TRENDS REPORT

Rhode Island
Moving Forward
Long-Range Transportation Plan

MOVING FORWARD RI 2040

PREPARED FOR

Statewide Planning Program
Division of Planning
Rhode Island Department of Administration

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Introduction

Many people may not put much thought into transportation, however, it is an integral part of everyday life that directly and indirectly impacts our lives. Looking out to the year 2040 the changing transportation landscape has broad and varied impacts on our network. This report explores different trends that are impacting transportation in Rhode Island.

To understand transportation conditions in the year 2040 trends in several areas have been reviewed and projections and outlooks provided including the following:

- People, population, and demographics
- Funding
- Climate change and sustainability
- Health and the role of active transportation
- Transportation technology

The Federal Highway Administration (FHWA) released a Strategic Plan in December 2008 and revised it in July 2016. This plan projected key trends influencing transportation over upcoming decades. While these trends may be intended for the nation, there are still important takeaways that can be applied to Rhode Island more specifically. The findings from the FHWA Strategic Plan follow.

Federal Highway Administration Strategic Plan

Key Influencing Trends

Longer commutes

Population shift is impacting travel patterns. Fueled by immigration, more than 60 percent of population growth between now and 2050 will occur in the nation's 50 largest metropolitan areas. Emerging networks of metropolitan areas, which are sometimes referred to as megapolitan areas, will be the focus for much of the population growth in the coming decade. Growth in inter-metropolitan commuting will continue to increase at a faster rate than intra-metropolitan commuting.

Changing mode splits, lower vehicle ownership

More travel options are becoming available. While use of a private vehicle continues to be the predominant mode of travel, the percentage of household trips by walking and bicycling is increasing. Younger Americans are also driving less and increasing their use of car sharing and ride-hailing. This growing trend is likely to persist with advances in communications and payment technologies. The costs of owning an automobile and more restrictive driver licensing laws may also drive this trend.

Mobility-limited population growth

Americans are getting older. Over 56 million citizens, representing 17 percent of the population, will be age 65 or older in 2020. By 2050, this group will make up more than one-third of the U.S. population. This group is already introducing new needs for safety and mobility in the transportation system.

Transportation networks are critical to economic development

Trade growth placing new demands on freight movement. Canada, Mexico, and China will continue to be the United States' top trading partners. U.S. exports are predicted to grow by 6 percent by 2020. This trend is fueling strong growth in freight movement and increasing the link between transportation and the Nation's economic competitiveness. Trade growth will result in an increase in both shipping container volumes as well as truck freight.

Highways will remain critical to industry productivity. To stay competitive, manufacturers require an efficient and reliable transportation system. Marginal reductions in transportation costs for goods movement are critical to the economic vitality of the nation. Highways are recognized as an important contributor to industry productivity and competitiveness.

Need more than fuel economy to reduce energy consumption

Transportation will continue to be a major source of energy use. Transportation currently accounts for approximately 28 percent of energy consumption including 71 percent of all petroleum usage. Fuel consumption by heavy-duty vehicles is likely to increase as truck travel demand outpaces fuel economy improvements; whereas consumption by light duty vehicles including passenger cars is expected to decline due to an increase in vehicle fuel efficiency. The market for passenger cars using alternative fuels and hybrid-electric or electric vehicles will continue to grow, albeit with some uncertainty in forecasts that are dependent on assumptions about gasoline prices and advances in battery technologies.

Driverless cars are coming

Autonomous vehicles will be more widely deployed in the vehicle fleet. Independent autonomous vehicles, including models with functions such as driver

alerts and controlled braking or steering, will constitute a much larger portion of the U.S. vehicle fleet in the coming decade. Even more advanced versions of these vehicles that can perform complex and sophisticated communication functions when connected to the Internet are also likely to be more commonly deployed.

Resiliency needed in transportation decision-making

Extreme weather events are likely to be more frequent. There is strong evidence that events related to heat, precipitation, and coastal flooding are likely to increase in frequency and severity. An increase in the occurrence and duration of heat waves could cause additional thermal expansion of paved surfaces, which would result in a shorter service life. A greater frequency and severity of flooding or storm surges in low-lying regions could require additional drainage and pumping capacity. Both situations will cause an increased rate of asphalt degradation and require more frequent road maintenance.

Highway Transportation Trends

Highway travel is on the rebound Total vehicle miles traveled (VMT) is a direct measure of demand and use of U.S. public roads. After peaking at 3.039 trillion in 2007, VMT was stagnant during the recent recession and recovery. Early estimates show that the largest annual increase in VMT during the past 25 years occurred from 2014 to 2015 with likely contributors being sustained growth in the economy and low gasoline prices.

Traffic volumes and congestion will increase

Traffic congestion will continue to worsen. Despite ongoing efforts to minimize congestion through capacity expansion and active transportation and demand management strategies, the impacts are likely to increase through this decade. Traffic congestion worsened from 2013 and 2014 in 95 of the 100 largest metropolitan areas in the U.S. Congestion is no longer a big city phenomenon, it occurs in cities of all sizes and at all times of the day and week. By 2020, the societal cost of congestion is forecast to increase to $192 B (in 2014 dollars), with delay increasing to 8.3 billion hours and wasted fuel increasing to 3.8 billion gallons.

Achieving and maintaining a state of good repair should be a goal for all roadway classes

The condition of highway and bridges will remain a concern. A comparison between road conditions in 1990 and 2008 indicates that while Interstates and other higher order systems have improved, conditions on lower-order systems have generally stayed the same or declined, particularly in urban areas. In general, ride quality is better on roads with higher functional classification, such as the Interstate and principal arterials, than on roads such as collectors carrying less traffic at a lower speed. The number of bridges, as well as the percentage of bridges weighted by deck area, classified as structurally deficient also declined to 6.0 percent in 2014. While about 11 percent of NHS bridges are still classified as structurally deficient, these bridges carry only about 6 percent of annual daily traffic.

Rhode Island will continue to pursue a vision Towards Zero Deaths

Improving traffic safety will remain a priority. In 2014, 32,675 people died and an estimated 3.231 million people suffered injuries in motor vehicle crashes in the U.S. The fatality rate was 1.07 per 100 million vehicle miles traveled (VMT), the lowest fatality rate on record. The total number of fatalities declined slightly from 2013 although pedestrian fatalities increased by 2.2 percent. While the number of fatal

crashes decreased slightly, the total number of crashes increased by 6.6 percent between 2013 and 2014 to over 6.064 million largely due to an increase in property-damage only crashes. Our nation expends $242 billion per year on traffic crash-related costs.

In Rhode Island, 51 people died in traffic crashes in 2016 and 465 suffered a serious injury. The Rhode Island Strategic Highway Safety Plan has the ultimate goal of zero traffic fatalities (*Toward Zero Deaths*), with an interim goal to halve fatalities and serious injuries by 2030, which translates to the measurable objective of approximately 3.2 percent annual reduction in deaths and serious injuries.[1]

Highway Industry Trends

Highway construction costs will continue to rise. Between June 2013 and June 2015, highway construction prices rose 3.1 percent, maintaining a 30-year trend of increasing prices. While still below peak prices experienced in the mid-2000s, roadway construction costs are likely to maintain an upward trend.

Construction processes and methodologies will continue to evolve. New construction techniques, such as broader use of prefabricated bridges, are creating the need for changes in project development processes. These new techniques offer opportunities for minimizing traffic disruption and congestion, improving work zone safety, and lowering costs. The use of e-Construction techniques will increase efficiencies for some tasks through the use of mobile devices, digital signatures, and secure delivery systems.

Use of recycled materials will continue to grow. In 2014, the use of reclaimed asphalt pavement and reclaimed asphalt shingles saved approximately $2.8 billion in road-building costs compared to using new material. More than 75 million tons of recycled materials were used in hot and warm-mix asphalt. This is a 28 percent increase from 2009 and a 6 percent increase from the previous year.

Alternative contracting approaches and outsourcing will continue. States and partners are increasingly turning to Public-Private Partnerships (P3) and other contracting and project delivery mechanisms (such as design-build) to deliver large, complex and higher-cost projects. States and local governments will likely make greater use of federal loan guarantees and P3, in some cases without federal dollars, to finance capital improvements and operate infrastructure.

Real-time travel data and new analysis tools will impact planning, management, and operations. Priority-setting practices in transportation agencies continue to evolve and are becoming more transparent, participatory, interrelated, and complex. Goal setting and performance measures are now being widely used in most states and larger metropolitan planning organizations to provide greater accountability for how public funds are being spent. The increasing availability of

[1] Rhode Island Dept. of Transportation. 2017. "Strategic Highway Safety Plan: 2017-2022." URL: http://www.dot.ri.gov/documents/community/safety/Strategic_Highway_Safety_Plan.pdf.

real-time travel-related data and the new tools and techniques for analyzing the data will impact how transportation agencies plan, manage, and operate transportation systems.

It will continue to be difficult for agencies to attract and retain a capable workforce. As much as 50 percent of the transportation workforce will be eligible for retirement in the next decade. As these workers depart, they will take valuable knowledge and skills with them. Transportation agencies are experiencing difficulties attracting and retaining capable employees, facing competition from other industries as well as within industry.

2

People

This section focuses on the people that live and work in Rhode Island; how they live, who they are, and their diverse backgrounds. How people move throughout the transportation network is crucial for anticipating future needs. As the Rhode Island population and economy grow, our transportation systems will have to adapt to support this growth.

Population, both overall magnitude and the distribution of age groups, along with employment, are primary drivers of trip generation. Understanding trends in those demographics is an initial step in understanding transportation needs and strategies to best meet those needs.

Although the population of Rhode Island is projected to remain relatively unchanged through 2040, significant changes in the state's age distribution are expected. Like the country overall, the population of Rhode Island will become older, with substantial increases in those age 65 and older, and decreases in those under age 30. Also like the country overall, household size will continue to decrease.

A more detailed Rhode Island Socioeconomic and Transportation Trends Report is included as an appendix to this document.

Population

Growth focused in Washington and Providence Counties

Rhode Island will have very low population growth through 2040. The change between 2020 and 2040 is only about 20,000 people (2.0%). Between 2020 and 2035 slight growth is anticipated in both births versus deaths and net migration. In the 2030s the number of deaths will start to exceed the number of births and population will begin to decline.

The growth projections are summarized by county in Table 2-2. Washington County is projected to see the highest growth between 2020 and 2040, both in number (12,539) and rate (11%). Newport County is projected to experience the lowest growth rate, decreasing by 4,085 (-4.4%)

Table 2-1 Summary of Statewide Population Projections

	2010	2015	2020	2025	2030	2035	2040
Population	1.052,567	1,046,327	1,049,177	1,061,796	1,070,677	1,073,799	1,070,104
5-year rate of change		-0.6%	0.3%	1.2%	0.8%	0.3%	-0.3%
Births	60,436	57,825	56,470	56,015	55,848	54,751	52,518
Deaths	48,100	50,722	49,646	50,191	53,592	58,492	63,056
Net Migration	-24,088	-13,346	-4,153	6,795	6,904	6,864	6,840

Note: Values for Births, Deaths, and Net Migration are amounts over previous five years.
Source: Technical Paper 162, Rhode Island Population Projections 2010-2040, April 2013, Rhode Island Statewide Planning Program.

Table 2-2 County Population Projections, 2010-2040

County	2010	2015	2020	2025	2030	2035	2040	Change 2020-2040
Bristol	49,875	49,212	48,957	79,156	49,192	48,961	48,422	-535 (-1.1%)
Kent	166,158	164,613	164,452	165,811	166,619	166,516	165,351	899 (0.5%)
Newport	95,264	93,160	91,843	91,402	90,676	89,481	87,758	-4,085 (-4.4%)
Providence	630,159	625,669	627,214	634,566	639,847	641,644	639,326	12,112 (1.9%)
Washington	111,111	113,672	116,710	120,860	124,343	127,196	129,249	12,539 (11.0%)

Source: Technical Paper 162, Rhode Island Population Projections 2010-2040, April 2013, Rhode Island Statewide Planning Program.

Households

The number of households in an important component of trip generation since the number of individuals living together in households tend to produce different types of trips at predictable rates. For example, larger households have a higher percentage of non-work trips and a lower percentage of work trips than does a single person household.

The average household size has been falling in the United States, fastest in urban areas. This trend is consistent in Rhode Island, where average household size has fallen from 2.70 in 1980 to 2.44 in 2010, and is expected to decrease further to 2.15 in 2040.

Table 2-3 Statewide Average Household Size

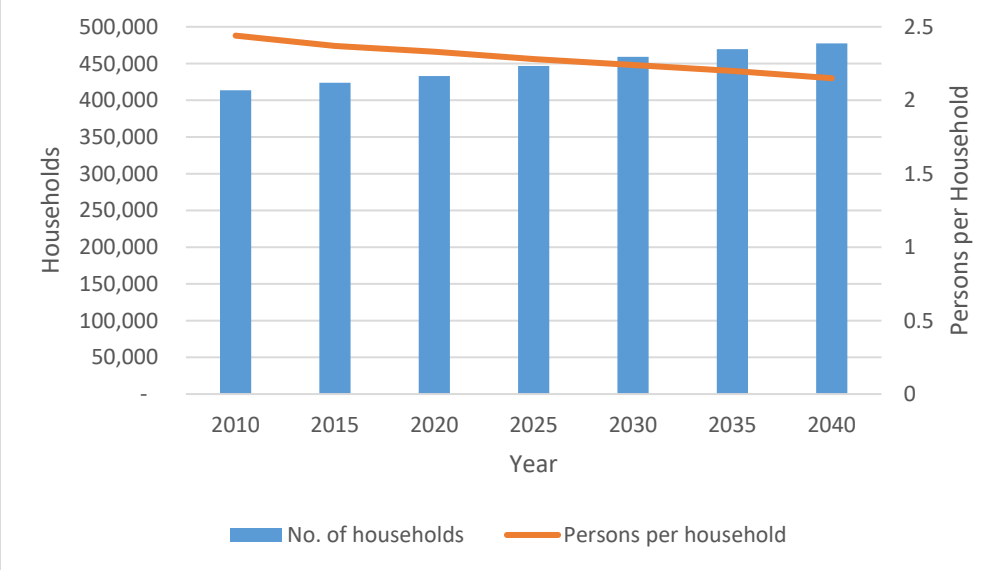
1980	1990	2000	2010	2015	2020	2025	2030	2035	2040
2.70	2.55	2.47	2.44	2.37	2.33	2.28	2.24	2.20	2.15

Source: Technical Paper 162, Rhode Island Population Projections 2010-2040, April 2013, Rhode Island Statewide Planning Program.

By 2040, population could increase by 2%; households could increase by 15%

The decline in the average household size leads to an increase in the number of households, despite relatively stagnant population growth. While the state population is projected to increase by 2 percent from 2010 to 2040, the number of households is projected to increase by 15 percent.

Figure 2-1 Rhode Island Households/Persons Per Household Ratio



Source: Technical Paper 166, Rhode Island Statewide Model Update, July 2016, Rhode Island Statewide Planning Program.

Age Distribution

The Rhode Island population is aging. Although the overall population is projected to increase by 1.7 percent between 2010 and 2040, the number age 65 and older is projected to increase by 74. Representing 14.4 percent of the state population in 2010, persons 65 and older will account for 24.6 percent of Rhode Island residents in 2040.

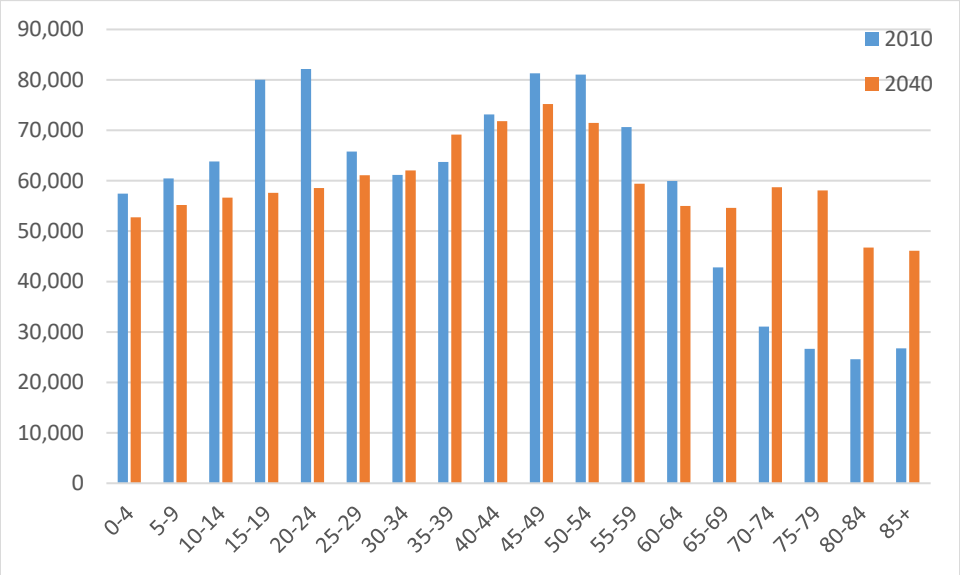
By 2040 the senior population could grow by 74%

Table 2-4 Change in Age Distribution, 2010 and 2040

Age	2010	2040	Change
Age 65+	151,881	264,238	+74%
Less than 65	900,686	805,865	-11%
Age 15-64 (working age population)	718,974	641,287	-11%
Total Population	1,052,567	1,070,104	+1.7%

Source: RI Dept. of Administration. 2013. "Technical Paper 162, Rhode Island Population Projections. 2010-2040." Division of Planning, Statewide Planning Program. April 2013.

Figure 2-2 Change in Age Distribution, 2010 and 2040



Source: Technical Paper 162, Rhode Island Population Projections 2010-2040, April 2013, Rhode Island Statewide Planning Program.

As the percentage of seniors increases, the working age population (15-64) will decrease. The projected decline between 2010 and 2040 is 11 percent. Representing 68.2 percent of the population in 2010, the working age population will decline to 59.8 percent of total population by 2040.

The aging population will change the Rhode Island economy. Older people spend less on consumer goods, affecting overall retail sales and sales tax revenue. Health care requirements for this group are considerably higher than for younger people.

Less public expenditure on education may be required with fewer children in the population.

Many seniors have reduced mobility as they age. Effective transportation is essential for this group, allowing them to remain in their homes and access the world beyond the front door. It connects them to appointments, grocery shopping, community events, social services and to friends and family. Transportation is an essential part of keeping seniors mentally and physically healthy and engaged in the community.

Seniors have reduced mobility as they age, but allowing them to age in place results in better outcomes

Senior citizens have serious limitations to their transportation options. Many elderly people suffer from chronic diseases which make it hard to drive a car, walk or use public transportation. Losing access to driving – and the ability to get around, generally – is a major fear among older adults. Lack of effective transportation may mean the difference between being socially and physically isolated in one's home, or moving to a senior facility which decreases the need for most trips, but is also very expensive and removes an older person from his or her social network and surroundings. Research has shown that aging in place results in healthier and more independent seniors.

Driving is the predominant means of transportation for most older people. Nationally, people ages 65 to 84 make an estimated 90 percent of all trips by car, and most often drive themselves. Automobiles are still the major mode of transportation for those older than 85 (80 percent of trips), though these individuals drive themselves less.

Walking is the second most common mode of transport for seniors, though vastly less common than driving (9 percent of trips). Walking can become difficult for many people as they age, and the condition of both pedestrian resources and the density of destinations found in more mixed-use land use patterns play a large role in whether a place is considered walkable. Transit ridership among older adults is low – RIPTA reports just 6 percent of riders are over 65.[2] Bicycling is almost non-existent.

Some key transportation measures that may benefit Rhode Island's elderly population include:

- Implementation of the Safe and Complete Streets policy and smart growth policies to allow seniors to age in place.
- Offer small grants to support expansion of volunteer transportation programs or pilot cost-sharing programs with taxi companies and ride-hailing services.
- Improve the Non-Emergency Medical Transportation (NEMT) and Elderly Transportation Program (ETP) services offered by LogistiCare (which took over this role from RIPTA in 2014) and require independent review of LogistiCare's performance and to manage the complaint process.

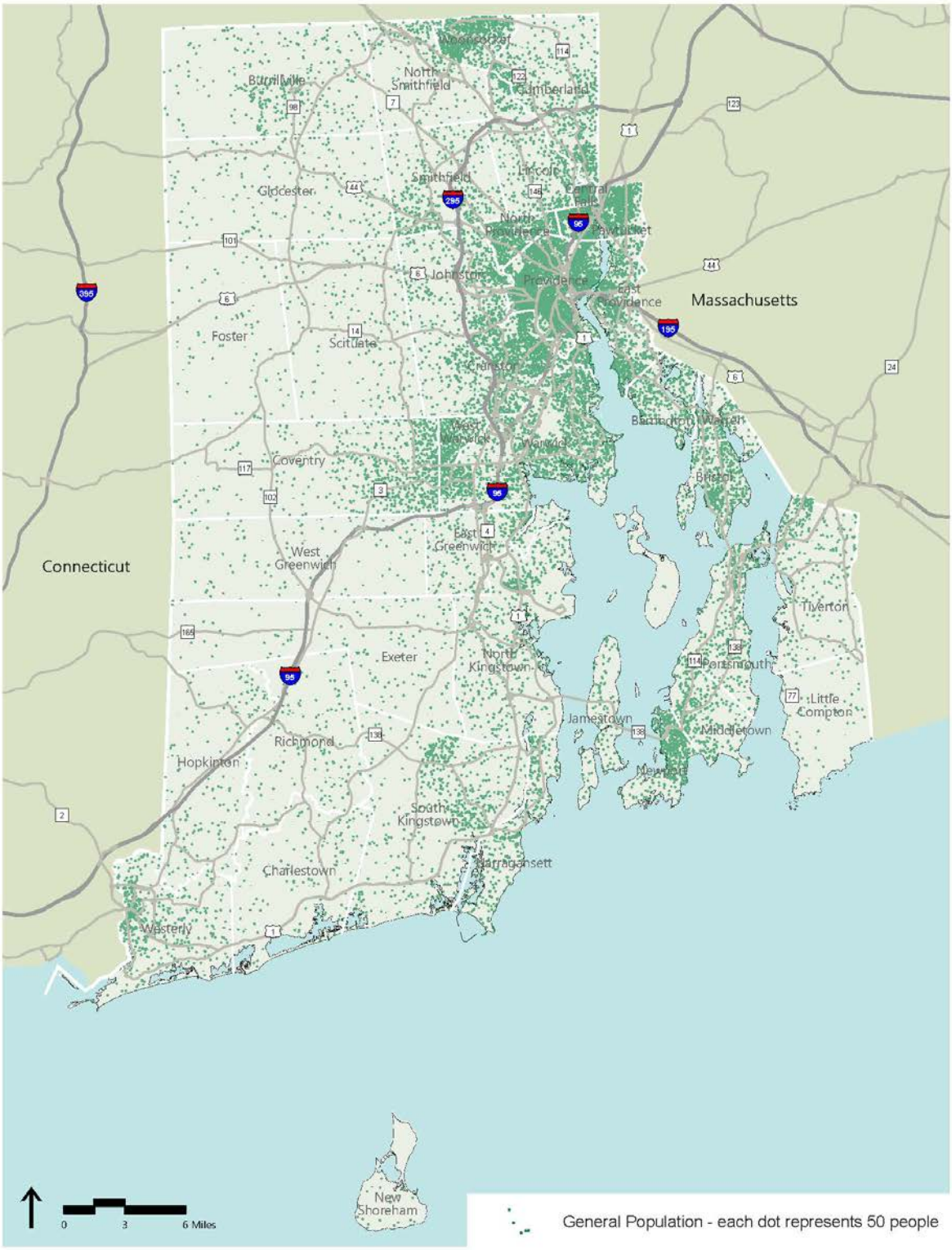
[2] Maigret, Maureen. 2017. "Supporting People as They Age in Community: Transportation." The Collaborative. Posted August 29, 2017. URL: http://www.collaborativeri.org/research/supporting-people-as-they-age-in-community-transportation.

- Make new technologies more available and accessible to older populations, including ride-hailing, online shopping, meal delivery, internet banking and telehealth services.[3]

Figure 2-3 shows the state population, Figure 2-4 and Figure 2-5 show youth and elderly populations across the state. Figure 2-6 shows the locations of populations with disabilities.

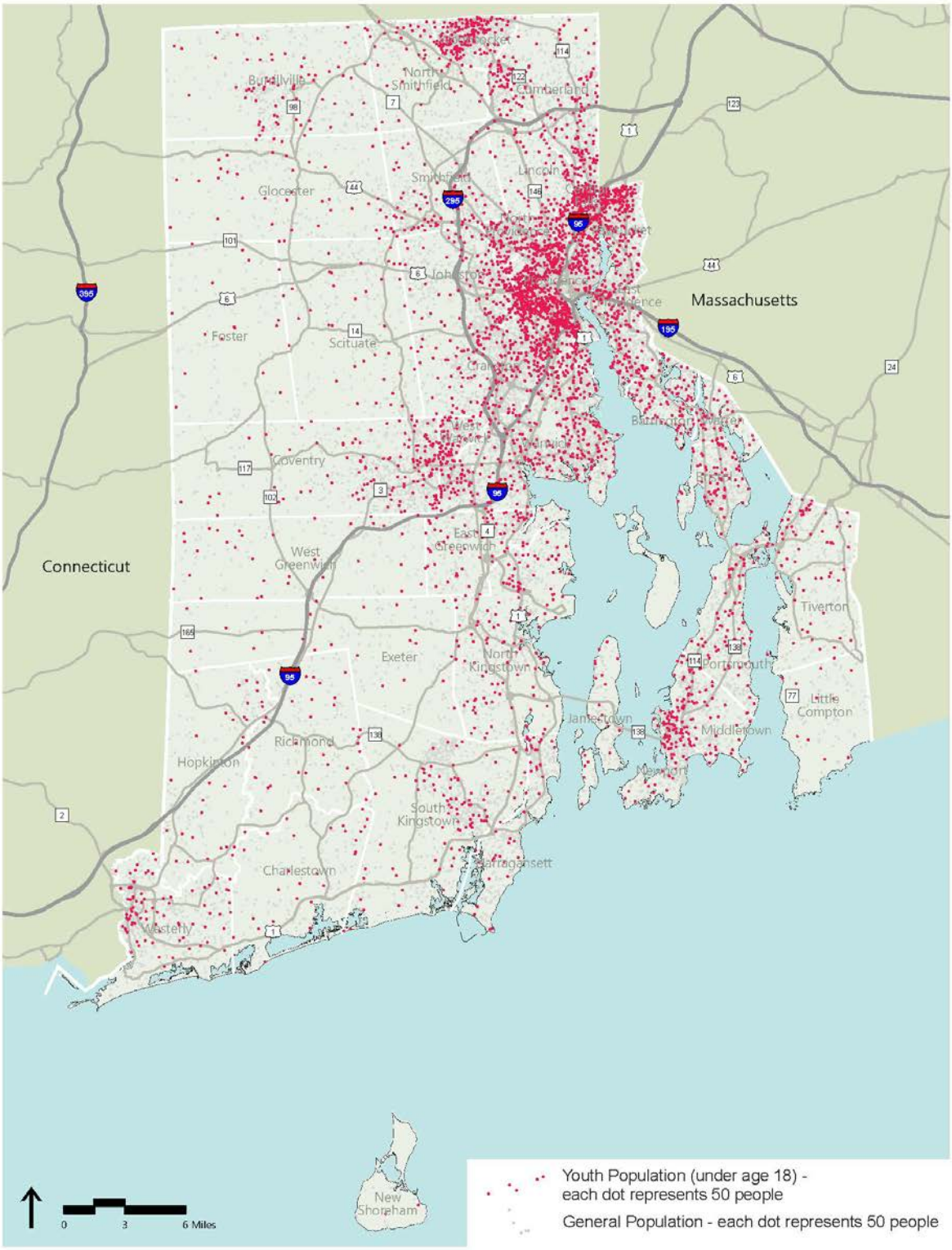
[3] Ibid.

Figure 2-3 Population Statewide (2016)



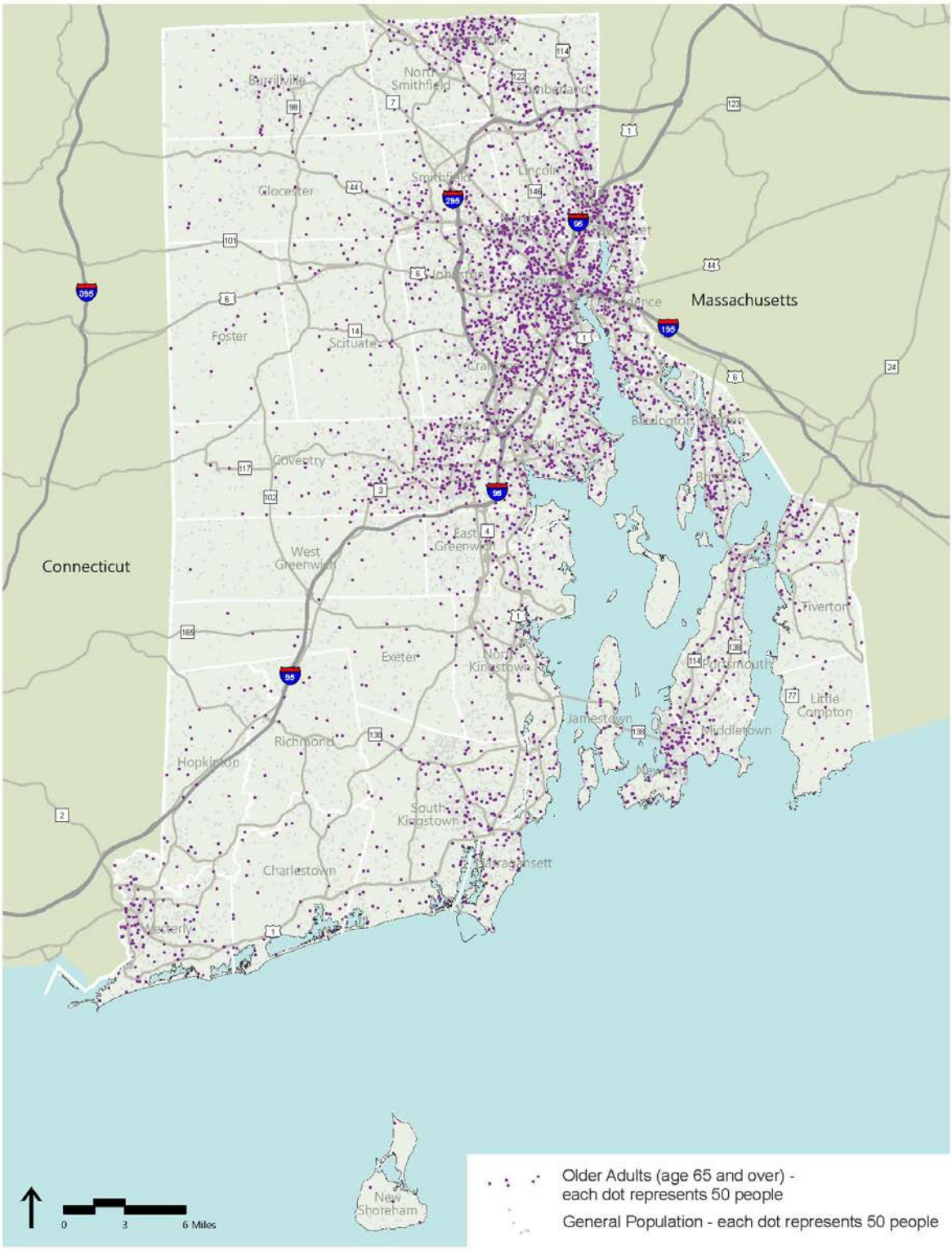
Source: US Dept. of Commerce. 2016. "2012-2016 American Community Survey 5-Year Estimates." US Census Bureau.

Figure 2-4 Youth (under age 18) Population Statewide (2016)



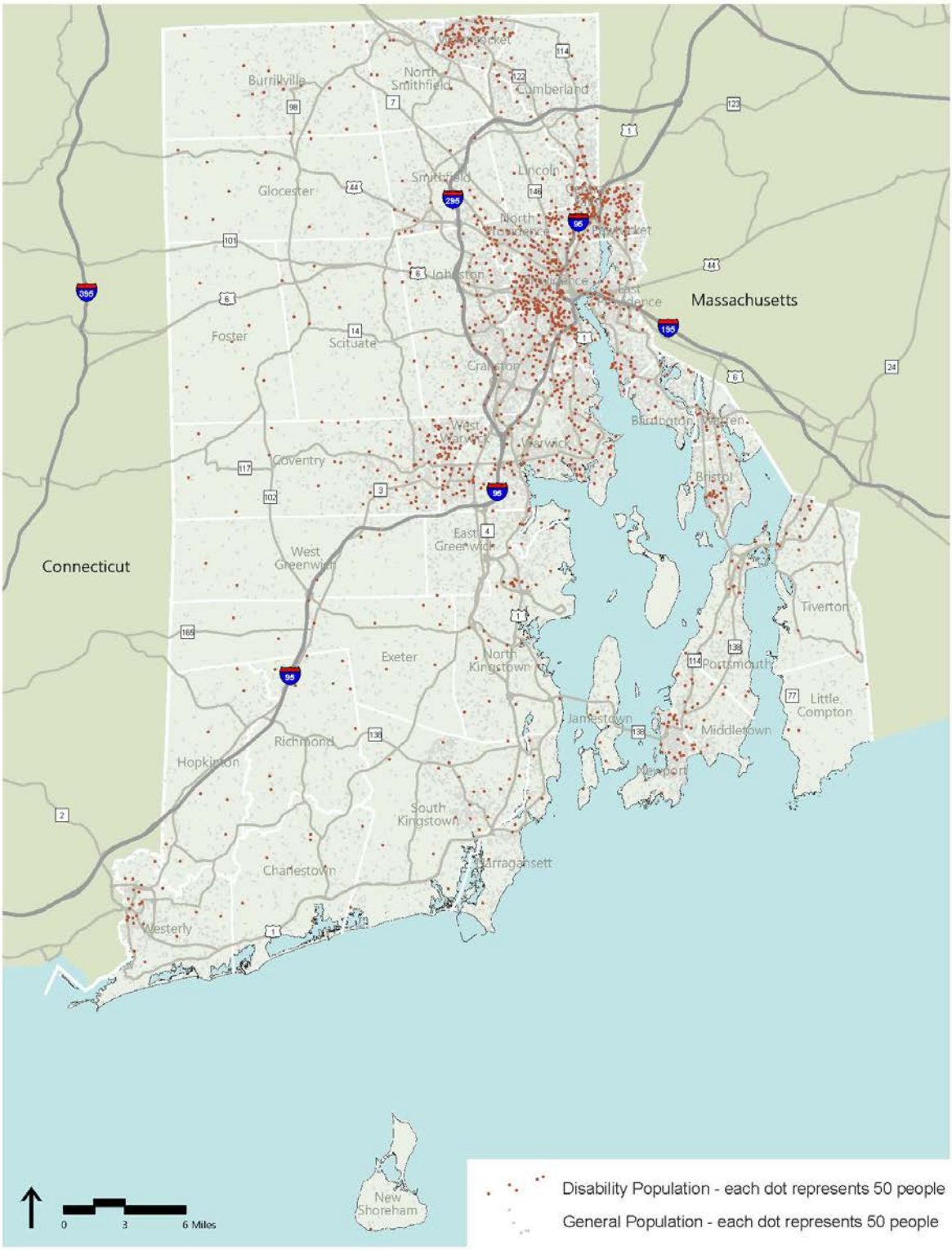
Source: US Dept. of Commerce. 2016. "2012-2016 American Community Survey 5-Year Estimates." US Census Bureau.

Figure 2-5 Older (age 65 and over) Population Statewide (2016)



Source: US Dept. of Commerce. 2016. "2012-2016 American Community Survey 5-Year Estimates." US Census Bureau.

Figure 2-6 Population with a Disability Statewide (2016)



Source: US Dept. of Commerce. 2016. "2012-2016 American Community Survey 5-Year Estimates." US Census Bureau.

Employment

The effect of employment on travel and trip generation depends on many factors, including the number of jobs, the location of those jobs, and the residence of the people working those jobs. Rhode Island's employment growth is expected to continue to outpace population growth, with substantial numbers of Rhode Island residents working out of state and substantial numbers of out of state residents working in Rhode Island. As outlined in Rhode Island's Land Use 2025 Report, attraction of new workers and retention of existing workers and graduating students within Rhode Island must remain a priority to achieve a "vibrant, sustainable economy".[4]

Commuting Patterns

Table 2-5 presents data from the Census Bureau's 2009-2013 American Community Survey regarding where Rhode Island employees work and live. Providence, Warwick, Cranston, and Pawtucket are highest for both where Rhode Island residents work and where Rhode Island residents live. Some 14.7 percent of employed Rhode Island residents work out of state and 11.2 percent of Rhode Island jobs are filled by workers from out of state.

[4] RI Dept. of Administration. 2006. "Land Use 2025: State Guide Plan Element 121, Report Number 109." Division of Statewide Planning. April 2006.

Table 2-5 Where Rhode Island Residents Live and Work

Where Rhode Island Residents Work			Where Rhode Island Employees Live		
Providence, RI	106,466	21.3%	Providence, RI	67,527	14.1%
Warwick, RI	43,508	8.7%	Warwick, RI	38,746	8.1%
Cranston, RI	31,489	6.3%	Cranston, RI	33,366	7.0%
Pawtucket, RI	20,870	4.2%	Pawtucket, RI	23,166	4.8%
Newport, RI	19,680	3.9%	East Providence, RI	17,490	3.6%
East Providence, RI	17,610	3.5%	Coventry, RI	15,704	3.3%
South Kingstown, RI	15,429	3.1%	North Providence, RI	14,270	3.0%
Woonsocket, RI	13,691	2.7%	South Kingstown, RI	13,833	2.9%
North Kingstown, RI	13,485	2.7%	West Warwick, RI	13,542	2.8%
Lincoln, RI	12,570	2.5%	Newport, RI	12,662	2.6%
Smithfield, RI	11,790	2.4%	North Kingstown, RI	12,626	2.6%
Johnston, RI	10,837	2.2%	Johnston, RI	12,568	2.6%
Middletown, RI	9,737	1.9%	Cumberland, RI	12,490	2.6%
Cumberland, RI	8,954	1.8%	Woonsocket, RI	11,164	2.3%
West Warwick, RI	8,053	1.6%	Bristol, RI	10,027	2.1%
North Providence, RI	8,036	1.6%	Smithfield, RI	8,789	1.8%
Westerly, RI	7,698	1.5%	Lincoln, RI	8,759	1.8%
East Greenwich, RI	7,422	1.5%	Narragansett, RI	7,823	1.6%
Coventry, RI	7,076	1.4%	Portsmouth, RI	7,303	1.5%
Bristol, RI	6,482	1.3%	Middletown, RI	7,273	1.5%
Other RI Communities	45,223	9.1%	Other RI Communities	76,978	16.1%
Other States	73,583	14.7%	Other States	53,504	11.2%

Source: RI Dept. of Labor & Training. 2017. "Rhode Island Commuting Patterns." Labor Market Information Unit. Based on US Census 2009-2013 American Community Survey data.

Employment Growth

Employment could increase by 7% by 2040

Rhode Island's employment growth has historically outpaced population growth and is projected to continue to do so. Employment in Rhode Island is projected to increase by about 7 percent between 2010 and 2040, compared to projected population growth of 2 percent. The growth in employment is expected to be sustained by an increase in the net inflow of workers living out of state.

Table 2-6 Employment Projections – Rhode Island

	Labor Force	Total Employment	Total Population
2010	566,704	488,479	1,052,567
2015	549,012	495,440	1,046,327
2020	566,410	514,705	1,049,177
2025	575,889	522,793	1,061,796
2030	581,527	526,178	1,070,677
2035	583,258	526,121	1,073,799
2040	582,179	523,865	1,070,104
Increase 2010-2040	15,475	35,384	17,537
Percent increase 2010-2040	2.7%	7.2%	1.7%

Labor Force is defined as the portion of the population legally willing and able to work.
Source: RI Department of Administration. 2016. "Technical Paper 166: Rhode Island Statewide Model Update." Division of Planning, Statewide Planning Program.

The most prevalent current RI occupations are on the lower end of the earnings spectrum

The top three industries in Rhode Island as measured by employment are healthcare and social assistance (16.3 percent of total employment), government (12.2 percent), and food and accommodations (10.1 percent). Together these industries are expected to add 48,400 jobs by 2047.

The fastest growing industry is anticipated to be administrative services, adding 20,900 jobs by 2047, a 77 percent increase from 2017. Manufacturing is expected to continue to decline, employing 11,300 fewer workers in 2047 than in 2017.

The most prevalent types of occupations in Rhode Island (administrative support, food preparation and serving, and sales) are on the lower end of the median hourly wage scale. A high percentage of these occupational profiles do not earn a "living wage," defined as the "minimum employment earnings necessary to meet a family's basic needs while also maintaining self-sufficiency." Earning a living wage is an important aspect of having access to various housing types, employment and transportation options.

STEM-intensive occupations will have the largest growth in the next 30 years

The occupational profiles with the largest expected growth through 2047 are computer and mathematical (16 percent growth), construction and extraction (14 percent), and business and financial operations (12 percent). These are STEM-Intensive (science, technology, engineering, and math) occupations that provide higher salaries and hourly wage rates. [5]

Figure 2-7 shows employment density by city/town. As would be expected, employment clusters mainly around the Providence metro area, with other notable pockets in Newport and Woonsocket.

[5] RI Department of Administration. 2018. "Rhode Island Socioeconomic and Transportation Trends Memo. [Draft]." Division of Statewide Planning. Rhode Island Moving Forward: Long Range Transportation Plan.

Poverty, Unemployment and Education

Rhode Islanders mostly commute by car, and commutes are getting longer

As of 2016, 13.8 percent of Rhode Island residents lived in poverty (as defined by the Federal Poverty Level), an economic measure used to determine eligibility for certain government programs. This rate is 1.5 percent higher than the Rhode Island rate for 2005, but still slightly lower than the national poverty rate of 14 percent in 2016. Rhode Island's unemployment rate in 2016 was 5.3 percent and has been higher than the national unemployment rate since 2005 but is now starting to reach parity.

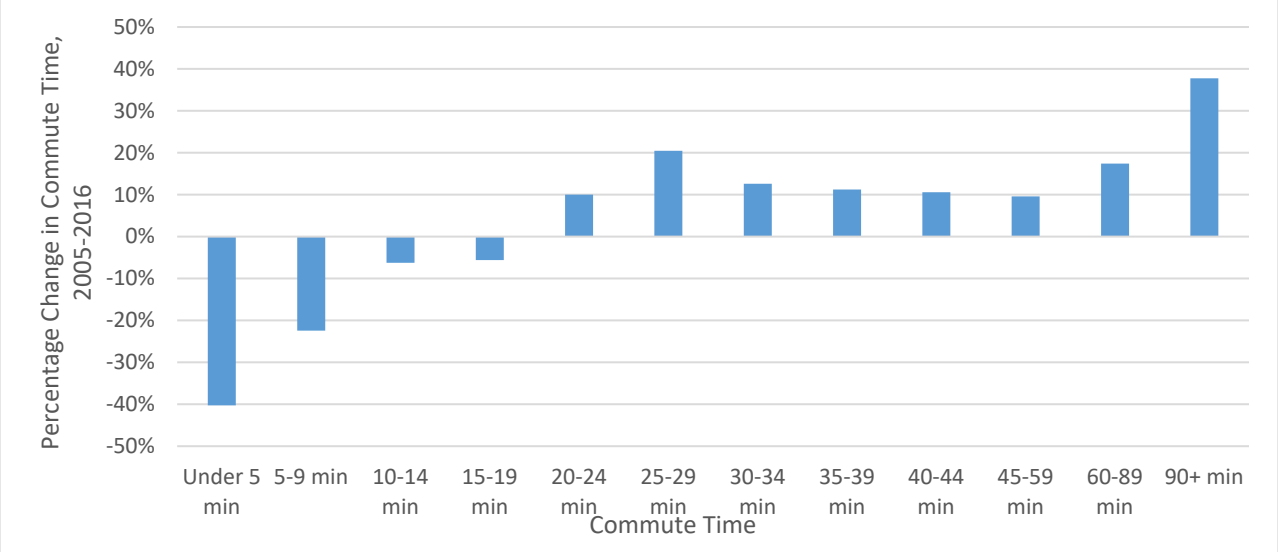
From 2005 to 2016, the number of Rhode Island residents with a bachelor's degree or higher rose from 29.9 percent to 32.5 percent and is slightly higher than the national rate.[6]

Household Travel Patterns

Travel in Rhode Island is currently car-centric, and commute times are rising. In 2016, the share of Rhode Islanders driving alone to work was 84.5 percent, compared to 76.3 percent of workers nationally.

Commutes aren't particularly long – over two-thirds of Rhode Islanders have a commute less than 30 minutes and 93 percent have a commute less than an hour. Yet Figure 2-7 shows the trend is toward higher commute times. Looking across the spectrum, the number of shorter commutes is decreasing, while longer commutes are increasing.[7]

Figure 2-7 Change in Rhode Island Commute Times (2005-2016)

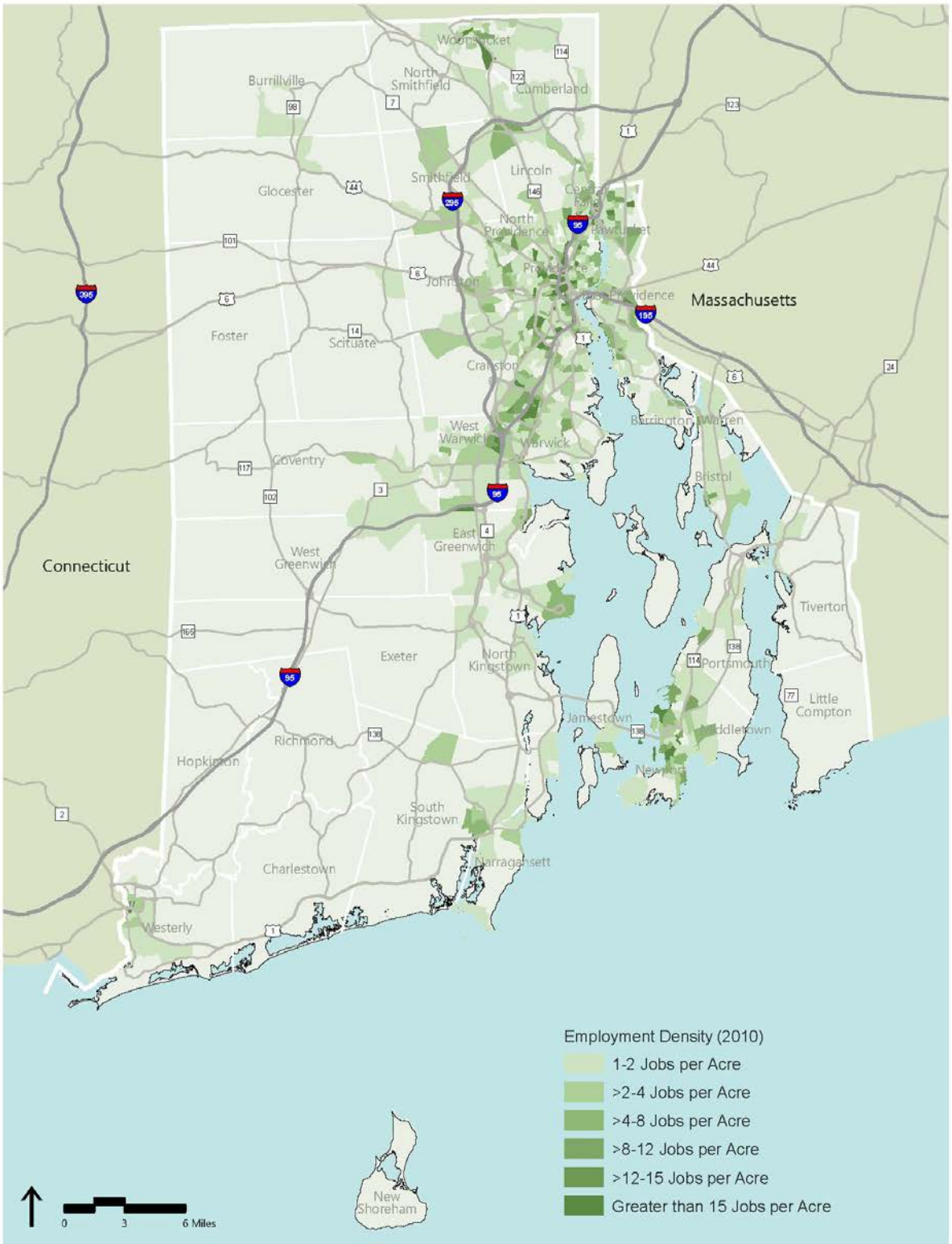


Source: U.S. Dept. of Commerce. 2016. "2016 American Community Survey 1-Year and 5-Year Estimates." U.S. Census Bureau.

[6] Ibid.

[7] U.S. Dept. of Commerce. 2016. "2016 American Community Survey 1-Year and 5-Year Estimates." U.S. Census Bureau.

Figure 2-8 Employment Density



Source: Rhode Island Department of Administration. Statewide Planning Program. Rhode Island Statewide Model (July 2016).

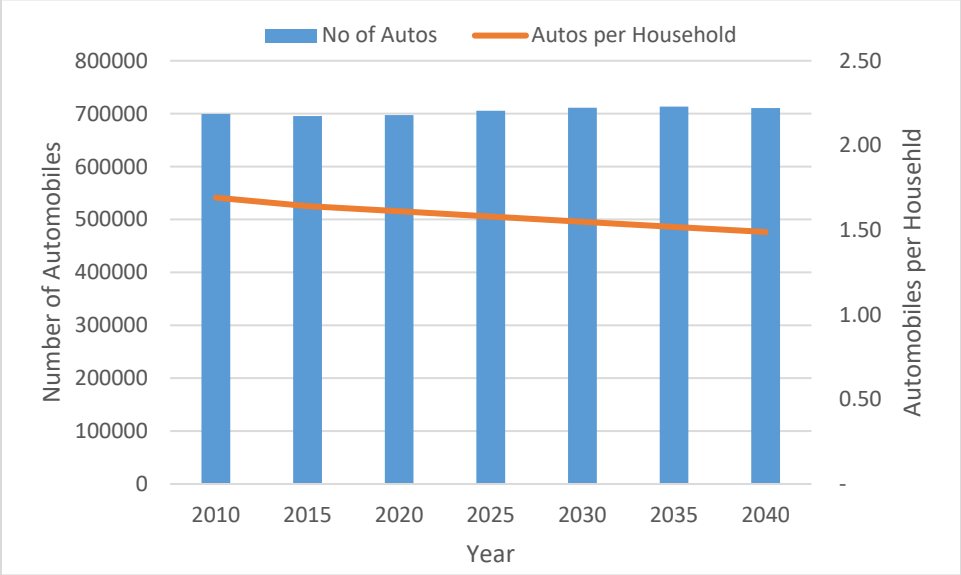
Auto Ownership

19.2% of households in Providence do not have access to a vehicle

Auto ownership continues to increase slowly, although growth has slowed compared with previous decades. Over half of Rhode Island households own two or more cars; this number has changed little since 2000. The share of households with one car increased by one percentage point to 37 percent, while the share of households without a car fell a percentage point to 10 percent in 2010. These figures vary greatly by city and town. In Providence, about 19 percent of households did not have access to a vehicle (2010 1-year ACS) while in some rural towns only one or two percent of households had no vehicles (2006-2010 5-year ACS).

Figure 2-9 shows households without a vehicle statewide.

Figure 2-9 Rhode Island Automobile Ownership Projections



Source: RI Dept. of Administration. 2016. "Technical Paper 166, Rhode Island Statewide Model Update." Division of Planning, Statewide Planning Program. July 2016.

Auto ownership is projected to increase slightly, from 700,000 cars in 2010 to 710,000 in 2040. This increase of 1.6 percent is slightly less than the projected population increase of two percent.

One factor that may accelerate the decrease in per-person auto ownership is the changing attitude towards auto ownership by the millennial and post-millennials generations. A 2013 study by the Urban Land Institute found that 77 percent of millennials commute by car versus over 90 percent for older workers. The reasons for this are many and interrelated. Lifestyle changes such as marrying later, having children later or not at all, and going to college at higher percentages than other generations have led to a greater likelihood that millennials live in urban areas with where the need for car travel is less and the access to other modes is greater. Millennials also have a higher preference for walking and biking, and for mobility sharing through such things as ride-hailing and bike/car sharing services.

Percent of Commutes by Car per Generation

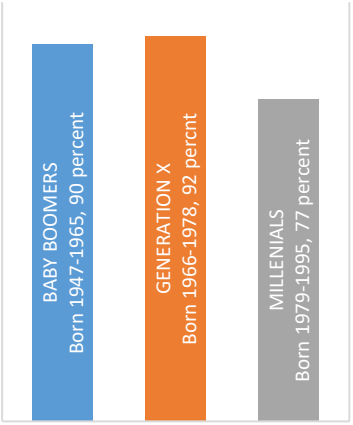
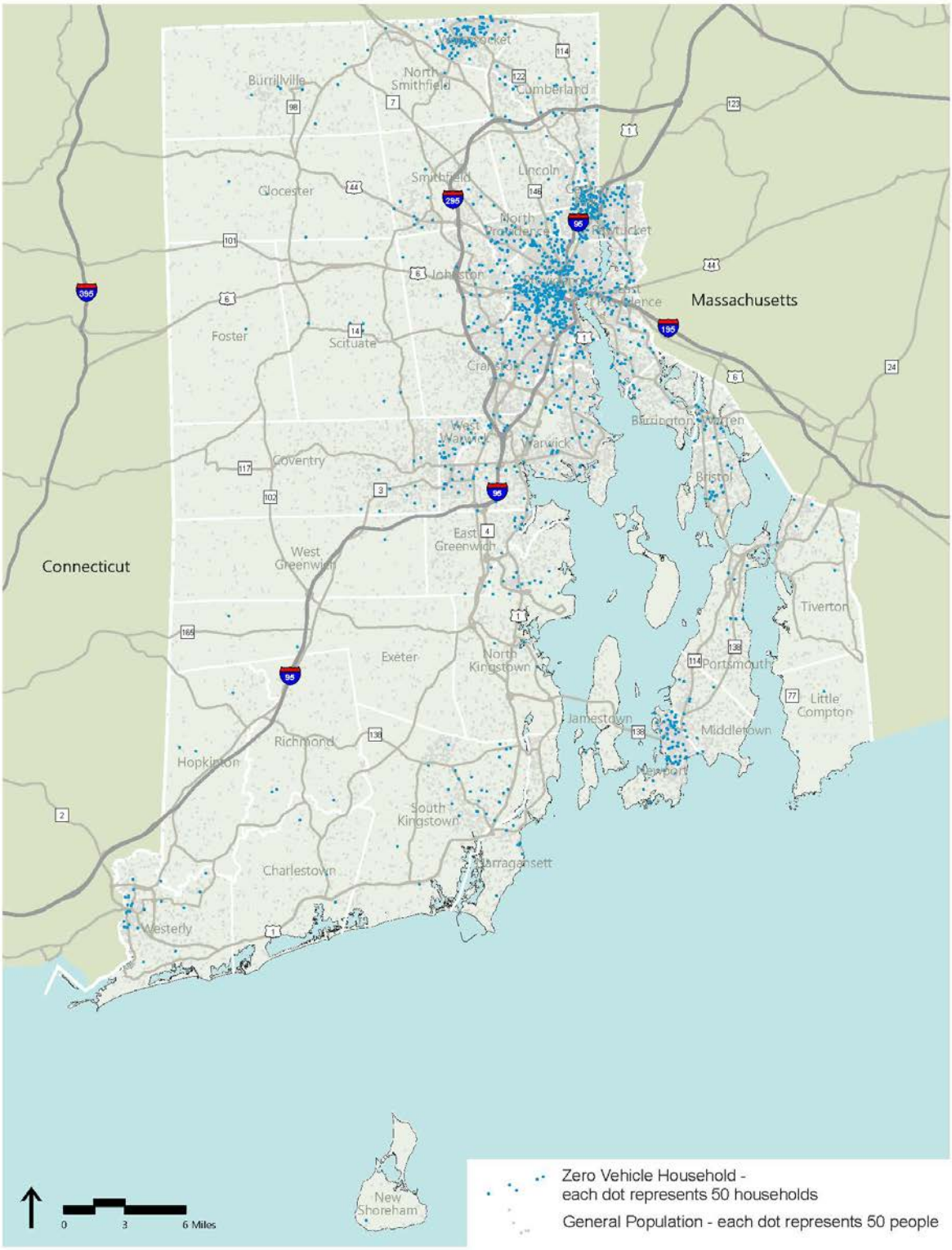


Figure 2-10 Zero Vehicle Households (2016)



Source: US Dept. of Commerce. 2016. "2012-2016 American Community Survey 5-Year Estimates." US Census Bureau.

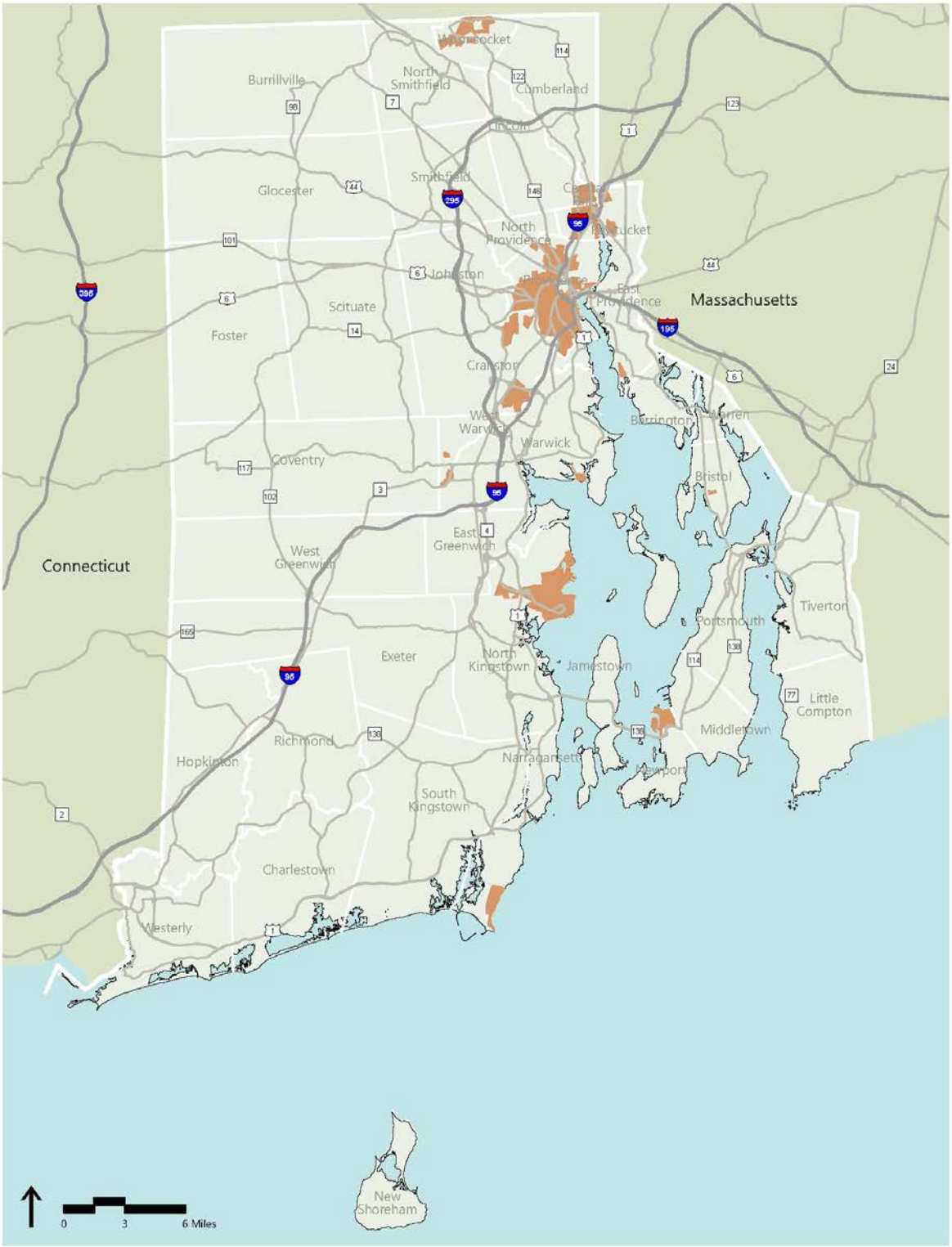
Environmental Justice Areas

Environmental Justice (EJ) is defined by the U.S. Environmental Protection Agency as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies". Transportation can play an important role in providing environmental justice to disadvantaged communities. Effective mobility can provide equitable access to jobs and resources. In communities where private vehicle ownership could be a burden, public transit expands transportation options and can open up greater opportunity for residents and employment.

The Rhode Island Department of Environmental Management has identified Environmental Justice Areas for the state. These areas have been designated using U.S. Census data and are evaluated on the block group level. Environmental Justice Areas in Rhode Island are defined as those areas that rank within the top 15 percent of block groups statewide by percent minority population or percent low-income population (household income below the 200% Federal Poverty Line). Some block groups may meet both criteria. Significant Environmental Justice Areas in Rhode Island area generally located in Woonsocket, Pawtucket, Central Falls, Providence, North Kingstown, Newport, and Narragansett with small populations in other cities/towns as well (see Figure 2-10).

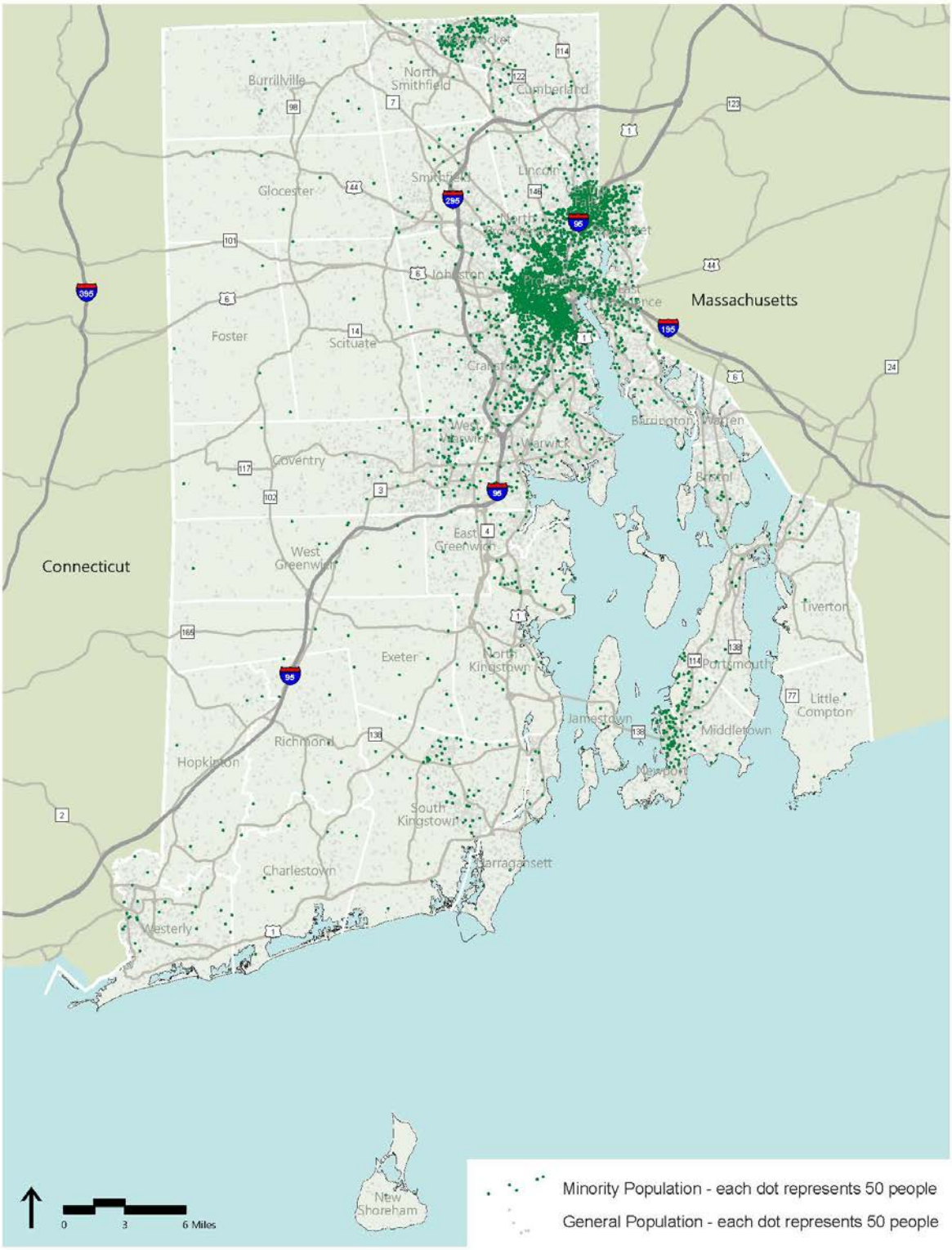
Figure 2-11 shows the locations of minority populations in Rhode Island, and Figure 2-12 shows locations of families living in poverty in Rhode Island. Again, populations of these individuals reside primarily in the Providence area, with smaller populations in Woonsocket and Newport.

Figure 2-11 Environmental Justice Areas



Source: Rhode Island Department of Environmental Management. 2009. "Policy for Considering Environmental Justice in the Review of Investigation and Remediation of Contaminated Properties" SOP # BEP-AWC-1. June 26, 2009. URL: http://www.dem.ri.gov/envequity/pdf/ejfinal.pdf

Figure 2-12 Minority Populations in Rhode Island (2016)



Source: US Dept. of Commerce. 2016. "2012-2016 American Community Survey 5-Year Estimates." US Census Bureau.

Figure 2-13 Families Living in Poverty in Rhode Island (2016)

Source: US Dept. of Commerce. 2016. "2012-2016 American Community Survey 5-Year Estimates." US Census Bureau.

3

Funding

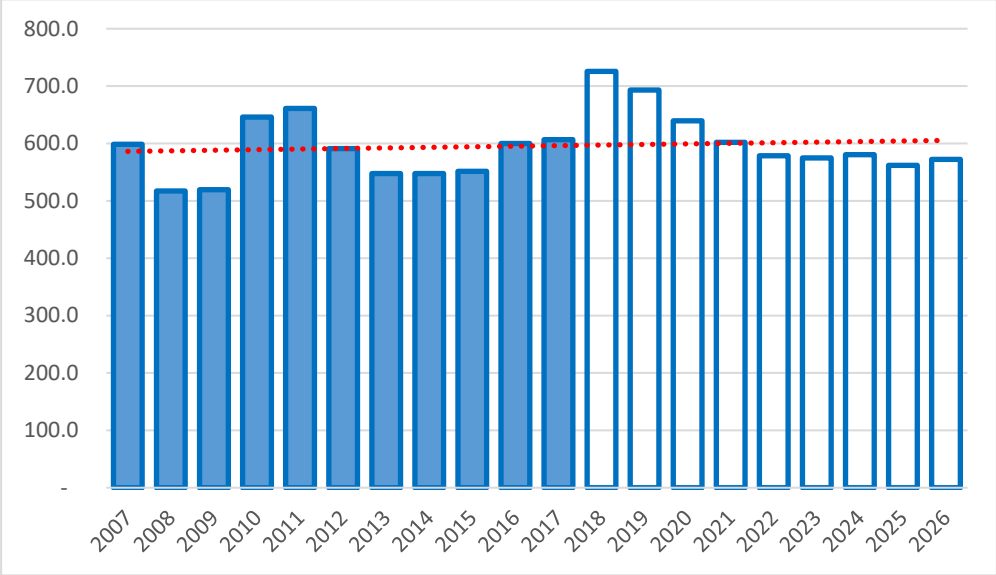
While vision and plans for transportation improvements are important, the transportation program is ultimately governed by funding. This section looks at historic funding and projected funding over the near term.

Annual Transportation Funding

As shown in Figure 4-1, during the past 10 years Rhode Island's annual transportation funding has ranged from $548 million to $661 million, with the highest years representing those where additional federal transportation funding was provided to states as part of the American Recovery and Reinvestment Act (ARRA) economic stimulus package passed in 2009.

Transportation funding for FY 2018 is budgeted at $726 million. The current State Transportation Improvement Program (STIP) anticipates annual funding to decline to $572 million by FY 2026. The $572 figure for FY26 is more typical of annual funding levels than are the amounts for the next few years. Known as RhodeWorks, the large uptick in funding levels for FY 2018 and FY 2019 is due to bond refinancing and issue of new bonds that take advantage of new federal funding rules and which will allow the state to implement an accelerated bridge repair and replacement program that will achieve greater long-term savings on bridge maintenance costs. Additionally, a Green Economy bond was issued to support the bikeway network.

Figure 4-1 Annual Transportation Funding, Historic and Projected

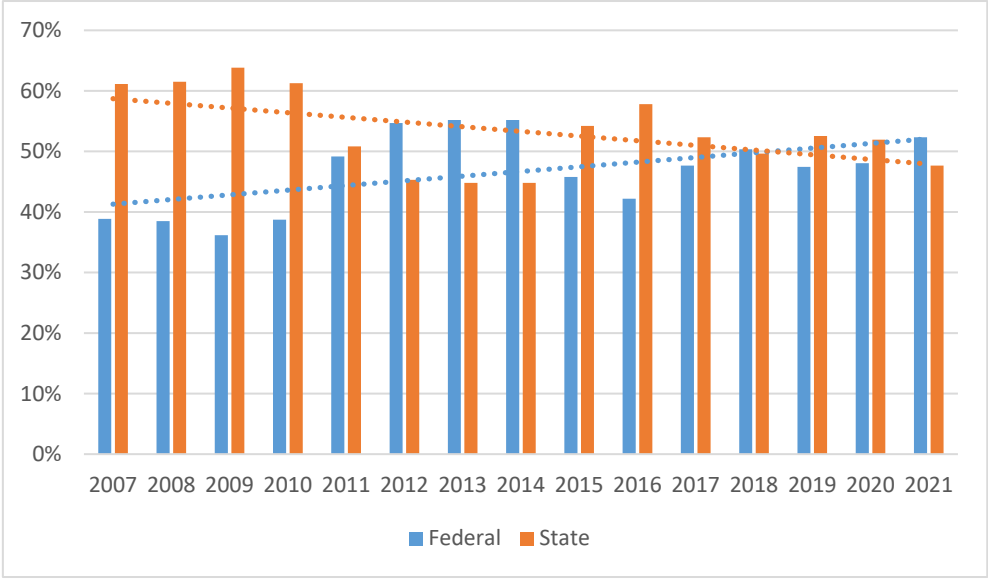


Source: RIDOT Office of Performance Management (historic).
Transportation Improvement Program FFY 2018-2027 (projected).

Sources of Funding

Figure 4-2 depicts the share of Rhode Island transportation funding from federal and state sources. During most years a majority of funding is from state sources, whereas in past years more than 60 percent of funding was from state sources, the split is more even now.

Figure 4-2 Federal/State Transportation Funding Split, 2007-2021

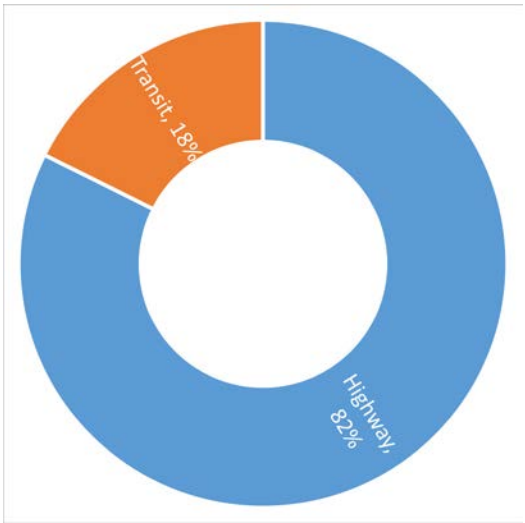


Source: RIDOT Office of Performance Management (historic).
Transportation Improvement Program FFY 2018-2027 (projected).

Federal Funding

Most federal transportation funding is through the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA), and most of the funding is for highway projects. Under the current federal five-year transportation authorization – the Fixing America's Surface Transportation (FAST) Act –anticipated highway-transit federal funding split is 82 percent for highways and 18 percent for transit.

Federal Funding Allocations (2017)



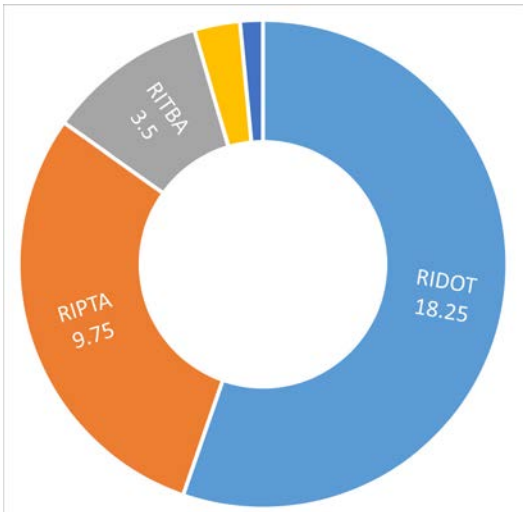
The federal programs from which Rhode Island receives the most highway funding are the National Highway Performance Program (NHPP), the Surface Transportation Block Grant Program (STBG), and the Highway Safety Improvement Program (HSIP). The NHPP provides about $130 million annually, almost half of all federal highway funding received by Rhode Island. The STBG program provides some $62 million annually and the HSIP provides $18 million. Funding for these and other federal highway programs is specified in FAST Act and total funding increases are less than one percent annually.

Federal transit funding is provided through a variety of FTA-administered programs. The FAST Act will provide an average of $58 million annually.

State Funding

State funding for transportation comes from a variety of sources, the largest of which is the gas tax. The state gas tax is currently (FY 2017) 34 cents per gallon. State law sets how the gas tax is distributed. It is currently shared by five agencies – RIDOT, RIPTA, the RI Turnpike & Bridge Authority (RITBA), the RI Department of Human Services (RIDHS), and the Underground Fuel Tank Storage (UFTS) program. For the latest STIP, the gas tax is anticipated to provide about $115 million annually to RIDOT and RIPTA for highway and transit operations. Long-term projections show declining revenue over time, due in large part to changes in vehicle fuel efficiency. A penny of gas tax currently generates about $4.3 million annually and it is estimated that a penny of gas tax will generate $4.1 million in 2027.

RI Gas Tax Allocations (2017)



Source: RI Dept. of Administration. 2017. "Transportation Improvement Program FFY 2018-2027." Division of Planning, Statewide Planning Program. Adopted 12/14/17.

The other largest state funding sources include:

- The RI Highway Maintenance Account is funded principally through transportation-related fees, such as motor vehicle and registration fees, and is projected to provide about $85 million annually.
- The Rhode Island Capital Plan (RICAP) is an account that receives any revenues in excess of 95 percent of state revenue upon which the Governor is required to build the annual budget. The funds are used for capital projects. RICAP is projected to provide about $47 million annually.
- Toll revenue is anticipated to be a significant part of future state funding. Once tolling is implemented, RIDOT estimates annual gross toll revenue to be approximately $45 million.
- RIPTA passenger fares are anticipated to provide about $25 million annually.
- The last of the larger state funding sources is bonding. Funding is expected to average about $65 million over the next four years, although most funding will be received in FY 2018 and FY 2019. The bond sales include the Green Economy Bond that will provide about $10 million to expand the state bikeway network, a $35 million bonding for mass transit hub infrastructure, and more than $200 million in Grant Anticipation Revenue Vehicle Bonds (GARVEE) bonds that are backed by future federal transportation funds allocated to Rhode Island and the proceeds of which will be used to fund accelerated bridge replacement, reconstruction, and maintenance projects.

4

Climate Change and Sustainability

Transportation plays a significant role in supporting Rhode Island's economic vitality and livability, from providing mobility and access for residents and visitors, to connecting and delivering goods and services for businesses and consumers in and outside of the state. However, transportation is the largest factor producing Greenhouse Gases (GHGs) in Rhode Island and nationally, a driving factor of climate instability. Human activity – in the form of burning fossil fuels and releasing GHGs – is considered the dominant cause of observed global warming since the mid-20th century.

Although emissions have declined in electrical power generation in recent years, continuing high GHG production in the transportation sector makes it difficult to effectively combat climate change. Effectively reducing the amount of greenhouse gases generated by the transportation sector, in concert with other efforts, will be key to Rhode Island's ability to meet greenhouse gas targets.

Ensuring safe, efficient, sustainable and resilient transportation systems is critical to Rhode Island's overall efforts to meet the needs of businesses, residents, and visitors. These systems support the state's growing economy, minimize impacts to

the environment, protect human health, and can help reduce contributions to climate change.

While the transportation sector represents the most significant contributor to climate change through greenhouse gas emissions,[8] potential impacts from climate change also pose major threats across transportation systems by increasing risk of delays, disruptions, damage, and even operational failure. [9]

Key trends that will be explored in this section include:

- Role of transportation sector in sustainability and resiliency
- Climate trends and projections, and potential impacts across transportation systems
- Greenhouse gas emissions reduction and energy planning
- Resilience and adaptation planning

Transportation and Sustainability

Transportation systems offer many benefits as well as challenges related to sustainability. Having reliable transportation systems can help improve productivity and efficiency for connecting people to goods, services and information. Similarly, being able to offer various transportation modes, including a reliable public transit system, will enhance mobility and access for residents and visitors across communities. At the same time, existing infrastructure and the current energy sources employed to power the majority of transportation systems are greatly contributing to greenhouse gas emissions, and consequently affecting air quality, public health, and contributing to global climate change.

The majority of transportation-related greenhouse gas (GHG) emissions consist of fuel consumption (burning of fossil fuels) by on-road vehicles (e.g., light-duty cars and trucks, short- and long-haul trucking, buses) and off-road sources (e.g., trains, marine vessels, aircraft and construction equipment).[10] Additionally, the transportation network includes other infrastructure and facilities (e.g., public transit systems, airports, ports and harbors, maintenance facilities, train stations, lighting) that are major consumers of energy and also generate GHG emissions.

8 Transportation Research Board. 2008. "TRB Special Report 290, The Potential Impacts of Climate Change on U.S. Transportation." Appendix B: Contribution of U.S. Transportation Sector to Greenhouse Gas Emissions and Assessment of Mitigation Strategies. URL: http://onlinepubs.trb.org/onlinepubs/sr/sr290.pdf.

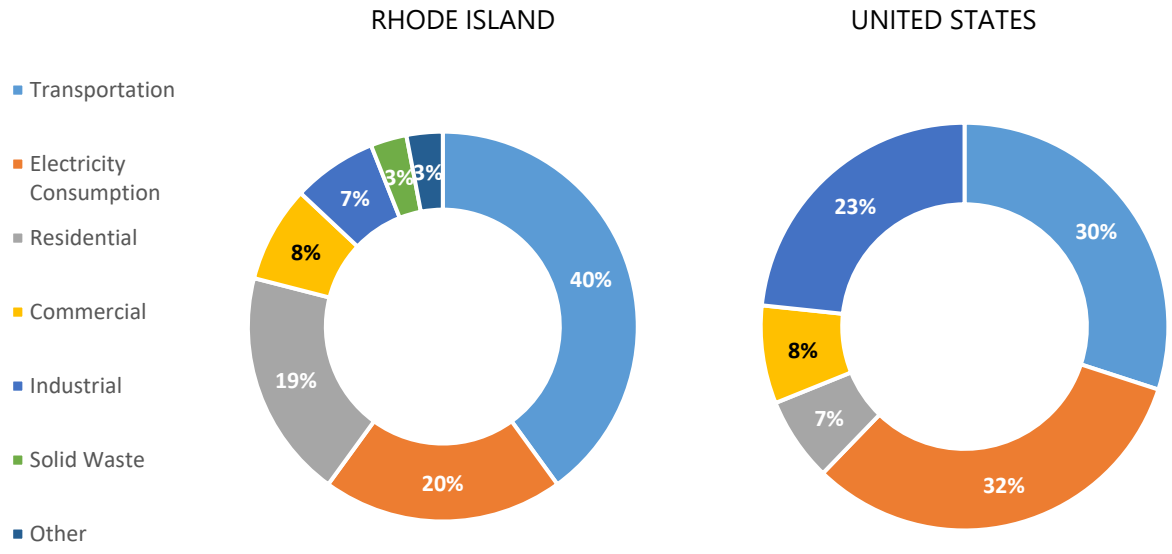
9 US Environmental Protection Agency. 2017. "Climate Impacts on Transportation." URL: https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-transportation_.html#ref2.

10 US Environmental Protection Agency. 2017. "Sources of Greenhouse Gas Emissions: Transportation Sector Emissions." URL: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#transportation. Accessed November 2017.

The most significant contributor to GHG emissions in Rhode Island comes from the transportation sector (40 percent). In 2010, the primary fuels consumed in Rhode Island were gasoline and distillate fuels (diesel).[11]

Figure 5-1 shows that in Rhode Island the transportation sector is a larger contributor to GHG emissions than the national average of 30 percent. Likely, the mix of GHG emitting sources is more diversified in the U.S. as a whole than in Rhode Island. This is particularly notable in the industrial sector, which has been in decline in Rhode Island for many years. It is likely that electrical consumption in Rhode Island follows similar patterns to many other states; the explanation for why GHG emissions are so much more significant for the transportation sector versus electrical consumption would seem to be that driving plays a larger role in Rhode Island than in the U.S. more broadly, and other modes such as public transportation and non-motorized are less prevalent.

Figure 5-1 Rhode Island vs. US Greenhouse Gas Source Sectors (2015)



Source: Rhode Island Executive Climate Change Coordinating Council (EC4). *Rhode Island Greenhouse Gas Emissions Reduction Plan.* December 2016.
US Environmental Protection Agency. 2017. "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015."

Note: The US Energy Information Agency reported that transportation was the largest contributor to overall greenhouse gas emissions in the US as of the end of 2016.

11 RI Dept. of Administration. 2015. "State Guide Plan Element report #120. Energy 2035: Rhode Island State Energy Plan." Division of Statewide Planning. October 8, 2015.

Greenhouse Gas (GHG) Emissions Reduction Target & Strategies

In 2014, the Governor signed into law the Resilient Rhode Island Act of 2014. This act calls upon the state to:

1. Assess, integrate, and coordinate climate change efforts throughout state agencies to reduce emissions, strengthen the resilience of communities, and prepare for the effects of climate change
2. Submit to a plan that includes strategies, programs, and actions to meet targets for greenhouse gas emissions reductions as follows:
   1) 10 percent below 1990 levels by 2020
   2) 45 percent below 1990 levels by 2035
   3) 80 percent below 1990 levels by 2050

In general, approaches to GHG emissions reduction should consider, in tandem, the following components:

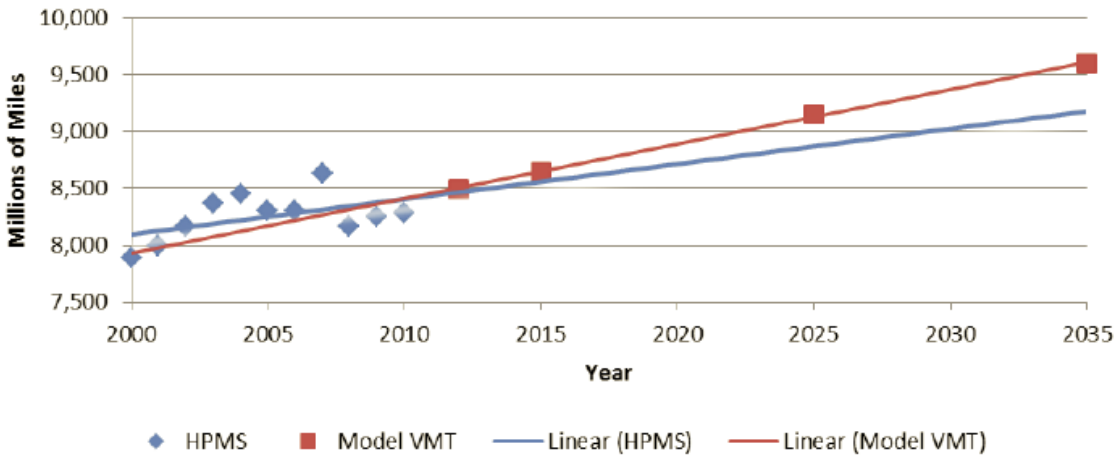
- ***Efficiencies and reductions*** – Explore solutions to shift away from transportation modes that rely on fossil fuels, improve efficiency of vehicles, and reduce the overall vehicle miles traveled (VMT).
- ***Clean energy sources*** – For modes that rely on grid-supplied energy, invest in conversion to renewable energy sources, biofuels, or other low-carbon technologies.
- ***New technologies*** – Explore innovative solutions such as energy storage, regenerative braking, and electrification of vehicles.

Energy 2035 Plan

In 2015, the state adopted Energy 2035: Rhode Island State Energy Plan, a revision of the energy plan adopted in 2002. This revision outlines the existing energy system and sets goals and policies to improve energy security, cost-effectiveness, and sustainability in all sectors of energy production and consumption. The plan proposes that to decrease transportation emissions, Rhode Island must find ways to scale up the use of lower- or no-carbon transportation fuels and reduce the total number of vehicle miles traveled. This will include the need to develop a viable market for alternative fuel and electric vehicles.

In the near term, more fuel-efficient cars may help Rhode Island meet the 2020 target but that alone would not be enough to meet the 2035 and 2050 targets. The number of vehicle miles traveled (VMT) continues to increase (Figure 5-4).

Figure 5-2 Rhode Island Vehicle Miles Traveled (VMT), 2000-2035



Source: RI Dept. of Administration. 2017. "Transportation 2037: Interim State Guide Plan Element 611." Statewide Planning Program.
Note: HPMS refers to the Highway Performance Monitoring System, which are actual traffic counts reported to FHWA. The HPMS data shown are through 2010.

Reductions in VMT will result in less fuel and/or electricity being consumed, and therefore, help reduce the overall energy consumption. Potential strategies to reduce VMT include:

1. Decreasing the absolute number of single-occupancy vehicle trips by promoting alternative modes of transportation (e.g., rail, bus, ride sharing, biking, walking).
2. Reducing the absolute length of single-occupancy vehicle trips by encouraging higher-density patterns of development or changes in behavior.
3. Investing in alternatives to solo driving (single-occupancy vehicle), such as public transit, biking, walking and carpooling, and using pricing incentives to manage traffic and parking.

Potential obstacles may include a decline in gas tax revenues and existing public transportation use that is below the national average.

2016 Greenhouse Gas Emissions Reduction Plan

In December 2016, the Rhode Island Executive Climate Change Coordinating Council (EC4) submitted a Greenhouse Gas Emissions Reduction Plan, which documents policy options and implementation strategies that support the state in achieving the GHG emission targets established under the Resilient Rhode Island Act of 2014. Table 5-1 highlights the connection between the transportation sector and policies and strategies to reduce GHG emissions. The transportation sector is applicable to almost all of the identified categories and pathways towards deep GHG mitigation.

Table 5-1 Categories for Deep GHG Mitigation

Category	Description	Applicable Sections
Energy Efficiency	Significant improvements in energy efficiency (using less energy to provide the same outputs or services) are critical in the buildings, transportation, and industrial sectors. These can include changes in practices by consumers or businesses, such as reducing travel by single-passenger vehicles, as well as technological improvements that increase efficiency, such as energy efficient appliances or lighting.	Buildings Transportation
Electrification	Electrifying energy end uses (converting from fossil fuels to electricity, such as with efficient electric heat pump systems or electric vehicles) maximizes the mitigation benefit of clean electricity.	Buildings Transportation
Decarbonization of Electricity	The GHG intensity of electric power can be reduced by increasing the role of renewable, no to-low carbon energy resources (such as large hydropower), nuclear power, and carbon capture and storage.	Electricity
Decarbonization of Other Fuels	In addition to electricity, other fuels must be replaced by low-carbon alternatives to the extent feasible, such as substituting biogas for conventional natural gas or cellulosic ethanol for gasoline.	Buildings Transportation

Source: Rhode Island Executive Climate Change Coordinating Council. 2016. "2016 Greenhouse Gas Emissions Reduction Plan." December 2016.

As noted in this Plan, one way to reduce GHG emissions in the transportation sector is to replace fossil-fuel burning vehicles with electric ones. The state has already invested in this option by being a signatory to the multi-state Zero Emission Vehicle Memorandum of Understanding (ZEV MOU), with a goal of deploying 43,000 ZEVs on Rhode Island roadways by 2025.[12] However, to achieve the 2050 goals, approximately 75% of the on-road miles driven (not including construction, rail, marine, and agriculture) would have to be served by electric vehicles. As a point of reference, as of 2015, less than one percent of the registered light-duty vehicles were electric. Further transition to electrification of transportation would need to include additional incentives for electric vehicles and charging stations, evaluation of electrifying the freight and passenger rails, and helping RIPTA to transition to a zero-emissions fleet.

The decarbonization of electricity will be a necessary component of any shift to electrification of vehicles to have a significant impact in emissions reductions. One challenge, similar to overall VMT reduction, will be the decline in gas tax revenues which are used for infrastructure improvements. Alternative funding mechanisms will need to be explored to replace this lost revenue.

12 Ibid.

Table 5-2 Major Transportation-Related GHG Mitigation Option Scenario Penetration Levels

Major Mitigation Option	2035	2050
VMT Reductions	**2% reduction in passenger car and truck VMT**	**10% reduction in passenger car and truck VMT**
Utility-Scale Renewable Energy	67% renewable installed capacity 72% carbon-free generation	98% renewable installed capacity 99% carbon-free generation
Distributed Generation	*No change from reference case*	*No change from reference case*
Clean Energy Imports	Two new 1090 MV interconnections with Canada	Unchanged from 2035
Nuclear Re-Licensing	*No change from reference case*	Millstone 2 and 3 are not retired in 2036
Electric Vehicles	**34% of on-road VMT electrified** **62% of rail transport electrified**	**76% of on-road VMT electrified** **97% of rail transport electrified**
Transport Biofuels	**10% biodiesel in diesel** **28% cellulosic ethanol in ethanol** **10% ethanol and cellulosic ethanol in gasoline**	**31% biodiesel in diesel** **78% cellulosic ethanol in gasoline**

Note: Items shown in bold providing the clearest link to transportation.

Source: Rhode Island Executive Climate Change Coordinating Council. 2016. "2016 Greenhouse Gas Emissions Reduction Plan." December 2016.

Table 5-3 Summary of State Policies for GHG Mitigation

GHG Mitigation Option	Applicable Major Existing Rhode Island Policies	Legislative Sunset
VMT Reductions	› **Transit Program (bus, rail, ferry)**	**N/A**
	› Land Use 2025	N/A
	› **Long-Range Transportation Plan**	**N/A**
Clean Energy (utility-scale renewable energy, distributed generation, clean energy imports)	› Renewable Energy Standard	2035
	› Long-Term Contracting Standard for Renewable Energy	N/A
	› Affordable Clean Energy Security Act	N/A
	› Renewable Energy Growth Program	2019
	› Net Metering	N/A
Electric Vehicles	› **Zero Emission Vehicle Memorandum of Understanding**	**N/A**
	› **Drive Rhode Island to Vehicle Electrification**	**N/A**
	› **State Rail Plan**	**N/A**
Transportation Biofuels	› **None**	N/A

Source: Rhode Island Executive Climate Change Coordinating Council. 2016. "2016 Greenhouse Gas Emissions Reduction Plan." December 2016.

Electric Vehicles

Climate change resiliency plans have placed a strong emphasis on the important of electric vehicles to achieving transportation greenhouse gas emissions goals. This section focuses on electric cars, but it is worth noting that significant efforts are underway for electric freight-hauling trucks (Tesla) and electrified public transportation in the form of trains and buses, of which there are many examples. Electrification is standard in some public transportation test vehicles.

Electric Cars

EVs are simply cars that run on electricity. A battery or series of batteries stores the electric charge to power an electric motor, which in turn propels the vehicle. Their operational costs are tied to the price of the electricity used to charge their batteries. EVs take advantage of regenerative braking, where the energy of the moving car can be captured during braking and turned back into stored electricity. EVs have lower maintenance costs, because electric motors have far fewer parts that require attention over time. They provide quiet and smooth operation and have less noise and vibration than traditional vehicles.

Benefits and Disadvantages of Electric Cars

Electric vehicles have a lower per-mile operating cost than traditional internal combustion vehicles because the price of fuel (in the form of electricity) is generally lower than the price for gasoline or diesel fuel, though this changes constantly. The lower operating cost is also a product of regenerative braking (particularly in stop-and-go driving) and the fact that EVs do not need to idle when not in motion.

EVs have no tailpipe emissions, so electrification of the general automobile fleet would improve localized air quality near congested roads and intersections. Although EVs are frequently marketed as "zero emission," this is only true if the electricity they use comes from a renewable source. If the electricity comes from wind turbines or solar cells, the vehicle is running on clean electricity; if it comes from a coal fired powerplant, this is not the case. Therefore, decarbonization of electricity generation is an important issue with respect to electric vehicle adoption as a strategy for combatting carbon emissions.

EVs are subject to range limits. This is a factor both due to the low energy density of batteries compared with the fuel used in traditional vehicles, and because the recharging process for these batteries is generally a lengthy process compared to refueling a traditional car. One of the main EVs – the Nissan Leaf – has an estimated range of 150 miles. In additional, recharging stations are limited, though their

availability is improving (Figure 5-3). The number of public EV charging stations in the US jumped from just 375 in 2007 to 322,265 in 2017.[13]

Limited range means that electric-only vehicles are most practical for more local trips. However, the average trip distance in Rhode Island for 2017 was less than 9 miles,[14] meaning that many trips of this length could easily be accomplished within the daily range of EVs available today.

Electric Vehicle Trends

Electric vehicles currently make up only a small portion of the US vehicle fleet. In 2016, of more than 260 million registered vehicles in the US, electric vehicles made up just 540,000 of them (0.22 percent). For 2016 vehicle production, EVs were 0.77 percent of the 17.5 million cars produced.[15] EVs are by no means mainstream.

Yet is fair to state that EVs are an emerging technology poised for much more widespread adoption. EV sales growth in the US has picked up significantly in recent years (Figure 5-2). All major automakers now sell at least a model of electric vehicle or a plug-in hybrid electric vehicle; none of these companies offered this type of vehicle ten years ago.

In October 2016, General Motors announced that is planning to fully electrify its fleet.[16] GM currently offers two fully electric models, but this will ramp up to 18 more by 2023. The company did not announce a date for the full conversion of its offerings, but this news is a significant signal from one of the largest auto manufacturers in the world that they believe that electric vehicles are the future.

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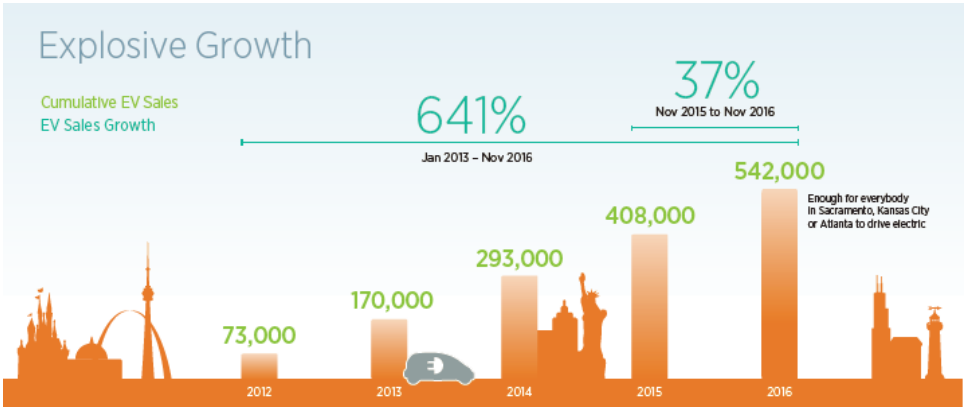
13 Chargepoint. 2018. "Discover Why Now Is the Time to Evolve to a Smart City." URL: https://www.chargepoint.com/blog/see-why-your-city-must-join-future-urban-mobility-now/.

14 U.S. Dept. of Transportation. 2017. "2017 National Household Travel Survey." Federal Highway Administration. URL: http://nhts.ornl.gov.

15 Nanalyze. 2017. "How Many Electric Cars Are There in the USA?" URL: https://www.nanalyze.com/2017/03/electric-cars-usa/. Accessed 3/25/18.

16 Davies, Alex. 2017. "General Motors is Going all Electric." *Wired*. October 2, 2017. URL: https://www.wired.com/story/general-motors-electric-cars-plan-gm/.

Figure 5-3 US EV Sales Growth 2012-2016



Source: Chargepoint. 2017. "The Future of Urban Mobility in Smart Cities."

GM's announcement is part of a larger trend. Other manufacturers have made similar plans (Volvo, Aston Martin, Jaguar Land Rover). Several countries, including the United Kingdom, France, the Netherlands and Norway have all made plans to ban the sale of diesel and gasoline powered cars soon to combat air pollution.

Possibly more important, EVs are making fast inroads in China. More than 700,000 new-energy vehicles (including gas-electric hybrids and fully electric vehicles) were sold in 2017, and sales are expected to increase to 2 million by 2020 and 5 million by 2025.[17] Volkswagen – the world's largest automaker – announced plans in late 2017 to invest almost $12 billion to build electric and hybrid cars in China.[18] With more than a billion people, a fast-growing middle class, and strong efforts by Chinese governments to decrease urban air pollution, high electric vehicle demand in China will impact the market for these vehicles worldwide.

Rhode Island Electric Vehicle Policy

Two Rhode Island State Policies apply to electric vehicles.

Adopted in 2016, the Zero Emission Vehicle Action Plan identifies specific actions and strategies to grow the zero-emission vehicle market in Rhode Island. It was created after Governor Chafee signed a Memorandum of Understanding with the governors of seven other states to reduce greenhouse gas and smog-causing emissions by transforming the transportation sector. The MOU commits to having 3.3 zero emission vehicles collectively on the roads of the eight states by 2025.[19]

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17 Tan, Ashley. 2018. "Expectations Are High for Electric Vehicles in China." CNBC. February 12, 2018. URL: https://www.cnbc.com/2018/02/12/expectations-are-high-for-electric-vehicles-in-china.html.

18 Shane, Daniel. 2017. "VW Has a $12 Billion Plan for Electric Cars in China." CNN. November 16, 2017. URL: http://money.cnn.com/2017/11/16/investing/volkswagen-electric-vehicles-china/index.html?iid=EL.

19 RI Office of Energy Resources. 2016. "State of Rhode Island Zero Emission Vehicle Action Plan." URL http://www.energy.ri.gov/documents/Transportation/Rhode%20Island%20ZEV%20Action%20Plan%20Final%202016.pdf.

The Driving Rhode Island to Vehicle Electrification (DRIVE) Program is an EV rebate program administered by the Rhode Island Office of Energy Resources to support adoption of EVs in the state. It offers residents a rebate of up to $2,500 per vehicle to assist in purchasing or leasing an EV. The program began January 29, 2016, but was suspended due to lack of funding on July 10, 2017. As of writing, this suspension remains in place.

Implications of Electrification of Vehicles for Rhode Island

There are several important public policy issues that need to be addressed when considering more EVs on Rhode Island roads.

Charging Stations

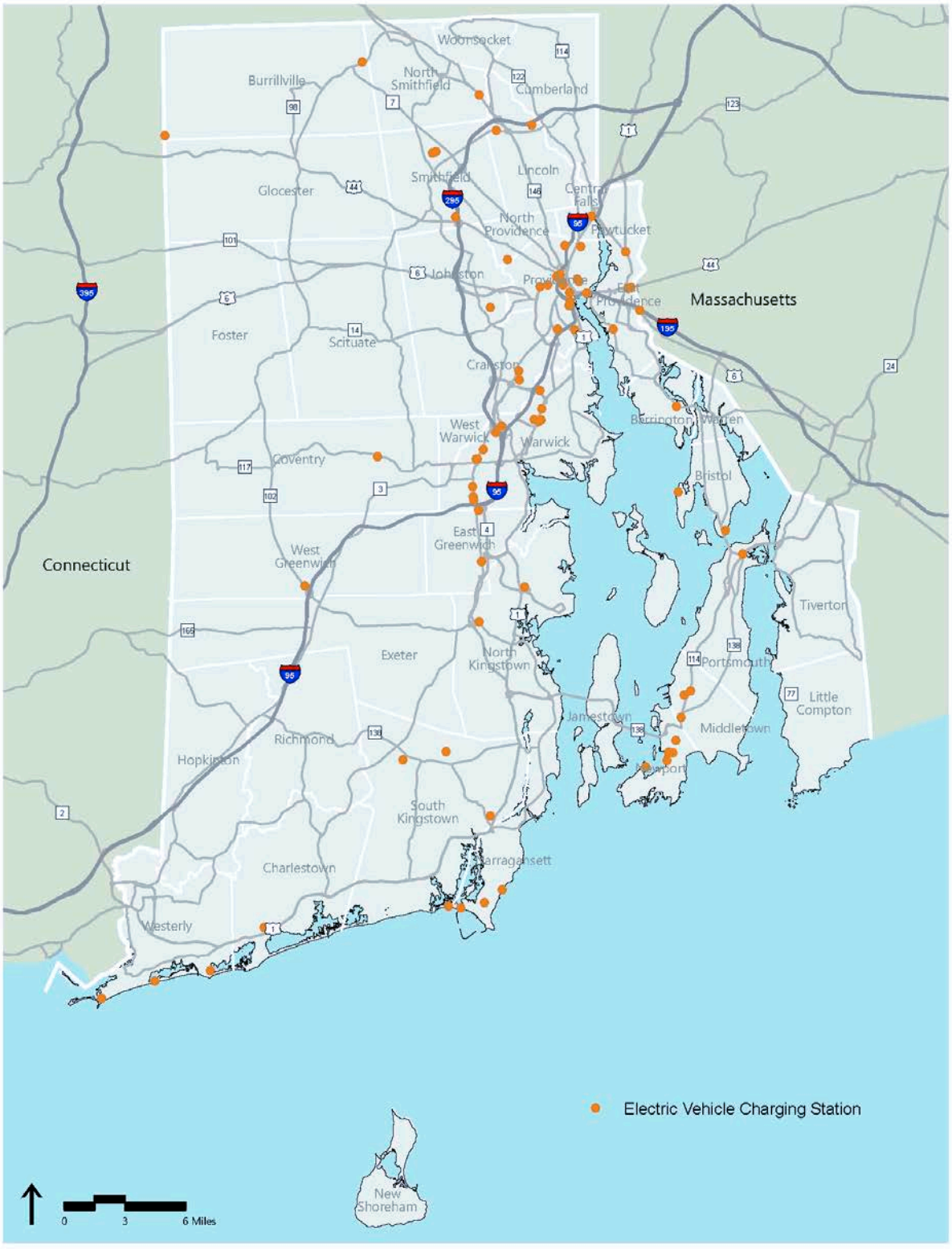
EVs require places to charge, just as traditional vehicles require fueling stations. Charging stations in the state are shown in Figure 7-8. There are currently 78 electric charging stations with 179 charging outlets in Rhode Island. The bulk of these are in the Providence area, with additional clusters near Warwick/West Warwick/East Greenwich, and Newport. Electrical vehicle owners may also charge their vehicles at home by other means. As EVs become more mainstream, charging stations would continue to become more widely available across the state and region.

Gas Taxes

The gas tax is one of the primary sources of transportation funding in Rhode Island. The tax is currently set at 33 cents per gallon. The federal gas tax is currently 18.4 cents per gallon, so a Rhode Island consumer pays 51.4 cents in tax per gallon of gasoline purchased. Since the gas tax is dependent on the volume of fuel consumed, decline in fuel consumption results in lower tax receipts by the state. This can happen when traditional cars become more efficient per mile, but also when consumers opt to use EVs, no longer powering these vehicles with gas or diesel fuel.

Electrification of the vehicle fleet over time will result in significant decline in gas tax revenue. There are alternative measures to raise revenue for transportation. Information regarding these measures can be viewed in the funding projections section of the Long Range Transportation Plan.

Figure 5-4 Electric Vehicle Charging Stations in Rhode Island



Source: US Dept. of Energy. 2018. "Electric Vehicle Charging Station Locations." Alternative Fuels Data Center." URL: https://www.afdc.energy.gov/fuels/electricity_locations.html#/analyze?fuel=ELEC. Accessed March 2018.

Role of this Long Range Transportation Plan

This Long Range Transportation Plan is called out in the state's Greenhouse Gas Emissions Reduction Plan as a major policy driver for reducing GHG emissions (Table 5-3). As noted in that plan, the LRTP "should consider setting more aggressive mode share targets than in the current plan to aid in reducing GHG emissions through VMT reductions. Integrated land use and transportation decisions to bolster the effectiveness of transportation policy and investments (e.g., development or redevelopment of transit stations) as identified through the Long Range Transportation Plan could be considered. Investing in alternatives to solo driving, such as public transit, biking, walking and carpooling, and using pricing incentives to manage traffic and parking are also potential policy solutions for VMT reduction."[20] As the Plan will be informed by various resources, including public and stakeholder engagement outreach, it will also play a major role in protecting, improving, and shaping the transportation systems in ways that contribute to the overall sustainability, mobility, and livability of Rhode Island.

Adaptation and Resilience

Climate Trends and Projections

Changes in climate conditions, as projected by various climate models, primarily include:

- Increase in average temperatures,
- Changes in precipitation patterns,
- Increase in frequency and intensity of weather events, and
- Sea level rise (SLR) and storm surge.[21]

Rhode Island is anticipated to continue experiencing an increase in average annual temperature, including frequency and intensity of heat waves; an increase in both mean and extreme precipitation, particularly in the winter and spring; as well as potential sea level rise of one to four feet by end of the century.

These climate change conditions can have compounding effects on the transportation system and how it is used. According to the Third National Climate Assessment, "Extreme events associated with climate change threaten transportation systems and supply chains, potentially disrupting production and distribution networks required for consumers to access goods and services. Supply chains may be impacted by the disruption of transportation and telecommunication systems. Processes involving the extraction and delivery of raw materials or the distribution of

20 Ibid.

21 Koetse., Mark J.; Rietveld. 2009. "The impact of climate change and weather on transportation: An overview of empirical findings". URL: http://www.mowe-it.eu/wordpress/wp-content/docs/general/Koets_Rietveld_2009_Climate_weather_impacts_on_transport.pdf.

goods can be interrupted by higher temperatures and increased frequency or intensity of extreme events."[22]

Vermont's catastrophic flooding in the wake of Tropical Storm Irene in 2011 illustrates how extreme events can have major impacts on transportation infrastructure. Heavy rains triggered flash flooding on almost every river and stream in the state, resulting in serious damage to transportation infrastructure. This included destruction of road and railbeds, undermined bridge foundations, and washed out culverts. The cost of infrastructure damage totaled in the hundreds of millions of dollars.[23] The flash flooding damage in Vermont was to some degree a product its topography, but the example is instructive for Rhode Island as more frequent heavy rain events are predicted as part of a warming climate.

Sea Level Rise and Storm Surge

Considered as individual hazards, sea level rise and storm surge can be a cause for concern. Coupled together, the impact of rising sea levels and storm surge is magnified. This is especially dangerous in low-lying coastal areas.

According to the National Oceanic and Atmospheric Administration (NOAA), sea level has risen over 9 inches since 1930 in Newport, Rhode Island, a rate faster than the global average. As of early 2017, NOAA estimates the global average sea level is expected to increase by 8 feet by the year 2100. The Northeast, is expected to experience an additional 1 to 3 feet of sea level rise during that same period resulting in potential sea levels up to 11.5 feet above current levels.[24] These levels have been adopted by the RI Coastal Resources Management Council for planning purposes. This means that the high tide line for a storm-free day will gradually move inland due to sea level rise, placing an increasing number of critical transportation assets in harm's way. The RI Coastal Resources Management Council developed STORMTOOLS as a method to illustrate and display storm inundation, with and without sea level rise, for different types of storms that could occur along Rhode Island's coast line. STORMTOOLS analysis indicates that all 21 coastal Rhode Island communities will experience impacts to their transportation infrastructure due to sea level rise.[25]

22 Burbank, C.J., et al. 2014. "Climate Change Impacts in the United States: The Third National Climate Assessment, Chapter 5: Transportation." URL: http://nca2014.globalchange.gov/report/sectors/transportation.

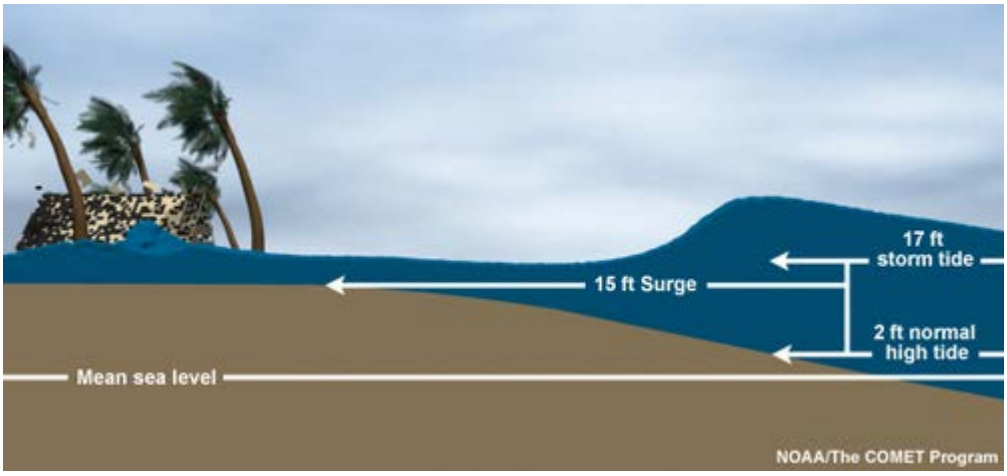
23 Vermont Agency of Transportation. 2012. "Adapting Vermont's Transportation Infrastructure to the Future Impacts of Climate Change." August 13, 2012. URL: http://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/VTrans%20Climate%20Change%20Adaptation%20White%20Paper%202012.pdf.

24 US Dept. of Commerce. 2017. "NOAA Technical Report NOS CO-OPS 083: Global and Regional Sea Level Rise Scenarios for the United States." National Oceanic and Atmospheric Administration. January 2017. URL: https://tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_US_final.pdf.

25 RI Dept. of Administration. 2016. ""Vulnerability of Municipal Assets to Sea Level Rise and Storm Surge, Technical Report 167." Statewide Planning Program. URL: http://www.planning.ri.gov/documents/sea_level/2016/TP167.pdf.

Compounding the issue of sea level rise, storm surge is a localized event where ocean water is forced up onto the land during a coastal storm (see Figure 5-5). For instance, when a storm coincides with normal high tide period, a typical 2-feet normal high tide can result in 15-feet or more storm surge.[26] The extent of this inundation depends largely on the storm magnitude and land topography.

Figure 5-5 Storm Surge vs. Storm Tide



Source: US Dept. of Commerce. "Storm Surge Overview." National Oceanic and Atmospheric Administration (NOAA). National Hurricane Center, . URL: http://www.nhc.noaa.gov/surge/.

As sea levels continue to rise, the normal high tide levels will move inland. The impacts of storm surge become more severe, such that battering waves and flooding from the storm surge can increase coastal erosion rate and damage critical infrastructure, facilities, and sensitive equipment located near or along the coast. For instance, Superstorm Sandy in October 2012 resulted in 9.4-foot storm surge above normal high tide in Providence that led to extensive coastal flooding of the area.[27]

Considering transportation assets are so crucial to our state, research has been invested in identifying how sea level rise and storm surge will impact the transportation network. A STORMTOOLS analysis projects that a 100-year storm surge event would flood up to 337 miles of roadway, and more than 500 miles of roadways may experience flooding in a 100-year storm surge event combined with a five to seven feet of sea level rise (see Table 5-4).[28] This is projected to occur by the end of the century. A 100-year storm surge event does not suggest that it will be 100 years before we see those high-water levels. Also called the 1 percent annual chance storm, the event has a 1 percent chance of occurring every year.

26 US Dept. of Commerce. "Storm Surge Overview." National Oceanic and Atmospheric Administration (NOAA). National Hurricane Center. URL: http://www.nhc.noaa.gov/surge/.

27 Runkle, J., K. Kunkel, D. Easterling, B. Stewart, S. Champion, L. Stevens, R. Frankson, and W. Sweet. 2017. "Rhode Island State Climate Summary. NOAA Technical Report NESDIS 149-RI." National Oceanic and Atmospheric Administration, National Centers for Environmental Information. URL: https://statesummaries.ncics.org/ri.

28 RI Dept. of Administration. 2016. "Vulnerability of Municipal Assets to Sea Level Rise and Storm Surge, Technical Report 167." Statewide Planning Program. URL: http://www.planning.ri.gov/documents/sea_level/2016/TP167.pdf.

Note that the most extreme impacts shown in Table 5-4 are for a 100-year storm surge event and 7 feet of SLR, which is less than 9.4-foot observed storm surge event observed with Superstorm Sandy in 2012, and less than the estimated 11.5 feet of sea level rise NOAA anticipates by 2100. In those scenarios, even more miles of the existing Rhode Island roadway network would be affected.

Table 5-4 Linear Miles of Rhode Island Roads Exposed to a 100-Year Storm Surge Event Plus SLR by Functional Classification[29]

Road Type	With NO SLR	Plus 1-ft. SLR	Plus 3-ft. SLR	Plus 5-ft. SLR	Plus 7-ft. SLR	Total
Interstate	1.50	0.16	0.21	0.17	0.45	**2.49**
Freeways and Expressways	2.11	0.92	0.95	1.59	0.99	**6.56**
Principal Arterial	17.76	2.50	2.73	2.86	2.66	**28.50**
Minor Arterial	21.57	2.27	3.90	3.20	4.04	**34.98**
Major Collector	34.00	4.26	6.19	7.29	8.06	**59.80**
Minor Collector	29.00	1.89	3.44	3.37	2.26	**39.95**
Local Roads	230.94	24.34	45.39	50.42	50.10	**401.19**
GRAND TOTAL	**336.88**	**36.34**	**62.81**	**68.9**	**68.55**	**573.47**

Source: RI Dept. of Administration. 2016. "Vulnerability of Municipal Assets to Sea Level Rise and Storm Surge, Technical Report 167." Statewide Planning Program. URL: http://www.planning.ri.gov/documents/sea_level/2016/TP167.pdf.

Analysis also shows that there are 90 bridges vulnerable to sea level rise and 148 bridges susceptible to storm surge.[30] Most of these are located in the East Bay. These temporary (storm surge) or permanent (sea level) rises in water affect bridge accessibility and limit available freeboard (space from bottom of bridge to top of water). Changes in precipitation may result in more runoff and sedimentation, leading to shallower and less accessible shipping channels. Dredging of ports like Galilee may need to occur more frequently.

7-foot sea level rise would put downtown Providence underwater

Coastal infrastructure and industries will be most affected by sea level rise and storm surge. Harbor infrastructure such as docks and bridges may have to be elevated to accommodate higher sea levels "However, climate change has not had a significant enough effect on Rhode Island to drive adaptation efforts in the marine trades industry.[31] Deeper waters may allow for different types of vessels to use Rhode Island ports — as long as the ports are not underwater.

Transportation assets such as Kennedy Plaza bus station in Providence, may not be along the shoreline, but are in riverine floodplains. Under the 7-foot sea level rise

29 Ibid.

30 Ibid.

31 RI's Climate Change Challenge. 2014. "Economic Impacts: Gauging the Wind." URL: http://www.riclimatechange.org/reports/Economic_Impacts.pdf.

scenario and storm surge from the one percent annual chance storm, the water depth in Kennedy Plaza is expected to be over 15 feet above the road!

As mentioned above, more intense storms will disrupt air traffic throughout the country. Quonset State Airport is within the inundation zone for up to 7 feet of sea level rise. The primary airport in the state, T.F. Green Airport, is not within this zone, however storm surge from a one percent annual chance storm – without any sea level rise – will begin to push water up Buckeye Brook and at the end of one of the runways at T.F. Green Airport. From the floods of 2010 we know that the nearby Pawtuxet River can also flood, causing smaller tributaries to overtop their banks and flood roads and other infrastructure. See the STORMTOOLS online mapping platform (http://www.beachsamp.org/stormtools) to view different inundation levels under various storm scenarios in Rhode Island.

Figure 5-6 TF Green Airport Sea Level Rise Impacts

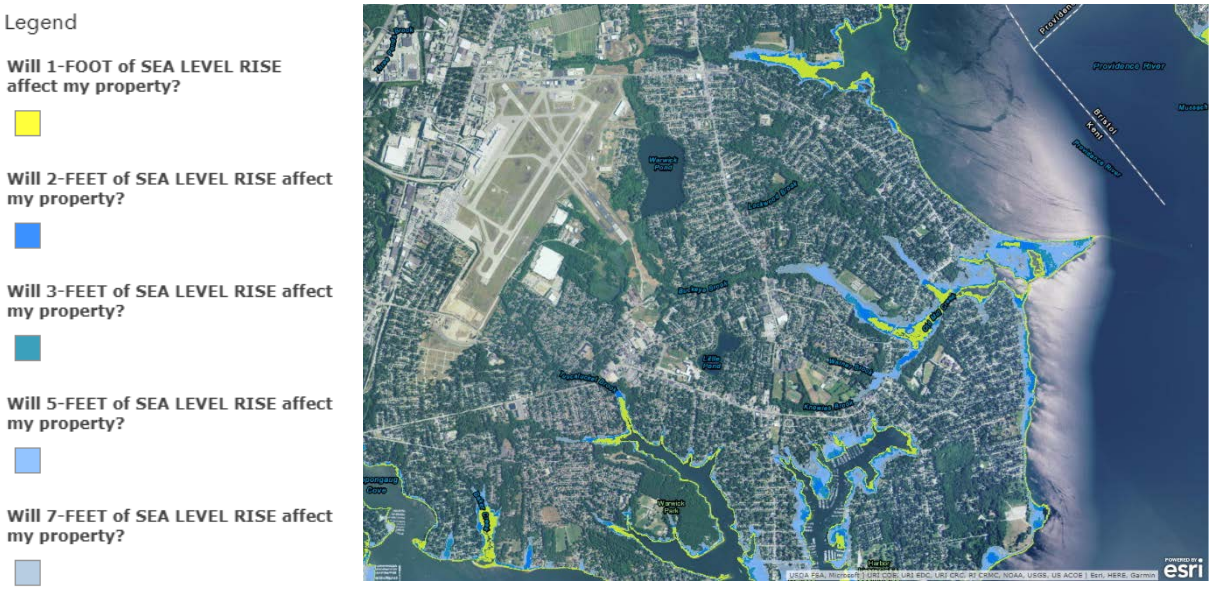


Figure 5-7 Quonset Airport Sea Level Rise Impacts

Source (Figure 5-6, 5-7): RI Shoreline Change Special Area Management Plan. "Stormtools." URL: http://www.beachsamp.org/stormtools/. Accessed November 2017.

Potential Climate Impacts Across Transportation Systems

Considerations of potential impacts of climate change across transportation systems include:

Land-based Transportation

Land-based transportation such as roadways, vehicles, and railways can be disrupted by elevated temperatures, increased extreme precipitation events, and inundation of roads from rising sea levels. For instance:

- While warmer temperatures may reduce the need for road salt and snow plowing, in the summer months extreme temperatures may cause roads to soften and expand. This can lead to more rutting and potholes in heavily traveled roads.
- Exposure to flooding and extreme snow events shortens the life expectancy of highways and roads. Given Rhode Island's geographic location, a large portion of roads are located very close to the shore, and therefore more susceptible to damages caused by frequent flooding from coastal storms and high waves due to sea level rise, thus requiring more frequent maintenance, repairs, and even rebuilding. [32] Additionally, landslides and wash-outs may occur more frequently, as saturated soils are exposed to more rainwater due to increased precipitation.
- The increase in frequency and intensity of extreme weather events may cause landslides and wash-outs to occur more frequently, resulting in

32 RI Dept. of Administration. 2015. "Vulnerability of Transportation Assets to Sea Level Rise, Technical Report 164." Statewide Planning Program. URL: http://www.planning.ri.gov/documents/sea_level/2015/TP164.pdf.

disruption and/or delay of traffic, construction activities, and even weakening or washing out the soil and culverts that support roads, tunnels, and bridges.

- Railways are also susceptible to the impacts of climate change; warming temperatures can cause tracks to buckle and expand. Tracks that are close to the coast are at risk of flooding and erosion as sea level rises and storm surges intensifies.[33]
- In Rhode Island, all roadways under state jurisdiction are subject to inundation, and the top ten most vulnerable of these roads are projected to experience daily high tide flooding at one to three feet of sea level rise. Furthermore, many of RIPTA routes and stops are located on roads that are sea level rise inundation zones.[34]
- Evidence has shown that rainfall and both very high and low temperatures can decrease bike use. However, it is more likely to affect recreational cycling than utilitarian cycling.[35] There remains uncertainty on how climate change will impact commuters' choice to take public transportation over their private vehicles. However, it will be critical to consider the implications of higher temperatures and urban heat island effects for commuters who rely on public transportation, walking, or biking for all or part of their commute.

Air Transportation[36]

Air Transportation for passengers and cargo is subject to disruption from increased extreme weather events and elevated temperatures. For instance:

- Extreme weather events can affect runway integrity over time.
- Extreme heat can affect aircraft performance and may result in cargo restrictions, flight delays, and cancellations.
- Increasing rain and flooding in the winter and spring may disrupt air travel, and increasing frequency and intensity of storms can result in airport operational downtime, as experienced by multiple airports recently after Hurricane Harvey in Texas and Hurricane Irma in Florida.

33 Ibid.

34 Ibid.

35 Koetse., Mark J.; Rietveld. 2009. "The impact of climate change and weather on transportation: An overview of empirical findings". URL: http://www.mowe-it.eu/wordpress/wp-content/docs/general/Koets_Rietveld_2009_Climate_weather_impacts_on_transport.pdf.

36 US Environmental Protection Agency. 2017. "Climate Impacts on Transportation." URL: https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-transportation_.html#ref2.

Marine Transportation

Marine or water-based transportation is subject to disruptions from changing water levels for inland navigation during drought and floods, and damage to coastal facilities from extreme weather events. For instance:

- Higher sea levels would result in lower clearance for ships under waterway bridges. Near coast waterways this could limit water traffic during extreme high tides initially.
- Flooding could cause ship channel closure, and increased runoff from extreme storm events could result in silt and debris build up which would lead to shallower and less accessible channels.
- As most ports are located in low-lying areas, they are at risk of storm surge damage due to increase in frequency of extreme storms and sea level rise. [37]

In addition to affecting the built environment and transportation infrastructure, climate change also has implications for consumption patterns, commerce, and supply chains. For example, more frequent or intense extreme weather may cause more interstates and airports to temporarily shut down, thereby delaying the delivery of freight and passengers. On the supply side, long-term changes in the growing season may open up new locations for agriculture. These newly created prime agricultural areas may not be serviced by old transportation routes.

Adaptation & Resilience Strategies

Adaptation is the process of adjusting to new conditions in order to enhance resiliency and reduce the risks to valued assets. For example, elevating a road is a way to adapt to sea level rise or a flooding issue. Climate resilience refers to a system's ability to prevent, withstand, respond to, and recover from a weather event. For example, suspension bridges maintain a level of resiliency by being built to sway and withstand high winds. As a coastal state, resilience, as defined by the RI Coastal Resources Management Council (CRMC), means "building the ability of individuals, communities, infrastructure, and the environment to 'bounce back'… A community that is more informed and prepared will have a greater opportunity to rebound quickly from weather and climate-related events... Resilience is our ability to prevent a short-term hazard event from turning into a long-term community-wide disaster."[38]

Land, air, and water-based transportation systems need to be climate resilient, especially in a coastal state like Rhode Island where storm surge, sea level rise, and associated flooding are already causing damage. Protecting and preparing the transportation systems for future climate impacts will also greatly contribute to economic and community resiliency. In addition to potentially severe damage to the

37 Ibid.

38 RI Coastal Resources Management Council. 2017. "Coastal Resilience and Adaptation. URL: http://www.crmc.ri.gov/coastalresilience.html. Accessed November 2017.

physical assets and infrastructure, climate-related impacts to the transportation systems can also pose a major threat to the state's economy and businesses, disruptions to the connection and delivery of people and goods, as well as the safety and welfare of residents and visitors. Therefore, decision-makers should consider the degree of environmental impact, community benefits, the financial cost of inaction, near- and long-term opportunities for enhancing resiliency of existing and future transportation projects.

The Rhode Island Statewide Planning Program also identifies the following strategies to protect and improve transportation investments in Technical Paper 167, which communities may incorporate to enhance their resiliency.

Protect—Armor. Examples include hard armor structures such as sea walls and bulkheads which protect critical transportation assets from storm surge, flooding, and sea level rise. However, they are costly to build and maintain, and may provide a false sense of security from other threats. A seawall built to protect a property from sea level rise may not withstand storm surge forces. In Rhode Island, these methods are no longer favored due to the impacts they cause to adjacent property and ecosystems. Local examples: Providence Hurricane Barrier (built to protect downtown), the seawall in Narragansett (built to protect Ocean Road), and the coastal armoring projects in South Kingstown (built to protect private property and Matunuck Beach Road).

Protect—Enhance Natural Protections. Creating dunes, wetlands, and preserving natural features can offer enhanced protection from the ocean or river. In Vermont, state agencies are working on stream and river management to reduce conditions that cause flooding to the transportation systems. A local example includes maintaining the dunes along Atlantic Avenue in Westerly to protect the property along Atlantic Avenue.

Accommodate in Place. The previous two methods addressed the area adjacent to the structure. Sometimes improving the structure itself is useful to better withstand flooding. Without changing the location of the roadway, adaptation measures may include increasing culverts, enhancing scour protection on bridges, and elevating roads. The waves and water may still come up, but the infrastructure has been enhanced to withstand the stressors. Techniques include regular maintenance and cleaning of culverts, adding freeboard to bridge design, installing expansion joints to prevent rail buckling (Portland, Oregon), and elevating subway ventilation gates to reduce the risk of flooding (New York). A local example includes elevating the "White Church" bridge in Barrington when it was rebuilt. This additional level of freeboard allows for emergency watercraft to pass under the bridge during high tide events.

Accommodate through Realignment. Sometimes the vulnerable asset needs to be moved away from the rising waters. Though a managed retreat approach, areas that were previously protected are allowed to flood, creating additional flood storage capacity and protecting inland areas. Changing a bus route or bike route away from the coast may be feasible. Realigning a road, however, may be more challenging

especially in areas that are already developed and have limiting topography or available space.

Retreat. Rising water levels or a receding shoreline may eliminate the need for some existing transportation infrastructure if the people have left the area. This retreat strategy may be a highly efficient solution to protect society but is the most controversial.

Do Nothing. Some communities may decide not to take action and handle each threat as it comes up. This may seem desirable short term but could have long-term consequences for the community, and economy. [39]

Next Steps: Comprehensive Climate Resiliency Strategy

In September 2017, Governor Gina Raimondo signed Executive Order 17-10 *Action Plan to Stand Up to Climate Change*. In addition to creating the position of a State Chief Resiliency Officer, the EO tasks state agencies and municipalities to coordinate their actions, priorities and funding towards a statewide Action Plan to Stand Up to Climate Change. The LRTP and statewide climate adaptation plan, especially given concurrent development, provide opportunities to explore synergies and align overarching strategies to improve mobility while also enhancing the overall resiliency of the transportation system and the state, as a whole.

39 RI Dept. of Administration. 2016. "Vulnerability of Municipal Assets to Sea Level Rise and Storm Surge, Technical Report 167." Statewide Planning Program. URL: http://www.planning.ri.gov/documents/sea_level/2016/TP167.pdf.

5

Health

Initially, health may not come to mind when developing a transportation plan, however, there are critical links between transportation and health that must be considered when addressing current needs and planning for future facilities.

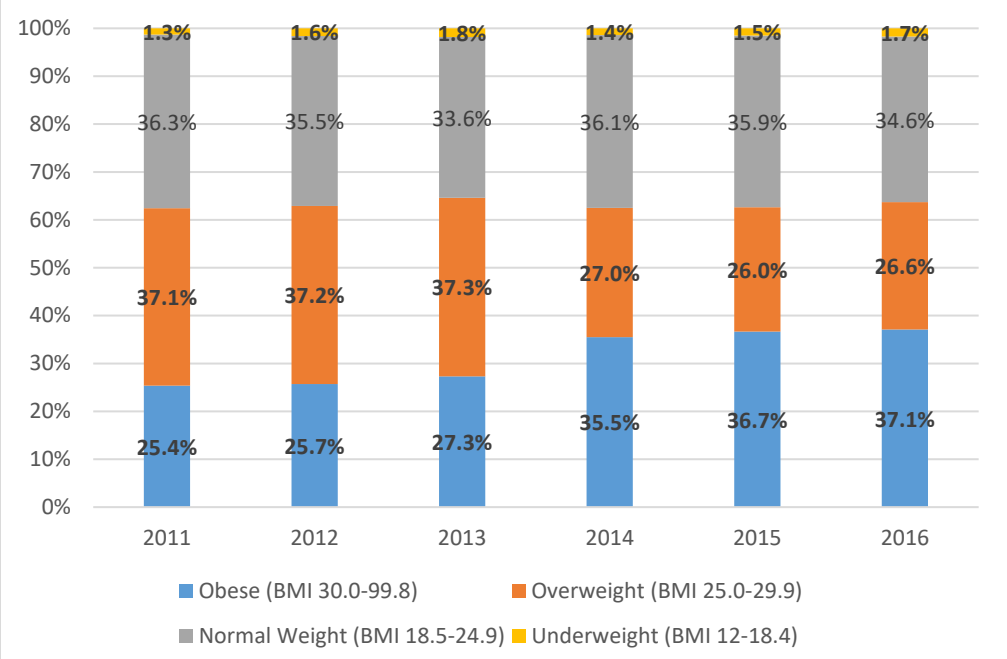
This section considers the role that active transportation can play in improving health and how transportation can also have a negative impact on health due to air quality impacts of vehicles and congestion.

Rhode Island's current adult obesity rate is 27 percent. The problem of obesity is not confined to the adult population as 12 percent of high-school students are also overweight or obese. If present trends continue, projections show that by 2030 the state will have a 40 percent increase in new adult diabetes diagnoses and a 370 percent increase in heart diseases diagnoses compared to 2010.

The following figures illustrate recent trends:

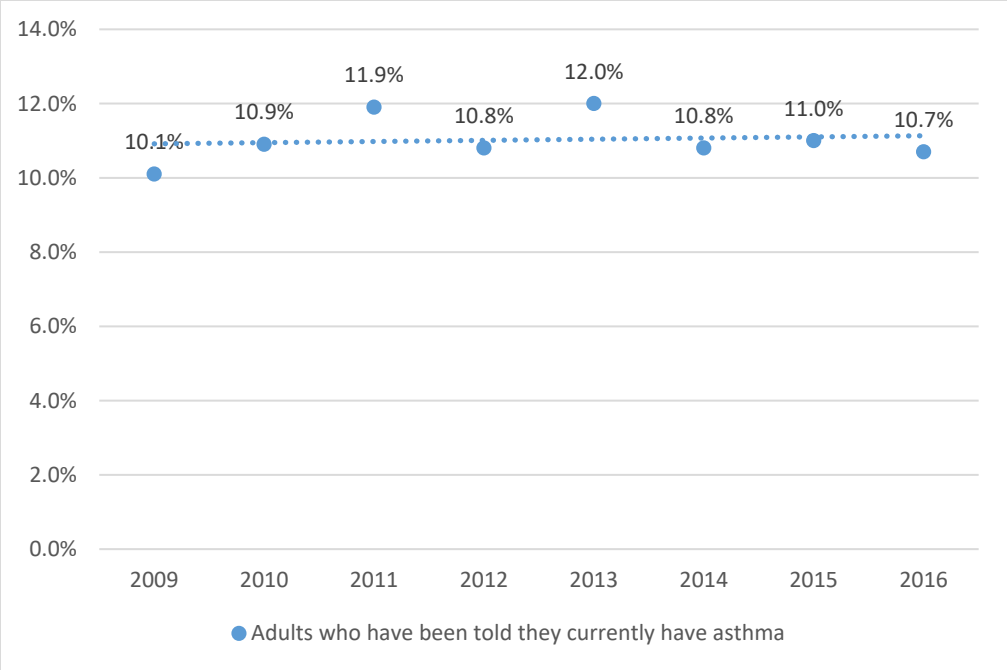
- Since 2009, obesity in the state's population has increased, up by 11.7 percentage points from 2009 to 2016. The overweight population has decreased, down 10.5 percentage points from 2009 to 2016, and the normal weight category has remained the same. It is likely that the overweight population is increasing their BMI and becoming obese.
- The number of adults who have been told they currently have asthma is slightly up since 2009 with a 0.6 percentage point increase.
- The number of adults who have been told they have diabetes is up 2.8 percentage points since 2009. Possible connection to the increase in obesity.
- Blood pressure diagnosis trends have been rising slightly since 2009 to 32.4 percent in 2015.
- The number of adults who are limited in activities due to physical, mental, or emotional problems has increased by 3.8 percentage points over the past 6 years.
- Just under half of adults in Rhode Island typically report achieving the recommended levels of physical activity.

Figure 6-1 Rhode Island Population Obesity Trends (2009-Present)



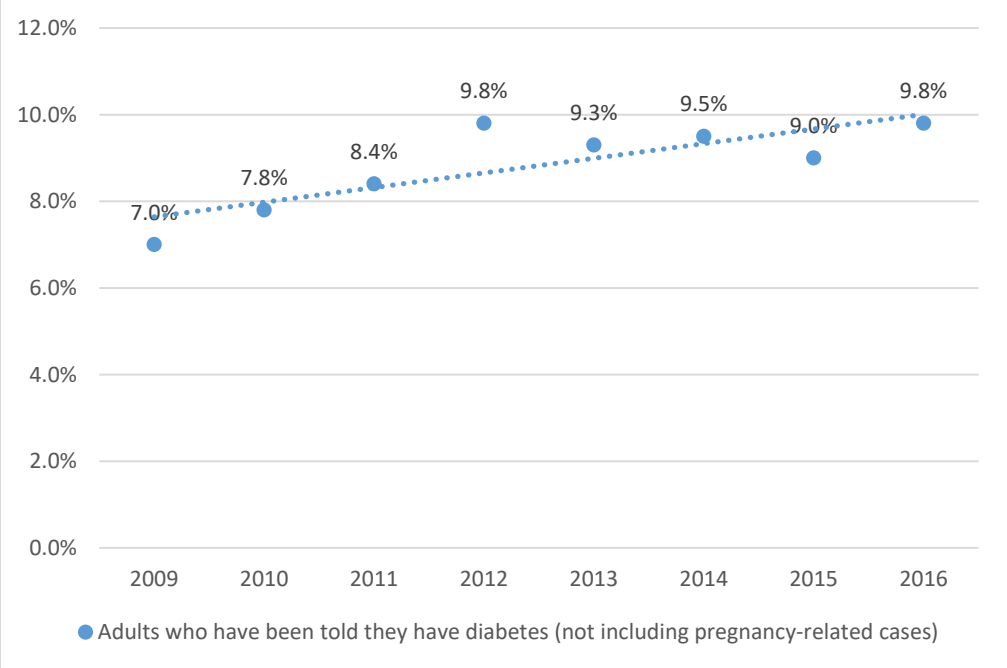
Source: US Centers for Disease Control and Prevention. 2016. "Behavioral Risk Factor Surveillance System Prevalence & Trends Data." URL: https://www.cdc.gov/brfss/brfssprevalence/. Accessed November 2017.

Figure 6-2 Rhode Island Population Asthma Trends (2009-Present)



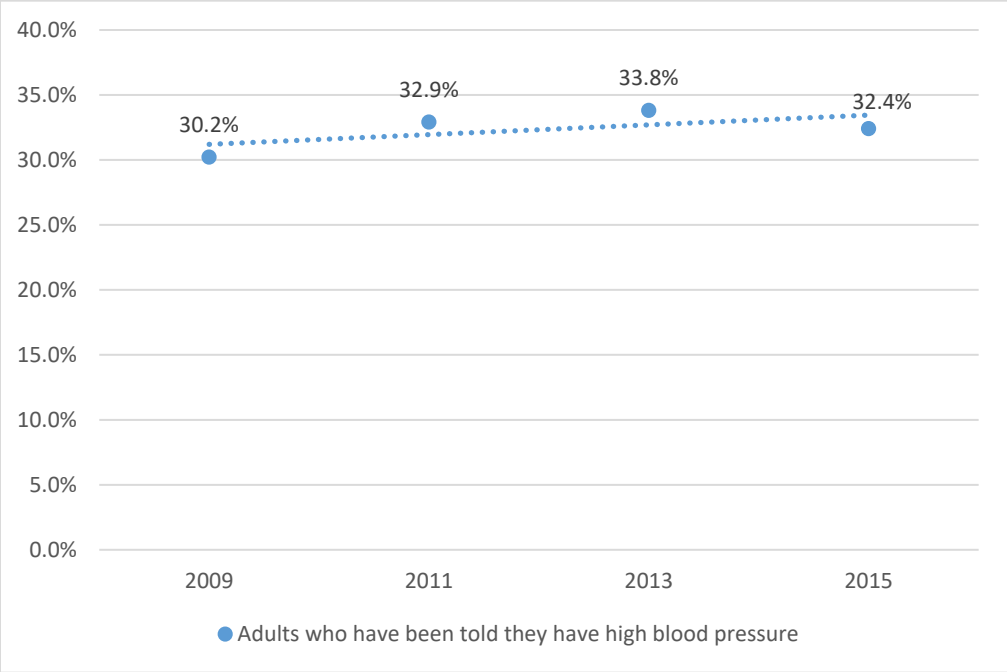
Source: US Centers for Disease Control and Prevention. 2016. "Behavioral Risk Factor Surveillance System Prevalence & Trends Data." URL: https://www.cdc.gov/brfss/brfssprevalence/. Accessed November 2017.

Figure 6-3 Rhode Island Population Diabetes Trends (2009-Present)



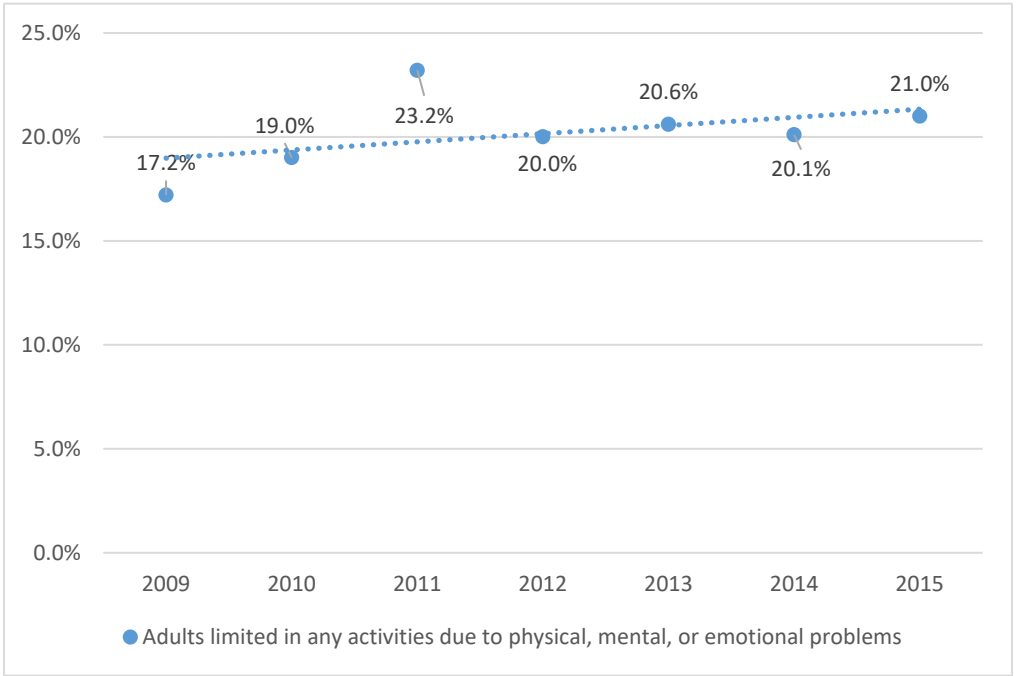
Source: US Centers for Disease Control and Prevention. 2016. "Behavioral Risk Factor Surveillance System Prevalence & Trends Data." URL: https://www.cdc.gov/brfss/brfssprevalence/. Accessed November 2017.

Figure 6-4 Rhode Island Population High Blood Pressure Trends (2009-2015)



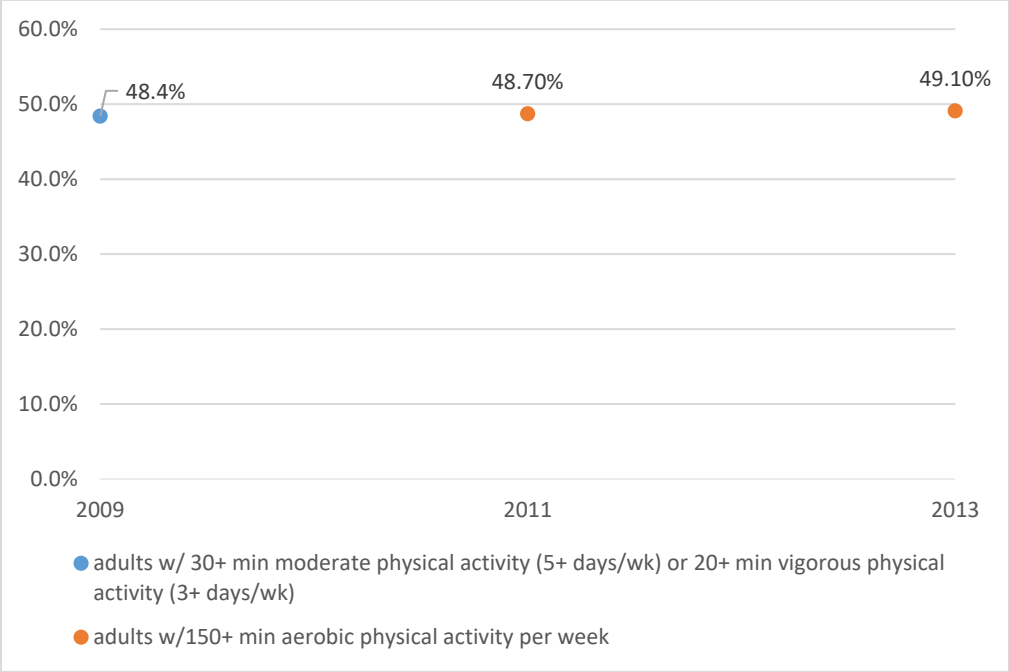
Source: US Centers for Disease Control and Prevention. 2016. "Behavioral Risk Factor Surveillance System Prevalence & Trends Data." URL: https://www.cdc.gov/brfss/brfssprevalence/. Accessed November 2017.

Figure 6-5 Rhode Island Population Activity Limitations Trends (2009-2015)



Source: US Centers for Disease Control and Prevention. 2016. "Behavioral Risk Factor Surveillance System Prevalence & Trends Data." URL: https://www.cdc.gov/brfss/brfssprevalence/. Accessed November 2017.

Figure 6-6 Rhode Island Population Physical Activity Trends (2009-2013)



Source: Ibid.

Similarly, September 2012 the US Centers for Disease Control (CDC) Rhode Island State Nutrition, Physical Activity, and Obesity Profile report used a survey to determine that:

- 23.8% of adults were physically active for a total of at least 60 minutes per day on each of the 7 days prior to the survey
- 13.3% did not participate in at least 60 minutes per day on each of the 7 days prior to the survey
- 22.2% of adolescents attended daily physical education classes in an average week (when they were in school)

Without safe environments where bicycling and walking can be incorporated into daily life, these trends will likely continue and could potentially reach epidemic levels. The Surgeon General recommends the following levels of activities by age group:

- Children and adolescents should do 60 daily minutes or more of physical activity.
- Adults should do at least 150 minutes per week of moderate-intensity, or 75 minutes per week of high-intensity, aerobic physical activity, or an equivalent combination.
- When older adults cannot do 150 minutes of moderate-intensity aerobic activity per week because of chronic conditions, they should be as physically active as their abilities and conditions allow.

Active Transportation

Active transportation includes modes that are human powered—bicycling and walking. Public transportation complements active transportation modes for longer trips where bicycling or walking is not practical. Currently, mode share data shows that 4.1 percent of Rhode Island commuters travel via bicycling or walking, 2.9 percent commute via public transportation, and 80.0 percent drive alone (2015). The proportion of commuters using active transportation for part of their commute is minor compared to those driving alone. The percentage has seen minor growth over recent years.

The Alliance for Biking and Walking compiles data on walking and biking in communities throughout the country. The latest results of the studies are presented in the *Bicycling and Walking in the United State 2016 Benchmarking Report* and summarized below.

Rhode Island's population density makes it well positioned for walking and biking commute trips. At over 1,000 persons per square mile, Rhode Island is ranked second in the nation, behind only New Jersey. Population density is calculated as the resident population divided by the total land area of the state. Some areas of Rhode Island have higher population density than the state as a whole, such as Central Falls (16,107/mile), Providence (9,676/mile) and Pawtucket (8,178/mile). Rhode Island also ranks second in the percentage of urban land area, with 38.8 percent.

In recent years the share of those commuting by walking or biking have increased gradually, both nationally and in Rhode Island. As shown in Table 6-1, the increases are higher for those walking to work than for those biking to work. Rhode Island's growth in those walking to work was 0.5 percentage points from 2007 to 2013 – tied with Oregon, South Carolina and Massachusetts for the largest increase among states.

Table 6-1 Percentages of Commuters Walking or Bicycling to Work

	Nationally (2005)	Nationally (2013)	Rhode Island (2007)	Rhode Island (2013)
Walk to work	2.5%	2.8%	3.1%	3.6%`
Bike to Work	0.4%	0.6%	0.3%	0.4%
Total	3.9%	4.6%	3.4%	4.0%

Source: Alliance for Biking and Walking. 2016. "Bicycling and Walking in the United State 2016 Benchmarking Report."

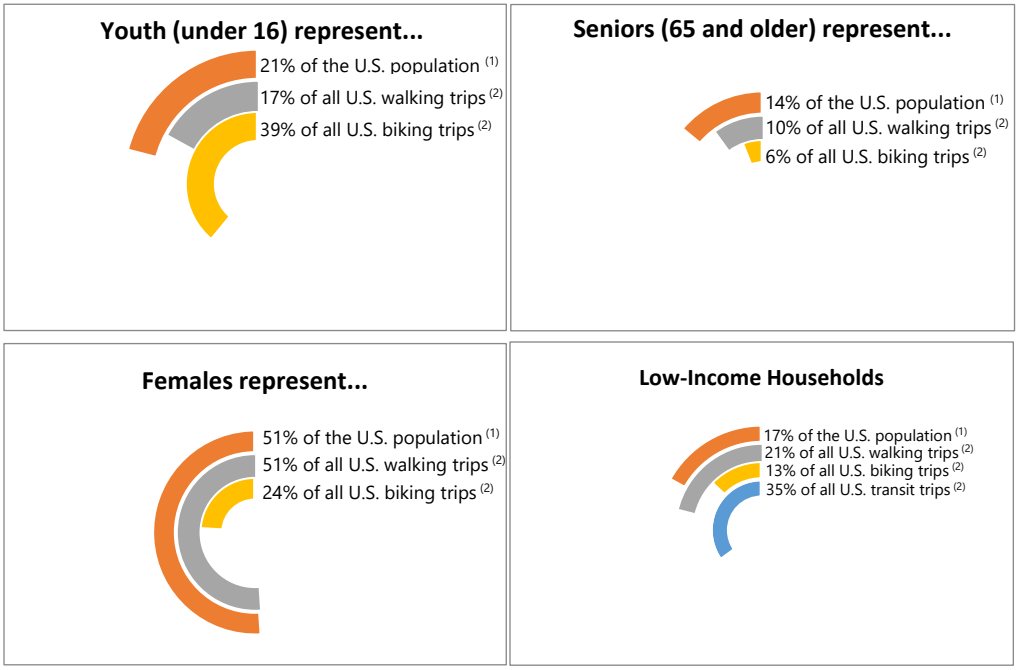
Rhode Island currently ranks 13th in the nation for those who walk to work and 31st for those who bike to work. At 4 percent, Rhode Island is 18th in the overall percentage of those commuting by walking or biking.

Demographics of Active Transportation

The figures below highlight who is biking and walking nationally. Among the factors affecting the ability, desire, and likelihood of people to complete trips on foot or by bicycle are age, gender, and income. As illustrated in Figure 6-7, children are more

likely to make biking trips while seniors are less likely to make walking or biking trips. Females account for half of walking trips but only one-quarter of bicycle trips. Those from low-income households are more likely to make trips by walking (or by transit).

Figure 6-7 Demographics of Walking, Biking, and Transit Trips in the U.S.



Note: Low-income households are those with an annual income less than $20,000.
Source: (1) US Dept. of Commerce. 2013. "American Community Survey 1-Year Estimates, 2013)." US Census Bureau.
(2) US Dept. of Transportation. 2009. "National Household Transportation Survey, 2009." Federal Highway Administration.

Strategies

To document the critical link between health and transportation state health departments and transportation departments can both adopt goals and strategies to support one another. Some such examples in Rhode Island include:

- Health Equity Zones – identified areas with a health disparity
  - Increase access to health, affordable food and local farmer's markets
  - Create linkages to job training
  - Create safe routes to school and encourage walking via the "walking bus"
  - Improve public transportation
  - Improve walkability and transportation
  - Improve access to recreation

    - Support local pedestrian plans such as "Woonsocket Walks – A City on the Move"
    - Adopt Complete Streets policies
    - Secure open space, parks, and trails
- A New Vision for Outdoor Recreation in Rhode Island
    - Connect Rhode Island to their communities
        - Improve connectivity of bike paths and trails/establish overall bike and trail plan
        - Further accelerate the incorporation of Complete Streets principles
        - Explore ways to improve public transportation to recreation sites (RIPTA pilot program)

Health departments in other states have adopted comprehensive statewide Health Improvement Plans. These plans promote similar goals, objectives, and strategies. The key themes from other state plans are similar to those themes addressed in the Health Equity Zones.

- Promote Safe Routes to School programs
- Promote Complete Streets programs and policies
- Encourage non-motorized infrastructure (sidewalks, bike facilities, lighting, trails, and parks) and travel (biking, walking, public transportation)
- Focus on appropriate maintenance for non-motorized and public transportation facilities
- Increase public lands
- Support programs to address climate change and reduce vehicle emissions

Similarly, the American Planning Association (APA) released *Metrics for Planning Health Communities* in May 2017. Key policies and strategies that tie transportation to health include:

- Transportation demand management policies
- Legislation prioritizing funding for pedestrian/bicycle facilities
- Complete Streets policies
- Traffic calming
- Smart growth policies
- Reducing greenhouse gas emissions

Air Quality

While automobiles and buses provide valuable opportunities for access and mobility, they also present a threat to the environment due to degraded air quality and ultimately to health due to exposure to emissions. The following section details various pollutants found in automobile emissions. Currently, Rhode Island is in

conformance with the congestion mitigation and air quality standards set by the Environmental Protection Agency concerning air pollution. As air quality and emissions volumes change this status can change.

Carbon monoxide is a colorless and odorless gas that is a product of incomplete combustion. Carbon monoxide is absorbed by the lungs and reacts with hemoglobin to reduce the oxygen-carrying capacity of the blood. At low concentrations, CO has been shown to aggravate the symptoms of cardiovascular disease. It can cause headaches and nausea and, at sustained high concentration levels, can lead to coma and death.

Particulate matter is made up of small solid particles and liquid droplets. PM_{10} refers to particulate matter with a nominal aerodynamic diameter of 10 micrometers or less, and $PM_{2.5}$ refers to particulate matter with an aerodynamic diameter of 2.5 micrometers or less. Particulates can enter the body through the respiratory system. Particulates over 10 micrometers in size are generally captured in the nose and throat and are readily expelled from the body. Particles smaller than 10 micrometers, and especially particles smaller than 2.5 micrometers, can reach the air ducts (bronchi) and the air sacs (alveoli) in the lungs. Particulates are associated with increased incidence of respiratory diseases, cardiopulmonary disease, and cancer.

Ozone is a strong oxidizer and an irritant that affects the lung tissues and respiratory functions. Exposure to ozone can impair the ability to perform physical exercise, can result in symptoms such as tightness in the chest, coughing, wheezing, and can ultimately result in asthma, bronchitis, and emphysema.

Volatile Organic Compounds (VOCs) are a general class of compounds containing hydrogen and carbon and are a precursor to the formation of the pollutant ozone. While concentrations of VOCs in the atmosphere are not generally measured, ground-level ozone is measured and used to assess potential health effects. Emissions of VOCs and nitrogen oxides (NOX) react in the presence of heat and sunlight to form ozone in the atmosphere.

Nitrogen Oxides are a result of combustion. When combustion temperatures are extremely high, as in automobile engines, atmospheric nitrogen gas may combine with oxygen gas to form various oxides of nitrogen. Of these, nitric oxide (NO) and nitrogen dioxide (NO_2) are the most significant air pollutants. This group of pollutants is generally referred to as nitrogen oxides or NOX. Nitric oxide is relatively harmless to humans but quickly converts to NO_2. Nitrogen dioxide has been found to be a lung irritant and can lead to respiratory illnesses. Nitrogen oxides, along with VOCs, are also precursors to ozone formation.

Carbon Dioxide is one of various greenhouse gases. Greenhouse gases (GHGs) are essential to maintaining the temperature of the Earth; without them, the planet would be so cold as to be uninhabitable. The earth's climate is predicted to change over time, in part because human activities are altering the chemical composition of the atmosphere through the buildup of GHGs. Climate change is having and will continue to have wide ranging impacts on water, energy, transportation, agriculture, ecosystems, and health. While there are other GHGs, CO_2 is the predominant

contributor to climate change, and emissions can be calculated for CO_2 with readily accessible data. The U.S. Environmental Protection Agency (EPA) has identified certain greenhouse gases as pollutants under the Clean Air Act and regulatory actions to date have included emissions standards for motor vehicles, fuel standards, and carbon pollution standards for new power plants, among other actions. These policies have been strongly debated since 2017, and some of these emissions standards have been rolled back.

Degraded Air Quality Impacts

Air quality impacts to health are greatest where traffic volumes and traffic congestion is highest. Idling vehicles stuck in traffic provide a stagnant source of emissions for extended periods each day. Roads with high traffic volumes, in general, are also major sources of air pollution. Neighborhoods and sensitive receptors near such infrastructure are at a higher risk for adverse health impacts related to poor air quality.

Vehicles are major sources of carbon monoxide (CO), nitrogen oxides (NO and NO_2, generically known as NOX), fine particulate matter ($PM_{2.5}$ and PM_{10}), volatile organic compounds (VOCs, such as off-gassing from gasoline and other fossil fuel products or as automobile exhaust through burning fossil fuels). Non-road mobile sources (such as airplanes, trains and ships) are also significant sources for all the pollutants listed here. While specific thresholds for risk and exposure do not exist, the Department of Health through the Community-Scale Air Toxics Ambient Monitoring Project monitors air pollution adjacent to major roadways and in potentially at-risk communities.

The Community-Scale Air Toxics Ambient Monitoring Project has a total of five fixed near road sites (adjacent to 95) listed below. Both Vernon Street and the Park and Hayes sites existed prior to this community-scale project which started around March of 2017.

4. Vernon Street, Pawtucket
5. Park and Hayes Street (also referred to as "near road"), Providence
6. 10 Bay Street, Providence
7. Providence Community Health Centers, Warren Way, Providence
8. 385 Niagara Street, Providence

By taking a proactive approach to air quality monitoring this historic data will be available as needed in the future.

6

Technology

Looking forward to the year 2040 requires a new framework for how we think about transportation. Technology is changing how we think about mode choice, introducing new opportunities for shared mobility, and altering the traditional design and function of the automobile, something that has been unchanged in over 100 years.

Key trends in transportation technology that will be explored include:

- Mode Choice in a Sharing Economy
- Shared Mobility
- Connected and Autonomous Vehicles

Mode Choice in a Sharing Economy

The sharing economy has been developing and growing since the 2000s. The sharing economy is defined as "an economic system in which assets or services are shared between private individuals, either free or for a fee, typically by means of the

internet."[40] Typically, the sharing economy is characterized by individuals using the internet to communicate one-on-one (peer-to-peer) to advertise or seek goods or services. The nearly ubiquitous presence of smartphones has allowed transactions in the sharing economy to happen faster and in real-time. Common examples of the sharing economy are Craigslist or eBay for buying and selling goods, Airbnb for renting out a home or apartment for a short-term stay like a hotel, Car2go for access to a pool of vehicles used for local trips (carshare), Hubway or Citibike for access to a pool of bicycles (bikeshare), and Uber or Lyft for ride-hailing/ridesourcing as a taxi may have been used in the past (rideshare). Examples such as Car2go, Hubway, and Uber make the link to transportation undeniable.

Traditionally, mode choice includes options such as personal automobile (single occupancy vehicle), carpool, public transportation (rail, subway, bus), bicycle, and walking. While carshare can still be viewed as a personal automobile and rideshare is a variation on carpooling, the sharing economy changes the incentives and factors involved in choosing a mode. Ride-hailing services, also known as ridesourcing, ridesharing, and transportation network companies, have been rapidly growing in popularity since the early 2010s.

Surveys conducted from 2014 to 2016 in seven major U.S. cities drew the following conclusions about ride-hailing services[41]:

- In major cities, 21 percent of adults personally use ride-hailing services; an additional 9 percent use ride-hailing with friends, but have not installed the app themselves.
- Nearly a quarter (24 percent) of ride-hailing adopters in metropolitan areas use ride-hailing on a weekly or daily basis.
- Parking represents the top reason that urban ride-hailing users substitute a ride-hailing service in place of driving themselves (37 percent).
- Avoiding driving when drinking is another top reason that those who own vehicles opt to use ride-hailing versus drive themselves (33 percent).
- Only 4 percent of those aged 65 and older have used ride-hailing services, as compared with 36 percent of those 18 to 29.
- College-educated, affluent populations have adopted ride-hailing services at double the rate of less educated, lower income populations.
- 29 percent of those who live in more urban neighborhoods of cities have adopted ride-hailing and use them more regularly, while only 7 percent of suburban areas around major cities use them to travel in and around their home region.

40 Oxford Dictionaries. 2017. Definition for Sharing Economy. URL: https://en.oxforddictionaries.com/definition/sharing_economy. Accessed November 2017.

41 Clewlow, Regina R. and Gouri S. Mishra. 2017. "Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States." Institute of Transportation Studies, University of California, Davis. Research Report UCD-ITS-RR-17-07.

While the participants surveyed may not be representative of Rhode Island as a whole, projections for growth in the area of ride-hailing show that ride-hailing can be expected to continue to grow with increasing use in major cities and be entering new localities.

Goldman Sachs Group completed an assessment in 2017 titled *Rethinking Mobility* on the future of ride-hailing services and their impact looking into the future. Some key points that can inform trends in Rhode Island include:

- 'Cloud' mobility is changing how cities move: this could include ride-hailing, smart shuttle bus services, or car sharing services, among other technologies.
- Ride-hailing is 33 percent the size of today's global taxi market, but could grow eightfold to $285 billion by 2030, ultimately outsizing the taxi market by 5.3 times.
- In San Francisco, the ride-hailing market is now four times the size of the taxi market, representing the growth potential for ride-hailing.
- Alternatively, low population density areas with high rates of vehicle ownership that are characteristic of areas of the state may limit the ability for ride-hailing to grow significantly.

Both the assessment of current ride-hailing utilization and the projections of the future ride-hailing market suggest that ride-hailing plays an important role in transportation choices and has changed some of the traditional views on modes and mode choice. Up to this point, much of the discussion has been focused on using ride-hailing as a substitution for a personal automobile or a taxi service, however, these are not the only roles emerging for ride-hailing services.

Ride-Hailing and Public Transportation

While ride-hailing has been characterized as a substitute for taxi service, it has also been identified as a complement to public transportation. The following two examples of ways that ride-hailing is being used to enhance access to public transportation services.

These examples show areas where there is potential for growth in the ride-hailing industry outside of high-density populations and low-car ownership areas. These examples are specific to moderate to low density populations and not contingent on car-ownership or lack of ownership.

First-Mile/Last-Mile Gap

Localities and public transit agencies have begun various pilot programs that are geared toward using ride-hailing to fill first-mile/last-mile public transportation gaps. The problem of the first-mile/last-mile is that public transit may be available for the vast majority of a commute, however, is not available for the first-mile/last-mile at an individual's home or destination. Pilot programs geared toward closing the first-mile/last-mile gap subsidize ride-hailing to/from major commuter stations.

By doing so, new incentives are put in place to encourage public transportation use and reduce the need for parking.

In 2016, Summit, New Jersey started a pilot program that applies subsidies to Uber rides to its congested train station to reduce parking demand. Riders in the program who have a parking permit can instead use Uber to travel to the station at no cost. Those who do not have a parking permit will be charged $2 for the Uber ride. The remaining cost to Uber is covered by the town. Other municipalities or agencies that have considered similar programs include Centennial, CO, San Clemente, CA, LA Metro (Los Angeles, CA), and Sound Transit (Seattle, WA). The goal of these programs is to incentivize transit use in metropolitan areas.

Paratransit

Paratransit services provide door-to-door service for disabled persons unable to board a bus using the lift/ramp or unable to travel to a bus stop. Paratransit service helps fill basic mobility needs for those individuals. Rhode Island Public Transit Authority (RIPTA) provides this service through their RIde program. Similarly, RIPTA provides a Flexible (Flex) Service program that allows passengers in Flex Areas with little or no fixed-route service to utilize flex vans by reservation.

In October 2017, the Greater Attleboro-Taunton Regional Transit Authority (GATRA) received a $30,000 grant from the Massachusetts Department of Transportation to support a pilot program to expand the Dial-A-Ride program to provide services on evenings and weekends using Uber service. Dial-A-Ride provides door-to-door transportation service for passengers with an ADA requirement and for senior citizens unable to use fixed-route service.

Competition with Public Transportation

Ride-hailing may also compete directly with public transportation. In a 2018 survey of ride-hailing customers in Boston, 42 percent of respondents said that had ride-hailing not been an option, they would have taken public transportation. The same study estimates that 12 percent of ride-hailing trips are *transit substitute* trips during the morning and evening commute periods. Interestingly, this transit substitution appears more prevalent among riders who have weekly or monthly transit passes – they are willing to not use transit even though the cost of ride-hailing is much higher, and even though they have already paid for transit use.[42]Shifting from larger vehicles like buses to smaller vehicles, such as ride-hailing vehicles, increases vehicle miles travelled and drives up congestion and air pollution. Increased congestion is always a problem for buses, which have to share the road with other types of vehicles and don't have the ability to change routes. Slow travel times decreases the attractiveness of public transportation as an option.

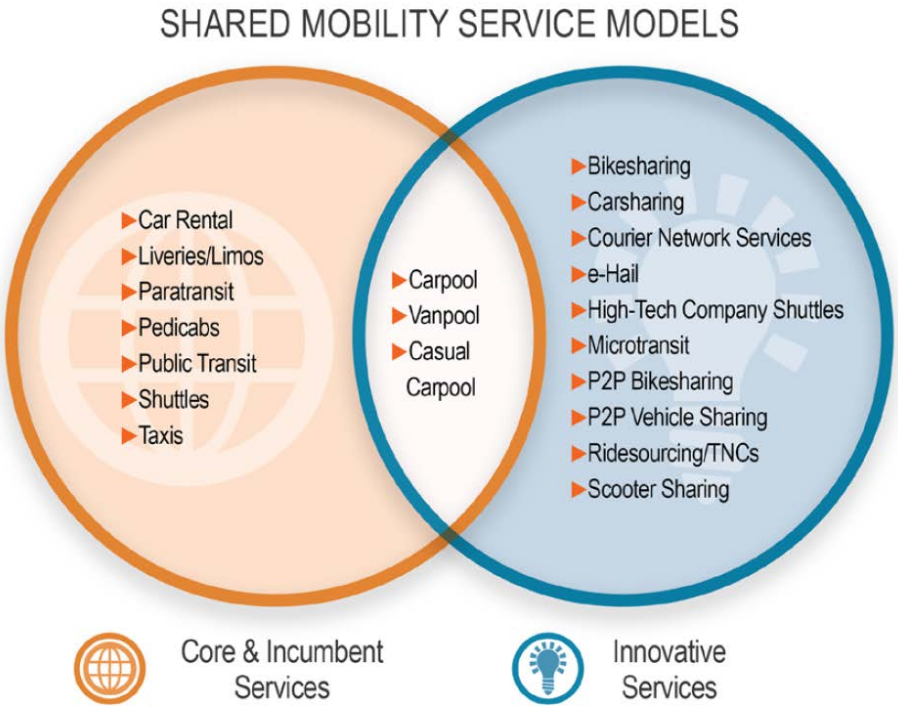
42 Metropolitan Area Planning Council. 2018. "Fare Choices: A Survey of Ride-Hailing Passengers in Metro Boston. Report #1." February 2018.

Shared Mobility

The Federal Transit Administration (FTA) defines shared mobility as "Transportation services that are shared among users, including public transit; taxis and limos; bike sharing; car sharing; ride sharing; ride sourcing; scooter sharing; shuttle services; neighborhood jitneys; and commercial delivery vehicles providing flexible goods movement". Shared mobility as a transportation strategy is one that offers and connects several shared use services and tools to create a comprehensive transportation network serving user needs on-demand without reliance on a personal automobile.

Figure 7-1 illustrates existing or incumbent transportation services and emerging or innovative services and where overlaps exist.

Figure 7-1 Incumbent and Innovative Transportation Services



Source: US Dept. of Transportation. 2016. "Shared Mobility: Current Practices and Guiding Principles." Report No. FHWA-HOP-16-022. Federal Highway Administration. Washington, DC.

Who is Using Ride-Hailing Services?

- *Mostly under 35*
- *Use the service weekly*
- *Don't own a car*
- *Incomes are similar to the region overall*
- *Where To? Most trips start/end at home, but another third are from one non-home location to another*
- *Travel Alone – Most don't share the ride with others, but prefer to travel alone*
- *Willing to Pay – 66% of trips cost more than $10 and 20% cost more than $20*
- *If I hadn't hailed a ride, I would've:*
  - *Walked or biked (12%)*
  - *Taken transit (42%) – estimated 12% of ride-hailing trips substitute for a transit trip during the morning or afternoon commute period*

This transit substitution is more frequent among riders with a weekly or monthly transit pass. Those who ride transit are more likely to drop it for ride-hailing, even while doing it at a huge cost differential, and even when they have already paid for transit.

-Metropolitan Area Planning Council, 2018

Using rideshare to supplement parking garages or paratransit services as described in the previous section are two examples of isolated programs that could be elements of a broader shared mobility strategy.

The Federal Highway Administration *Shared Mobility Primer* (April 2016) summarizes some of the key trends impacting shared mobility and its growth potential.

- Commuting patterns are more variable than they have been in the past. This is due to increasing opportunities for telecommuting, growing part-time employment, and shifts toward electronic communication rather than face-to-face meetings.
- Increases in part-time employment also opens a market for drivers who might be seeking opportunities to earn additional wages.
- E-commerce continues to enter more and more retail markets allowing more purchases to be made online and products to be delivered directly to homes and businesses.
- Services, not just products, are moving online. Examples include delivery takeout services that can deliver prepared foods not typically available for delivery and e-medical services that allow a diagnose to be made through teleconference and prescriptions to be delivered.
- The near ubiquity of smart phones, personal devices, and internet access enables greater adoption of shared and on-demand services.

What these findings point to is fewer trips and a lower need for a personal automobile with a greater need for shared on-demand services and delivery services.

As shared modes continue to expand incumbent modes will need to integrate with new modes or risk being lost in a new transportation landscape.

While Rhode Island may not offer all elements defined in a shared mobility network (e.g., bikeshare, carshare), the core structure is present in the existing public transit network provided by Rhode Island Public Transit Authority (RIPTA) and the Massachusetts Bay Transit Authority (MBTA) Commuter Rail. The emerging sharing modes described can all complement the access and mobility provided by public transportation services creating new incentives to ride public transit and ultimately opportunities to capture new riders. This also presents an opportunity to reduce single occupancy vehicle use and car ownership. A trend that can link to broader benefits both within and outside the transportation sector.

Strategies and Policies

This section provides examples of strategies and policies that could be adopted to build a transportation network around the shared mobility concept.

Option Zones

Option zones is a concept adopted in Portland, Oregon in the late 2000s when car sharing was a growing trend. Although shared transportation has changed greatly in that time, the option zone concept is still relevant. Option zones are on-street zones formerly used for metered parking that are designated for car sharing. While car sharing parking is not limited to these zones there is incentive in having a designated parking area. These zones are enhanced by changing the existing parking meters into bike racks providing a link between the two modes. With thoughtful planning, a bus stop located adjacent to an option zone could further link the modes allowing for seamless intermodal connections. Similar applications include:

- Bay Area bikeshare has coordinated with Caltrans to co-locate bikeshare stations at key transit stations improving connections from San Francisco to San Jose.
- Washington Metropolitan Area Transit Authority is providing carshare parking at 45 metro stations.
- In 2017, the City of Boston released a transportation vision plan titled Go Boston 2030. The plan takes the option zone a step further and proposes to install multi-modal microHUBs in neighborhoods around the City.

Mobility microHUBs:

Centered around T-stations, bus network nodes, and local destinations such as community centers and small business districts, Mobility microHUBs are designed to provide and identify a range of connected travel choices. Using clearly-branded kiosks or nodes with real-time interactive information displays about transit schedules and shared vehicle availability, people can connect quickly between bus and train service, a Hubway station, secure bike parking, car share vehicles, ride-hailing pick-up spots, and electric vehicle charging stations at every microHUB. Coupled with free Wi-Fi and intuitive wayfinding, these nodes become reliable ways to start, continue, or complete a multimodal journey. Placemaking strategies including plazas or parklets, sidewalk amenities, information signs, shelters, and works of art at each of these hubs will make them places that are worth stopping in when you have the time or if you have to wait.

-Go Boston 2030

Operational Integration

In addition to physically integrating modes through co-located facilities, services can also be operationally integrated for seamless transitions between modes. A system that utilizes fare integration could provide users with a single fare card to access an entire network of mobility options: commuter rail, bus, bikeshare. Making multimodal trips could also be incentivized through an integrated fare approach by providing some cost savings when transferring modes.

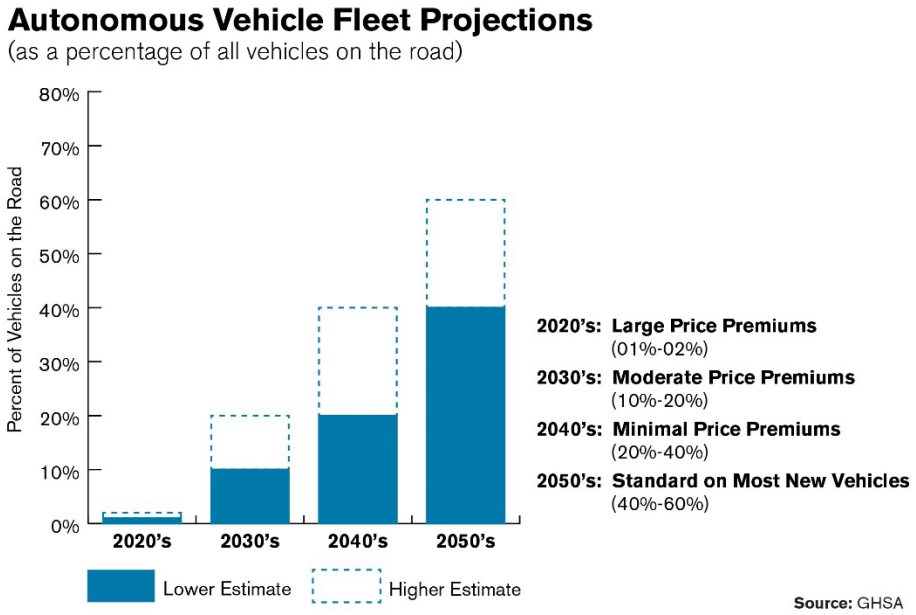
Los Angeles County Metropolitan Transportation Agency (LA Metro) operates both the transit network and bikeshare. This allows seamless integration for operations including a single access pass for users.

Connected and Autonomous Vehicles

Connected and autonomous vehicles could be the most significant change to transportation over the next 20 years. Today, many have heard of "self driving" cars or "driverless" cars, and some vehicles are marketed with technology that can allow drivers to release control to the vehicle. Looking out to the year 2040 such technology could become commonplace. This section summarizes some key points to understand about connected and autonomous vehicle technology and the impacts that they could have on transportation.

The Governors Highway Safety Association published a research spotlight about autonomous vehicles in 2017. This document suggests that by the year 2040 between 20 percent and 40 percent of the vehicle fleet could be autonomous vehicles with a minimal premium on the price of the vehicle.

Figure 7-2 Autonomous Vehicle Fleet Projections

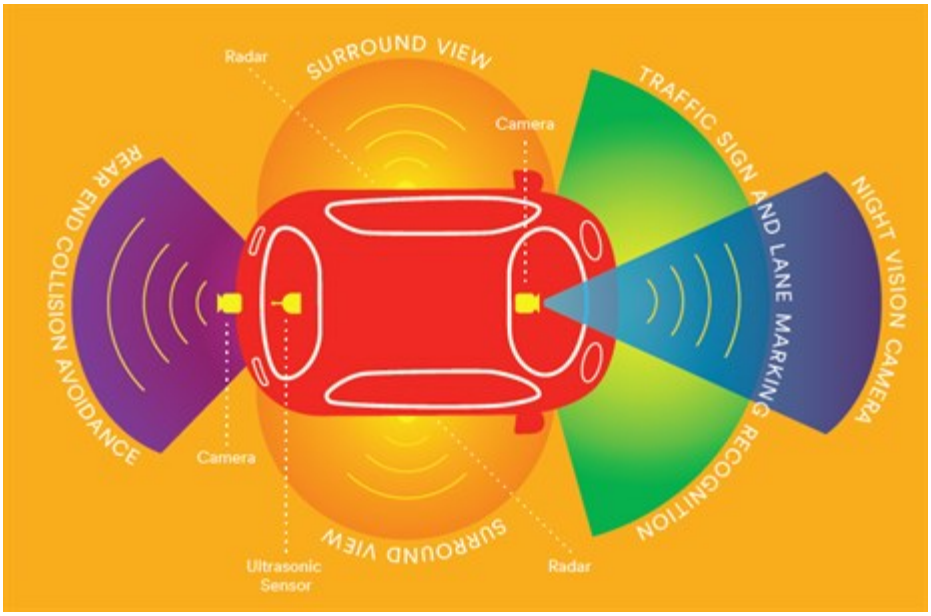


Source: Hedlund, James. 2017. "Autonomous Vehicles Meet Human Drivers: Traffic Safety Issues for States." Governors Highway Safety Association.

Connected and autonomous vehicles are two different types of technologies that could change driving. Table 7-1 describes each of these technologies and how the two technologies complement one another.

Autonomous vehicle development is driven by automobile and technology developers and manufacturers, and the vehicles themselves operate in an isolated way using several sensing devices to identify and read cues in the environment (for example: roadway striping, signs, other road users). Figure 7-3 shows an example of the range of sensors needed for autonomous operations.

Figure 7-3 Autonomous Vehicle Sensing



Source: ITS America. 2017. "3M Reflects on why CAVs need lines and signs" May 19, 2017. URL: http://www.itsinternational.com/sections/nafta/features/3m-reflect-on-why-cavs-need-lines-and-signs/.

Connected vehicles use communication and computing technology to communicate or connect with other vehicles (vehicle-to-vehicle, V2V), with infrastructure (vehicle-to-infrastructure, V2I), or with another device (vehicle-to-anything, V2X). A major implementation hurdle for connected vehicles is in equipment deployment. Autonomous vehicles operate independently, not relying on others for data. V2V communication would require all vehicles to have communications equipment, and V2I would additionally require infrastructure (traffic signals, signs, etc.) to be equipped with communications devices. Looking beyond deployment, maintaining this equipment will be an important need to keep the system operating smoothly.

The key difference between connected and autonomous vehicles is that autonomous vehicles are operating in an isolated way, collecting information online and through vehicle sensors to maneuver the driving environment, while connected vehicles are working cooperatively with other vehicles and infrastructure to gather information and make wise decisions to avoid collisions, reduce travel time, reduce fuel consumption, and enhance the driving task. Because these two technologies are taking different approaches to driving, they also become complementary. A connected/autonomous vehicle can utilize observed data collected through sensors, communicated data shared by other road users, and allow vehicle control over the driving task to optimize travel.

Table 7-1 Connected/Autonomous Vehicle Types

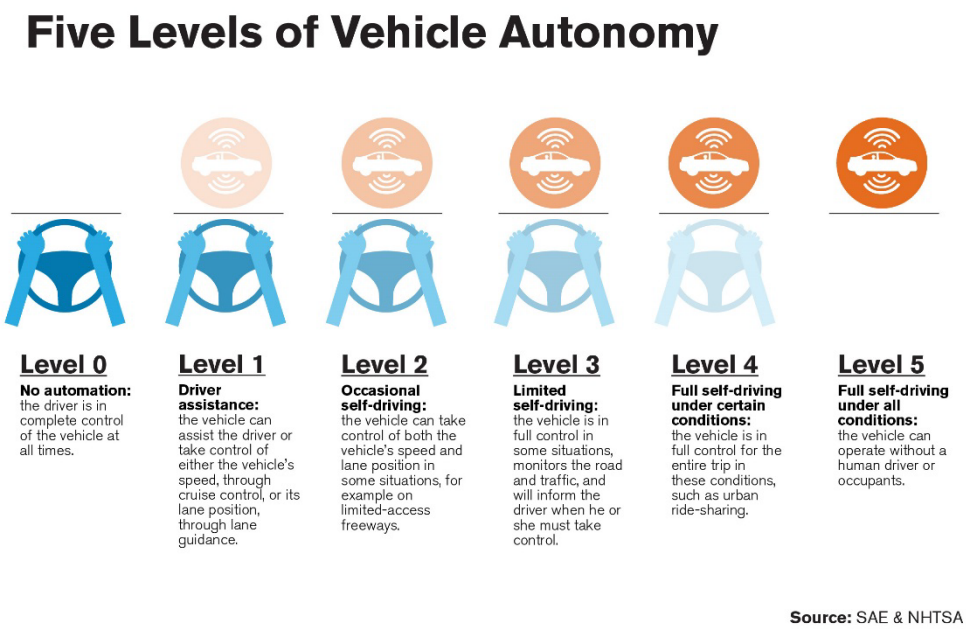
Vehicle Types	Definition
Connected Vehicle (CV)  Source: USDOT	Vehicle uses computing and sensing technology and wireless communication to collect and share information between vehicles (vehicle-to-vehicle, V2V), with infrastructure (vehicle-to-infrastructure, V2I), or with mobile devices (vehicle-to-anything, V2X) to enhance safety, operations, and mobility. Connected vehicle technology relies on vehicles that are equipped with a technology package that will allow communication and data sharing with other vehicles or the infrastructure. Similarly, infrastructure elements must be equipped with a technology package to allow data sharing and communication. Progress toward connected vehicle deployment is incremental based on application development. The pace and direction is dictated by vehicle manufacturers, technology, and academia and research.
Autonomous Vehicle (AV)  Source: Google www.waymo.com	Vehicle transitions safety-critical driving tasks (steering, braking, decelerating) from the driver to the vehicle. The level of vehicle automation is dependent on the range of safety-critical driving tasks shifted to the vehicle and the driver level of responsibility for monitoring the driving environment. Vehicle manufacturers partnered with technology firms have the highest level of control over the direction of progress on autonomous vehicle development and deployment with policy and legislation driven by the government.
Connected/Autonomous Vehicle (C/AV)  Source: USDOT	The functionality of a connected vehicle for data sharing in conjunction with self-driving autonomous vehicles can enhance vehicle capabilities and outcomes. The driving environment for an autonomous vehicle is limited to nearby elements it can independently sense through technologies such as Light Detection and Ranging (LIDAR). Connected vehicles can expand that range through wireless communication making them aware of connected elements or hazards as much as 1,000 feet away. Similarly, connected vehicles can help drivers reduce reaction time to sudden changes in the driving environment.

Currently, some connected vehicle applications are on the market that rely on sensors and cameras to take some tasks from drivers (for example, emergency braking to prevent a rear end crash, correcting driving alignment to avoid a run off the road crash), however, V2V and V2I communication is not publicly available. The National Highway Traffic Safety Association (NHTSA) has proposed a rule to require

automobile manufacturers to begin including communications hardware standard in new automobiles within two years, however, no decision has been made on the rulemaking.

Currently, some automobile manufacturers offer vehicles with self-driving operating modes (Tesla) and many more offer limited self-driving applications such as automatic parallel parking or automatic braking (similar to connected vehicles). NHTSA has identified five levels of autonomous driving. Level five is fully autonomous under all driving environments. No manufacturer is selling a level five fully autonomous vehicle.

Figure 7-4 Five Levels of Vehicle Autonomy



Source: SAE & NHTSA

Changing Trends

Unlike ride sharing and other shared mobility practices, connected/autonomous vehicle technology is in the earliest stages of adoption with a great deal of development and policy making yet to come. How driving trends could change over the next 20 years is unclear. The Victoria Transport Policy Institute offers several predictions for possible scenarios (see Table 7-2).

Many of these trends lend themselves to increased vehicle travel, parking needs, and roadway costs. Additionally, studies typically agree that there are opportunities to enhance traffic safety through connected/autonomous vehicles due to their ability to perceive dangerous situations and react quickly; reducing perception reaction times typical of human drivers, particularly those who are distracted. Table 7-3 summarizes some of the possible benefits and costs of autonomous vehicles.

Table 7-2 Some Possible Future Autonomous Vehicle Scenarios

Scenario	Travel Impacts	Infrastructure Impacts
Independent mobility for non-drivers Jake is an affluent man with degenerating vision. In 2026 his doctor convinced him to give up driving. He purchases an autonomous vehicle instead of shifting to walking, transit and taxies.	Increased vehicle travel and external costs	Increased residential parking and roadway costs
Vehicle cost savings Bonnie lives and works in a suburb. She can bike to most destinations but occasionally needs to travel by car. In a city she could rely on taxis and carsharing, but such services are slow and expensive in suburbs. However, starting in 2030 a local company started offering fast and affordable automated taxi services.	Reduced vehicle ownership and travel	Reduced residential parking and roadway costs
Improved home location options Malisa and Johnny have two children. Malisa works at a downtown office. After their second child was born in 2035, they shopped for a larger home. With conventional cars they would only consider houses within a 30-minute drive of the city, but more affordable new autonomous vehicles let them consider more distant homes, with commutes up to 60-minutes, during which Malisa could rest and work.	Increased vehicle ownership and travel	Increased residential parking and roadway costs
Avoids driving drunk and associated consequences Garry is hard-working and responsible when sober, but a dangerous driver when drunk. By 2040 he had accumulated several impaired citations and caused a few accidents. With conventional cars Garry would continue driving impaired until he lost his drivers' license or caused a severe crash, but affordable used self-driving vehicles allow lower-income motorists like Garry to avoid such problems.	Less high-risk driving, more total vehicle travel	Increased residential parking and roadway costs

Source: Litman, Todd. 2017. "Autonomous Vehicle Implementation Predictions: Implications for Transport Planning". Victoria Transport Policy Institute. September 8, 2017.

Table 7-3 Autonomous Vehicle Potential Benefits and Costs

Benefits	Costs/Issues
Reduced driver stress. Reduce the stress of driving and allow motorists to rest and work while traveling. Reduced driver costs. Reduce costs of paid drivers for taxis and commercial transport. **Mobility for non-drivers.** Provide independent mobility for non-drivers, and therefore reduce the need for motorists to chauffeur non-drivers, and to subsidize public transit. **Increased safety.** May reduce many common accident risks and therefore crash costs and insurance premiums. May reduce high-risk driving, such as when impaired. **Increased road capacity, reduced costs.** May allow platooning (vehicle groups traveling close together), narrower lanes, and reduced intersection stops, reducing congestion and roadway costs. **More efficient parking, reduced costs.** Can drop off passengers and find a parking space, increasing motorist convenience and reducing total parking costs. **Increase fuel efficiency and reduce pollution.** May increase fuel efficiency and reduce pollution emissions. **Supports shared vehicles.** Could facilitate car sharing (vehicle rental services that substitute for personal vehicle ownership), which can provide various savings.	**Increases costs.** Requires additional vehicle equipment, services and maintenance, and possibly roadway infrastructure. **Additional risks.** May introduce new risks, such as system failures, be less safe under certain conditions, and encourage road users to take additional risks (offsetting behavior). **Security and Privacy concerns.** May be used for criminal and terrorist activities (such as bomb delivery), vulnerable to information abuse (hacking), and features such as GPS tracking and data sharing may raise privacy concerns. **Induced vehicle travel and increased external costs.** By increasing travel convenience and affordability, autonomous vehicles may induce additional vehicle travel, increasing external costs of parking, crashes and pollution. **Social equity concerns.** May have unfair impacts, for example, by reducing other modes' convenience and safety. **Reduced employment and business activity.** Jobs for drivers should decline, and there may be less demand for vehicle repairs due to reduced crash rates. **Misplaced planning emphasis.** Focusing on autonomous vehicle solutions may discourage communities from implementing more cost-effective transport solutions such as better walking and transit improvements, pricing reforms and other demand management strategies.

Source: Litman, Todd. 2017. "Autonomous Vehicle Implementation Predictions: Implications for Transport Planning". Victoria Transport Policy Institute. September 8, 2017.

One key takeaway of these possible future scenarios is that policy making and transportation investment in a network that prioritizes multiple types of shared mobility presents the best opportunity to leverage connected/autonomous vehicles to reduce vehicle travel and transportation costs.

Applications and Strategies

This section describes strategies, applications, and pilots available today in the field of connected/autonomous vehicles.

Autonomous Vehicle Test-Beds

As of January 2017, the US Department of Transportation has designated ten automated vehicle proving grounds around the county to foster development of autonomous vehicle technology. While none of these sites are in New England, nearby, the City of Boston has passed legislation to allow self-driving vehicle testing.

Boston allows self-driving vehicle testing in two areas in the Seaport: South Boston Waterfront (designated for nuTonomy) and Raymond Flynn Marine Park (designated for Optimus Ride and Delphi). Before allowing on-street testing, the City of Boston requires that AV companies meet certain functionality and safety standards.

From a policy standpoint, the City of Boston is interested in partnerships within the following four areas: 1) vehicle technology testing focused on Boston's unique environment; 2) business model exploration that speaks to the goals of the Go Boston 2030 transportation vision plan; 3) experiments with connected transportation infrastructure; and 4) research and engagement with the public on autonomous mobility and workforce implications. By setting these clear policies, the City of Boston seeks to help guide the development and deployment of connected vehicle technology.

Rideshare

In September 2016, Uber began testing rides using self-driving vehicles in Pittsburgh, Pennsylvania. Use of autonomous vehicles for ride sharing has both advantages and disadvantages. Without a driver, ride costs could be reduced and travel could become more efficient, which leads to a service that is more widely available to more people with fewer barriers. Alternatively, removing drivers eliminates jobs. Pittsburgh has seen an increase in jobs for high-tech careers due to the Uber pilot, has not yet seen low-tech jobs to offset those lost by drivers.

Transit

Public transit has been another opportunity to pilot autonomous vehicles. Smaller shuttles seating approximately 15 people are being piloted on routes on campuses and universities. Autonomous vehicles typically need to learn their surroundings and can repeat a route, which lends itself to public transportation. Autonomous transit vehicles could become an opportunity for a public transportation authority to provide mobility on lower density flex routes at lower cost. An autonomous shuttle bus may also be able to more easily adapt to adding or skipping stops as needed. Such a service may utilize a single "driver" at a central location monitoring multiple vehicles on fixed routes.

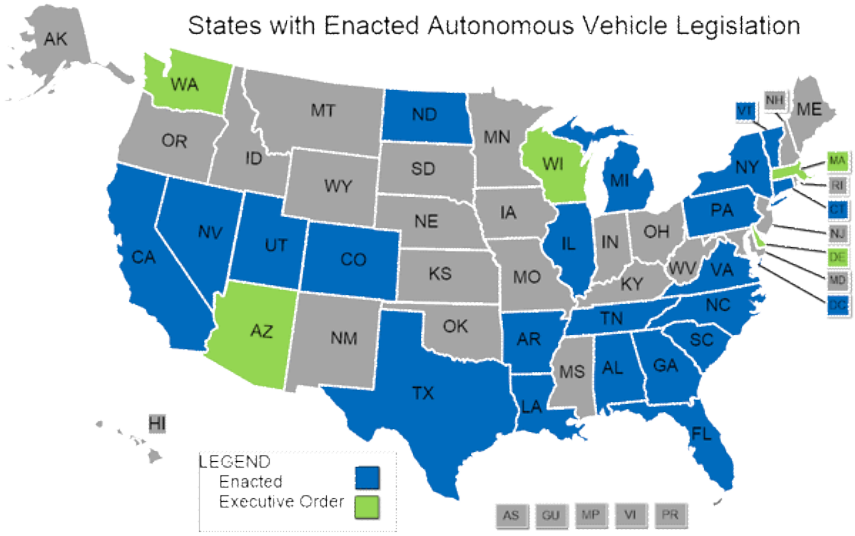
Figure 7-5 NAVYA Self-Driving Shuttle

State of the Practice

Nationally, states around the country have begun proposing and passing legislation to help guide the deployment of connected/autonomous vehicle technology, foster research, and leverage the benefits that technology can bring locally.

While Rhode Island has not enacted legislation on autonomous vehicles, Rhode Island has still made substantial progress through strategies and initiatives championed by the Rhode Island Department of Transportation. Currently, a request for information has been released inviting developers to work with the state on testing opportunities.

Figure 7-6 States with Enacted Autonomous Vehicle Legislation



Source: National Conference of State Legislatures. 2017. "Autonomous Vehicles: Self-Driving Vehicles Enacted Legislation." URL: http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx. Accessed: November 2017.

7

Next Steps

This Trends Report is one study of several that will be used to develop the Long-Range Transportation Plan: Rhode Island Moving Forward.

In addition to this Trends Report the following technical reports are under development to inform the Long-Range Transportation Plan:

- Compendium of Plans Review
- Baseline Conditions Report
- Stakeholder Outreach Report
- Systems Needs Assessment
- Implementation Program

Simultaneously, public outreach efforts including presentations to stakeholders and transportation professionals and public workshops have been taking place and will continue through the duration of the project. These events solicit valuable feedback and providing an ongoing sounding board for the project.

Appendix

Rhode Island Socioeconomic and Transportation Trends Report

Rhode Island Moving Forward

Long Range Transportation Plan

PREPARED FOR

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Division of Planning
Department of Administration
State of Rhode Island
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PREPARED BY

IN ASSOCIATION WITH
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EDR Group
Pare Corporation

MARCH 2018

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Introduction

The purpose of this memo is to provide a profile of socioeconomic trends and forecasts for Rhode Island residents, and an assessment of the state economy and expectations for the future. Included are selected transportation measures that highlight the role transportation plays in the lives of Rhode Islanders.

This trends analysis complements the existing conditions report by reviewing key socioeconomic indicators. The forecasts will help inform readers about the expected future and the role transportation will likely play in that future. This information can be used to evaluate what transportation policy measures need to be leveraged to achieve future scenarios based on community outreach.

Several key conclusions are clear for population, workforce, and demographic factors:

- Rhode Island's population and employment are growing but retaining and attracting future workers is important to supporting a strong economy.
- The most prevalent jobs held by Rhode Island's current workforce do not pay well, but the job sectors with the greatest levels of future growth are more highly skilled and expected to provide higher salaries.

- A significant percentage or Rhode Island's residents live in poverty, though the poverty level is similar to the nation as a whole.
- Rhode Islanders predominantly commute by car and at higher rates than for the nation. Work commute times are generally on the rise.

These trends are expanded upon in greater detail below.

1.1 Population and Employment

- Rhode Island's population is projected to reach 1.14 million people by 2030, an increase of 8.4 percent over its 2010 level.
- By 2024, employment in Rhode Island is expected to reach between 496,000-527,000.
- Attraction of new workers and retention of existing workers and graduating students within Rhode Island must remain a priority to achieve a "vibrant sustainable economy," as outlined in Rhode Island Statewide Planning's Land Use 2025 report[1].
- The top three industries in Rhode Island as measured by employment are healthcare and social assistance (16.3 percent of total employment), government (12.2 percent), and food and accommodations (10.1 percent). Together these industries are expected to add 48,400 jobs by 2047.
- Administrative Services is forecasted to be the fastest-growing industry, adding 20,900 jobs by 2047, a 77 percent increase from 2017.
- Manufacturing is expected to continue a steep decline, employing 11,300 fewer workers in 2047 than in 2017.

1.2 Occupations

- Prevalent occupations in the state pay lower hourly wage rates compared to other occupations experiencing growth, and do not meet "living wage" criteria.
- Rhode Island's largest occupational profiles are office and administrative support (15 percent), food preparation and serving (10 percent), and sales (10 percent).
- These occupations are on the lower end of the median hourly wage scale:
  - Office and administrative support: $10.83/hour for hotel, motel, and resort desk clerk; up to $28.85 for administrative assistants
  - Food preparation: $9.68 for a waiter/waitress; up to $26.14 for a chef
  - Sales: $10.59 for a cashier; up to $58.24 for a sales engineer

[1] Rhode Island Department of Administration. 2006. "Land Use 2025: State Guide Plan Element 121, Report Number 109." Division of Statewide Planning. April 2006.

- A high percentage of these occupational profiles do not earn an "living wage," defined as the "minimum employment earnings necessary to meet a family's basic needs while also maintaining self-sufficiency."
- Occupational profiles with the largest expected growth are computer and mathematical (16 percent growth), construction and extraction (14 percent), and business and financial operations (12 percent) considered to be STEM-Intensive (science, technology, engineering, and math) occupations that provide higher salaries and hourly wage rates.

1.3 Poverty, Unemployment, and Education

- As of 2016, 13.8 percent of Rhode Island residents lived in poverty as defined by the Federal Poverty Level (FPL), an economic measure used to determine eligibility for certain government programs. This rate is 1.5 percent higher than the rate in 2005, but still slightly lower than the national poverty rate of 14 percent in 2016.
- Rhode Island's unemployment rate in 2016 was 5.3 percent and has been higher than the national unemployment rate since 2005 but is now starting to reach parity.
- From 2005 to 2016, the number of Rhode Island residents with a bachelor's degree or higher rose from 29.9 percent to 32.5 percent and is slightly higher than the national rate.

1.4 Household Travel

- Rhode Island is currently a car-centric state with increasing commute times.
- In 2016, the share of Rhode Islanders driving alone to work was 84.5 percent, compared to 76.3 percent nationally.[2]
- Over two-thirds of Rhode Island workers have a commute less than 30 minutes, and over 93 percent have a commute less than one hour.
- Between 2005-2016, the number of commutes less than 30 minutes decreased by 5 percent and the number of "super commutes" (greater than 90 minutes) grew by 38 percent.
- In 2016, 43.9 percent of Rhode Island households had two vehicles available and 30.3 percent had three or more vehicles available.[3]

[2] U.S. Census Bureau. 2016. "2016 American Community Survey 1-Year and 5-Year Estimates." URL: https://factfinder.census.gov/.

[3] Ibid.

2

Population and Employment

The number of people and jobs in Rhode Island are both expected to grow in the coming years, but at slower rates than in neighboring Massachusetts and the U.S. Expected employment growth in healthcare and several other industries will help offset steep losses in Rhode Island's manufacturing industry.

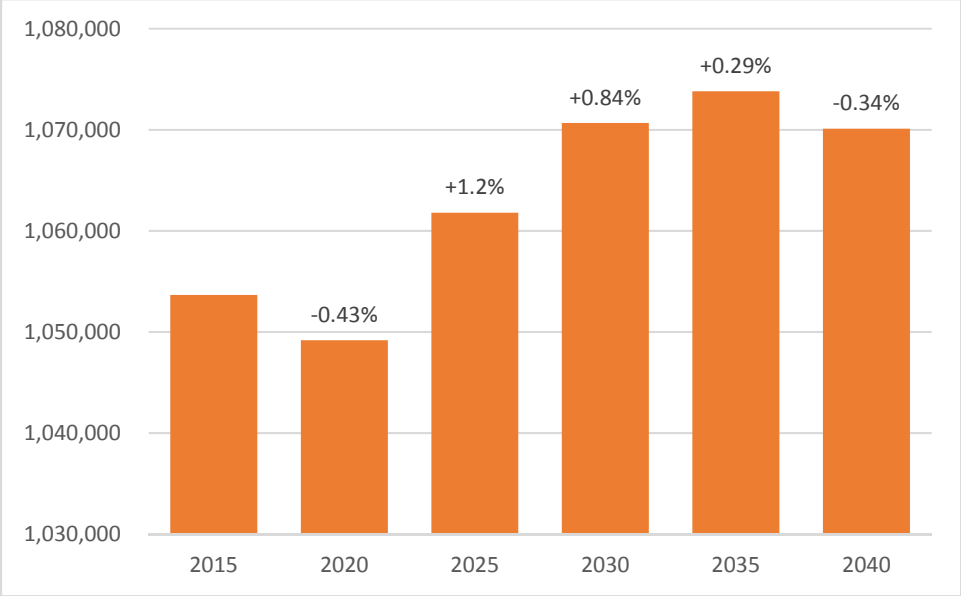
2.1 Population Change

Rhode Island's population is projected to reach 1.07 million people by 2040, an increase of 1.6 percent over its 2015 level (Figure 1).[4] Between 2015-2040, the number of births in Rhode Island is expected to decrease while the number of deaths is projected to increase, meaning that net population growth will come from people moving into the state. Between 2035-2040, the state is projected to lose population as the number of deaths exceeds the number of births and in-migrants.

[4] Rhode Island Dept. of Administration. 2013. "Rhode Island Population Projections 2010-2040, Technical Paper 162." Division of Statewide Planning. April 2013. URL: http://www.planning.ri.gov/documents/census/tp162.pdf. Accessed March 5, 2018.

From 2015-2040, the U.S. population is projected to grow by 18.3 percent.[5] The population of Massachusetts is projected to grow by 7.8 percent from 2015-2035 and the population of Connecticut is projected to grow by 1.7 percent from 2015-2040.[6] (Population projections for Massachusetts are available until only 2035.)

Figure 1 Rhode Island Historical and Projected Population (2015-2040)



Source: U.S. Census Bureau. 2016. "2016 American Community Survey 1-Year and 5-Year Estimates." URL: https://factfinder.census.gov/.

Rhode Island Department. of Administration. 2013. "Rhode Island Population Projections 2010-2040, Technical Paper 162." Division of Statewide Planning. April 2013.

5 U.S. Census Bureau. 2014. "2014 National Population Projection Tables." URL: https://www.census.gov/data/tables/2014/demo/popproj/2014-summary-tables.html. Accessed January 23, 2018.

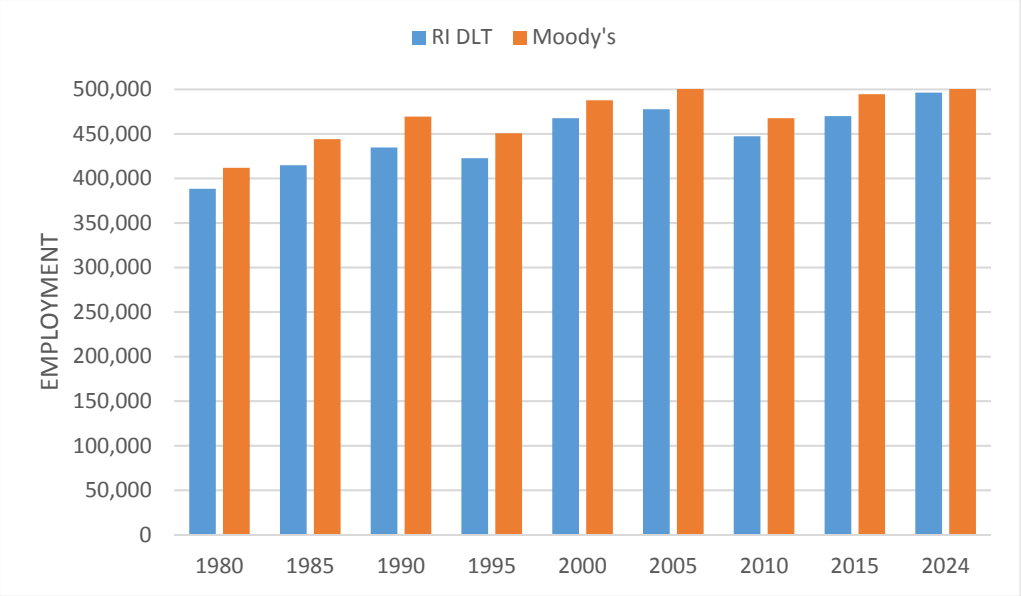
6 Office of the Secretary of the Commonwealth of Massachusetts. 2015. "Long-term Population Projections for Massachusetts Regions and Municipalities." UMass Donahue Institute. Boston, MA. March 2015. URL: http://pep.donahue-institute.org/downloads/2015/new/UMDI_LongTermPopulationProjectionsReport_2015%2004%20_29.pdf.

University of Connecticut. 2015. "2015 to 2040 Population Projections – State Level." Connecticut State Data Center. URL: https://ctsdc.uconn.edu/2015-to-2040-population-projections-state-level/. Accessed January 23, 2018.

2.2 Employment Change

By 2024, employment in Rhode Island is expected to reach between 496,000-527,000 jobs, depending on the forecast source (Figure 2).[7] This represents an increase of between 5.6-6.5 percent over 2015 employment levels. During this time, employment in Massachusetts is forecast to grow by 8.9 percent, employment in Connecticut is forecast to grow by 3.9 percent, and national employment is forecast to grow by 8.3 percent.[8]

Figure 2 Rhode Island Historical and Projected Employment (1980-2024)



Source: Rhode Island Dept. of Labor and Training (DLT). "Annual Average Covered Employment by Major Industry Division 1978-2002." URL: http://www.dlt.ri.gov/lmi/es202/statesic/annave.htm. Accessed March 22, 2018.

Employment forecasts developed by the Rhode Island Department of Labor and Training (DLT) and Moody's Analytics. Rhode Island Dept. of Labor and Training. "Occupational Outlook 2024." URL: http://www.dlt.ri.gov/lmi/pdf/occoutlook.pdf. Accessed March 22, 2018.

[7] Historical employment values from the Rhode Island Department of Labor and Training exclude employees of the federal government. To derive projected employment in 2024, we calculated the percent change from 2014-2024 and applied it to 2014 historical employment from the DLT source above. This was necessary because the Occupational Outlook includes data for only two points in time (2014 and 2024), and because 2014 employment is different in the Occupational Outlook than it is in the DLT source above.

[8] Moody's Analytics. Historical 2015 employment and employment forecast for 2024. URL: https://www.economy.com/databuffet. Accessed January 2018. According to employment forecasts produced by Moody's Analytics, in 2015 there were an estimated 17,740 federal government jobs in Connecticut. By 2024, Moody's forecasts that there will be 20,420 federal government jobs in Connecticut, an increase of 15.1 percent over the 2015 level.

Moody's Analytics. Historical employment for 1980-2015 and employment forecast for 2024. URL: https://www.economy.com/databuffet. Accessed January 2018.

If the number of jobs in Rhode Island grows faster than the number of people, the state will need to attract workers from elsewhere.[9] Attraction of new workers and retention of existing workers and graduating students must therefore remain a priority for the state. Attracting and retaining a talented workforce will help the state achieve its goal of creating a "vibrant sustainable economy," as outlined in the Land Use 2025 report.[10] One strategy for increasing the retention of high school and college graduates is to offer educational programs that prepare students for careers in Rhode Island's growing occupations (see Section 1.2.2).

The growth of Rhode Island's economy also depends in part on land use policies that increase access to jobs for the state's workers. These could include policies that increase employment density or support multiple modes of transportation (see more on the ways Rhode Islanders get to work in Section 3.1).

2.2.1 Employment by Industry

The top three industries in Rhode Island as measured by employment are healthcare and social assistance (16.3 percent), government (12.2 percent), and food and accommodations (10.1 percent) (Figure 3). Between 2017-2047, these industries are forecast to collectively add 48,400 jobs in Rhode Island according to Moody's Analytics (Figure 3). This represents 60.2 percent of total job growth across all Rhode Island's industries during the same period.

Among the remaining industries, administrative services are forecasted to be the fastest-growing industry in Rhode Island in percentage terms from 2017-2047. Today the industry employs 27,200 workers and by 2047 is forecast to employ 48,100 workers, an increase of 77 percent (Figure 3 and Figure 4).[11] Job categories in administrative services include the following[12]:

- Office administration;
- Hiring and placement of personnel;
- Document preparation and similar clerical services;
- Solicitation, collection, security and surveillance services;
- Cleaning; and
- Waste disposal services.

[9] Some Rhode Island residents may re-enter the workforce to fill job openings.

[10] Rhode Island Dept. of Administration. 2006. "Land Use 2025: State Guide Plan Element 121, Report Number 109." Division of Statewide Planning. April 2006.

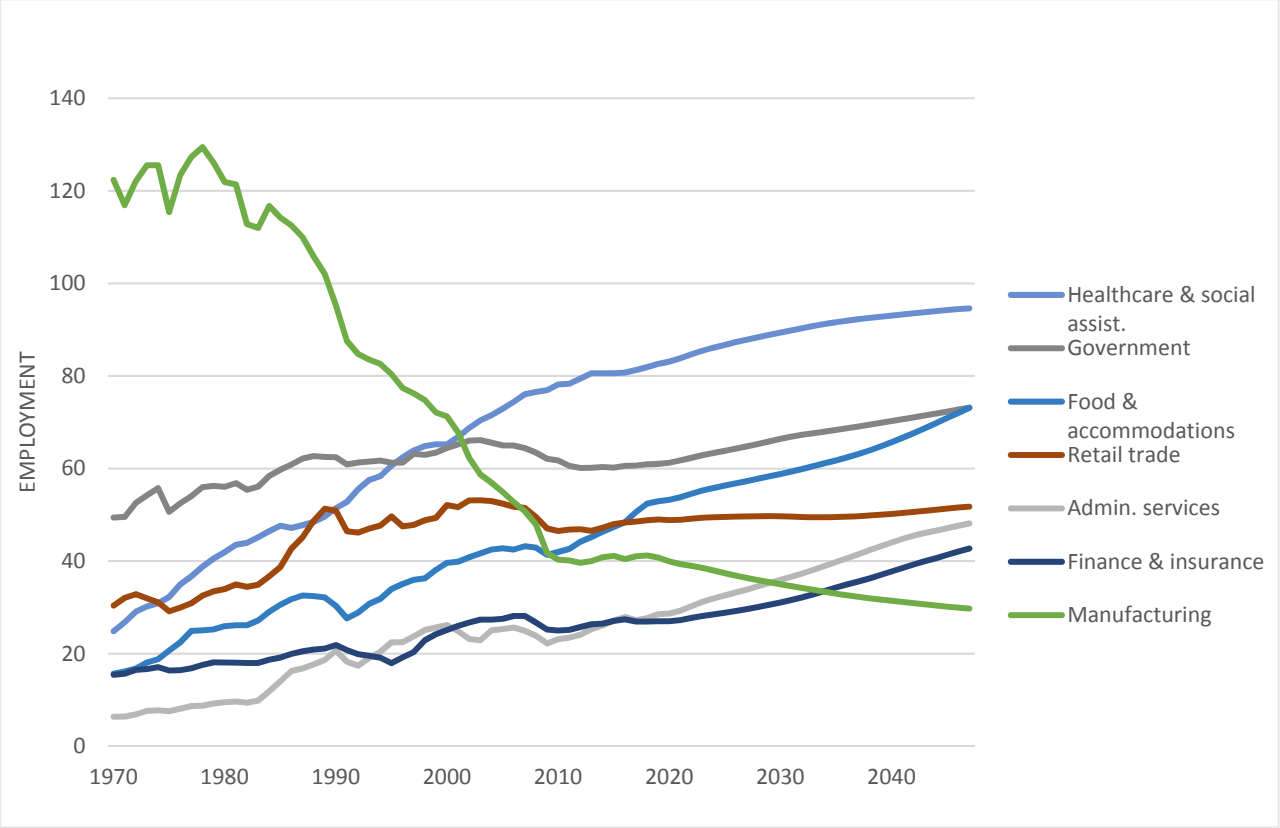
[11] Moody's Analytics. Employment forecasts. URL: https://www.economy.com/databuffet. Accessed January 2018.

[12] U.S. Dept. of Labor Bureau of Labor Statistics. 2018. "Industries at a Glance: Administrative and Support and Waste Management and Remediation Services: NAICS 56." URL: https://www.bls.gov/iag/tgs/iag56.htm. Accessed January 2018.

Finance and insurance is the second fastest-growing industry in Rhode Island. Between 2017-2047, employment in this industry is forecast to increase by 59 percent, a gain of 15,800 jobs.[13]

Manufacturing in Rhode Island is forecast to continue a steep decline that began in the 1980s. According to Moody's Analytics, by 2047 the industry will likely employ 11,300 fewer workers than it did in 2017, a decrease of 27.6 percent. This trend is also present in surrounding states and the nation, with declines in manufacturing employment expected in Connecticut (-22.5 percent), Massachusetts (-27.4 percent), and the U.S. (-25.7 percent).

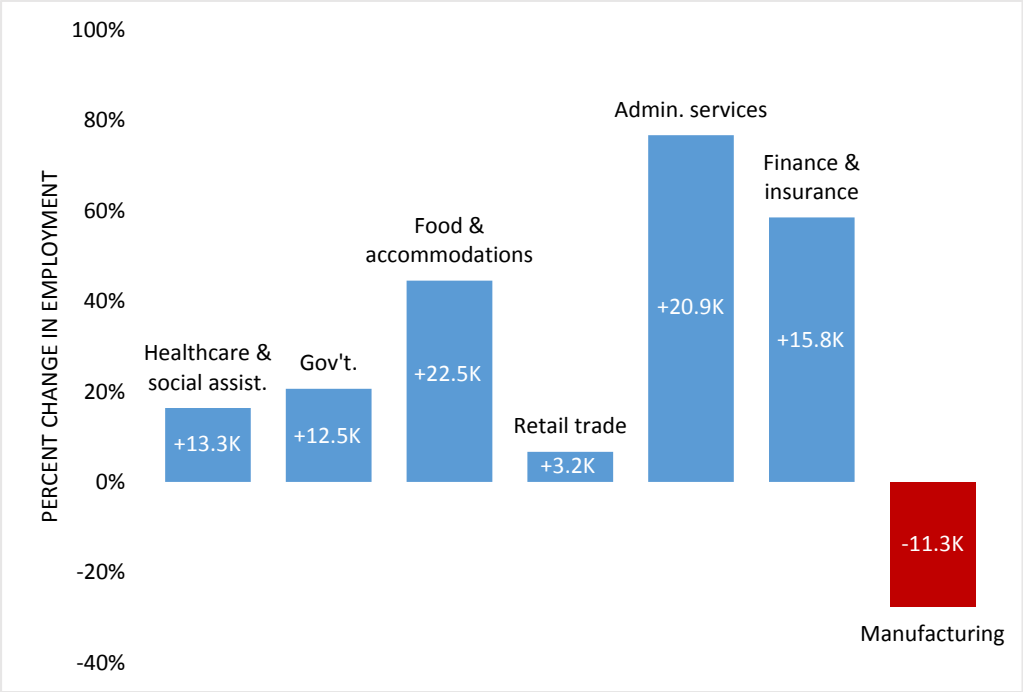
Figure 3 Rhode Island Historical and Forecasted Employment by Major Industry (1970-2047)



Source: Moody's Analytics. Historical employment for 1970-2017 and employment forecasts for 2018-2040. URL: https://www.economy.com/databuffet. Accessed January 2018.

[13] Moody's Analytics. Employment Forecasts, URL: https://www.economy.com/databuffet. Accessed in January 2018.

Figure 4 Change in Rhode Island Employment by Major Industry (2017-2047)



Source: Moody's Analytics. Historical employment for 1970-2017 and employment forecasts for 2018-2040. URL: https://www.economy.com/databuffet. Accessed January 2018.

Rhode Island's other industries are forecast to experience a mix of growth and decline by 2047. These other industries represent a third of total employment. Growth industries include construction (+19.9 percent); professional, technical, and scientific services (+18.2 percent); real estate (+11.7 percent); and other services (+2.2 percent).

The list of industries forecast to experience employment *decline* is longer, although overall employment in these categories is relatively smaller than major industries[14]:

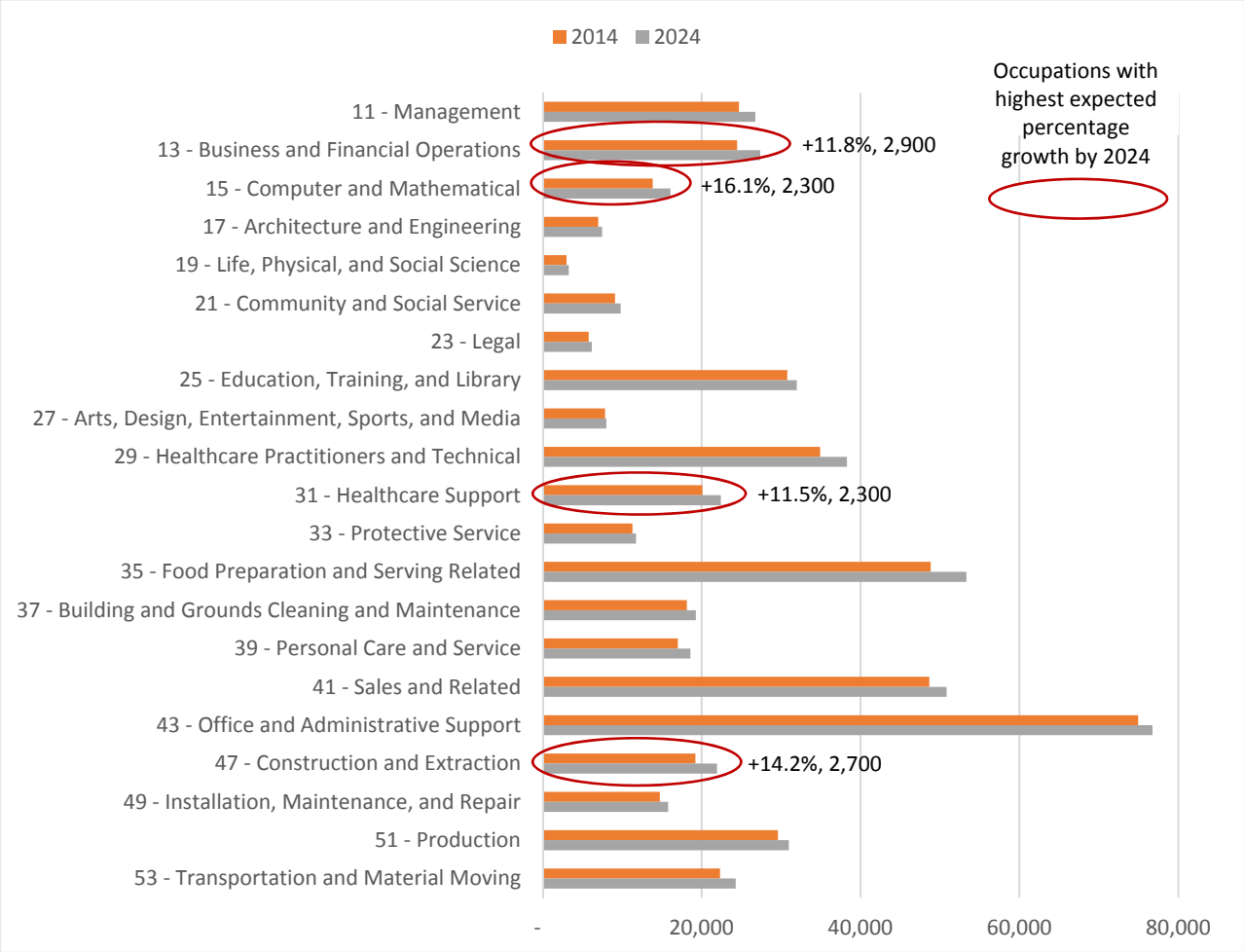
- Utilities (-29.1 percent)
- Mining, quarrying, and oil and gas extraction (-25.5 percent)
- Educational services (-10.4 percent)
- Management of companies and enterprises (-8.9 percent)
- Transportation and warehousing (-8.2 percent)
- Agriculture (-4.5 percent)
- Arts, entertainment, and recreation (-4.3 percent)
- Information (-3.2 percent)
- Wholesale trade (-3.0 percent)
- Fishing and hunting (-0.1 percent)

[14] Employment forecast developed by Moody's Analytics and accessed in January 2018.

2.2.2 Employment by Occupation

Occupational profiles are common across industries and provide insight into where certain jobs fall within a business's organizational hierarchy. Rhode Island's largest occupational categories by employment are in office and administrative support, which employs 75,000 workers (15.4 percent of total employment in 2014); food preparation and serving, which employs 48,800 (10 percent); and sales, which employs 48,700 (10 percent) (Figure 5).[15] Employment is projected to grow in all of these major occupational categories by 2024.

Figure 5 Rhode Island Employment by Major Occupational Category (2014 and 2024)



Source: Rhode Island Department of Labor and Training Labor Market Information. 2018. "RI Occupational Projections Occupational Code Order." URL: http://www.dlt.ri.gov/lmi/proj/occprojocc.htm.

Note: Total employment by occupation in 2024 does not sum exactly to the total employment values in Section 1.2 because sources vary in their estimates.

[15] Rhode Island Dept. of Labor and Training. "RI Occupational Projections Occupational Code Order," URL: http://www.dlt.ri.gov/lmi/proj/occprojocc.htm. Accessed January 2018.

Occupational categories projected to grow the fastest by 2024 are computer and mathematical (16.1 percent); construction and extraction (14.2 percent); business and financial operations (11.8 percent); and healthcare support (11.5 percent) (Table 1). Except for healthcare support, occupations in these categories are projected to grow at a faster rate in Rhode Island than the nation. Healthcare support occupations are projected to grow at twice the rate nationally as they are in Rhode Island.

Table 1 Rates of Employment Change in the Fastest-Growing Occupational Categories in Rhode Island and the U.S. (2014-2024)

Occupational Category	Rhode Island	U.S.
Growing		
Computer and mathematical	+16.1%	+13.5%
Construction and extraction	+14.2%	+11.1%
Business and financial operations	+11.8%	+9.3%
Healthcare support	+11.5%	+23.2%

Source: Rhode Island Dept. of Labor and Training. "RI Occupational Projections 2014-2024." URL: http://www.dlt.ri.gov/lmi/proj.htm. Accessed January 2018.

STEM-Intensity

Some of Rhode Island's fastest-growing occupations are high-STEM, meaning they require a high level of knowledge in science, technology, engineering, and/or math.[16] These include 40 percent of construction and extraction jobs; 42 percent of business and financial operations jobs; and 100 percent of computer and mathematical jobs. Demand for STEM-oriented jobs in growing industries merits a review of training programs and courses offered by educational institutions to verify if graduating students are attaining the necessary skills to qualify for these jobs. STEM jobs are noted here because they are the types of higher-skill jobs that provide higher wage compensation in growing industries.

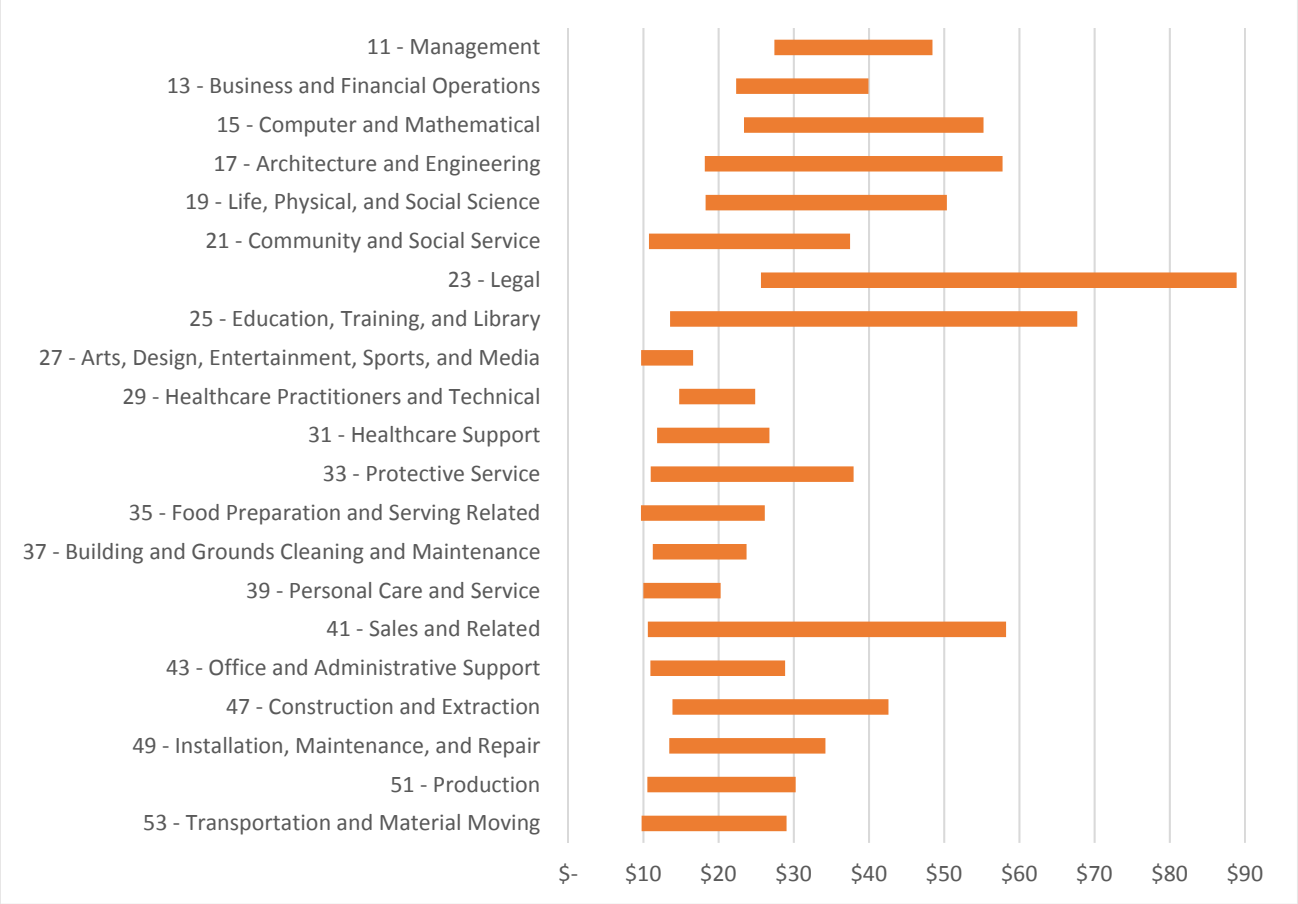
Wages by Occupation

A review of wage rates enables an insightful perspective on compensation, equity, and economic well-being, one of the major goals outlined in the *Land Use 2025* report. Specifically, the major occupational profiles within Rhode Island in general are on the lower side of the wage scale. For the food preparation and serving

16 Calculated using the methodology in Jonathan Rothwell, *The Hidden STEM Economy,* Washington, DC: The Brookings Institution Metropolitan Policy Program, June 2013, https://www.brookings.edu/wp-content/uploads/2016/06/TheHiddenSTEMEconomy610.pdf.

occupational category, median hourly wages range from $9.68 for a waiter/waitress to $26.14 for a chef or head cook (Figure 6).[17] Within sales, median wages range from $10.59 per hour for a cashier up to $58.24 per hour for a sales engineer.[18] Among office and administrative support occupations, median wages hourly range from $10.93 for hotel, motel, and resort desk clerks to $28.85 for executive secretaries and executive administrative assistants.

Figure 6 Minimum and Maximum Wages by Occupational Category in Rhode Island (2016)



Source: Rhode Island Dept. of Labor and Training. 2018. "RI Occupational Projections Occupational Code Order," URL: http://www.dlt.ri.gov/lmi/proj/occprojocc.htm.

[17] Rhode Island Dept. of Labor and Training Labor Market Information. "RI Occupational Projections Occupational Code Order." URL: http://www.dlt.ri.gov/lmi/proj/occprojocc.htm. Accessed January 2018.

[18] Sales engineers sell complex scientific and technology products. U.S. Bureau of Labor Statistics Occupational Outlook Handbook. URL: https://www.bls.gov/ooh/sales/sales-engineers.htm. Accessed January 2018.

Living Wage Occupations

Some of Rhode Island's most common occupations pay less than a living wage, according to values from the Living Wage Calculator.[19] A living wage represents the "minimum employment earnings necessary to meet a family's basic needs while also maintaining self-sufficiency." It differs from a poverty-level wage because it accounts for geographic variation and living costs beyond a basic food budget, including expenses for "childcare, health insurance, housing, transportation, and other basic necessities (e.g. clothing, personal care items, etc.)."

Table 2 below shows the percentage of occupations in each of Rhode Island's major occupational categories that pay less than a living median wage for the type of family indicated. For example, 94 percent of food preparation and serving-related occupations in Rhode Island pay less than a living wage for a single parent raising one child.

Table 2 Percentage of Occupations in Rhode Island's Major Occupational Categories Paying Less Than a Living Wage (2016)

Family Composition	Living Wage	Food Prep	Sales	Office Support
1 Adult	$11.12	69%	6%	2%
1 Adult 1 Child	$24.51	94%	56%	80%
1 Adult 2 Children	$30.52	100%	75%	100%
1 Adult 3 Children	$37.98	100%	88%	100%
2 Adults (1 Working)	$17.93	94%	38%	36%
2 Adults (1 Working) 1 Child	$22.21	94%	50%	73%
2 Adults (1 Working) 2 Children	$24.69	94%	56%	80%
2 Adults (1 Working) 3 Children	$27.30	100%	63%	89%
2 Adults (1 Working Part Time) 1 Child	$13.77	81%	19%	11%
2 Adults	$8.97	0%	0%	0%
2 Adults 1 Child	$13.77	81%	19%	11%
2 Adults 2 Children	$16.57	88%	25%	25%
2 Adults 3 Children	$19.44	94%	44%	57%

Source: Calculations using the MIT Living Wage Calculator. URL: http://livingwage.mit.edu/. Accessed January 2018.

[19] Amy K. Glasmeier and the Massachusetts Institute of Technology. "Living Wage Calculator." URL: http://livingwage.mit.edu/. Accessed January 23, 2018.

3

Poverty, Unemployment & Educational Attainment

Rhode Island is experiencing similar trends as the nation regarding the number of residents who live in poverty or are unemployed. At the same time, the state has a higher share of college-educated residents than the U.S., an important predictor of future economic growth.

3.1 Poverty

In 2016, 13.8 percent of Rhode Islanders lived in poverty, compared to 14 percent in the U.S. (Figure 7).[20] The Federal Poverty Level (FPL) is an economic measured used to determine eligibility for certain government programs that varies based on family size (similar to a living wage).[21] A poverty rate represents the number of people with an income below the FPL.

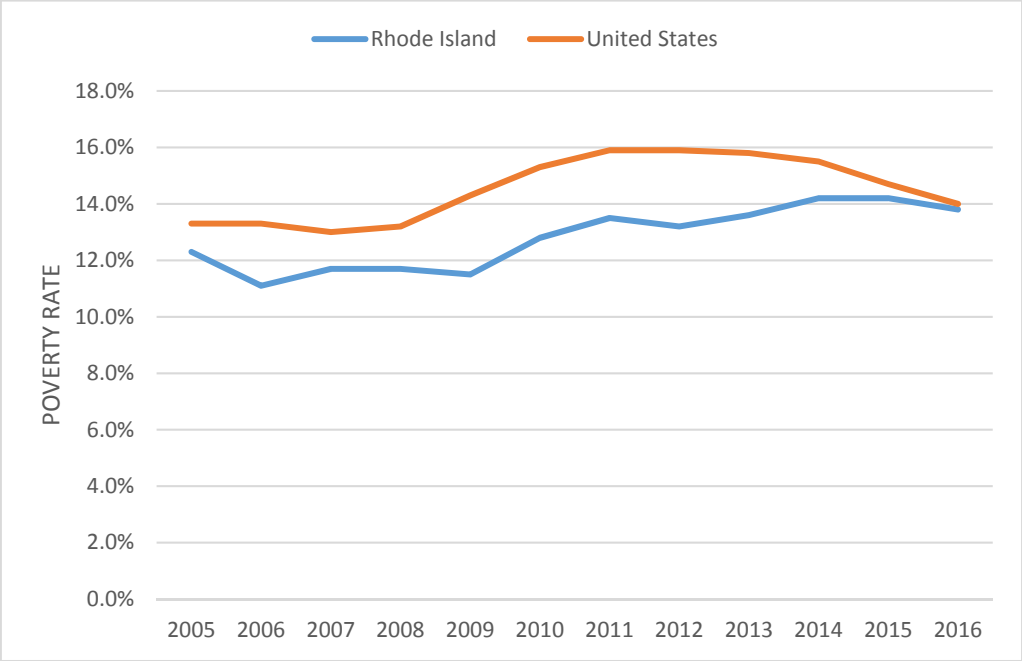
Rhode Island's poverty rate rose by 1.5 percentage points from 2005-2016, but the rate is still slightly lower than the national rate and has been lower than the national

[20] U.S. Census Bureau. 2016. "2016 American Community Survey 1-Year and 5-Year Estimates." URL: https://factfinder.census.gov/.

[21] U.S. Dept. of Health & Human Services. "Federal Poverty Level (FPL)." Healthcare.gov. URL: https://www.healthcare.gov/glossary/federal-poverty-level-FPL/. Accessed January 23, 2018.

rate since at least 2005. The national poverty rate and Rhode Island poverty rate are converging on a downward trajectory after climbing after the Great Recession.

Figure 7 Percent of Rhode Islanders and U.S. Residents Living in Poverty (2005-2016)



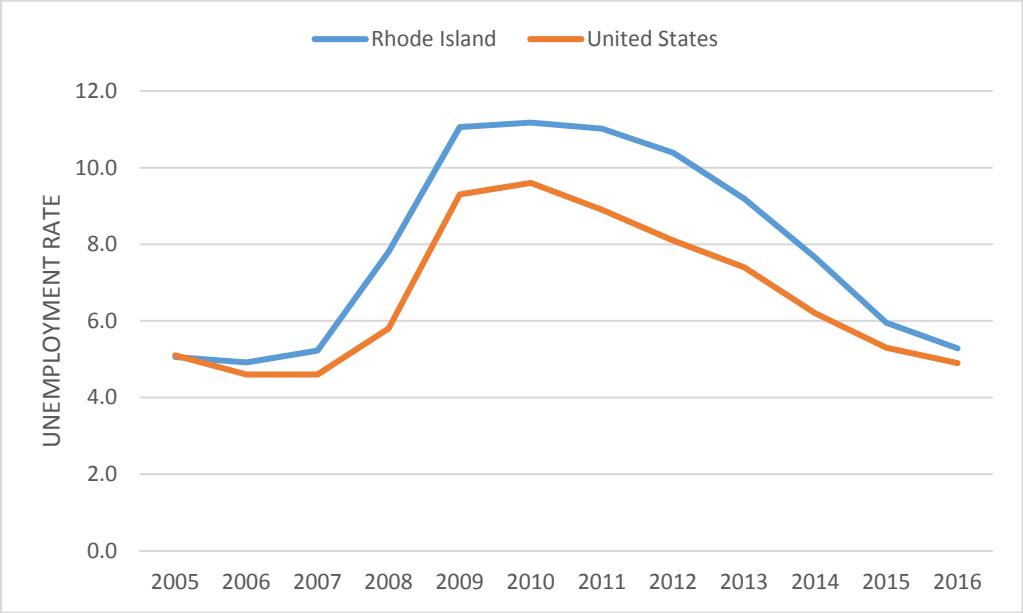
Source: U.S. Census Bureau. 2016. "2016 American Community Survey 1-Year and 5-Year Estimates." URL: https://factfinder.census.gov.

3.2 Unemployment

Rhode Island's unemployment rate has exceeded the national rate since 2005 when both rates were 5.1 percent (Figure 8).[22] The difference was most pronounced in 2008—during the Great Recession—and in 2012, when Rhode Island's unemployment rate was 2.3 percentage points higher than the national rate. Like state and national poverty rates, unemployment rates in the U.S. and Rhode Island are declining and reached near parity in 2016, the latest year for which data are available.

[22] U.S. Dept. of Labor. 2018. "Local Area Unemployment Statistics." Bureau of Labor Statistics. URL: https://www.bls.gov/lau/.

Figure 8 Average Annual Unemployment Rate in Rhode Island and the U.S. (2005-2016)



Source: U.S. Dept. of Labor. 2018. "Local Area Unemployment Statistics." Bureau of Labor Statistics. URL: https://www.bls.gov/lau/.

3.3 Educational Attainment

Educational attainment in Rhode Island has increased slightly since 2005. In 2016, 87 percent of Rhode Islanders over age 25 had a high school diploma or higher, compared to 87.4 percent nationally.[23] In 2005, Rhode Island's high school attainment level was at near parity with the nation's (83.6 percent vs. 83.7 percent), meaning the U.S. increased its attainment by slightly more percentage points than Rhode Island from 2005-2016.

From 2005 to 2016, the number of Rhode Island residents with a bachelor's degree or higher rose from 29.9 percent to 32.5 percent. Nationally, this number rose from 29.3 percent to 31.2 percent, meaning Rhode Island increased its educational attainment by more percentage points than the U.S. over the ten-year period.

[23] U.S. Census Bureau. 2016. "2016 American Community Survey 1-Year and 5-Year Estimates." URL: https://factfinder.census.gov/.

4

Household Travel

Most Rhode Islanders drive to work, either alone or as part of a carpool. Commute times are short compared to the national average—over two-thirds of workers travel less than 30 minutes—but travel times are growing. At the same time, trends indicate that more Rhode Islanders are living in households with just one vehicle or no vehicle available.

4.1 Means of Transportation to Work

Driving alone to work is by far the most common mode of travel for Rhode Island commuters. In 2016, the share of Rhode Islanders commuting this way was 84.5 percent, compared to 76.3 percent nationally.[24] This share declined slightly following the Great Recession but has since returned to levels seen in the mid-2000s.

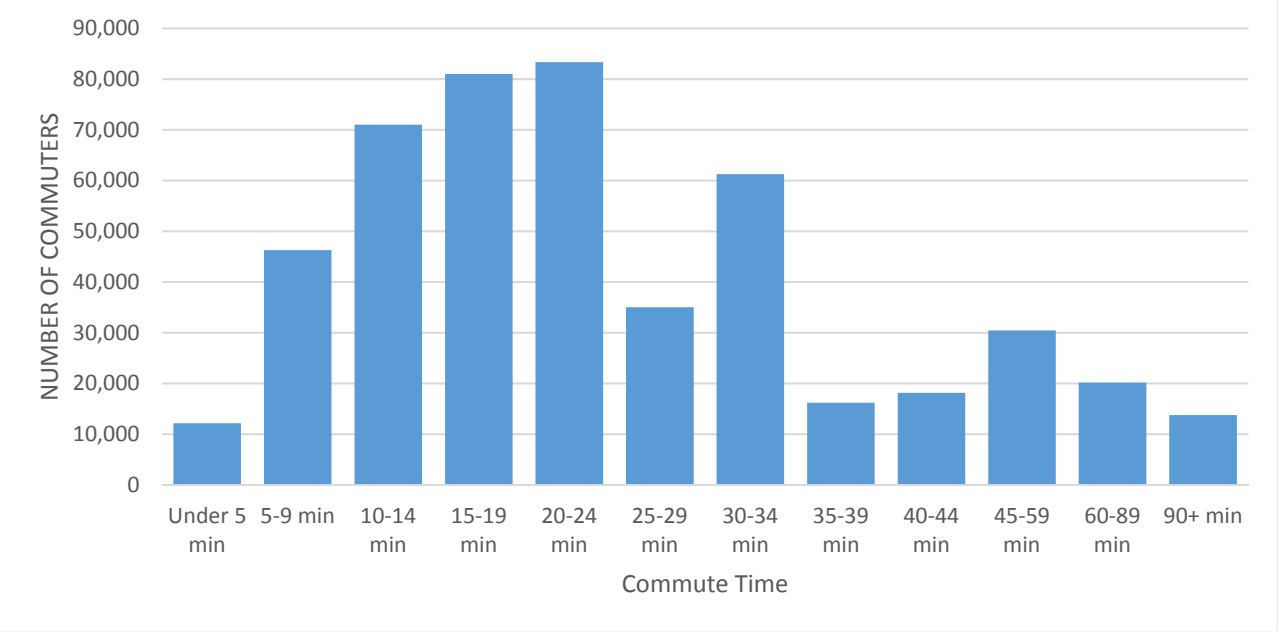
The share of Rhode Island commuters who carpool is 8.3 percent, while 4 percent walk, 2 percent use public transportation is, and the 1.1 percent use taxis, motorcycles, bikes, or other modes of transportation.

[24] Ibid.

4.2 Commute Times

Over two-thirds of Rhode Island workers have a commute less than 30 minutes and over 93 percent have a commute less than one hour (Figure 9). Nationally, 62 percent of workers have a commute less than 30 minutes and 91 percent have a commute less than one hour. The largest share of Rhode Island commuters has a commute of 20-24 minutes and the second-largest share has a commute of 15-19 minutes (Figure 9).

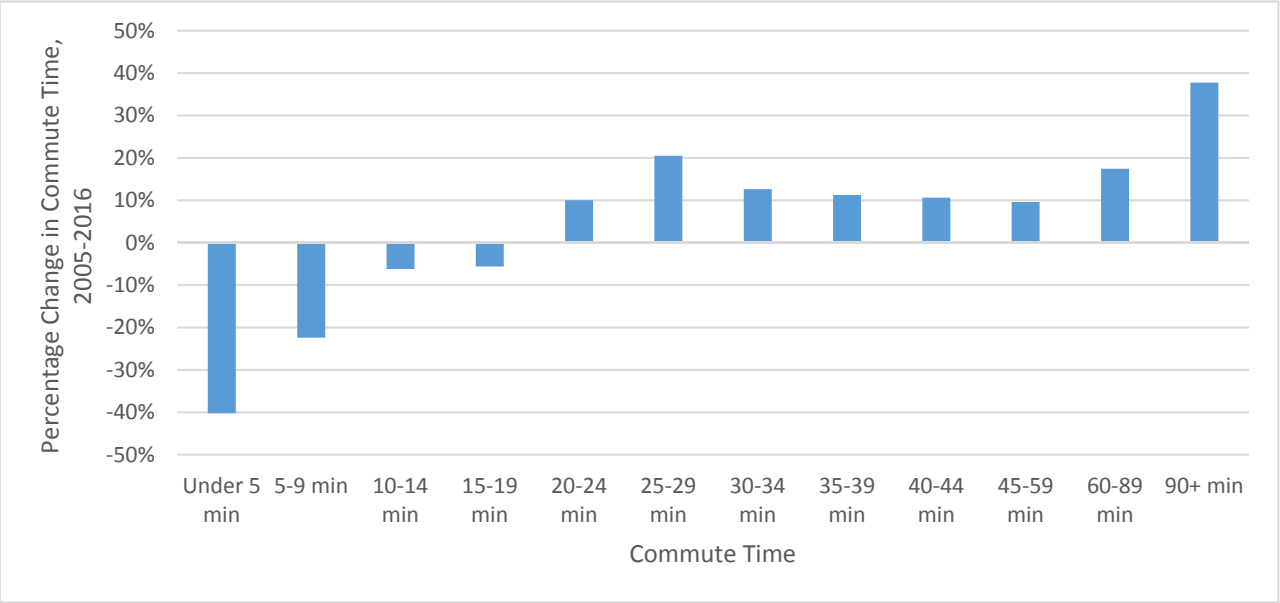
Figure 9 Commute Times in Rhode Island (2016)



Source: U.S. Census Bureau. 2016. "2016 American Community Survey 1-Year and 5-Year Estimates." URL: https://factfinder.census.gov/.

Since 2005, commute times have grown for virtually all Rhode Island workers. Between 2005-2016, the number of commutes that are less than 30 minutes decreased by 5 percent. During the same period, the number of "super commutes," or those greater than 90 minutes, grew by 38 percent (Figure 10).

Figure 10 Change in Rhode Island Commute Times (2005-2016)



Source: U.S. Census Bureau. 2016. "2016 American Community Survey 1-Year and 5-Year Estimates." URL: https://factfinder.census.gov/.

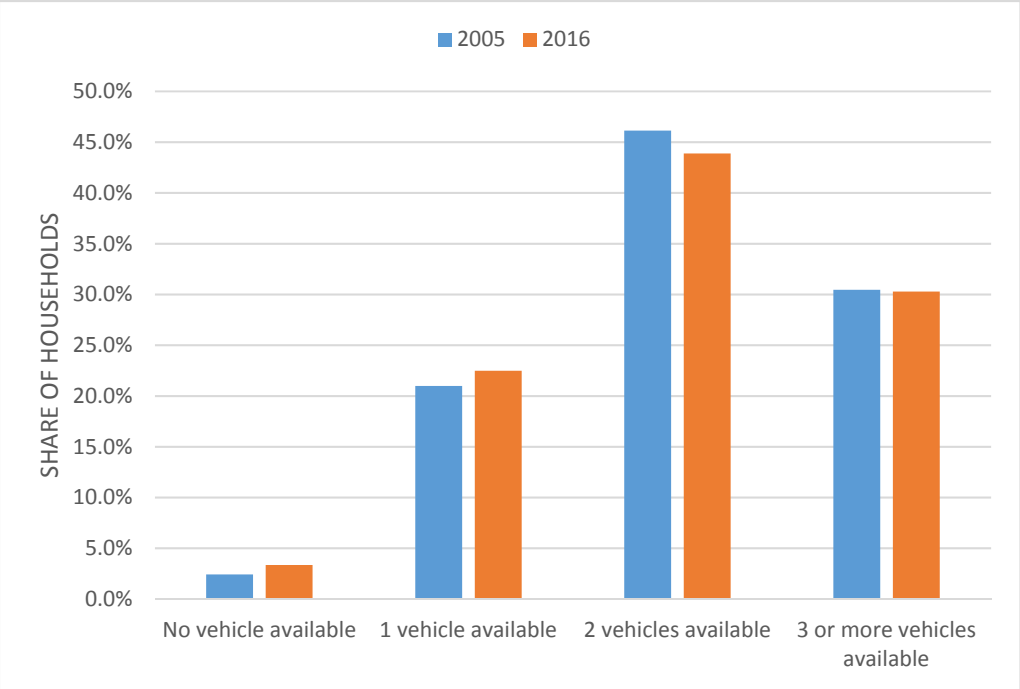
4.3 Vehicle Ownership

Vehicle ownership rates reflect how dependent Rhode Island residents are on passenger vehicles for their transportation needs. In 2016, 43.9 percent of Rhode Island households had two vehicles available and 30.3 percent had three or more vehicles available (Figure 11).[25] The share of households with just one vehicle available was 22.5 percent in 2016, and the share with no vehicle available was 3.3 percent.

From 2005-2016, the share of Rhode Island households with no vehicle available increased (+0.9 percentage points), as did the share with one vehicle available (+1.5% points). The share of households with two vehicles available declined (-2.2% points), as did the share with three or more vehicles available (-0.2% points).

[25] Ibid.

Figure 11 Household Vehicle Ownership Rates in Rhode Island (2005-2016)



Source: U.S. Census Bureau. 2016. "2016 American Community Survey 1-Year and 5-Year Estimates." URL: https://factfinder.census.gov/.

Dependence on passenger vehicles among Rhode Islanders raises issues on how to accommodate future population and employment growth. Unless adequate funding or infrastructure improvements are made, growth in the number of privately-owned vehicles use can strain the existing transportation system. Some of the primary goals mentioned in the Land Use 2025 report include mitigating congestion, promoting alternative modes of transportation, and preserving environmental quality. To meet these goals, Rhode Island should consider diversifying transportation options to reduce passenger car usage. Doing so will also provide expanded access and mobility to residents who cannot currently afford a vehicle.