Executive Summary

Over the past five years, the City of Fall River has been working to convert a former rail line adjacent to the Quequechan River into a multi-use path for bicyclists and pedestrians. The City has already built one mile of trail in Fall River's Flint and Maplewood neighborhoods (Phase One), and is currently considering how to construct Phase Two of the project, a 1.6 mile extension of the Quequechan River Rail Trail (QRRT) that will connect the existing section of trail to Fall River's downtown. This Health Impact Assessment (HIA) examines the potential health impacts associated with constructing Phase Two of the QRRT (QRRT extension), specifically focusing on: physical activity, safety from collisions, crime, economic development, air quality, and social cohesion.

The analysis concludes that the proposed QRRT extension would likely have **positive health impacts** in Fall River.

Constructing the QRRT extension will **increase opportunities for residents and visitors to be physically active**, which in turn helps prevent obesity and reduces the risk of many chronic diseases. Because the proposed trail runs through densely populated, low-income neighborhoods, the physical activity benefits associated with the QRRT might also help reduce health disparities in Fall River.

The QRRT extension will likely provide a small boost to local businesses and may increase nearby home values. By helping to **grow the local economy**, the QRRT may positively affect health outcomes associated with socioeconomic conditions. Financial gains for small business owners and homeowners may decrease stress and promote spending on healthy behaviors or foods, while additional tax revenue could help the city of Fall River better maintain health promoting resources for residents.

The QRRT extension will **create safer recreation and active transportation opportunities** for Fall River residents and visitors, preventing injuries and accidents.

The QRRT extension would likely have a **positive impact on Fall River's public safety**. While Fall River has high crime rates relative to other cities in Massachusetts, crime rates on rail trails tend to be low. Real and perceived crime on the QRRT can be mitigated through increased surveillance by encouraging trail use, maintaining the facilities, and lighting the trail and underpasses.

Walking or biking trips on the QRRT are likely to replace a small number of car trips in Fall River. Resulting **improvements in air quality**, which protect against asthma and cardiovascular disease, would likely be quite modest.

Outdoor spaces such as the QRRT extension provide opportunities for neighbors to socialize, are convenient meeting locations that can foster walking clubs, and even create incentives for residents to get out of their homes and into their communities. As such, the QRRT would likely **improve Fall River's social environment**, helping to build social capital and strengthening social cohesion among residents.

This HIA also provides recommendations on how to maximize the potential health benefits of the QRRT extension.

Engineering/Design

The QRRT extension design team should incorporate:

- Highly visible signage and traffic calming elements at trail crossings to improve pedestrian and cyclists' safety.
- Trail lighting to be used during non-daylight hours.
- Underpass lighting to be used at all times.

Trail Use and Maintenance

The City of Fall River should:

- Develop appropriate policy and program strategies such as safety campaigns and trail education to encourage walking and biking as mobility options to potential users, with an emphasis on low income and at-risk groups.
- Promote the QRRT with the support of multiple neighborhood associations, advocacy groups, schools, and nonprofits to advance social and civic engagement opportunities within the new community space.
- Include a long-term maintenance plan to encourage a positive image of the trail. This plan should include city departments, community groups, and volunteer-led programs such as neighborhood-led seasonal cleanups and/or a youth-led urban ranger program.

City/Regional Connectivity

The City of Fall River, SMMPO, and SRPEDD should:

- Add bicycle infrastructure (e.g. racks, corrals, lockers, shelters) in and around Fall River's downtown business/commercial areas to help attract QRRT users to the downtown area, and to increase bicycle mode share in Fall River.
- Conduct long-term pedestrian and bicycle planning, prioritize regional and intra-municipal connectivity, and include pedestrian and bike planning in Fall River's public health, economic development and tourism strategies. Community engagement will be vital to these city and regional planning processes.

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Document Guide

This document is a Rapid Health Impact Assessment of the potential health impacts of the proposed Quequechan River Rail Trail (QRRT) Phase Two extension in Fall River, Massachusetts. This document is divided into three Parts. Part One reviews what a Health Impact Assessment is; provides background on the QRRT project; explains our methodology; and discusses our stakeholder engagement process. Part Two examines in detail the pathways to health that might be impacted by the QRRT, describing the expected changes in health outcomes due to the 1.6-mile QRRT extension. Part Three summarizes the conclusions from Part Two and provides recommendations based on these conclusions.

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Part One

1.1 Background

The Metropolitan Area Planning Council (MAPC) in partnership with Massachusetts Department of Health (DPH), the Southeastern Regional Planning & Economic Development District (SRPEDD) and Fall River Mass in Motion conducted an HIA that examines the proposed Phase Two of the Quequechan River Rail Trail (QRRT) project. The HIA identifies and assesses opportunities for maximizing health benefits of the project while mitigating any potentially adverse health impacts. Health determinants that could be impacted by the project include physical activity, crime and safety, air quality, economic development, access to healthy goods and services, and social cohesion.

Because this project was selected for an HIA in spring 2012 with a required deadline of September 2012, the short time frame did not allow for an extensive review and modeling of health impacts. Therefore, this should be considered a rapid HIA.

Rail Trails Nationwide

A rail trail is a multi-purpose public path (paved or natural) created along an inactive rail corridor (Schmid 2001). Rail trails are most often bought and built by a local, state, or federal government agency. Management of these trails is often conducted by public agencies, land trusts, nonprofits, or community foundations (RTC 2007). The number of rail trails in the U.S. has grown substantially in the last 20 years from an estimated 250 miles of rail trails in 1985 to more than 22,000 miles of rail trails in 2011 (RTC 2011). Rail trails provide a setting for various modes of recreation and active transportation to be built into daily living. Health benefits of rail trails may include:

- Promoting recreation opportunities and active transportation by creating an off-road trail for cyclists and pedestrians
- Preventing fatalities and serious injuries to cyclists and pedestrians
- Changing the composition of near-roadway pollutants, thereby potentially affecting cardiovascular and respiratory morbidity and mortality
- Improving connectivity, both within an urban area, as well as across regional trails

The Quequechan River Rail Trail (QRRT)

Over the past five years, the City of Fall River has been working towards converting a former rail line through the Quequechan River into a multi-use path for bicyclists and pedestrians. The Quequechan River Rail Trail (QRRT) project began in 2008 with the construction of Phase One, a one-mile long path that extends along the South Watuppa Pond from the Westport town line to Brayton Avenue. It borders the Advanced Technology and

Manufacturing Center of the University of Massachusetts (UMass) at Dartmouth and Meditech.

This document focuses on Phase Two of the project (Figure 1). The proposed Phase Two project would extend from the terminus of Phase One and follow Brayton Avenue to the Route 24 ramps where it would cross Brayton Avenue and follow a Massachusetts Department of Transportation (MassDOT) rail right of way (ROW) which runs through the Quequechan River into the downtown area. The Phase Two terminus has two arms: one will be located at Plymouth Avenue and Britland Park and the second travels under Interstate 195 to Rodman Street.

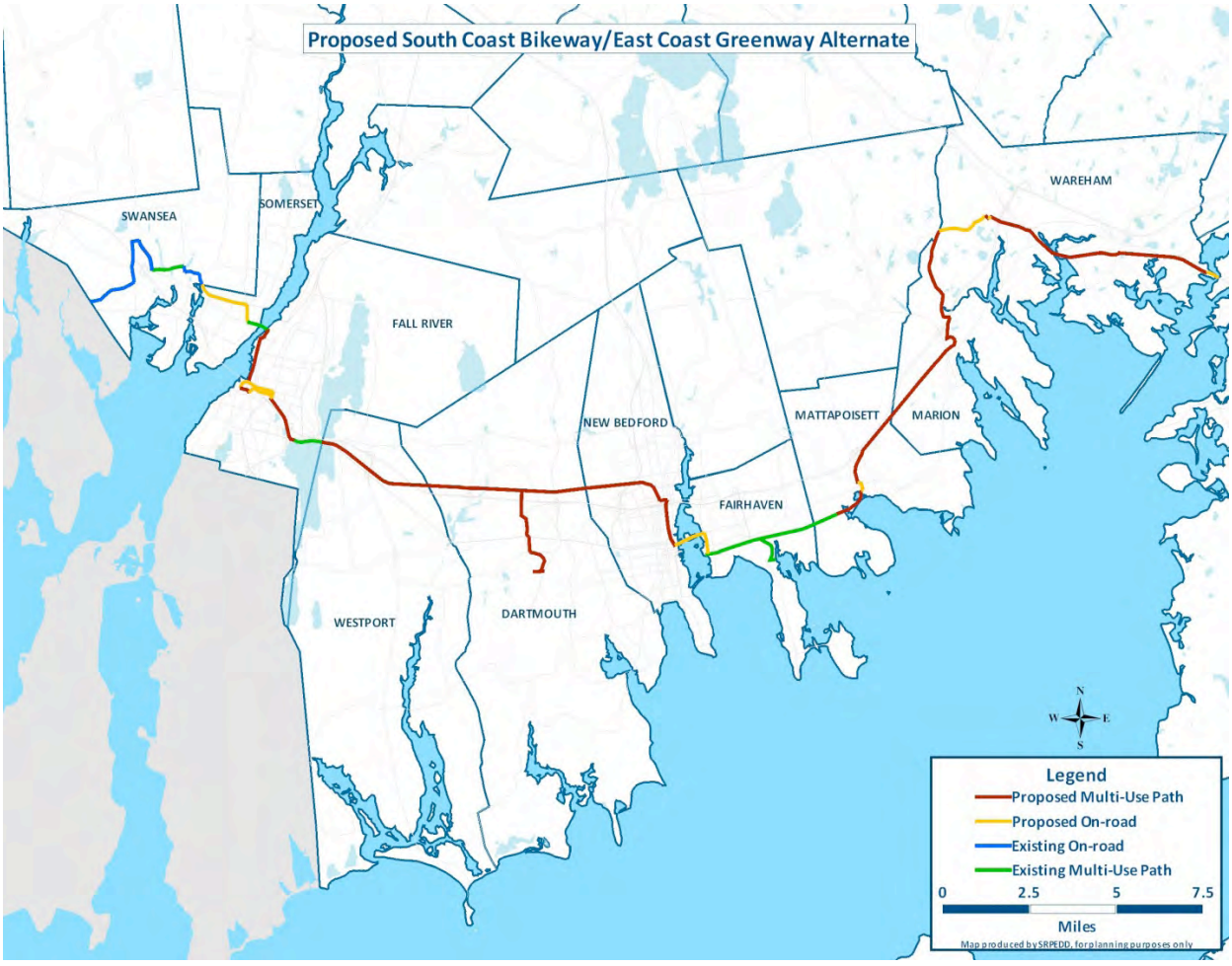
Figure 1: Open Space, Existing Trail, and Proposed Trail

The total length of the Phase Two project, including the MassDOT ROW; a short segment through a private property; and a segment that connects to Phase One of the Quequechan River Rail Trail, is estimated to be 8,800 linear feet (1.6 miles). MassDOT has indicated its willingness to provide the City of Fall River with the necessary public ROW interests for the rail to trail conversion. Additionally, the plan calls for a loop to be constructed from Britland Park to Father Travasso Park on primarily private property. A second loop connecting to the Wal-Mart under construction has been proposed. The City had also applied for a *Bikes Belong* grant to create the Scholarship City Bicycle Route to link the end of Phase One to

two college campuses, three high schools, a middle school, and three elementary schools. Though they did not receive this grant, the city plans to develop this route with other funds in the future.

Future phases of the QRRT will eventually provide access from downtown Fall River to the Bioreserve, the largest wildlife management area in the state. The reserve includes 13,600 acres in Fall River, Freetown and Dartmouth. It was created a decade ago after the city of Fall River and the state completed a land swap and the Trustees of Reservations purchased 516 acres that became Copicut Woods. The QRRT is also an essential piece of the South Coast Bikeway—a proposed 70 mile regional bike network running from the Warren, Rhode Island border with Massachusetts through Swansea, Somerset, over the Veterans Memorial Bridge, and continuing through the cities and towns from Fall River to Wareham, linking to the Cape Cod trails (Figure 2).

Figure 2: Proposed South Coast Bikeway



Project History

Fall River is one of 52 communities working to promote wellness and prevent overweight and obesity as a part of the Mass in Motion Municipal Leadership Grant program. Mass in Motion is a Massachusetts Department of Public Health statewide initiative that helps municipalities make policy, systems and environmental changes to foster healthy eating and active living in their communities. The City of Fall River, Fall River Mass in Motion, Southeastern Massachusetts Metropolitan Planning Organization (SMMPO) and SRPEDD has been the main entities involved in the decision making process of the QRRT extension. The QRRT extension is a complicated construction project. The total project cost is approximately $5.75 million, with $5 million for construction and $750,000 for design. This cost is more than the average bike path, which typically runs about $750,000 per mile due to the replacement of eight railroad bridges. Additionally, annual maintenance costs for similar rail trails in this area usually run about $8,000 per mile.

The project will extend northwest from the existing South Watuppa Pathway (Phase One of the QRRT) and include the demolition of the railroad bridges and construction of a boardwalk with eight new bridge structures and two trail crossings at Brayton Avenue and Quequechan Street. In early 2012, the QRRT received a Gateway City Park Grant of more than $700,000 from the state's Executive Office of Energy and Environmental Affairs (EOEEA) for the engineering design of the project. At the same time, a Parkland Acquisitions and Renovations for Communities (PARC) program grant from the state of $500,000 (30% match) was awarded to the City for the restoration of Britland Park. This restoration project will include replacing the soccer field with artificial turf to allow far greater usage by players of all ages; removal of fencing along the river; removal of invasive vegetation species; improvement to the pathway and parking lot; and installation of educational kiosks. Federal Surface Transportation Funds, allocated to the QRRT by SMMPO, will provide around $1.4 million of the project's construction cost, while approximately $3.6 million will be provided by the state through the Gateway Cities grant program. There is currently no state or federal funding available to improve municipal bike/pedestrian connectivity and infrastructure beyond the QRRT extension at the city and regional level.

1.2 HIA and the Quequechan River Rail Trail

A Health Impact Assessment (HIA) is a systematic, yet flexible tool used to increase the consideration of health in important decision-making processes. An HIA uses an array of data sources, analytic methods and input from stakeholders to determine the potential effects of a proposed policy, plan, program, or project on the health of a population and the distribution of those effects within a population. The goal of an HIA is to offer recommendations that enhance the positive health impacts of policy-making and development projects while reducing negative impacts on health. HIA also focuses on promoting health equity and identifying mitigation measures for threats to health outcomes.

An HIA can be used broadly in assessing health effects across various sectors including education, agriculture, labor, land use, and transportation.

HIA Practice Standards

The standard steps of an HIA include screening, scoping, assessments, recommendations, reporting, and monitoring.

Screening

Screening involves determining whether or not there is a potential for significant health impacts of a policy, project, or program. The screening process for this HIA took place in spring 2012 and involved a selection process at Massachusetts Department of Public Health (DPH). The Quequechan River Rail Trial (QRRT) was one of three policies/ projects chosen to be completed in the summer 2012.

Scoping

The HIA scoping process was initiated in June 2012. The HIA scoping objective is to create a plan and timeline for conducting an HIA that identified priority issues, research questions, methods, and participant roles. This included an HIA training that educated community stakeholder about the process and steps of HIA, discussed a variety of roles for stakeholders to play in the process, and how HIA's could be effectively used with the QRRT project proposal. A pathway diagram was drafted by participants to demonstrate the links between extending the QRRT by 1.6 miles and its potential impact on specific health outcomes. The final pathway diagram is provided in Part Two.

Assessment & Recommendations

The objective of the assessment step is to provide a profile of existing conditions and evaluate the potential health impacts of the Quequechan River Rail Trail project. The assessment portion of this document (Part Two) is followed by evidence-supported recommendations (Part Three) for mitigating the project's negative impacts and maximizing its positive health impacts.

Reporting

This step involves the creation of the HIA report by communicating findings and recommendations to stakeholders and decision makers. This report considers the nature and magnitude of the health impacts and their effects on the population. It summarizes the key health issues the project could impact and make recommendations to improve health outcomes.

Monitoring

The objective of monitoring is to review the effectiveness of the HIA process and evaluate the project's actual health outcomes over time.

Decision-Makers and Decision-Making Process

Major decisions-makers in this project include the SMMPO, EOEEA, Fall River Planning Department, MassDOT and Southeastern Regional Planning & Economic Development District (SRPEDD). The SMMPO is the final decision making body that determines if federal transportation funding will be allocated to the project so it can move forward with design. EOEEA will also be a final decision maker in allocating the Gateway Cities Parks Program funding to the project. Both decisions will receive input from the city of Fall River and the project will be managed by MassDOT since it is receiving federal transportation funding. The 25% design hearing, an important milestone for federally-funded transportation projects, has yet to be held or scheduled as it is pending design submission and review.

Stakeholder Engagement

There is no single method to involve stakeholders in the HIA process. Stakeholder engagement methods in this HIA process included an HIA scoping training and electronic communications. More than 30 decision makers, residents, neighborhood associations, and public health specialists attended the HIA scoping training. The agencies and organizations represented at the training included, the City of Fall River, Mass in Motion, Healthy City Fall River, Urban Institute (UMASS Dartmouth), SRPEDD, Fall River Park Advocates, Health First, Niagara Neighborhood Association, EOEEA, Fall River School Wellness, South Coast Hospital Group, YMCA South Coast, and Bristol Community College. The potential of the QRRT increasing residents' physical activity levels was a primary benefit voiced by stakeholders. Other benefits mentioned included economic development, safety from collisions, safety from crime, social cohesion, and air pollution.

A design public information session was held on June 19, 2012, and stakeholders were encouraged to attend. Attendees included residents, retailers, non-profits, and mill owners. Overall there was positive support for the proposal and design. One major concern brought up during the design comment period was safety issues regarding the proposed Quequechan Street crosswalk. Residents were particularly worried about motor vehicles not yielding and believed that a non-signaled crosswalk would not improve the crossing's safety. The 25% design public hearing has yet to be held or scheduled as it is pending design submission and review. This hearing will be open to the public for comment.

The potential QRRT extension benefits and concerns shared during the community engagement process helped to define the research scope for this HIA.

1.3 HIA Methodology

The process of conducting this rapid HIA involved gathering baseline data from publicly available sources; reviewing literature supporting the connections between trails and physical activity, safety from collisions, crime, economic development, air quality, and social cohesion; and making qualitative assessments about the impacts the QRRT will have on health.

In order to relate the relationships seen in the literature to site-specific data on Fall River, baseline statistics were compiled from various sources for Fall River and the area around the QRRT. The following data was gathered:

- Demographics and socioeconomic data were compiled by SRPEDD using the 2006-2010 Five Year Estimates from American Community Survey (ACS) Census Data. The ACS is a sample done in one, three and five year increments (depending on geography) that provides estimates of housing characteristics, population characteristics, education levels, modes of transportation, age, etc. ACS demographic totals for the city of Fall River as a whole were taken directly from the Census American Fact Finder, which provides ACS summaries for county subdivisions, including New England cities and towns.
- Data on health conditions, risk factors, and behaviors at the state level were collected using the Massachusetts Behavioral Risk Factor Surveillance System (BRFSS), Youth Risk Behavior Surveillance System (YRBSS), and 2010 Census data.
- Data on collisions and injuries in Fall River were provided by SRPEDD from the MassDOT Motor Vehicle Crash Database. State level data for pedestrian and bicyclist related injuries were retrieved from Massachusetts Health and Human Services (HHS).
- Average automobile speed and daily volume data for the proposed QRRT trail crossings were provided by Spofford & Thorndike, an independent transportation engineering firm.
- Baseline data for crime in Fall River was obtained from the Federal Bureau of Investigation's (FBI) 2010 Uniform Crime Reports. The Fall River police department provided specific crime data for the one-mile radius around the QRRT.

Peer-reviewed literature from transportation, urban planning, and public health journals were used to evaluate the relationships between health determinants and trails. We focused our search in PubMed, Transport Research International Documentation (TRID), and Google Scholar. The condensed timeline of this HIA did not allow for a comprehensive literature review.

Air Quality Methods

In order to assess the impact of the air quality, we gathered data on baseline conditions and then used state and federally-approved worksheets to estimate the impact of the QRRT on

changing air quality. Due to the quantitative nature of the air quality pathway we provide a more in depth review of methodology steps below.

Air Quality Improvements & Vehicle Miles Traveled Reductions from Bicycle Facility Construction

Data sources for this pathway include general demographic information available from the United States Census, transportation data from SRPEDD, ozone level data available from Massachusetts Department of Environmental Protection (MassDEP), and air quality improvement data available from MassDOT. Demographic data was derived from the American Community Survey (ACS) block group and city level data.

The transportation data from SRPEDD includes outputs from its Regional Travel Demand Model and its 2012 Regional Transportation Plan. The Regional Travel Demand Model uses inputs of population, housing employment and roadway characteristics to provide baseline vehicle miles traveled (VMT) data for the year 2010. VMT within one mile of the QRRT as well as VMT for the entire city of Fall River was obtained from this model. The ozone levels obtained from MassDEP summarize statewide and local trends in ground ozone levels.

The tool used to calculate potential air quality improvements was the MassDOT/Federal Highway Administration (FHWA) Congestion Mediation and Air Quality (CMAQ) Air Quality Analysis Worksheet for bicycle facilities. The spreadsheet is based on bicycle commuting assumptions developed by FHWA and uses several inputs to determine VMT reductions resulting from multi-use path construction including population, employment, households, bicycle commute to work mode share and multi-use path length. VMT reductions are then translated into reductions in VOCs and NOx in kilograms per year, the major precursors to ozone formation according to the EPA.

The basis for air quality improvements resulting from an off-road bicycle trail is that the presence of such a trail will encourage more people to use bicycling and walking as a form of transportation and recreation. This is the assumption made by both FHWA and MassDOT in qualifying bicycle and pedestrian projects for CMAQ funding. The justification for this has been demonstrated in several different peer-reviewed studies, including one recently completed in the Chicago area. In this particular study, a survey of 228 bicyclists and pedestrians using different bicycle and pedestrian facilities in the greater Chicago area showed that 30% of bicycle commuters and 18.6% of pedestrian commuters used to commute solely by single-occupancy vehicles. Where neighborhoods have low percentages of car-owning households and good public transit, the propensity to shift from single occupancy vehicles to bicycling and walking was higher (Thakuriah et al. 2012).

1.4 Fall River Demographic and Socioeconomic Profile

Baseline demographics and socioeconomic data were compiled by SRPEDD using the 2006-2010 ACS Census Data. ACS demographic totals for the city of Fall River as a whole were taken directly from the Census American Fact Finder, which provides ACS summaries for county subdivisions, including New England cities and towns. A one-mile radius around the QRRT was chosen to define the immediate area impacted by the project, as this radius is generally the service area for an off-road trail as defined by MassDOT. In the case of the QRRT, a one-mile radius extends slightly into northern Westport; however, the majority of the radius is located within Fall River. Demographic information about the one-mile radius is presented in the tables below, as well as throughout the document.

Despite experiencing population loss since 2000, Fall River is the tenth largest city in Massachusetts, with a total population of 88,857 (U.S Census Bureau 2010). Fall River's demographic composition is 89.3% White, 6.5% Hispanic or Latino (of any race), 2.6% Black or African American, 2.4% Asian, and 2.5% identified as two or more races (Table 1). Nearly half of the city's residents are of Portuguese ancestry (U.S. Census Bureau 2010). Based on Fall River's 2007 Strategic Economic Development Study, its economy is characterized by low wages. The median household income is $34,236, compared to the state's median household income of $64,509. Per capita income is $19,306, with 22.4% of individuals living below the Federal poverty level (Table 2). Fall River has one of the lowest median income levels for families with children under 18 in Massachusetts, with 19.1% of Fall River families below the poverty level, compared to the state average of 12.2% (U.S. Department of Labor).

TABLE 1: Population by Race/Ethnicity	QRRT 1-Mile Radius	%	Fall River	%
White	38, 009	86%	79,920	89%
Black	1,306	3%	2,337	2.6%
Hispanic Origin	3,536	8%	5,842	6.5%
American Indian/Alaska Native	93	0.2%	158	0.2%
Asian	1,102	2.5%	2,189	24%
Other Race	1,883	4.3%	2,642	3%
Two or More Races	1,629	3.7%	2,236	2.5%
Total	44,022		89,482	

TABLE 2: General Demographic Information	QRRT 1-Mile Radius	Fall River
Total Population	44,022	89,482*
Total Households	19,758	38,140
Median Age	36.7	37.3
Median Household Income	41,369	34,236
Total Employment, 2010	16,950	34,127
Unemployment Rate	- -	11.6% (MA 6.3%)
Population Density (per mile^2)	5, 823	2,342

**2006-2010 ACS Estimate. 2010 Census actual: 88,857*
***Data obtained from the 2006 – 2010 ACS and 2012 Massachusetts Labor &Workforce Development*

Fall River's local economy is primarily dependent on its healthcare and manufacturing sectors. According to the Massachusetts Department of Labor and Workforce Development, the city of Fall River had 38,137 jobs as of June 2012. These jobs were in various sectors of the economy, with the highest percentage in healthcare (31%), followed by manufacturing (13%) and retail (9%). While the manufacturing base (apparel and textiles) has been in decline since 2001, there have been opportunities in distribution (i.e. wholesale trade, transportation), finance, and information services (Mt. Auburn Study 2007). As of June 2012, the city's unemployment rate is the second highest in Massachusetts (11.6%), close to double the state average of 6.3%.

Low levels of educational attainment also characterize Fall River's workforce population (Table 3). Educational attainment is low for both high school and college levels. The Massachusetts Department of Education reports that Fall River's dropout rate is one of the highest in the state, with nearly half of residents not receiving a high school diploma, as compared to the state average of 20%. Only 9.6% of adults over 25 years old have a Bachelor's degree.

Table 3: Educational Attainment

	Fall River	Massachusetts
Population 25 +	61,080	4,382,378
Less than 9th Grade	17.4%	4.9%
9th through 12th, No Diploma	15.1%	6.4%
High School Graduate	30.3%	26.7%
Some College	16.2%	16.0%
Associates Degree	7.0%	7.6%
Bachelors Degree	9.6%	21.9%
Graduate Degree	4.5%	16.4%

Part Two: Health Impacts

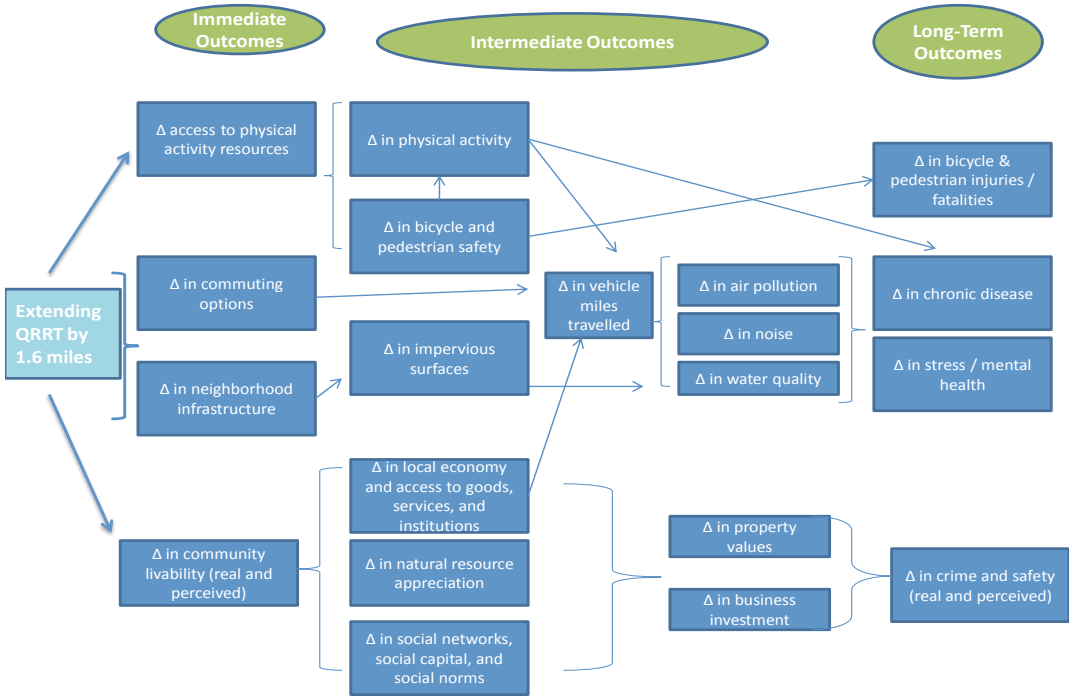
In Part Two, we discuss the specific causal pathways linking the QRRT extension to health. These pathways were determined during the HIA's scoping process with extensive engagement, as described above. For each pathway, we:

- Describe how the pathway may be related to the extension
- Profile the existing conditions relevant to the pathway
- Evaluate how the extension will impact pathways
- Provide a summary on the overall impact of the QRRT extension proposal on the pathway

Pathways Linking the QRRT and Health

The main health determinants that may be impacted by the 1.6 mile QRRT extension include a change in physical activity, crime and safety, air quality, economic development, and social cohesion. These health determinants can lead to the following health outcomes: a change in chronic diseases such as obesity, cardiovascular disease, respiratory disease, injuries, and premature mortality. These pathways are diagramed below in Figure 3.

Figure 3: Pathways for QRRT Extension and Health



2.1 Physical Activity

Background

There is growing evidence that the built environment impacts physical activity within a community, with evidence that increased density of recreational facilities and parks is associated with higher physical activity levels and lower Body Mass Indices (BMIs) for adults (Handy 2005; Sallis et al. 2009). These measures have been revealed in cross-sectional studies that associate increased density, mixed use, and higher connectivity with elevated levels of physical activity and lower body mass indices (McCann and Ewing 2003; Saelens, Sallis, and Frank 2003; Frank et al. 2005). For example, in communities that are considered highly walkable, individuals walk an average of 15 to 30 minutes more per week than those who live in neighborhoods with low walkability (Saelens, Sallis, and Frank 2003). Though small, such increases in physical activity aid in alleviating the negative health outcomes associated with inactivity and obesity, including premature mortality; chronic diseases such as diabetes, obesity, and hypertension; and poor psychological well-being (Handy 2005).

Building trails has gained popularity as a recommended environmental approach for improving physical activity levels and health outcomes by providing low cost recreation and active transportation opportunities to tens of millions of people of all ages and abilities every year. The literature on trails and physical activity overall shows a positive correlation between trail use and the frequency and amount of physical activity levels (Brownson et al. 2000; Evenson, Herring, and Huston 2005; Troped et al. 2001). In U.S. national samples of physical activity levels among trail users, people who reported using trails at least once a week were twice as likely to meet physical activity recommendations than people who reported rarely or never using trails (Librett, Yore, and Schmid 2006). Numerous studies examining urban trails and physical activity for trail users demonstrate that proximity to a trail is associated with up to a 50% increase in the likelihood of meeting physical activity recommendations (Abildso et al. 2007; Dunton et al. 2009; Huston et al. 2003; Pierce et al. 2006; Troped et al. 2001; Troped et al. 2003). In Arlington, Massachusetts, living an additional quarter mile from a rail trail was associated with 55 fewer minutes per week of walking or biking, while Los Angeles individuals living within two miles of a park were 34% more likely to exercise in a park (D. Cohen et al. 2006; Troped et al. 2003).

Beyond the physical activity benefits that are apparent with a trail, trail usage also appears to be greater in neighborhoods with high levels of commercial activity, trail amenities (e.g. drinking fountains, streetlights, and trailside facilities), and green space. A 2007 study of three urban trails (>15 mile) in Los Angeles, Chicago, and Dallas found that excellent trail surface conditions, streetlights, and cafes were associated with 35- 73% higher levels of trail use (Aultman-Hall and Hall 1998; Aultman-Hall and Kaltenecker 1999; Kaplan 1975; Moritz 1997). From a socioeconomic standpoint, urban trail usage is positively associated with income and education (Francesca Dominici et al. 2003; F. Dominici et al. 2006; Goldberg et al. 2001). Residents with higher incomes are more likely to use walking trails than those with lower incomes, and individuals with a college education or higher are more likely to use trail than individuals with no college education (Brownson et al. 2000; Librett, Yore, and Schmid

2006; Troped et al. 2001). These findings are important to consider when proposing an urban rail trail.

Limitations

While associations between trails and physical activity are apparent in literature, it is still unclear on whether people will become more physically active in response to the construction of new trails, and the effects trails have on active transportation versus recreation levels (Evenson, Herring, and Huston 2005; Merom et al. 2003). While our literature review primarily focused on urban trails, predictors of trail use and the effects on physical activity may vary across communities. Thus, more research is needed to evaluate and distinguish between varying trail types, uses, geographies, and demographic differences.

Existing Conditions

Promoting physical activity at a population level has been a public health concern in the U.S for more than 30 years. Today, the majority of adults (81.6%) and adolescents (81.8%) do not get the recommended 30 minutes of daily physical activity (Health and Human Services 2008). This behavior, compounded by unhealthy diets, has led the nation to a staggering increase in obesity. Currently, approximately one in three adults (34.0%) and one in six children and adolescents (16.2%) are obese (CDC 2012a). Physical inactivity and obesity is also linked to premature mortality; chronic diseases such as diabetes and hypertension; and poor psychological well-being (Handy 2005). In Fall River, a recent age-adjusted analysis of BRFSS data by Massachusetts Department of Public Health (MDPH), reveals that the percentage of overweight and obese adults are above both the state and regional average, while the proportion receiving regular physical activity is below the state and regional average (Table 4). Physical inactivity and prevalence of obesity in children and adolescents is also of great concern. Data on the number of overweight or obese students in Fall River's school district from 2003-2010 suggests a significant difference in comparison to national data. The national average of overweight/obese school-age youth is 28% (CDC 2012b). In 2009-10, the prevalence of overweight/obese youth in the Fall River school district reached a high of 38%.

TABLE 4: Risk Factors, Disease, and Mortality Rates for Fall River and Massachusetts

Risk Factors, Disease & Mortality Rates	Fall River	Southeast MA	MA
Adults who are overweight	63%	57.6%	55.4%
Adults who are obese	28.4%	21.2%	19.4%
Adults with diabetes	10%	8.1%	7.5%
Diabetes mortality rates per 100,000	17.3	14.0%	14.5
% Adults who were regularly physically active	44.8%	51.8%	52.1%
% Adults who eat 5+ servings of fruits/vegetables	21%	27.4%	28.7%
% Adults who currently smoke cigarettes	30.6%	20.9%	18.1%
% of Adults with Heart Disease	9.3%	7.6%	6.8%
Cardiovascular mortality rates per 100,000 (age adjusted)	257.9	227.6	218.5

Additionally, a recent report confirmed that certain sections of Fall River have even higher obesity prevalence than the citywide number reported by MDPH (Li et al. 2009). The city's south and east ends have the lowest income residents and the largest immigrant population, and were classified as high priority communities in the state based on obesity prevalence rates and higher risks for chronic diseases such as diabetes and hypertension. The QRRT extension is within a one-mile radius of two of the three high priority zip codes, 02721 and 02723. These two zip codes have the highest obesity prevalence in the city at 20.3% and 29.2%, respectively. Six Fall River neighborhoods are located within these two zip codes including; Maplewood, Niagara, Corky Row, Below the Hill, Flint and Bank St (Figure 4).

Figure 4: Fall River Neighborhoods within 1 mile of the QRRT

Assessment

With a total population of just under 90,000 residents, approximately 32.3% of Fall River adults are obese and 44.8% report no daily physical activity (MassCHIP 2010). Currently, 44,000 residents reside within a one-mile radius of the existing and proposed rail trail. Although it is not expected that the rail trail extension will serve the entire Fall River population, residents who live or work in close proximity to the rail trail will have increased access to the trail, as well as existing parks that will be linked to the proposed trail extension.

Based on the overall literature linking trails to physical activity, we predict a positive, yet modest impact to Fall River residents through increased access to physical activity resources (trails, open space). Increases in physical activity due to trail usage will aid in

alleviating the negative health outcomes associated with inactivity and obesity including; premature mortality; chronic diseases such as diabetes and hypertension; and poor psychological well-being (Handy 2005).

Creating trails is an effective method for impacting physical activity levels across a variety of communities, especially for lower socioeconomic groups (Brownson et al. 2000). Based on the demographic and socioeconomic profile of Fall River, a majority of the lowest income and largest immigrant populations—populations that are most vulnerable to health disparities and least likely to access to trails—reside in neighborhoods within a one-mile radius of the rail trail. These neighborhoods include Maplewood, Niagara, Corky Row, Below the Hill, Flint and Bank Street. While some studies show that trail use positively correlates with higher socio-economic status and education, close proximity to trails is also a factor in trail use and meeting physical activity recommendations. The QRRT extension will most likely be beneficial in promoting physical activity among segments of the population at highest risk for inactivity in Fall River, especially within the one-mile radius. Identifying key community partnerships will be crucial in effectively promoting and education the QRRT to potential users. The brand new HealthFirst Community Health Center is one example of a partnership that can promote the use of the QRRT through "prescribed" walking for prevention and health maintenance. It is within close proximity to the QRRT extension and serves over 9,000 low-income patients.

Summary

- The health of Fall River's adult residents is consistently poorer than that of the residents of the state as a whole
- The literature shows that there is evidence that the availability of trails, trail usage, and trail promotion promotes physical activity
- We predict a positive impact to this population through increased access to physical activity resources (trail, open space), particularly within a mile radius of the QRRT

2.2 Collisions

Background

Pedestrians and cyclists are two of the most vulnerable types of road users and account for a large number of motor vehicle-related injuries. It is also well established that injuries arising from events involving motor vehicles are more severe compared to other causes of injuries, including pedestrian–bicycle collisions (Graw and König 2002; Haileyesus, Annest, and Dellinger 2007). Nationwide, pedestrians and bicyclists accounted for 14% of motor vehicle collision fatalities and more than 122,000 individuals were injured in motor vehicle traffic crashes in 2010 (NHTSA 2012a; NHTSA 2012b). In Massachusetts, there were 79 pedestrian deaths and a combined total of 4,713 inpatient hospitalizations, observation stays, and emergency department visits for non-fatal pedestrian-related injuries in 2005. There were also six bicycle deaths among Massachusetts residents and a combined total of 9,110 inpatient hospitalizations, observation stays, and emergency department visits for non-fatal bicycle-related injuries (Health and Human Services 2007).

Considering the risk motor vehicles pose for pedestrians and cyclists, trails can provide a safer built environment for users to separate them from traffic. Evidence shows that there is a reduced risk of injury on off-road paths in comparison to roadways (Moritz 1997; Tinsworth, Cassidy, and Polen 1994; OECD 1998). These findings were summarized in reports looking at the impact of infrastructure on bicycling injuries and crashes (OECD 1998; Reynolds et al. 2009). Tinsworth et al. (1994) found that for both adults and children, there was close to a 90% higher risk of injury on streets than on bike paths (i.e. trails). A North American commuting survey showed similar evidence, with 40% fewer accidents on bike paths than local streets (Moritz 1997).

Although risk of injury is reduced on trails, trail intersections can pose a significant danger for users. Intersections in urban areas are risky locations for collisions due to the more frequent conflicts between pedestrian, cyclist, and motor vehicle flows. According to Traffic Safety Facts 2010, close to 75% of pedestrian fatalities occurred in urban settings, and 25% of pedestrian fatalities occurred at intersections. Similarly, a majority of cyclist fatalities occurred in urban areas, and 33% of cyclist fatalities occurred at intersections (NHTSA 2012b). A 1998 review of vulnerable road users reported that while bicycle paths are safer, bicycle paths may increase collision risk at crossings (OECD 1998). Due to these safety concerns, studies have investigated various methods for minimizing safety risks on trails and trail crossings. A 2007 study by Parks and Trails New York and the National Highway Traffic Safety Administration examined trail intersection safety through an extensive review of literature, interviews with trail experts, and mail surveying. The report provides policy and design recommendations to improve trail intersection safety including additional signage, pavement markings, raised crosswalks, and local enforcement and education of speed limits and crosswalk laws (Parks and Trails New York 2007).

Perceived safety also contributes to the role that rail trails play in a community. Evidence indicates a higher perception of safety for bicyclists and walkers who travel on paths than on

roads (Badgett, S.I., Niemeier, D.A., Rutherford, G.S. 1993; Zegeer et al. 1994). A 1994 National Bicycling and Walking Study found that those walking and biking in areas without bike paths or trails were twice as likely to feel endangered compared to those using bike paths or trails (Zegeer et al. 1994).

Limitations

Currently there is limited trail injury data available in the U.S. Despite a number of studies associating bike paths and trails with lower rates of injury, some studies contradict these findings and suggest roads are safer than off-road trails for travel due to more established operating procedures on roadways (Aultman-Hall and Hall 1998; Aultman-Hall and Kaltenecker 1999; Kaplan 1975; Moritz 1997). However, these studies have a number of methodological shortcomings. First, these studies combined paved, unpaved, bike only, and multi-use trails into the off-road category. Second, the authors could not determine the specific factors that caused higher injury on bike paths versus roads. Conditions and trail design vary across trails and multi-use paths, and more research should be aimed at looking at the safety risks associated with specific trail designs.

Existing Conditions

Fall River has a significant number of motor vehicle crashes involving bicycles and pedestrians. Between 2006 and 2008, the city of Fall River experienced 60 crashes involving bicyclists and 234 involving pedestrians (Figure 5). Within one mile of the QRRT, there were 43 crashes involving bicyclists and 130 involving pedestrians, representing 72% of bicycle crashes in the city and 56% of pedestrian crashes in the city. Within one mile of the QRRT, 29 crashes involving bicyclists resulted in an injury (67% of all bicycle crashes) and 102 involving pedestrians resulted in an injury (78% of all pedestrian crashes). These statistics show that a majority of motor vehicle crashes involving bicyclists and pedestrians result in injury and require hospitalization of the victims.

Commuters within one mile of the QRRT are less likely to use single-occupancy vehicles in Fall River as a whole, though fewer use walking, bicycling or taxi (Table 5). The one-mile radius around the QRRT is densely populated, and the percentage of households with no access to a vehicle is much higher within one mile of the QRRT than Fall River as a whole.

Figure 5: Crashes Involving Bicycles and Pedestrians, 2006 - 2008

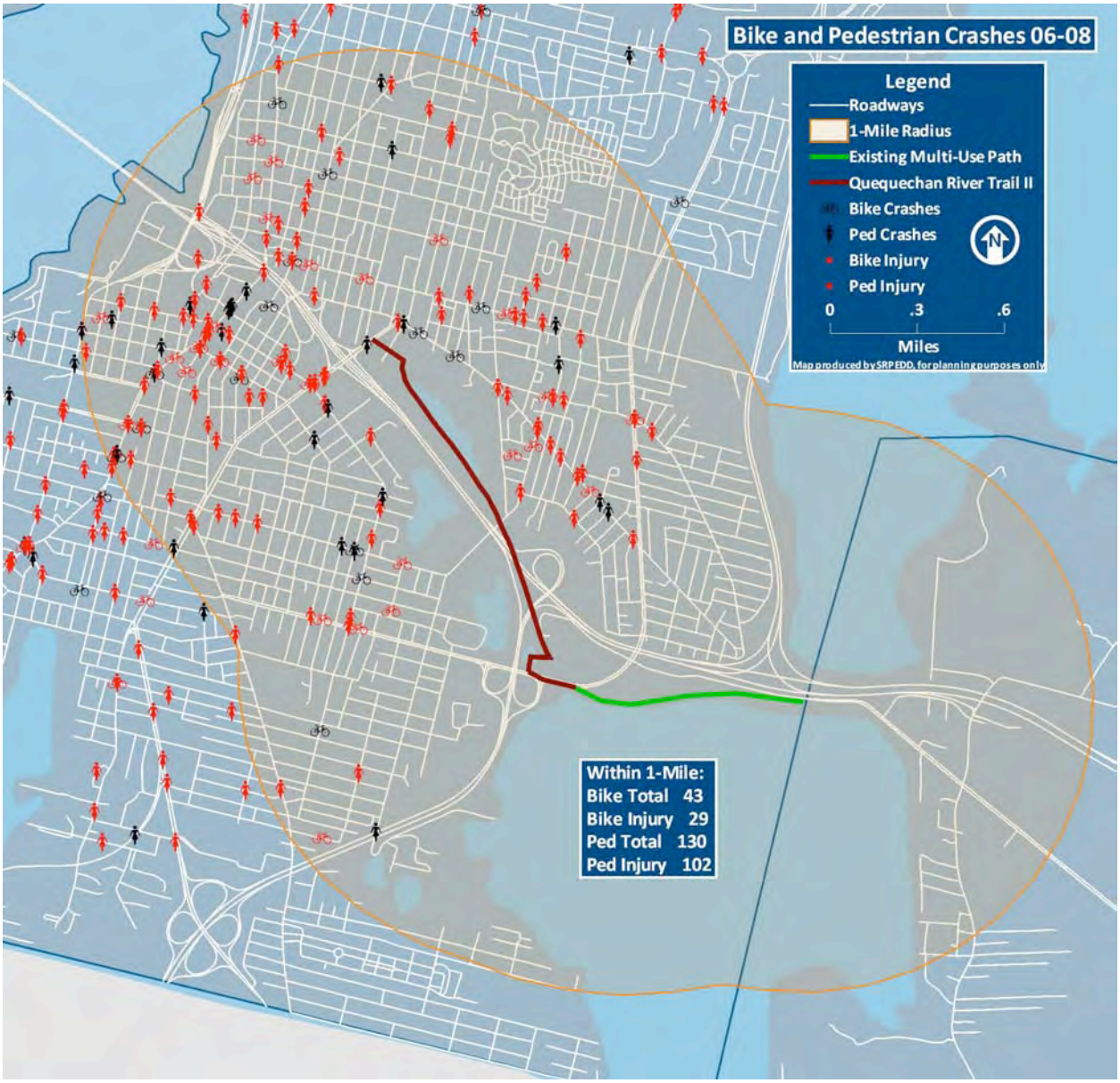


TABLE 5: Commuting Characteristics	QRRT 1-Mile Radius	Fall River
Total Commuters	17,918	37,471
Drove Alone	78.2 %	80.6 %
Car-pooled	15.0 %	12.0%
Public Transportation	1.5%	1.6%
Walk/Bike/Taxi	5.3%	5.8%
Households With 1+ Vehicle(s)	77.6%	82.2%
Households With No Vehicles	22.4%	17.8%

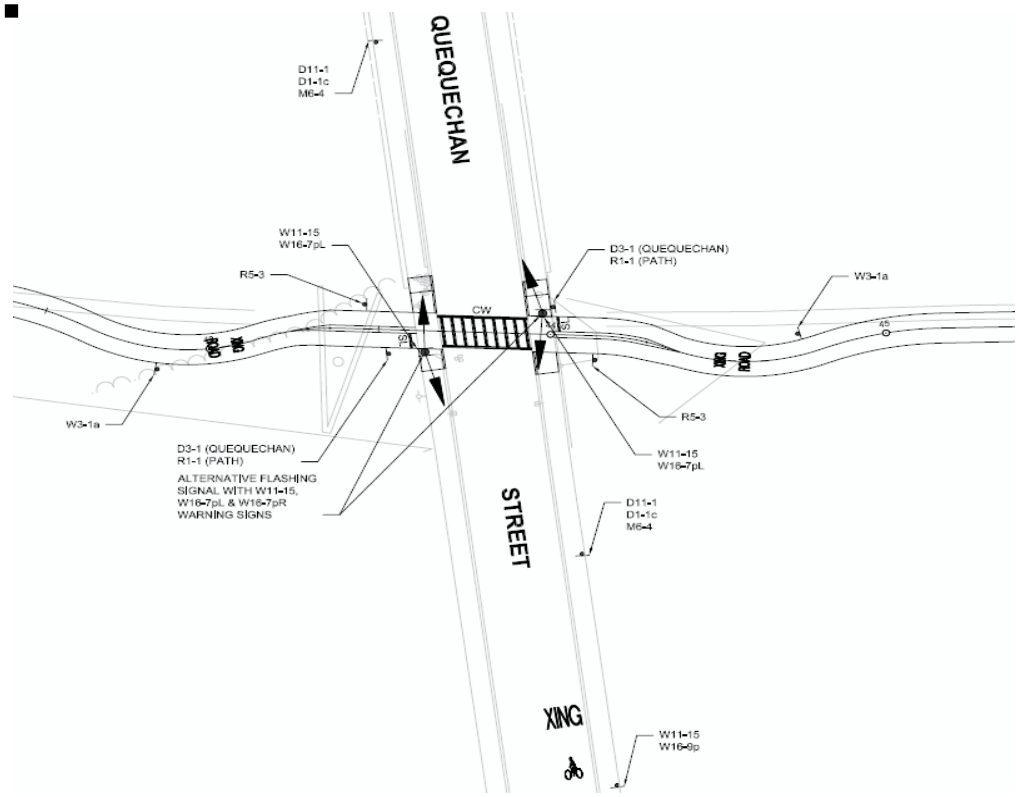
QRRT Trail Crossings

The 25% design for the QRRT has two trail crossings: one on Brayton Avenue and the other on Quequechan Street. The crossing designs are based on a traffic control needs study of traffic conditions including speed and volume analyses (See Tables 6 and 7). These results help determine whether the installation of traffic signals are justified at these locations. As of June 2012, the 25% design calls for a signalized crossing (crossing at an existing traffic signal at the Route 24 NB ramps) at Brayton Avenue and Quequechan Street is proposed to have an unsignalized crossing (See Figure 6). The unsignalized crossing design was based on low road speeds and low daily traffic volume. The speed limits for Brayton Avenue and Quequechan Street are 45 mph and 25 mph, respectively.

TABLE 6 – Traffic Volumes for Quequechan St. & Brayton Ave.				
	Vehicles/day	Vehicles/Hour (Peak AM)	Vehicles/Hour (Peak PM)	Vehicles/Hour (Saturday Midday)
Quequechan St, North of Route 195 Overpass	12,850	788	1,095	1,070
Brayton Avenue, East of Route 24	17,360	1180	1,505	1,280

TABLE 7 – Existing 2011 Speeds for Quequechan St. & Brayton Ave.					
Quequechan St.			Brayton Ave.		
Speed	North Bound	South Bound		East Bound	West Bound
Recorded 85th percentile Speed	26 mph	29mph		55 mph	41 mph
Recorded Average Speed	19mph	20mph		44 mph	35 mph

Figure 6: Engineering Design of Quequechan St. Rail Trail Crossing



Assessment

Rail trails/multi-use paths are one built environment element that can encourage more walking and biking, while at the same time creating a safer space for the trail user. Currently, the majority of crashes in Fall River involving bicyclist and pedestrians occur within one mile of the QRRT. Bicyclists, in particular, have the greatest potential to see a reduction in crashes with motor vehicles when using the QRRT as an alternative route to downtown Fall River. Another common route to downtown is Pleasant Street, which runs parallel to the QRRT, and experienced three bicycle crashes between 2006 and 2008 (Massachusetts Registry of Motor Vehicles 2006). The QRRT will most likely decrease motor vehicle crashes involving bicyclists and pedestrians by offering a separated and safe path in which to travel with less interaction with motor vehicles.

Rail trail safety was a common concern among stakeholders throughout the HIA process, especially regarding the risks associated with trail crossings. The QRRT 25% Design Plan includes modifications to minimize collisions and injuries between trails users and motor vehicles, including signage and proposed crossing designs. However, based on resident concerns for safety, as well as the evidence from literature on trails and safety, we argue that trail lighting, intersection design, and pedestrians/bike master planning should be further investigated in order to maximize health benefits associated with the QRRT and minimize unnecessary injury.

Lighting

Currently, Fall River intends not to light the trail extension due to the high costs associated with installing light fixtures and close the trail at dusk. However, this decision-making approach poses significant safety issues to the community. Literature suggests that the lack of appropriate lighting on trails is associated with an increase in the risk of collisions between pedestrians and cyclists (Klop and Khattak 1999; Kim et al. 2007). Additionally, lack of lighting could encourage criminal activity (Abildso et al. 2007; Wolch et al. 2010).

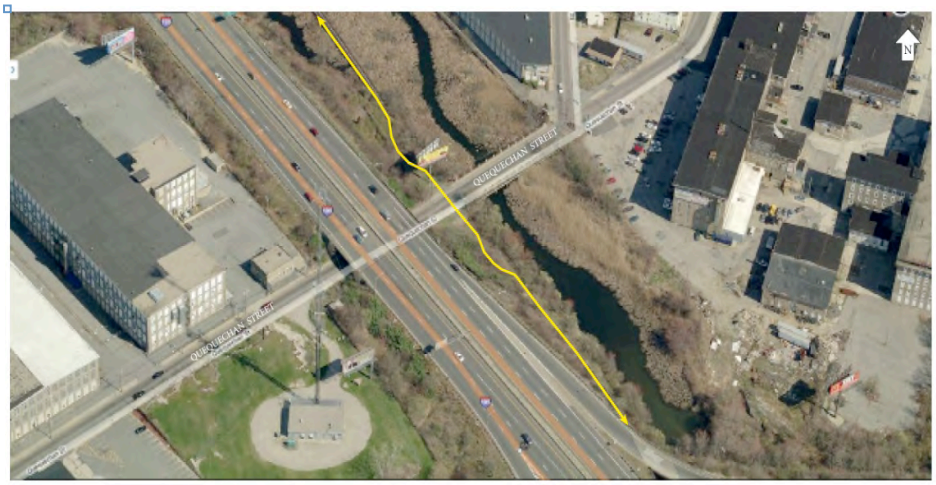
It is very likely that users will intend to access the trail in the early morning or late evenings, whether for recreational and/or active transportation needs. This also raises further concerns during winter months, when daylight is limited during commuting hours. Follow-up is needed to challenge the rationale behind not lighting the QRRT.

Trail Crossings

While the QRRT offers cyclists and pedestrians a separated path with less motor vehicle interaction, proper trail crossings are crucial to ensure all users can safely access and use the trail. One major concern raised during the public process was the possible collision and injury risk at the proposed Quequechan Street trail crossing (See Figure 7 and 8).

Figure 7: Brayton Avenue Proposed Trail Crossing

Figure 8: Quequechan Street Proposed Trail Crossing



Because many bicyclist and pedestrian collisions occur at intersections, engineering design options have been suggested to minimize conflicts at trail crossings (Hugget, K., Powell, S. 1998; Parks and Trails New York 2007) Evidence demonstrates that unintentional injuries from traffic collisions are correlated with the improper design of trail crossings. For instance, roadway design factors, such as the absence of marked and signalized crosswalks and lack of appropriate lighting, are associated with an increase in the risk of collisions between pedestrians and vehicles injuries (Kim et al. 2007; Klop and Khattak 1999).

When crossing roadways, off-road trails must have the proper traffic controls to ensure that bicyclists and pedestrians crossing the roadways can do so safely. The 25% Design proposed an unsignalized crossing with a flashing warning light for motorist at the Quequechan Street crossing (North of Route 195 Overpass). The design for an unsignalized crossing was based on the Manual of Uniform Traffic Control Devices (MUTCD) engineering standards for streets with low speeds and average daily traffic volumes. The average daily traffic on this road was 12,850 vehicles/day, with a recorded average speed of 19 mph in the northbound direction and 20 mph in the southbound direction.

While motorists by law must yield to pedestrians and bicyclists in crosswalks at unsignalized locations, many motorists do not, potentially resulting in a collision with a bicyclist or pedestrian**.** Additional traffic controls should be considered for the Quequechan Street trail crossings to ensure that bicyclists and pedestrians crossing the roadways can do so safely. Various passive options have been suggested to minimize conflicts at crossings including signage; appropriate lighting; painted and raised crossings; bumpouts; and the narrowing of roadways to slow vehicles down (Gårder, Leden, and Pulkkinen 1998; Hugget, K., Powell, S. 1998; Jensen 2008; Kim et al. 2007; Klop and Khattak 1999).

As mentioned above, design is crucial to minimizing conflicts at trail crossing. Still, communities can look beyond design and look at education and enforcement strategies. These can include community safety campaigns, bike safety workshops, and pedestrian right of way enforcement at crosswalks (Ulfarsson, Kim, and Booth 2010).

Bicycle/Pedestrian Master Planning

Although there is uncertainty about the trail's eventual level of use and who in fact will be accessing the trail, based on community interest and improved connectivity to downtown we can infer that there will be an increase in pedestrian and bicycle traffic accessing the trail. With even a small to modest volume increase, injury risks to the individual pedestrian or bicyclist will most likely decrease. This is based on the substantial evidence supporting the "safety in numbers" transportation principle where motorists are less likely to collide with a pedestrian or cyclists if more people are walking or biking (Jacobsen 2003).

Still, a major factor in ensuring trail safety is providing a network that supports pedestrians and bicyclists. Currently, Fall River's predominately car-centric transportation system could prove hazardous for those wanting to access the trail from various neighborhood locations. More strategic design and community outreach efforts would help create a supportive pedestrian/bicycle infrastructure that improves active transportation connectivity citywide and regionally.

Summary

- Fall River crash statistics indicate that the majority of crashes in the city involving bicyclists and pedestrians occur within one mile of the QRRT
- Existing literature shows that the QRRT extension will create safer recreation and active transportation opportunities for Fall River residents and visitors, preventing injuries and accidents
- The safety benefits associated with trails are likely to be realized provided that the planning/design process ensures a safe, accessible facility for all pedestrians and bicyclist
- This includes modifications to trail infrastructure, such as appropriate crossings that allow bicyclist and pedestrians to safely cross roadway intersections

2.3 Crime

Background

Real and perceived crime influences the perception of public spaces, such as the QRRT. Typically, public spaces that are well lit, have a lot of people, and have well maintained facilities have lower levels of crime, while public spaces with signs of "incivilities," such as graffiti, abandoned structures, and neglected facilities, are associated with higher crime levels (Loukaitou-Sideris 2005). Studies show that perceived safety is one of the most important predictors of trail use (Gordon, Zizzi, and Pauline 2004; Wolch et al. 2010) and peer-reviewed literature identifies high crime rates and fear for personal safety as barriers to physical activity, particularly among women and minorities (Bennett et al. 2007; Loukaitou-Sideris and Eck 2007; Loukaitou-Sideris 2005). While there are limited prospective studies that measure incidences of major and minor crimes on rail trails, a 2001 study on linear parks measured incidences of major and minor crime (real and perceived) 15 years after the completion of a multi-use corridor in Boston, Massachusetts. The study found no significant increase in crime for those living near the corridor in comparison to commercial streets on the edge of the study area. Perceived corridor safety expressed by residents varied depending on the time of day, physical layout, and numbers of people assumed to be walking at any given time of day (Crewe 2001).

In 2010, Fall River had the sixth highest number of aggravated assaults (778), violent crimes (1,087), and property crimes (3,297) in the Commonwealth, according to the FBI Uniform Crime Reports. Additionally, for the first seven months of this year (January 1, 2012, through July 13, 2012), the Fall River Police Department recorded one murder, 198 incidents of theft, 114 incidents of aggravated assault, and 56 incidents of robbery within a one-mile radius around the QRRT. Fall River struggles with crime already, and stakeholders voiced concerns that crime might deter individuals from using the QRRT, lessening its value as a resource for recreation and transportation.

Assessment

While the City of Fall River may have a high number of crime incidents relative to the rest of Massachusetts, the QRRT extension will likely be a relatively safe environment. In general, rail-trails are safe environments, according to a crime survey of 372 trails conducted by the Rails to Trails Conservancy. On 36 urban rail trails surveyed, one trail reported muggings (15 incidents) and three trails reported assaults (17 incidents total) in 1996 (Tracy et al. 1998). Minor crimes, such as graffiti, littering, and sign damage, may be more of a concern for the QRRT. About a quarter of urban rail-trails reported graffiti, littering, and sign damage in 1996 (Tracy et al. 1998). The Rails to Trails Conservancy recommends preventing overgrown vegetation and tall shrubs to minimize hiding places and maintain a long line of sight for users, as well as providing upkeep for the trail to inspire community ownership of the trail and to discourage incidents of minor crime such as litter, graffiti, and vandalism (Tracy et al. 1998).

The 25% design plan includes aesthetic safety measures that may increase safety, such as plantings, information kiosks, and aesthetic benches and trail markers. According to the literature, there are three recommendations for maintaining a safe and positive image of the QRRT: 1) encouraging usage, 2) maintaining the facilities, 3) lighting the underpasses (Abildso et al. 2007; A. Loukaitou-Sideris 2005; Wolch et al. 2010).

Encouraging Usage

Generally, crime does not occur in well-maintained places that are well populated and have few places to hide. By encouraging usage, there will be an increase in natural surveillance, which comes from more eyes on the trail (Loukaitou-Sideris 2005). Usage could be further enhanced by trail programming and outreach/education.

Maintaining Facilities

In the long term, upkeep of the trail facilities by the City of Fall River and QRRT partners will be important in dissuading crime. The 25% design plan incorporates easily-maintained, aesthetically pleasing furnishings and plantings that encourage a positive image of the trail. The design, as well as policy strategies like policing, educational programs, and employment of social networks, should help to discourage crime (Loukaitou-Sideris 2005; Loukaitou-Sideris and Eck 2007; Wolch et al. 2010).

Lighting the Underpasses

One of the major deterrents of crime is lighting (Abildso et al. 2007; Foster and Giles-Corti 2008; Loukaitou-Sideris 2005; Loukaitou-Sideris and Eck 2007; Wolch et al. 2010). In a before and after study of the installation of improved street lighting in Stoke-on-Trent, UK, incidences of crime decreased by 43% where the lighting was installed and by 45% in the adjacent area (Painter & Farrington 1999). Current proposals for the QRRT do not include lighting, with the exception of the I-195 and Route 24 underpasses. While the final decision on lighting for the underpasses has yet to be made, the preliminary idea is to only light the underpasses during the day and not at night. The rationale is that it will discourage negative uses of the trail. There is no literature to our knowledge that supports or dissuades this rationale, however the American Association of State Highway and Transportation Officials (AASHTO) released a *Guide for Planning, Design, and Operation of Bicycle Facilities* in 2010, which strongly recommends providing lighting in underpasses and at night, as "lighting in tunnels is important to provide security" (AASHTO 2010). Therefore, we recommend the QRRT be lit at night.

Summary

- The literature shows that real and perceived crime have an effect on trail usage
- Fall River has high crime rates compared to other cities in Massachusetts. Nationally, however, crime rates on rail trails tend to be low
- Real and perceived crime can be mitigated through increased surveillance, and by encouraging trail use, maintaining the facilities, and lighting the trail and underpasses

2.4 Economic Development

Background

Because Fall River suffers from some of the state's highest municipal-level poverty and unemployment rates, economic development is an important priority for residents and city officials. Previous studies suggest that trails and multi-use paths can support the revitalization of downtown districts and strengthen local and regional economies (RTC 2009), potentially increasing property values near trails, and even promoting tourism (Asabere and Huffman 2009; Bowker, Bergstrom, and Gill 2007; Lindsey et al. 2004; Nicholls and Crompton 2005; Penna, C. 2006).

Property Values

Trails provide residents with places to jog, walk the dog, socialize with neighbors, and get around town safely. As a result, residents report that trails are valuable community assets that may enhance their property values (Crompton 2001). Empirical real estate studies have confirmed residents' intuitions, demonstrating that proximity to rail trails actually boosts property values in suburban and urban areas (Asabere and Huffman 2009; Krizek 2006; Nicholls and Crompton 2005; Penna, C. 2006; Przybylski and Lindsey 1998). For example, a 2009 study analyzing 10,000 home sales in San Antonio, Texas, demonstrated that proximity to trails was associated with increased home values of roughly 2%. Further, proximity to greenbelt or greenway trails has been associated with 5% higher home values (Asabere and Huffman 2009).

Massachusetts-specific data also demonstrates the link between trails and higher home values. Penna (2006) examined home values in seven Massachusetts towns through which rail trails run. Evidence demonstrates that homes near trails sold at 99.3% of the list prices, while homes located away from trails sold at only 98.1% of the list price. Though these differences are small, they can make a meaningful difference to municipal tax bases when aggregated across neighborhoods.

Business/ Tourism

In addition to raising property values, trails may also bolster local commercial activity and bring new visitors to town. Research shows that pedestrian and bike infrastructure promotes local business, and that a dollar spent at an independent business rather than a chain retailer generates roughly three times as much benefit to a local economy. While driving to reach shopping destinations may encourage residents to travel far distances to find the lowest prices, by contrast, those walking or biking to the store stay closer to home and shop more frequently. For example, visitors arriving in Toronto's dense, walkable downtown by foot or bike were found to visit the downtown more often and spend more money per week than those arriving by car (American Independent Businesses Alliance 2003; Toronto Clean Air Partnership 2009). In short, densely built, walkable communities help locally-owned businesses thrive. Municipal governments have become aware of the business sense of constructing trails, with urban communities across the U.S., including Boston, San Antonio,

Providence, Indianapolis, and Chattanooga, including trail development in strategic plans designed to attract residents, tourists, and businesses (Asabere and Huffman 2009).

U.S. rail trails have generated millions of dollars in commercial activity for municipalities (Bowker, Bergstrom, and Gill 2007; RTC 2009). Furthermore, compared to trails on undeveloped or conservation land, rail trails boast more economic development potential due to their proximity and connectivity to downtown districts and business centers (RTC 2009). Leadville, Colorado, for example, reported a 19% increase in sales tax revenue after it opened its rail trail. In another example of success, the Dallas, Texas, Mineral Wells/Weatherford Rail Trail helped generate local revenues of $200 million (NTEC 2002).

Limitations

While literature indicates that the impacts of trails are positive with respect to property values and tourism, more regional based research is needed to fully understand the economic benefits associated with varying types of trails.

Existing Conditions

Employment

Fall River's local economy is dominated by healthcare and manufacturing. However, in a city grappling with below average educational attainment and above average dropout rates compared to the rest of the state, regional trends away from industry and towards the "knowledge economy" have resulted in an unemployment rate roughly twice that of the overall state. Residents living within a mile of the proposed QRRT extension earn more, on average, than those further from the trail. The one-mile radius includes Fall River's wealthier "Highlands" neighborhood, and Westport, a more affluent town south of Fall River. Housing density is higher near the trail, and these homes are more likely to be occupied by renters than housing in the rest of the city. Specifically, the median household income within the one-mile radius is $41,369, or 21% higher than that of Fall River overall (U.S Census Bureau, 2006-2010 ACS).

Approximately 16,950 jobs are located within one mile of the QRRT, representing 50% of the city's total employment. Looking more closely at job types within one mile of the QRRT, approximately 45% are in the service industry while 21% are in the retail industry. The remaining 34% are in export industries such as manufacturing and construction (Massachusetts Dept. of Labor and Workforce Development 2012).

Housing characteristics

The QRRT one-mile radius contains slightly more than 22,000 housing units (Table 8). Of the total housing units, approximately 60% are renter occupied and 27% owner occupied. Of the city's total housing units, roughly 50% of the total units are renter occupied and 33% are owner occupied. Mean assessed property values within this area for single-family homes, condominiums and mobile homes was $215,632 while for two and three family homes it was $256,903 (City of Fall River 2010). The mean assessed property values for the city as a

whole, by contrast, stands at $235,844 and $258,527 for single family/condo/mobile homes and two to three family homes, respectively (Figure 9 and 10) (City of Fall River 2010).

TABLE 8: Housing Characteristics				
	QRRT 1-Mile Radius	%	Fall River	%
Total Housing Units	22,242	100.0%	43,050	100.0%
Occupied Housing Units	19,758	88.8%	38,140	88.6%
Owner Occupied Housing Units	5,945	30.1%	14,271	37.4%
Renter Occupied Housing Units	13,604	68.9%	23,869	62.6%

Figure 9: Multi-Family Property Values within 1-mile of the QRRT

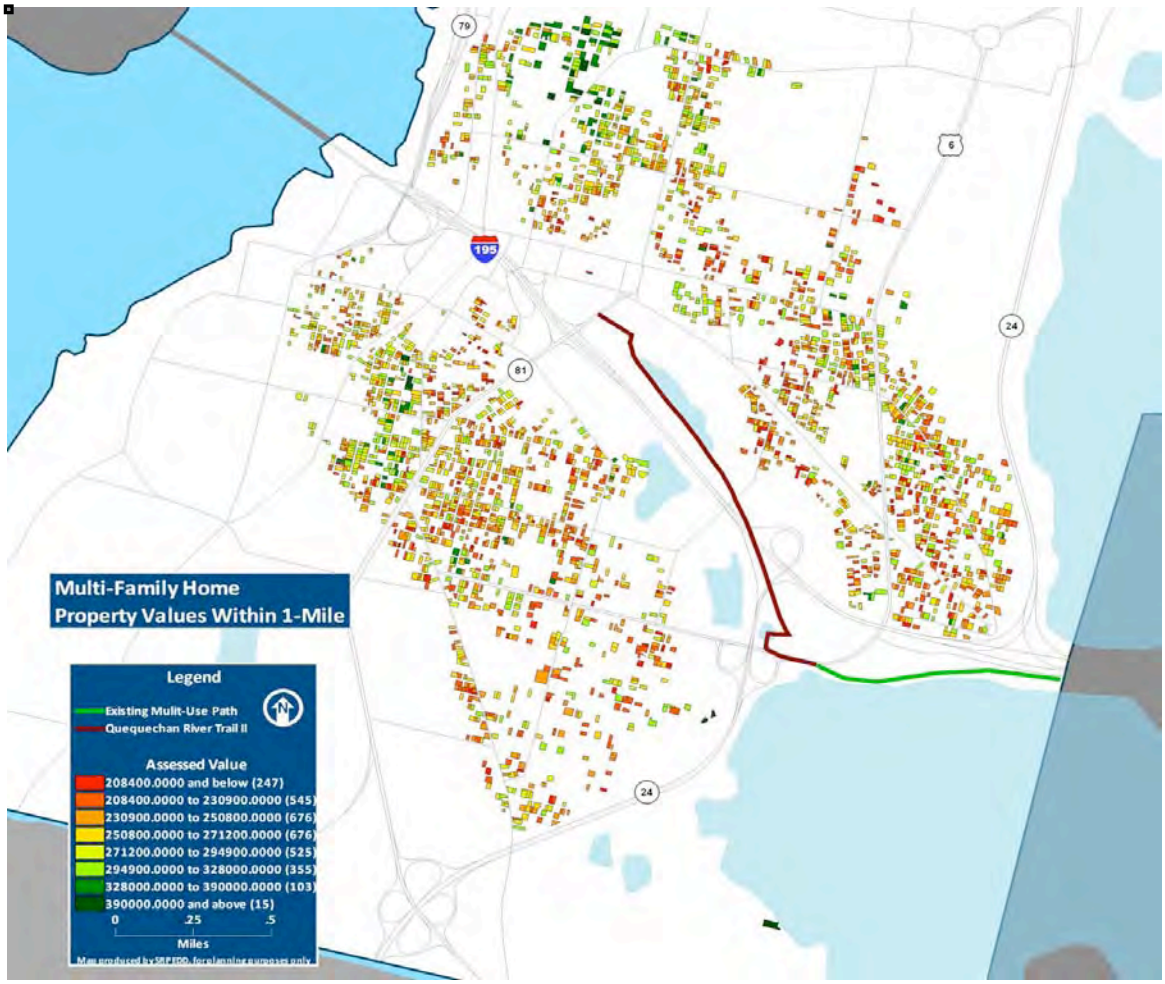
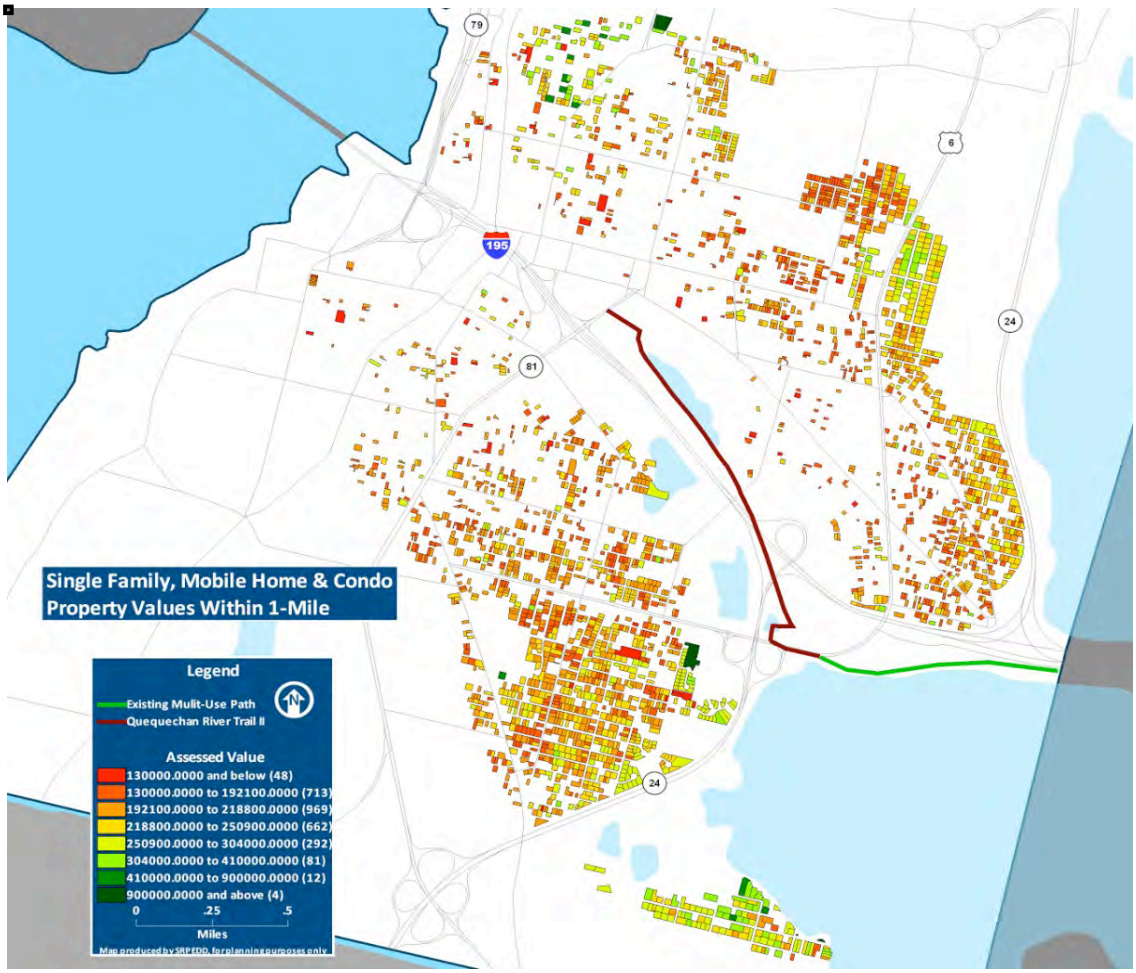


Figure 10: Single Family, Mobile Home, Condo Property Values within 1-mile of the QRRT

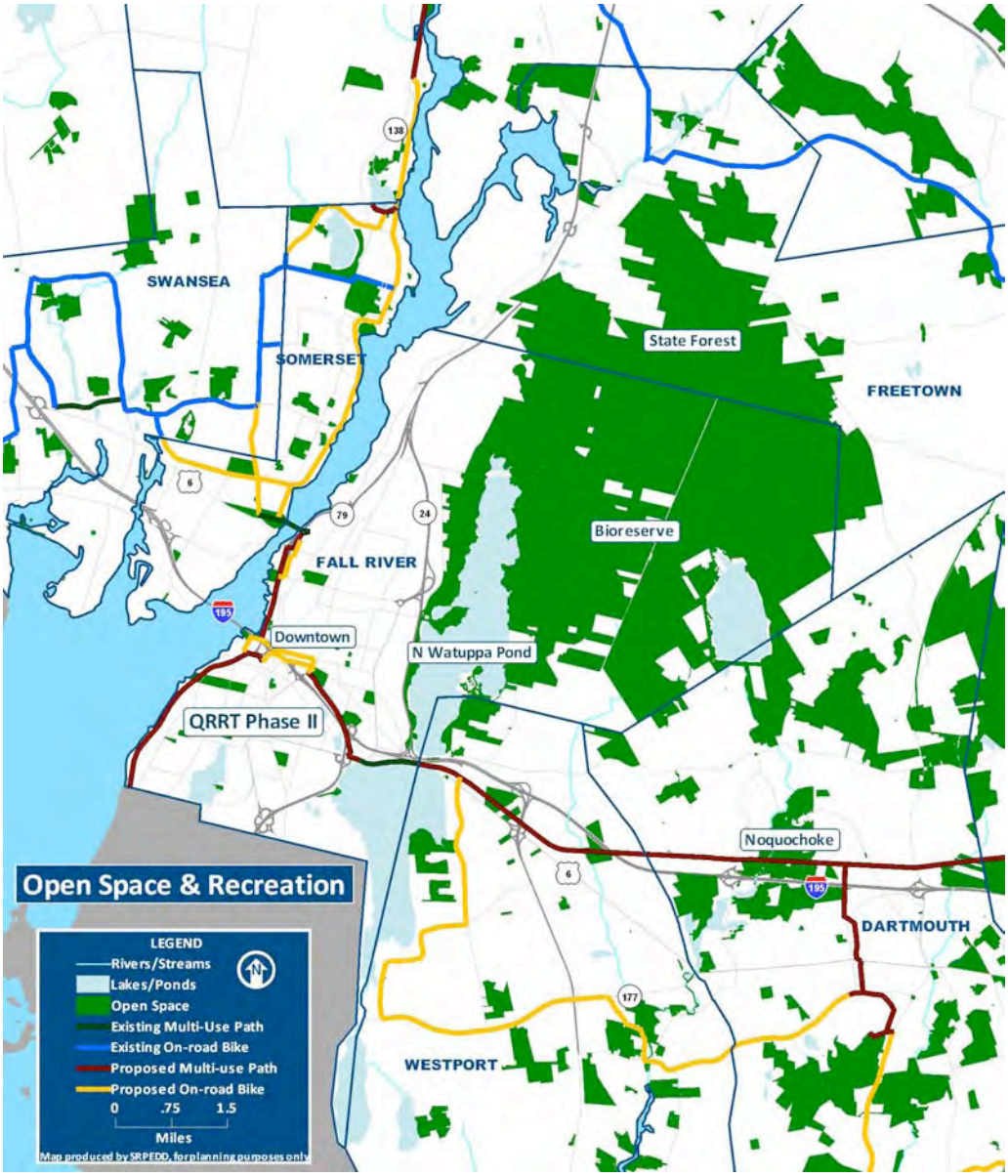


Tourism

Massachusetts' tourism provides an array of opportunities for travelers. During 2010, travelers directly spent $15.5 billion, supporting over 121,000 jobs and providing $1 billion in state and local taxes. At the county level, Suffolk County leads all of Massachusetts, receiving $6.4 billion in domestic travel expenditures, accounting for 47.6 percent of the state total. In comparison, Bristol County, which includes the City of Fall River and 19 other towns and cities, received close to $400 million from domestic travelers, approximately 2.6% percent of the state total (U.S. Travel Assoc. 2011).

Though Bristol County's impact on statewide tourism is small, the southeastern region has a lot to offer in the form of recreation, entertainment, and historical landmarks. Some of the main attractions specific to Fall River include: Battleship Cove, the Lizzie Borden House Museum, the Fall River Historical Society and Marine Museum. Fall River also has an array of parks and state forests, including Heritage State Park and the Southeastern Bioreserve. The Bioreserve is the largest wildlife area in Massachusetts, totaling some 13,600 acres and representing nearly half of Fall River's land area (Figure 11). The QRRT and South Coast Bikeway are part of Fall River's long-term plan of improving connectivity between downtown, parks and forests, and regional bike network.

Figure 11: Open Space and Regional Bike Plan



In 2009, Fall River updated its Master Plan to include strategies to focus on tourism. Since then, Fall River has created a tourism committee and successfully hosted a summit in 2012 to explore best practices in improving tourism citywide, as well as regionally. There is great potential for Fall River to capitalize on their current assets, and the committee will look to improved coordination, infrastructure improvements, as well as targeted marketing.

Approximately 16,950 jobs are located within one mile of the QRRT, representing 50% of the city's total employment. By the year 2020, SRPEDD is projecting an overall increase in employment within one mile of the QRRT to 17,256 jobs—306 more than 2010 totals. This projection was primarily based on known developments in the pipeline (i.e. the Community Health Center, the Wal-Mart development) and general increases in urban employment due to the rehabilitation of old mills. It is also based on major transportation improvement projects such as the new Route 79/I-195 interchange.

Assessment

Previous studies suggest that the QRRT extension may create a positive economic impact in Fall River, potentially increasing property values, encouraging sales at local businesses, and bringing in new visitors from out of town. Phase One of the QRRT has benefitted abutters such as LePage Seafood Restaurant, the Advanced Technology and Manufacturing Center (ATMC) of UMass Dartmouth, and Biotech. The QRRT extension can further improve the entry of commercial amenities that attracted business and tourist to Fall River.

Furthermore, increases in property values within the one-mile radius generated by the QRRT extension would help bring current values closer to the city's average, which would increase Fall River's tax base. The QRRT may also strengthen small business growth and tourism, especially if connectivity to downtown businesses, parks, and in the near future, the South Coast Bikeway is prioritized.

Summary

- Existing studies suggest that rail trails create meaningful economic benefits, including higher home values (and therefore tax revenue), increased tourism, and more spending at local businesses
- Employment in Fall River is projected to increase by 2020; the QRRT's positive effects on local business could create additional jobs, though effects would likely be modest
- The QRRT will provide a new resource to increase tourism in Fall River
- Homes near trails will likely see increased property values

Background

One of the often-highlighted benefits of a trail is its ability to encourage commuting by bicycling or walking. When used for commuting, trails can help reduce the use of single-occupancy vehicles (SOV's) and therefore reduce total vehicle miles traveled (VMT) and subsequent vehicle emissions that contribute to poor air quality. VMT is the total number of miles driven by all vehicles within a given time period and geographic area. This logic of trails reducing reliance on automobiles is the basis for the Federal Highway Administration (FHWA) to allow for the construction of bicycle and pedestrian facilities under its Congestion Mitigation Air Quality (CMAQ) program. This program is specifically targeted at improving air quality through transportation infrastructure construction and programs to reduce SOV use in areas that are in non-attainment of the National Ambient Air Quality Standards (NAAQS) of the Clean Air Act. Ozone and particulate matter are major pollutants regulated by the Clean Air Act that are attributed to vehicles. There is an extensive body of literature linking vehicular air pollution to mortality and hospitalizations due to asthma, chronic lung disease, heart attacks, ischemic heart disease, and major cardiovascular disease.

Ground level ozone is what the EPA considers "bad ozone" and is considered a harmful air pollutant and the chief ingredient in "smog." Ground level ozone is not emitted directly into the air, but is created by chemical reactions between NOx and VOCs in the presence of sunlight. Emissions from motor vehicle exhaust and gasoline vapors are some of the major sources of NOx and VOC (MassDEP 2012a; EPA 2012)

Numerous scientific studies have linked ground-level ozone exposure to a variety of respiratory problems. Breathing ozone can irritate the respiratory system and cause coughing, throat irritation and uncomfortable sensations in the chest. It can also reduce lung function, which may limit a person's ability to engage in vigorous activities. Ozone also plays a role in heightening sensitivity to allergens, leading to more doctor and emergency room visits and greater use of medication; and inflames the lung lining, which can lead to permanent scarring and loss of lung function over time. Finally, ozone may contribute to premature death in people with heart and lung disease (MassDEP 2012a). In general, as concentrations of ground-level ozone increase, more people experience health symptoms, the effects become more serious, and hospital admissions for respiratory problems increase (MassDEP 2012a). When ground-level ozone reaches unhealthy levels, children are the group at highest risk because they tend to spend more time playing outdoors and they also are more likely to have asthma. People with asthma or other respiratory diseases are especially vulnerable, even at lower ozone levels. Because they have a higher-level of prior respiratory disease, elderly people are also at greater risk of negative health effects of ozone.

Particulate matter (PM) air pollution has been linked to higher rates of mortality and coronary disease in many studies (Dockery et al. 1993; Pope et al. 1995). Research has focused on particles with an aerodynamic diameter of 10 micrometers or smaller (PM_{10}), and especially particulate less than 2.5 micrometers ($PM_{2.5}$) as they can be inhaled deep into the

lungs. Health effects include asthma, difficult or painful breathing, and chronic bronchitis, especially in children and the elderly. Cardiovascular disease events account for most of the excess mortality attributed to PM exposure. Additionally, epidemiologic evidence has accumulated for a relationship between acute PM_{10} and nonfatal cardiovascular events, including: hospital admissions (Goldberg et al. 2001; Francesca Dominici et al. 2003; F. Dominici et al. 2006), myocardial infarction (Peters et al. 2001; Zanobetti and Schwartz 2005), and cardiac arrhythmias (Dockery et al. 1993; Peters et al. 2001). MassDEP monitors PM throughout the state, concentrating on urban areas where they are most prevalent, including Fall River.

Existing Conditions

Bristol County, Massachusetts, where Fall River is located, is classified as an "attainment" area by the Environmental Protection Agency (EPA) for ground level ozone, meaning that ground level ozone levels are within attainment of the NAAQS. Despite being in attainment, Bristol County's location upwind of New York and New Jersey put it right on the edge of non-attainment. Thus, it is a priority of the state to reduce its emissions of volatile organic compounds (VOCs) and nitrogen oxides (NOx), the two major precursors to ozone formation (SMMPO 2012).

MassDEP summarizes the highest eight-hour ozone level on a daily basis for each monitoring station. Values above the 0.075 ppm EPA standard are noted and classified as "exceedances". Table 9 summarizes the number of days with exceedances for the Fairhaven monitoring station for the three-year period from 2009 through 2011. The Fairhaven monitoring station is the closest station to Fall River that measures ozone.

Table 9: Number of Exceedance Days, Fairhaven Monitoring Station

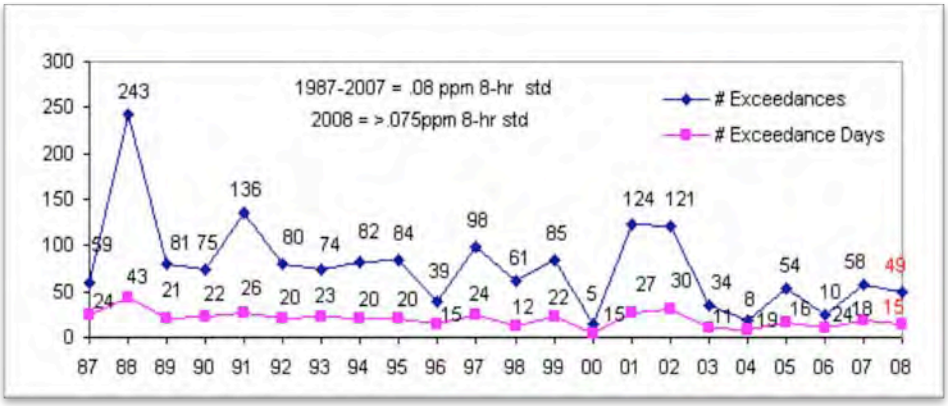
	2009	2010	2011
Fairhaven	1	4	4

Source: MassDEP, 2012b

The design values used for determining non-attainment status for a site is calculated by averaging the fourth-highest observed eight-hour values each year over a three-year period (MassDEP 2011). Thus, four or more exceedances days over a three period would result in "non-attainment" status for a site. The Fairhaven site had four exceedance days in both 2010 and 2011, and to date, its replacement site in Fall River has had four exceedance days in 2012. Thus, it is likely that Bristol County could enter non-attainment status again after this year.

The state as a whole has managed to lower its daily and total exceedances of the ground ozone standard over the past 20 years. Total exceedances and exceedance days for the eight-hour ground ozone standard have been tracked by MassDEP since 1987 and are displayed in Figure 12 below.

Figure 12: Eight-Hour Ozone Exceedance Days and Total Exceedances 1987-1998



As evident from the above graph, air quality in the state is improving when it comes to ground level ozone levels. Tougher government regulations on vehicles, power plants, factories, and other pollution sources are aiding in this process. When it comes to transportation infrastructure, the CMAQ program is serving to reduce ozone formation by lowering NOx and VOC emissions through its variety of projects, including bicycle and pedestrian facilities like the QRRT.

In addition to ground level ozone, MassDEP monitors PM 2.5 at its testing site in the city of Fall River. The 24-hour standard for PM 2.5 set by the EPA is currently 35ug/m (micrograms per cubic meter of air) while the annual standard is 15ug/m3. Table 10 summarizes PM 2.5 measurements from 2009 through 2011 at the Fall River monitoring site.

TABLE 10: PM2.5 Annual Averages and Maximum Values, Fall River Monitoring Site

	2009	2010	2011
Annual Average	8.0	9.0	10.3
Maximum Daily	29.9	40.4	33.9

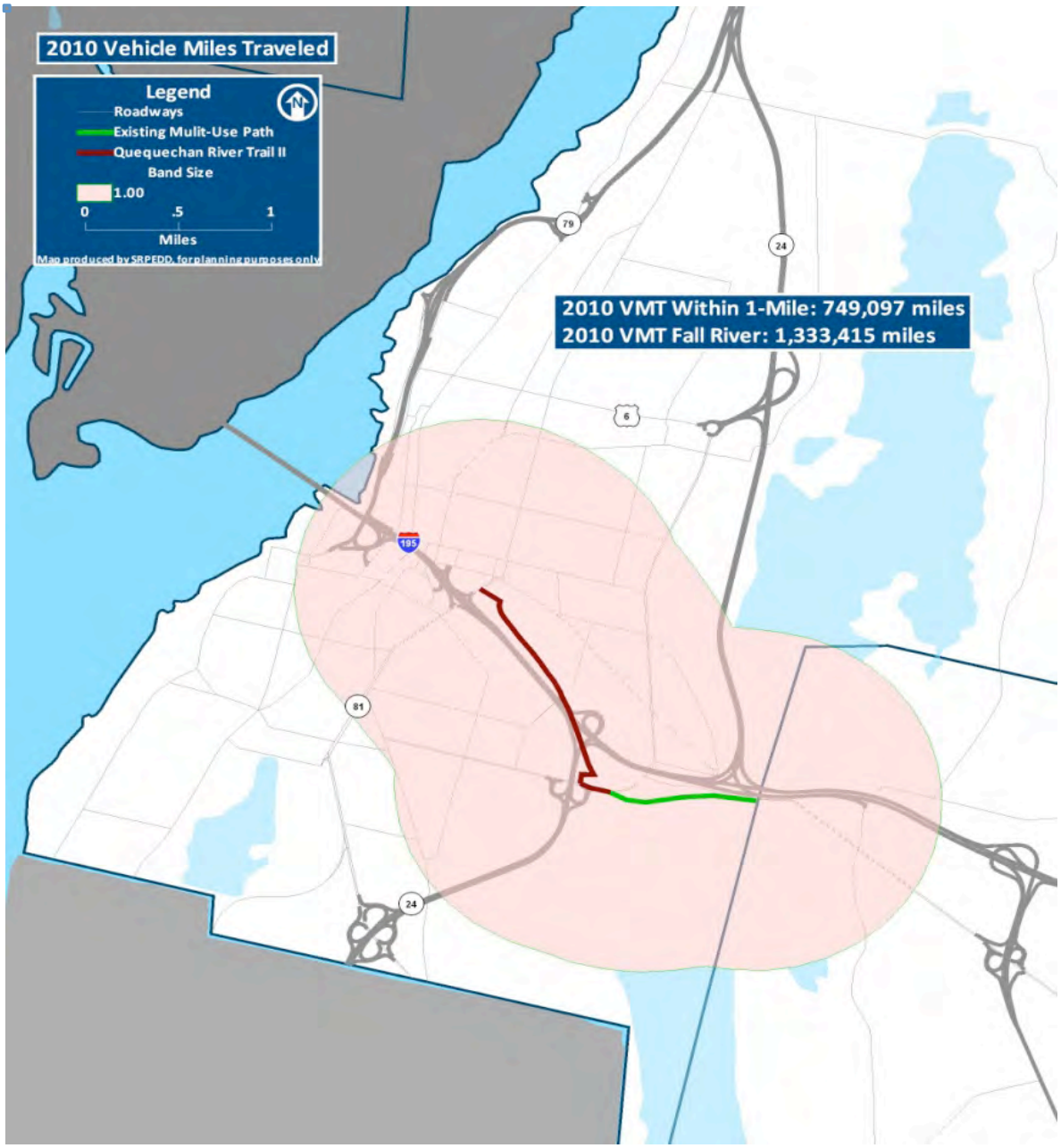
Source: MassDEP, 2012b

As is evident from the table above, Fall River does not exceed the annual standard for $PM_{2.5}$ and it only exceeded the 24-hour standard once during this three year period, in 2010. The upward trend in annual $PM_{2.5}$ levels in the city, however, could mean that levels could reach unacceptable levels in the future. Overall, the state does meet the NAAQS for all particulate matter, $PM_{2.5}$ and PM_{10} (MassDEP 2012b).

Transportation

Baseline VMT data was obtained from SRPEDD's Regional Travel Demand Model. SRPEDD's Regional Travel Demand Model calculates daily VMT for the region's roadway network that includes Fall River. In 2010, the base year for SRPEDD's model, the total VMT for the city of Fall River was 1,333,415 miles and the total VMT within one mile of the QRRT was 749,097 miles. The high amount of VMT within one mile of the QRRT lends itself to the fact that I-195 and Route 24, two major limited access highways, are within this radius. Figure 13 below illustrates VMT for the city of Fall River and for a one-mile radius around the QRRT.

Figure 13: Fall River VMT and for a 1-mile radius around the QRRT



Assessment

The potential VMT reductions from this project and subsequent emissions reductions can be quantified using the FHWA/MassDOT CMAQ Air Quality Analysis Worksheet seen in Appendix A. This worksheet was completed for the QRRT by SRPEDD and demonstrates the following changes to VMT and vehicle emissions:

- Reduction in VMT of 53.5 miles per day or 10,704 miles per year
- Reduction in Summer VOC of 2.5 kg/year
- Reduction in Summer NOx of 1.9 kg/year

The reductions in VOCs and NOx will lead to an overall reduction in ground level ozone, thereby improving the air quality in Fall River and all of eastern Massachusetts. Lowering VMT would also lead to a decrease in other vehicular-emissions, such as PM; however, the CMAQ model does not estimate this change.

The QRRT will likely decrease SOV commuting modestly, thereby decreasing levels of vehicular air pollution modestly. These impacts will most likely impact those who live and/or work close to the QRRT, although shifts in commuting patterns and the movement of air pollution over large geographic areas may cause decreases in exposure to air pollution for many residents of Fall River. Additionally, while air pollution affects everyone, some people are more sensitive to its impacts than others, especially children, who are most risk for asthma, and the elderly, who are more likely to have previous lung disease. Children under 15 years old represent 18% of the population within one mile of the QRRT and 17% of the population in the city of Fall River. Additionally, the elderly (65+) are at the highest risk for lung diseases, such as Chronic Obstructive Pulmonary Disease (COPD), and represent 13% of the population within one mile of the QRRT and 15% of the population in the city of Fall River. These susceptible populations may experience even greater benefits from decreasing levels of air pollution due to the QRRT.

There are a number of limitations to this assessment of changes in air quality due to the QRRT. Air pollution data in Fall River is limited, so we were not able to accurately estimate the current levels of air pollution around the QRRT site. Additionally, there is a great deal of uncertainty in the assumptions and constants on the CMAQ worksheet, and therefore it is unclear how reliable the specific estimates of changes in VMT and subsequent air pollution might be. Furthermore, when the QRRT connects to greater networks of regional paths, it is possible that it may have a larger impact on changes in VMT than can be accurately estimated here. It is also worth noting that users of the QRRT may have higher respiration rates when using the trail for physical activity. These individuals may therefore have higher levels of exposure to air pollution because of their respiration rates; however, the net benefit of physical activity on health would likely outweigh the negative effects of air pollution exposure.

Summary

- The QRRT, like all off-road multi-use paths, provides an opportunity to decrease single-occupancy vehicle use and to promote bicycling or walking as a form of transportation for the residents and workers of Fall River
- This will result in a reduction in VMT near and around the trail, which in turn will lower vehicle emissions and improve air quality for all Fall River residents
- Improvements in air quality will likely be modest for a trail of this size and will likely lead to very small decreases in negative health outcomes such as asthma and cardiovascular disease

2.6 Social Cohesion

Background

Clinicians, social scientists, and public health researchers have long recognized that "psychosocial" risk factors, including social isolation and stress, can harm health, while social support and social cohesion actually promotes good health. For example, we know that social isolation and a lack of social cohesion increase the risk of mental health problems, heart disease, and even death (Berkman and Kawachi 2000; Kawachi and Kennedy 1997). By contrast, people with better social environments—a larger number of friends, more social interactions, a tighter knit community, or more trust among neighbors–have access to social resources that help keep them healthier (S. Cohen and Wills 1985). For example, better social environments make it more likely that residents will enjoy emotional social support, or will have friends around when things are rough, which has been shown to help people cope with stress. Those in better social environments may have an easier time finding people to meet to go for a walk, or sharing cooking tips with neighbors. Those with positive social environments are also able to access material support, for example, in the form of a neighbor who offers to babysit or take the dog out, or who helps out if the family car breaks down. Access to material support can also ease stress, which is good for mental and cardiovascular health, among other outcomes (Flier, Underhill, and McEwen 1998). In short, better social environments have consistently been shown to impart significant health benefits when looking across a range of health outcomes (Berkman and Kawachi 2000)

As a result, communities have sought to understand what they can do to improve their social environments, encouraging more people to interact with each other more often, and to participate more in civic life, thereby creating trust among neighbors (Putnam 2001) .

Researchers have recently begun investigating the role of public spaces in fostering social interaction among residents, examining whether the availability of parks, trails, and other open spaces actually helps improve the community social environment. As a nascent area of research, only a small number of studies have addressed the role of trails in fostering positive social interactions. However, the limited research that does exist suggests that trails and other similar spaces may carry positive benefits for the local social environment. For example, Sullivan et al. found in 2004 that more social interaction takes place in green, rather than barren, spaces near residences and that such spaces appear to actually encourage more socialization among women (Sullivan, Kuo, and Depooter 2004) called neighborhood green spaces "vital neighborhood spaces," and reviewed literature on how such areas may actually draw people out of their homes into the outside where they have more opportunities for social interactions, fostering more social cohesion and better ties among neighbors. In similar research, Fan and colleagues reported in 2011 that park spaces in neighborhoods reduce residents' stress by fostering social support among residents (Fan, Das, and Chen 2011). The authors describe that while neighborhood green spaces can have direct stress reduction benefits created by giving people a chance to unwind outside, structured green spaces may also reduce stress via increased opportunities for physical activity and socialization.

Therefore, structured open spaces, such as trails, can benefit residents' mental and physical health, in part by improving the local social environment. Finally, in related but distinct research, at least one study demonstrates that features that make neighborhoods more walkable may also promote better social environments (Leyden 2003). In 2003, Leyden found that residents of walkable neighborhoods were more likely to report knowing their neighbors, trusting others, and being involved in social/civic life. Similarly, Richard et al. found that frequent walking was predictive of higher social participation rates (Richard et al. 2009).

Existing Conditions

Researchers often measure the quality of the social environment by asking residents about social support (e.g., how many close friends do you have), social cohesion (e.g., to what extent do people from different backgrounds get along here), and/or social capital more generally (e.g., how many of your neighbors' first names do you know). In the absence of regular public surveys asking such questions of residents, it is difficult to quantify baseline social environment conditions in Fall River. However, participation of in social/civic organizations and voting participation rates are frequently used indicators of social capital, a broad social construct related to the concept of social cohesion (Saguaro Seminar 2012).

In the 2010 statewide election, Fall River had the eighth lowest voter turnout of Massachusetts' 351 municipalities, with only 37% of eligible voters participating in the election (MetroBoston DataCommon 2012). Because this indicator only measures the behavior of eligible voters, communities with high number of ineligible residents (e.g., youth or non-naturalized immigrants) are not automatically penalized by this statistic. Further, the 2010 voter turnout rate in Fall River fell 9% between 2006 and 2010, one of the largest declines in the state over the four year period. While low voter turnout is one worrisome indicator of the state of social capital in Fall River, other signs point to the municipality's interest in fostering a positive social environment. For example, the Southeastern Massachusetts non-profit organization Coalition for Social Justice (CSJ) has a long history of working on voting rights and legislation advocacy for Fall River residents. Also the Massachusetts Social Capital, Inc. has established a program in Fall River meant to encourage increased social capital in the community (SCI Social Capital Inc. 2012). In addition to nonprofits groups, the municipal government features a strong system of neighborhood associations. Such organizations have the potential to connect residents to their neighbors and the broader municipal community, effectively building social capital and promoting social interaction.

Assessment

While scant empirical data exists on Fall River's social environment, low voter turnout rates suggest that initiatives to foster social capital have the potential to benefit the city's residents. Further, the presence of organizations such as Coalition for Social Justice, Healthy City Fall River, Social Capital, Inc., and participation in the city's extensive network of neighborhood associations may indicate a local appetite for more opportunities to engage socially and civically.

Constructing the QRRT, a new structured green space in Fall River, would provide residents a new space in which to socialize, bump into neighbors, and even serve as a destination that might lure people out of their homes and into public space. The limited body of peer-reviewed evidence on the social environment impacts of such spaces suggests that constructing the QRRT would likely improve Fall River's social environment.

Summary

- A small number of studies have addressed the role of trails in fostering positive social interactions and suggest that trails and other similar spaces may carry positive benefits for the local social environment
- While low voter turnout is one worrisome indicator of the state of social capital in Fall River, other signs point to city agencies and nonprofits fostering a positive social environment
- The QRRT would likely improve Fall River's social environment, helping to build social capital and strengthening social cohesion among residents

Part Three

3.1 Conclusions

It is expected that the proposed QRRT extension would have a positive impact on the health of Fall River residents, resulting in increased physical activity opportunities, safer conditions to walk/bike, improved air quality, and encouraging effects on community identity/social cohesion.

- Constructing the QRRT extension would increase opportunities for residents and visitors to be physically active, which in turn helps prevent obesity and reduces the risk of many chronic diseases. Because the proposed trail runs through densely populated, low-income neighborhoods, the physical activity benefits associated with the QRRT might also help reduce health disparities in Fall River.
- The QRRT extension will likely provide a small boost to local businesses and may increase nearby home values. By helping to grow the local economy, the QRRT may positively affect health outcomes associated with socioeconomic conditions. Financial gains for small business owners and homeowners may decrease stress and promote spending on healthy behaviors or foods, while additional tax revenue could help the city of Fall River better maintain health promoting resources for residents.
- The QRRT extension will create safer recreation and active transportation opportunities for Fall River residents and visitors, preventing injuries and accidents.
- The QRRT extension would likely have a positive impact on Fall River's public safety. While Fall River has high crime rates relative to other cities in Massachusetts, crime rates on rail trails tend to be low. Real and perceived crime on the QRRT can be mitigated through increased surveillance by encouraging trail use, maintaining the facilities, and lighting the trail and underpasses.
- Walking or biking trips on the QRRT are likely to replace a small number of car trips in Fall River. Resulting improvements in air quality, which protect against asthma and cardiovascular disease, would likely be quite modest.
- Outdoor spaces such as the QRRT extension provide opportunities for neighbors to interact, convenient meeting locations that can foster walking clubs, and may even create incentives for residents to get out of their homes and into their communities. As such, the QRRT would likely improve Fall River's social environment, helping to build social capital and strengthening social cohesion among residents.

3.2 Recommendations

The QRRT project has great potential in improving recreational and active transport opportunities in and around Fall River's community. The following evidence-based recommendations should be considered in mitigating the potential negative impacts of the QRRT, as well as maximizing positive health impacts associated with this project. While many of these recommendations can be applied in a rather short to medium time frame, we also provide longer-term city and regional strategies.

Engineering/Design

The safety benefits associated with the QRRT are likely to be realized provided that the planning/design process ensures a safe, accessible facility for all pedestrians and bicyclist. There are various engineering/design strategies for ensuring a safer environment for pedestrians and bicyclists accessing the QRRT. The QRRT extension design team should:

Modify the 25% design to improve pedestrian and cyclists' safety at trail crossings

Designing an appropriate non-signalized crosswalk on Quequechan Street is crucial in permitting bicyclist and pedestrians of all abilities to safely cross roadway intersections with minimal risk. Ensuring that the crosswalk is highly visible and that approaching speeds to the crosswalks are slow is essential to having a safe non-signalized trail crossing. Signage, traffic calming and roadway design elements such as "bump outs" that force traffic to slow down are all good examples of safety improvements that should be explored further.

Light the QRRT for safety (both crime and collisions)

Real and perceived crime can be mitigated through lighting the trail and underpasses because these measures increase natural surveillance. The American Association of State Highway and Transportation Officials (AASHTO) released a Guide for Planning, Design, and Operation of Bicycle Facilities in 2010 which strongly recommends lighting be provided to provide security (AASHTO 2010). If cost is a major deterrent to providing trail lighting, decision makers should explore other options for lighting the trail or identifying where lighting may be most important on the trail. For example, installing solar lights may minimize the long-term cost of lighting the trail.

Trail Use and Maintenance

The City of Fall River should:

Survey current users, as well as non-users, to gather baseline conditions for trail usage volume, purpose, (recreation vs. transportation), as well as trail user behavior and motivations

Surveys should be conducted with the support of local bike advocacy groups, school age youth, and/or organizations interested in promoting the QRRT. These findings will

help support the planning/design mentioned above, as well as the promotion phases trail management of the QRRT.

Develop programs such as safety campaigns and trail education to promote walking and biking as mobility options to low income and at-risk groups, as well as improve Fall River's social environment

Good planning and design alone may not determine usage among target groups, especially children, the elderly, and minorities at highest risk for inactivity. Developing appropriate policy and program strategies, such as safety campaigns and trail education are highly recommended to promote walking and biking as mobility options to low income and at-risk groups. Programs may include city trail festivals; coordinated bike rides or walks; low-income bike programs and discounted bike shops for repairs. This effort should be inclusive of community-based groups and organizations such as churches, schools, community health centers, and senior citizen facilities.

Increase awareness and understanding of vehicle/traffic laws

The QRRT project provides an opportunity for Fall River and the police department to review traffic laws with trail users, motorists, and law enforcement officials. Clarifying laws to address the unique needs on the QRRT and road intersections should be re-examined and discussed with the public through various forms of communications (e.g. public meetings, social media, schools, and community organizations).

Upkeep of the trail facilities is central in attracting users and dissuading criminal activity

The 25% Design Plan incorporates easily-maintained, aesthetic furnishings and plantings that encourage a positive image of the trail. A long-term maintenance plan should be developed by the city with community input to ensure the QRRT is properly maintained over time.

City/Regional Connectivity

The City of Fall River, SMMPO, and SRPEDD should:

Provide new or upgraded bike parking infrastructure

Add bicycle infrastructure (e.g. racks, corrals, lockers, shelters) in and around Fall River's downtown business/commercial areas to help attract QRRT users to the downtown area, and to increase bicycle mode share in Fall River.

Conduct long-term pedestrian and bicycle planning, prioritize regional and intra-municipal connectivity, and include pedestrian and bike planning in Fall River's public health, economic development, and tourism strategies. Community engagement will be vital to these city and regional planning processes. This longer term recommendation should focus on three main strategies:

1. Perform a survey of trail users to determine specific needs and best development potential, as well as the surrounding businesses and residential community to improve the connectivity and access to Fall River's downtown district, urban parks, Bioreserve, and regional pathway to business, tourist destinations, and residents.
2. Continue efforts in improving connectivity to routes and trails (i.e. South Coast Bikeway) to increase recreation and active transportation opportunities at a city and regional level.
3. Improve on measurement of air pollution around QRRT and connect QRRT to regional pathway to decrease single occupancy vehicle commuting and reduce air pollution.

3.3 Monitoring

In the context of this rapid HIA, monitoring refers to the process of evaluating the outcomes of the QRRT extension on health determinants. It entails laying out a management plan that includes the duties of agencies and organizations responsible for instituting mitigations and recommendations, methods for reporting and monitoring findings, and the timing to which these responsibilities can be met.

To monitor the effectiveness of this HIA, the City of Fall River, SRPEDD, and community organizations should:

- Examine the progress of the 25% Design for the HIA's safety recommendations;
- Survey users and the community at large about the awareness of the trail's existence and trail usage volume, purpose (recreation vs. transportation), and user motivations, annually;
- Develop safety campaigns and trail education to promote walking and biking as mobility options, as well as improve Fall River's social environment;
- Collect data on the number of bicycle and pedestrian infrastructure in the community annually (e.g. number of bike rack, sidewalks, and bike lanes);
- Continue to secure state/regional transportation funding for bike/pedestrian projects.

A more detailed management plan is provided in Appendix B.

References

AASHTO. 2010. *Guide for Planning, Design, and Operation of Bicycle Facilities in 2010*. American Association of State Highway and Transporation Officials. http://www.google.com/search?q=Guide+for+Planning,+Design,+and+Operation+of+Bicycle+Facilities+in+2010&hl=en&.

Abildso, C. G., S. Zizzi, L. C. Abildso, J. C. Steele, and P. M. Gordon. 2007. "Built Environment and Psychosocial Factors Associated with Trail Proximity and Use." *American Journal of Health Behavior* 31 (4): 374–383.

Asabere, Paul, and Forrest Huffman. 2009. "The Relative Impacts of Trails and Greenbelts on Home Price." *The Journal of Real Estate Finance and Economics* 38 (4): 408–419. doi:10.1007/s11146-007-9089-8.

Aultman-Hall, Lisa, and Fred L. Hall. 1998. "Ottawa-Carleton Commuter Cyclist On-and Off-road Incident Rates." *Accident Analysis & Prevention* 30 (1) (January): 29–43. doi:10.1016/S0001-4575(97)00059-6.

Aultman-Hall, Lisa, and M.Georgina Kaltenecker. 1999. "Toronto Bicycle Commuter Safety Rates." *Accident Analysis & Prevention* 31 (6) (November): 675–686. doi:10.1016/S0001-4575(99)00028-7.

Badgett, S.I., Niemeier, D.A., Rutherford, G.S. 1993. "Bicycle Commuting Deterrents and Incentives: a Survey of Selected Companies in the Greater Seattle Area" presented at the 73rd Annual Meeting of the Transportation Research Board,, Washington DC.

Bennett, Gary G, Lorna H McNeill, Kathleen Y Wolin, Dustin T Duncan, Elaine Puleo, and Karen M Emmons. 2007. "Safe To Walk? Neighborhood Safety and Physical Activity Among Public Housing Residents." *PLoS Medicine* 4 (10) (October). doi:10.1371/journal.pmed.0040306. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2039759/.

Berkman, L. F., and I. Kawachi. 2000. *Social Epidemiology*. Oxford University Press, USA.

Bowker, J. M., J. C. Bergstrom, and J. Gill. 2007. "Estimating the Economic Value and Impacts of Recreational Trails: a Case Study of the Virginia Creeper Rail Trail." *Tourism Economics* 13 (2): 241–260.

Brownson, Ross C, Robyn A Housemann, David R Brown, Jeannette Jackson-Thompson, Abby C King, Bernard R Malone, and James F Sallis. 2000. "Promoting Physical Activity in Rural Communities." *American Journal of Preventive Medicine* 18 (3) (April): 235–241. doi:10.1016/S0749-3797(99)00165-8.

CDC. 2012a. "Healthy People 2020 - Improving the Health of Americans." http://www.healthypeople.gov/2020/default.aspx.

CDC. 2012b. *Youth Risk Behavior Surveillance System - United States, 2011*. Centers for Disease Control and Prevention. http://www.cdc.gov/HealthyYouth/yrbs/index.htm.

City of Fall River. 2010. *Fall River Assessor's Parcel Database. [Data File].* City of Fall River, MA. http://lmi2.detma.org/lmi/lmi_es_a.asp.

Cohen, Deborah, Amber Sehgal, Stephanie Williamson, Roland Sturm, Thomas L. McKenzie, Rosa Lara, and Nicole Lurie. 2006. "Park Use and Physical Activity in a Sample of Public Parks in the City of Los Angeles". Product Page. http://www.rand.org/pubs/technical_reports/TR357.html.

Cohen, S., and T. A. Wills. 1985. “Stress, Social Support, and the Buffering Hypothesis.” *Psychological Bulletin* 98 (2): 310–357.

Crewe, Katherine. 2001. “Linear Parks and Urban Neighbourhoods: A Study of the Crime Impact of the Boston South-west Corridor.” *Journal of Urban Design* 6 (3): 245–264. doi:10.1080/13574800120105779.

Crompton, J. L. 2001. “Perceptions of How the Presence of Greenway Trails Affects the Value of Proximate Properties.” *Journal of Park and Recreation Administration* 19 (3): 114–132.

Dockery, Douglas W., C. Arden Pope, Xiping Xu, John D. Spengler, James H. Ware, Martha E. Fay, Benjamin G. Ferris, and Frank E. Speizer. 1993. “An Association Between Air Pollution and Mortality in Six U.S. Cities.” *N Engl J Med* 329 (24) (December 9): 1753–1759. doi:10.1056/NEJM199312093292401.

Dominici, F., R. D. Peng, M. L. Bell, L. Pham, A. McDermott, S. L. Zeger, and J. M. Samet. 2006. “Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases.” *JAMA: The Journal of the American Medical Association* 295 (10): 1127–1134.

Dominici, Francesca, Aidan McDermott, Scott L Zeger, and Jonathan M Samet. 2003. “National Maps of the Effects of Particulate Matter on Mortality: Exploring Geographical Variation.” *Environmental Health Perspectives* 111 (1): 39–44.

Dunton, Genevieve Fridlund, Donna Spruijt-Metz, Jennifer Wolch, Chih-Ping Chou, Michael Jerrett, Jason Byrne, Susan Weaver, and Kim D. Reynolds. 2009. “Reasons for Urban Trail Use Predict Levels of Trail-Related Physical Activity.” *Journal of Physical Activity & Health* 6 (4) (July): 426–434.

EPA. 2012. “Ground Level Ozone | US Environmental Protection Agency.” http://www.epa.gov/glo/.

Evenson, Kelly R., Amy H. Herring, and Sara L. Huston. 2005. “Evaluating Change in Physical Activity with the Building of a Multi-use Trail.” *American Journal of Preventive Medicine* 28 (2) (February): 177–185. doi:10.1016/j.amepre.2004.10.020.

Fan, Yingling, Kirti V. Das, and Qian Chen. 2011. “Neighborhood Green, Social Support, Physical Activity, and Stress: Assessing the Cumulative Impact.” *Health & Place* 17 (6) (November): 1202–1211. doi:10.1016/j.healthplace.2011.08.008.

Flier, J. S., L. H. Underhill, and B. S. McEwen. 1998. “Protective and Damaging Effects of Stress Mediators.” *New England Journal of Medicine* 338 (3): 171–179.

Foster, Sarah, and Billie Giles-Corti. 2008. “The Built Environment, Neighborhood Crime and Constrained Physical Activity: An Exploration of Inconsistent Findings.” *Preventive Medicine* 47 (3) (September): 241–251. doi:10.1016/j.ypmed.2008.03.017.

Frank, Lawrence D., Thomas L. Schmid, James F. Sallis, James Chapman, and Brian E. Saelens. 2005. “Linking Objectively Measured Physical Activity with Objectively Measured Urban Form: Findings from SMARTRAQ.” *American Journal of Preventive Medicine* 28 (2, Supplement 2) (February): 117–125. doi:10.1016/j.amepre.2004.11.001.

Gårder, Per, Lars Leden, and Urho Pulkkinen. 1998. “Measuring the Safety Effect of Raised Bicycle Crossings Using a New Research Methodology.” *Transportation Research Record: Journal of the Transportation Research Board* 1636 (-1) (January 1): 64–70. doi:10.3141/1636-10.

Goldberg, Mark S., Richard T. Burnett, John C. Bailar III, Jeffrey Brook, Yvette Bonvalot, Robyn Tamblyn, Ravinder Singh, and Marie-France Valois. 2001. “The Association

Between Daily Mortality and Ambient Air Particle Pollution in Montreal, Quebec: 1. Nonaccidental Mortality." *Environmental Research* 86 (1) (May): 12–25. doi:10.1006/enrs.2001.4242.

Gordon, Paul M., Samuel J. Zizzi, and Jeff Pauline. 2004. "Use of a Community Trail Among New and Habitual Exercisers: A Preliminary Assessment." *Preventing Chronic Disease* 1 (4) (September 15). http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1277951/.

Graw, M., and H. G. König. 2002. "Fatal Pedestrian–bicycle Collisions." *Forensic Science International* 126 (3) (May 23): 241–247.

Haileyesus, Tadesse, Joseph L. Annest, and Ann M. Dellinger. 2007. "Cyclists Injured While Sharing the Road with Motor Vehicles." *Injury Prevention* 13 (3) (June 1): 202–206. doi:10.1136/ip.2006.014019.

Handy, S. 2005. "Critical Assessment of the Literature on the Relationships Among Transportation, Land Use, and Physical Activity." *Transportation Research Board and the Institute of Medicine Committee on Physical Activity, Health, Transportation, and Land Use. Resource Paper for TRB Special Report* 282. http://onlinepubs.trb.org/onlinepubs/archive/downloads/sr282papers/sr282handy.pdf.

Health and Human Services. 2007. "Pedestrian and Bike Safety Massachusetts Statistics." *Health and Human Services*. http://www.mass.gov/eohhs/consumer/wellness/injury-prevention/transportation-safety/pedestrian-and-bike-safety.html.

Health and Human Services. 2008. *Physical Activity Guidelines Advisory Committee Report*. Washington DC: U.S Department of Health and Human Services. http://www.health.gov/paguidelines/report/.

Hugget, K., Powell, S. 1998. *London Cycle Network Design Manual*. UK: Director of Environmental Services, Royal Borough of Kingston upon Thames. http://www.tfl.gov.uk/businessandpartners/publications/2766.aspx.

Huston, S.L., K.R. Evenson, P. Bors, and Z. Gizlice. 2003. "Neighborhood Environment, Access to Places for Activity, and Leisure-time Physical Activity in a Diverse North Carolina Population." *American Journal of Health Promotion* 18 (1) (October): 58–69.

Jacobsen, P L. 2003. "Safety in Numbers: More Walkers and Bicyclists, Safer Walking and Bicycling." *Injury Prevention* 9 (3) (September 1): 205–209. doi:10.1136/ip.9.3.205.

Jensen, Søren Underlien. 2008. "Safety Effects of Blue Cycle Crossings: A Before-after Study." *Accident Analysis & Prevention* 40 (2) (March): 742–750. doi:10.1016/j.aap.2007.09.016.

Jim Schmid. 2001. *Trails Primer: A Glossary of Trails, Greenway and Outdoor Recreation Terms and Acronyms*. South Carolina State Trails Program. http://www.americantrails.org/glossary3.html.

Kaplan, J. A. 1975. "CHARACTERISTICS OF THE REGULAR ADULT BICYCLE USER" (July). http://trid.trb.org/view.aspx?id=63188.

Kawachi, I., and B. P. Kennedy. 1997. "Socioeconomic Determinants of Health: Health and Social Cohesion: Why Care About Income Inequality?" *Bmj* 314 (7086): 1037.

Kim, Joon-Ki, Sungyop Kim, Gudmundur F. Ulfarsson, and Luis A. Porrello. 2007. "Bicyclist Injury Severities in Bicycle–motor Vehicle Accidents." *Accident Analysis & Prevention* 39 (2) (March): 238–251. doi:10.1016/j.aap.2006.07.002.

Klop, Jeremy, and Asad Khattak. 1999. "Factors Influencing Bicycle Crash Severity on Two-Lane, Undivided Roadways in North Carolina." *Transportation Research Record:*

Journal of the Transportation Research Board 1674 (-1) (January 1): 78–85. doi:10.3141/1674-11.

Krizek, Kevin J. 2006. Guidelines for Analysis of Investments in Bicycle Facilities. Transportation Research Board.

Leyden, K. M. 2003. "Social Capital and the Built Environment: The Importance of Walkable Neighborhoods." *Journal Information* 93 (9). http://ajph.aphapublications.org/doi/pdf/10.2105/AJPH.93.9.1546.

Li, Wenjun, Jennifer L. Kelsey, Zi Zhang, Stephenie C. Lemon, Solomon Mezgebu, Cynthia Boddie-Willis, and George W. Reed. 2009. "Small-Area Estimation and Prioritizing Communities for Obesity Control in Massachusetts." *American Journal of Public Health* 99 (3) (March): 511–9.

Librett, John J., Michelle M. Yore, and Thomas L. Schmid. 2006. "Characteristics of Physical Activity Levels Among Trail Users in a U.S. National Sample." *American Journal of Preventive Medicine* 31 (5) (November): 399–405. doi:10.1016/j.amepre.2006.07.009.

Lindsey, G., J. Man, S. Payton, and K. Dickson. 2004. "Property Values, Recreation Values, and Urban Greenways." *Journal of Park and Recreation Administration* 22 (3): 69–90.

Loukaitou-Sideris. 2005. *Transportation, Land Use, and Physical Activity*. TRB Special Report. Transportation Research Board. http://onlinepubs.trb.org/onlinepubs/archive/downloads/sr282papers/sr282Sideris.pdf.

Loukaitou-Sideris, Anastasia, and John E. Eck. 2007. "Crime Prevention and Active Living." *American Journal of Health Promotion* 21 (4s): 380–389. doi:10.4278/0890-1171-21.4s.380.

Massachusetts Dept. of Labor and Workforce Development. 2012. "Employment and Wages (ES-202)." *Labor Market Information*. http://lmi2.detma.org/lmi/lmi_es_a.asp.

Massachusetts Registry of Motor Vehicles. 2006. "Motor Vehicle Crash Database." http://www.mass.gov/bb/h1/fy10h1/exec10/hbudbrief29.htm.

MassCHIP. 2010. "Risk Factors and Health Behaviors Fall River." http://www.mass.gov/eohhs/researcher/community-health/masschip/topics/risk-factors-and-health-behaviors.html.

MassDEP. 2011. *2010 Air Quality Report*. Mass Dept. of Environmental Protection. http://www.mass.gov/dep/air/priorities/10aqrpt.pdf.

MassDEP. 2012a. "Ground-Level Ozone." *MassDEP*. http://www.mass.gov/dep/air/aq/aq_ozone.htm#trends.

MassDEP. 2012b. "Trends by Pollutant-ozone & PM2.5 [Data Set]." http://public.dep.state.ma.us/MassAir/Pages/ChartByPollutant.aspx?&ht=2&hi=201.

McCann, B. A., and R. Ewing. 2003. "MEASURING THE HEALTH EFFECTS OF SPRAWL: A NATIONAL ANALYSIS OF PHYSICAL ACTIVITY, OBESITY AND CHRONIC DISEASE" (September). http://trid.trb.org/view.aspx?id=661006.

Merom, Dafna, Adrian Bauman, Philip Vita, and Glenn Close. 2003. "An Environmental Intervention to Promote Walking and Cycling—the Impact of a Newly Constructed Rail Trail in Western Sydney." *Preventive Medicine* 36 (2) (February): 235–242. doi:10.1016/S0091-7435(02)00025-7.

MetroBoston DataCommon. 2012. "Welcome! | MetroBoston DataCommon." http://metrobostondatacommon.org/.

Moritz, W. E. 1997. “Survey of North American Bicycle Commuters: Design and Aggregate Results.” *Transportation Research Record: Journal of the Transportation Research Board* 1578 (-1): 91–101.

NHTSA. 2012a. *Traffic Safety Facts 2010 Data, Pedestrians*. U.S Department of Transportation. http://www-nrd.nhtsa.dot.gov/cats/listpublications.aspx?Id=A&ShowBy=DocType.

NHTSA. 2012b. *Traffic Safety Facts 2010 Data, Bicylists*. U.S Department of Transportation. http://www-nrd.nhtsa.dot.gov/cats/listpublications.aspx?Id=A&ShowBy=DocType.

Nicholls, Sarah, and John L. Crompton. 2005. “The Impact of Greenways on Property Values: Evidence from Austin, Texas.” *Journal of Leisure Research* 37 (3): 321–341.

NTEC. 2002. *Enhancing America’s Communities: A Guide to Transporation Enhancements*. National Transporation Enhancements Clearinghouse(NTEC).

OECD. 1998. *Safety of Vulnerable Road Users*. Organisation for Economic Co-Operation and Development, Paris. http://www.oecd.org/dataoecd/24/4/2103492.pdf.

Painter & Farrington. 1999. “Street Lighting and Crime:Diffusion of Benefits in the Strong-on-Trent Project.” *Crime Prevention Studies* 10: 77–122.

Parks and Trails New York. 2007. *Road and Trail Intersection Safety: An Examination of Present Practice, Recommendations for Future Actions*. http://www.railstotrails.org/ourwork/trailbuilding/toolbox/informationsummaries/crossings.html.

Penna, C. 2006. *Home Sales Near Two Massachusetts Rail Trails*. Northhampton, MA: The Murphys Realtors, Inc. http://www.google.com/search?q=Home+Sales+near+Two+Massachusetts+Rail+Trails&hl=en&.

Peters, A., D. W. Dockery, J. E. Muller, and M. A. Mittleman. 2001. “Increased Particulate Air Pollution and the Triggering of Myocardial Infarction.” *Circulation* 103 (23): 2810–2815.

Pierce, J., Anne Denison, Ahmed Arif, and James Rohrer. 2006. “Living Near a Trail Is Associated with Increased Odds of Walking Among Patients Using Community Clinics.” *Journal of Community Health* 31 (4): 289–302. doi:10.1007/s10900-006-9014-8.

Pope, C. A., M. J. Thun, M. M. Namboodiri, D. W. Dockery, J. S. Evans, F. E. Speizer, and C. W. Heath. 1995. “Particulate Air Pollution as a Predictor of Mortality in a Prospective Study of U.S. Adults.” *American Journal of Respiratory and Critical Care Medicine* 151 (3) (March 1): 669–674.

Przybylski, M., and G. Lindsey. 1998. “Economic Evaluation of Major Urban Greenway Projects. 1998.” *Center for Urban Policy and the Environment: Indianapolis*.

Putnam, Robert D. 2001. Bowling Alone: The Collapse and Revival of American Community. Simon and Schuster.

Reynolds, Conor CO, M Harris, Kay Teschke, Peter A Cripton, and Meghan Winters. 2009. “The Impact of Transportation Infrastructure on Bicycling Injuries and Crashes: a Review of the Literature.” *Environmental Health* 8 (1): 47. doi:10.1186/1476-069X-8-47.

Richard, L., L. Gauvin, C. Gosselin, and S. Laforest. 2009. “Staying Connected: Neighbourhood Correlates of Social Participation Among Older Adults Living in an Urban Environment in Montreal, Quebec.” *Health Promotion International* 24 (1): 46–57.

RTC. 2007. “Rails-to-Trails Conservancy: Frequently Asked Questions.” http://www.railstotrails.org/ourWork/trailBasics/FAQs.html.

RTC. 2009. *Economic Benefits of Trails and Greenways Rails-to-Trails Conservancy*. Rails-to-Trails Conservancy. http://www.railstotrails.org/ourWork/trailBasics/benefits.html.

RTC. 2011. “Rails-to-Trails Conservancy: About Us: History.” http://www.railstotrails.org/aboutUs/history/index.html.

Saelens, Brian, James Sallis, and Lawrence Frank. 2003. “Environmental Correlates of Walking and Cycling: Findings from the Transportation, Urban Design, and Planning Literatures.” *Annals of Behavioral Medicine* 25 (2): 80–91. doi:10.1207/S15324796ABM2502_03.

Saguaro Seminar. 2012. “The Saguaro Seminar: Civic Engagement in America.” http://www.hks.harvard.edu/saguaro/measurement/measurement.htm.

Sallis, James F., Heather R. Bowles, Adrian Bauman, Barbara E. Ainsworth, Fiona C. Bull, Cora L. Craig, Michael Sjöström, et al. 2009. “Neighborhood Environments and Physical Activity Among Adults in 11 Countries.” *American Journal of Preventive Medicine* 36 (6) (June): 484–490. doi:10.1016/j.amepre.2009.01.031.

SCI Social Capital Inc. 2012. “SCI Social Capital Inc. | Connecting Citizens to Strengthen Communities.” http://www.socialcapitalinc.org/.

SMMPO. 2012. *2012 Regional Transportation Plan: SMMPO Determination of Air Quality Conformity, Chp. 18*. Southeastern Massachusetts Metropolitan Planning Organization. www.srpedd.org/transportation/2012-documents/…/chapter-18.pdf.

Sullivan, W. C., F. E. Kuo, and S. F. Depooter. 2004. “The Fruit of Urban Nature.” *Environment and Behavior* 36 (5): 678–700.

Thakuriah, Piyushimita (Vonu), Paul Metaxatos, Jane Lin, and Elizabeth Jensen. 2012. “An Examination of Factors Affecting Propensities to Use Bicycle and Pedestrian Facilities in Suburban Locations.” *Transportation Research Part D: Transport and Environment* 17 (4) (June): 341–348. doi:10.1016/j.trd.2012.01.006.

Tinsworth, Deborah K., Suzanne P. Cassidy, and Curtis Polen. 1994. “Bicycle-related Injuries: Injury, Hazard, and Risk Patterns.” *International Journal for Consumer and Product Safety* 1 (4): 207–220. doi:10.1080/09298349408945738.

Tracy, T., H. Morris, Rails-to-Trails Conservancy, United States. National Park Service. Rivers, Trails, and Conservation Program. 1998. *Rail-Trails and Safe Communities: The Experience on 372 Trails*. Rails-to-Trails Conservancy.

Troped, Philip J, Ruth P Saunders, Russell R Pate, Belinda Reininger, and Cheryl L Addy. 2003. “Correlates of Recreational and Transportation Physical Activity Among Adults in a New England Community.” *Preventive Medicine* 37 (4) (October): 304–310. doi:10.1016/S0091-7435(03)00137-3.

Troped, Philip J., Ruth P. Saunders, Russell R. Pate, Belinda Reininger, John R. Ureda, and Shirley J. Thompson. 2001. “Associations Between Self-Reported and Objective Physical Environmental Factors and Use of a Community Rail-Trail.” *Preventive Medicine* 32 (2) (February): 191–200. doi:10.1006/pmed.2000.0788.

U.S Census Bureau, 2006-2010 American Community Survey. “American FactFinder.” *Table B01003 Fall River Total Population, Race and Ethic Groups: 2006-2010*. http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10_SF4_B01003&prodType=table.

U.S Census Bureau, 2010 Census. "American FactFinder." *DP-1: Fall River: Profile of General Population and Housing Characteristics 2010.* http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_DP_DPDP1&prodType=table.

U.S Census Bureau, 2006-2010 ACS. "American FactFinder." *Table B19013 Fall River: Median Household Income in Past 12 Months (Adjusted)*. http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10_5YR_B19013&prodType=table.

U.S. Travel Assoc. 2011. *Economic Impact of Travel on Massachusetts Counties*. Washington DC: Research Dept. of the U.S. Travel Association. http://www.massvacation.com/research/#aImpact.

Ulfarsson, Gudmundur F., Sungyop Kim, and Kathleen M. Booth. 2010. "Analyzing Fault in Pedestrian–motor Vehicle Crashes in North Carolina." *Accident Analysis & Prevention* 42 (6) (November): 1805–1813. doi:10.1016/j.aap.2010.05.001.

Wolch, Jennifer R., Zari Tatalovich, Donna Spruijt-Metz, Jason Byrne, Michael Jerrett, Chih-Ping Chou, Susan Weaver, Lili Wang, William Fulton, and Kim Reynolds. 2010. "Proximity and Perceived Safety as Determinants of Urban Trail Use: Findings from a Three-city Study." *Environment and Planning A* 42 (1): 57 – 79. doi:10.1068/a41302.

Zanobetti, Antonella, and Joel Schwartz. 2005. "The Effect of Particulate Air Pollution on Emergency Admissions for Myocardial Infarction: A Multicity Case-Crossover Analysis." *Environmental Health Perspectives* 113 (8) (March 16): 978–982. doi:10.1289/ehp.7550.

Zegeer, C., J. Stutts, B. Hunter, W. Pein, C. D. Feske, D. Cheeney, P. McCarville, and C. Geiger. 1994. "THE NATIONAL BICYCLING AND WALKING STUDY: TRANSPORTATION CHOICES FOR A CHANGING AMERICA. FINAL REPORT." http://trid.trb.org/view.aspx?id=404830.

Appendix A

Congestion Mitigation & Air Quality (CMAQ) Worksheet for QRRT Extention

SRPEDD (2012)

CMAQ Air Quality Analysis Worksheet for Bicycle and Pedestrian Project

FILL IN SHADED BOXES ONLY

TIP YEAR: 2015

MPO: Southeast **Municipality:** Fall River

Project: Bike Path Phase 2

Step 1: Calculate Estimated Reduction in Vehicle Miles Traveled (VMT):

If VMT reduction per year is known then go to Step 2B, if not proceed with Step 1 :

A.	Facility Length **(L)**:	1.5	Miles	
B.	Service Area Radius **(R)**:	1.0	Miles	(Default = 1 Mile)
C.	Service Area of Community(ies) **(SA)**: L * 2R = SA	3	Sq. Miles	
D.	Total Land Area of Community(ies) **(T)**:	38.6	Sq. Miles	
E.	Service Area % of Community(ies) Land Area **(LA)**: SA / T = LA	7.8%		
F.	Total Population of Community(ies) **(TP)**:	88,857	Persons	
G.	Population Served by Facility **(P)**: LA * TP = P	6,906	Persons	
H.	Total Number of Households in Community(ies) **(HH)**:	36,457	HH	
I.	Number of Households Served by Facility **(HS)**: LA * HH = HS	2,989	HH	
J.	Total Number of Workers Residing in Community(ies) **(W)**:	34,005	Persons	
K.	Workers Per household **(WPHH)**: W / HH = WPHH	0.88	Persons	
L.	Workers in Service Area **(WSA)**: HS * WPHH = WSA	2,643	Persons	
M.	Population Density of the Service area **(PD)**: P / SA = PD	2,302	Persons Per Sq. Mile	
N.	If the bicycle and pedestrian commuter mode share is known, enter the percentage at the right. If not, use the 2000 US Census Journey to Work data to determine the mode share and enter the percentage to the right.	**(BMS)** 0.5%		
O.	Bike and Ped. Work Utilitarian Trips **(BWT)**: WSA * BMS = BWT	13	One-Way Trips	
P.	Bike and Ped. Non-Work Utilitarian Trips **(BNWT)**: BWT * 1.7 = BNWT (Latest planning assumptions estimate non-work utilitarian trips to be 1.7 times the work utilitarian.)	22	One-Way Trips	

Step 2: Calculate the VMT Reduction Per Day:

A.	((2 * BWT) + (2 * BNWT)) * (0.5* L) = VMTR		53.5	VMTR Per Day
B.	VMTR * Operating Days Per Year	53.5 * 200 =	10,704	VMTR Per Year
	If the Vehicle Miles Traveled Reduction is known enter in the box to the right.			VMTR Per Year

Note: A manual entry of the VMTR will override the calculated cell.

Step 3: MOBILE 6 Emission Factors for Average Commuter Travel Speed:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH

2016 Auto Summer VOC Factor grams/mile	2016 Auto Summer NOx Factor grams/mile	2016 Auto Summer CO Factor grams/mile	2016 Auto Summer CO2 Factor grams/mile
0.232	0.178	3.540	368.100

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
2.5	1.9	38.6	4,014.1

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$4,000,000	/	2.5	=	**$1,581,071**
Summer NOx	$4,000,000	/	1.9	=	**$2,060,721**
Summer CO	$4,000,000	/	38.6	=	**$103,618**
Summer CO2	$4,000,000	/	4,014.1	=	**$996**

Spreadhseet Template Prepared by the Office of Transportation Planning

Appendix B

Monitoring Plan

RECOMMENDATIONS	AGENCY (or AGENCIES) RESPONSIBLE	TIMING
Increased Safety (Collisions, Crime)		
Crossing Safety Modifications in 25% Design	SRPEDD, City of Fall River, EEA, MassDOT	Fall 2012
Lighting Modifications in 25% Design	SRPEDD, City of Fall River, EEA, MassDOT	Fall 2012
Trail Use and Maintenance		
Survey current users, as well as non-users, to gather both baseline and post-construction conditions for trail usage volume, purpose, (recreation vs. transportation), as well as trail user behavior and motivations	SRPEDD, City of Fall River, community organizations	2012-ongoing
Increased awareness and understanding of vehicle/traffic laws for trail users and motorists	City of Fall River, Police Department	2013-ongoing
Development of safety campaigns and trail education to promote walking and biking as mobility options, as well as improve Fall River's social environment	City of Fall River, community organizations	2013-ongoing
Establishment of long-term maintenance plan to make sure trail is properly maintained overtime	City of Fall River , community organizations	2013-ongoing
Citywide/Regional Planning		
Addition of Biking Parking Infrastructure in business/commercial areas	SRPEDD, SMMPO,City of Fall River	2012-2014
Improved connectivity to routes and trails to increase recreation and active transportation opportunities at a city and regional level.	SRPEDD, City of Fall River (Dept. Planning, tourism, and economic development)	2012-ongoing
Perform a survey of trail users, businesses, and residential community to determine specific needs and best development potential,	City of Fall River (Dept. Planning, Economic Development), community partners	2012-2014
Increase in available state/regional transporation funding for bike/pedestrian projects	City of Fall River, SRPEDD, SMMPO, MassDOT	2012-ongoing
Increase in businesses/commercial/tourism activity within 1 mile radius of QRRT, and regionally	City of Fall River (Dept. Planning and Economic Development)	2013-ongoing
Decrease in single occupancy vehicle commuting and reduced air pollution.	SRPEDD, City of Fall River, MassDEP, MassDOT	2013-ongoing