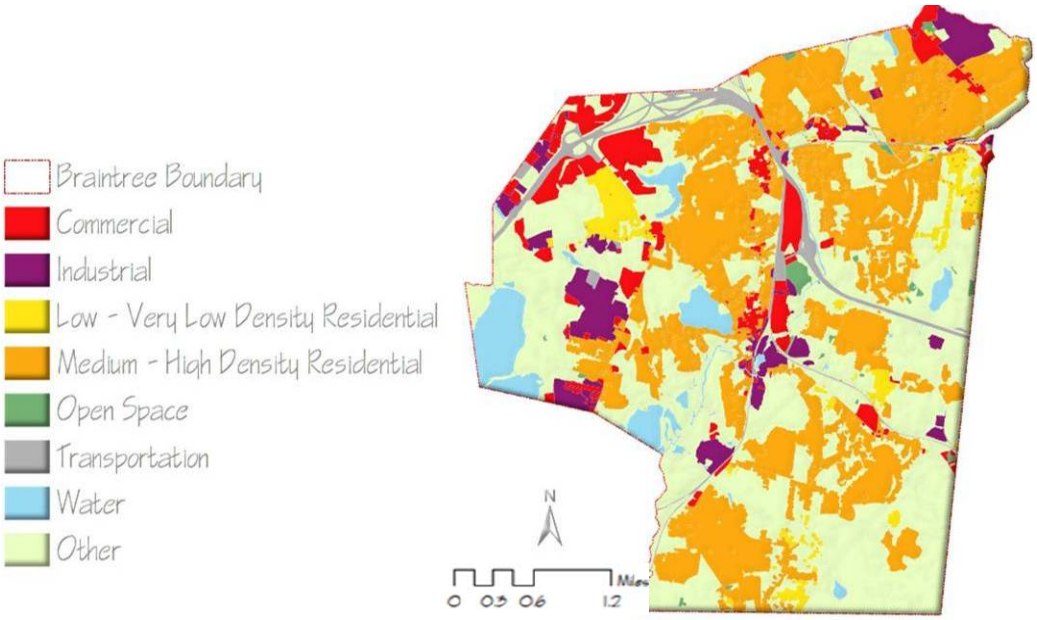

Figure 8: Land Use in Braintree (2005). Source: MassGIS.

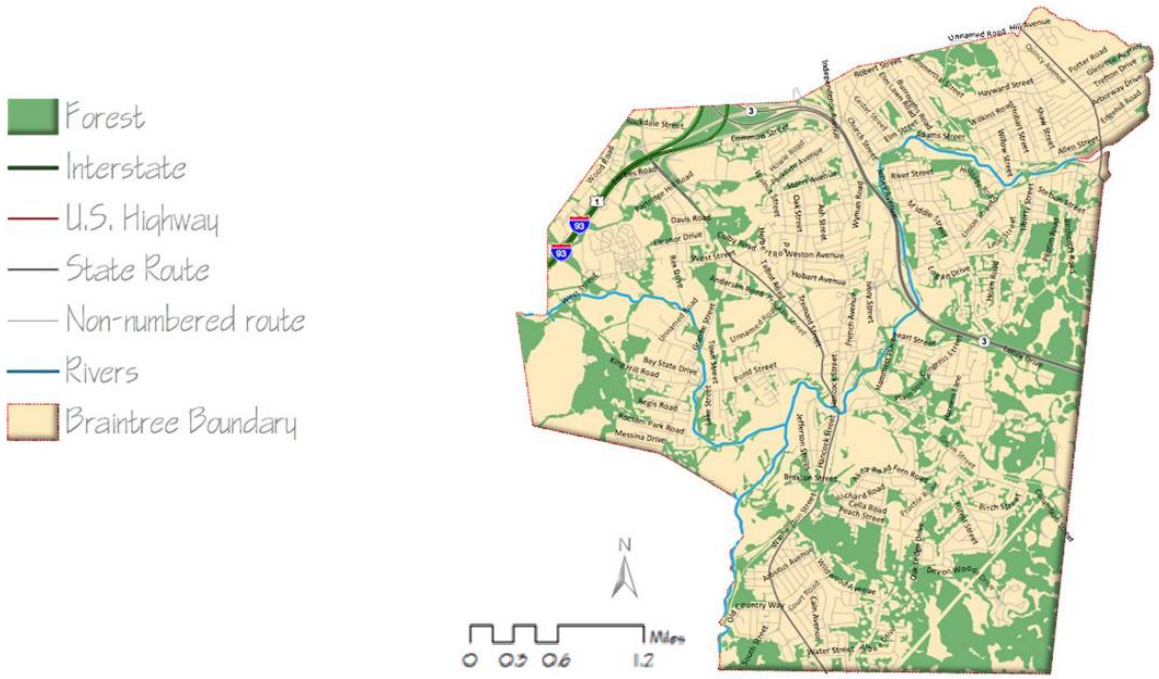

Figure 9: Forest Land in Braintree. Source: MassGIS.

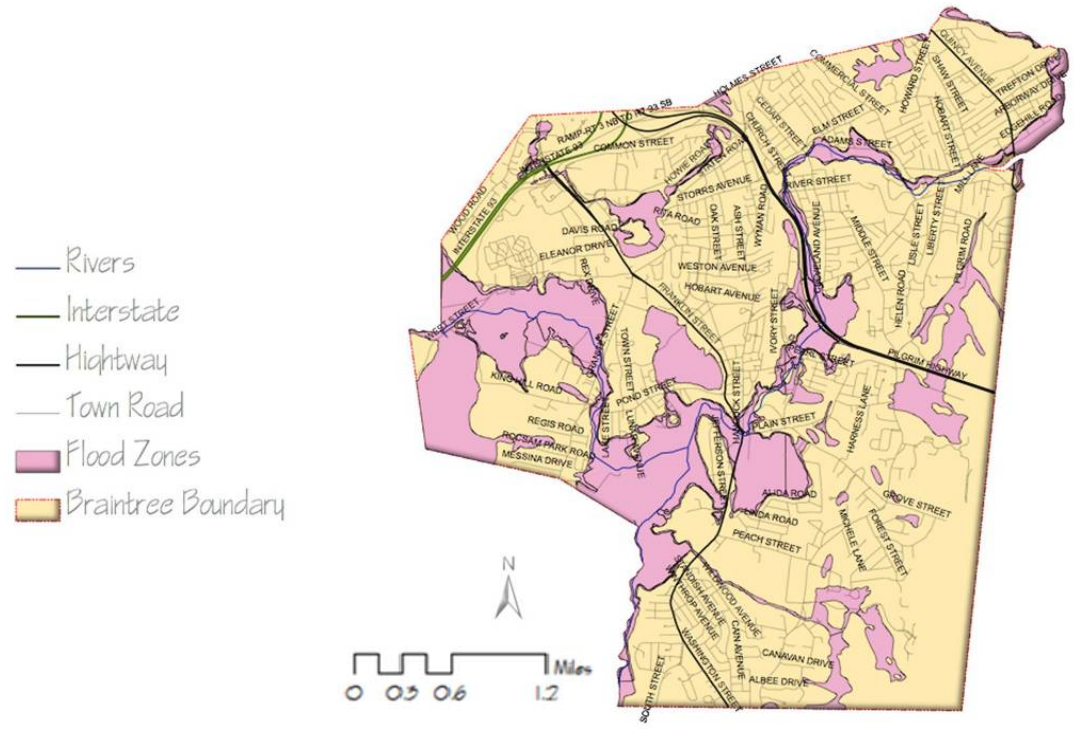

Figure 10: FEMA Flood Zones in Braintree. Source: MassGIS.

2.3 RIVER HISTORY

The Monatiquot River flows for 4.9 miles entirely within Braintree and is formed by the confluence of the Farm and Cochato Rivers as seen in Figure 11. The confluence occurs in the Braintree Municipal Golf Course. The river meanders to the northeast, and discharges into the tidal Weymouth Fore River estuary which flows into the Boston Harbor.

Figure 11: Confluence of the Farm, Cochato, and Monatiquot Rivers in Braintree.

River Herring were important to the river in colonial times for food and sale. The river's strong flow was useful for industry such as grist mills in earlier eras. Figures 12-16 depict flooding in Braintree's past.

Figure 12: Flood of 1891. Source: John A. Dennehy, P39.

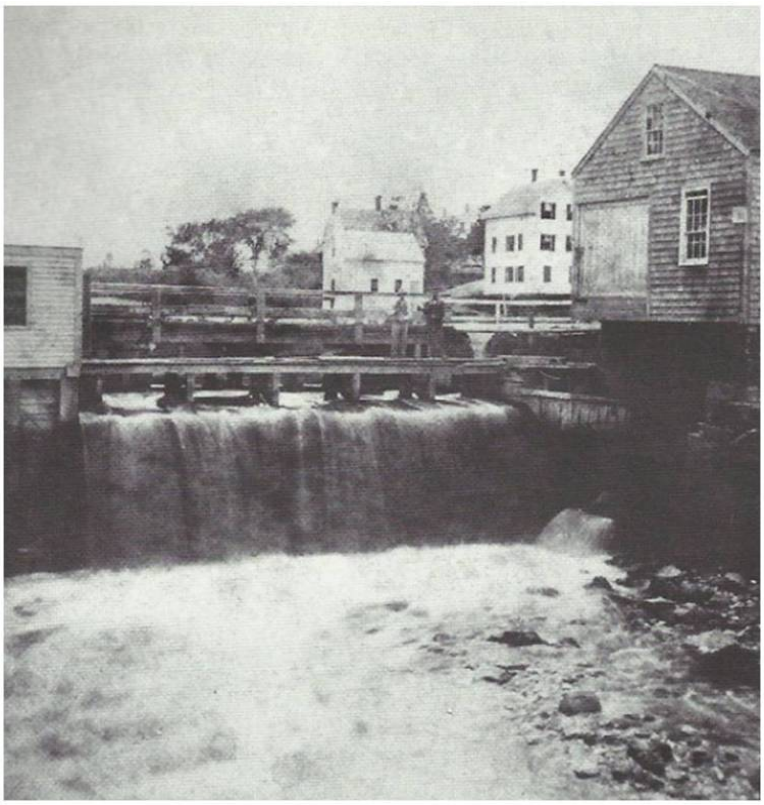

Figure 13: Shaw Street Dam circa 1900. Source: John A. Dennehy, P34.

Figure 14: Flood of 1948. Source: John A. Dennehy,P36.

Figure 15: Flood of March 2010 at the intersection of Route 37 (Washington Street), Hancock and Plain Streets. Source: Town of Braintree.

Figure 16: Flood of March 2010 at Jefferson Street. Source: Town of Braintree.

3. VISION STATEMENT

The Town of Braintree will become a leader to surrounding communities where aspects of stormwater management, water quality, and river accessibility may be capitalized upon. The implementation of Best Management Practices will become a showcase of flood mitigation and water quality improvement as aesthetically and ecologically enhancing infrastructures. The improved quality of the water in the Monatiquot River will generate numerous economic and health benefits to Braintree. There will be reconnections for the community to the Monatiquot River and establishment of long term stewardship. These results will reinstate the historic role of the Monatiquot River as a central asset to the town and a pride to the residents of Braintree.

4. SUB-WATERSHED INVENTORY AND ASSESSMENT

4.1 INTRODUCTION

An initial analysis of the Weir River sub-watershed was undertaken by the production and evaluation of GIS mapping. In addition, the initial analysis was informed by case study and other research. The Monatiquot River is part of the Weir River sub-watershed as shown in Figure 7. The scope of this project focused on the Monatiquot River sub-watershed in the context of Braintree.

4.2 SWOT ANALYSIS

Preliminary analysis utilized the SWOT method to determine sub-watershed strengths (S), weaknesses (W), opportunities (O) and threats (T).

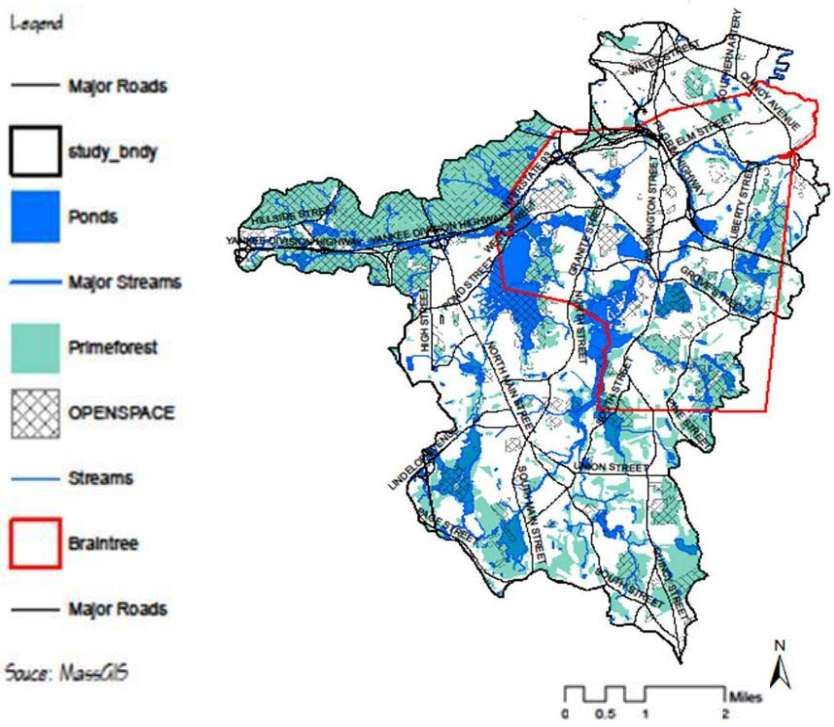

Figure 17: Weir sub-watershed prime forest and open space (open space defined as protected and recreational which include the boundaries of conservation lands and outdoor recreational facilities)

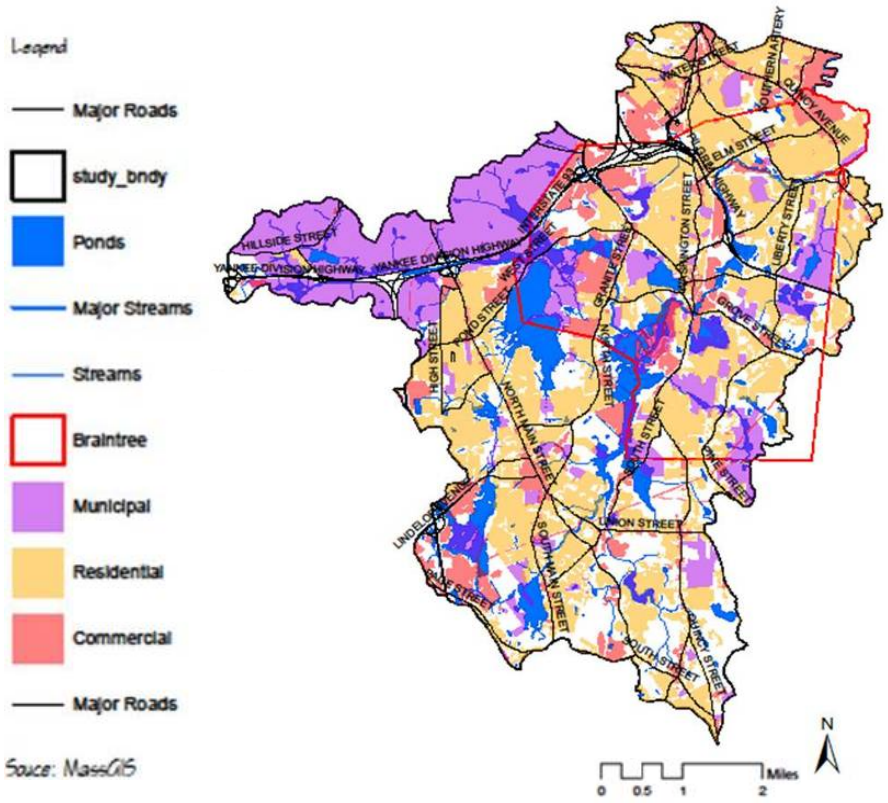

Figure 18: This is a map of Weir sub-watershed showing land use and ownership. Municipal is in purple, residential is in yellow, and commercial is in red. There are municipal, commercial, and residential lands surrounding the rivers, lakes, ponds, and reservoirs.

STRENGTHS

- Existing protected and recreational open spaces in the sub-watershed outside of Braintree such as the Blue Hills Reservation as well as other permeable land that would promote infiltration into the soil and protect water quality (Figure 17).
- Municipal owned land of existing protected and recreational open spaces, e.g., the Blue Hills Reservation, ensure long-term protection from urbanization (Figure 18).

WEAKNESSES

- Impervious surfaces runoff from western towns flows towards Braintree creating a higher level of water that flows into the Monatiquot River (Figure 19).

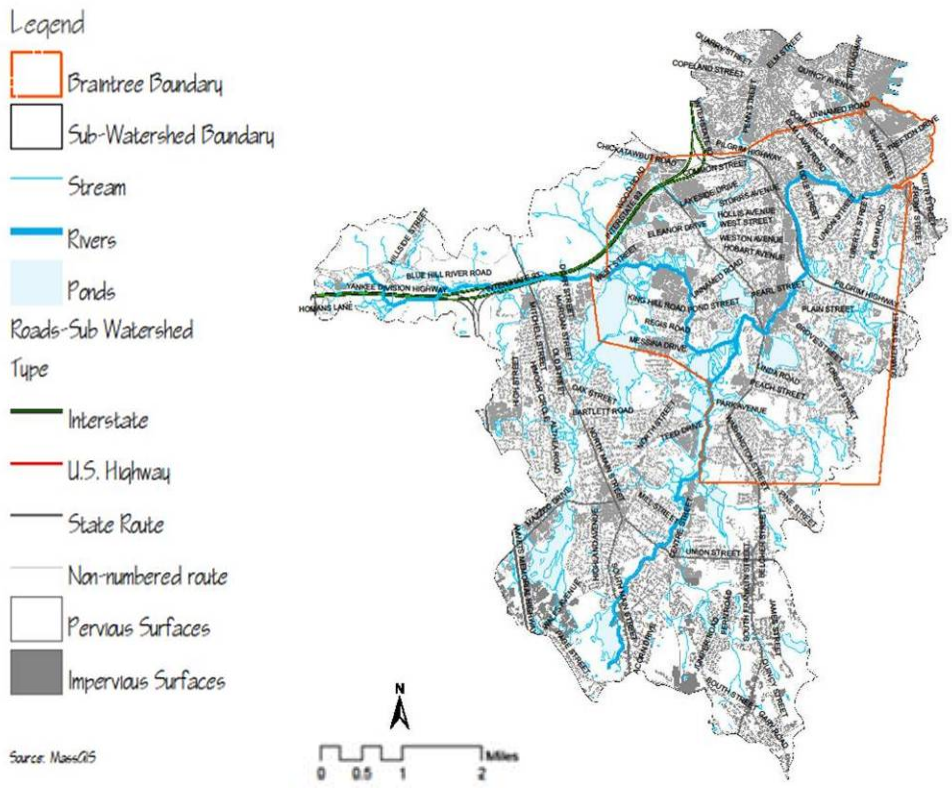

Image 19: Impervious surfaces at the sub-watershed scale. Town water bodies disconnected, making formation of continuous green infrastructure difficult

- Historical development patterns during industrialization needed to be situated along rivers for power, which currently impinges along the buffer zone.
- There is a lack of connectivity between open space and recreational uses.

OPPORTUNITIES

- Expand implementation of Best Management Practices (BMPs) not only for Braintree, but for surrounding towns in the sub-watershed
- Increase assets from improved water quality such as recreational activities like swimming, fishing, boating, and increased wildlife
- Create connected open and green spaces in the sub-watershed in order to bring people together for recreation and outdoor activities

THREATS

- Large amount of impervious areas in the watershed creates flooding concerns
- Current and future development within the river corridor and on floodplains increase flood risks
- Climate change impacts on increasing flooding risks and threats to Braintree
- Increasing population may increase impervious surfaces and increased water use, stormwater management, and flood control infrastructure demands

4.3 GOALS

- Reduce flood risks in the Weir sub-watershed particularly in down-stream communities by wide-spread application of BMPs
- Improve the water quality of the sub-watershed
- Improve connectivity of existing conservation and recreation land

4.4 OBJECTIVES

- Strengthen collaboration among municipalities and stakeholders within the watershed region
- Develop watershed-wide outreach and education programs for residents and stakeholders to better understand the importance and benefits of using BMPs
- Control point and non-point source pollution
- Reduce impervious surface area
- Minimize erosion along riparian buffers
- Improve assessment and monitoring of water quality
- Encourage public engagement with water resources
- Connect existing and proposed greenways and trails in subwatershed to the larger system in eastern Massachusetts
- Accommodate accessibility to the rivers throughout the subwatershed

5. STORMWATER MANAGEMENT

5.1 INTRODUCTION

In part, this report was spurred by major flooding that occurred in March 2010 during which every area of Braintree was impacted by flooding. During this event, the Monatiquot River overflowed its banks and flooded homes, businesses, and roadways causing economic losses and public health threats. Combining map analysis, case studies and public input, the stormwater management team identified contributors to flooding risk and areas of Braintree at greatest risk and potential for improvement. The team then proposed effective implementation strategies for best management practices (BMPs) indicated for the management of stormwater (a list of BMPs can be found in Glossary and a summary of BMPs application can be found in Appendix 12.5.). It is exceedingly important to note that the recommendations made herein are designed to help Braintree improve the management of stormwater and thereby become more resilient to future flooding risks. The implementation of BMPs and reduction of impervious surfaces does not free the town of risk for future extreme flood events. A further study for comprehensive risk or disaster management that includes hazard mitigation, preparedness and response for disasters, and recovery plans is needed to complement the integrated long-term planning strategies that are provided here. Such consideration underscores the importance of regional, watershed-wide stormwater management, especially for down-stream communities including Braintree.

SECTION 5.2 summarizes the initial SWOT analysis for stormwater management performed at the town scale.

SECTION 5.3 AND SECTION 5.4 list the goals and objectives respectively of the stormwater management team.

SECTION 5.5 describes how the public workshop clarified and informed the focus of the team's final recommendations.

SECTION 5.6 explains the specific recommendations proposed by the stormwater management team.

SECTION 5.7 offers implementation strategies for the recommendations.

SECTION 5.8 summarizes the stormwater management section of the report

5.2 SWOT ANALYSIS

STRENGTHS

- Potential for implementation of BMPs for water quantity management and flood mitigation.
- Resident town workshop participation and citizen interest in reducing flooding risks. Braintree officials and resident interest in exploring solutions that would allow Braintree become more resilient to flooding.
- Implementation of BMPs to reduce the urban heat island effect. The urban heat island effect is the result of reduced tree cover and the increase of impervious surfaces that increases the temperature of urban environments relative to rural areas.
- Braintree does not employ a Combined Sewer Overflow (CSO) system; instead Braintree incorporates a separate system between stormwater runoff and sewage. This reduces the potential to release untreated sewage into water bodies during major flooding where treatment systems are not be able to treat the increased amount of effluent.

WEAKNESSES

- Public lack of knowledge of BMPs, how to implement them, their cost, and benefits.
- Lack of infiltration due to amount of impervious surfaces and the increasing amount of urbanization in Braintree (Figure 20).
- Stormwater drainage pipes discharging directly into the Monatiquot River (Figures 21-22) increases river bank overflow and therefore flooding risks. In addition, water quality decreases as a result of the concentration of pollutant and river bank erosion along with the stormwater pipe discharge.
- Need to evaluate dam structures, either to repair or remove entirely.

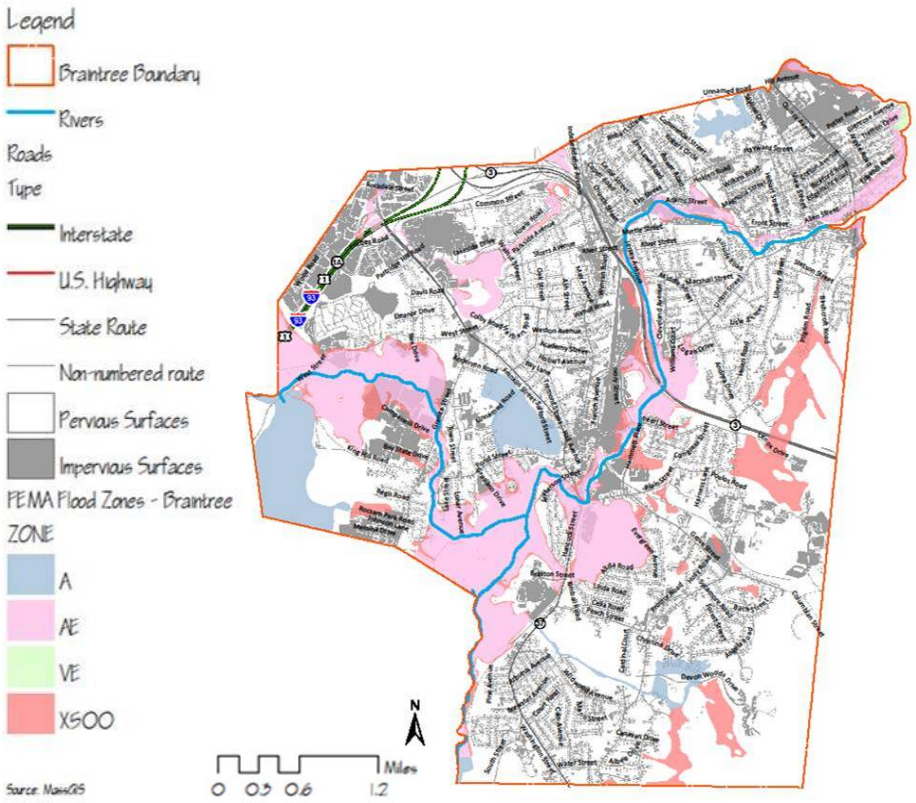

Figure 20: Impervious surfaces and FEMA Flood Zones at the town scale.

FEMA FLOODING ZONES DEFINITIONS

A- An area inundated by 100 year flooding, for which no Base Flood Elevations have been determined.

AE- An area inundated by 100 year flooding, for which Base Flood Elevations have been determined.

VE- A-An area inundated by 100 year flooding with velocity hazard (wave action), Base Flood Elevations have been determined.

X500- An area inundated by 500 year flooding or an area inundated by 100 year flooding with average depths of less than one foot or with drainage areas less than 1 square mile or an area protected by levees from 100 year flooding.

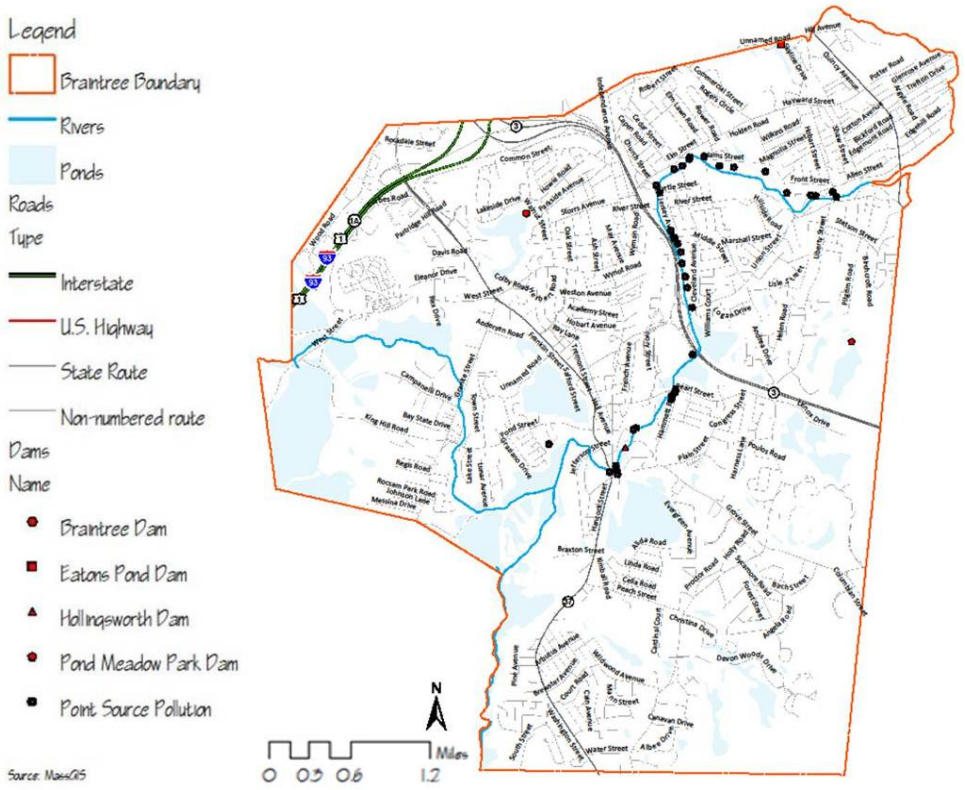

Figure 21: Dam locations and stormwater drainage pipe outlet locations at the town scale.

Figure 22: Stormwater discharge through drainage pipe adjacent to the Shaw Street Bridge. Photo by Benjamin D'Agostino.

OPPORTUNITIES

- BMPs provide activities that have been tested and are intended to increase infiltration into the soil while reducing the impacts of regular storm events and associated flooding.
- Creation of outreach and education programs for the community to take on the problem of floodwater mitigation as a whole.
- Pilot programs implementing BMPs from Braintree would provide a model for surrounding communities and local business. Education for residents to enable the creation of programs specific to Braintree.
- Regulations need to be enacted to improve the existing development in areas on or near the floodplain. Areas of concern that have flooded, both from workshop result findings and GIS analysis, show that impervious surfaces such as roads and parking lots located in both residential and business properties situated on the floodplain contribute to flooding risks. Retrofitting existing development with BMPs will help to alleviate regular storm events.
- Priority consideration given to the overlap of flood zones and forested undeveloped areas with hydric soil most suitable for stormwater management BMPs (Figure 23).

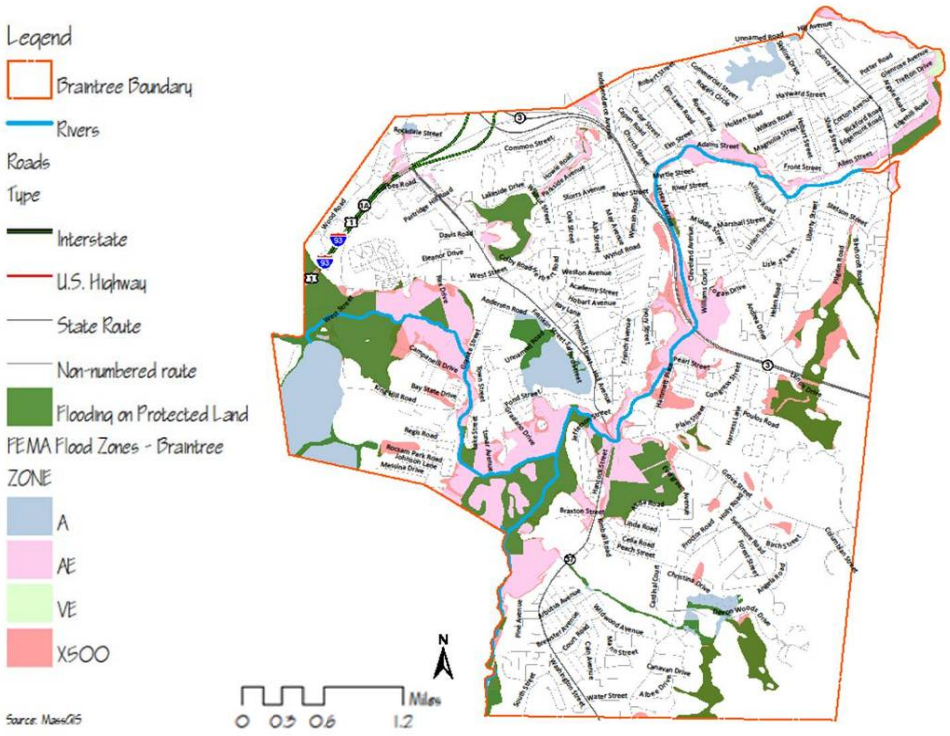

Figure 23: Protected recreational and open land on floodplain at the town scale.

THREATS

- Numerous areas with relatively flat topography covered by impervious surfaces that are adjacent to the Monatiquot River.

Figure 24: Residential property on Jefferson Street adjacent to the Monatiquot River. Photo by Benjamin D'Agostino.

- Dam and dam safety- The need to evaluate dam structures by either repairing or replacing them. The Hollingsworth Dam located on the Monatiquot River is classified as a high hazard dam by the Massachusetts Dam Safety Department due to its height and storage volumes and requires it to pass what is called the ½ Probable Maximum Flood (PMF). As of 2009, this dam did not pass the PMF.
- Significant residential and commercial/industrial property at risk for flooding resulting in public welfare and economic loss as well as impacts to water quality. Emergency access is limited when these areas flood (Figure 26).

Figure 25: Hollingsworth Dam at Armstrong Factory. Photo by Benjamin D'Agostino.

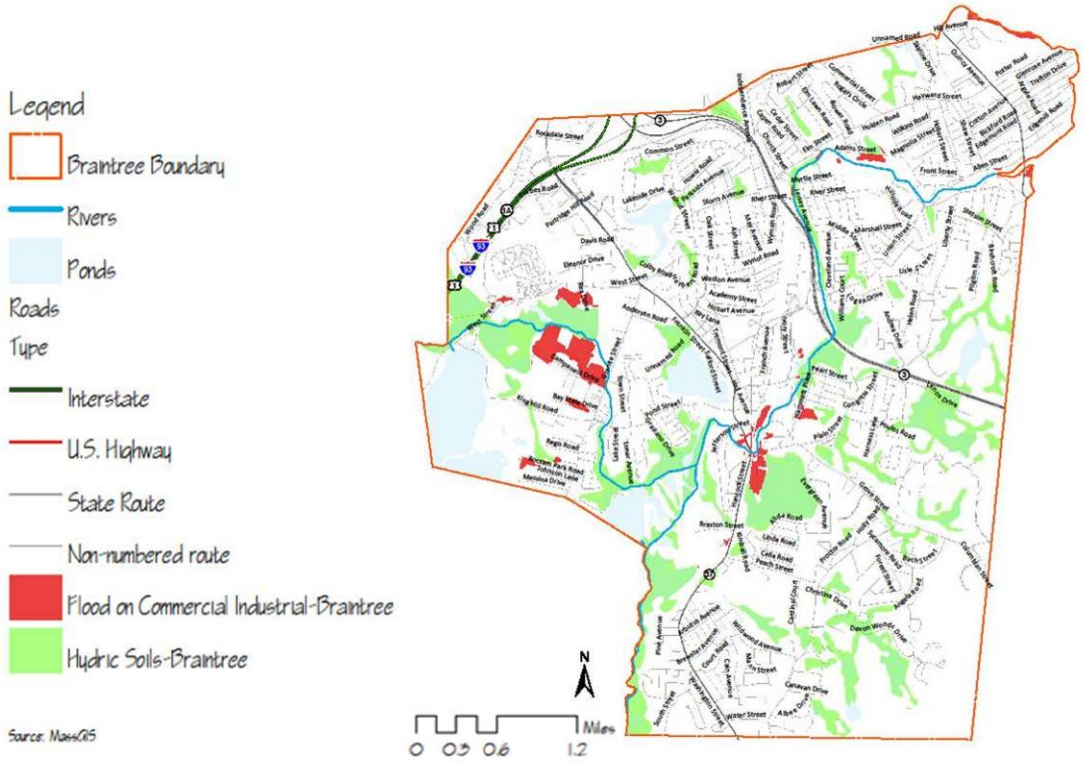

Figure 26: Commercial/industrial land use on floodplain and hydric soil at the town scale.

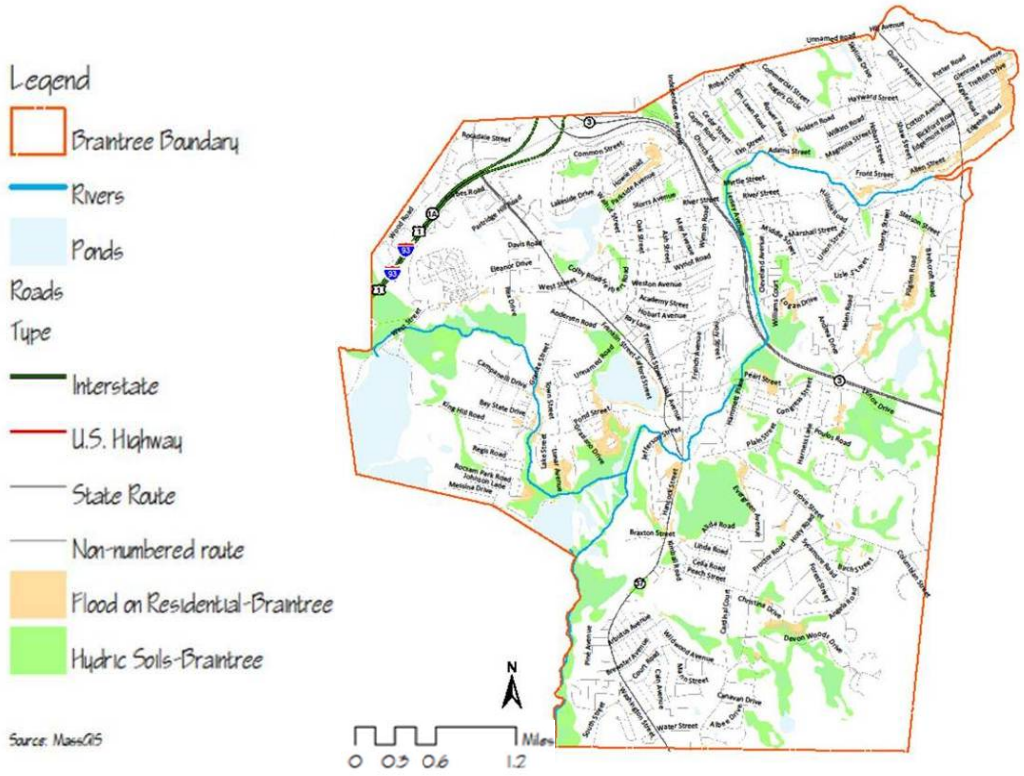

Figure 27: Residential property on floodplain and hydric soil at the town scale.

5.3 GOALS FOR STORMWATER MANAGEMENT

Both SWOT analysis and public workshop results have emphasized the need for flood mitigation. The goal of the stormwater management plan is to reduce flood hazards and associated public health and economic impacts. Outreach and education programs will provide resources to the residents of Braintree as well as surrounding towns in the sub-watershed.

STRUCTURAL RECOMMENDATIONS FOR TOWN SCALE

Short Term (within 5 years)	**Long Term (5 years and beyond)**
Install Small-Medium Scale (50-150 sq ft) BMP	Install Large Scale (>150 sq ft)BMP Install Multiple Small-Medium Scale BMP

NON-STRUCTURAL RECOMMENDATIONS FOR TOWN SCALE

Short Term (within 5 years)	**Long Term (5 years and beyond)**
Implement Outreach Strategy Raise Awareness of Stormwater Management Strategies Advertise Existing Policies Incentivize Yard Waste Disposal to Waste-Treatment	Continue Outreach Strategy: Community-Day Activities; Community Planting Day
Implement Educational Program: Elementary Level Middle-School Level Lesson Plans/ Projects	Continue Educational Program: Elementary Level; Middle-School; High-School Level Lesson Plans/ Science-Fair Projects
Incentivize BMPs for Industrial/ Commercial Buildings; Residential Houses	Incentivize BMPs for Industrial/ Commercial Block; Residential Neighborhood
Retrofit BMPs and improve existing development on floodplains	Acquisition of properties that are prone to flooding and on floodplains Restore floodplains

Figure 28: Short and Long term Structural and Non- Structural goals for Stormwater Management

5.4 OBJECTIVES FOR STORMWATER MANAGEMENT

The following objectives will facilitate the achievement of the goal listed above:

- Identify flood vulnerability factors.
- Identify local flooding risk areas.
- Develop action plans for implementing site-specific stormwater BMPs.
- Develop outreach and education programs for residents and stakeholders to better understand the importance and benefits of using BMPs.

5.5 PERSPECTIVES BEFORE AND AFTER WORKSHOP

With knowledge gained through data assessment and case studies (Figures 29, 30, 31), the stormwater management team presented findings at the public workshop. The workshop provided an opportunity to gauge public interest, knowledge and motivation for improvement of flooding risks. The meeting also provided a forum for providing initial public education about specific stormwater management BMPs.

In addition, the workshop allowed residents who are most familiar with Braintree to guide team efforts on the areas of highest risk and greatest potential for the deployment of interventions.

Figure 29: Best Management Practices (BMPs) Public Education Poster

Case Study: SW 12th Avenue Green Street Project Portland, Oregon

This project disconnects street stormwater runoff from directly flowing into storm drains. As the first planter fills with water, up to 6 inches, the next planter accepts water for infiltration this process continues throughout the system. Water infiltrates into the soil at a rate of 4 inches per hour. Stormwater planters slow, cleanse, capture, and infiltrate water runoff from the street.

Figure 30: Sidewalk before (upper left) and after implementation of BMPs in Portland, Oregon. The BMPs incorporate curb cuts and filter strips to collect street runoff and allow infiltration into the soil. Educational components are implemented through interpretative signage so that the public will be aware of the project goals and objectives of reducing the flood risks and the amount of runoff entering catch basins. Source: ASLA 2006 Professional Awards.

Case Study: SEA Street - Seattle, Washington

The City of Seattle's Street Edge Alternatives (SEAStreet) project incorporates new street designs that reduce road width and offer unique ecological-based drainage techniques. As a pilot project, SEAStreet showcases drainage, water quality, mobility, and landscape moving through the street. It successfully creates an opportunity for education and encourages community's buy-in for BMPs installation. After this pilot project, more projects as such are successfully implemented throughout Seattle and the nation.

Figure 31: SEAStreet demonstration project of stormwater management practices along the street in Seattle, Washington. Meandering streets provide safer streets that encourage mobility. Stormwater management techniques along the street promote infiltration such as bio-retention swales. Source: City of Seattle.

The community workshop provides insights from people's perceptions on flooding mitigation and BMPs. In general, survey results show that 75% of residents in attendance were not aware of the Braintree's hazard mitigation plan that had been recently updated. In addition, while many residents did not feel knowledgeable about BMPs, 40% of the participants did indicate a willingness to use them if concerns about expense and construction were addressed.

Insights provided by community members underscored the need for education and outreach efforts as well as town partnership for the deployment of flooding risk improvements. As will be discussed below, the workshop also helped to focus efforts on areas of greatest concern for flooding risk and potential areas or location for effective improvement.

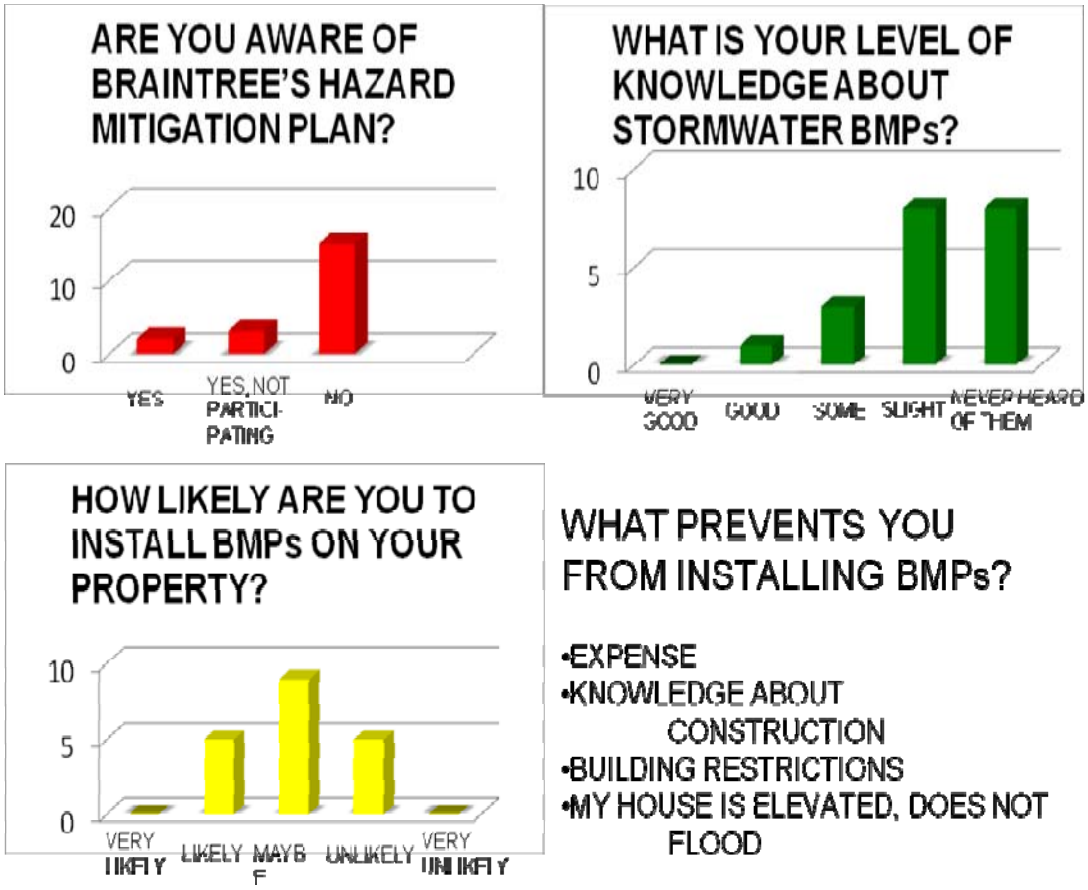

Figure 32: Workshop survey results

5.6 RECOMMENDATIONS

In the community workshop, participants were asked to identify areas of greatest concern for flooding hazard and resulting threats. Three priority areas were clearly identified by the participants: (1) Adams and Elm Streets, (2) Kensington Street and (3) the intersection of Route 37 (Washington Street), Hancock and Plain Streets as seen in figure 32. While recommendations for improvements in these areas are proposed here, it is important to note that BMPs are tools that can be applied in other areas with similar settings. In addition, while the BMPs will contribute to the reduction of flooding risks at regular storm events, they are not designed for the prevention of extreme floods.

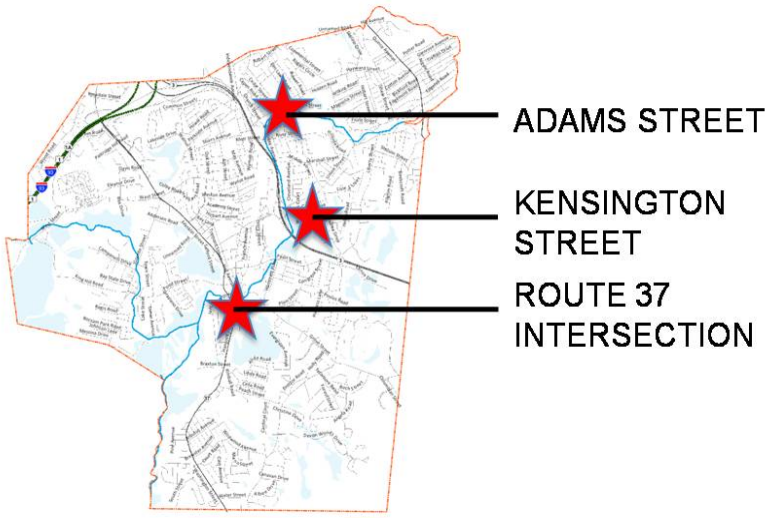

Figure 33: Three locations of proposed designs in Braintree.

ADAMS STREET

This area has a mix of residential and commercial/industrial development. Community workshop participants expressed concerns that as a result of the current height of the Adams Street Bridge, it becomes more like a dam when debris carried by high water becomes lodged on the bridge resulting in overflow of water as seen in the flood of March 2010. Therefore, examination of the bridge height is recommended. Other interventions in this area include the construction of a berm along the eastern edge of the river that would serve as a storm wall protecting adjacent properties. The augmentation of trees and other plantings in the area would also encourage more efficient uptake of water and increase stormwater infiltration. These plantings would be included as part of the riparian corridor with bio-swales on both private and commercial property. In addition, it is recommended that curb cuts be made on the roadways to create opportunities for infiltration rather than funneling all stormwater into the Monatiquot River.

Figure 34 (left): Adams Street location in Braintree.

Figure 35 (right): Commercial/industrial properties on Adams Street and high amounts of impervious surfaces. Photo by Benjamin D'Agostino.

Figure 36: Residential property on Adams Street. Photo by Benjamin D'Agostino.

Figure 37: Close proximity between residential property and Monatiquot River on Adams Street. Photo by Benjamin D'Agostino.

Figure 38: Aerial view and section elevation cut line of Adams Street. Source: Google Earth 2010.

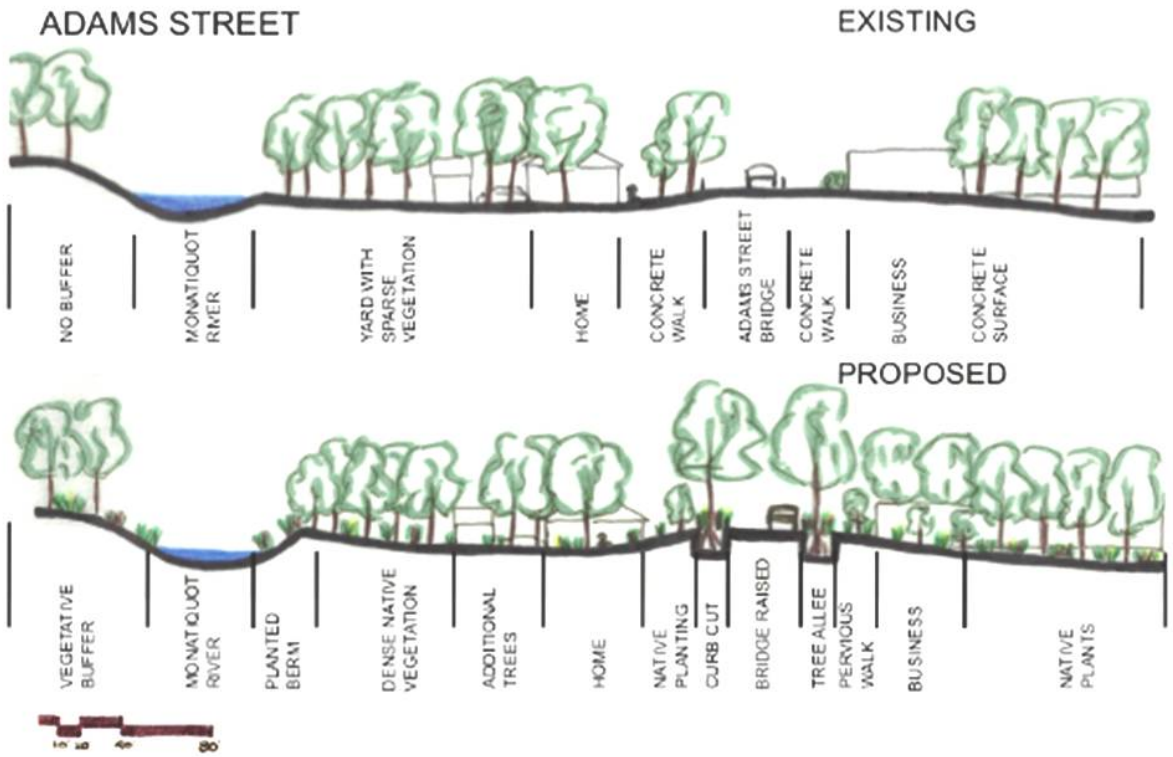

Figure 39: Existing and proposed cross-section rendering of Adams Street showing the application of BMPs

KENSINGTON STREET

This residential area was dramatically affected by the flood of March 2010. Stormwater runoff from the eastern slope and overflow of wetland to west resulted in flash flooding of homes. Workshop participants indicated an understanding of the functions of the wetland and commented that they like the appearance of it; nevertheless, they also relayed their fears of future floods.

Potential interventions in this neighborhood include ways to store stormwater and increase infiltration opportunities. Considering land acquisition by the town may be necessary to protect home owners on susceptible floodplain properties.

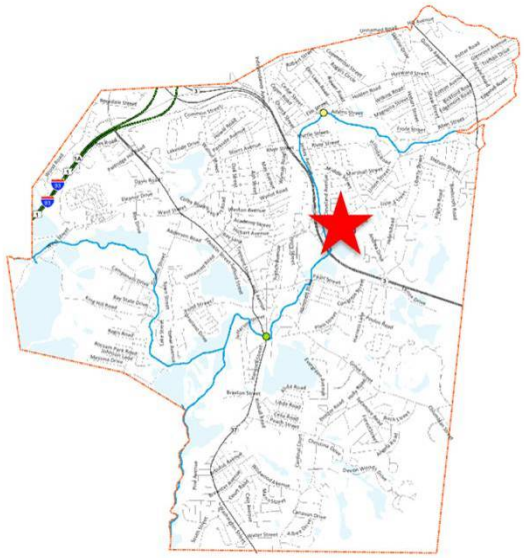

Figure 40: Kensington Street location in Braintree.

Figure 41: Residential property on Kensington Street located on a floodplain showing close proximity to the wetland. Photo by Chingwen Cheng.

Figure 42: Residential property on Kensington Street located on a floodplain. To the right is the Monatiquot River. Photo by Chingwen Cheng.

Figure 43: Aerial view and section elevation cut line of Kensington Street. Source: Google Earth 2010.

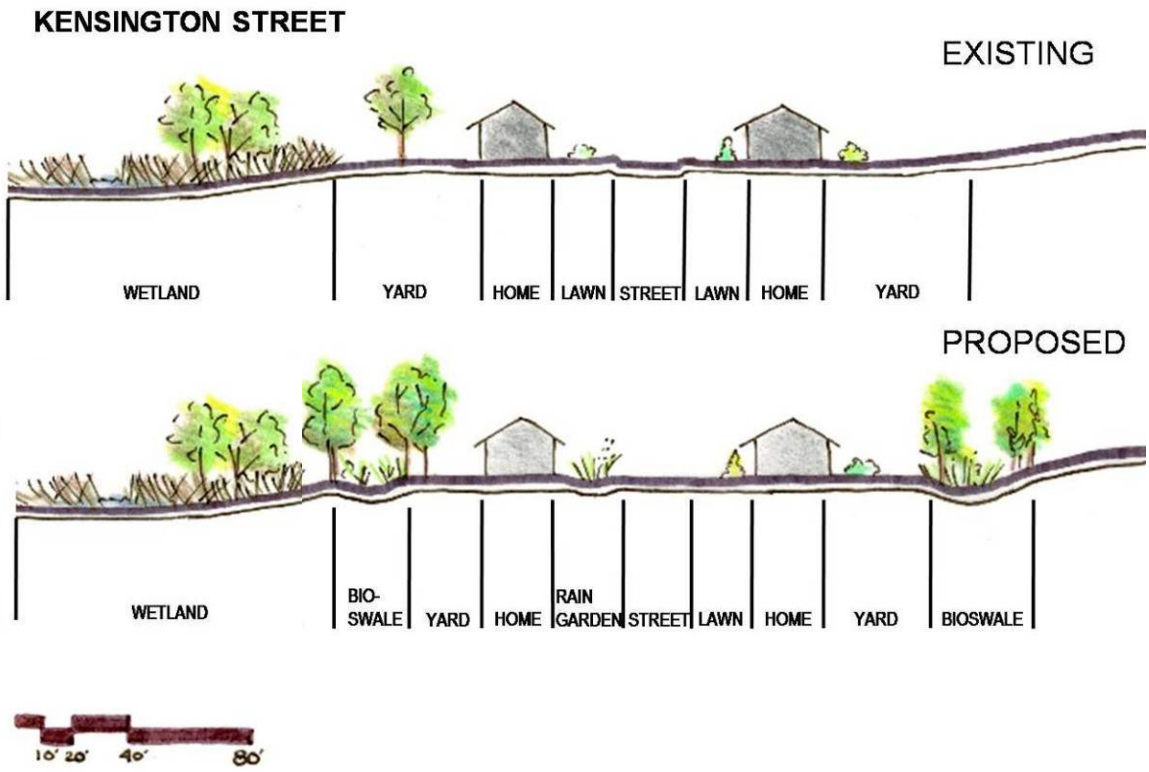

Figure 44: Existing and proposed cross-section renderings of Kensington Street showing the application of BMPs.

Figure 45: Current view of Kensington Street. Photo by Chingwen Cheng.

Figure 46: Perspective rendering of Kensington Street with the implementation of BMPs. This includes decreasing the width of the street, adding swales along the street, rain barrels, and bio-retention swales on residential property.

INTERSECTION OF ROUTE 37 (WASHINGTON STREET), HANCOCK AND PLAIN STREETS

This is a highly developed area with a large amount of impervious surfaces from roads, parking lots, commercial and industrial buildings. Suggested interventions will serve to improve infiltration such as native plantings along the river and reduce runoff such as pervious cross-walks and sidewalks. This area also presents opportunities for corporate involvement (and the subsequent public relations benefits) such as the construction of highly visible green roofs for retaining stormwater from small storm events and cisterns for collecting rainwater that can be reused for irrigation and utilitarian uses in the buildings.

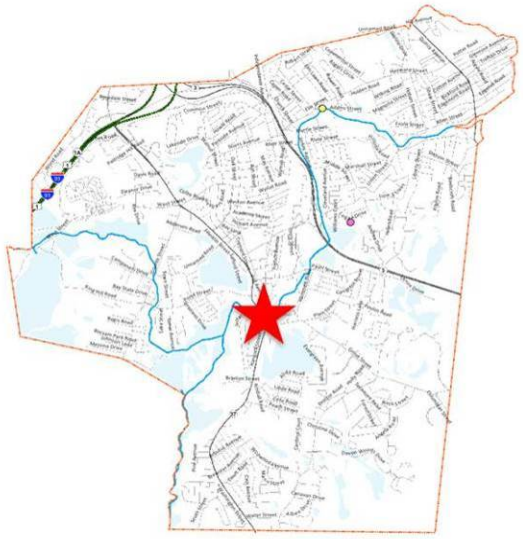

Figure 47: Intersection of Route 37 (Washington Street), Hancock and Plain Streets in Braintree.

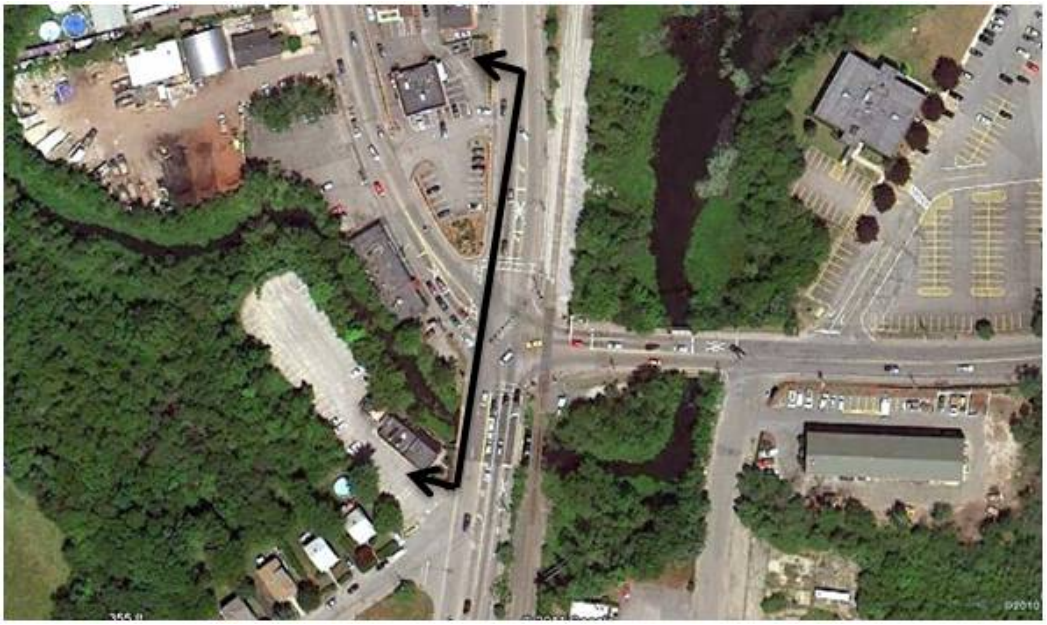

Figure 48: Aerial view and section elevation cut line of the intersection of Routes 37 (Washington Street), Hancock and Plain Streets. Source: Google Earth 2010.

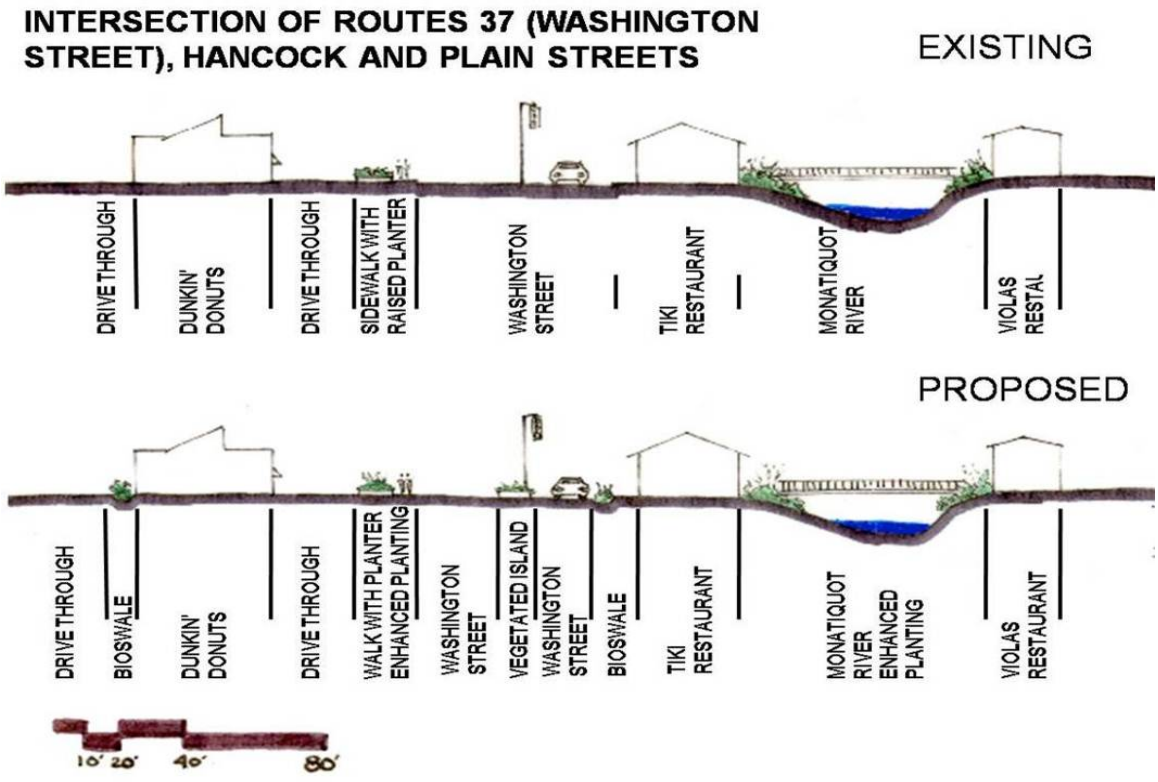

Figure 49: Existing and proposed cross-section renderings of the intersection of Routes 37 (Washington Street), Hancock and Plain Streets.

Figure 50: Current view at the intersection of Route 37 (Washington Street), Hancock and Plain Streets. Photo by Eric Wojtowicz

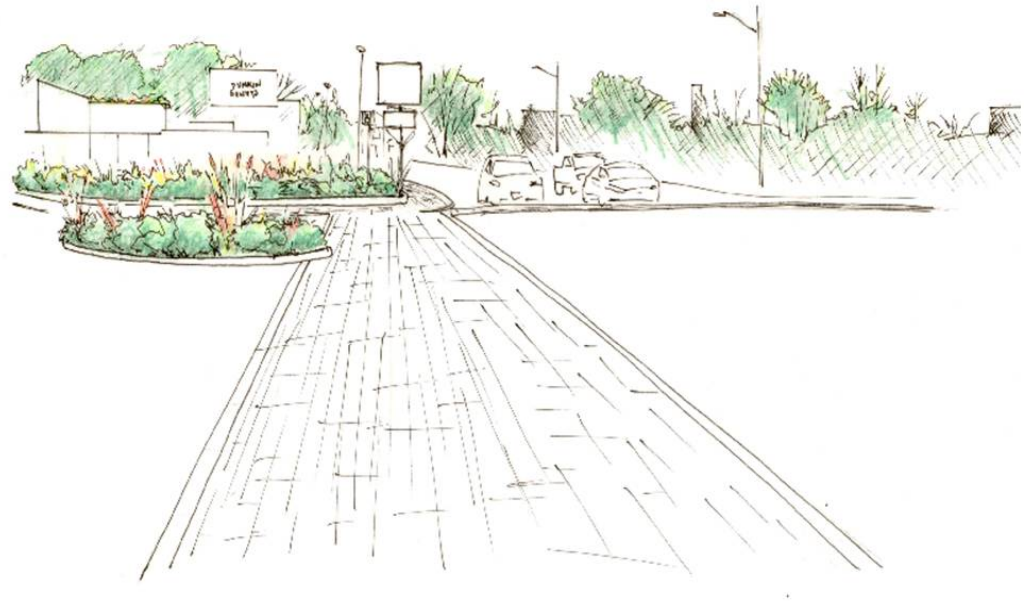

Figure 51: Perspective of proposed implementation of BMPs at the intersection of Route 37 (Washington Street), Hancock, and Plain Streets. Included in the design are pervious paving, roof gardens, and the implementation of more vegetation

Figure 52: Current view of the intersection of Route 37 (Washington Street), Hancock, and Plain Streets. Photo by Eric Wojtowicz.

Figure 53: Perspective of proposed implementation of BMPs at the intersection of Route 37 (Washington Street), Hancock, and Plain Streets. Included in the design are pervious paving, roof gardens, creation of swales and the implementation of more vegetation.

5.7 IMPLEMENTATION STRATEGIES

The pathways available to Braintree to help implement BMPs are offered multilaterally, ranging from the federal to the local governments. These pathways include both structural strategies (aimed to create actual sustainable sites: flood control berms, porous paving, green roofs, bioswales, rain gardens, bio-retention ponds, etc.) and non-structural strategies (aimed to create local policies, education programs, grant development, acquire floodplain properties, etc.).

Among the Federal non-structural programs obtainable are those such as the Environmental Policy and State Sustainability Grants, the National Environmental Education Programs, the Five-Star Restoration Program, and the Clean Water State Revolving Fund which in 1997 awarded the state of New York a land acquisition grant in order to place a watershed protection and water quality improvement plan into effect.

Entities that offer structural strategies are the Partnership of Sustainable Communities, which is a trinity partnership between: the Housing and Urban Development (HUD), Department of Transportation (DOT), and Environmental Protection Agency (EPA). This partnership has set aside flagship projects in Indianapolis, IL, Seneca Falls, NY, and along the Fairmount Commuter Rail in Roxbury, Dorchester, and Mattapan, MA.

The Five-Star Restoration Program also offers structural assistance to nearby communities. They granted funds to the community of Plymouth, MA in order to enact the Town Brook Herring Run Restoration Program.

There are private and non-profit strategy options as well. The Trust for Public Land helps communities create land acquisition conservation plans and passing local conservation policies. In addition, the Land Trust Alliance provides both tax refund incentives, and land easement options for landowners who want to improve the environmental quality of their surroundings. The Prospect Hill Foundation awards grants for environmental preservation and conservation practices. Moreover, the American Society of Landscape Architects (ASLA) and partners' Sustainable Sites Initiative provides a credit system for sustainable strategies. The credits are applied to site development and maintenance. The U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification on green buildings and credits to low impact development practices incorporating BMPs also helps to provide incentives for implementation.

At the local level there are more community-based strategies. They include cost-sharing

by communities in order to implement structural strategies. In addition, community groups and organizations such as Boy Scouts, Girl Scouts, and school groups can engage in fund raising activities. Setting up a table at the South Shore Plaza is great way to engage the community, raise awareness, and accept donations. Door-to-door donations are another strategy. These same groups can also promote community volunteer activities such as “Plant a Tree Day” or “Collect Yard Waste Day”

5.8 CONCLUSION

Braintree has significant flooding hazard risks. On one hand, as a down-stream community, Braintree receives the collective impacts of stormwater mismanagement from the upstream communities. On the other hand, Braintree has opportunities to positively impact both the quantity and quality of water entering the Monatiquot River with the use of BMPs. A comprehensive stormwater management program with participation at government, commercial and residential levels could further accomplish the town's goals. Nevertheless, Braintree should consider the need for land acquisition in order to move residents off of susceptible floodplains. There are numerous potential areas that can be retrofitted or redesigned to accept BMPs. More importantly, further study needs to be done to locate the most effective areas for such redesigns, and may introduce the possibility of municipal partnerships in order to create a more holistic design approach.

An education and outreach program (discussed at length in Section 9) is vitally important for the success of these programs.

6. WATER QUALITY IMPROVEMENT

6.1 INTRODUCTION

This chapter addresses the issue of *water quality* (see Glossary) at the town scale and provides a definition, analysis, goals, and recommendations for water quality improvement. Within the town, study area for water quality improvement is further divided into three categories based on land ownership: Municipal, Commercial, and Residential. These three categories are the primary types of land use and ownership within the town based on land use and open space data provided by MassGIS. Municipally owned land includes open space and prime forest land. Open space refers to protected and recreational land which include the properties of conservation lands and outdoor recreational facilities. Residentially owned land is composed of low density, multi family, very low density, medium density, and high density residential. Commercially owned land is composed of commercial, industrial, power line/utility, mining, and marina.

A brief description of qualitative data gathered from Braintree residents at the community workshop is presented and followed by revised recommendations based on public input.

Another aspect of this study was to examine previous studies of the Monatiquot River. The most notable report was titled *Feasibility Analysis to Restore River Herring to the Fore River.* This study examines the ecology of the River Herring and steps necessary to restore habitat within the watershed. It proposes a number of alternatives and strategies along with cost estimates. Following recommendations from this study would positively impact Braintree by correcting problems associated with the Monatiquot River.

SECTION 6.2 summarizes the initial SWOT analysis for water quality improvement as categorized above performed at the town scale.

SECTION 6.3 lists the goals and objectives respectively of the water quality improvement team.

SECTION 6.4 describes how the public workshop clarified and informed the focus of the team's final recommendations.

SECTION 6.5 explains the specific recommendations proposed by the water

quality improvement team.

SECTION 6.6 summarizes the water quality improvement section of the report.

6.2 SWOT ANALYSIS

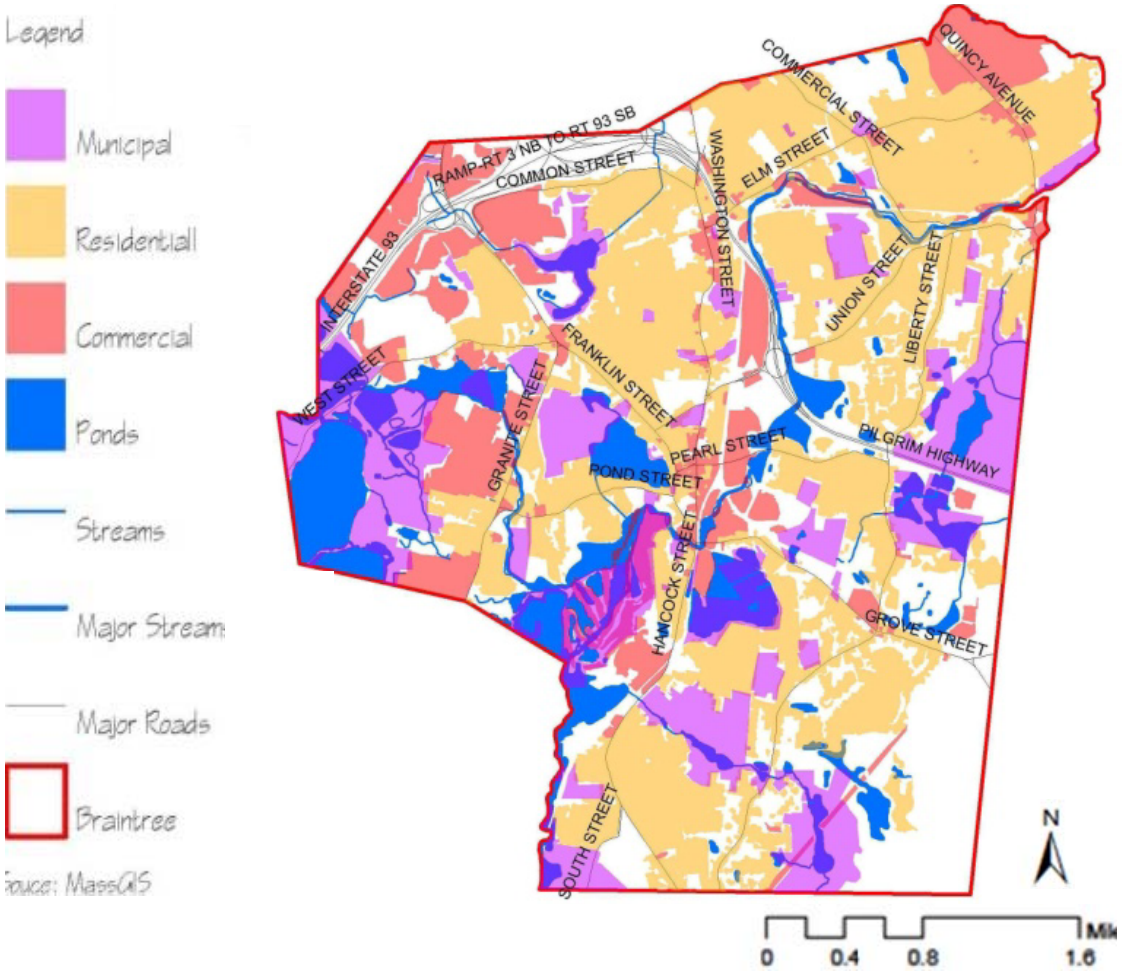

Figure 54: Major land use and ownership in Braintree. Braintree is largely developed for residential use with commercial development concentrated along major roads. In addition, a large amount of municipally owned lands are surrounded by the rivers, lakes, ponds, and reservoirs.

Municipally Owned Land

STRENGTHS

- Town government is a centralized authority with personnel to research and implement changes in management practices that affect water quality.
- Locations prone to problems are already known to town managers.
- Town government is structured to maintain existing facilities and to react quickly to emergencies.

WEAKNESSES

- Budgets are negatively impacted by current economic conditions of the nation and state.
- Bureaucracy is a well-known challenge faced by all levels of government and can hinder implementation of programs.
- Many gaps exist in riparian buffer zone.

OPPORTUNITIES

- Revisit data across the variety of scientific and studies of Monatiquot River and its watershed such as the *Massachusetts Buffer Manual and Dam Removal in Massachusetts,* and to look for opportunities to integrate recommendations made in them.
- Partner with other communities inhabiting the watershed to most efficiently use technology and planning to address watershed issues that do not recognize municipal borders.
- Unite the community through promoting a common effort. Public events such as a riverside litter cleanup day, a River Herring Festival, or other events that rally around the improvement of the Monatiquot River can build relationships within the community.
- Reduce exposure to flood damage and costs as a co-benefit of water quality improvement measures. BMPs provide positive effects in a number of ways. An example of this might be rainwater harvesting for irrigation instead of the use of potable water. Besides the benefit of a continued supply of high quality drinking water, volumes of water can be held from entering the Monatiquot River during heavy precipitation.

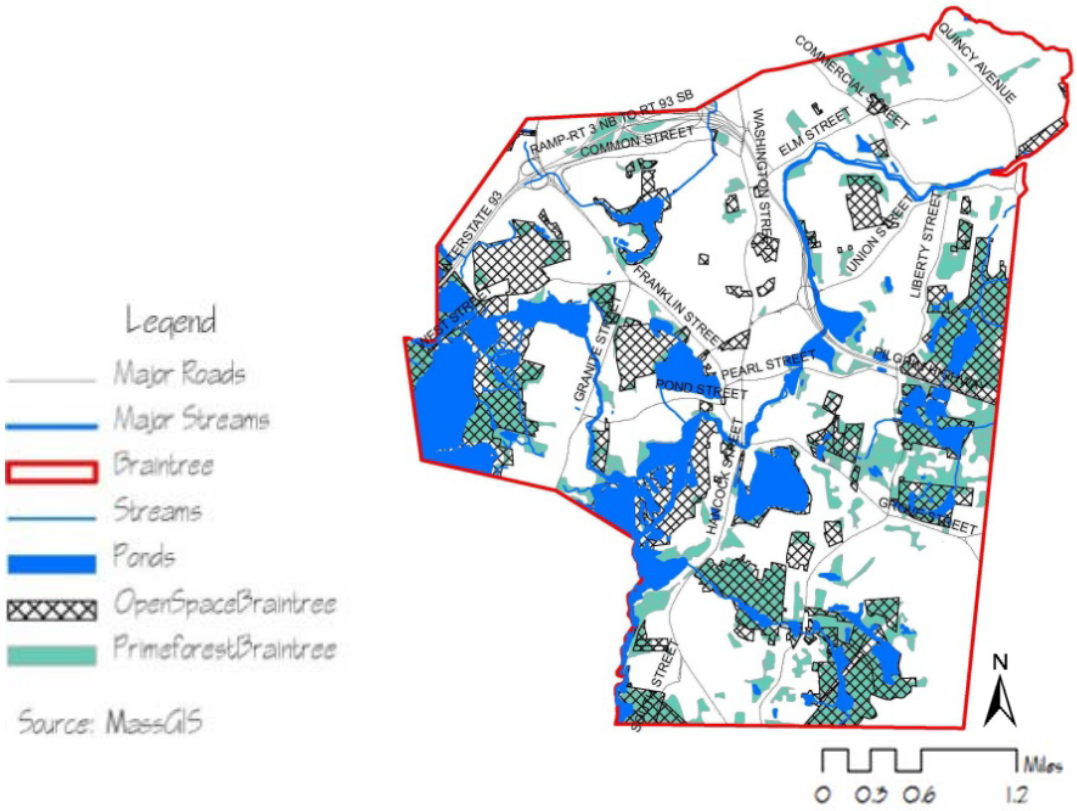

Figure 55: Map of Braintree prime forest and open space (open space defined as protected and recreational which include the boundaries of conservation lands and outdoor recreational facilities).

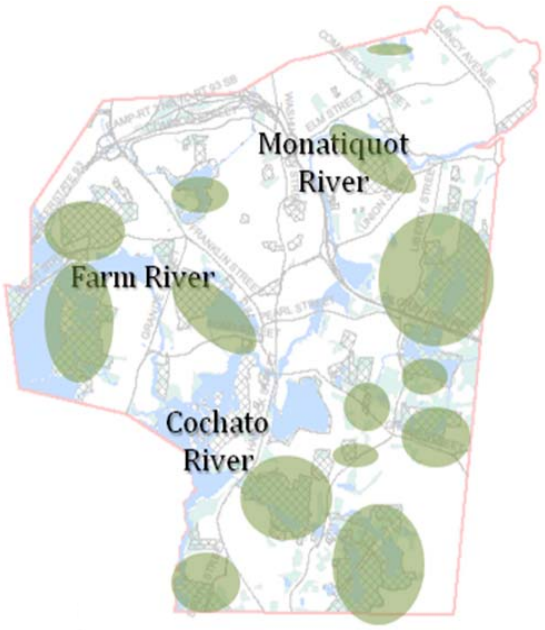

Figure 56: Conceptual diagram showing the densest areas of prime forest and open space as green dots (based on Figure 55). The Farm River feeds some of the reservoirs for drinking water, due to its status as an Outstanding Resource Water. To the northwest, the Great Pond Reservoir has prime forest and open space around its shorelines. There are also other locations of dense prime forest and open space; however they are not directly linked to the rivers. Outstanding Resource Water is a high quality river and therefore is protected from pollution that would impair the level of quality of the river.

THREATS

- Competition for funds by a multiplicity of urgent projects.
- Changing the look of landscapes that communities are familiar with may be unpopular to some residents.
- Braintree may be forced to deal with a water quality disaster triggered by events occurring on non-municipal property.
- The population of Braintree is increasing. Water quality and availability is already an issue during summer months. As the town grows and demands for potable water increases, water quality has potential to decrease.

Commercially Owned Land

STRENGTHS

- Large commercial enterprises such as shopping malls have the land-mass and management structures to make significant positive impacts.
- Businesses often donate to community projects as part of public relation strategies.
- Both small and large businesses must comply with EPA and municipal regulations.

WEAKNESSES

- Commercial and industrial lands comprise the largest contiguous areas of impermeable surface in Braintree (Figure 57-58). Large volume of runoff from precipitation is funneled into sewers that drain into rivers and streams increasing their size and velocity. Much of the surface flow surface flow from parking lots becomes polluted becomes polluted on its way to sewer systems and eventually pollute surface bodies of water.
- Businesses that deal with moving or storing products prone to spilling or erosion (i.e. sand, salt, and mulch piles) can have significant impact on water quality when moving and storage practices allow products to be washed into streams during rain and snowmelt.

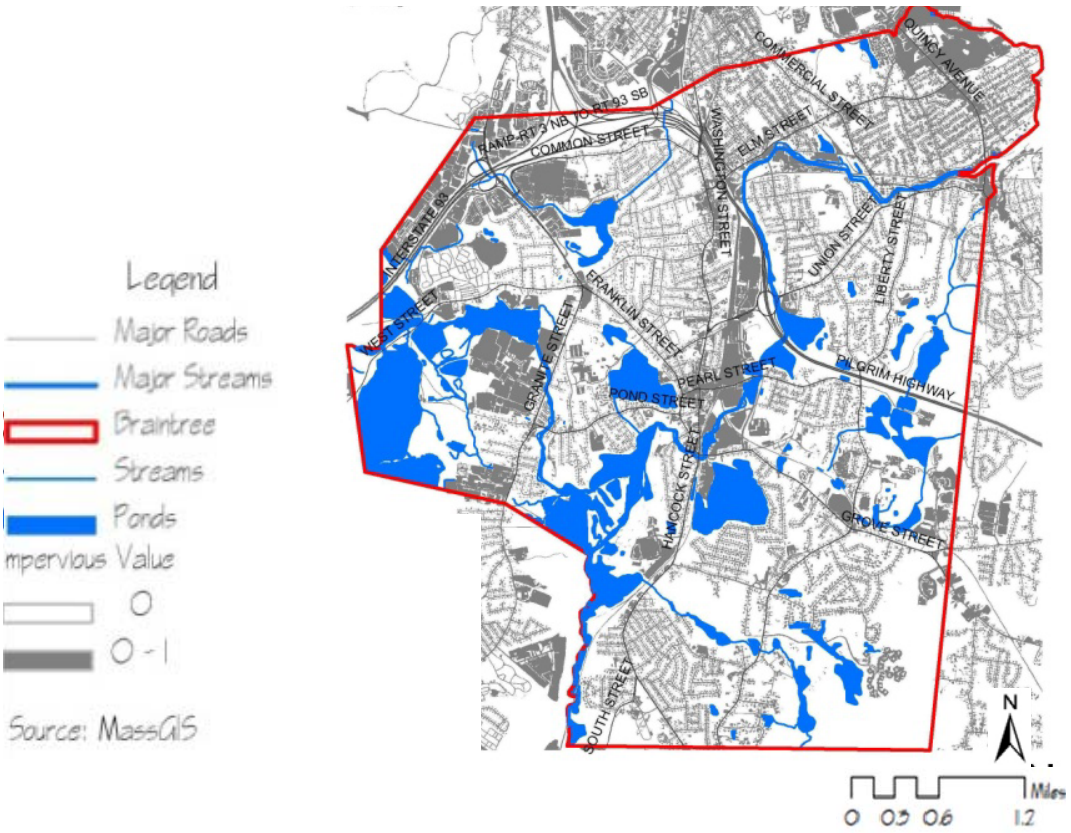

Figure 57: Map of Braintree impervious surface and water

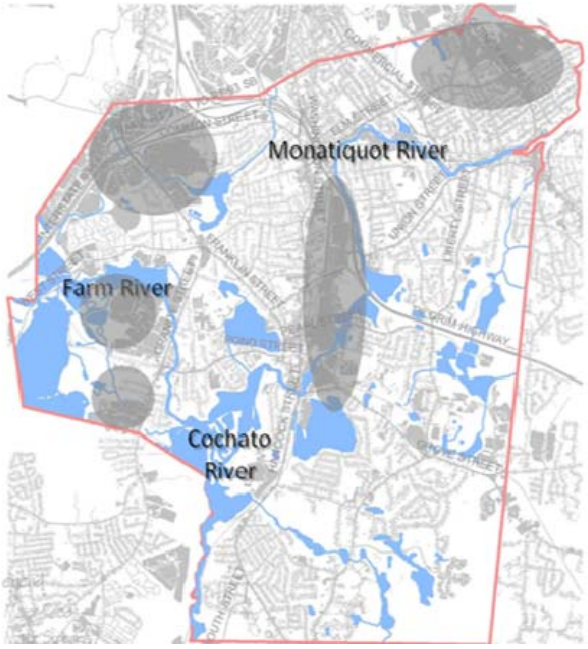

Figure 58: Conceptual diagram showing the densest areas of impervious surface and water as gray dots (based on Figure 57). The dense areas of impervious surfaces are primarily of commercial land use and ownership. Many of the areas surrounding the rivers, ponds, and reservoirs are residential. Although the residential areas have a more dispersed impervious surface pattern, added up, they can have impacts on the water quality as well. The runoff from the residential areas may be going into the rivers, ponds, and reservoirs and could be affecting the water quality.

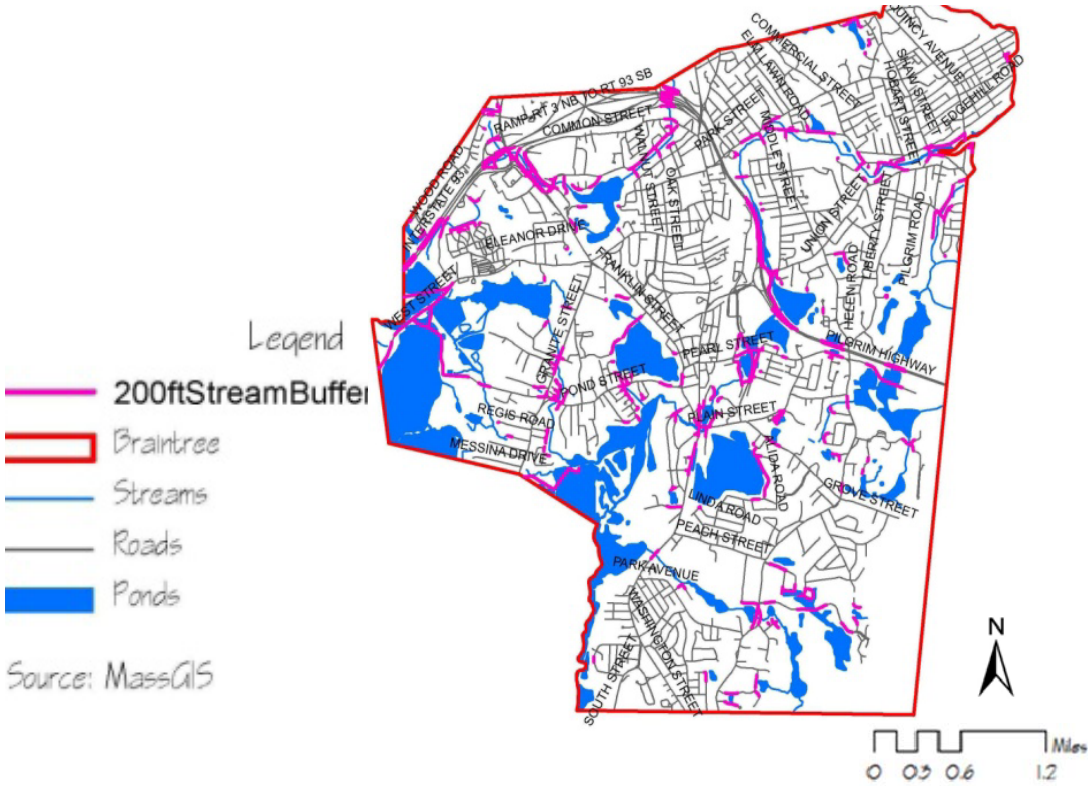

Figure 59: Map of Braintree roads and river intersections

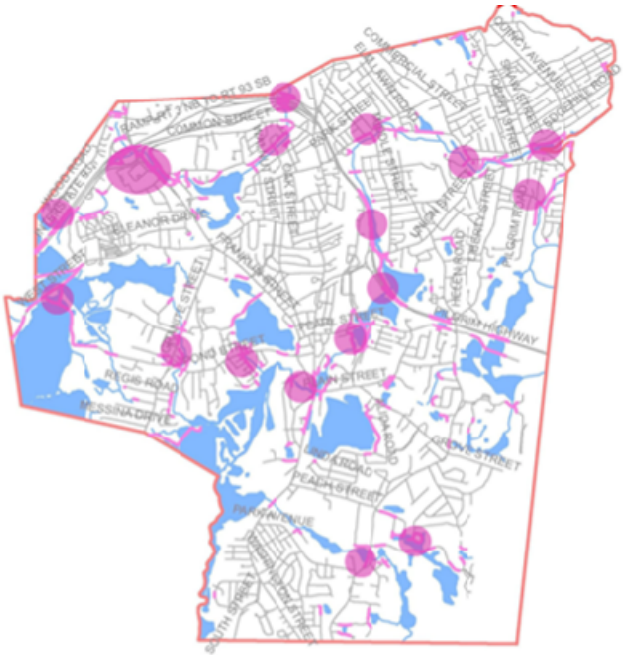

Figure 60: Conceptual diagram showing the densest areas of road and river intersections as pink dots (based on Figure 59). At these intersections, there is a potential for whatever is on the roads to get into the rivers, especially during a storm event.

- Some commercial properties are not locally owned and ownership may not be interested in improving sites.

OPPORTUNITIES

- Large open structures such as mall roofs and parking lots can support water catchment and infiltration systems such as rain-gardens, porous pavements, detention ponds and increased plantings that particularly opt for nutrients and toxics uptake.
- As highly visible elements of surrounding communities, businesses have the opportunity to take on leading roles in sustainable development practices in Braintree. As gathering nodes, shopping centers can be used to disseminate information pertaining to water quality improvement.
- Some businesses have funding via public relations and advertising to engage water management practices if given a ready-made program to follow.

THREATS

- Zoning for commercial uses lies along rivers as a result of historical development pattern, though no longer reliant on the Monatiquot River for Power. Consequently, many businesses are situated directly on rivers and runoff and spills have potential to inflict damage to water quality. An example might be a company that stores large piles of mulch or soil next to a river or stream in uncovered piles. When rain falls, mulch and soil would be washed directly into the stream, polluting it. See Figure 53
- Older businesses may have pipes that discharge commercial/industrial effluent directly into the river.

Residential Land

STRENGTHS

- Residential neighborhoods typically have less non-permeable surface area than businesses.
- Residents do more planting and maintenance of trees and plants than most businesses.
- Residents in the same neighborhoods are more likely to work together to achieve water quality objectives.

WEAKNESSES

- Homeowners may possess various perceptions and levels of willingness to make change in lawns and highly manicured landscapes that require a lot of fertilizers and pesticides
- Average citizens may be unfamiliar with concept of buffer zones or how land use on their lots impacts water quality.
- Residents may not find the supply of drinking water quality in downstream neighborhoods an important issue.

OPPORTUNITIES

- Instead of land mass that commercial property possesses, each residential lot can significantly impact water quality because of the aggregated effect from large residential areas.
- A caring attitude regarding water resources can become part of a community's pride and identity.
- To improve water quality is also to improve quality of life in communities (i.e., aesthetics, increased property values, community events, etc.)

THREATS

- High pesticide and fertilizer usage is common in neighborhoods with lots of lawns and manicured landscaping.
- Town landscape ordinance or related codes regarding appearance are often discouraging native plantings and riparian buffers
- Concentration of sewage in neighborhoods, especially historic ones, poses threats to water quality if pipes and other sewage infrastructure begin to fall into disrepair.

6.3 GOALS AND OBJECTIVES FOR WATER QUALITY IMPROVEMENT

Figure 61: Water quality at Armstrong Factory. Photo by Eddie Haynes

Figure 62: Point discharge adjacent to Adams Street Bridge. Photo by Eddie Haynes

GOAL 1: Develop and implement long-term water sampling and monitoring program to improve baseline data

OBJECTIVES:

- Develop and encourage partnerships between Non-governmental Organizations (NGOs) dedicated to resource protection such as Mass Audubon, Wildlife Conservancy, Project WET, watershed

associations, and local high schools.

- Conduct assessments for aquatic life, fish consumption, primary contact, secondary contact, aesthetics for rivers, streams, and lakes flowing through Braintree.

GOAL 2: Extend the riparian buffer zone to 200 feet

OBJECTIVES:

- Install plantings on eroding stream banks.
- Encourage planting of riparian species to replace turf where possible on properties in buffer zones.
- Encourage or enforce buffer-zone regulations.

GOAL 3: Reduce stormwater runoff and associated pollutants

OBJECTIVES:

- Encourage the installation of rain gardens, roof gardens, and permeable paving throughout the town on all properties wherever applicable.

GOAL 4: Change land management practices that impinge on water quality

OBJECTIVES:

- Encourage native and drought-tolerant landscaping and minimize the use of turf and ornamental plants and their associated maintenance practices such as mowing, fertilizing, employing pesticides, and watering with potable water.
- Discourage direct stormwater discharge into river by disconnecting downspouts and removing curb cuts in parking lots on river.
- Ban exposed storage of erodible materials near riparian zones.

GOAL 5: Develop and conduct effective community outreach and education programs

OBJECTIVES:

- Identify as many clubs and community organizations as possible in Braintree with the intent of bringing all groups together to explore ways in which each can use their area of interest to focus on the restoration of the Monatiquot River.
- Learn from other successful outreach programs from adjacent towns, towns in Massachusetts, and national flagship examples.
- Install highly visible demonstration projects.
- Encourage public engagements with rivers and streams.
- Bring the awareness of water quality and the river system by using the Monatiquot River whenever possible as an underlying theme to unite otherwise unrelated community groups, businesses, and municipal agencies.

6.4 PERSPECTIVES BEFORE AND AFTER WORKSHOP

Residents at the water quality discussion table had many questions. The question asked most was, "How is our water? Is there anything in it?" Second most asked question was, "What is water quality?" The most significant, recurring topic brought by the people of Braintree was the lack of information they had regarding water quality. Improved outreach in both traditional and innovative ways will be necessary if Braintree hopes to effectively communicate and work with its demographically diverse population.

Figure 63: Community workshop-Photo by Chingwen Cheng

A written survey was administered providing the following data. The first Water Quality question within the survey was "Monatiquot River is home to the Herring Fish. How do you feel about protecting them? Overall, the results revealed that protecting the Herring is of medium to high priority (Figure 64).

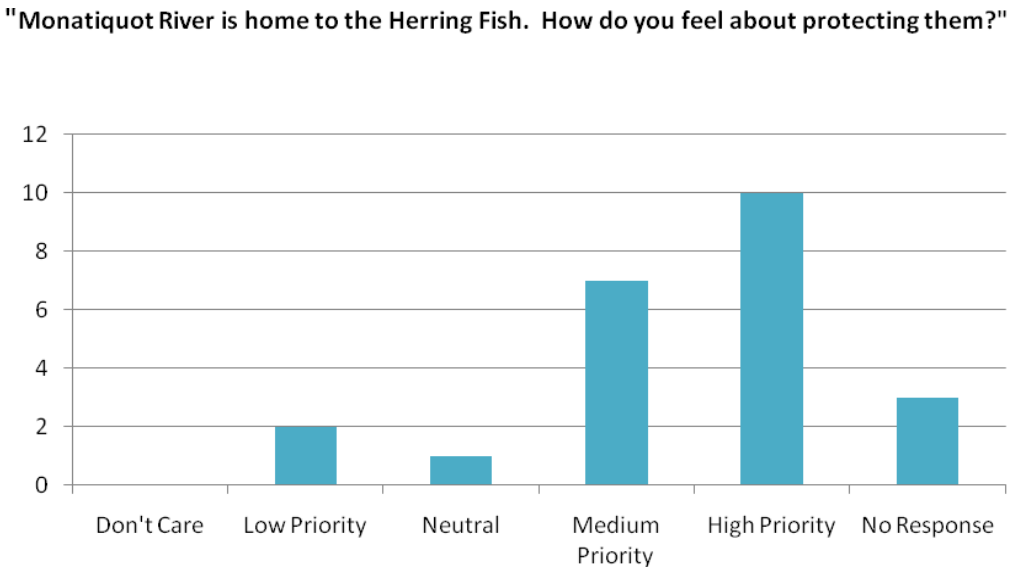

Figure 64: Workshop Survey Result

The next survey question regarding Water Quality stated "How important is the water quality of the Monatiquot River to you?" Overall, the results revealed that water quality is of importance to the people at the community workshop (Figure 65).

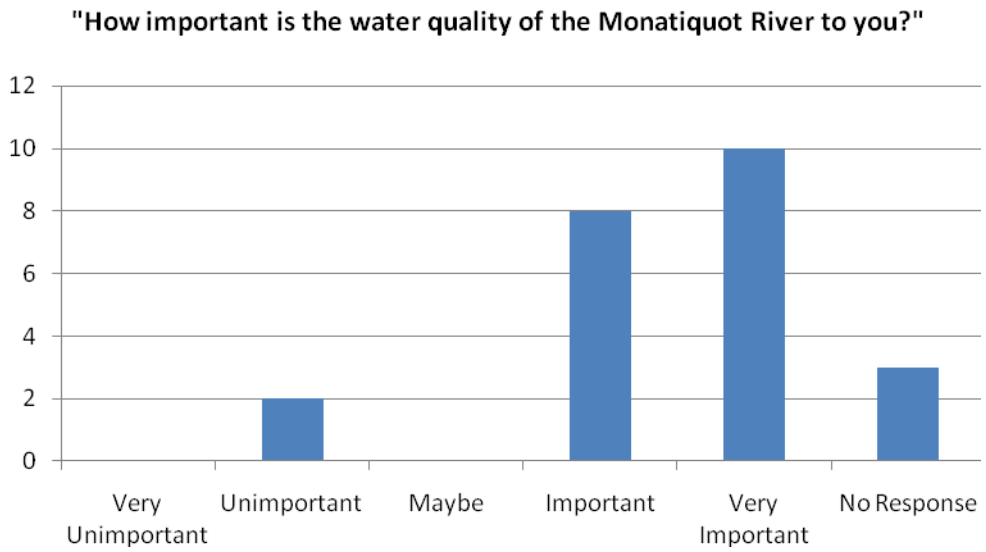

Figure 65: Workshop Survey Result

The third survey question about Water Quality stated “How well do you know about landscaping BMPs for lawn care and native plants landscaping on your yards and properties to conserve water and protect water quality?" Overall, the results revealed that the people at the community workshop had some to no knowledge of BMPs for lawn care and native plants landscaping in order to conserve water and protect water quality (Figure 66).

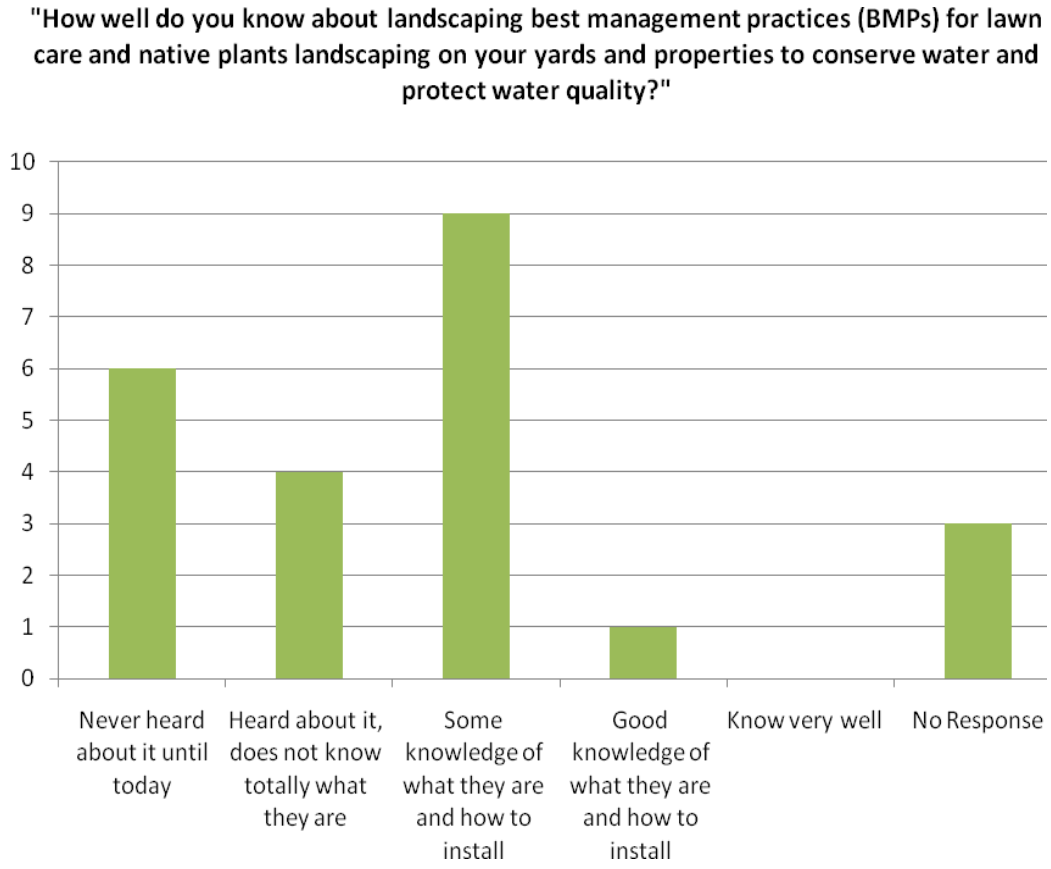

Figure 66: Workshop Survey Result

The fourth survey question about Water Quality stated "How likely are you going to install BMPs on your property to improve water quality?" Overall the results showed that the people at the community workshop may install BMPs to improve water quality (Figure 67).

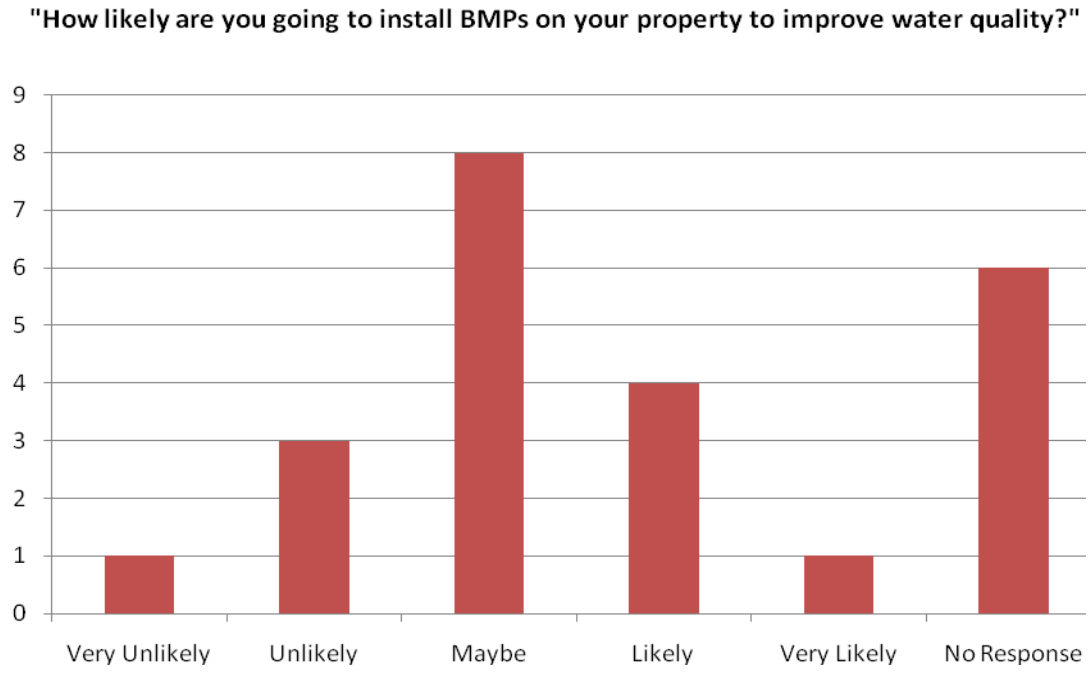

Figure 67: Workshop Survey Result

6.5 RECOMMENDATIONS

Based on the combination of SWOT analysis, research and stakeholder input, the following are recommendations for the improvement of water quality in Braintree:

NON-STRUCTURAL RECOMMENDATIONS FOR TOWN SCALE WATER QUALITY IMPROVEMENT

Short Term (within 5 years)	**Long Term (5 years and beyond)**
Public Outreach: Develop and conduct effective community outreach and education programs. Cultivate relationships between communities, local professional and social organizations, and educational organizations with water management as the uniting element.	Continue Public Outreach
Revisit Herring Restoration Plan: Revisit the document Feasibility Analysis for Restoring River Herring To the Fore River. Actions taken to restore herring habitat along the Monatiquot River will also contribute significantly to the improvement of water quality and reduce the risk of flooding.	Implement Herring Restoration Plan
Citizen Water Sampling Program: Develop and implement long-term water sampling and monitoring program that samples from multiple points, providing baseline data that can be used for river management decisions.	Continue Citizen Water Sampling Program
Compile Existing Studies: Bring together principle investigators and authors to revisit data across the variety of scientific and cultural studies of the Monatiquot River watershed to look for opportunities to prioritize and integrate recommendations made in them.	Continue with further studies and updated plans

STRUCTURAL RECOMMENDATIONS FOR TOWN SCALE WATER QUALITY IMPROVEMENT

Short Term (within 5 years)	**Long Term (5 years and beyond)**
Reduce Impervious Surface Area by 5%	Reduce Impervious Surface Area by 25%
Best Management Practices on Municipal, Commercial, and Residential sites	Implementation and testing of Best Management Practices to determine whether or not there has been a difference in water quality
25ft Buffers: increase plantings of native riparian vegetation, remove invasive species vegetation	200ft Buffers: increase plantings of native riparian vegetation, remove invasive species vegetation
Streamside Erosion Control: Install erosion control measures such as cribbing and plantings on eroding stream sides.	Rainwater Harvesting/ Irrigation Practices: Install rainwater harvest systems and intelligent irrigation systems to reduce use of drinking water for turf irrigation.
Remove trash and excessive debris from and around the Monatiquot River	Restore structure and functions of the Monatiquot River
Public Outreach: Develop and conduct effective community outreach and education programs. Cultivate relationships between communities, local professional and social organizations, and educational organizations with water management as the uniting element.	Continue Public Outreach

Figure 68: Short and Long term Structural and Non- Structural goals for Water Quality Improvement

IMPLEMENTATION OF RECOMMENDATIONS

Currently within Braintree there are many absences or missing links of riparian buffers along the rivers. Figure 69 and 70 illustrate conceptual proximity of the linkage location for 25-foot and 200-foot buffers along the Monatiquot River. It is worth noting that those maps are for reference only. Further study for identifying exact location and developing implementation plan is needed.

There are also a lot of impervious surfaces which do not allow water to infiltrate into the soil. The impervious surfaces cause water to runoff into the waterways and may be causing pollution of the local streams, rivers, ponds, lakes, and reservoirs. By increasing the permeable surfaces and reducing impermeable surfaces, broadening the buffers, connecting areas of existing buffers, filling in the missing links with vegetative, riparian buffers, the water quality can be improved.

Broadening riparian buffers and filling in missing links is crucial to protecting the current water quality and potentially improving the water quality. Practicing BMPs may further the cause in protecting and possibly improving the water quality. Using native riparian plants when planting and enriching buffers will help to promote the native wildlife populations.

Figure 71 and 72 are conceptual drawings of the area surrounding the Armstrong Factory and pond. The drawings were created by tracing views of Braintree, obtained from Google Earth. Figure 71 depicts existing areas covered by impervious surfaces which are drawn in gray. Green areas represent vegetation and therefore pervious surfaces. Figure 72 illustrates what the area might look like with increased amounts of vegetation in the form of street tree plantings, roof gardens, and increased riparian buffer zone plantings. By broadening buffers and fostering an appreciation for maintaining riparian plant species, residentially owned properties can have significant positive impact on water quality and increase biological diversity in riparian corridors. Figures 73 to 78 illustrates examples of before and after implementation of BMPs that can be applied on commercial, municipal, and residential properties for the improvement of water quality.

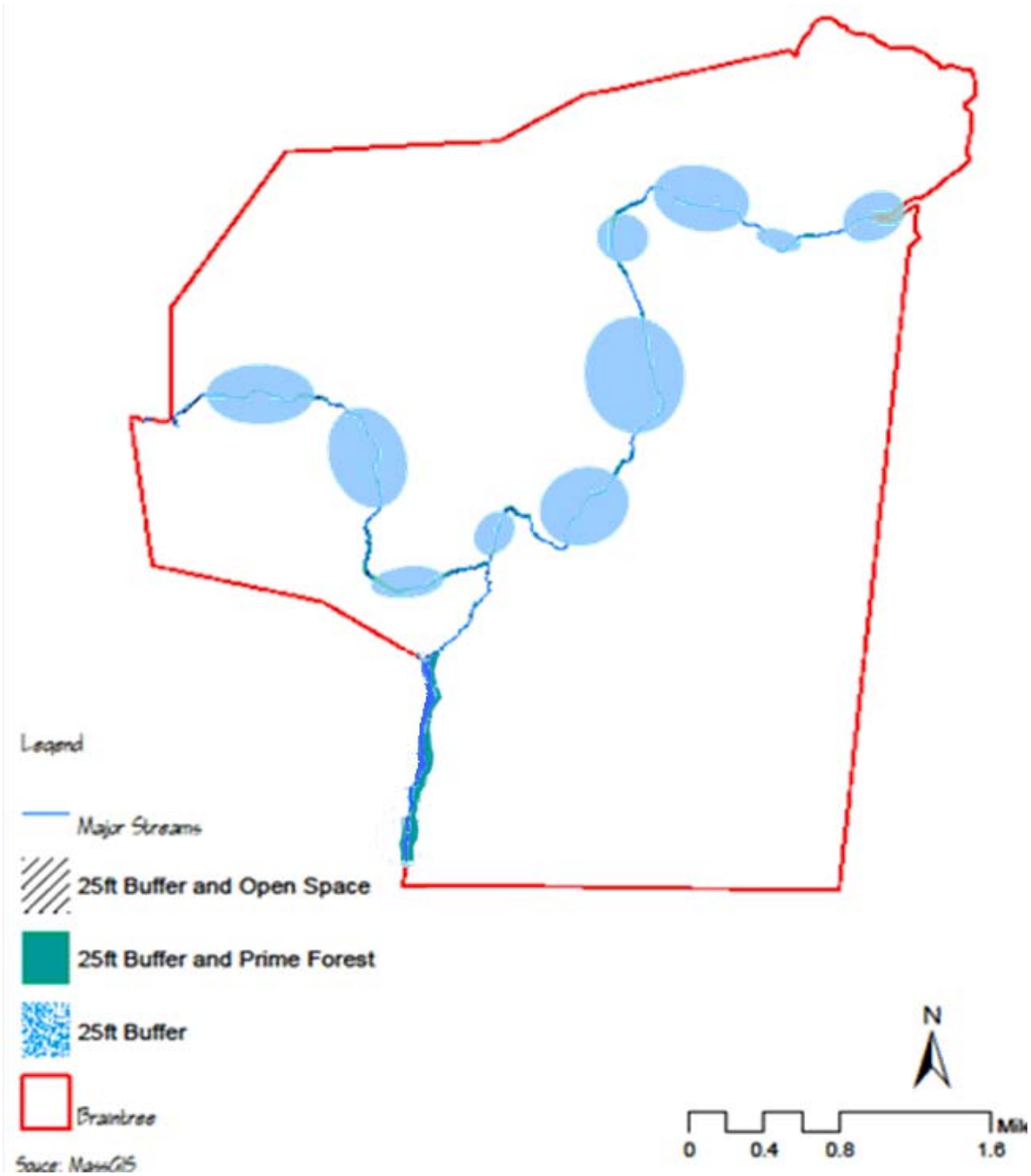

Figure 69: Map of missing links of 25 foot buffer along the Monatiquot River shown as blue dots. These missing links are areas of little to no buffer and are in high priority for restoration of riparian buffers as a short-term goal.

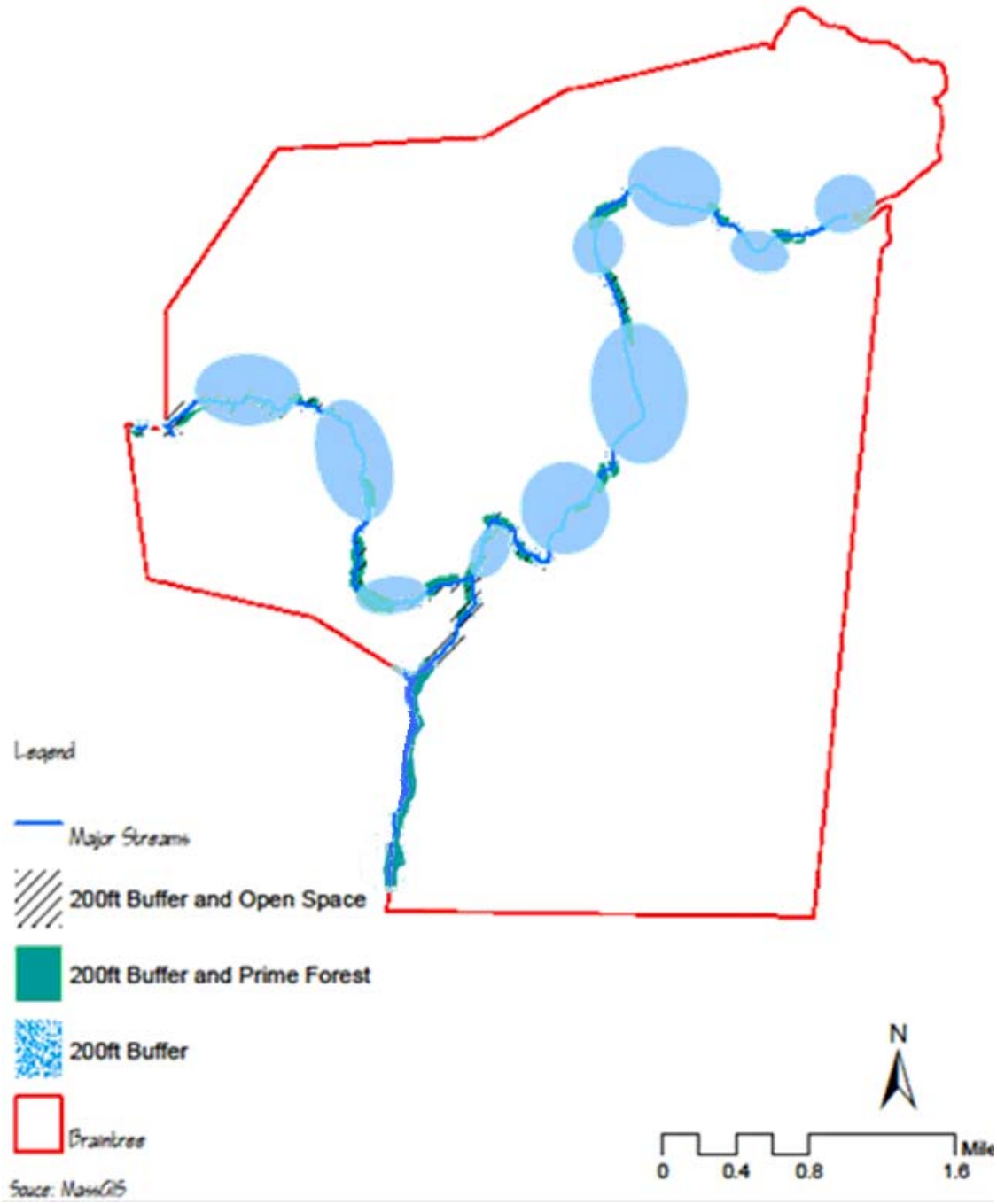

Figure 70: Map of missing links of the 200 foot buffer along the Monatiquot River shown as blue dots. These missing links are areas of little to no buffer and are recommended for long-term goals and implementation.

Figure71: Commercial existing impervious surface study before planting treatments

Figure72: Commercial impervious surface study with Increased planting and pervious surfaces (concept)

Figure 73: Commercial parking lot existing condition

Figure 74: Conceptual improvement of riparian buffer planting in commercial parking lot.

Figure 75: Municipal property example in existing condition

Figure 76: Municipal conceptual perspective with reduced mowing edge treatment. By altering mowing and watering regimens and area requirements, less potable water is needed to maintain municipally owned fields.

Figure 77: Residential property example in existing condition

Figure 78: Residential perspective concept diagram showing some native riparian plant species

6.6 CONCLUSION

Water quality is an issue that affects Braintree and requires a multifaceted approach to successfully address it. It is impossible to separate water quality from the issues of flooding and the cultural relationships of Braintree's residents to the rivers and streams they live near. With this in mind, building relationships with all stakeholders to plan for water management strategies is of utmost importance. Because of the scale and scope of the problems facing water quality in the Monatiquot, Cochato, and Farm Rivers, it is also important to have a good working relationship with scientists and other experts who have in-depth technical knowledge of them. Revisiting studies such as *Feasibility Analysis for Restoring River Herring to the Fore River*, and using it as a guiding document for watershed restoration would serve as a major step not only to protect Braintree residents from a variety of water related risks, but to turn the town's rivers into major assets.

7. RIVER ACCESS AND RECREATION

7.1 INTRODUCTION

This section presents the findings of the River Access and Recreation team. Through GIS and data analysis, six proposed visual and physical access points were identified along the Monatiquot River. We feel strongly to introduce a trail system that would create a framework for a future Monatiquot River *Greenway* (See Glossary) Initiative connecting these points. Nevertheless, the development of a greenway system is outside the scope of this project and highly recommended for further study and implementation. In the mean time, improvement on accessibility at 4 proposed plus 2 existing access points can achieve short-term river access and recreation goals.

The disconnect between numerous protected and recreational green spaces found within Braintree as well as in the sub-watershed district prompted the Access and Recreation committee to consider a series of trail systems utilizing the Monatiquot River as the spine to connect these spaces to each other as well as outlying areas. As the central feature to this concept, the Monatiquot River and its role as well as its visibility within the community will begin to be shed in a positive light.

These findings were presented to the public at a community workshop involving homeowners, members of various committees, public officials and concerned citizens. The community members' input led to the refinement of the six point access plan. A new four-point access plan was developed. This 4-point river access plan involves the redevelopment of the Armstrong Factory and the Robert Salvaggio Recycling center as multi use destination and gathering areas. In the further study of long-term greenway plan, a bicycle/walking trail is highly recommended for further connection between the Salvaggio Recycling Center and the Armstrong Factory as well as to existing recreational facilities such as Pond Meadow to the east and Watson Park to the North. In addition, development of a Monatiquot River Greenway in the Town of Braintree will allow this community to easily access the larger regional system of Greenways in Massachusetts thus, connecting Braintree, its numerous green spaces and the Monatiquot River to the greater region as a whole.

SECTION 7.2 summarizes the initial SWOT analysis for river access and recreation performed at the town scale.

SECTION 7.3 AND SECTION 7.4 list the goals and objectives respectively of

the river access and recreation team.

SECTION 7.5 describes how the public workshop clarified and informed the focus of the team's final recommendations.

SECTION 7.6 explains the specific recommendations proposed by the river access and recreation team.

SECTION 7.7 offers case study examples for Armstrong Factory and Robert Salvaggio Recycling Center redevelopment.

SECTION 7.8 offers implementation strategies for the recommendations.

SECTION 7.9 summarizes the river access and recreation section of the report.

7.2 SWOT ANALYSIS

SWOT analysis leads us to identify the Strengths, Weaknesses, Opportunities and Threats of the access points identified along the Monatiquot River as well as factors influencing and involved in the future development of a Monatiquot River Greenway.

STRENGTHS

- The proposed Monatiquot River Greenway will connect the southern (golf course) edge of Braintree with a trail system leading to and from the Boston Harbor just northeast of Watson Park. Figure 79 illustrates the abundance of protected and recreational open space.
- The Armstrong Factory, Robert Salvaggio Recycling center and Route 3 rotary sites will provide physical access points for launching kayaks and canoes that can utilize the river during spring runoff periods to paddle to the Boston Harbor Area as well as serve as points of connection.
- Additional strengths identified in the analysis process involve the abundance of Public Schools and Public Transportation stops (e.g. MBTA) within a half mile of the Monatiquot River. Providing school children with access to the Monatiquot River allows for outdoor classroom use and a deeper bond between the river and the next generation of environmental stewardship. Figures 80 and 81 show numerous educational facilities as well as transportation points within close proximity of the Monatiquot River.

- Public transportation stops within close proximity of the Monatiquot River give members of the Community as well as people who come from the Metropolitan Boston Areas on the Red Line T subway system an opportunity to enjoy the Monatiquot River (Figure 81).
- The greatest strength in Braintree is the level of excitement and willingness to be involved with a Monatiquot River Greenway Initiative that was expressed during the community workshop. Community members spoke about wanting their children to be able to swim in the Monatiquot River like they did as children.

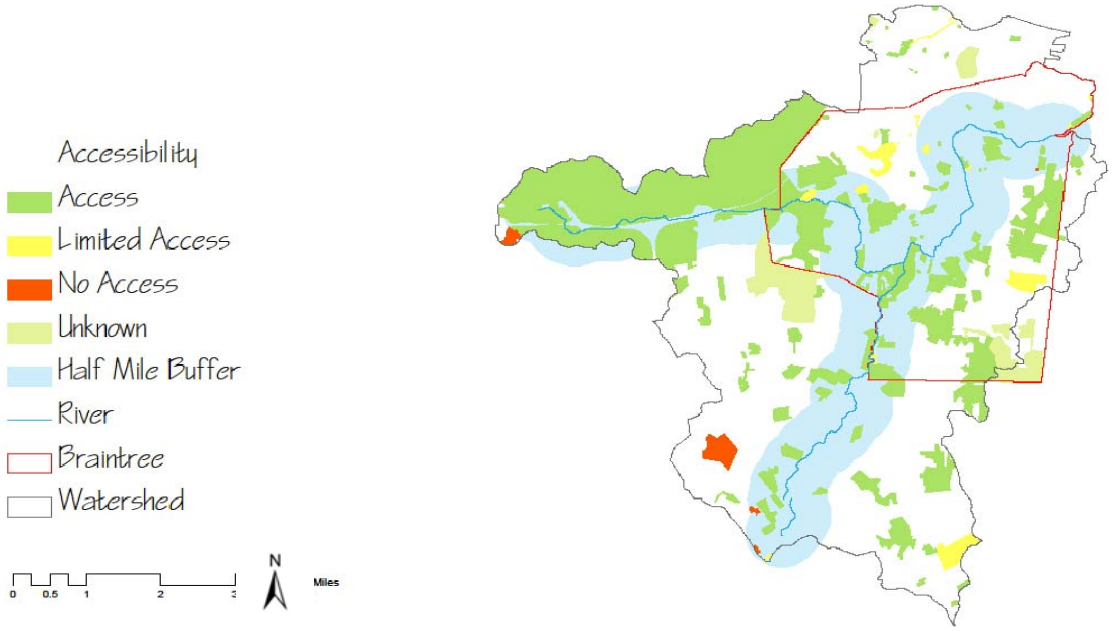

Figure 79: Existing Protected and Recreational Open Space within the Weir subwatershed

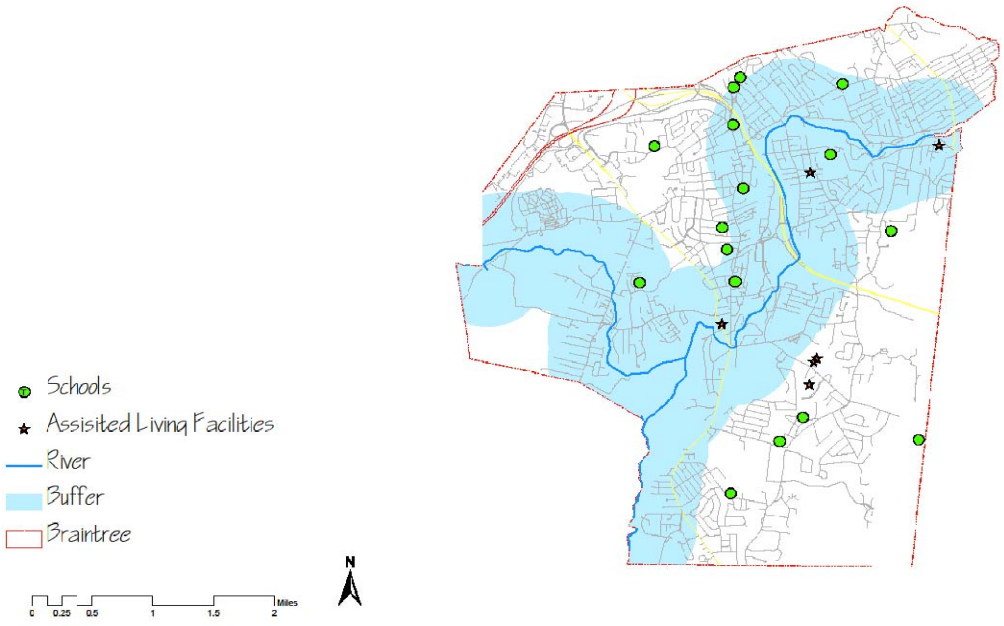

Figure 80: Schools and Assisted Living Facilities within close proximity of the Monatiquot River (note: the blue buffer here refers to a half-mile walking accessible zone to the river)

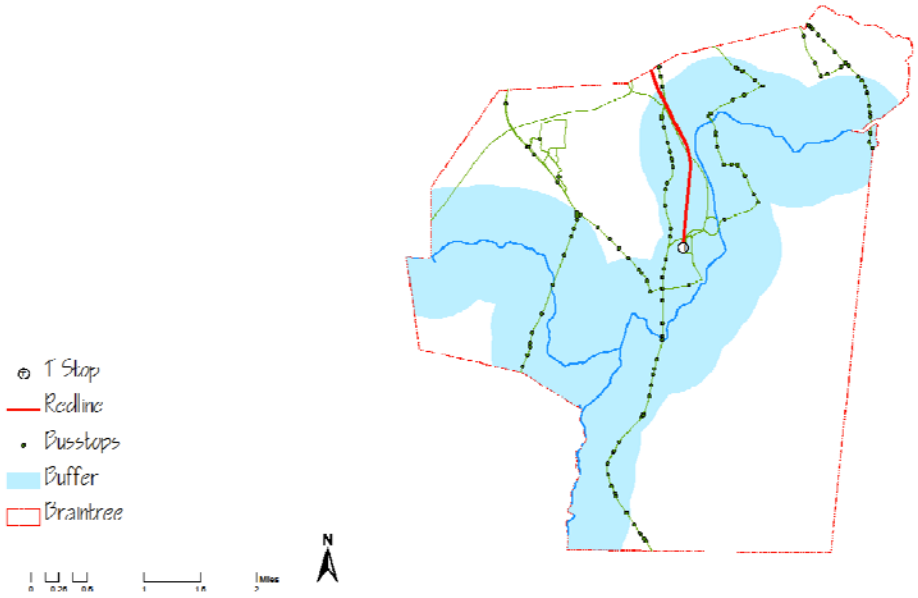

Figure 81: Public Transportation in relation to the Monatiquot River (note: the blue buffer here refers to a half-mile walking accessible zone to the river).

WEAKNESSES

- The main weakness for the River Access and Recreation team was to address river accessibility and the lack of designated physical access points to the river. With GIS data and a walking tour with Kelly Phelan data showed that there is no connectivity of city owned open space along the river. The town will have to acquire the privately owned open space or work closely with the private owners in order to ensure the connectivity necessary in establishing a Monatiquot River Greenway. Figure 82 shows an extreme example of private ownership along the banks of the Monatiquot River.

Figure 82: House on stilts at the Adams street bridge showing the Monatiquot River running 4 feet under the home. Photo by Elizabeth Englebretson, 2011.

- The topography surrounding the Monatiquot River is not conducive to easy physical access and hinders the future development of a Monatiquot River Greenway initiative. At various locations it will not be possible for a trail to be run along the river due to the heavy structural development including homes and commercial properties. For example, in the northern part of Braintree, the Monatiquot River cuts 4 feet beneath a historical house at the Adams Street Bridge where the home is on stilts with the Monatiquot River flowing beneath (Figure 82). Just north of this location along the river, the topography is steep and there is no area for trail development. At these points it is necessary for the trail to be diverted from the river to a bicycle/walking trail winding into the

neighborhoods using the East Middle School as a midpoint and reconnecting with the Monatiquot River East of the Myrtle and Front Street connection. Figure 83 illustrates areas typical of this portion of the Monatiquot River and its banks.

Figure 83: Topography typical of the northwestern section of the Monatiquot River. photo by Eddie Haynes, 2011

OPPORTUNITIES

- As shown through data analysis, Braintree owns property along the river as shown in Figure 84 that can be developed as access points without having to purchase private land and invest in large scale development.
- Through the future development of the Monatiquot River Greenway, the river can once again become the central interest and economic engine for residents and visitors to Braintree.
- The MBTA Red line terminus is located directly across Ivory Street adjacent to the Recycling Center. Developing the Robert Salvaggio Recycling Center as a

multi-use access point will provide easy and immediate access to the Monatiquot River for visitors coming in to Braintree on the public transportation system (Figure 85).

- From the Robert Salvaggio Recycling Center, a further study of a trail, including on-street connection, is highly recommended for connecting to the Pond Meadow and then north to Watson Park and eventually reach the Boston Harbor (Figure 86)

THREATS

- Current and future threats to the future development of a Monatiquot River Greenway include seasonal flooding in some parts along the river, consistent maintenance along the Monatiquot River Greenway involving available resources from Braintree as well as perpetual community interest in the preservation and stewardship of a local natural resource such as the Monatiquot River.

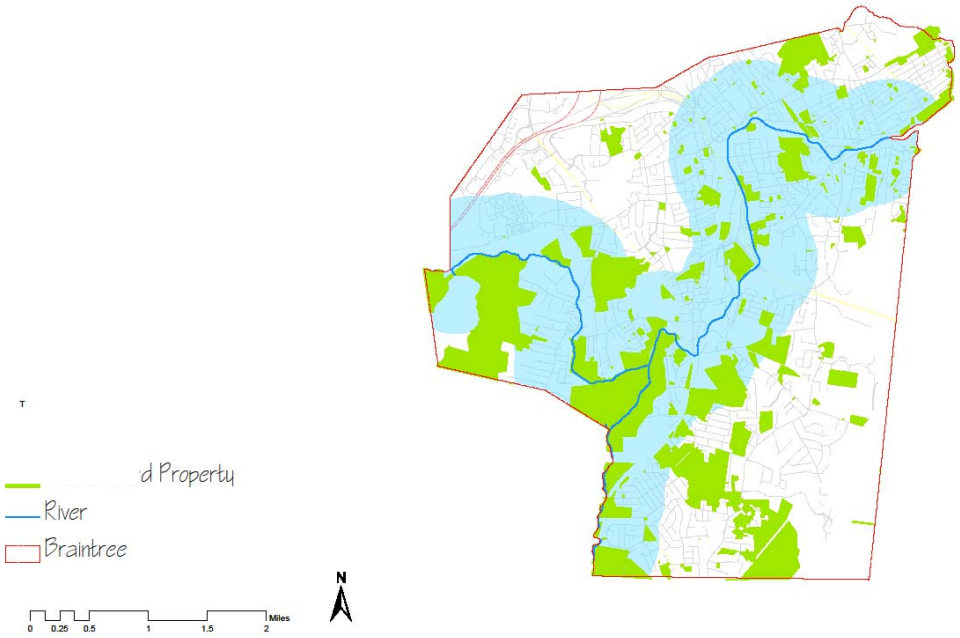

Figure 84: Braintree owned property along the Monatiquot River (note: the blue buffer here refers to a half-mile walking accessible zone to the river).

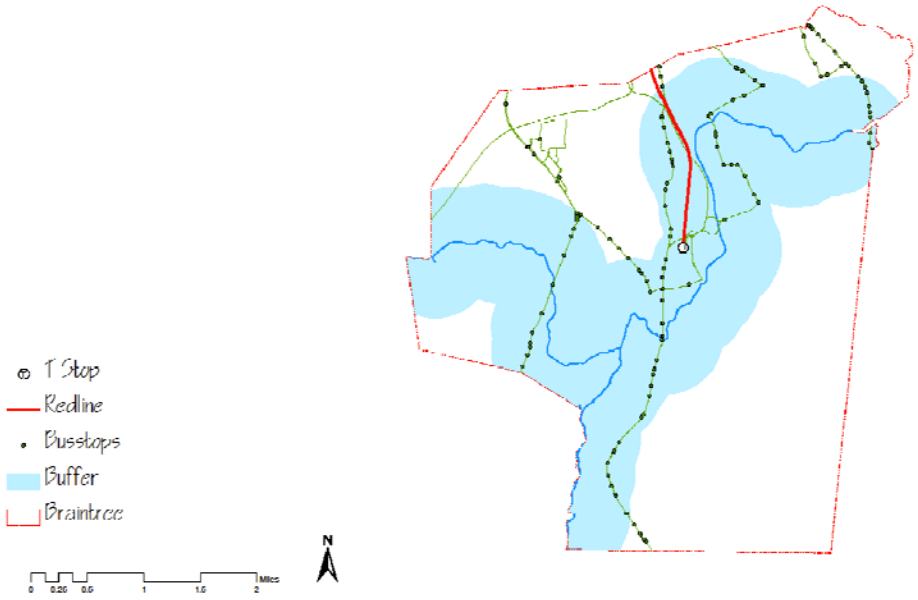

Figure 85: The T Terminal in relation to the Monatiquot River (note: the blue buffer here refers to a half-mile walking accessible zone to the river).

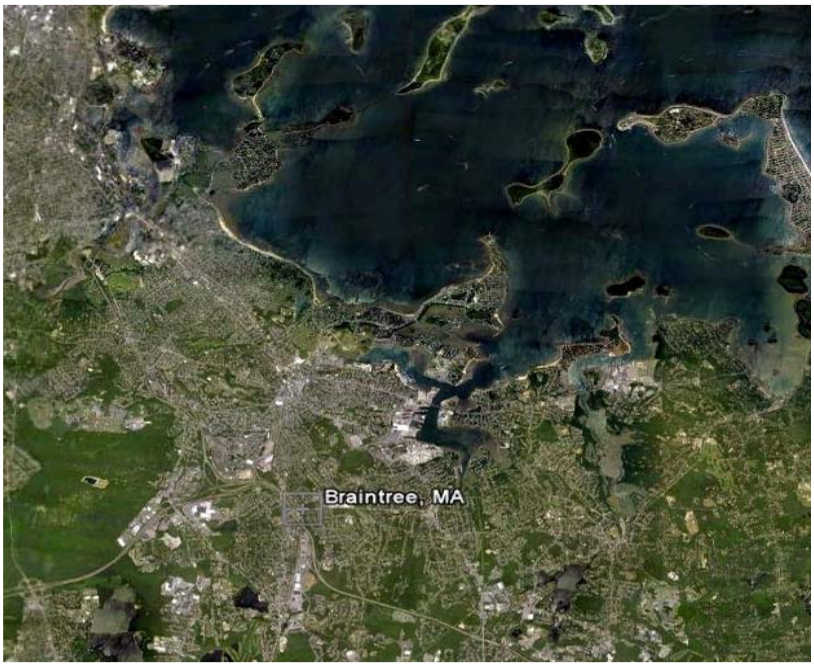

Figure 86: Google Earth Image showing Braintree and the proximity to the Boston Harbor.

7.3 GOALS FOR ACCESS AND RECREATION

The goal of the River Access and Recreation Plan is to reconnect Braintree visually and physically with the Monatiquot River and provide gathering areas and destination areas along a proposed future Monatiquot River Greenway Plan.

Figure 87: Artist rendition of a river trail system. This image illustrates a few of the possible uses imagined for the future Monatiquot River Greenway. www.ohbike.org

7.4 OBJECTIVES FOR ACCESS AND RECREATION

The following objectives will facilitate the achievement of the River Access and Recreation goal mentioned above.

- Improve Monatiquot River visibility through a consistent program of stewardship and maintenance.
- Create physical access and gathering spaces along the River
- Provide connectivity of green spaces within Braintree
- Initiate future development of a Monatiquot River Greenway system that

connects Braintree to a larger scale regional greenway system.

- Create public outreach programs and public interaction with the Monatiquot River through the creation of Public Outreach programs; such as the suggested Friends of the Monatiquot River Organization.

7.5 PERSPECTIVES BEFORE AND AFTER WORKSHOP

Through GIS and data synthesis, a connective bicycle/walking trail with six river access points were identified along the Monatiquot River. The proposed points plan from the initial inventory and assessment process was brought to the public workshop in order to acquire input (Figure 88). The Armstrong Factory and Robert Salvaggio Recycling Center are two of the six access points identified for further development as community parks and large scale gathering areas. Proposal of the Monatiquot River Greenway will also connect to larger scale regional greenways surrounding Braintree.

Through the process of discussion at the community workshop, residents expressed the need and desire for a trail system to connect the community. The trail system could be expanded to move away from the Monatiquot River and connect to the heavily used Pond Meadow Park to the west and then north to Watson Park. This trail would be an additional side system that can be accessed at the Robert Salvaggio Recycling Center.

Figure 88: Conceptual diagram of access points identified before (left) and after (right) workshop

Two of the six proposed access points were removed from the plan due to concerns regarding right of way easements at the north street location and current improvement initiatives at Watson Park (Figure 88). The remaining four include The Armstrong Factory and Robert Salvaggio Recycling Center still being developed as multi use destination points and the golf course and the Route 3 rotary being proposed as readily available access points.

Input from the community was obtained in several ways. One example was a questionnaire distributed to all who attended the community workshop. The following graphics illustrate public responses to the pertinent questions asked on the survey.

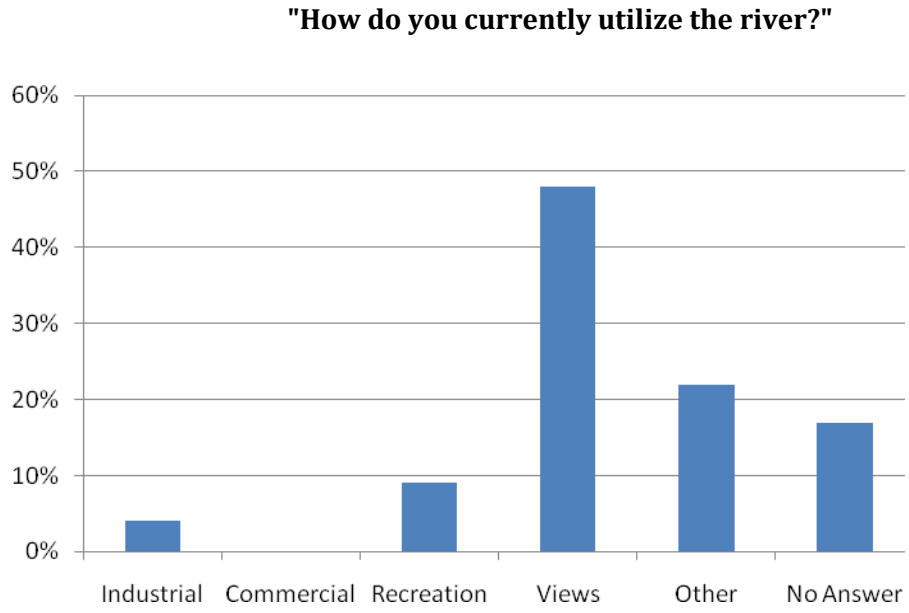

Figure 89: Workshop survey result

When asked about their use of the river citizens who attended the community workshop answered that for the most part if they had a relationship with the river, it was limited to viewing though there were a few enthusiastic residents who recreate in and around the river. Results show an overwhelming number interact with the river from afar (Figure 89).

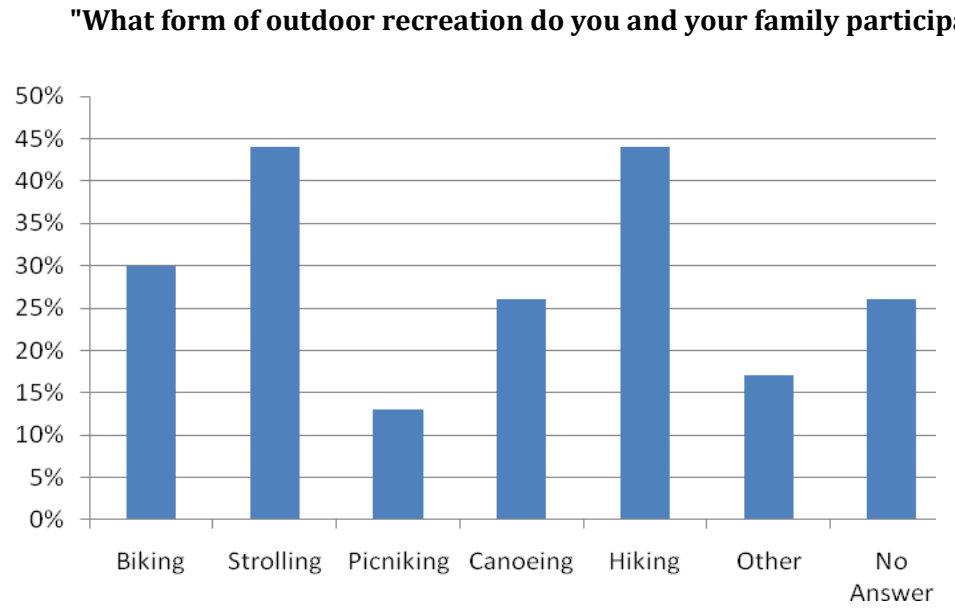

Figure 90: Workshop survey result

Workshop survey results showed almost half of the residents asked participate in walking/hiking activities (Figure 90). The results of these survey questions encouraged outdoor activities. A sizable number of those surveyed engaged in outdoor recreation activities that would be supported by a river-centric unified recreation system. Participation in activities such as kayaking, strolling, biking and canoeing were heavily represented in our survey. By proposing access to the Monatiquot River as well as providing spaces along its banks, community members will be able to participate in these activities within their community while enjoying and appreciating the Monatiquot River.

7.6 RECOMMENDATIONS

STRUCTURAL RECOMMENDATIONS FOR TOWN SCALE

Short Term (within 5 years)	**Long Term (5 years and beyond)**
Install access point signage Improve facilities at 4 proposed and 2 existing access points	Redevelopment of the Armstrong Factory and Robert Salvaggio Recycling Center Develop way-finding system based on the future proposed Monatiquot River Greenway Plan

NON-STRUCTURAL RECOMMENDATIONS FOR TOWN SCALE

Short Term (within 5 years)	**Long Term (5 years and beyond)**
Establish a "Friends of the Monatiquot River Greenway" organization in order to promote and encourage active community involvement in the maintenance and stewardship of the Monatiquot River.	Develop Monatiquot River Greenway Plan and implement connectivity to larger Regional Greenway system
Establish physical and visual access at readily available sites through improved maintenance and development	Redevelopment of the Armstrong Factory and Robert Salvaggio Recycling Center in order to provide larger gathering spaces and destinations along the proposed Monatiquot River Greenway

Figure 91: Short and Long term Structural and Non- Structural goals for River Access and Recreation.

SHORT TERM RECOMMENDATIONS

ESTABLISH A FRIENDS OF THE MONATIQUOT RIVER GREENWAY ORGANIZATION

The importance of public participation in the health and well-being of the Monatiquot River and its environs is essential in the success or failure of any recommendations regarding river accessibility or recreation. Past events have proven to dictate the essence of many residents relationship to the river. Because the role of the river remains ambiguous to most, it is of paramount concern that a citizens advocacy group be implemented to speak for the river, promote its importance, and work towards re-defining its role with the community members in which they live.

Figure 92: The Charles River Watershed Association organizes several river cleanup events and other community activities throughout the year encouraging Charles River Stewardship and Maintenance. Source: www.crwa.org

ESTABLISH ACCESS AT THE READILY AVAILABLE SITES

There are several parcels of property along the river corridor that are town-owned. Of these, the two locations most conducive to river accessibility are adjacent to the golf course and northeast of the Route 3 rotary.

The Route 3 rotary location proves to be an exceptional access point where the launching of small vessels can be accomplished with minimal resources or cost to the town. Its proximity to interstate 3 and the T terminal (1/3mile East) make it readily available to not only residents of Braintree but those from surrounding communities.

At present, the location is used as an overflow area to the Braintree Department of Public Works operations. The vegetation consists primarily of opportunistic, invasive species. The topography of the river bank is at less than a 5 percent grade with an open parking area 120 feet from the river bank. With maintenance of the vegetation, cleanup of debris and clear delineation of pathways to the river and parking areas, access at this area can be achieved within short term duration (Figure 93).

Figure 93: Google Earth image showing the Route 3 rotary site that is currently used for the Braintree Department of Public Works operations overflow area. The Illustration shows proposed access and parking. A map shows this location in Braintree.

Adjacent to the Golf Course

Located off Jefferson Street and Shepard Road in the southwest portion of Braintree, the area adjacent to the golf course is flooded in winter months and used as a skating area. Year-round use of the site can be accomplished by designated parking and picnic areas. The area would prove favorable for shoreline fishing, picnic, and rest areas. Because two dams are located ¼ mile downstream, travel via canoe or kayak is obstructed and therefore the area is not recommended for the launching of small vessels (Figure 94).

Figure 94: Google Earth image showing the Golf Course area at Jefferson and Shepard Road. A conceptual diagram shows proposed access and recreation activities. A map shows the Golf Course location in Braintree.

LONG TERM RECOMMENDATIONS

CONNECTION TO THE REGIONAL GREENWAY NETWORKS

Promoting a Monatiquot River Greenway as the framework by which to connect to existing greenway systems will serve to enhance the community of Braintree as a whole in the long run (Figure 95). Connectivity with the surrounding areas will serve to encourage a pathway system into Braintree rather than bypass it. An initiative for further Monatiquot River Greenway study for detailed trail plan and implementation plan is highly recommended.

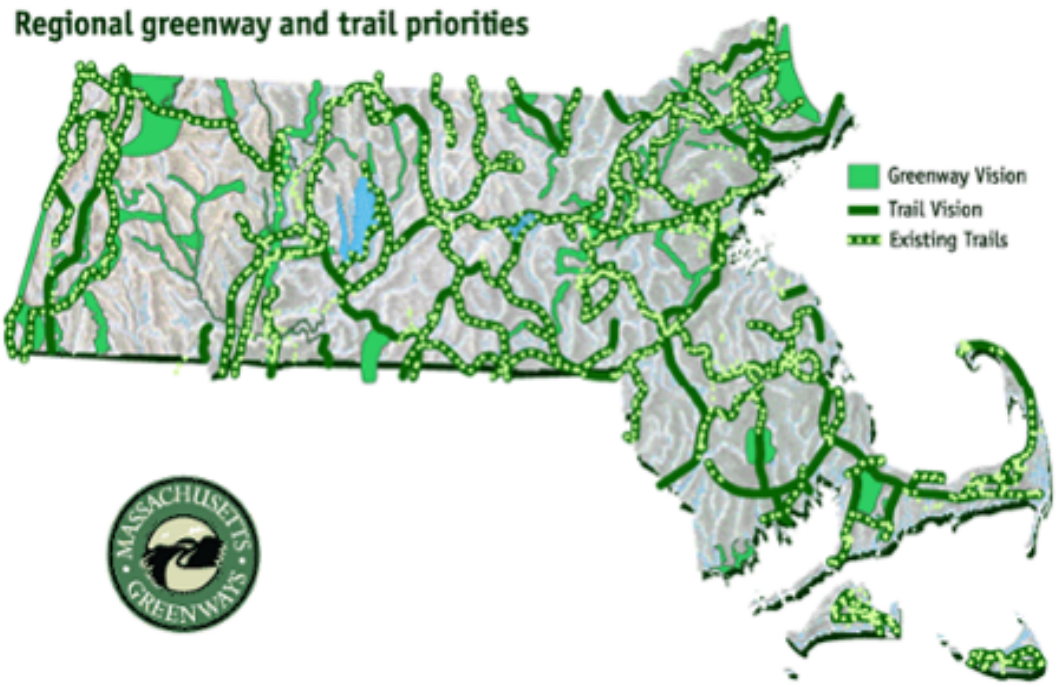

Figure 95: Map showing the existing Massachusetts Greenways that the Access and Recreation long term plan will connect with. Source: DCR Greenway and Trails.

REDEVELOPMENT OF THE ARMSTRONG FACTORY AND ROBERT SALVAGGIO RECYCLING CENTER

Armstrong Factory

The redevelopment of the Armstrong Factory site as a mixed use destination with river access along the Monatiquot River corridor is recommended to enhance cultural activities within Braintree as well as cultivate local economy. Privately owned, the Armstrong Factory has been closed since 1996. The 31 acre site is located ½ mile from the MBTA terminal with the Monatiquot River flowing through the central portion of the property.

At present, a portion of the easternmost structure on the site is utilized by local businesses; however, a large portion of the structure remains vacant. The Armstrong Factory owner has expressed interests in turning the site into a commercial venue or a residential complex. Recommendation that both of these as well as other uses be considered to develop a mixed use site to include light manufacturing for locally produced products.

Flexible outdoor space is recommended to promote a local performing and visual arts venue. Spaces and nodes along the outer rim of the site prove to compliment use and activities of the structure as well as provide access to the river, with a foot bridge over the river providing ample parking adjacent to the open area (Figures 96 and 97).

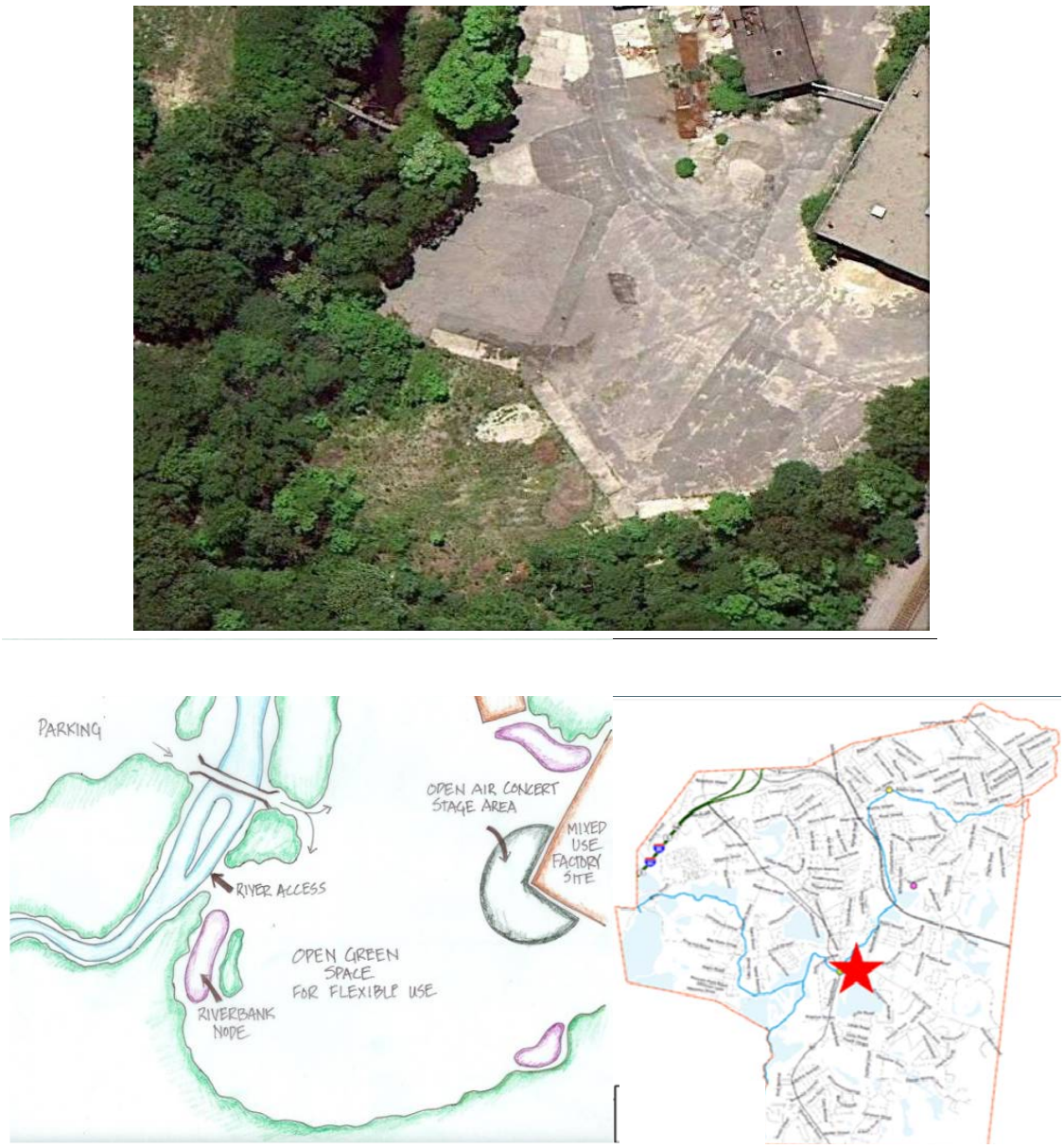

Figure 96: Google Earth image showing the Armstrong Factory area proposed for redevelopment and the Armstrong Factory proximity to the Monatiquot River. Bottom Left: Proposed Access and Recreation Areas. Bottom Right: Map showing Armstrong Factory location within Braintree.

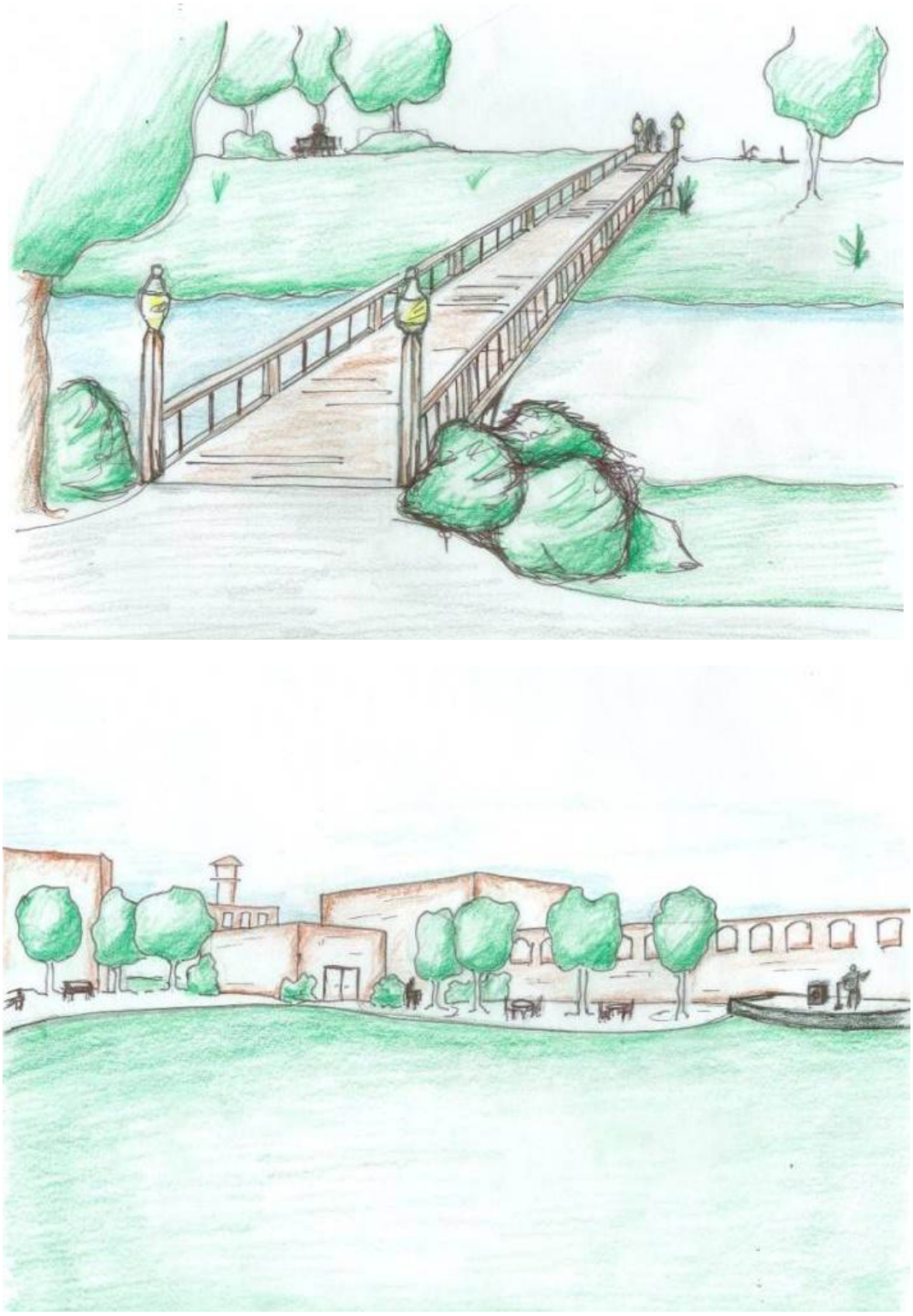

Figure 97: Top: proposed access over the Monatiquot River from parking to site. Bottom: proposed mixed- use site for Armstrong Factory with outdoor activity areas

Roberts Salvaggio Recycling Center

The Robert Salvaggio Recycling Center is located in Braintree on Ivory Street directly across from the Red Line T-Stop. The Robert Salvaggio Recycling Center provides recycling drop off services to Braintree as well as being a recycling transfer station. The landfill area behind the recycling station has been capped and offers Braintree a large amount of open green space within 200 feet of the river and 500 feet from the T-stop station. Development of this area will include a looping fitness/walking trail that is 1/2 mile at the base and connects with a series of smaller trails that loop to the top of the landfill. The bottom 1/2 mile loop will contain several exercise areas providing users with cross training such as pull ups and balance beams. Informational signage provides basic fitness information about each stop. The top of the landfill is about 800 feet by 800 feet and would be used for open space and community events.

The roughly 800 foot long and 200 foot wide flat area between the river and the base of the landfill, Route 3 and the recycling building provide a great environment for a looping nature trail and outdoor classroom space. Educational signage and designated learning areas can provide visitors with information about the ecological processes and wildlife along and within the Monatiquot River, ncluding the history and future of the River Herring. The Robert Salvaggio Recycling Center is also a prime location for a nature center and learning areas for schools and community groups. As the path winds along the Monatiquot River, there will be a series of physical access points for vessel launch as well as a small bridge crossing the Monatiquot River splitting from the proposed Monatiquot River bicycle trail and giving the visitor the option to continue along the Monatiquot River or ride to Pond Meadow (Figure 98) as part of the future Monatiquot River Greenway Plan.

Redesigning the Robert Salvaggio Recycling Center building would also be a great addition and complement to this proposed park area. Redesigning The Robert Salvaggio Recycling Center in a way that opens the building up to the public provides public education opportunities about recycling and waste production in their community.

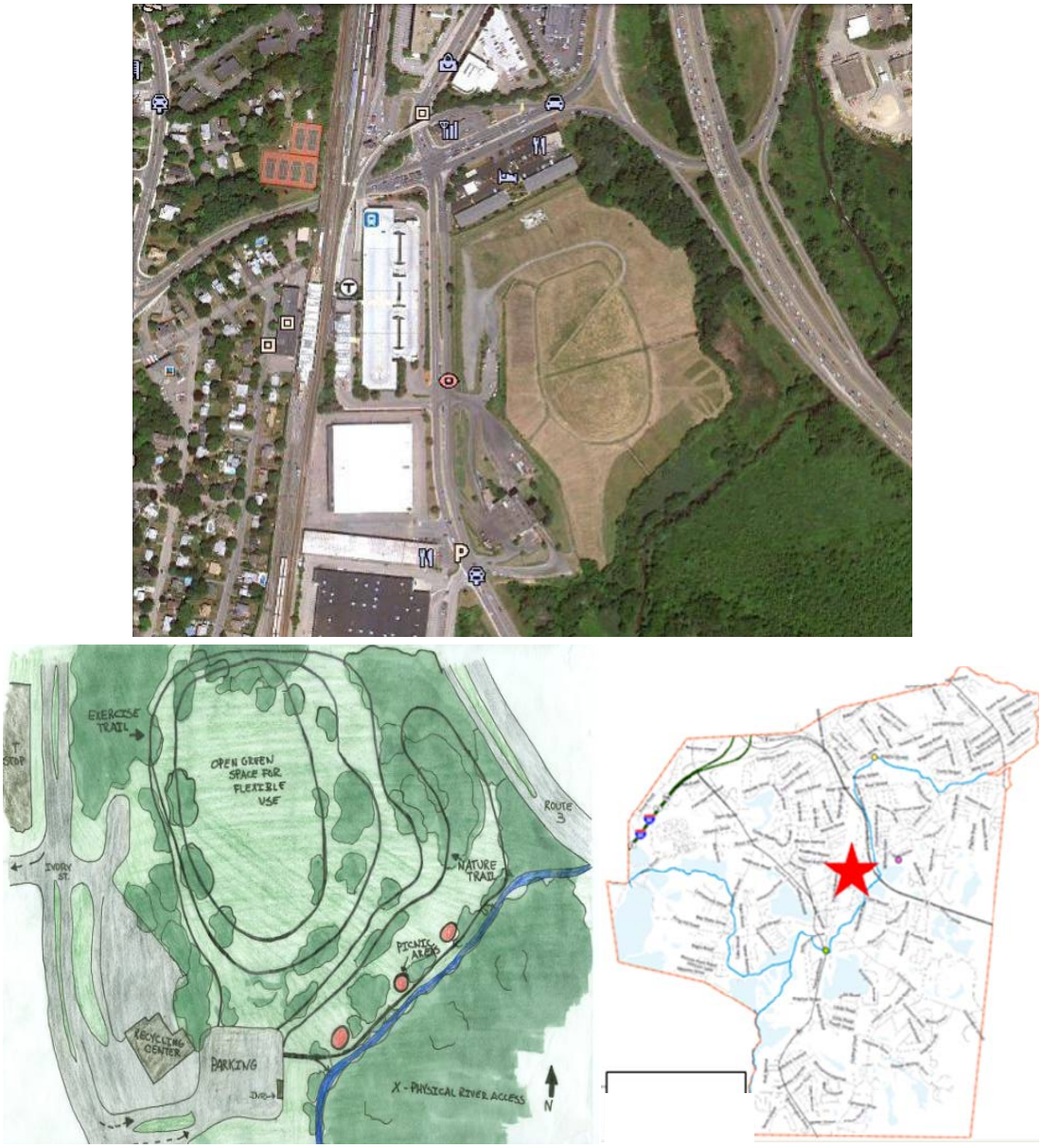

Figure 98: Google Earth image showing the Robert Salvaggi[illegible] Monatiquot River and the MBTA Red Line Station. Bottom Left: Proposed Access and Recreation. Bottom Right: Map showing the location of the Robert Salvaggio Recycling Center within Braintree.

7.7 RELEVANT CASE STUDIES

Armstrong Factory Site

Precedent to adaptive reuse is Gas Works Park in Seattle, Washington. Designed by Richard Haag, Gas Works opened in 1975 and embraces the industrial past of the site. Much of the original Gas Light factory structure exists within the park and serves as a sculptural representation of the merging of past and present (Figure 99).

Figure 99: Gas Works Park, Seattle , Washington designed by Richard Haag. Gas Works Park is intended to highlight and embrace the industrial history of the site. Source: www.gasworkspark.com

The second case study is the Landschaftpark located in Duisburg Nord, Germany. Here the coal and steel production plant is evident in the design and function of the area. Latz and Partners 1991 design found new uses for many of the old structures where interaction between visitors and the plant take place (Figure 100 and 101).

Source: http://static.flickr.com/115/289880938_f58dca0166_o.jpg

Figure 100: Landschaftpark located in Duisburg Nord, Germany shown at night. Lighting Artists have used lighting to revision the site at night to depict what the factory may have looked like while in full production.

Figure 101: Landschaftpark located in Duisburg Nord, Germany, showing the possibilities for redevelopment at the Armstrong Factory. Source: static.flicker.com

Robert Salvaggio Recycling Center

During the period of 1989-1993 Michael Singer and Linnea Glatt worked to redesign the Phoenix Solid Waste Transfer Station. Michael Singer stated that through this redesign he "wanted people to understand this place and be open to it". The new building reveals the process of recycling as well as other issues related to disposal of garbage (Figure 102).

Figure 102: Phoenix Solid Waste and Recycling Center, Phoenix, Arizona. The building redesign by Singer and Glatt opened the building to the public encouraging education and engagement with the process of solid waste management and recycling. Source: www.michaelsinger.org

7.8 IMPLEMENTATION STRATEGIES

Implementation of the River Access and Recreation Plan requires community and government involvement on multiple scales. Involvement on an individual and community scale includes development of a "Friends of the Monatiquot River Greenway" organization to encourage public participation and municipal support to encourage the connection between the needs of the private citizen and the process of city and state government. The "Friends of the Monatiquot River Greenway" organization should also interact with other regional and state greenway systems and conservation groups to foster learning and cooperation. Funding sources for the Monatiquot River Greenway initiative include Department of Conservation and Recreation (DCR) and Environmental Protection Agency (EPA) programs. The DCR offers Recreational Trail Grants as well as Greenway Trails and Demonstration Grants; the EPA offers Brownfield and Land Revitalization Grants.

On the town scale, regulations that help to gain access along the Monatiquot River such as conservation easements and zoning bylaws are highly recommended. The redevelopment of the Armstrong Factory and the Robert Salvaggio Recycling Center will require consideration of mixed use zoning measures.

7.9 CONCLUSION

The Monatiquot River is rich in historic relevance to the incorporation and growth of Braintree. With the development of mills along its banks, the Monatiquot River once held an integral role within the community. However, like many other mill towns, that role has slowly become obscured by contemporary economic, social, and political trends, thus leaving the Monatiquot River disconnected from the community that was found by the river. The identity of the Monatiquot River must be reinvented through the exploration of a renewed relationship based on merging the contemporary needs of the community with preserving the ecological integrity of the waterway. Through recommendations of connectivity, accessibility and recreational activities, Braintree has the tremendous opportunity to re-create the role of the Monatiquot River, instigate a dialog in exploring a collective vision for its role in the future and promote the dynamic resource for the community of Braintree as a whole.

8. MONATIQUOT RIVER OUTREACH AND EDUCATION PROGRAM

An educational outreach program is at the crux of successful implementation of the strategies for valuable and sustainable design for Braintree. Advantages of how a healthy watershed system works, and how this affects the overall health of Braintree, need to be detailed and explained to the general public in unambiguous terms. A successful outreach program can be founded on a multi-step, multi-layered strategy reaching out to public, private, and governmental entities. At the forefront of this educational outreach program is the creation of the outreach strategy and its particular goals: generating public awareness, and public education programs that build upon existing relationships with the watershed system. This is the foundation that will then guide the success of the actual programs, events, and memorabilia of the watershed education project.

The operating plans include educational materials for schools including coloring books and games that introduce the ideas and vocabulary to a younger audience, and lesson plans that allow middle and high school students to conduct experiments on water quality, and aquatic species inventories. This is also the area where tax incentives and rebate programs can be introduced to residential and commercial populations. Introducing specific plans that the general public can implement and recognize will reinforce the general educational and outreach component of the plan. Flagship projects funded by local businesses will reinforce the idea that they are committed to creating a healthier community. Engaging trusted and popular local public figures will also raise the popularity and overall acceptance of the BMPs toolbox strategies.

Distributing the idea to the general public is vital to creating continual and ongoing awareness of watershed health and management issues, as well as engaging the public at a social and communal level. Distribution of educational materials throughout the school systems will help promote ideas to the future generations of Braintree, and help to comingle the health of the watershed system with their own. In addition, other visual reminders are effective in bringing the awareness of the watershed. For example, the creation of t-shirts (Figure 103), calendars, buttons, and key chains continually remind the public of watershed issues and opportunities available to them. Furthermore, kiosks placed at flagship projects and other highly visible areas are also a way of continually

educating the public about the watershed system.

The final portion of a successful plan is to include an evaluation section. This helps to track success and future opportunities for engagement and implementation in the overall recovery strategy. The evaluation should focus on three areas: administrative indicators, social indicators, and environmental indicators. Administrative indicators focus on the successes of stated policy goals and activities timelines. Social indicators focus on the public's acceptance of and commitment towards policy goals and actual implemented designs. Environmental indicators focus on the improvements of the surroundings, including water quality improvements, and wildlife restoration.

A comprehensive and dedicated plan that engages the public on many levels, and through various media, is of prime importance for the successful implementation of BMPs strategies (see a list of BMPs in Glossary and a summary of application of BMPs in Appendix 12.5). It should involve community groups, commercial entities, governmental agencies, and school districts. This 'total education' approach ensures that through continual exposure of an idea. The idea will become embedded within the community more quickly and efficiently.

The outreach program provides an introduction and a constructed avenue for Braintree to become stewards of the Monatiquot River; consequently of the greater watershed system. Done effectively, the education program need not end at the borders of Braintree, but can influence and educate surrounding towns to follow by example.

Figure 103: Tee-shirt concept

9. CONCLUSIONS

For every problem there is an opportunity for solution. The river systems of Braintree, that were once the economic lifeline of the town, have turned into an economic liability in terms of sheer cost of clean-up, repairing infrastructure, and lost wages. By re-connecting Braintree with the Monatiquot River (and larger river/ watershed system), both the residents and the natural system can profit from the mutual relationship: Braintree can gain an economic and public attraction; the Monatiquot River can re-establish a more sustainable ecological rhythm. By way of re-evaluating water quality improvements, stormwater management strategies, and river access proposals Braintree can re-invent the relationship between the residents and their environment.

This re-evaluation requires town-wide investment, both financially and sentimentally. Although this initial investment is by far the most difficult (fear of unknown results are no new thing for society), what it offers in the end could potentially be a system that restores ecological functions of the Farm, Cochato and Monatiquot Rivers that have long played an important role in Braintree and the Weir sub-watershed system in terms of ecological health and longevity. It also will serve as an attractor for tourism and business, as well as for both present and future residents. This creates a positive and cost-effective cyclical relationship: even though the initial investment given towards a renewed watershed identity could be substantial, they pay for themselves through time, freeing extra resources to put towards larger public projects, which in turn help to attract more profitable tourist attractions, businesses, and healthy residents.

No single solution will solve the complex issues of a watershed system. A holistic approach incorporating structural and non-structural strategies, ecological and public health criteria, and equal access opportunities will ensure the success of Braintree reconnecting with its waterways.

10. GLOSSARY

Best Management Practices (BMPs), (EPA definition)- Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Bio-retention (bio-retention pond or swale)- The process in which contaminants and sedimentation are removed from stormwater runoff. A bio-retention pond consists of a grass buffer strip, sand bed, retention area, organic or mulch layer, planting soil, and plants. Runoff passes first over or through a sand bed, which slows the runoff's velocity, distributes it evenly along the length of the retention area, which consists of a surface organic layer and/or groundcover, and the underlying planting soil. The retention area is graded, its center depressed. Water is retained to a depth of 15 cm (5.9 in) and gradually infiltrates the bio-retention area or is evaporated. The bio-retention area is graded to divert excess runoff away from itself. Stored water in the bio-retention area planting soil infiltrates over a period of days into the underlying soils.

Brownfield- A former industrial or commercial site where future use is affected by real or perceived environmental contamination.

Buffer Zone- Any area along a stream that is managed to mitigate or neutralize potential damage to the stream through targeted plantings and land use restrictions.

Combined Sewer Overflow (CSO)- The discharge of wastewater and stormwater from a combined sewer system directly into a river, stream, lake, or ocean.

Detention Basin- An area where excess stormwater is stored or held temporarily and then slowly drains when water levels in the receiving channel recede. In essence, the water in a detention basin is temporarily detained until additional room becomes available in the receiving channel.

Filter Strips- Areas with native vegetative cover used to filter and absorb runoff from adjacent impervious surfaces. They slow runoff speed, trapping sediment and other pollutants and providing absorption.

Flash flood - The result of heavy or excessive amounts of rainfall within a short period of time, usually less than 6 hours, causing water to rise and fall quite rapidly.

Green Roof- Vegetated roof system that retains and slows rainwater runoff from the tops of housing and buildings.

Greenway- A connected linear system of land with multiple functions that provide ecological health, recreation, transportation, and economic benefits.

Impervious Surface - A surface that does not allow water to pass through it into the soil.

Native Landscaping- Utilizing native plants in the design.

Permeable Paving- Paving systems with spaces that allows water to move through the driving surface to the stone base below to allow infiltration.

Rain Garden- A planted depression that has an infiltration trench designed to store and retain storm water.

Retention Basin- Holds storm water indefinitely.

Riparian- of, pertaining to, or situated or dwelling on the bank of a river or other body of water.

Vegetated Swale- A broad, shallow vegetated channel used for the movement and temporary storage of runoff. Has a dense stand of vegetation that covers the sides and bottom.

Water Quality- Water Quality is a term used to describe the biological, chemical and physical characteristics of water and its general composition. These attributes affect water's ability to sustain life and its suitability for human consumption.

Watershed- An area that topographically appears to contribute all the water that passes through a given cross section of a stream. More simply, an area of land which drains to a common point.

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“Getting in Step: A Guide for Conducting Watershed Outreach Campaigns”, 2003

“Smart Growth”, http://www.epa.gov/smartgrowth

12. APPENDICES

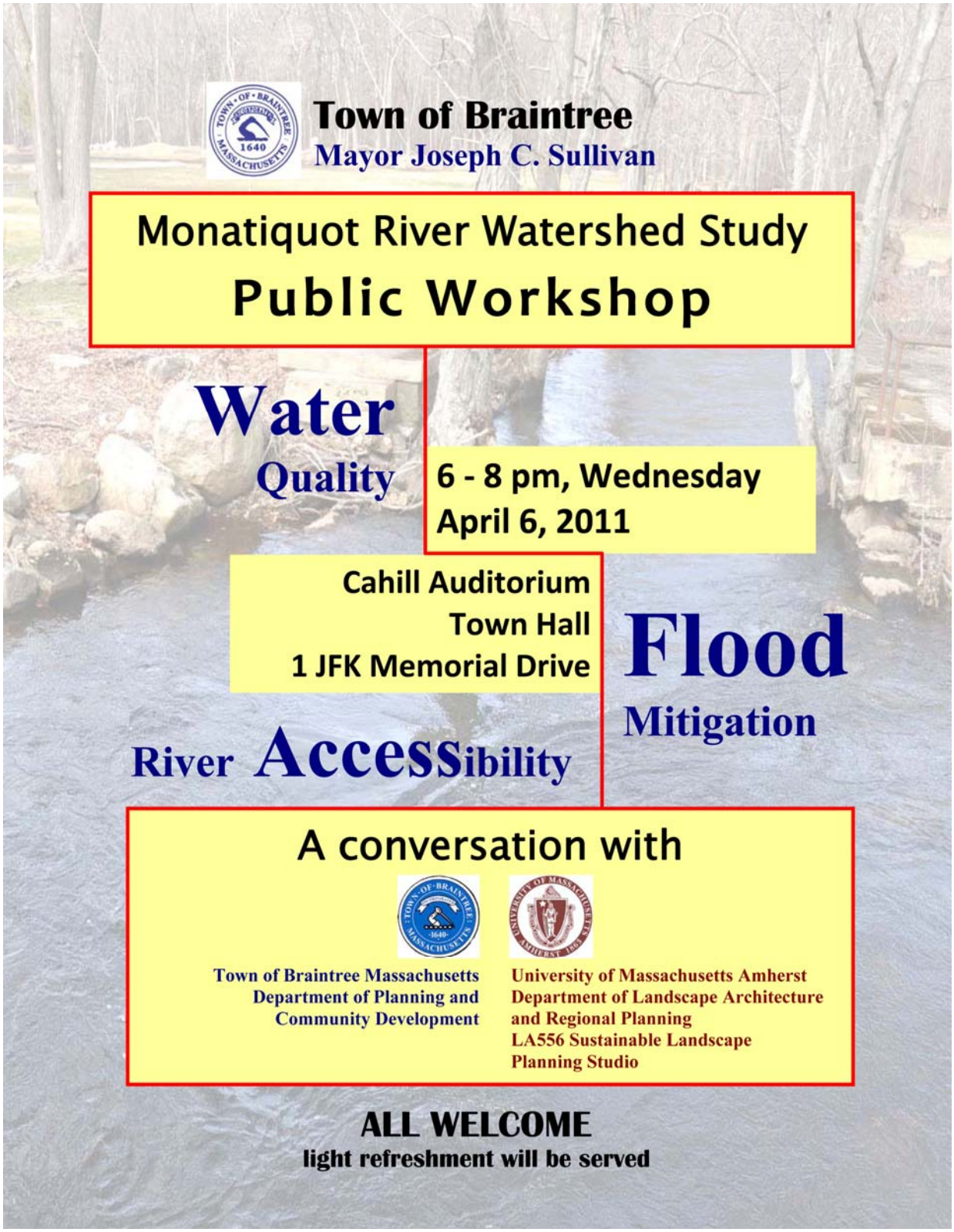
12.1 COMMUNITY WORKSHOP ANNOUNCEMENTS

Source: http://www.wickedlocal.com/braintree/news/x675836352/UMass-students-preparing-Monatiquot-River-study-for-Braintree#axzz1Ks5ZNJ6p

Source: http://www.patriotledger.com/news/x1053026864/Braintree-workshop-to-discuss-Monatiquot-River-plans

Source: http://www.dredgingtoday.com/2011/04/01/braintree-hosts-workshop-on-monatiquot-river

12.2 COMMUNITY WORKSHOP FLYER



12.3 COMMUNITY WORKSHOP AGENDA

Town of Braintree
Major Joseph C. Sullivan
Planning and Community Development
Department

University of Massachusetts Amherst
Department of Landscape Architecture and
Regional Planning

Town of Braintree Monatiquot River Watershed Study
Public Workshop
6 – 8 pm, Wednesday, April 6, 2011
Cahill Auditorium, Town Hall, 1 JFK Memorial Drive, Braintree, MA

Vision of the Monatiquot River for Braintree

Monatiquot River is an important unifying element in the landscape for the Town of Braintree. The Town of Braintree Monatiquot River Watershed Study is conducted by the instructor and 8 Master's students in the Landscape Architecture program at LARP, UMass Amherst, as a hands-on Sustainable Landscape Planning Studio Project. Together with the Town Planning and Community Development Department, we envision the sustainability of the Monatiquot River will enhance the health, safety, and welfare of the Town of Braintree by improving water quality, reducing flood risks, and making the river as an asset to all residents.

Public Workshop Goals

The public workshop is embedded in the planning assessment process of this Studio Project, which aims to:

- Inform the residents and stakeholders about Town's initiatives and the Studio Project
- Engage transdisciplinary planning process by communicating effectively among town officials, stakeholders, planners, and the residents
- Bridge the gap between technical expert's and the public's perceptions on town issues
- Collect the town officials', stakeholders' and the residents' knowledge, preferences, and concerns into the next step of developing planning strategies and action plans

Public Workshop Agenda

6:00 - 6:10 **Introduction**
Christine Stickney, Planning Director, and Kelly Phelan (Braintree PCDD)
Chingwen Cheng, Instructor (UMass Amherst LARP)

6:10 - 6:25 **Introduction of Studio Project and Workshop**
Team A Water quality: Carli Foster & Eddie Haynes
Team B Flood mitigation: Ben D'Agostino, Scott Fulford & Eric Wojtowicz
Team C River accessibility: Elizabeth Englebretson,Tracy Murphy & Sparky Von Pinsky

6:30 - 7:30 **Focus Group Conversations**
Objective: Allow feedback, share knowledge, exchange information, and brainstorm ideas
Format: - Each focus group includes city officials, stakeholders, the residents, and students. The residents rotate among 3 teams, 20 minutes for each session.
- Public Survey

7:40 - 8:00 **Summary & Next steps**
Summary of Workshop Findings (Student Teams)
Next Steps (Chingwen Cheng)

8:00 **Adjourn**

Stay Tuned for Final Presentation (April 25-27) in LARP, UMass Amherst

Stay Connected with LARP UMass Amherst at chingwen@larp.umass.edu

Thanks for your participations in making an even better Braintree!! ☺

12.4 COMMUNITY WORKSHOP QUESTIONNAIRE

Town of Braintree
Major Joseph C. Sullivan
Planning and Community Development
Department

University of Massachusetts Amherst
Department of Landscape Architecture and
Regional Planning

Town of Braintree Monatiquot River Watershed Study
Public Survey

Please check one answer that closely applies

A. Please tell us about your flood experience

1. Did you experience the extreme flood in March 2010?	☐ Yes ☐ Overheard from residents ☐ Saw news ☐ Never heard
2. Did you have flood experience before 2010? If yes, when was the previous one?	☐ 2005-09 ☐ 2000-04 ☐ 1990s ☐ 1980s ☐ 1970s ☐ 1960s ☐ Don't remember
3. What was your estimated loss of property for the amount of damage as a result of the flood in 2010?	☐ No damage ☐ Less than $1000 ☐ $1000 to $10,000 ☐ $10,000 to $50,000 ☐ More than $50,000 ☐ No estimates
4. Do you own a property on the floodplain?	☐ Yes, Commercial ☐ Yes, Residential ☐ No ☐ Don't know if it is on floodplain
5. Do you have property flood insurance?	☐ Yes ☐ No ☐ Don't know if enrolled ☐ No idea about the availability of insurance
6. Do you live on the floodplain?	☐ Yes, owned ☐ Yes, rental property ☐ No ☐ Don't know if on floodplain
7. How surprised were you about the extreme flood happened in 2010?	☐ Did not expect flooding at all, totally surprised ☐ Expect annual flood but not the same severity ☐ Not totally surprised, it was an act of God ☐ Not totally surprised, it might be the Climate Change
8. How prepared are you for future flood events?	☐ I am always prepared for annual flood ☐ I know well how to prepare but I am not well prepared ☐ I have some knowledge and I prepare as much as I can ☐ No idea how to prepare for flood events
9. To what degree do you think you and your properties are exposed to future flood risk?	☐ No risk ☐ low risk ☐ moderate risk ☐ high risk ☐ very high risk
10. From your flood experience in 2010, how much time did you have between receiving warnings and evacuation?	☐ over night ☐ more than 1 hour ☐ 30 to 60 minutes ☐ less than 30 minutes ☐ received no warnings
11. Did you consider selling your property after the flood in 2010?	☐ Just thinking ☐ Yes and tried ☐ Yes and sold ☐ Will try again ☐ Don't want to sell ☐ Can't afford to sell

Prepared by LA556 Sustainable Landscape Planning Studio, Department of Landscape Architecture and Regional Planning
University of Massachusetts Amherst

B. Flood Mitigation

12. Are you aware of ongoing Updated Hazard Mitigation Plan in Braintree?	☐ Yes, I attended public meeting regularly ☐ Yes, I follow it but am not participated ☐ Not aware
13. How well do you know about stormwater best management practices (BMPs)?	☐ Know very well ☐ Good knowledge of what they are and how to install ☐ Some knowledge of what they are and how to install ☐ Heard about it, does not know totally what they are ☐ Never heard about it until today
14. How likely are you going to install BMPs on your property to mitigate floods?	☐ Very likely ☐ Likely ☐ Maybe ☐ Unlikely ☐ Very unlikely

Please tell us what prevents you from installing Stormwater BMPs on your property?

_____

_____

_____

C. Water Quality

15. How important is water quality of the Monatiquot River to you?	☐ Very important ☐ Important ☐ Maybe ☐ Unimportant ☐ Very unimportant
16. Monatiquot River is home to Herring fish. How do you feel about protecting them?	☐ High priority ☐ Medium priority ☐ Neutral ☐ Low priority ☐ Don't care
17. How well do you know about landscaping best management practices (BMPs) for lawn care and native plants landscaping on your yards and properties to conserve water and protect water quality?	☐ Know very well ☐ Good knowledge of what they are and how to install ☐ Some knowledge of what they are and how to install ☐ Heard about it, does not know totally what they are ☐ Never heard about it until today
18. How likely are you going to install BMPs on your property to improve water quality?	☐ Very likely ☐ Likely ☐ Maybe ☐ Unlikely ☐ Very unlikely

Please tell us what prevents you from installing Landscaping BMPs on your property?

_____

_____

_____

We sincerely appreciate your volunteer time. Your opinion will be anonymous and is the key to the success of the Project.
For more information, please contact Chingwen Cheng at Chingwen@larp.umass.edu

D. River Accessibility (check all that apply)

19. How do you currently utilize Monatiquot River?	☐ Industrial ☐ Commercial ☐ Recreational ☐ Views ☐ Other_____
20. How do you currently gain access to Monatiquot River?	☐ I own riverfront ☐ Public parks ☐ Don't care ☐ Don't know where ☐ Other_____
21. What outdoor recreation activities do you and your family like to do?	☐ Biking ☐ Strolling ☐ Picnicking ☐ Canoeing ☐ Hiking ☐ Other_____

Please tell us what prevents you from accessing the River?

_____

_____

_____

E. Please tell us your specific concerns about issues related to Flood Risk Management (preparedness, response, recovery, and mitigation):

_____

_____

_____

F. Background Information (all information provided are confidential)

22. Gender	☐ Female ☐ Male	26. Marital status	☐ Never Married ☐ Married ☐ Divorced ☐ Separated ☐ Widowed
23. Age	☐ < 20 ☐ 20-30 ☐ 30-40 ☐ 40-50 ☐ 50-60 ☐ > 60	27. Number of children age under 12 in your household	☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ more than 4
24. Ethnicity	☐ Caucasian ☐ Asian ☐ African American ☐ Hispanic ☐ Other	28. How long have you lived in Braintree?	☐ 0-5 years ☐ 6-10 years ☐ 11-20 years ☐ 21-30 years ☐ more than 30 years
25. Education	☐ High school ☐ Associate degree ☐ Bachelor's degree ☐ Graduate school	29. What is your total annual household income?	☐ < $35K ☐ $35-$75K ☐ $75-$125K ☐ $125-$200 K ☐ more than $200K

Your home address (for the purpose of spatial analysis only, no identity will be disclosed)

Street Number Street Name Zip Code

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12.5 SUMMARY OF BMPS APPLICATIONS

BMPs	Improve Water Quality	Water Quantity Measures		
		Increase infiltration	Prolong discharge	Provide storage
Vegetated swale	X	X	X	
Rain garden	X	X	X	
Filter strip	X	X		
Permeable paving		X		
Green roof			X	
Bio-retention pond	X	X	X	X
Detention basin		X	X	X
Native landscaping	X	X		
Riparian buffer zone	X	X	X	X