CAPE COD
COMMISSION

2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix A: Historical Context

Draft
June 15, 2015

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Technical Appendix A: Historical Context

Cape Cod and its transportation system is a story of a continually evolving community with ever-changing transportation needs. This appendix will touch on how the region arrived where it is today, what today's transportation landscape looks like, and what are the challenges and opportunities that lie ahead is maintaining the region's connection to the past while looking toward the future.

Additional information on the region's development and land use patterns over time has been compiled by the Cape Cod Commission and is available in an online Chronology Viewer. The Cape Cod Commission Chronology Viewer is available at:

www.capecodcommission.org/chronology/

The Chronology Viewer explores how the population is changed over time, where and when houses where constructed, and when key infrastructure was developed.

RESOURCE DEPLETION, TECHNOLOGICAL CHANGE, AND GOVERNMENT POLICY

Cape Cod's development and economy have been heavily influenced by three factors:

- Resource depletion,
- Technological change, and
- Government policy.

The Cape has seen many ways of making a living come and go as a result of these three factors. These include agriculture, fin fishing, shell fishing, whaling, salt, limited clothing and shoe manufacturing, and glass manufacturing. The Cape's current economy is dominated by tourism.

At the time the Cape was settled by Europeans in the colonial period it was rich in natural resources including hardwood forests, fertile soil, and waters teaming with marine life. By the end of the Colonial period the region has been clear cut and the soils exhausted.

The overcutting of woodlands and excessive farming had reduced soil fertility, resulting in lower than average crop yields. The lack of ground cover, combined with the effects of wind and water, resulted in topsoils being eroded away, to one-third or one-half their 17th-century depths. This erosion may have been in part responsible for the silting in of numerous harbors and for the death of oyster beds.

Historical & Archaeological Resources of Cape Cod & the Islands, Massachusetts Historical Commission, 1986

The region had to import wood to heat homes and cook. Whaling on the Cape started with salvaging dead or stranded whales off the beach; by the end of that industry ships were sailing all the way to the South Pacific to find whales. Fishing peaked in 1851, employing over 3,200 in the industry. Like whaling, fishing was initially a near shore activity but gradually moved farther off shore as stocks where depleted. Today we face the near if not complete collapse of the cod fishery for which the peninsula is named. Even tourism is now threatened by environmental damage due to over development. Ponds and estuaries that were once pristine are clouded, mucky, and in some cases, devoid of marine life. Shell fishing beds are gone and swimming is no longer desirable in some places. Time will tell the fate of the tourism industry on Cape Cod.

Changes in technology have had a major impact on the economic and social history of the Cape. Technology has changed the scale of commercial activity everywhere by increasing both productivity and distribution. Advances in productivity, have in some cases accelerated the resource depletion discussed above.

By the early 1890s, Barnstable, Brewster, Wellfleet, Truro, and Province town had all built large numbers of these traps and weirs to supply both fish for market as well as bait for fishing vessels. Extensive trapping, however, had a severe effect on fish populations. When the mackerel disappeared from New England waters in the mid 1880s, many blamed the use of these traps.

Historical & Archaeological Resources of Cape Cod & the Islands, Massachusetts Historical Commission, 1986

The discovery of new resources elsewhere also had a great impact on major regional industries. For example, the opening of the first commercial oil well in Pennsylvania in 1859 significantly reduced the demand for whale oil for lighting. But transportation technology has possibly the greatest impact on the way of life, economy, and level of development on Cape Cod. The railroads brought the first significant influx of tourist, particularly summer residents, to the Cape as early as 1870.

None, however, were more prominent in their resort success than the Woods Hole Branch, opening in 1872. Although organized initially to serve the guano works at Woods Hole, the line quickly became instrumental in the development of Bourne, Falmouth, and, through the ferry terminal at Woods Hole, Martha's Vineyard and Nantucket. Small villages from Buzzards Bay to Woods Hole sprouted hotels and resort communities almost overnight.

Historical & Archaeological Resources of Cape Cod & the Islands, Massachusetts Historical Commission, 1986

The salt industry is perhaps the best example of how government action impacts the economy. The industry was made viable by a tariff placed on imported salt by the US government along with a subsidy to domestic manufacturers. Combine with improvements to the evaporation process, this led to a thriving salt industry on the Cape from the late 1700's to 1840's. At its peak, every town except for Mashpee and Bourne had multiple saltworks lining their beaches.

But the industry virtually collapsed when the subsidy was removed and the US reduced the tariff on imports of salt.

Probably the chief reason for the decline in production, however, was the lowering of the duty on imported salt. Ever since 1790 there had been a duty of at least ten cents a bushel… In 1842, the duty on imported salt fell to 8C a bushel, and in 1846 it was changed to a 20% ad valorem scale, greatly to the advantage of foreign sources.

Historical & Archaeological Resources of Cape Cod & the Islands, Massachusetts Historical Commission, 1986

Another example of the government's role in the Cape's economy is its investment in roads, particularly interstates, in the 1950's. This changed the nature tourism on Cape Cod as well as the development patterns which to date had been fairly concentrated in villages accessible by rail. This coincided with a stronger middle class with disposable income and a reduction in the cost of construction. Sprawling auto oriented development has dominated since that time and been reinforced by zoning rules.

TRANSPORTATION INFRASTRUCTURE DEVELOPMENT

Cape Cod's transportation system has both shaped and been shaped by development patterns of the region. As our regional economy has evolved so too has our transportation infrastructure. From a reliance on ports and marine transport, to a steady growth by rail, and explosion of change fueled by the automobile – our region has undergone dramatic changes.

The first recorded European expedition to Cape Cod was led by Bartholomew Gosnold, who was credited with naming the peninsula in 1602. In 1620, the Pilgrims landed at Provincetown. This was different than previous European appearances because the Pilgrims were more interested in settling somewhere, rather than exploring and trading with the native Wampanoag tribe. Although this is how we traditionally tell the story of Cape Cod's history, it actually extends long before that.

EARLY TRAIL AND ROAD NETWORK

Contact (1500 - 1620) and Plantation (1620 - 1692) Periods

By the time the Pilgrims arrived, there was an extensive trail network stretching from one end of the region to the other as shown in Contact Period map in Figure 1. Even this far back, we can see connections that would eventually become the road network of Cape Cod. As Native Americans and Europeans used the network more extensively, trails were upgraded to cartpaths or roadways. As shown in Figure 1 portions of present day Route 6A took shape as County Road.[1]

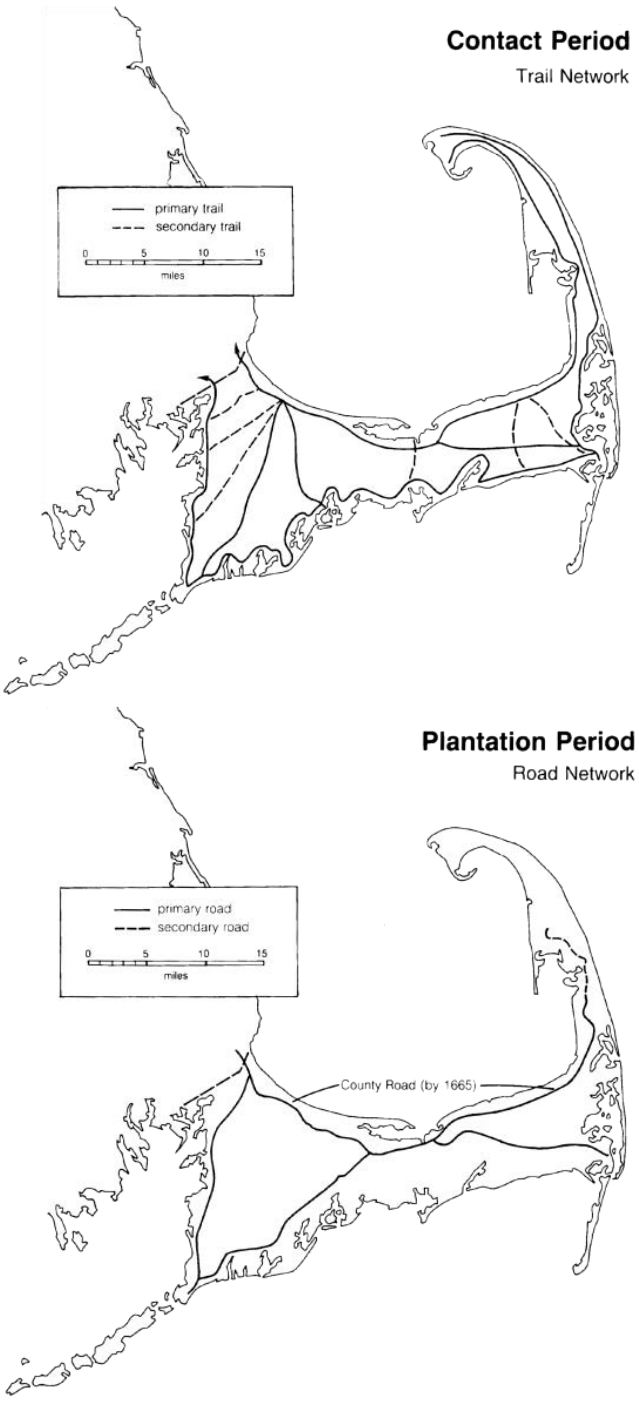

FIGURE 1. EARLY TRAIL AND ROAD NETWORK[1]

[1] Historic & Archeological Resources of Cape Cod & the I
Originally published August 1986. PDF reprint version, 2007.

EXPANSION OF WATER ROUTES

Colonial (1692 - 1775) and Federal (1775-1830) Periods

As local transportation and commerce increased, water routes were the life blood of the region. Land routes were improved, widened, and expanded to support connection to the ports. Figure 2 shows the expansion of the road network and connection to water routes in these periods.[1]

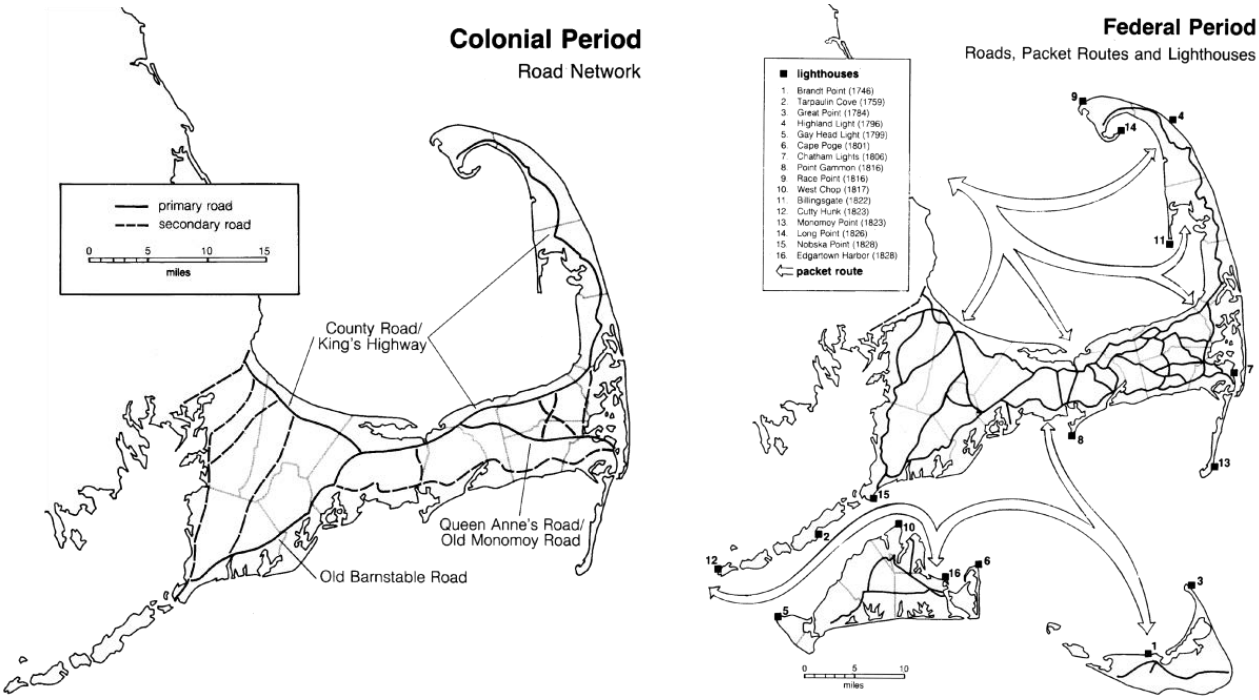

FIGURE 2. EXPANSION OF WATER ROUTES AND LAND CONNECTIONS[1]

EXPANSION OF RAILROADS

Early and Late Industrial Periods (1830-1915)

The industrial period saw the development and expansion of railroads across the region. Still tied to major ports, as shown in Figure 3, rail served both freight needs as well as the emerging tourism market. This period saw multiple expansions of the rail network ultimately including connections to almost every town on Cape Cod. As the rail network expanded, development grew up around the train depot. These pockets of development thrived while rail transportation dominated the region. As the predominance of rail waned, some of these developments evolved to meet new needs while others did not.[1]

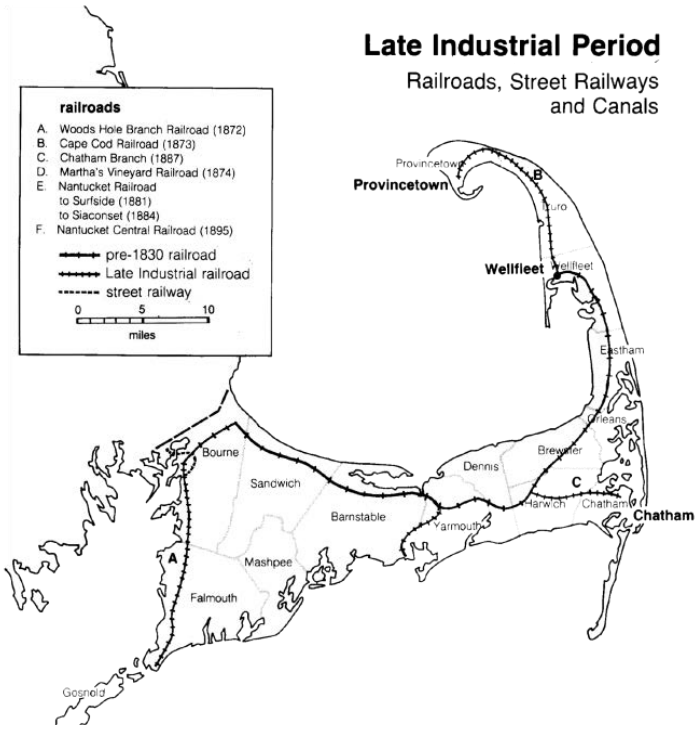

FIGURE 3. RAIL EXPANSION[1]

AGE OF THE AUTOMOBILE

Modern Period to Present Day (1915-)

The emergence of the automobile and tourism industry on Cape Cod forever changed the transportation network of the region. Construction of the Cape Cod Canal redefined the transportation landscape of the region. Expanding from the Cape Cod Canal, the transportation system was significantly expanded and modernized during the 20th century. As shown in the Table 1, some of greatest expansions occurred in the 1950's.

TABLE 1: INDUSTRIAL PERIOD RAIL EXPANSION

YEAR	MILESTONE
1935	Bourne, Sagamore, and Railroad bridges over the Cape Cod Canal
1950	Rt. 6: Sagamore Bridge to Hyannis (exit 6) – 2 lanes
1954	Rt. 6: Sagamore Bridge to Hyannis (exit 6) – 4 lanes
1955	Rt. 6: Hyannis (exit 6) to Dennis (exit 9) – 2 lanes
1956	Rt. 6: Dennis (exit 9) to Harwich/Brewster (exit 11) – 2 lanes
1958	Rt. 6: Harwich/Brewster (exit 11) to Orleans (exit 12) – 2 lanes
1959	Rt. 6: Orleans (exit 12) to Orleans/Eastham Rotary – 2 lanes
1967	Rt. 6: Hyannis (exit 6) to Yarmouth (exit 7) – 4 lanes
1971	Rt. 6: Yarmouth (exit 7) to Dennis (exit 9) – 4 lanes

HISTORIC PRESERVATION TOOLS

Cape Cod towns utilize a wide variety of tools to protect their historic resources. The most commonly used are local historic districts and demolition delay bylaws, though many towns have also adopted more specialized regulations. Some historic resource protections are initiated by town historical commissions, while others are spurred by planning boards, nonprofit historic societies, and neighborhood groups. Key information about tools such as historic inventories and districts is available at the Massachusetts Historical Commission (MHC)[2].

While these preservation tools are primarily applied to the demolition or modification of structures, a number of the tools apply to roadway work as well.

INVENTORIES

Inventory is an important first step toward protecting a community's historic resources. Historic inventories can be used to teach people about their community's history and to guide town boards in future land use decisions. The MHC provides standardized inventory forms for different types of historic resources. The forms are typically filled out by local historical commission members, volunteers, or private consultants, and many Cape towns have sought grants to support this work. Completed forms are kept both in the town and at MHC, which provides online access through its MACRIS database.[3]

LOCAL HISTORIC DISTRICTS

Local Historic Districts require review by a historic district commission for any exterior alteration to buildings and structures visible from a public way.

On Cape Cod, local historic districts in the towns of Barnstable, Dennis, Eastham, Harwich, and Provincetown were created under Chapter 40C (the Historic Districts Act) of Massachusetts General Law. The towns of Chatham and Falmouth have established local historic districts under special legislation. The Old Kings Highway Regional Historic District, covering portions of Sandwich, Barnstable, Yarmouth, Dennis, Brewster and Orleans, was also created by a special act of legislation. (See Figure 4)

NATIONAL REGISTER BUILDINGS AND DISTRICTS

The National Register of Historic Places is the official list of the Nation's historic places worthy of preservation. Authorized by the National Historic Preservation Act of 1966, the National Park Service's National Register of Historic Places is part of a national program to coordinate and

[2] http://www.sec.state.ma.us/mhc/mhcidx.htm
[3] http://mhc-macris.net/

support public and private efforts to identify, evaluate, and protect America's historic and archeological resources.[4]

National Register of Historic Places offers special protection for individual historic buildings and properties in historic districts on Cape Cod. As shown in Figure 4, historic properties are spread across Cape Cod In addition to protections under local historic districts; the Cape Cod Commission Act[5] provides additional protections. Under the Cape Cod Commission Act, demolition or substantial alteration of National Register properties, whether individually listed or part of a National Register Historic District, are subject to review by the Cape Cod Commission if there is no other historic district protection in place.

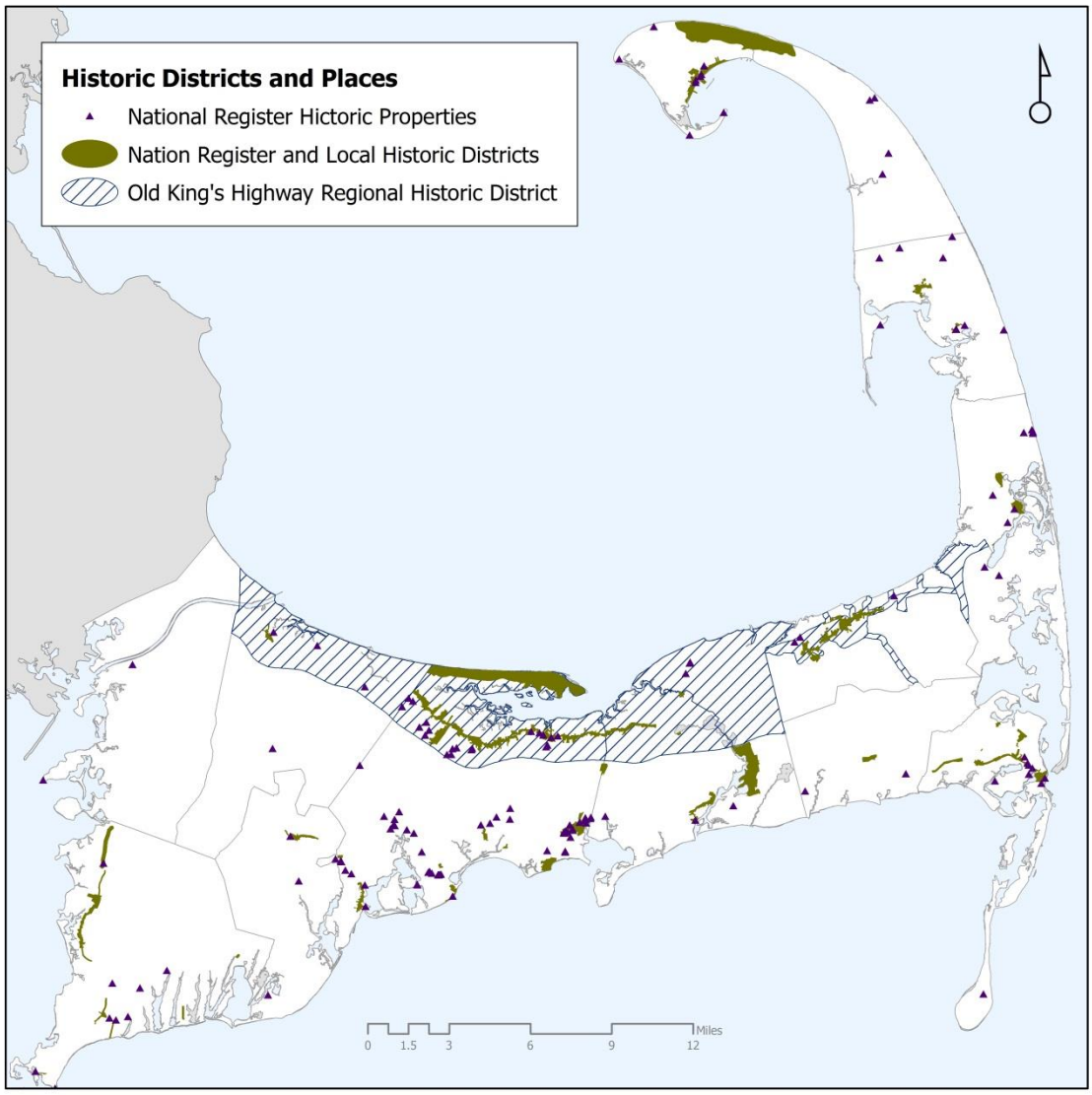

FIGURE 4. STATE REGISTERED HISTORIC DISTRICTS AND PLACES

[4] http://www.nps.gov/nr/
[5] http://www.capecodcommission.org/aboutccc/act

PRESERVATION BYLAWS

- **Demolition Delay Bylaws** create time to explore alternatives to demolition of historically significant buildings. Any demolition permit request is reviewed by the Historical Commission to determine if a building is "preferably preserved" and if a delay period should be imposed. On Cape Cod, delay periods range from 6 to 18 months. See the Cape Cod Commission's Demolition Delay Network[6].
- **Overlay Districts** create special zoning regulations for unique areas. Brewster's Corridor Overlay Protection District limits the scale and massing of commercial buildings along historic Route 6A. The Village Commercial Overlay District in Harwichport allows smaller setbacks and mixed uses consistent with historic development patterns. The Cape Cod Commission's Village Development Model Bylaw[7] guides small-scale, mixed-use development in village centers. It can be established as an overlay district or as a stand-alone zoning district.
- **Archaeological Resource Districts** aim to protect archaeological sites by limiting ground disturbance in sensitive areas. The towns of Barnstable and Brewster protect historic values in their Wetland Protection Bylaws, using Massachusetts Historical Commission review to help determine if an area is likely to have archaeological significance.
- **Scenic Road Bylaws** protect trees, stone walls, and features that fall within the right-of-way of designated roads. A planning board hearing is required prior to repair, maintenance, reconstruction, or paving work if it would involve removal or cutting of trees, or destruction of stone walls within the road right-of-way. It does not address trees or walls on adjacent private property. Barnstable, Falmouth, and Sandwich coordinate their scenic road reviews with the Planning Board, Department of Public Works, Tree Warden, and Historical Commission.
- **Districts of Critical Planning Concern** are a tool created by the Cape Cod Commission Act to protect special resource areas. Towns nominate an area to the Cape Cod Commission and work with Commission staff to craft regulations that protect the district. The Designated DCPCs page[8] describes the Centerville Village, Craigville Beach, and Sandwich Three Ponds DCPC regulations to protect cultural and scenic resources.

PRESERVATION RESTRICTIONS

Preservation Restrictions and Conservation Restrictions are legal agreements used to protect historic buildings and lands from change. The restrictions are drawn up by the property owner and a nonprofit preservation group or a government entity that is in charge of their enforcement. Restrictions can be placed on buildings or on land, and may also be used to protect archaeological resources hidden beneath the surface of the land.

The Massachusetts Historical Commission holds Preservation Restrictions on numerous Cape properties that have received preservation grant monies. Preservation Restrictions are required for some projects that use Community Preservation Act (CPA) funding, and many of these restrictions are held by conservation trusts and local historical commissions.

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6 http://www.capecodcommission.org/resources/regulatory/HistoricPreservation_CCCActandNationalRegister.pdf

7 http://www.capecodcommission.org/resources/bylaws/village.doc

8 http://www.capecodcommission.org/departments/planning/DCPC/designated

CAPE COD COMMISSION

3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

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2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix B: Existing Conditions

Draft
June 15, 2015

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Technical Appendix B: Existing Conditions

VEHICLE INFRASTRUCTURE

ROADS

Travel by vehicle in Barnstable County is the primary method of transportation and can often be a unique and picturesque for visitors and residents. The style of the roads and the buildings that line them are internationally recognized as Cape Cod. In certain parts of the county the historical district or town by-laws dictate the style of the road and the buildings along that road to preserve the culture of the town or city. The residents on Cape Cod have a long standing connection to the preservation of infrastructure character and natural open space. It is well known that the largest attractions in Barnstable County are the beaches; however it is the style of roadway that enhances the experience of traveling to destinations while living or visiting the region.

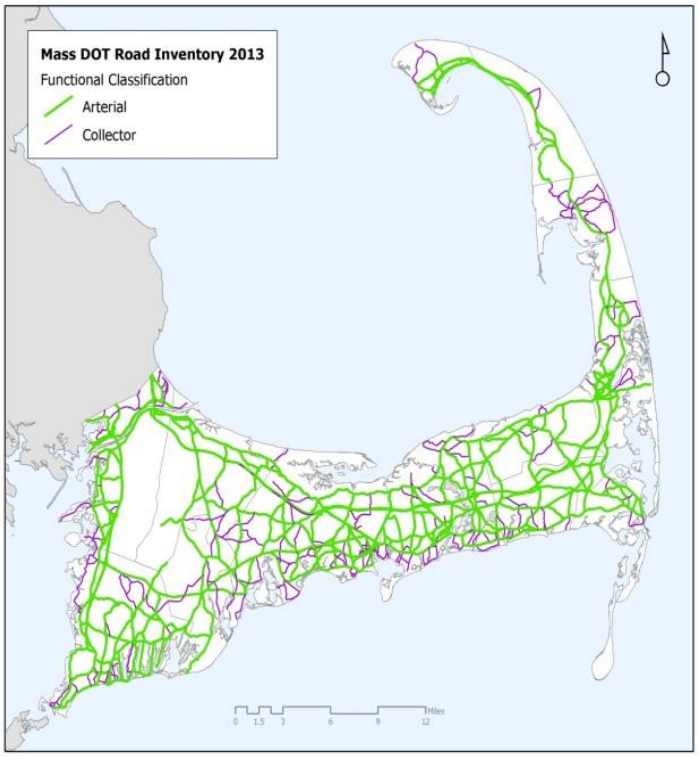

FIGURE 1: ROADWAY CLASSIFICATION

Roadway Functional Classification

Cape Cod's three major routes, Route 6, Route 28, and Route 6A, comprise only less than 6% of Cape Cod's roads by mileage. The majority (80%) of Cape Cod roads are designated as Functional Class "0/null," or local roads. 6% of roads are classified as minor or major "Collector" roadways. This means that just over two-tenths of Cape Cod's roadways are used as primary routes, while the remaining nearly eight-tenths are used to access residential and other private areas. There are no interstate highways on Cape Cod. Cape Cod's roadway functional classes are presented in the following figure.

Limited Access Roads

Limited-access highways south/east of the Cape Cod Canal bridges are portions of either Route 6 or Route 28 and are shown in the figure above. The only limited-access portions of Route 28 are located in Bourne and Falmouth. Most of Route 28 (MacArthur Boulevard) in Bourne is partial-access control with sporadic opportunities to change direction in U-turn lanes. The majority of Cape Cod's roads do not have access control. The lack of availability of limited access routes, especially on the Outer Cape area can create congestion.

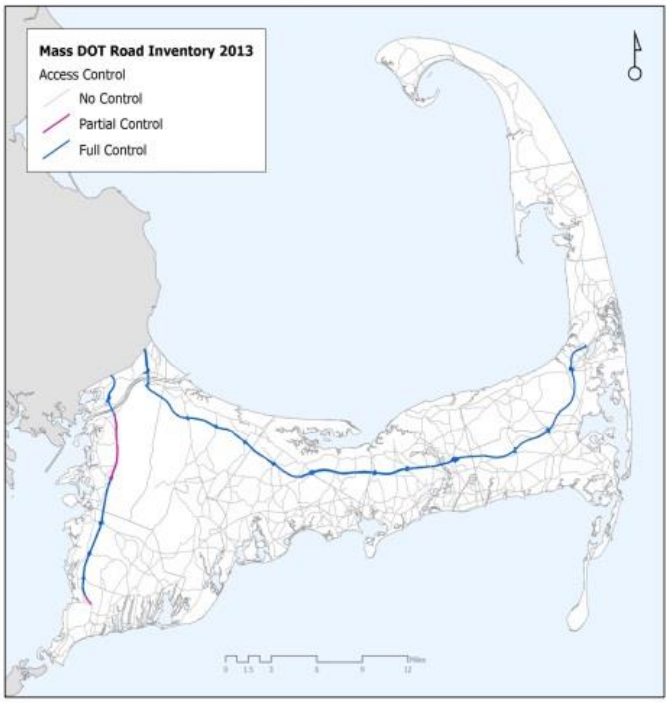

FIGURE 2: LIMITED ACCESS ROADS

Speed Limits

The maximum legal speed limit on most Cape Cod highways is 55 mph. Exceptions include Route 3 (60 mph) and Route 25 (65 mph) in Bourne. The majority of roads that are not recognized as highways have posted speed limits below 50 mph. Exceptions include portions of Route 28 in Falmouth, Mashpee and Barnstable and Route 151 in Falmouth and Mashpee.

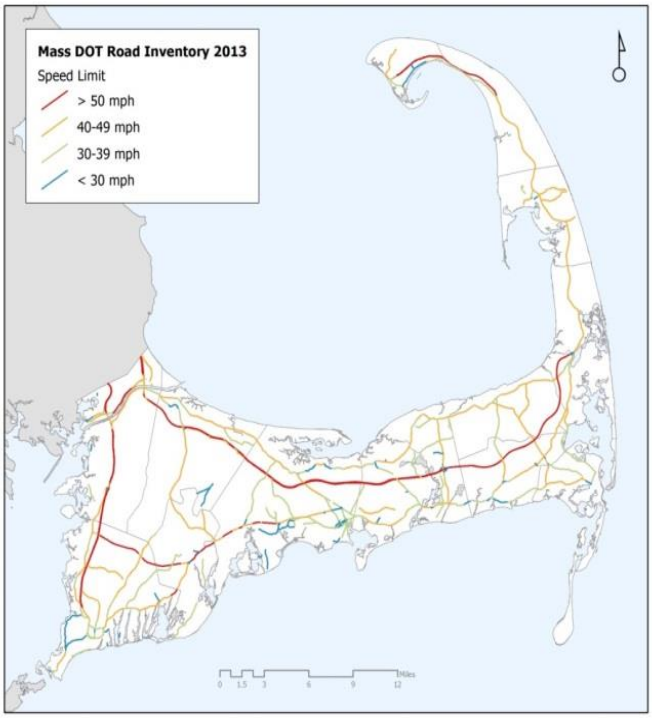

FIGURE 3: SPEED LIMITS

FIGURE 5: SPEED LIMITS

Intersections

There are thousands of roadway intersections across Cape Cod. Of these intersections, 129 are signalized and 25 are circular. Circular intersections refer to rotaries and roundabouts. Rotaries tend to be larger in diameter, and their interior travel speed is often faster than a modern roundabout. Roundabouts are identified by smaller diameters and approaches that enter at a greater angle than rotaries – encouraging slower speeds. Barnstable has five circular intersections, the most of any Cape Cod town.

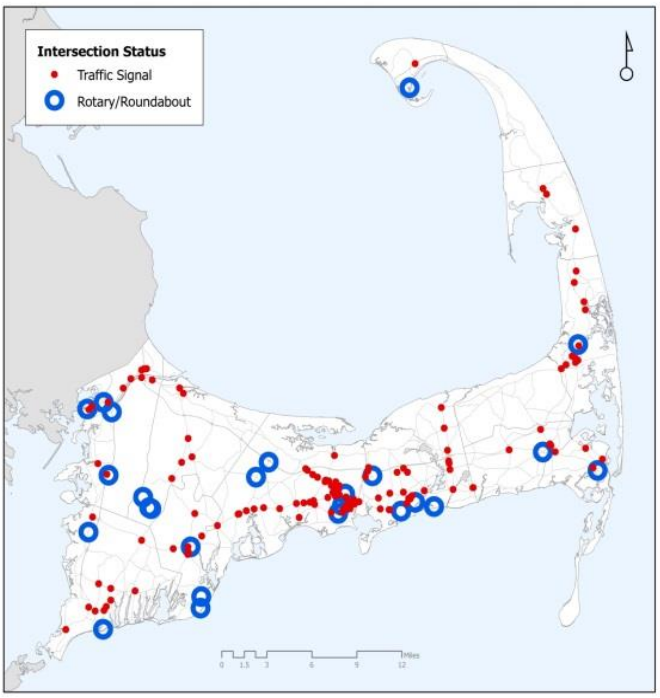

FIGURE 6: INTERSECTIONS

Average Annual Daily Traffic

The following figure shows year-round average daily traffic volumes on major Cape Cod roads. Heaviest travel occurs on the Cape Cod Canal road and canal bridges and the Mid-Cape Highway. High volumes of traffic are found on the roads leading to and within the Hyannis area (an area that receives/sends goods to/from many businesses, institutions such as Cape Cod Hospital and multimodal facilities such as the ferry ports). In comparison, downtown Falmouth also experiences high levels of congestion.

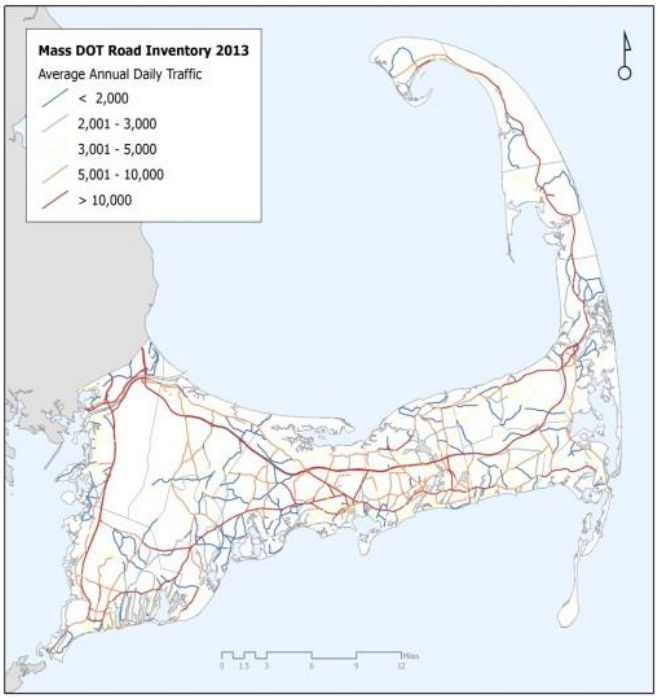

FIGURE 7: AVERAGE ANNUAL DAILY TRAFFIC

U.S. Route 6

U.S. Route 6 runs from Provincetown, Massachusetts all the way to Bishop, California, and is the longest continuous route in the United States. On Cape Cod, Route 6 is the major transportation corridor, particularly for those traveling long distances. From where it enters Barnstable County in Buzzards Bay until its end in Provincetown, it provides a primarily limited-access high-speed means of traveling along the spine of the Cape for commercial traffic. The Route 6 corridor in the Outer Cape does not have limited access. This portion of Route 6 also contains segments of the Claire Saltonstall Bikeway, or State Bicycle Route 1. During peak travel periods in the summer it is not unusual for westbound traffic to be stopped for several miles east of the Sagamore Bridge or in Wellfleet or in Dennis.

FIGURE 8: ROUTE 6 FROM BUZZARDS BAY TO SAGAMORE BRIDGE

Buzzards Bay to Sagamore Bridge

From where it enters the county in Buzzards Bay to where it crosses the Cape Cod Canal at the Sagamore Bridge Route 6 is a two- to four-lane road with curb cuts on both sides. The Sagamore Rotary, located north of the Sagamore Bridge, was eliminated by 2006. This grade separated intersection provides for a direct connection between Route 3 and the Sagamore Bridge.

FIGURE 9: ROUTE 6 FROM SAGAMORE BRIDGE TO EXIT 9

Sagamore Bridge to Exit 9, Dennis

From the Sagamore Bridge to just after Exit 9 in Dennis, Route 6 is a four-lane limited-access highway with a grass shoulder and rest areas.

Exit 9, Dennis to Orleans Rotary

From Dennis to the Orleans/Eastham rotary the road narrows to two lanes but remains limited-access, with a raised median and yellow reflective post delineators to reduce crossovers from one direction of traffic to the other.

FIGURE 10: ROUTE 6 FROM EXIT 9 TO ORLEANS ROTARY

Orleans Rotary to Provincetown

Route 6 in the Outer Cape area is generally a consolidation of existing roadways over time since the 1930s. Short sections of the original Route 6 have been retained for local access for road straightening projects. In northern Truro and Provincetown, the original Route 6 became Route 6A – several sections of which have been realigned.

Finally, from the Orleans Rotary until the road's end in Provincetown the road is once again a two- to four- lane road with curb cuts on both sides, although a grassed median limits crossovers on sections of Route 6 in Provincetown.

FIGURE 11: ROUTE 6 FROM ORLEANS ROTARY TO PROVINCETOWN

State Route 28

State Route 28 begins at the New Hampshire border and joins Route 6 as it enters Barnstable County at Cohasset Narrows on the border of Bourne/Wareham. Route 28 runs for almost sixty-five miles after crossing the Cape Cod Canal and passing through villages adjacent to Buzzards Bay/Nantucket Sound/the Atlantic Ocean from Bourne to Orleans Center. Route 28 is a regional roadway but it does not provide direct inter-regional travel options in most cases. The cross section of Route 28 varies greatly throughout the Cape. However, there are three primary sections to Route 28, which are identifiable by their roadway characteristics.

Traffic flow along the corridor is generally heavy during the summer, with gridlock occurring in many locations. However, the level of traffic varies greatly along the corridor. Much of the Route 28 corridor is congested during summer peak hours. Some sections, such as in Hyannis and Falmouth, can experience congestion year-round.

Buzzards Bay to Bourne Rotary

Route 28 consists of four lanes from the county line across the Bourne Bridge to the Bourne Rotary.

Bourne Rotary to Palmer Avenue, Falmouth

Route 28 consists of four lanes, divided by a grassy median, from the Bourne Rotary to Saconesset Hills in Falmouth. The western side of Route 28 in Bourne from the Bourne Rotary to the Otis Rotary (MacArthur Boulevard) allows property access. Vehicles can reverse direction via a number of U-turn areas in the median.

FIGURE 12: ROUTE 28 FROM BOURNE ROTARY TO PALMER AVENUE

Palmer Avenue, Falmouth to Orleans Rotary

From Palmer Avenue in Falmouth, Route 28 is predominately two lanes to the intersection of Old Stage Road in Barnstable. Route 28 then transitions to four Lanes from Old Stage Road to Phinneys Lane in Barnstable and then predominately is two lanes from Phinneys Lane to the Orleans/Eastham Rotary. Portions of this route are more developed than others. The most developed and subject to congestion area is Hyannis. Congestion in this area is experienced year-round.

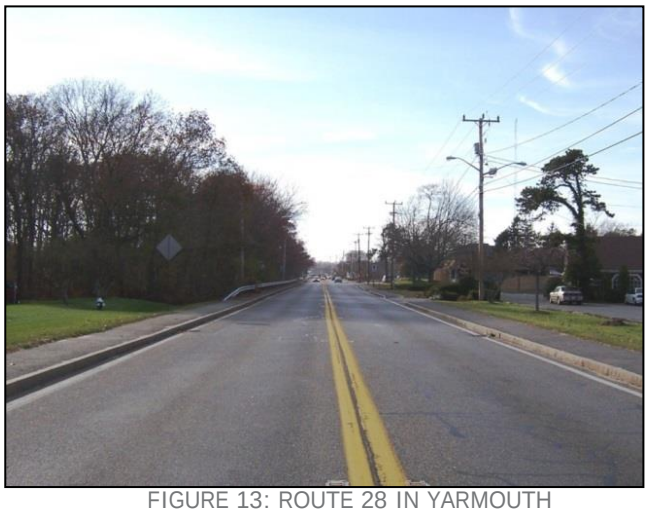

FIGURE 13: ROUTE 28 IN YARMOUTH

Route 6A

Route 6A on Cape Cod is one of the oldest travel corridors in the country. Originally a path used by Native Americans, it was later adopted by colonists for travel from Plymouth out to Eastham. Later it served as state Route 6 until the construction of the current Route 6 in the 1950s. Today it serves much of the Old Kings Highway Historic District and is designated as a state Scenic Byway.

FIGURE 14: ROUTE 6A CORRIDOR

Route 6A is a narrow and windy two lane road with little or no shoulder. One exception to this is the four-lane cross section in Orleans (which is not included in the Old Kings Highway Historic District). Because of the narrow shoulders, passing zones are limited and biking can be difficult. There are not any rest areas located on this corridor. Traffic congestion along the corridor is generally heavy during the summer however; the level of traffic varies greatly along the corridor.

Much of the Route 6A corridor is congested during summer peak hours. Recommendations from the Route 6A Corridor Management Plan (Cape Cod Commission, 2010) include the reduction of speed limits to 35 MPH and accommodation of alternate mode users such as pedestrians, bicyclists and public transportation users.

BRIDGES

Cape Cod Canal Bridges

The largest bottlenecks on Cape Cod occur at the canal bridges during the summer season. Cape Cod's bridges serve many important functions, one of which is to permit travel over waterways by automobile and along waterways by boat or barge, between Buzzards Bay and Cape Cod Bay. The Bourne Bridge and Sagamore Bridge permit vehicular travel over the Cape Cod Canal. If not for the canal bridges, vehicles would have to use a ferry to reach Cape Cod. Summer time delays at the canal bridges can sometimes be measured in hours.

FIGURE 15: CONGESTION AT THE BOURNE BRIDGE

The Bourne Bridge and Sagamore Bridge are both under the jurisdiction of the Army Corp of Engineers (ACOE). One or the other of the two highway bridges may have restrictions on lanes

and heavy vehicles during several weeks of the year to accommodate painting and structural maintenance activities. While avoiding the heavy summer traffic season, these lane closures have been observed to result in traffic backups of several hours.

The Bourne and Sagamore bridges provide the only crossings of the Cape Cod Canal for motorists, pedestrians and cyclists. Maintained by the U.S. Army Corps of Engineers, the geometric design of each bridge includes a roadway width of 40 feet (four 10 foot wide lanes) flanked by a 6-foot wide sidewalk on one side and a 2-foot wide safety curb on the other. The roadways are separated from the sidewalks and safety curbs by 16-inch high vertical granite curbing.

The bridges first opened to traffic in 1935. Historic records indicate a general upward trend in the annual bridge crossings and this traffic is currently approaching 100,000 vehicles per average day. Over the decades, the bridges have been exposed to deicing salts, the effects of which include progressive deterioration of the concrete deck and some steel members of the bridges. These effects are compounded by the fact that the bridges are located near salt water. An additional maintenance activity is the periodic painting of the exposed steel portions of the bridges.

For certain maintenance activities, including repairs to the concrete deck, the worksite requires the closures of two lanes. For a bridge undergoing maintenance, the four lanes are reduced to two. Depending on the duration of the closure and the seasonal demand, significant delays and backups may occur. The ACOE is committed to minimizing these conditions by avoiding daytime lane reductions during the summer months and limiting work to one bridge at a time.

Bridge condition information, provided by MassDOT is presented in Appendix P: Statewide Tables.

INTELLIGENT TRANSPORTATION SYSTEMS

Intelligent Transportation Systems (ITS) is an emerging aspect of infrastructure that has surfaced on Cape Cod. Along Route 6, permeant message boards display travel time to exits on the roadway. This information calculated using Bluetooth technology to calculate drive times. This information has been effective at reducing distraction and driver confusion by presenting valuable information to automobile drivers outside of content received by cellphones or GPS devices. The project began in 2012 with signage installed on Route 3 approaching Cape Cod and plans to be statewide in 2015.

FIGURE 16: TRAVEL TIME ITS

A second source of Intelligent Transportation Systems on Cape Cod is the use of remote counting stations. Currently there are seven stations maintained by MassDOT including Sagamore Bridge, Bourne Bridge, Route 6 East of Exit 5 in Barnstable, Route 3 at the Bourne/Plymouth Town Line, Route 28 East of Higgins Crowell Road in Yarmouth, and Route 28 West of Old Post Road in

Barnstable. A counter at Route 28 East of Main Street Cotuit in Barnstable was maintained by MassDOT but recently was discontinued. In addition to the MassDOT devices, the Cape Cod Commission Maintains three permeant counters at Route 137 at Route 39 in Harwich, Route124 at Queen Anne Road in Harwich, and Route 28 at Lumbert Mill Road in Barnstable. Each of these counting stations count vehicles using detectors installed in the pavement. Similar technologies use cameras to count cars, but this is not practiced on Cape Cod. This information is useful to planners in reflecting traffic patterns throughout the year and could redefine seasonal factors used in design, improve signal optimization or affect the priority of regional projects.

Other technologies that are emerging or integrated include assisted diving cars or signal priority for emergency vehicles. As new technologies their acceptance into infrastructure is changing the way people travel. Intelligent transportation systems in development or in practice nationally that have not been integrated on Cape Cod include infrastructure to support driverless cars, pavement that is responsive to weather changes, and signal priority for transit.

BUS INFRASTRUCTURE

INTERMODAL FACILITIES

Hyannis Transportation Center

FIGURE 17: HYANNIS TRANSPORTATION CENTER

The Hyannis Transportation Center was built in 2002 as a hub for Cape Cod's transportation needs. The property has entrances from Route 28, Center Street, and Ridgewood Avenue. The facility includes a bus terminal and a connection to the Cape Cod Central Railroad terminal. Additionally, there is parking space available for 220 cars on an eight-acre lot.

The building itself is owned and operated by the Cape Cod Regional Transit Authority (CCRTA). The Hyannis Transportation is open 7 days a week, excepting holidays, from early morning to 8:30pm. Inside, travelers are offered several amenities, such as Wi-Fi internet, vending machines, an ATM, and restrooms. Electronic route maps are posted throughout the facility and announcements of arrivals and departures are made over the loud speaker system. Additional travel information is available at the information desk.

The Hyannis Transportation Center brings together local and interregional bus services, rail facilities, and connections to air and ferry service. Plymouth and Brockton, Peter Pan, and Bonanza Bus lines all make daily use of the bus terminal facilities. Four RTA bus lines make stops at the Hyannis Transportation Center, as well as two RTA shuttles. These transit lines provide connections to ferry service in Hyannis and air service and rental car service at Barnstable Municipal Airport. Plymouth and Brockton service from Boston and Provincetown, and Peter Pan service from Providence and New York make stops at the Hyannis Transportation Center. There is also an area designated for Taxi service pick-up and drop-off. Nearby ferry service to Martha's Vineyard and Nantucket is accessible by local transit. Given the variety of transportation options available, the Hyannis Transportation Center is sometimes also referred to as the Hyannis Intermodal Center.

In addition the Hyannis Transportation Center, several other locations serve as bus terminals and stops throughout Cape Cod.

FIGURE 18: MACMILLAN PIER

MacMillan Pier and Bus Depot

MacMillan Pier in Provincetown is located at the intersection of Commercial Street and Ryder Street. The facility is open Monday through Saturday from 9am to 6pm and is closed on Sundays and holidays. MacMillan Pier includes a bus depot, ferry terminal, and a parking facility open seven days a week. The bus depot serves as a terminal for Plymouth and Brockton service from Hyannis and Boston. The Cape Cod Regional Transportation Authority's (CCRTA) seasonal Provincetown Shuttle makes scheduled stops at the facility on its way to Race Point, Provincetown Municipal Airport and North Truro. Ferry service to Plymouth and Boston is also available seasonally. MacMillan Pier is located in the heart of downtown Provincetown, with access to restaurants, hotels and shopping.

Falmouth Bus Depot

The Falmouth Bus Depot is located on Depot Avenue in Falmouth. The building itself used to be a railway station. After rail service to Woods Hole was suspended, the building was converted into a bus terminal. The facility is open 7 days a week, excepting holidays, from 5am to 5pm. Limited parking is available. The Falmouth Bus Depot serves as a destination for local transit and interregional bus service, and provides connections to various ferry terminals. Peter Pan service from Boston to Woods Hole stops at the Falmouth Bus Depot. Additionally, the RTA's Hyannis-Falmouth SeaLine service and the seasonal WHOOSH Trolley will make stops at the Bus Depot. These transit services provide connections to the ferry terminals at Woods Hole and Falmouth Marina. Beyond the available transit services, the Shining Sea Bike Path is located next to the depot along the former rail right-of-way. Given its proximity to downtown, the Falmouth Bus Depot also provides access to restaurants, hotels and shopping.

Woods Hole Steamship Authority Piers

The Steamship Authority piers in Woods Hole are also used as a bus terminal.

FIGURE 19: WOODS HOLE STEAMSHIP AUTHORITY PIERS

Across from the ferry terminal is a small Peter Pan ticket facility and place for buses to pick-up and drop-off. Peter Pan buses continue from the Steamship Authority Piers to Boston. Due to the demand for ferry service, parking for the bus terminal is extremely limited. Travelers using the bus terminal can make use of amenities at the ferry terminal including restrooms, and food services. Additionally, the Shining Sea Bikepath terminates at the Steamship Authority Pier, providing bicycle access to downtown Falmouth and points north. Nearby Wood Hole offers restaurants, hotels and shopping.

Tedeschi Food Shop in Bourne

Tedeschi Food Shop on Trowbridge Road in Bourne also serves as a stop for interregional bus service. The location was selected due to its proximity to the Bourne Bridge and Route 25. Peter Pan makes stops at Tedeschi on its route from Boston to Woods Hole and on its route from Providence to Hyannis. Tickets can be purchased inside Tedeschi and a portion of their parking lot is available for commuters.

Sagamore Park-and-Ride Lot

The Sagamore Park-and-Ride Lot is owned by MassDOT located by Interchange 1a in Bourne, near Routes 3 and 6. In early 2009, the lot was been expanded to a total of 396. Sagamore Park-and-Ride Lot is accessed by Plymouth and Brockton on its Boston to Hyannis route. In this way it serves as a commuter stop for those traveling to work in Boston, Logan International Airport and other points north.

FIGURE 20: SAGAMORE PARK-AND-RIDE LOT

Barnstable Park-and-Ride Lot

The Barnstable Park-and-Ride Lot is a MassDOT owned facility located off Exit 6 of Route 6 in Barnstable. The lot was expanded to 365 parking spaces in August 2001. As part of the expansion, two new shelters were installed and currently appear to be in good condition. This lot has a ramp directly onto Route 6 westbound, making it convenient for motorists and buses. The Exit 6 facility is adjacent to amenities such as restrooms, food service, a convenience store, ATMs, fuel, and a seating area. The Barnstable Mobil Mart located inside is open 24 hours and sells tickets for interregional bus service. The Barnstable Park-

FIGURE 21: BARNSTABLE PARK-AND-RIDE LOT

and-Ride Lot is used as a stop for the Plymouth and Brockton route from Hyannis to Boston and for the Peter Pan route from Hyannis to Providence. The CCRTA's Barnstable Villager service provides local bus service to the Route 132 entrance to the Park-and-Ride lot, with connections to Barnstable Village, Route 132, and Hyannis.

Harwich Park-and-Ride Lot

The Harwich Park-and-Ride Lot is a MassDOT owned facility located off Exit 10 of Route 6 on Route 124. The lot has 75 parking spaces. The lot is available as a stop (on-demand) for the CCRTA's Flex Service.

Hyannis Park-and-Ride Lot

The Hyannis Park-and-Ride Lot is located at the Hyannis Transportation Center. There is room for 225 vehicles. Long-term parking (over 30 minutes) is officially available on a pay-basis. The lot has access to all of the bus services and user amenities at the Hyannis Transportation Center.

Park-and-Ride Lot Usage

Data collected at Park-and-Ride locations are organized in the Figure 22 to show the capacity, average occupancy, and maximum occupancy for each of the lots from 1995-2013. The dark shaded bar graphs represent the capacity of each lot. The capacity has historically changed at the Barnstable and Sagamore Locations due to construction. The Barnstable location has grown from 225 spaces to 365 spaces from 1995-2013. The Sagamore Lot was reduced in 2005 due to the reconstruction of bridge access and then expanded in 2009 to accommodate 378 vehicles.

The average occupancy for each lot is shown by the lighter color on the bars. These data were collected in various samples during the summer months and shows inconsistent trends when comparing the data. The average occupancy does show that the Harwich lot averages fewer than 50 percent capacity for each year despite the removal of commuter bus service.

The maximum occupancy is shown by the red line located on or above the bar. A line located on the bar indicates that observations did not find a lot exceeding the capacity. A line located above the bar indicates that the lot did on occasion exceed capacity. Exceeding capacity would result in illegally parked cars. It can be noted that the Barnstable lot exceeded capacity 2011 and 2013, 2012 was observed at maximum capacity but not exceeding. The Sagamore Lot has not been observed to exceed capacity in the last ten years.

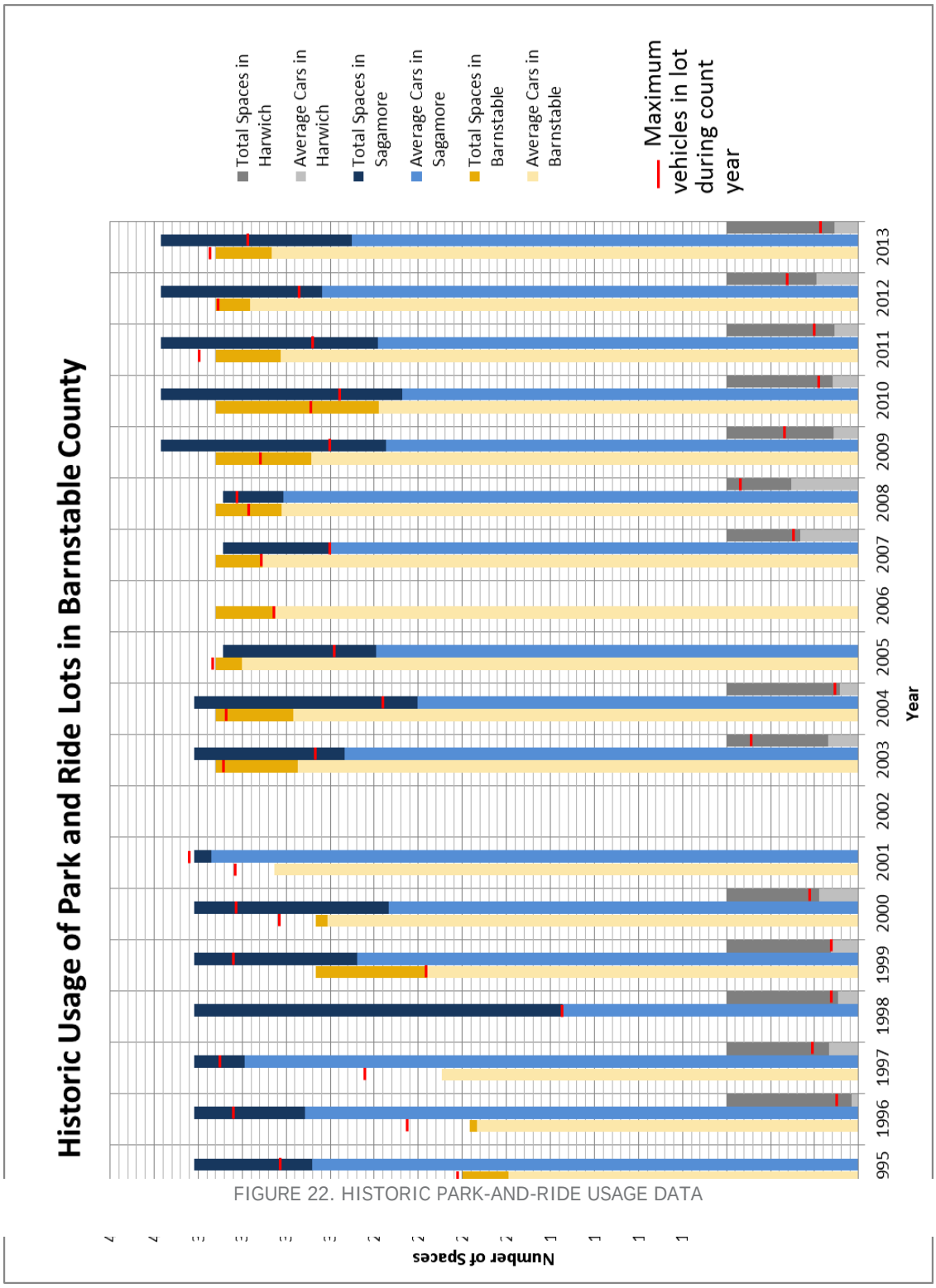

FIGURE 22. HISTORIC PARK-AND-RIDE USAGE DATA

INTERREGIONAL BUS SERVICE

Interregional bus service transports travelers to and from Cape Cod. Some examples are bus service from Hyannis to New York City, or Boston to Provincetown. Users of interregional bus service include commuters who work in Boston, Logan Airport users, and those traveling or vacationing. Two bus companies serve Cape Cod's interregional service needs.

FIGURE 23: PLYMOUTH AND BROCKTON BUS

Plymouth and Brockton Street Railway Company

The Plymouth and Brockton Street Railway (P&B) was established in 1888, as a local service provider for the area. According to P&B, electric trolley cars carried passengers to and from work, and on weekend "joy rides." Following World War I, street railway tracks were abandoned and replaced by motor coaches throughout the South Shore. Plymouth and Brockton's final electric trolley run was made on June 28, 1928 between Jabez Corner and Kingston. The company was purchased by the Anzuoni family in 1948, who continue to operate and manage the Plymouth and Brockton Street Railway to this day. P&B serves 25 cities and towns from Boston to Cape Cod and is partially subsidized by the Massachusetts Bay Transportation Authority (MBTA), MassPort, and the Cape Cod Regional Transit Authority (CCRTA).

Current Plymouth and Brockton service stretches from Logan International Airport to Provincetown. There are two primary routes. The first route is between Hyannis and Provincetown. This route is operated 4 times daily in both directions during the summer. The bus makes several stops along the Outer Cape route as shown on Table 1.

TABLE 1. PLYMOUTH AND BROCKTON OUTER CAPE BUS STOPS

STOP NAME	LOCATIONS
Hyannis	Hyannis Transportation Center
Harwich	Harwich Park-and-Ride Lot
Orleans	CVS @ Main St. & Route 6A
Eastham	Town Hall @ Rt. 6 and Samoset Rd.
North Eastham	Village Green @ Rt. 6 and Brackett Rd.
South Wellfleet	Farrell's Market, Rt. 6
Wellfleet	Town Hall, Main St.
Truro	Post Office and Jam's Store, Route 6A
North Truro	Dutra's Market, Route 6A

The second route is between Hyannis and points in Boston. Stops in Boston include Logan International Airport, Park Square & 200 Stuart Street, and South Station Transportation Center. In addition, several stops are made along the way both on and off Cape (See Table below). Buses terminate in Boston at Park Plaza, Logan Airport, and most frequently South Station. Total operations are reduced during the fall and winter to reflect the lower demand for travel.

TABLE 2. PLYMOUTH AND BROCKTON COMMUTER BUS STOPS

STOP NAME	LOCATIONS
Hyannis	Hyannis Transportation Center
Barnstable	Barnstable Park-and-Ride Lot
Sagamore	Sagamore Park-and-Ride Lot
Plymouth	Rt. 3 Exit 5 Info Center Park-and-Ride Lot
Rockland	Rt. 3 & Rt. 228 Park-and-Ride Lot
Boston	South Station Transportation Center
Boston	Park Square & 200 Stuart Street
Boston	Logan International Airport

Peter Pan and Bonanza Bus Lines

FIGURE 24: PETER PAN BUS

Bonanza Bus Lines was founded in 1955. Service to Hyannis was added in 1958. By 1965, the "Short Line," as it was then called, had service to Boston, New Bedford, Springfield, and beyond. Bonanza became the largest independent bus line in New England in 1974 when it began service from Hartford, CT to New York City. Service from Boston to Woods Hole, with connections to ferry service, began in 1978. After merging with Coach USA in 1998, the company was purchased by Peter Pan Bus Lines in 2003, along with three other New England affiliates of Coach USA. Additionally, Peter Pan has partnered with Greyhound to provide ticketing services, more connections and increased service. Currently, the Peter Pan Bus Lines network includes a 1,560-mile route system serving New England and beyond.

Peter Pan and Bonanza Bus Lines provide two routes serving Cape Cod. The first route is between Woods Hole and Boston. Stops are made in Falmouth and Bourne. Service may be reduced in the winter to reflect reduced demand.

TABLE 3. PETER PAN WOODS HOLE TO BOSTON

STOP NAME	LOCATIONS
Woods Hole	Steamship Authority Piers
Falmouth	Falmouth Bus Depot, Depot Ave.
Bourne	Tedeschi's Food Shop, Trowbridge Rd.
Boston	South Station Transportation Center

The second route run by Peter Pan and Bonanza on Cape Cod is the Hyannis to Providence, RI bus. Six round trips are made daily in the summer. Stops are made in Barnstable, Bourne, New Bedford, Fall River, and Providence. Service may be reduced in the winter in order to accommodate demand. Connections can be made at a number of stops along each route.

TABLE 4. PETER PAN HYANNIS TO PROVIDENCE

STOP NAME	LOCATIONS
Hyannis	Hyannis Transportation Center
Barnstable	Barnstable Park-and-Ride Lot
Bourne	Tedeschi's Food Shop, Trowbridge Rd.
New Bedford	SRTA Terminal, Elm Street
Fall River	SRTA Terminal, Second Street
Providence	Bonanza Bus Terminal
Providence	Kennedy Plaza

CAPE COD REGIONAL TRANSIT AUTHORITY

The Cape Cod Regional Transit Authority (CCRTA) is the agency in charge of operating and maintaining public transit services on Cape Cod. The CCRTA is an independent public agency, governed by a board of directors. The 15 Cape Cod towns each appoint one board member to represent their interests in the CCRTA. The CCRTA offers several types of services, including Fixed Route service, Flexible Route service, and Demand Response or Paratransit service. Some Paratransit and Demand Response services are not operated directly by the CCRTA, but are contracted.

Fixed Route Bus Service

Fixed Route bus service is the traditional form of transit. Vehicles follow specific routes and stop at designated areas. Fixed Route service on Cape Cod is slightly different, in that CCRTA buses (with the exception of the Flex) stop anywhere along their route when flagged. All CCRTA fixed route buses have bicycle racks, designed to carry two bicycles. In addition, all fixed route buses are wheelchair accessible and equipped with low floors, ramps or lifts. Service animals are the only animals allowed to board the buses.

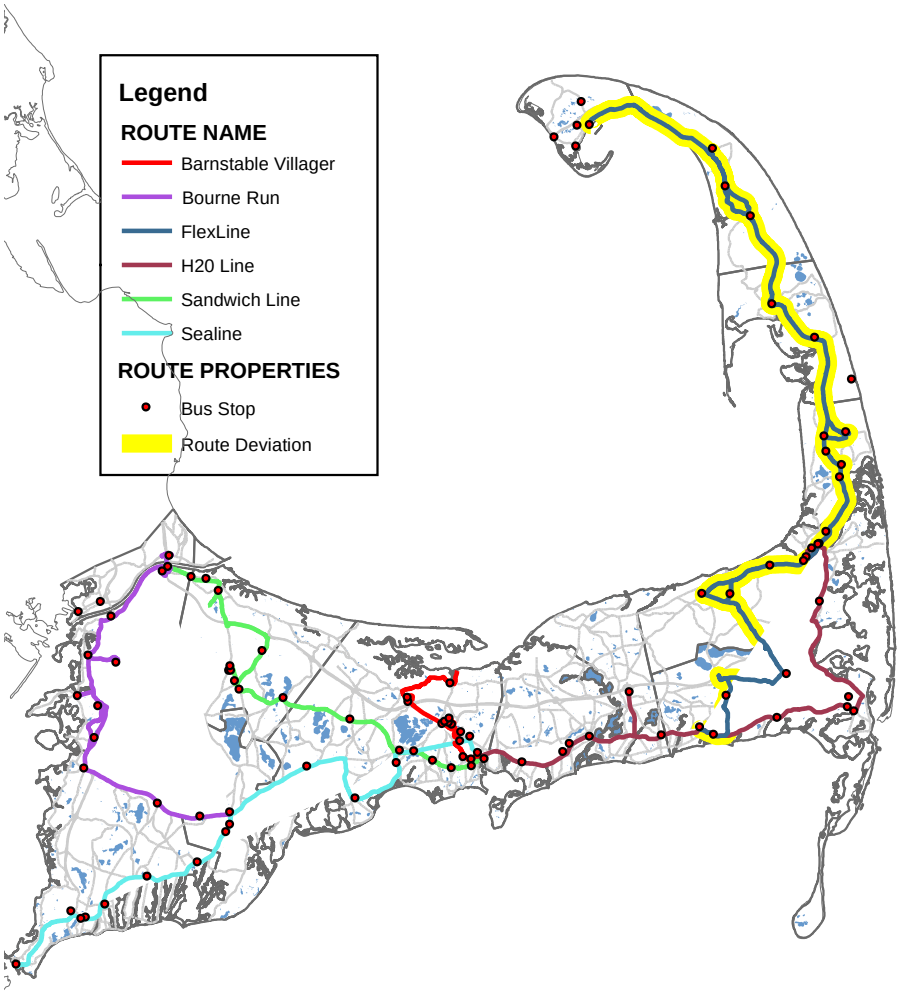

FIGURE 25: CAPE COD REGIONAL TRANSIT AUTHORITY SYSTEM MAP

Source: Cape Cod Regional Transit Authority

Hyannis-Falmouth Service: "SeaLine"

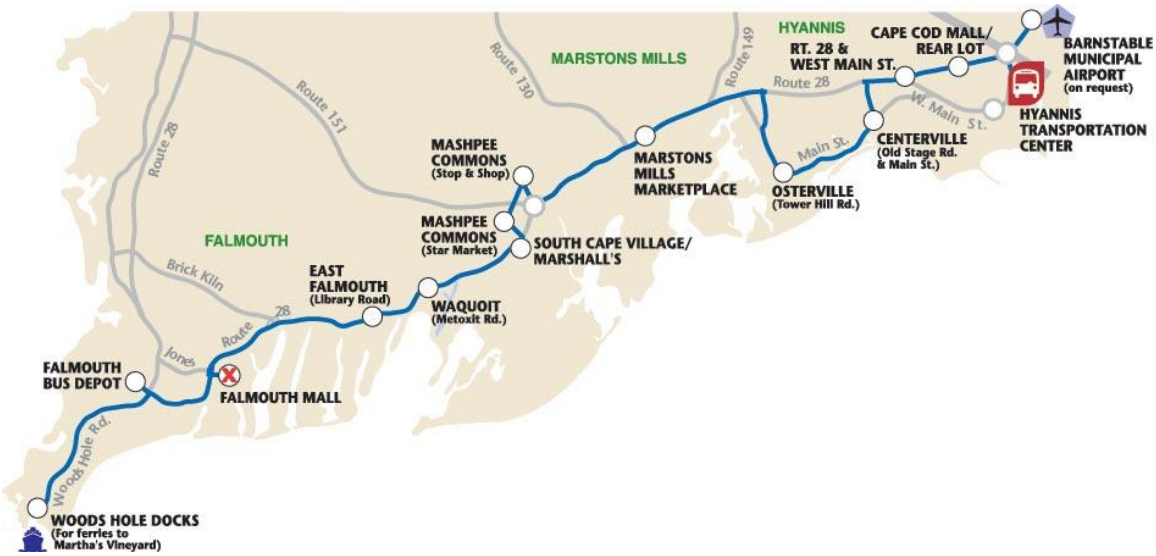

FIGURE 26: CCRTA SEALINE MAP

Source: Cape Cod Regional Transit Authority

The Hyannis-Falmouth service known as the SeaLine runs from the Hyannis Transportation Center to the Falmouth Mall on Route 28. Passengers can board the bus at any of the 10 designated stops, or flag the driver anywhere along the route to stop. The SeaLine operates round trips beginning at 5:30am and ending at 8:58pm. Some of the round trips feature stops that other do not and the number of trips are increased in the summer. Buses are schedule to run every 60 minutes, with a complete one-way trip taking one hour. During the summer months service operates 7 days per week. Outside of the summer months service operates Monday through Friday and reduced on Saturdays. Service may be reduced during the winter in order to reflect lower demand. The first two trips, made before 8:00am, skip the Centerville and Osterville stops, continuing straight down Route 28, and ending at the Steamship Authority Docks in Woods Hole. The SeaLine will also stop at the Barnstable Municipal Airport uponr equest. The SeaLine connects to the WHOOSH Trolley in Woods Hole and to most other lines at the Hyannis Transportation Center.

Hyannis-Orleans Service: "H2O"

FIGURE 27: CCRTA H2O MAP

Source: Cape Cod Regional Transit Authority

The Hyannis-Orleans service, also known as the H2O Line, runs from the Hyannis Transportation Center to the Stop and Shop on Routes 28/6A in Orleans. Passengers can board the bus at any of the 17 designated stops, or flag the driver anywhere along the route to stop. The H2O operates round trips beginning at 5:45am and ending at 8:50pm. Buses are scheduled to run about every hour, with the complete one-way trip taking 1 hour and 50. During the summer months the H2O operates seven days per week including holidays. Outside of the summer months the H2O operates Monday through Friday and reduced on Saturday. Service may be reduced during the winter in order to reflect lower demand. During the Orleans to Hyannis trip, the bus stops at the Cape Cod Hospital only upon request. Passengers riding the H2O can transfer to the Flex at four locations indicated by a red X on the map above in Harwichport and Orleans, and to most other lines at the Hyannis Transportation Center.

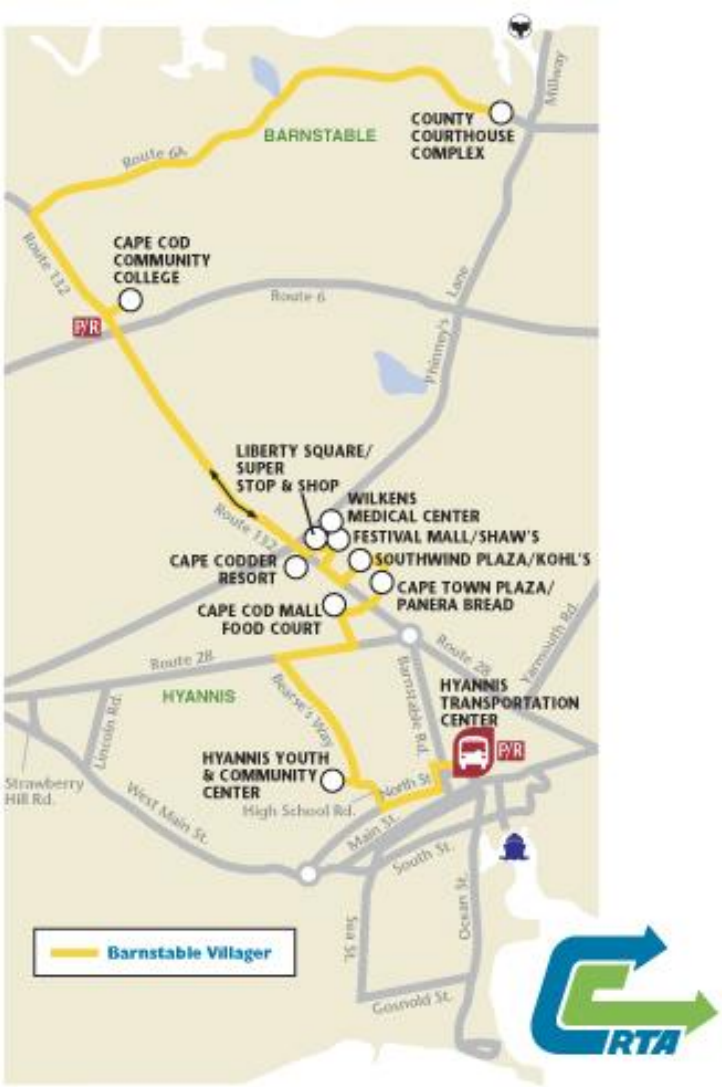

FIGURE 28: CCRTA BARNSTABLE VILLAGER MAP

Source: Cape Cod RTA

Barnstable Villager

The Barnstable Villager service runs from the Hyannis Transportation Center to the Barnstable County Complex on Route 6A and Barnstable Harbor. Passengers can board the bus at any of the designated stops, or flag the driver anywhere along the route to stop. The Barnstable Villager makes round trips, beginning at 7:30am and ending at 6:15pm. Buses are scheduled to run every hour, with the complete one-way trip scheduled to take 45 minutes. During the Summer Months the Villager operates seven days per week. Outside of the summer months service is offered Monday through Friday and reduced on Saturday. Service may be reduced during the winter in order to accommodate lower demand. The Barnstable Villager will stop at the Barnstable Municipal Airport upon request. Passengers riding the Villager can transfer to most other lines at the Hyannis Transportation Center.

Flexible Route Bus Service: "the Flex"

FIGURE 29: CCRTA FLEX MAP

Source: Cape Cod RTA

The Flex stretches from Harwichport to Provincetown. Along this route, the Flex picks up passengers at any of the designated stops. Of the designated stops, some are "Main Stops." This means that the Flex bus always makes a stop, usually within five minutes of schedule. The remaining stops are "In-Between Stops," and the Flex only stops when a passenger is waiting, or to drop off a passenger by request. The time of these stops vary. In addition to the "Main Stops" and "In-Between Stops" passengers may flag the bus down along the main route, with the exception of portions along Route 6.

The bus can also "flex" off its route up to ¾ of a mile to pick up passengers who cannot reach a regular stop. Users must call the RTA at least two hours in advance in order to schedule a Flex bus pick up or drop off. The fare for a one-way "off-route trip" is $4. TTY service is available for the deaf or hearing impaired.

Each bus has bio-diesel capability. Low floors and hydraulic drops provide accessibility to disabled users. Bicycle racks on the front of the Flex bus can carry up to two bicycles.

Buses are scheduled to run every 30 minutes, with a one-way trip taking 2 hours and 15 minutes. Service is available Monday through Friday and reduced on Saturdays. Service may be reduced during the winter in order to reflect lower demand. Transfers are available to the Hyannis-Orleans Breeze and Plymouth and Brockton service.

Bourne Route

FIGURE 31: CCRTA BOURNE RUN MAP

Source: Cape Cod RTA

The Bourne Run operates from the Mashpee Commons to the Walmart in Wareham. Passengers can board the bus at any of the designated stops, or flag the driver anywhere along the route to stop. Buses are scheduled to run about every hour and a half, with the complete one-way trip taking 1 hour and 15 minutes. The Bourne Run operates Monday through Friday and reduced on Saturday. Service may be reduced during the winter in order to reflect lower demand. Passengers riding the Bourne Run can transfer to the Sealine at the location indicated by a red X on the map above in Mashpee, and to intercity buses in Buzzards Bay.

Sandwich Line

FIGURE 32: CCRTA SANDWICH LINE MAP

Source: Cape Cod RTA

The Sandwich Line operates from the Hyannis Transportation Center to Park and Ride Lot in Sagamore. Passengers can board the bus at any of the designated stops, or flag the driver anywhere along the route to stop. Buses are scheduled to run about every hour and a half, with the complete one-way trip taking 1 hour and 15 minutes. The Sandwich Line operates Monday through Friday and reduced on Saturday. Service may be reduced during the winter in order to reflect lower demand. Passengers riding the Bourne Run can transfer to the Sealine at the

location indicated by a red X on the map above in Barnstable, and to other CCRTA routes and intercity buses in Buzzards Bay.

Seasonal Services

Hyannis Shuttle

FIGURE 33: CCRTA HYANNIS SHUTTLE

The Hyannis Shuttle is the summer service from the Hyannis Transportation Center to several beaches in the Hyannis area. Passengers can board the bus at any of the designated stops, or flag the driver anywhere along the route to stop. The Hyannis Shuttle makes round trips, beginning at 11:00am and ending at 9:00pm. Buses operate 7 days per week including holidays starting late June and continuing through Labor Day. Passengers riding the Hyannis Shuttle can transfer to most other lines at the Hyannis Transportation Center.

Provincetown/Truro Shuttle

FIGURE 34: CCRTA PROVINCETOWN/TRURO SHUTTLE

The Shuttle serves Downtown Provincetown, Provincetown Airport, Race Point Beach, Herring Cove Beach, and North Truro. The Shuttle operates on a reduced schedule from 7:am to 12:30am Monday through Saturday and from 7:00am to 8:00pm on Sunday from Memorial Day to mid-June. During the summer, shuttles run every 30 minutes, between 7:00am and 12:30am seven days per week, including holidays. Passengers riding the Shuttle may board at designated stops or flag the bus down at any location along its route. Passengers also are able to transfer to the Flex bus for free at Dutra's Market in North Truro.

The WHOOSH Trolley

FIGURE 35: CCRTA WOOSH TROLLEY

The WHOOSH Trolley, or the Woods Hole Trolley, runs from the Falmouth Mall to the Steamship Authority Docks in Woods Hole. Passengers can board the bus at any of the designated stops, or flag the driver anywhere along the route to stop. During the summer, the WHOOSH Trolley operates between 9:30am and 7:30pm Sunday through Thursday and 9:30am till 10:00pm on Friday and Saturday, including holidays. Transfers are available to the Sealine at the Falmouth Mall.

Demand Response Bus Service

Demand response bus service addresses the needs of passengers who cannot use standard transit services. Demand response buses do not use a route system, but instead pick up passengers at scheduled locations and times, often at their homes or offices, as requested.

Dial-A-Ride Transportation (DART)

The DART service is a demand response service that operates year round, seven days a week, with the exception of some holidays. In order to use the service, passengers must call the RTA at least one day in advance during normal business hours to schedule a pick up and drop off. If multiple passengers are being picked up or dropped off in the same location their trips will be grouped. For this reason, users must be flexible with their pick up and drop off times. If passengers do not show for a requested trip they are considered a "No-Show" and are subject to restrictions when scheduling their next trip. Repeat "No-Shows" could result in the loss of riding privileges.

The standard fare to ride the DART is $3.00. This rate is reduced for seniors and individuals with disabilities, and monthly passes are available. Many passengers use the DART to get to work or school, shopping trips, doctor's appointments, and even trips to medical centers in Boston.

ADA Paratransit Service

The Americans with Disabilities Act (ADA) is a federal law passed in 1990, which states that individuals with disabilities are entitled to a comparable level of public transportation service as individuals without disabilities. In order to comply with the ADA, the CCRTA offers a demand response, or paratransit specifically for individuals with disabilities. This paratransit service operates within ¾ mile of existing routes and runs during the same hours as existing bus services. Trips may be requested during normal business hours on the day prior to the desired service.

ADA Paratransit Service is available to people with physical, mental, cognitive, and visual impairments that prevent them from boarding or disembarking fixed route services, from recognizing destinations, from understanding bus transfers, or from distinguishing between different buses in different routes. Residents who think they may qualify are encouraged to contact the CCRTA to request an application.

Fully Funded and Councils on Aging

The CCRTA also helps transport passengers through contracting or funding bus service for other agencies. The buses are not operated by CCRTA staff, but were obtained through contract.

GREATER ATTLEBORO-TAUNTON REGIONAL TRANSIT AUTHORITY

The Greater Attleboro-Taunton Regional Transit Authority (GATRA) is the agency in charge of operating and maintaining public transit services for 17 member communities in Southeastern Massachusetts. GATRA serves Cape Cod with the Onset-Wareham Link (OWL), with stops in Bourne.

The OWL is a fixed route bus service, comprised of 4 "links" or routes, serving Wareham and Bourne. Link 2 connects Route 6/28, Onset Village, and Bourne and every hour from 7:55am to 5:30pm. Passengers can board at any point on the route by waving down the driver. Fares are $1 for a one-way trip, with discounts for the elderly, disabled, students, and children. Monthly passes are also available.

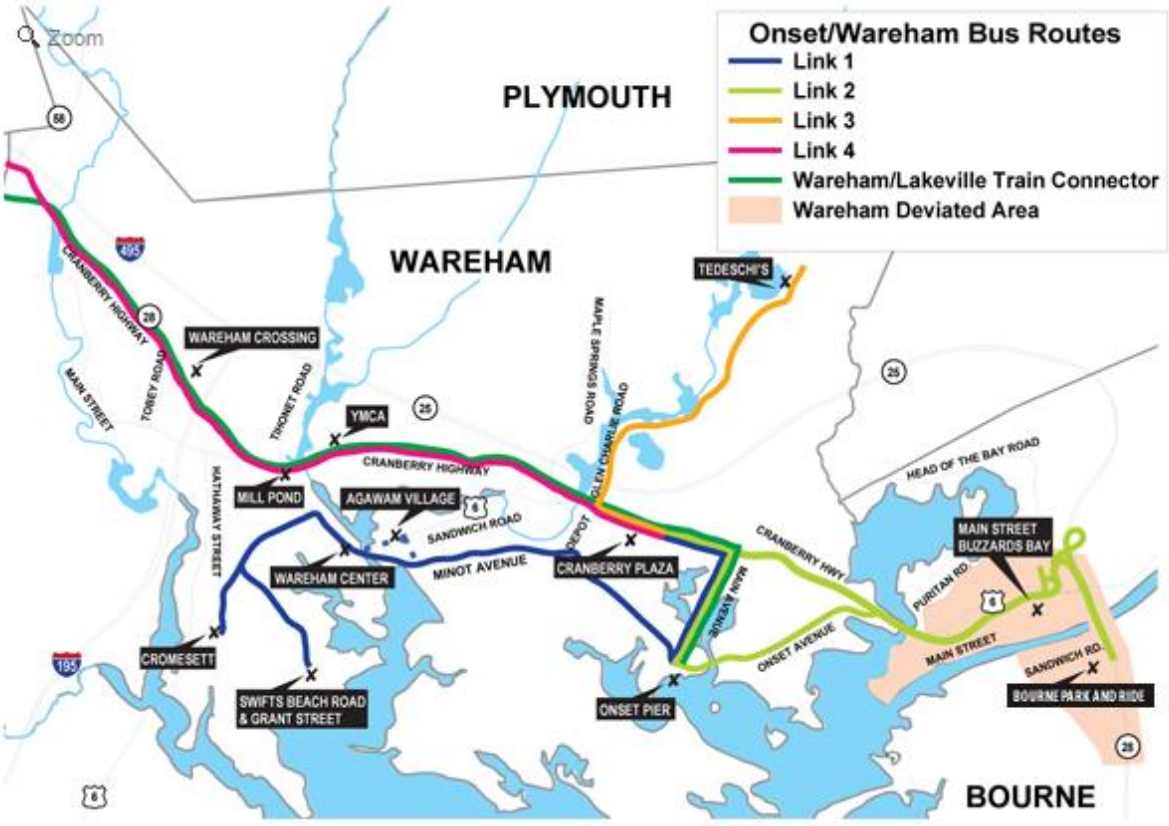

FIGURE 36: GATRA SERVICE IN BOURNE/WAREHAM/ONSET

Source: Greater Attleboro Taunton Regional Transit Authority

RAIL INFRASTRUCTURE

RAILS

Cape Cod has a single rail line, the Cape Cod Line, with three branches. Together, they form a network of rail infrastructure which serves the freight and recreational needs of Cape Cod residents and visitor.

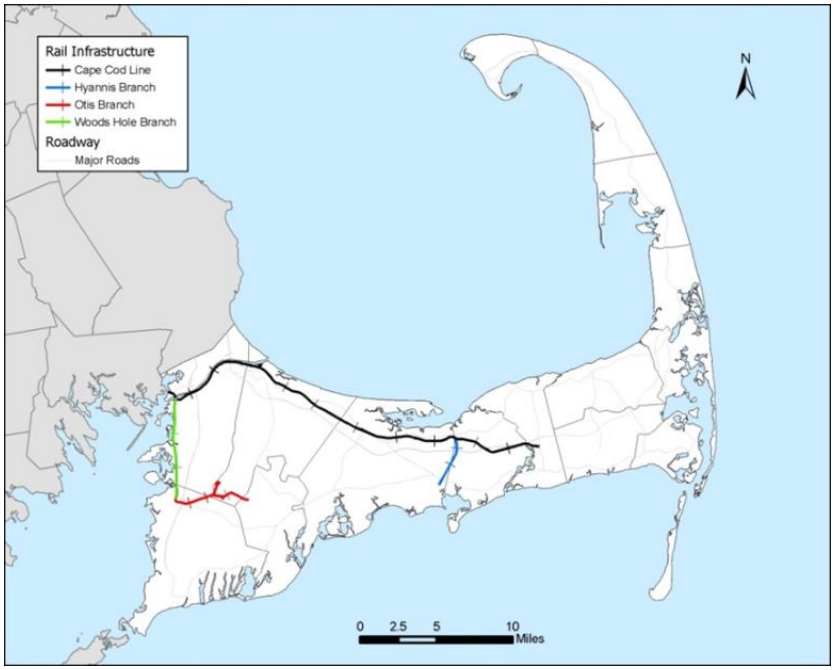

FIGURE 37: CAPE COD RAIL INFRASTRUCTURE

Rail infrastructure extended the entire length of Cape Cod, from Bourne to Provincetown, in the first half of the 1900s. Service was also available along the west coast, extending from Bourne to Woods Hole in Falmouth, and to Chatham. Today the expanse and usage of rail is reduced. Active rail still exists starting in Bourne and ending in three locations, Joint Base Cape Cod, Hyannis, and Yarmouth.

The portion of track that formally connected Dennis to Provincetown was dismantled. From Route 134 in Dennis to LeCount Hollow Road in Welfleet the former tracks were turned into the Cape Cod Rail Trail bicycle facility. From LeCount Hollow Road north the rail track right of way had various conversions including sale to private owners. An extension of the Rail Trail is planned to connect into Barnstable, using rail right-of-way from Route 134 in Dennis to an area to the east of Higgins Crowell Road in Yarmouth. Rail track in Falmouth, from Old County south to Woods Hole have also been converted to a bike path called the Shining Sea Bikeway in 1976.

The rail tracks that have remained in place have varied levels of usage. Figure 37 shows the location of existing rails and Table 5 details the mileage and percent of total. This data was obtained from the MassDOT roadway inventory file.

TABLE 5. CAPE COD RAIL MILEAGE BY CATEGORY

		TOTAL MILES	PERCENT OF TOTAL
	Cape Cod Total	53.8	
By Rail Line	Cape Cod Line	32.0	59.5%
	Hyannis Branch	4.4	8.2%
	Otis Branch	10.4	19.3%
	Woods Hole Branch	7.0	13.0%
By Owner	Federally Owned	9.8	18.2%
	Army Corps of Engineers	0.2	0.3%
	MassDOT	43.8	81.4%
By Town	Barnstable	11.2	20.8%
	Bourne	14.4	26.8%
	Dennis	1.2	2.2%
	Falmouth	4.0	7.4%
	Mashpee	0.4	0.8%
	Sandwich	14.8	27.5%
	Yarmouth	7.8	14.5%

Cape Cod Line

The Cape Cod Line begins in Buzzards Bay, Bourne after it crosses over the Cohasset Narrows Bridge. The tracks pass the former train station in Buzzards Bay. This building is currently used by the Canal Area Chamber of Commerce, is a stop on the CapeFLYER summer service and the parking lot has varied users including inter-city bus passengers. There are currently two rail platforms at this location. Cape Flyer passengers use the short raised platform, and the longer ground level platform is considered obsolete because it is not handicap accessible.

FIGURE 38: CAPE COD CANAL RAIL BRIDGE

Immediately after passing the Buzzards Bay train station the train must cross the Cape Cod Canal over the Cape Cod Canal Railroad Bridge. The Cape Cod Canal Railroad Bridge was first built in 1910 during the construction of the Cape

FIGURE 39: FORMER RAIL STATION IN BUZZARDS BAY

Cod Canal. When the canal was reconstructed in 1933, a new railroad bridge was built over the widened waterway. Since the railroad grade could not be easily raised, the Army Corps of Engineers constructed a vertical lift railroad bridge. The new bridge was completed in December of 1935 and was the longest bridge of its kind at the time. Recently, the Cape Cod Railroad Bridge underwent a major rehabilitation effort, in large part through $25 million in Federal funds. Normally the bridge remains in the "up" position, allowing marine traffic access through the canal, and is lowered for rail service as needed. Marine traffic has statutory right-of-way over rail traffic but can be managed to accommodate scheduled train service such as the Cape Flyer. The bridge is 806 feet long, 297 feet high and has a high water clearance of 136 feet. Rail improvement is scheduled for 2015 to decrease waiting time for crossing the bridge.

FIGURE 40: RAIL TRACKS WEST OF THE SAGAMORE BRIDGE

After Crossing the Cape Cod Canal the track splits between the Cape Cod Branch and Woods Hole Branch. The Cape Cod Branch follows the Cape Cod Canal and then runs alongside Route 6A through Sandwich and Barnstable. Out of service side tracks and former stations can be seen in West Barnstable and Sandwich. Plans to build a new platform for CapeFLYER passengers on the south side of the canal after the split were been presented in 2014. The Cape Cod Line continues to the Yarmouth "wye" (triangular junction) at Willow Street in Yarmouth. Here, the Hyannis Branch turns south, while the Cape Cod Line continues to the east.

East of Willow Street, the Cape Cod Line continues towards Dennis on its third segment. This is the easternmost section of railroad still in use on Cape Cod. It extends from Willow Street in Yarmouth to the Yarmouth Waste Management Facility just west of Station Avenue. The connection to the Waste Management Facility can be made from the mainline in either direction. Mass Coastal Railroad operates its "Energy Train" from this facility, usually one or two trips a day exporting solid waste to a waste-to-energy facility in Rochester, Mass. In total, the segment contains 3.38 miles of track, the grade separated crossing of Route 6, and 23 total roadway crossings.

FIGURE 41: RAIL CROSSING AT WILLOW STREET IN YARMOUTH

The last segment of the Cape Cod line is not in service. This segment starts at the Yarmouth Waste Management Facility east of Station Avenue and crosses the Bass River via a bridge. The Cape Cod Line used to continue all the way to Provincetown, with the Chatham Branch starting west of Route 124 in Harwich. However, the tracks were dismantled and a portion of the right-of-way was converted into the Cape Cod Rail Trail, which serves bicycle users and recreational purposes. Currently, however, the Cape Cod Line extends as far as Route 134 in Dennis. This final segment of track is out of service, abandoned, and not usable by train. Vegetation has encroached upon the rail tracks, crossing signals have been left in disrepair, and road crossings have been paved over. Plans for the westerly extension of the Rail Trail on a portion of this rail track through Yarmouth to Station Avenue have been designed are currently programed for construction in 2015.

FIGURE 42: RAIL TRACKS EAST OF GREAT WESTERN ROAD IN YARMOUTH

In sum, the Cape Cod Line is the backbone of rail service on Cape Cod. It stretches 31.09 miles, and includes 3 bridges over waterways, 8 grade separated roadway crossings, and 51 total roadway crossings. The Cape Cod Line forms the majority of regional rail infrastructure. It serves as the only access to Cape Cod by rail, and is used by both Mass Coastal freight services and Cape Cod Central Railroad for scenic excursion trains and the CapeFLYER for weekend passenger service.

Hyannis Branch

The Hyannis Branch begins at the Yarmouth "wye" (triangular junction) at Willow Street in Yarmouth and travels south. The historic Hyannis Roundhouse, located between Route 28 and Main Street in Barnstable, has been converted into a nightclub and warehouses. The rail yard is now used for the Hyannis Transportation Center and as a rail yard for Cape Cod Central Railroad. A restaurant and a retail store now occupy part of the site. The terminus of the Hyannis Branch is a station for the Cape Cod Central. Originally, the Hyannis Branch continued from the rail yard south to a port facility in the Outer Harbor of Hyannis Harbor. The port and rail

FIGURE 43: RAIL PLATFORM AT THE HYANNIS TRANSPORTATION CENTER

connection were dismantled however, and the right of way converted into Old Colony Road. This segment has also been rated for 30 MPH travel. In total, the Hyannis Branch contains 4.39 miles of track, 2 grade separated crossings under Route 6, and 6 total roadway crossings. Currently the Hyannis Branch only serves passengers.

Woods Hole Branch

The Woods Hole Branch begins at the Canal Junction, splitting off from the Cape Cod Line and traveling south through Bourne and Falmouth. Three depot stations along the route, in Monument Beach, Pocasset, and Cataumet, have been converted to other uses. The tracks continue south to the Otis Junction just south of Old County Road in Falmouth. The track from Otis Junction to Joint Base Cape Cod is currently are owned by Mass Coastal Railroad but currently not in use by train. An out of service side track runs from Old Main Road to the Otis Junction. This portion of the Woods Hole Branch has been rated for 30 MPH travel. In total, the segment contains 8.43 miles of track, 2 bridges over waterways, 5 grade separated roadway crossings, and 17 total road crossings.

FIGURE 44: RAIL TRACKS NORTH OF OLD COUNTY ROAD IN FALMOUTH

The final segment of the Woods Hole Branch runs from the Otis Junction to the overpass at the southern crossing of Palmer Avenue. Vegetation encroached upon the rail tracks and crossing signals have been left in disrepair, and road crossings have been paved. This section has been converted to an extension of the Shining Sea Bike Path. In total, the segment contains 5.82 miles of track, a bog sluiceway north of Fox Lane, 4 grade separated roadway crossings, and 14 road crossings.

Originally, the Woods Hole Line continued south with stations at Depot Street and the current Steamship Authority port at Woods Hole. Originally built in 1872, this section of the Woods Hole line has been dismantled. The station at Depot Street now serves as a bus terminal, while the right-of-way has been converted into the Shining Sea Bike path.

FIGURE 45: RAIL TRACKS AT THE OTIS JUNCTION

Otis Branch

From the Otis Junction, the Otis Branch runs east into Joint Base Cape Cod. Inside the base, the track splits into several terminals, with one track running as far east as Mashpee. The track from Otis Junction to Joint Base Cape Cod is

currently used by Mass Coastal Railroad to export solid waste; this service is due to expire later this year. In total, the segment contains 10.51 miles of track, 3 grade separated roadway crossings, and 15 total roadway crossings.

ROAD CROSSINGS

Exclusive rights-of-way can limit the interaction of rail and other modes, making rail transportation safer and faster. However, crossing at roadways can pose problems if the intersection is not properly signed and designed. Currently on Cape Cod, there are 66 at-grade roadway intersections along active rail lines. Some, such as the railroad crossing at Route 28 in Barnstable, can actually interfere with roadway traffic and cause congestion and delays. Of those, 21 are not gated, signalized or signed. Although most of these are minor roadways, they do represent a potential for mishap. Moreover, there are 18 grade separated roadway crossings, as well as 5 bridges over waterways along active rail lines. These bridges and overpasses must be maintained in order to ensure continued use. If rail service on Cape Cod is to be increased, further study of railroad crossings may be necessary to ensure safety and prevent interruptions to roadway traffic.

TABLE 6. RAILROAD CROSSING BY TYPE

		TOTAL	GRADE SEPARATED	GATED	SIGNALIZED	SIGNED	OTHER\ NONE
	Cape Cod Total	102	22	4	26	19	31
By Rail Line	Cape Cod Line	62	10	3	20	11	18
	Hyannis Branch	6	2	1	-	1	2
	Otis Branch	15	3	-	-	2	10
	Woods Hole Branch	19	7	-	6	5	1
By Owner	Federally Owned	13	4	-	5	3	1
	Army Corps of Engineers	15	3	-	2	-	10
	MassDOT	73	15	4	27	13	14
By Town	Barnstable	18	1	3	8	4	2
	Bourne	27	11	-	6	5	5
	Dennis	3	-	-	-	-	3
	Falmouth	6	4	-	1	-	1
	Mashpee	33	2	1	11	3	16
	Sandwich	15	4	-	1	6	4
	Yarmouth	7.8	14.5%				

Source: www.masscoastal.com/train-energy.php

AVIATION INFRASTRUCTURE

For Cape Cod travelers, air transportation provides an important link from Cape Cod to Boston, New York, and the islands of Martha's Vineyard and Nantucket. Six airfields and airports serve Cape Cod as a base for air transportation (see Table 7).

TABLE 7: AIRPORTS AND AIRFIELDS OF CAPE COD

NAME	FAA IDENTIFIER	FACILITY TYPE
Barnstable Municipal Airport	HYA	Scheduled Air Carrier Service
Provincetown Municipal Airport	PVC	Scheduled Air Carrier Service
Chatham Municipal Airport	CQX	General Aviation
Falmouth Airpark	5B6	General Aviation
Cape Cod Airfield	2B1	General Aviation
Cape Cod Coast Guard Air Station	FMH	Military

The commercial service airports, Barnstable Municipal Airport and Provincetown Municipal Airport, supply data on total enplanements to the Federal Aviation Administration (FAA). In 2013, Barnstable Municipal Airport reported 87,648 enplanements and Provincetown Municipal Airport reported 11,288 enplanements.[1]

[1] 2013 Air Carrier Activity Information System data

Barnstable Municipal Airport

FIGURE 46. BARNSTABLE MUNICIPAL AIRPORT TERMINAL

The largest airport on Cape Cod is Barnstable Municipal Airport, Boardman-Polando Field located in Hyannis. It is one of two airports on Cape Cod to provide scheduled air carrier service.

The history of the airport goes back to 1928, when Charles Ayling and his son Robertson formed the Hyannis Airport Corporation. During World War II, the Works Progress Administration funded the construction of three paved 4,000-foot runways, while the Army and then the Navy assumed control of the airport. After the war ended, the navy turned over control of the Hyannis Airport to the Town of Barnstable. The advent of larger planes and increased passenger service required the construction of a larger, 5,400-foot runway in the mid-1950s, new terminals in 1957, and a control tower in 1961. In 1981, the airport was renamed the Barnstable Municipal Airport, Boardman-Polando Field. Russell Boardman and John Polando were two Bay State pioneers who flew a record nonstop distance of 5,011 miles from the United States to Istanbul in 1931.

FIGURE 47. BARNSTABLE MUNICIPAL AIRPORT

Recent improvements to the airport include a new 35,000 sq. ft. passenger terminal, a new 85 ft. air traffic control tower, and a new vehicle access road—all opened at the end of 2011—extensive parking facilities, new aircraft ramps and taxiways, a rescue and maintenance building and an aircraft fuel farm.

Barnstable Municipal Airport the airport is home to Cape Air, Nantucket Airlines, Island Airlines, and Rectrix Aviation along with other charter, corporate and general aviation aircraft operators. JetBlue operates daily service to JFK-New York in season.[2]

A 2014 state study found that the airport has a direct economic impact of $119.2 million a year on the Cape Cod community. The analysis, by the Aeronautics Division of the Massachusetts Department of Transportation, calculated the value of jobs, payroll and business generated by the airport and its tenants, along with visitor spending.

[2] http://www.town.barnstable.ma.us/airport/aboutairport/aboutairport.asp

The study found there is a measurable multiplier of an additional $88.7 million a year produced by the recirculation of money spent locally by airport businesses and the people employed there. Overall, the study determined that Barnstable Municipal Airport generates 2,135 jobs, an $85.3 million payroll and $208 million a year in direct and indirect benefits.[3]

Provincetown Municipal Airport

FIGURE 48. PROVINCETOWN MUNICIPAL AIRPORT

The Provincetown Municipal Airport also has scheduled air carrier service. The Airport provides passenger service to Logan Airport in Boston. The airport is located at the end of Race Point Road and is one of two airports in the country that is located in National Park territory. Cape Air and Jet Blue Airways operate passenger services.

Cape Cod Coast Guard Air Station

U.S. Coast Guard Air Station Cape Cod (ASCC), with its four MH-60T Jayhawk helicopters and three HC-144A Ocean Sentry fixed-wing aircraft, is the only Coast Guard Aviation facility in the northeast. As such, ASCC is responsible for the waters from New Jersey to the Canadian border. Centrally located at Joint Base Cape Cod, ASCC maintains the ability to launch a helicopter and/or fixed-wing aircraft within 30 minutes of a call, 365 days-a-year, 24 hours-a-day, and in nearly all weather conditions.[4]

Other General Aviation Airports

Several other airports are open to the public and offer general aviation service. Chatham Municipal Airport, located on George Ryder Road, offers a variety of tours around Monomoy Island and the Outer Cape. One asphalt runway provides service for the 31 aircraft based on the field.

Another general aviation airport is the Falmouth Airpark, located near Route 28 and Fresh Pond Road. The airpark has a single asphalt runway, which serves 53 aircrafts. A nearby "Fly-In Community," with aircraft access from the homes to the runway, offers shares of the Falmouth Airpark with residence.

Lastly, the Cape Cod Airfield on Route 149 and Race Lane in Marstons Mills provides tours. and glider rides from three turf runways. The length of the runways, the height of the nearby trees and the absence of a fence restrict the type of airplanes that can use the airfield. It opened as the Cape Cod Airport on July 4, 1929 with an air circus, stunt flights, parachute jumps, and other

[3] http://www.town.barnstable.ma.us/airport/aboutairport/aboutairport.asp
[4] http://www.uscg.mil/d1/airstacapecod/

spectacles. Currently, the airfield is operated by Cape Cod Flying Service and serves as a base for 14 aircrafts.

AIR SERVICE ACCESSIBILITY AND MOBILITY

Barnstable Municipal Airport is accessible by various means. According to the Cape Cod Transit Task Force Report, the vast majority airport users arrive by automobile. Rental car service is provided by over a dozen rental car agencies, with taxi service available as well. Moreover, the Villager Line of the Cape Cod Regional Transit Authority provides local bus service to the airport upon request, carrying passengers to the Hyannis Transportation Center and Barnstable Park-and-Ride lot. Paratransit service to the airport can also be arranged.

The roadways surrounding the Barnstable Municipal Airport have always provided a challenge in providing safe and convenient access for passengers. While the airport is near many regional roadways (ie. Route 132 and Route 28), getting from the regional roadways to the airport is not always straightforward. While recent signage improvements and resources online, see Figure 49, have assisted motorists, long-term improvements are needed. Such access improvements, particularly at the Airport Rotary, have been included in preliminary designs that were part of the Hyannis Access Study[5]. As funding decisions are made, it is critical to the regional air service that these improvements be seen as a priority for the region.

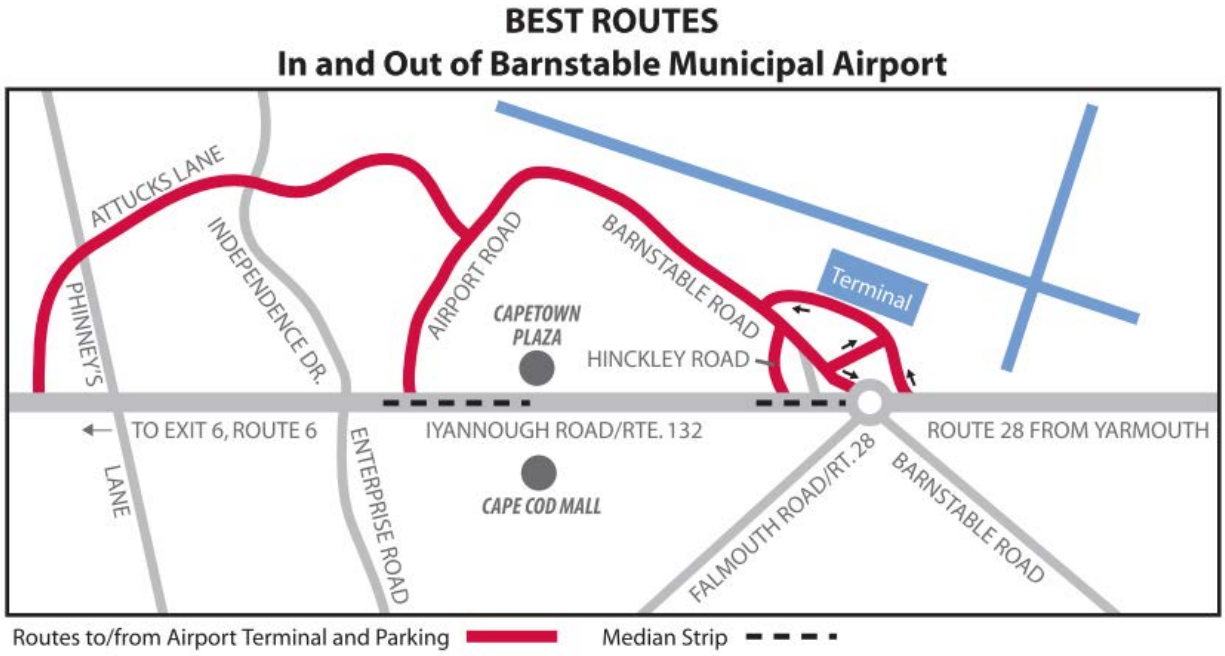

FIGURE 49. BARNSTABLE MUNICIPAL AIRPORT ACCESS

5 http://www.capecodcommission.org/resources/transportation/hyannisaccess/HASI_2013_final_report06282013.pdf

Provincetown Municipal Airport is primarily accessible by road. The Provincetown Shuttle service makes a stop at the airport, and connects air service passengers with interregional bus service and ferry service in downtown Provincetown. Provincetown Municipal Airport is also located along a bicycle path, which serves users that are traveling light. However, the majority of users access the Provincetown Municipal Airport via automobile, including taxi.

Interregional bus service also links travelers on Cape Cod to air service in Boston. Plymouth and Brockton Street Railway Company runs 16 buses each weekday from the Hyannis Transportation Center to the terminals at Logan International Airport and 15 per day on weekends and holidays. This route includes stops at the Barnstable and Sagamore Park-and-Ride lots. By providing direct service to Logan International Airport, Plymouth and Brockton provides travelers with increased access to domestic and international air services. Peter Pan Bus Lines currently offer six daily buses from Bourne to T.F. Green Airport in Providence, RI.

Air service on Cape Cod offers users the potential of global mobility. With service to major air transportation hubs such as New York City, Boston, and Providence, a user can transfer to domestic and international flights. Ironically, however, no scheduled flights exist between Cape Cod airports. Thus, there is a great deal of air service mobility between on-Cape and off-Cape sites, but no intraregional mobility.

MARTIME INFRASTRUCTURE

Cape Cod has approximately 586 miles of tidal coastline, with many inlets and bays that provide marine access to the land. Seaports have been constructed along several of these bays and inlets to facilitate the transfer of people and goods.

CAPE COD CHANNELS

Cape Cod Canal

The Cape Cod Canal connects Buzzards Bay to Cape Cod Bay through the towns of Bourne and Sandwich. The channel itself stretches 17.4 miles in length, extending from the outer end of the northerly breakwater in Cape Cod Bay to a point in Buzzards Bay near Cleveland Ledge about 5 miles southwest of the Wings Neck Light. It provides a shorter route for vessels traveling along the Atlantic Coast, reducing trip length by 65-150 miles depending on origin and destination. Additionally, the route is a safer path, allowing vessels to avoid the shoals and shipwrecks scattered along the Outer Cape route.

A canal was envisioned as early as 1623 by Myles Standish of the Plymouth Colony. Studies and surveys were produced over the next 250 years recommending the construction of a canal, until a charter was finally granted to the Cape Cod Canal Company in 1880.Finally, in 1907, August Belmont purchased the charter to build the canal. Work began in June of 1909, and was completed in 1914 at 100 feet wide and 25 feet deep. The new toll seaway opened with great celebration, however small dimensions and low toll revenues dogged operations in the upcoming years.

In 1918, the U.S. Government assumed control of the canal after a German U-boat attacked five vessels just three miles off Cape Cod. Control was returned to Belmont's company after World War I in 1920. The Cape Cod Canal was sold to the federal government for $11.5 million in 1921. Responsibility for the Cape Cod Canal was passed to the Army Corps of Engineers, who subsequently set out to improve it. The Corps began construction on an expanded canal in 1935 and completed the work by 1940. The existing canal is the result of this work.

The current Cape Cod Canal has a width of 480 feet and a 32-foot deep channel, allowing two-way travel. At that size, the Cape Cod Canal is the world's widest sea-level canal. The old canal drawbridges were replaced in 1935 by the Bourne, Sagamore, and Railroad bridges. The architect Ralph Adams Cram designed the Sagamore and Bourne bridges. Built simultaneously with Work Progress Administration funds, construction provided about 700 jobs. The existing bridges have larger spans of 616 feet each and provide an overhead clearance of 135 feet. A 32-foot deep approach channel was also constructed to facilitate movement of ships from Buzzards Bay into the canal. The channel is 700 feet wide from Cleveland Ledge to Wings Neck and 500 feet from Wings Neck to the canal entrance. Other improvements to the canal include two mooring basins, two basins for small boats, an improved lighting system, a 600-foot and a 3,000-foot stone jetty at the entrance to canal from Cape Cod Bay, and a dike between Hog Island and Rocky Point in Bourne. Support for the navigation mission at the Canal includes a

state of the art Marine Traffic Control System, Marine Traffic Patrol by Corps vessels, and maintenance and improvement of the Canal channel and mooring basins.

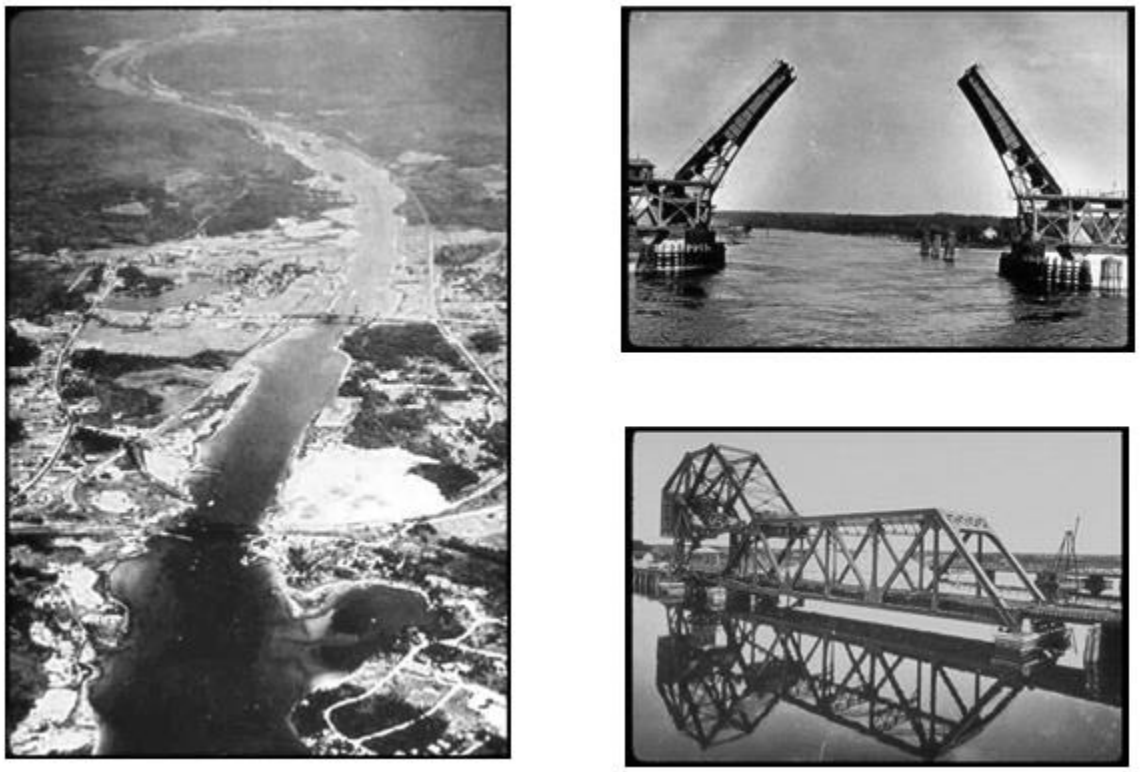

FIGURE 50. HISTORIC CAPE COD CANAL PICTURES

Source: U.S. Army Corps of Engineers

The Army Corps of Engineers continues to operate and maintain the Canal and its bridges today. The highway bridges now carry over 34 million vehicles to and from the isthmus of Cape Cod annually. Over six thousand ships, tug and barge combinations and other large commercial vessels pass through the canal annually. Marine traffic is monitored and regulated 24 hours a day, 365 days a year. Moreover, Corps patrol boats stand by to assist vessels in distress. As a result, the Cape Cod Canal is a safe shortcut for marine traffic from Cape Cod Bay to Buzzards Bay. Recreational boaters take advantage of this fact as well with over seven thousand small boat canal transits each year.

Woods Hole Channel

Woods Hole Channel connects ports and ferry terminals in Woods Hole Harbor to seaports in Buzzards Bay and Vineyard Sound and is the most heavily traveled Cape Cod waterway. It is located between Penzance Point on the mainland and the northernmost of the Elizabeth Islands. The channel connects Buzzards Bay with Great Harbor in Woods Hole.

The Army Corps of Engineers has performed work on the Woods Hole Channel since 1870. Major works include the dredging of the channel and the removal of dangerous shoals and boulders from the main channel. By 1913, the Corps completed the current dimensions of the channel.

The Woods Hole Channel is comprised of a main channel and two branches (see following figure). The main channel, referred to as "The Strait," is 2,500 feet long, 13 feet deep and 300 feet wide. It connects an inlet of Buzzards Bay to Woods Hole between Grassy Island and Red Ledge. The larger branch, called "Broadway," separates from the Strait at Middle Ledge and travels south of Red Ledge to Vineyard Sound. Broadway is 1,300 feet long, 13 feet deep and 300 feet wide. The final branch simply provides a route into Buzzards Bay that is aimed towards the north. The smaller branch is also 13 feet deep and 300 feet wide.

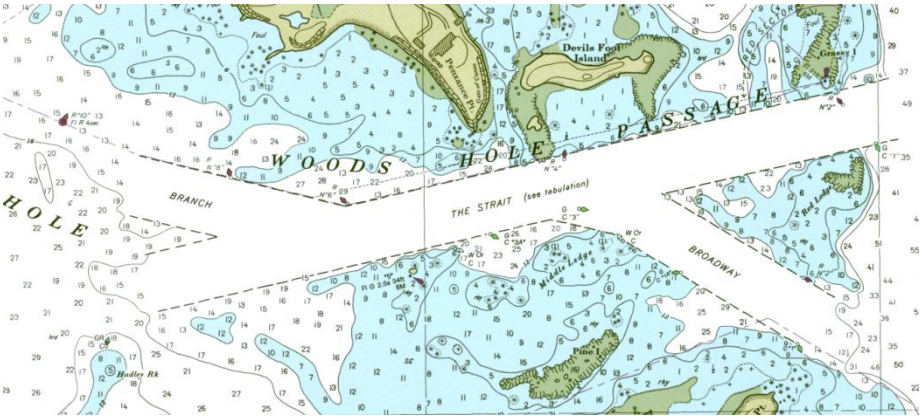

FIGURE 51. WOODS HOLE CHANNEL

Nantucket Sound Channels

Nantucket Sound also contains several channels that serve Cape Cod's water traffic. The Cross Rip Shoals mark the point, about 14 miles south of Hyannis Harbor, where several of these channels meet. From this point, vessels can travel to Buzzards Bay, Martha's Vineyard, Nantucket, Cape Cod, and the Atlantic Ocean. The channel at the Cross Rip Shoals was created by the Army Corps of Engineers and is 30 feet deep, 4,000 feet wide, and 1.7 miles long (see following table). The Pollack Rip Shoals are located about three miles to the east of Monomoy Island. The Army Corps of Engineers constructed a channel extending six miles through the Pollack Rip Shoals in 1925. The Pollack Rip Channel is 30 feet deep and 2,000 feet wide. It serves as the entrance to Nantucket Sound from the Atlantic Ocean. Taken together, the Wood Hole Channel, Cross Rip Channel, the Pollack Rip Channel, and the Main Channel create a thoroughfare for water traffic within Nantucket Sound (see following figure).

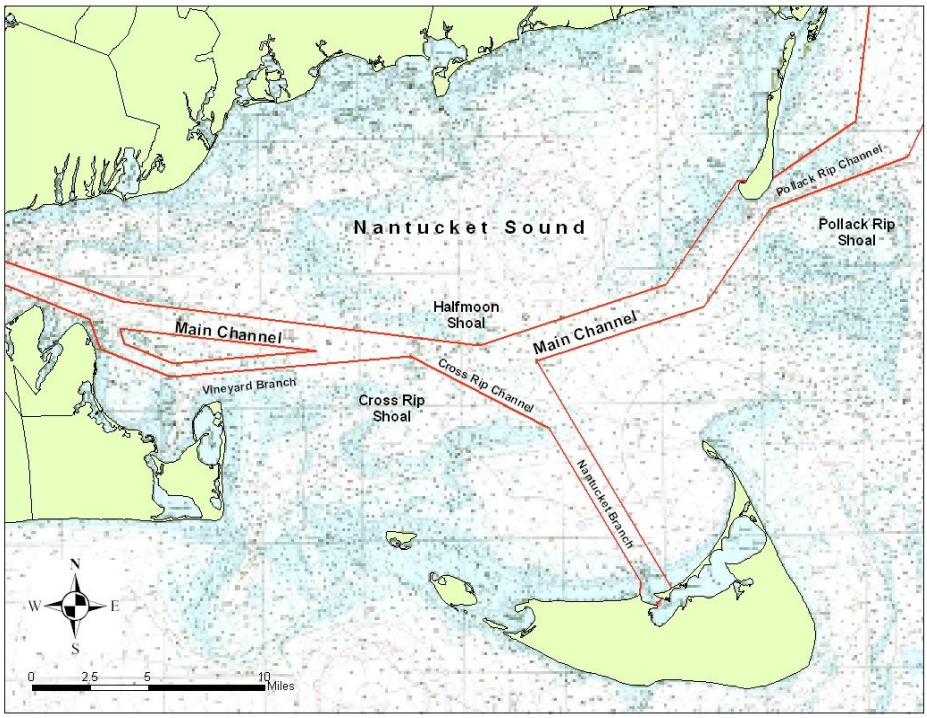

FIGURE 52. NANTUCKET SOUND CHANNELS

WATER TRANSPORTATION INFRASTRUCTURE

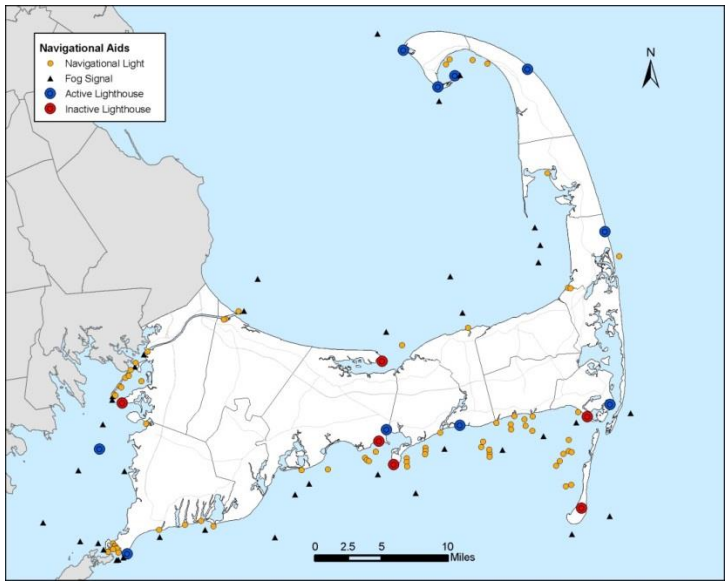

FIGURE 53. NAVIGATIONAL AIDS

A lighthouse is a structure, such as a tower, that gives a continuous or intermittent light signal to navigators. Cape Cod is famous for its many lighthouses and their unique towers. However, in addition to being aesthetically pleasing, these lights serve a vital purpose. Along with other navigational lights and aids, they form the infrastructure that keeps water traffic on course and out of danger. There are ten active lighthouses on Cape Cod, as listed in the table below. Most are located in the Outer Cape region. Additionally, there are six inactive lighthouse structures still in their original locations. Navigational lights and fog signals (bells, whistles, gongs, and horns) are generally located along the perimeter of channels and at dangerous areas.

Due to its shoals and other hazards, the majority of Cape Cod's navigational aids are located in Nantucket Sound. Cape Cod has 43 fog signals and 72 navigational lights in total.

TABLE 8: LIGHTHOUSES

LIGHTHOUSE NAME	TOWN
Nobska Light	Falmouth
Cleveland Ledge Light	In Buzzards Bay
Lewis Bay Light	Barnstable
West Dennis Light	Dennis
Chatham Lighthouse	Chatham
Nauset Light	Eastham
Highland Light	Truro
Race Point Light	Provincetown
Wood End Light	Provincetown

TABLE 9: NAVIGATIONAL LIGHTS AND FOG SIGNALS

	NAVIGATIONAL LIGHTS	FOG SIGNALS
Atlantic Ocean	1	4
Buzzards Bay	13	13
Cape Cod Bay	12	11
Nantucket Sound	46	15
Total	72	43

Charts of various ports shown in the following figures were produced by the National Oceanic and Atmospheric Administration's *Coast and Geodetic Survey*.

Woods Hole Harbor

Woods Hole Harbor is located in Falmouth. It is split into two harbors by Juniper Point: Great Harbor and Little Harbor (see following figures). Little Harbor is located in the 550,000 square feet of water between Juniper and Nobska Points. Located on the western side of Little Harbor is a Coast Guard station, which is also used for recreational purposes. Great Harbor is located between Penzance Point and Juniper Point. A bascule drawbridge separates Great Harbor from Eel Pond to the north. Woods Hole Channel, which leads west to Buzzards Bay, connects at the southern end of Great Harbor. Of the more significant ones are the 15-foot deep anchorage for the Steamship Authority ferries and the 22-foot deep anchorage for the Woods Hole Oceanographic Institute. Great Harbor is home to ferry passenger service, charter and sport fishing services, research vessels, and recreational boats.

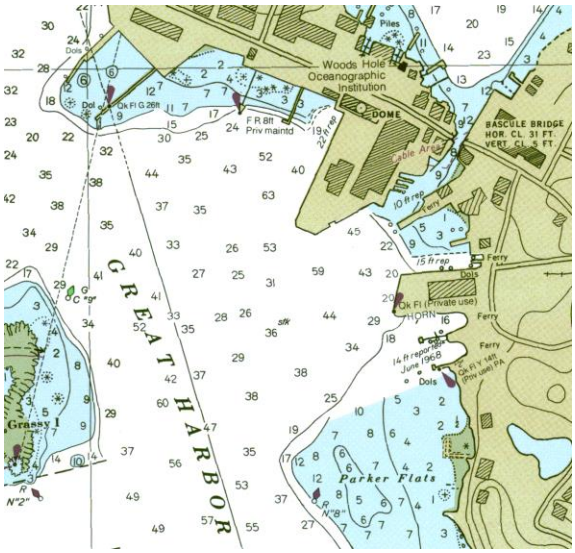

FIGURE 55: GREAT HARBOR IN FALMOUTH

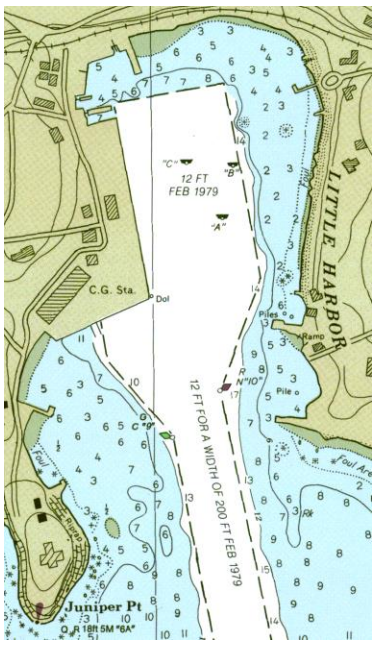

FIGURE 54: LITTLE HARBOR IN FALMOUTH

Hyannis Harbor

Hyannis Harbor in Barnstable consists of an outer harbor, a middle harbor (known as Lewis Bay), and an inner harbor (see following figure). Dunbar Point, a 1,000-foot stone jetty, and the Kalmus Park Beach separate the Outer Harbor and Lewis Bay. Major boat terminals and piers are located within the Inner Harbor. The Army Corps of Engineers began construction projects in the harbor in 1882. Currently, Hyannis Harbor includes a 12-foot deep anchorage at the eastern end of the Inner Harbor. In Lewis Bay, there is a 15.5-foot deep anchorage of about 55 acres behind a 1,170-foot long breakwater at Dunbar Point. A 6,000-foot long channel, 12 feet deep and 100 feet wide, extends from the Inner Harbor into the deep water in Lewis Bay. From there, a 7,200-foot long channel extends to the Outer Harbor. Hyannis Harbor is used as a terminal for ferry service, freight service, charter, and sport fishing services, as well as for recreational purposes.

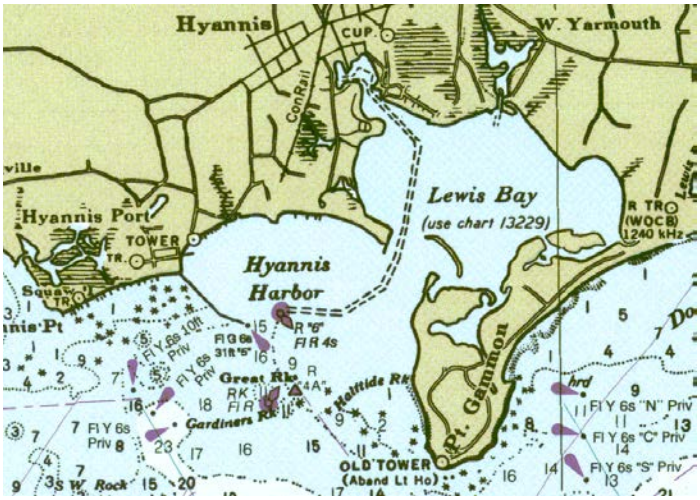

FIGURE 56: HYANNIS HARBOR

Provincetown Harbor

Provincetown Harbor was initially constructed during the nineteenth century. In 1914, the Army Corps of Engineers completed improvements to the harbor, including a 6,150-foot dike from Stevens Point across the House Point Island Flats to the sandy spit at Wood End. A stone breakwater, built in 1972, runs parallel to the shore about 835 feet from the end of MacMillan Wharf. The breakwater is 15.5 feet high and 2,500 feet long. Currently, the harbor is used as a terminal for ferries, whale watching tours, and as a base of operations for fishing boats (see following figure). Local and state officials have discussed and rejected the expansion of the harbor to include a freight pier. According to a MassDOT report ("Identification of Massachusetts Freight Issues and Priorities," 1999), the narrow streets in Provincetown's historic district and the traffic congestion during peak hours make such a proposal unfeasible.

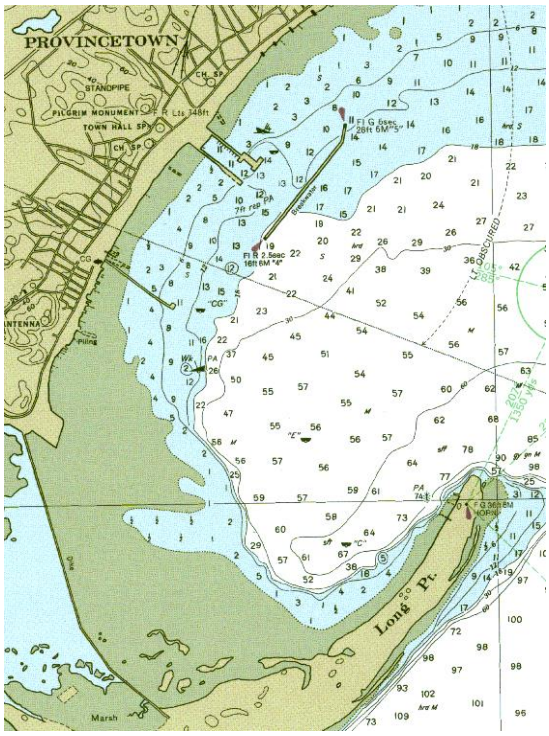

FIGURE 58: PROVINCETOWN HARBOR

Falmouth Harbor

Falmouth Harbor is located three miles east of Woods Hole, on the waterway between Falmouth Heights Road and Scranton Avenue. The Army Corps of Engineers began construction work in the harbor in 1957. Falmouth Harbor is 17 acres in area and 10 feet deep, with a 100-foot wide entrance channel. It is currently used as a terminal for ferries and charter tours, as well as for fishing and recreation.

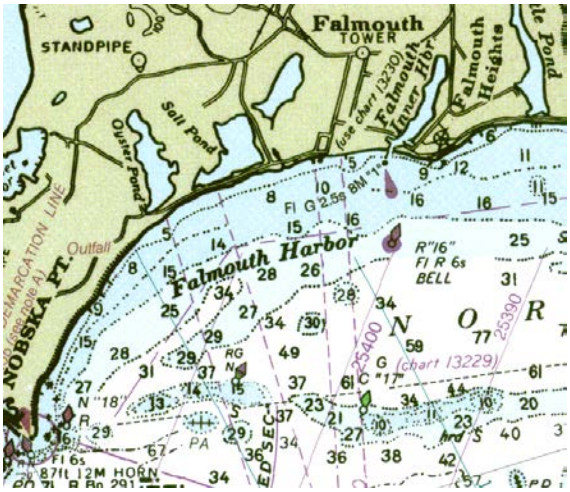

FIGURE 60: FALMOUTH HARBOR

Saquatucket Harbor (Harwichport)

Saquatucket Harbor in Harwich serves the Lower Cape (see following figure). The harbor has a 12-foot deep, 200-foot long channel leading to a 12-foot deep anchorage. The Coast Guard maintains a station at this facility. Accessible from Route 28 in Harwichport, the harbor is a terminal for ferry service, tour boats, commercial fishing and recreational use. A private passenger ferry operates from this harbor to provide seasonal service to Nantucket.

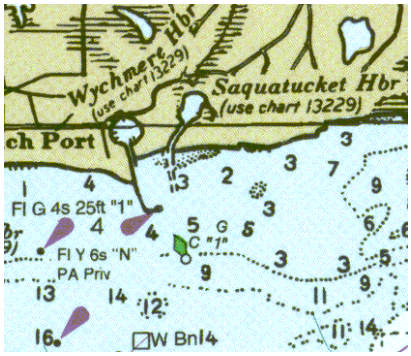

FIGURE 61: SAQUATUCKET HARBOR

Wellfleet Harbor

Wellfleet Harbor is located at the mouth of Duck Creek, just south of Wellfleet Center (see figure above). Work on the harbor dates back to 1899 when a 4-foot deep channel was constructed between deep water and the town wharves at Duck Creek. The state dredged the channel in 1916 and deepened it by two feet. The Army Corps o f Engineers later improved the harbor by creating a 10-foot deep, 125 foot-wide, 0.8-mile long channel from the middle of Wellfleet Harbor to the town landing, as well as a 10-foot deep, 500-foot long, 800-foot wide anchorage area. Currently, Wellfleet Harbor serves recreational boating, boat tours, commercial fishing, and sport fishing charter boats.

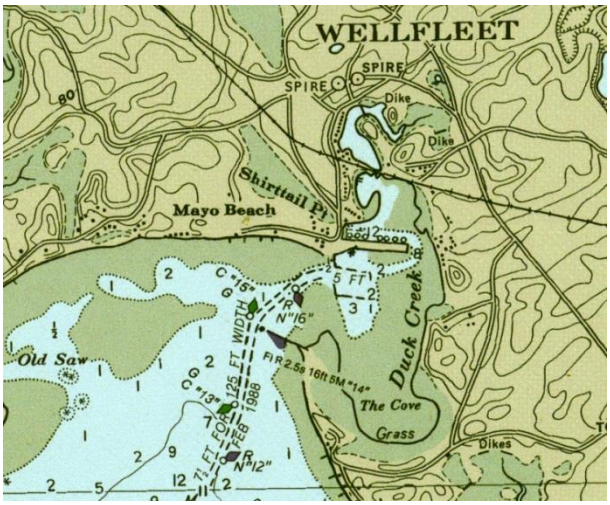

FIGURE 62: WELLFLEET HARBOR

Stage Harbor (Chatham)

Stage Harbor, located in Chatham, is one of the major seaports in the Lower Cape (see following figure). The harbor is divided into two parts: the Upper Harbor and Stage Harbor. The Upper Harbor extends from Bridge Street to Morris Island, and Stage Harbor extends from Morris Island to the Harding Beach bars. Original work in Chatham Harbor, including the construction of a channel through the Harding Beach bars, was completed in 1901. In the late-1950s, the Army Corps of Engineers constructed a new 2.1-mile channel from Chatham Roads through Harding Beach and into the Upper Harbor. Other harbor features include a 500-foot long stone jetty at the southwestern corner of the channel, a 2,500-foot long sand dike from Harbor Beach to Morris Island, and an adjacent 1,500-foot long timber jetty that has been partially removed. Additionally, a boathouse facility and dock in the Upper Harbor are maintained by the Chatham Coast Guard Station. Stage Harbor is used as a base for boat tours, recreational boats and a small local fishing fleet.

FIGURE 63: STAGE HARBOR

Barnstable Harbor

Barnstable Harbor lies between Sandy Neck and the mainland of Cape Cod (see figure above). The marina and landing in Barnstable Village serves as the primary seaport for Barnstable Harbor. A small channel, 7 feet deep, provides access to the marina from the entrance of the Harbor at Beach Point. Barnstable Harbor is the terminal for recreational and whale watching tours, as well as fishing vessels.

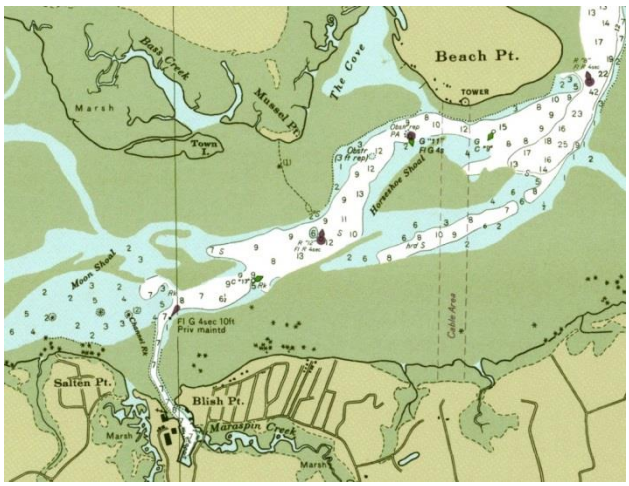

FIGURE 64: BARNSTABLE HARBOR

Sandwich Marina

Sandwich Marina is located on the eastern end of Cape Cod Canal in Sandwich. The marina has an anchorage of 8 feet, serving as a home to many fishing and recreational vessels. The marina primarily serves recreational and fishing vessels. With its proximity to road, rail tracks, and canal access, Sandwich Marina has the potential to be a ferry terminal for service from Boston and Plymouth (see following figure).

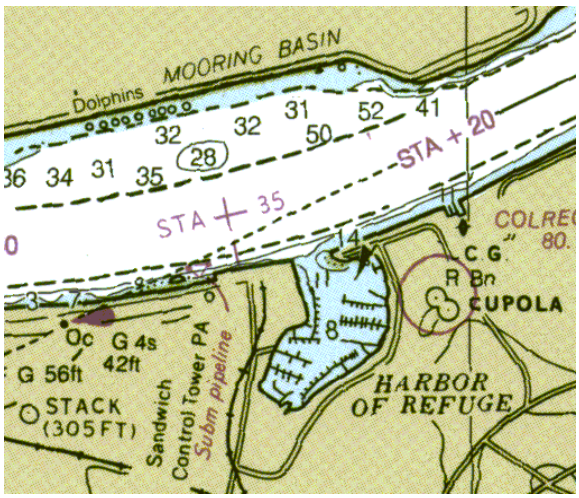

FIGURE 65: SANDWICH MARINA

Red Brook Harbor

Red Brook Harbor in Bourne is one of Cape Cod's seaports on Buzzards Bay. The harbor is located behind Bassetts Island between Handy and Long Points (see figure above). The boat docks are separated into two sections. The first, exposed to the harbor, provides an anchorage of 8 feet. The second is 7.5 feet deep and is connected to the harbor by a short channel. Red Brook Harbor serves as a base for fishing and recreational boats.

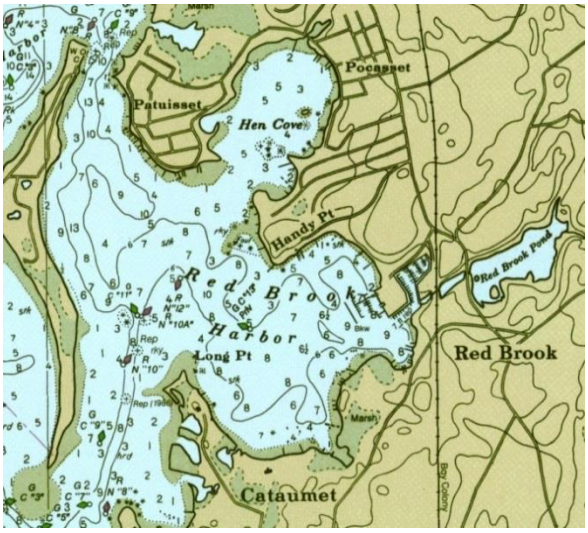

FIGURE 66: RED BROOK HARBOR IN BOURNE

Sesuit Harbor

Sesuit Harbor is located in the Town of Dennis. It is accessible by Sesuit Neck Road and Harbor Road on the west, and Cold Storage Road and Salt Works Road on the east. The channel entering the harbor is 100 feet wide, narrowing to 80-90 feet, and approaching an anchorage of 6-7 feet (see following figure). With a yacht club located on the western side of the harbor, and a boat ramp on the eastern side, Sesuit Harbor is used for fishing and recreational use.

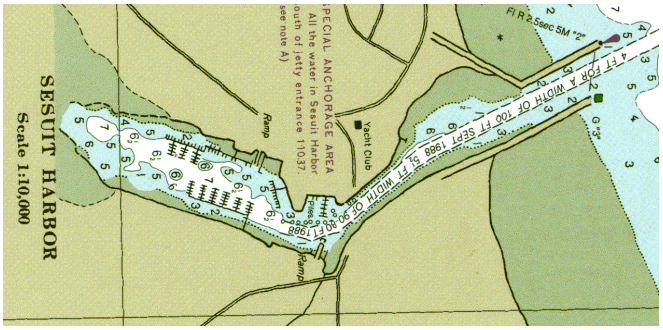

FIGURE 67: SESUIT HARBOR IN DENNIS

The nine ferry routes provide connection from Falmouth (Falmouth Harbor and Woods Hole), Hyannis (Hyannis Harbor), Provincetown (Fishermans Wharf), and Harwich Port (Squatucket Harbor) to Martha's Vineyard, Nantucket, Boston, and Plymouth.

BICYCLE AND AS A PEDESTRIAN INFRASTRUCTURE

There are numerous destinations and pathways for bicyclists and pedestrians to use on Cape Cod. Bicycle and pedestrian infrastructure and facilities require smaller right-of-ways and less overall investment than roadways. There are three basic types of bicycle infrastructure: paths, lanes, and routes. Paths generally have their own separated right-of-way and follow certain standards for width, grade, and accessibility. Bicycle lanes are separate lanes within roadways marked for bicycle use. Bicycle routes are roadways with wide shoulders that have been designated for bicycle use.

Pedestrians utilize shared use paths and sidewalks. Facilities of this type support village centers and local businesses, and encourage travelers to walk instead of driving. According to the Rails to Trails Conservancy, bicycle and pedestrian facilities can increase property values and make areas more attractive to new residents, businesses, and tourists.

The bicycle and pedestrian infrastructure of Cape Cod along with discussion of challenges those road users face in presented in Appendix F.

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CAPE COD COMMISSION

3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

CAPE COD
COMMISSION

2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix C: Safety

Draft
June 15, 2015

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Technical Appendix C: Safety

The concern over safety is made clear in the first goal of the Regional Transportation Plan:

"Provide safe travel options for all users"

Transportation users have a right to a transportation system where their person and possessions will arrive at their destinations unharmed and undamaged. Moreover, protecting the value of freight traveling over the transportation network is essential to the economy of Cape Cod. Therefore, it is important that transportation infrastructure be designed to minimize the possibility of hazardous situations or accidents. Existing traffic laws must also be enforced to prevent the improper use of the transportation system. For all of these reasons, the Regional Transportation Plan sets the goal of providing safety for people and goods.

This appendix includes sections describing the seasonal and year-round issues affecting transportation safety including a description of the Cape demographics and some information about how they will change over time. Summaries of important safety studies are presented as well.

BARNSTABLE COUNTY HIGH CRASH LOCATIONS

In 2014, the Cape Cod Commission completed an effort to rank the top intersections of critical safety concern across Cape Cod. Before the data could be gathered and sorted into any particular order or rank, it was necessary to specify the characteristics that signify an intersection as a safety concern. The Commission decided that there are several ways to interpret crash data – meaning, several possible ways to determine which intersections are of highest safety concern.

The Cape Cod Commission identified four methods of sorting data to create a top list of intersections of critical safety concern:

- **Based on Number of Crashes:** Perhaps most simple method is to look at the total number of crashes for each location and then rank them from most number of crashes to least. This method is very basic, in that it does not consider the severity of the crashes or the number of vehicles using the roadway.
- **Based on Equivalent Property Damage Only (EPDO):** This method considers the severity of each location's crashes. A location's EPDO value is determined using a formula that weights each crash based on whether it included a fatality, an injury but no fatality, or property damage only. Fatal crashes are assigned a value of ten; injuries are assigned a value of five; and property damage only crashes are assigned a value of one. To determine an intersection's EPDO, the weighted values are summed to an aggregate value. Under this method, the intersection with the highest EPDO value is ranked most hazardous.

- **Based on Crash Rate:** A crash rate for a location compares the number of crashes to the number of vehicles passing through it. The crash rate is interpreted as number of crashes per million entering vehicles. It is possible that a location with many crashes is not geometrically flawed or in poor condition, but merely a victim of the law of averages – many entering vehicles inflating the number of crashes. The crash rate method attempts to distinguish locations with safety problems relative to their usage.
- **Based on EPDO Rate:** This method is based on the same idea as using the crash rate, whereas it compares an intersection's EPDO to its usage. The EPDO rate is interpreted as EPDO per million entering vehicles. The vehicle with the largest EPDO rate is ranked number one under this method.

Base data for this analysis was provided by the Massachusetts Department of Transportation (MassDOT) in the form of geographically located crash clusters for the most recently available three years of data (2009-2011). The data provided by MassDOT included the number of reported crashes at each location and the severity of the crashes. It should be noted, however, that this dataset only includes incidents whose reports contained enough information to accurately locate them. Of the 11,987 crash reports collected by the Massachusetts Registry of Motor Vehicles, 10,935 incidents were located by MassDOT. The incidents are mapped on the following figure.

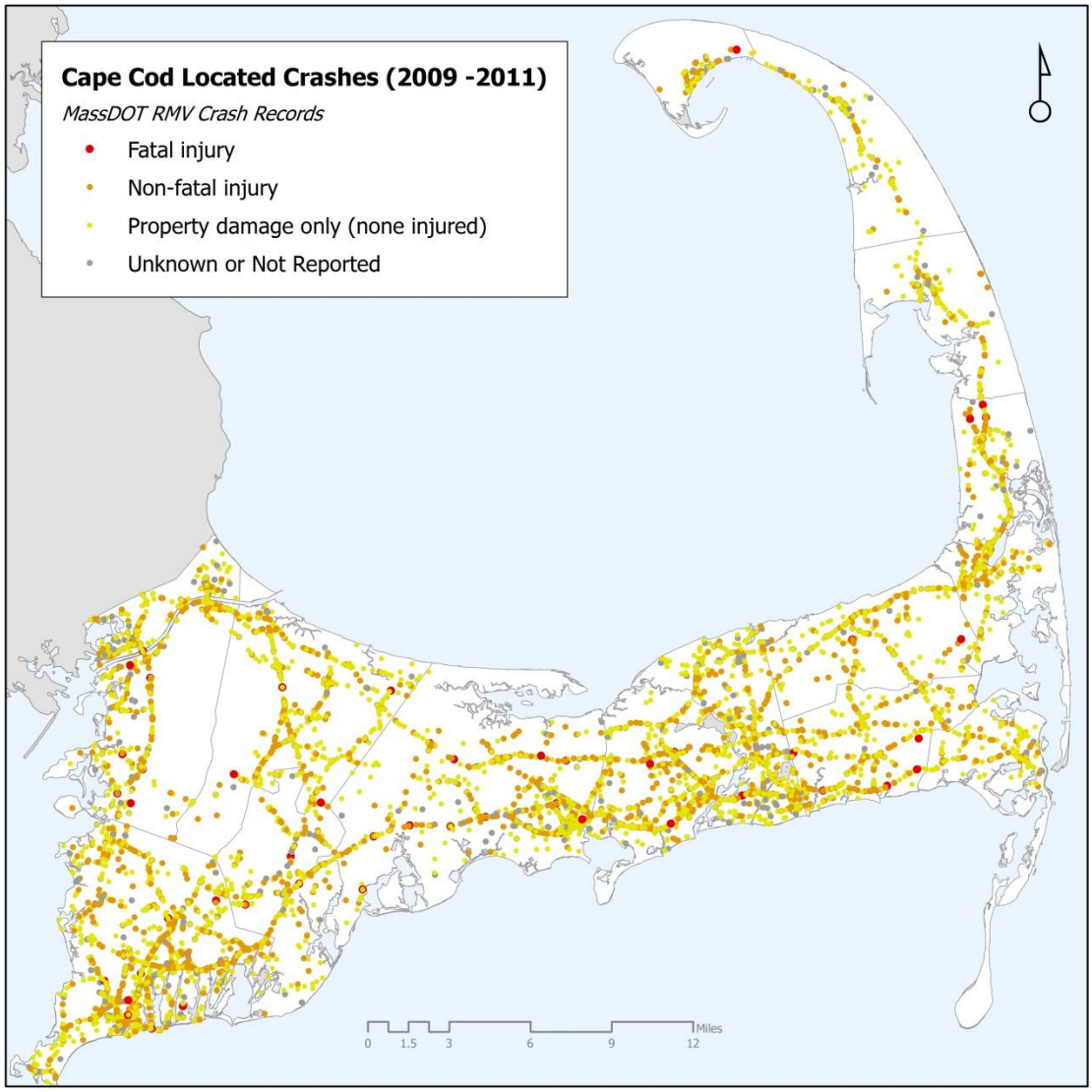

FIGURE 1 - CAPE COD LOCATED CRASHES 2009-2011

(Source: MassDOT Crash Records)

In each of the following top crash location lists, select locations are succeeded by a subscript. The subscript is a reference to a note in the Index of Notes table, which follows the fourth top crash list. The notes refer to any structural changes that have occurred or will occur at the intersections, and also highlight any studies that may have included the intersections.

TABLE 1 - TOP LOCATIONS BASED ON NUMBER OF CRASHES

Rank Crashes	TOWNS	Location	CrashCount	EPDO	Crash_Rate	EPDO_Rate
1	Dennis	Route 134 @ Patriot Square SD/Cumberland Farms [3]	125	181	5.0	7.2
2	Bourne	Bourne Rotary (Rte 28/Sandwich Rd/Trowbridge Rd) [32]	111	159	1.9	2.8
3	Dennis	Route 6 @ Route 134 (Exit 9) [37]	91	163	1.5	2.7
4	Barnstable	Route 6 @ Route 132 (Exit 6) [36]	84	184	1.2	2.7
5	Bourne	Otis Rotary (Rte 28/Rte 28A/Connery Ave) [8]	80	169	2.5	5.3
6	Sandwich	Route 6 @ Route 130 (Exit 2) [45]	74	154	1.1	2.3
7	Bourne	Route 6 @ Exit 1A/Exit1B [66]	63	119	0.9	1.8
8	Falmouth	Route 28 (Teaticket Hwy) @ Falmouth Mall east SD, Liquor Store, Apartments [4]	62	114	3.4	6.2
9	Bourne	Belmont Circle (Rt 28/Rt 6/Rt Bypass/Head of the Bay Rd) [42]	54	107	1.2	2.4
9	Yarmouth	Route 6 @ Willow St (Exit 7) [43]	54	142	0.9	2.4
9	Barnstable	Route 6 @ Route 149 (Exit 5) [76]	54	98	0.9	1.6
12	Eastham	Eastham Rotary (Rt 6/Rt 6A/Rt 28/Smith Ln) [22]	51	103	1.6	3.2
12	Falmouth	Route 28 (MacArthur Bvld) at Route 151 [38]	51	107	1.2	2.6
14	Yarmouth	Route 6 @ Union St/Station Ave (Exit 8) [59]	50	119	0.8	1.9
15	Falmouth	Route 28 (Teaticket Hwy) @ Stop & Shop Plaza SD/Hotel SD [15]	46	70	2.5	3.7
16	Dennis	Route 134 @ Theophilus F Smith Rd [35]	41	69	1.6	2.7
16	Harwich	Route 6 @ Route 124 (Exit 10) [61]	41	69	1.1	1.9
18	Falmouth	Route 28 (Davis Straits) @ Dillingham Ave/Spring Bars Rd [20]	35	63	1.9	3.3
18	Dennis	Route 134 @ Upper County Rd/Duck Pond Rd [39]	35	71	1.2	2.5
20	Falmouth	Route 28 (Teaticket Hwy) @ Maravista Av/Beagle Ln/Various Business SD [17]	34	66	1.9	3.6
21	Mashpee	Route 151 @ Old Barnstable Rd [16]	33	89	1.4	3.7
22	Harwich	Route 6 @ Route 137 (Exit 11) [63]	30	62	0.9	1.8
22	Sandwich	Route 6 @ Quaker Meetinghouse Rd (Exit 3) [83]	30	82	0.5	1.4
24	Mashpee	Mashpee Rotary (Rte 28/Rte 151/Great Neck Rd) [78]	28	56	0.8	1.5
25	Sandwich	Route 6 @ Chase Rd (Exit 4) [87]	26	70	0.5	1.3
26	Falmouth	Worcester Ct @ Spring Bars Rd [10]	24	44	2.7	4.9
26	Dennis	Route 134 @ Bob Crowell Rd/Hemlock Ln [67]	24	28	1.5	1.7
28	Falmouth	Route 151 @ Route 28A (North Falmouth Hwy) [33]	23	43	1.4	2.7
28	Falmouth	Route 28 (E Falmouth Hwy) @ Central Ave [52]	23	43	1.1	2.1
30	Dennis	Route 28 (Main St) @ Sea St [7]	22	50	2.4	5.4
31	Yarmouth, Barnstable	Route 28 @ East Main [68]	21	37	1.0	1.7
31	Orleans	Route 6 @ Route 6A (Exit 12) [91]	21	45	0.6	1.2
33	Falmouth	Route 28 @ Lorraine Rd/Dunkin Donuts SD/Family Food Plaza SD [49]	20	44	1.0	2.2
33	Falmouth	Route 151 @ Sandwich Rd [58]	20	40	1.0	1.9
33	Barnstable	Route 28 (Iyannough Rd) @ Yarmouth Rd [89]	20	32	0.8	1.3
36	Harwich	Route 39 (Orleans Rd) @ Pleasant Bay Rd [1]	19	43	3.6	8.0
36	Falmouth	Route 151 @ Boxberry Hill Rd [6]	19	47	2.3	5.7
36	Falmouth	Route 28 @ Old Meetinghouse Rd/Davisville Rd [27]	19	48	1.2	2.9
36	Dennis	Theophilus F Smith Rd @ Patriot Square Rear SD (near theater) [55]	19	19	2.0	2.0
36	Falmouth	Route 28 (Teaticket Hwy) @ Jones Rd [62]	19	39	0.9	1.9
36	Barnstable	Airport Rotary (Rte 132/Rte 28/Barnstable Rd) [98]	19	35	0.4	0.8
42	Dennis	Route 6A @ Post Rd/New Boston Rd [28]	18	34	1.5	2.9
42	Bourne	Sandwich Rd @ Adams St [41]	18	42	1.1	2.5
42	Falmouth	Route 28 (Teaticket Hwy) @ McDonalds SD/Various Business SD [47]	18	34	1.2	2.3
45	Bourne	Route 6A @ Cranberry Highway/Sandwich Rd [46]	17	37	1.0	2.3
46	Dennis	Route 28 (Main St) @ Depot St [9]	16	44	1.8	5.1
46	Sandwich	Route 130 (Forestdale Rd) @ Cotuit Rd [23]	16	56	0.9	3.1
46	Eastham	Route 6 (GAR Hwy) @ Samoset Rd [48]	16	40	0.9	2.3
46	Falmouth	Route 28 @ Old Barnstable Rd/Acapesket Rd [56]	16	36	0.9	2.0
46	Yarmouth	Route 28 @ Main St/N Main St [71]	16	28	0.9	1.7
46	Eastham	Route 6 (GAR Hwy) @ Brackett Rd/Old County Rd [73]	16	32	0.8	1.6
52	Mashpee	Great Neck Rd N @ Old Barnstable Rd [5]	15	55	1.6	5.8
52	Yarmouth	Buck Island Rd @ Town Brook Rd [13]	15	35	1.7	4.0
52	Falmouth	Route 28 (E Falmouth Hwy) @ Fresh Pond Rd [19]	15	43	1.2	3.4
52	Yarmouth	Station Ave @ Regional Ave/Studley Rd [21]	15	43	1.1	3.2
52	Falmouth	Brick Kiln Rd @ Sandwich Rd [53]	15	27	1.1	2.0
52	Dennis	Route 134 @ Route 28 (Main St)/Swan River Rd [54]	15	35	0.9	2.0
52	Falmouth	Route 28 (Main St) @ Perry Ln/Various Business SD [60]	15	31	0.9	1.9

Source: MassDOT Crash Records 2009-2011

TABLE 2 - TOP LOCATIONS BASED ON EQUIVALENT PROPERTY DAMAGE ONLY

Rank EPDO	Location	TOWNS	Crash Count	EPDO	Crash_Rate	EPDO_Rate
1	Route 6 @ Route 132 (Exit 6) [36]	Barnstable	84	184	1.2	2.7
2	Route 134 @ Patriot Square SD/Cumberland Farms [3]	Dennis	125	181	5.0	7.2
3	Otis Rotary (Rte 28/Rte 28A/Connery Ave) [8]	Bourne	80	169	2.5	5.3
4	Route 6 @ Route 134 (Exit 9) [37]	Dennis	91	163	1.5	2.7
5	Bourne Rotary (Rte 28/Sandwich Rd/Trowbridge Rd) [32]	Bourne	111	159	1.9	2.8
6	Route 6 @ Route 130 (Exit 2) [45]	Sandwich	74	154	1.1	2.3
7	Route 6 @ Willow St (Exit 7) [43]	Yarmouth	54	142	0.9	2.4
8	Route 6 @ Union St/Station Ave (Exit 8) [59]	Yarmouth	50	119	0.8	1.9
8	Route 6 @ Exit 1A/Exit1B [66]	Bourne	63	119	0.9	1.8
10	Route 28 (Teaticket Hwy) @ Falmouth Mall east SD, Liquor Store, Apartments [4]	Falmouth	62	114	3.4	6.2
11	Route 28 (MacArthur Bvld) at Route 151 [38]	Falmouth	51	107	1.2	2.6
11	Belmont Circle (Rt 28/Rt 6/Rt Bypass/Head of the Bay Rd) [42]	Bourne	54	107	1.2	2.4
13	Eastham Rotary (Rt 6/Rt 6A/Rt 28/Smith Ln) [22]	Eastham	51	103	1.6	3.2
14	Route 6 @ Route 149 (Exit 5) [76]	Barnstable	54	98	0.9	1.6
15	Route 151 @ Old Barnstable Rd [16]	Mashpee	33	89	1.4	3.7
16	Route 6 @ Quaker Meetinghouse Rd (Exit 3) [83]	Sandwich	30	82	0.5	1.4
17	Route 134 @ Upper County Rd/Duck Pond Rd [39]	Dennis	35	71	1.2	2.5
18	Route 28 (Teaticket Hwy) @ Stop & Shop Plaza SD/Hotel SD [15]	Falmouth	46	70	2.5	3.7
18	Route 6 @ Chase Rd (Exit 4) [87]	Sandwich	26	70	0.5	1.3
20	Route 134 @ Theophilus F Smith Rd [35]	Dennis	41	69	1.6	2.7
20	Route 6 @ Route 124 (Exit 10) [61]	Harwich	41	69	1.1	1.9
22	Route 28 (Teaticket Hwy) @ Maravista Av/Beagle Ln/Various Business SD [17]	Falmouth	34	66	1.9	3.6
23	Route 28 (Davis Straits) @ Dillingham Ave/Spring Bars Rd [20]	Falmouth	35	63	1.9	3.3
24	Route 6 @ Route 137 (Exit 11) [63]	Harwich	30	62	0.9	1.8
25	Route 130 (Forestdale Rd) @ Cotuit Rd [23]	Sandwich	16	56	0.9	3.1
25	Mashpee Rotary (Rte 28/Rte 151/Great Neck Rd) [78]	Mashpee	28	56	0.8	1.5
27	Great Neck Rd N @ Old Barnstable Rd [5]	Mashpee	15	55	1.6	5.8
28	Route 28 (Main St) @ Sea St [7]	Dennis	22	50	2.4	5.4
29	Route 28 @ Old Meetinghouse Rd/Davisville Rd [27]	Falmouth	19	48	1.2	2.9
30	Route 151 @ Boxberry Hill Rd [6]	Falmouth	19	47	2.3	5.7
31	Route 6 @ Route 6A (Exit 12) [91]	Orleans	21	45	0.6	1.2
32	Route 28 (Main St) @ Depot St [9]	Dennis	16	44	1.8	5.1
32	Worcester Ct @ Spring Bars Rd [10]	Falmouth	24	44	2.7	4.9
32	Route 28 @ Lorraine Rd/Dunkin Donuts SD/Family Food Plaza SD [49]	Falmouth	20	44	1.0	2.2
35	Route 39 (Orleans Rd) @ Pleasant Bay Rd [1]	Harwich	19	43	3.6	8.0
35	Route 28 (E Falmouth Hwy) @ Fresh Pond Rd [19]	Falmouth	15	43	1.2	3.4
35	Station Ave @ Regional Ave/Studley Rd [21]	Yarmouth	15	43	1.1	3.2
35	Route 151 @ Route 28A (North Falmouth Hwy) [33]	Falmouth	23	43	1.4	2.7
35	Route 28 (E Falmouth Hwy) @ Central Ave [52]	Falmouth	23	43	1.1	2.1
40	Route 124 (Harwich Rd) @ Tubman Rd [2]	Brewster	13	42	2.4	7.7
40	Sandwich Rd @ Adams St [41]	Bourne	18	42	1.1	2.5
42	Route 151 @ Jobs Fishing Rd/Public Safety Facility SD [29]	Mashpee	13	41	0.9	2.9
43	Route 3A/Canal St @ Scenic Hwy/Meetinghouse Ln [12]	Bourne	12	40	1.2	4.0
43	Route 6 (GAR Hwy) @ Samoset Rd [48]	Eastham	16	40	0.9	2.3
43	Route 151 @ Sandwich Rd [58]	Falmouth	20	40	1.0	1.9
46	Route 28 (Teaticket Hwy) @ Jones Rd [62]	Falmouth	19	39	0.9	1.9
47	Route 28 (Teaticket Hwy) @ Trotting Park Rd/Alphonse St [44]	Falmouth	14	38	0.9	2.4
48	Route 6A @ Cranberry Highway/Sandwich Rd [46]	Bourne	17	37	1.0	2.3
48	Route 28 @ East Main [68]	Yarmouth,Barnstable	21	37	1.0	1.7
48	Route 28 @ Wendward Way [86]	Yarmouth	13	37	0.5	1.3
51	Jones Rd @ Gifford St [50]	Falmouth	12	36	0.7	2.1
51	Route 28 @ Old Barnstable Rd/Acapesket Rd [56]	Falmouth	16	36	0.9	2.0
51	Station Avenue near Former Rail Crossing [64]	Yarmouth	12	36	0.6	1.8

Source: MassDOT Crash Records 2009-2011

TABLE 3 - TOP LOCATIONS BASED ON CRASH RATE

Rank Crashes/ MEV	Location	TOWNS	CrashCount	EPDO	Crash_Rate	EPDO_Rate
1	Route 134 @ Patriot Square SD/Cumberland Farms [3]	Dennis	125	181	5.0	7.2
2	Route 39 (Orleans Rd) @ Pleasant Bay Rd [1]	Harwich	19	43	3.6	8.0
3	Route 28 (Teaticket Hwy) @ Falmouth Mall east SD, Liquor Store, Apartments [4]	Falmouth	62	114	3.4	6.2
4	Water St @ Luscombe Ave/School St [11]	Falmouth	13	21	2.8	4.5
5	Worcester Ct @ Spring Bars Rd [10]	Falmouth	24	44	2.7	4.9
6	Otis Rotary (Rte 28/Rte 28A/Connery Ave) [8]	Bourne	80	169	2.5	5.3
7	Route 28 (Teaticket Hwy) @ Stop & Shop Plaza SD/Hotel SD [15]	Falmouth	46	70	2.5	3.7
8	Route 124 (Harwich Rd) @ Tubman Rd [2]	Brewster	13	42	2.4	7.7
9	Route 28 (Main St) @ Sea St [7]	Dennis	22	50	2.4	5.4
10	Route 151 @ Boxberry Hill Rd [6]	Falmouth	19	47	2.3	5.7
11	Theophilus F Smith Rd @ Patriot Square Rear SD (near theater) [55]	Dennis	19	19	2.0	2.0
12	Bourne Rotary (Rte 28/Sandwich Rd/Trowbridge Rd) [32]	Bourne	111	159	1.9	2.8
13	Route 28 (Teaticket Hwy) @ Maravista Av/Beagle Ln/Various Business SD [17]	Falmouth	34	66	1.9	3.6
14	Route 28 (Davis Straits) @ Dillingham Ave/Spring Bars Rd [20]	Falmouth	35	63	1.9	3.3
15	Route 28 (Main St) @ Depot St [9]	Dennis	16	44	1.8	5.1
16	Buck Island Rd @ Town Brook Rd [13]	Yarmouth	15	35	1.7	4.0
17	Depot St @ Upper County Rd [51]	Dennis	13	17	1.6	2.1
18	Old Town House Rd @ Forest Rd [24]	Yarmouth	13	25	1.6	3.1
19	Eastham Rotary (Rt 6/Rt 6A/Rt 28/Smith Ln) [22]	Eastham	51	103	1.6	3.2
20	Route 134 @ Theophilus F Smith Rd [35]	Dennis	41	69	1.6	2.7
21	Great Neck Rd N @ Old Barnstable Rd [5]	Mashpee	15	55	1.6	5.8
22	Route 6A @ Post Rd/New Boston Rd [28]	Dennis	18	34	1.5	2.9
23	Route 6 @ Route 134 (Exit 9) [37]	Dennis	91	163	1.5	2.7
24	Route 134 @ Bob Crowell Rd/Hemlock Ln [67]	Dennis	24	28	1.5	1.7
25	Cotuit Rd @ Harlow Rd [14]	Sandwich	12	32	1.5	3.9
26	Route 151 @ Route 28A (North Falmouth Hwy) [33]	Falmouth	23	43	1.4	2.7
27	Route 151 @ Old Barnstable Rd [16]	Mashpee	33	89	1.4	3.7
28	Route 134 @ Setucket Rd [25]	Dennis	12	28	1.3	3.0
29	Route 134 @ Upper County Rd/Duck Pond Rd [39]	Dennis	35	71	1.2	2.5
30	Belmont Circle (Rt 28/Rt 6/Rt Bypass/Head of the Bay Rd) [42]	Bourne	54	107	1.2	2.4
31	Route 28 (MacArthur Bvld) at Route 151 [38]	Falmouth	51	107	1.2	2.6
32	Route 6 @ Route 132 (Exit 6) [36]	Barnstable	84	184	1.2	2.7
33	Route 3A/Canal St @ Scenic Hwy/Meetinghouse Ln [12]	Bourne	12	40	1.2	4.0
34	West Yarmouth Rd @ Buck Island Rd [34]	Yarmouth	13	29	1.2	2.7
35	Route 28 (Teaticket Hwy) @ McDonalds SD/Various Business SD [47]	Falmouth	18	34	1.2	2.3
36	Route 28 (E Falmouth Hwy) @ Fresh Pond Rd [19]	Falmouth	15	43	1.2	3.4
37	Route 28 @ Old Meetinghouse Rd/Davisville Rd [27]	Falmouth	19	48	1.2	2.9
38	County Rd @ Barlows Landing Rd [26]	Bourne	10	26	1.2	3.0
39	Brick Kiln Rd @ Sandwich Rd [53]	Falmouth	15	27	1.1	2.0
40	Station Ave @ Regional Ave/Studley Rd [21]	Yarmouth	15	43	1.1	3.2
41	Route 28 (E Falmouth Hwy) @ Central Ave [52]	Falmouth	23	43	1.1	2.1
42	Route 6 @ Route 124 (Exit 10) [61]	Harwich	41	69	1.1	1.9
43	Route 6 @ Route 130 (Exit 2) [45]	Sandwich	74	154	1.1	2.3
44	Sandwich Rd @ Adams St [41]	Bourne	18	42	1.1	2.5
45	Route 28 (Main St) @ King St/Gifford St [85]	Falmouth	13	17	1.0	1.4
46	Route 6A @ Cranberry Highway/Sandwich Rd [46]	Bourne	17	37	1.0	2.3
47	Route 130 @ Great Neck Rd [40]	Mashpee	11	27	1.0	2.5
48	Route 28 @ Lorraine Rd/Dunkin Donuts SD/Family Food Plaza SD [49]	Falmouth	20	44	1.0	2.2
49	Dillingham Avenue @ Gifford St [18]	Falmouth	10	34	1.0	3.4
50	Route 28 @ East Main [68]	Yarmouth,Barnstable	21	37	1.0	1.7

Source: MassDOT Crash Records 2009-2011

TABLE 4 - TOP LOCATIONS BASED ON EPDO RATE

Rank EPDO/MEV	Location	TOWNS	CrashCount	EPDO	Crash_Rate	EPDO_Rate
1	Route 39 (Orleans Rd) @ Pleasant Bay Rd [1]	Harwich	19	43	3.6	8.0
2	Route 124 (Harwich Rd) @ Tubman Rd [2]	Brewster	13	42	2.4	7.7
3	Route 134 @ Patriot Square SD/Cumberland Farms [3]	Dennis	125	181	5.0	7.2
4	Route 28 (Teaticket Hwy) @ Falmouth Mall east SD, Liquor Store, Apartments [4]	Falmouth	62	114	3.4	6.2
5	Great Neck Rd N @ Old Barnstable Rd [5]	Mashpee	15	55	1.6	5.8
6	Route 151 @ Boxberry Hill Rd [6]	Falmouth	19	47	2.3	5.7
7	Route 28 (Main St) @ Sea St [7]	Dennis	22	50	2.4	5.4
8	Otis Rotary (Rte 28/Rte 28A/Connery Ave) [8]	Bourne	80	169	2.5	5.3
9	Route 28 (Main St) @ Depot St [9]	Dennis	16	44	1.8	5.1
10	Worcester Ct @ Spring Bars Rd [10]	Falmouth	24	44	2.7	4.9
11	Water St @ Luscombe Ave/School St [11]	Falmouth	13	21	2.8	4.5
12	Route 3A/Canal St @ Scenic Hwy/Meetinghouse Ln [12]	Bourne	12	40	1.2	4.0
13	Buck Island Rd @ Town Brook Rd [13]	Yarmouth	15	35	1.7	4.0
14	Cotuit Rd @ Harlow Rd [14]	Sandwich	12	32	1.5	3.9
15	Route 28 (Teaticket Hwy) @ Stop & Shop Plaza SD/Hotel SD [15]	Falmouth	46	70	2.5	3.7
16	Route 151 @ Old Barnstable Rd [16]	Mashpee	33	89	1.4	3.7
17	Route 28 (Teaticket Hwy) @ Maravista Av/Beagle Ln/Various Business SD [17]	Falmouth	34	66	1.9	3.6
18	Dillingham Avenue @ Gifford St [18]	Falmouth	10	34	1.0	3.4
19	Route 28 (E Falmouth Hwy) @ Fresh Pond Rd [19]	Falmouth	15	43	1.2	3.4
20	Route 28 (Davis Straits) @ Dillingham Ave/Spring Bars Rd [20]	Falmouth	35	63	1.9	3.3
21	Station Ave @ Regional Ave/Studley Rd [21]	Yarmouth	15	43	1.1	3.2
22	Eastham Rotary (Rt 6/Rt 6A/Rt 28/Smith Ln) [22]	Eastham	51	103	1.6	3.2
23	Route 130 (Forestdale Rd) @ Cotuit Rd [23]	Sandwich	16	56	0.9	3.1
24	Old Town House Rd @ Forest Rd [24]	Yarmouth	13	25	1.6	3.1
25	Route 134 @ Setucket Rd [25]	Dennis	12	28	1.3	3.0
26	County Rd @ Barlows Landing Rd [26]	Bourne	10	26	1.2	3.0
27	Route 28 @ Old Meetinghouse Rd/Davisville Rd [27]	Falmouth	19	48	1.2	2.9
28	Route 6A @ Post Rd/New Boston Rd [28]	Dennis	18	34	1.5	2.9
29	Route 151 @ Jobs Fishing Rd/Public Safety Facility SD [29]	Mashpee	13	41	0.9	2.9
30	Route 6 @ Cranberry Hwy (Exit 1C) [30]	Bourne	10	30	0.9	2.8
31	Route 134 @ Center St [31]	Dennis	10	30	0.9	2.8
32	Bourne Rotary (Rte 28/Sandwich Rd/Trowbridge Rd) [32]	Bourne	111	159	1.9	2.8
33	Route 151 @ Route 28A (North Falmouth Hwy) [33]	Falmouth	23	43	1.4	2.7
34	West Yarmouth Rd @ Buck Island Rd [34]	Yarmouth	13	29	1.2	2.7
35	Route 134 @ Theophilus F Smith Rd [35]	Dennis	41	69	1.6	2.7
36	Route 6 @ Route 132 (Exit 6) [36]	Barnstable	84	184	1.2	2.7
37	Route 6 @ Route 134 (Exit 9) [37]	Dennis	91	163	1.5	2.7
38	Route 28 (MacArthur Bvld) at Route 151 [38]	Falmouth	51	107	1.2	2.6
39	Route 134 @ Upper County Rd/Duck Pond Rd [39]	Dennis	35	71	1.2	2.5
40	Route 130 @ Great Neck Rd [40]	Mashpee	11	27	1.0	2.5
41	Sandwich Rd @ Adams St [41]	Bourne	18	42	1.1	2.5
42	Belmont Circle (Rt 28/Rt 6/Rt Bypass/Head of the Bay Rd) [42]	Bourne	54	107	1.2	2.4
43	Route 6 @ Willow St (Exit 7) [43]	Yarmouth	54	142	0.9	2.4
44	Route 28 (Teaticket Hwy) @ Trotting Park Rd/Alphonse St [44]	Falmouth	14	38	0.9	2.4
45	Route 6 @ Route 130 (Exit 2) [45]	Sandwich	74	154	1.1	2.3
46	Route 6A @ Cranberry Highway/Sandwich Rd [46]	Bourne	17	37	1.0	2.3
47	Route 28 (Teaticket Hwy) @ McDonalds SD/Various Business SD [47]	Falmouth	18	34	1.2	2.3
48	Route 6 (GAR Hwy) @ Samoset Rd [48]	Eastham	16	40	0.9	2.3
49	Route 28 @ Lorraine Rd/Dunkin Donuts SD/Family Food Plaza SD [49]	Falmouth	20	44	1.0	2.2
50	Jones Rd @ Gifford St [50]	Falmouth	12	36	0.7	2.1

Source: MassDOT Crash Records 2009-2011

TABLE 5 - INDEX OF NOTES (PAGE 1 OF 3)

Note	Location	TOWNS	Rank EPDO /MEV	Rank Crashes /MEV	Rank EPDO	Rank Crashes	Comment
1	Route 39 (Orleans Rd) @ Pleasant Bay Rd	Harwich	1	2	35	36	Flashing LED stop signs added on minor approaches after 2011
2	Route 124 (Harwich Rd) @ Tubman Rd	Brewster	2	8	40	64	RSA 2011, Additional signage and vegetation management 2012
3	Route 134 @ Patriot Square SD/Cumberland Farms	Dennis	3	1	2	1	Cumberland Farms drive reconfigured in 2012
4	Route 28 (Teaticket Hwy) @ Falmouth Mall east SD, Liquor Store, Apartments	Falmouth	4	3	10	8	
5	Great Neck Rd N @ Old Barnstable Rd	Mashpee	5	21	27	52	
6	Route 151 @ Boxberry Hill Rd	Falmouth	6	10	30	36	
7	Route 28 (Main St) @ Sea St	Dennis	7	9	28	30	CCC Report "Dennisport - Analysis of High-Crash Locations" 2012
8	Otis Rotary (Rte 28/Rte 28A/Connery Ave)	Bourne	8	6	3	5	CCC safety study 2006, RSA 2013
9	Route 28 (Main St) @ Depot St	Dennis	9	15	32	46	CCC Report "Dennisport - Analysis of High-Crash Locations" 2012
10	Worcester Ct @ Spring Bars Rd	Falmouth	10	5	32	26	CCC Spring Bars Road report analysis 2013
11	Water St @ Luscombe Ave/School St	Falmouth	11	4	128	64	
12	Route 3A/Canal St @ Scenic Hwy/Meetinghouse Ln	Bourne	12	33	43	83	
13	Buck Island Rd @ Town Brook Rd	Yarmouth	13	16	54	52	
14	Cotuit Rd @ Harlow Rd	Sandwich	14	25	64	83	Roundabout constructed 2012
15	Route 28 (Teaticket Hwy) @ Stop & Shop Plaza SD/Hotel SD	Falmouth	15	7	18	15	
16	Route 151 @ Old Barnstable Rd	Mashpee	16	27	15	21	RSA 2014 scheduled
17	Route 28 (Teaticket Hwy) @ Maravista Av/Beagle Ln/Various Business SD	Falmouth	17	13	22	20	
18	Dillingham Avenue @ Gifford St	Falmouth	18	49	57	117	
19	Route 28 (E Falmouth Hwy) @ Fresh Pond Rd	Falmouth	19	36	35	52	
20	Route 28 (Davis Straits) @ Dillingham Ave/Spring Bars Rd	Falmouth	20	14	23	18	CCC Spring Bars Road report analysis 2013
21	Station Ave @ Regional Ave/Studley Rd	Yarmouth	21	40	35	52	
22	Eastham Rotary (Rt 6/Rt 6A/Rt 28/Smith Ln)	Eastham	22	19	13	12	CCC safety study 2009; Recommendations included in Outer Cape Safety Study 2004
23	Route 130 (Forestdale Rd) @ Cotuit Rd	Sandwich	23	61	25	46	
24	Old Town House Rd @ Forest Rd	Yarmouth	24	18	87	64	
25	Route 134 @ Setucket Rd	Dennis	25	28	76	83	

TABLE 6 - INDEX OF NOTES (PAGE 2 OF 3)

Note	Location	TOWNS	Rank EPDO /MEV	Rank Crashes /MEV	Rank EPDO	Rank Crashes	Comment
26	County Rd @ Barlows Landing Rd	Bourne	26	38	85	117	
27	Route 28 @ Old Meetinghouse Rd/Davisville Rd	Falmouth	27	37	29	36	TIP year 2013
28	Route 6A @ Post Rd/New Boston Rd	Dennis	28	22	57	42	
29	Route 151 @ Jobs Fishing Rd/Public Safety Facility SD	Mashpee	29	57	42	64	
30	Route 6 @ Cranberry Hwy (Exit 1C)	Bourne	30	53	69	117	
31	Route 134 @ Center St	Dennis	31	55	69	117	
32	Bourne Rotary (Rte 28/Sandwich Rd/Trowbridge Rd)	Bourne	32	12	5	2	Bourne Rotary study completed 2014; safety improvements scheduled for FY2014
33	Route 151 @ Route 28A (North Falmouth Hwy)	Falmouth	33	26	35	28	TIP year 2017
34	West Yarmouth Rd @ Buck Island Rd	Yarmouth	34	34	74	64	
35	Route 134 @ Theophilus F Smith Rd	Dennis	35	20	20	16	Analysis 2013
36	Route 6 @ Route 132 (Exit 6)	Barnstable	36	32	1	4	Signalized 2007
37	Route 6 @ Route 134 (Exit 9)	Dennis	37	23	4	3	RSA completed 2009; new analysis 2013
38	Route 28 (MacArthur Bvld) at Route 151	Falmouth	38	31	11	12	
39	Route 134 @ Upper County Rd/Duck Pond Rd	Dennis	39	29	17	18	Reconstruction begun 2013
40	Route 130 @ Great Neck Rd	Mashpee	40	47	82	101	
41	Sandwich Rd @ Adams St	Bourne	41	44	40	42	Under review by Town of Bourne 2014
42	Belmont Circle (Rt 28/Rt 6/Rt Bypass/Head of the Bay Rd)	Bourne	42	30	11	9	MassDOT study begun 2013
43	Route 6 @ Willow St (Exit 7)	Yarmouth	43	58	7	9	
44	Route 28 (Teaticket Hwy) @ Trotting Park Rd/Alphonse St	Falmouth	44	65	47	59	
45	Route 6 @ Route 130 (Exit 2)	Sandwich	45	43	6	6	Signalized 2012
46	Route 6A @ Cranberry Highway/Sandwich Rd	Bourne	46	46	48	45	RSA completed 2012
47	Route 28 (Teaticket Hwy) @ McDonalds SD/Various Business SD	Falmouth	47	35	57	42	
48	Route 6 (GAR Hwy) @ Samoset Rd	Eastham	48	60	43	46	
49	Route 28 @ Lorraine Rd/Dunkin Donuts SD/Family Food Plaza SD	Falmouth	49	48	32	33	
50	Jones Rd @ Gifford St	Falmouth	50	76	51	83	

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51	Depot St @ Upper County Rd	Dennis	51	17	186	64	
52	Route 28 (E Falmouth Hwy) @ Central Ave	Falmouth	52	41	35	28	
53	Brick Kiln Rd @ Sandwich Rd	Falmouth	53	39	82	52	
54	Route 134 @ Route 28 (Main St)/Swan River Rd	Dennis	54	66	54	52	Added left turn lanes and new signal phasing, pedestrian improvements 2010
55	Theophilus F Smith Rd @ Patriot Square Rear SD (near theater)	Dennis	55	11	153	36	Analysis 2013
56	Route 28 @ Old Barnstable Rd/Acapesket Rd	Falmouth	56	62	51	46	
57	Cranberry Highway @ Adams St	Bourne	57	68	82	101	
58	Route 151 @ Sandwich Rd	Falmouth	58	51	43	33	
59	Route 6 @ Union St/Station Ave (Exit 8)	Yarmouth	59	70	8	14	RSA completed 2011
60	Route 28 (Main St) @ Perry Ln/Various Business SD	Falmouth	60	56	67	52	
61	Route 6 @ Route 124 (Exit 10)	Harwich	61	42	20	16	Signalization of Rt 124/Queen Anne Road adjacent to interchange 2011
62	Route 28 (Teaticket Hwy) @ Jones Rd	Falmouth	62	59	46	36	TIP year 2013
63	Route 6 @ Route 137 (Exit 11)	Harwich	63	63	24	22	Signalized eastbound ramps 2013
64	Station Avenue near Former Rail Crossing	Yarmouth	64	81	51	83	
65	West Main St @ Pitchers Way	Barnstable	65	89	76	175	
66	Route 6 @ Exit 1A/Exit1B	Bourne	66	54	8	7	
67	Route 134 @ Bob Crowell Rd/Hemlock Ln	Dennis	67	24	76	26	Analysis 2013
68	Route 28 @ East Main	Yarmouth, Barnstable	68	50	48	31	Recommendations included in Rt 28 Safety and Traffic Flow Study 2006
69	Buck Island Rd @ Higgins Crowell Rd	Yarmouth	69	64	87	64	
70	Route 28 (E Falmouth Hwy) @ Corte Real Ave	Falmouth	70	72	69	59	
71	Route 28 @ Main St/N Main St	Yarmouth	71	52	76	46	
72	Route 28 (Falmouth Rd) @ Orchard Rd/Ashers Path	Mashpee	72	85	67	101	
73	Route 6 (GAR Hwy) @ Brackett Rd/Old County Rd	Eastham	73	69	64	46	Signal upgrade & westbound left turn lane added 2010
74	Willow St @ Higgins Crowell Rd	Yarmouth	74	94	76	175	
75	Route 137 @ Route 39 (Orleans Rd)	Harwich	75	79	61	64	

CAPE COD DRIVERS

The demographics of Cape Cod depict a typical year-round resident that is older than the average population in the United States. Over 58% of Cape Cod's population as reported in the U.S Census Bureau (2013 estimates) was aged 45 or older (as compared to 40% for the national average). This trend is continuing. The migration of retirees to Cape Cod and a stable aging population is not being offset by new younger residents or births. With the trend toward an older population in America, the Federal Highway Administration (FHWA) has recognized that older drivers require special consideration. This recognition is demonstrated in the publication of several recent documents and a special address to Congress by the National Highway Traffic and Safety Administration (NHTSA). The focus in both cases was on the behavior of older drivers with respect to the "typical" driver. The NHTSA address also included issues related to younger drivers. Recommended guidelines for design standards that will help accommodate the needs of an older driver are also included in the literature.

Another dimension defining the unique character of Cape Cod drivers is their seasonal nature. The Cape is inundated with visitors, many of whom are not familiar with Cape Cod roads. Drivers that are used to city streets or parkways are also subjected to the scenic rural roads that compose a significant part of the Cape's character. The physical nature of these roadways may be somewhat unfamiliar to off-Cape drivers, leading to safety concerns.

Among the many drivers that visit to the Cape in the summer are a large number of younger motorists. These drivers have less experience in familiar surroundings and even less in the Cape driving environment. This coupled with a "vacation attitude" requires more considerations for roadway design and planning. These considerations must also be balanced with the natural qualities that bring people to Cape Cod.

THE SENIOR DRIVER

A large and increasing percentage of Cape drivers are 65 and older. According to the Census Bureau 2013 estimates, 27% or 58,320 residents of Barnstable County are aged 65 or older (see following table). This steadily increasing proportion of drivers will experience declining vision, slowed decision making and reaction times, additional difficulty in dividing attention between potential conflicts and traffic information, and reductions in strength, flexibility, and overall fitness. In many cases, these difficulties will outweigh the additional experience that older drivers have operating an automobile. The large majority of drivers who suffer from age-related driving deficiencies are not aware that a problem exists.

The overwhelming majority of Cape intersections are at grade. Based on FHWA crash statistics for drivers, 80 years and older, more than 50% of fatal crashes occur at intersections. This is compared with 24% or less for drivers up to age 50. According to studies referenced in the FHWA *Older Driver Highway Design Handbook* (1998), as driver age increases, involvement in intersection crashes increase as well. Older drivers typically experience two types of at-grade intersection difficulties. Left turn difficulties result from lack of sufficient caution and poor positioning on the road during the turn. Stopping difficulties result from a failure to stop, a

failure to make complete stops at stop signs, and stops that were abrupt. Comparing survey responses of drivers aged 66 to 68 with those aged 77 and older, showed that the older group had more difficulty following pavement markings, finding the beginning of left hand turn lanes, and driving across intersections. Another study of older drivers indicated that the most challenging aspect of intersection negotiation is making left turns during the green, left turn permitted signal phase. The protected "green arrow" left hand turn has been identified as an important improvement for older drivers.

Nighttime driving is associated with a higher crash risk for all drivers; however the effect of aging on vision is particularly compounded by the effect of darkness. The aging process causes gradual declines in a variety of ways; acuity, contrast sensitivity, glare-recovery, and peripheral vision. These declining functions make night driving particularly difficult for older drivers. The ability to notice and recognize objects at night and in low-light conditions such as dawn, dusk, rain, fog, haze, and snow is a chief concern. According to studies referenced in the FHWA handbook show that between age 20 and age 70, contrast sensitivity is reduced by a factor of three. This places the typical older driver at a relative disadvantage in low-light conditions. As expected, older drivers require significantly larger letters to read unfamiliar signs. Current sign standards are based on an assumed vision of 20/25 (as opposed to "perfect" 20/20 vision). Older drivers require a standard of 20/46.

OLDER DRIVER RECOMMENDATIONS

Based on the issues associated with the older driving population on Cape Cod the following suggestions are recommended as considerations for Cape Cod roadway improvements. Many of these recommendations are from FHWA's *Older Driver Highway Design Handbook* (1998). This resource should be consulted for more details. The Older Driver Handbook includes other recommendations and guidelines that should be considered in Cape roadway design but their use should also be tempered to maintain the character of Cape Cod's roadways.

Recommendations to accommodate older drivers include:

- Considering protected left turn phases into signalized intersections;
- Maintaining delineation through more frequent restriping and street cleaning;
- Improving signage standards to include larger lettering;
- Improving lighting level standards, in particular at intersections. Consider placing utilities underground and installing breakaway safety poles for lighting;
- Considering "all red" phases for signalized intersections;
- Establishing driver education programs for older drivers; and
- Providing education on other options for mobility.

Mobility programs to provide alternatives to driving also need to be improved. This was a major topic at Cape Cod's February 2000 Transit Summit. The recommendations from the Summit included a "dual challenge" of reducing auto dependency and meeting the needs of the transit dependent and those in need of human services. By improving mobility options, significant safety improvements may be realized

YOUNG DRIVERS

Safety and age-related crash statistics indicate that younger drivers' (under age 25) problems exceed those of any other age group. The shorter average trip length of older drivers is accompanied by a higher frequency of fatal crashes. Young drivers outnumber, out-travel, out-crash, and die more frequently by any other measure. There are slight differences between younger and older drivers in the types of crashes they experience. For example, young drivers have more speeding and alcohol-related crashes. Younger drivers' crashes are frequently caused by inexperience, poor judgment, and risk taking, while older drivers' crashes are more often related to reduced physical and cognitive capabilities.

Although most crashes occur at intersections, young drivers show a greater tendency than other age groups to be involved in non-intersection crashes. According to NHTSA statistics, 43% of crashes by drivers age 15 to 24 are at non-intersection locations. That number reduces to 41% for drivers age 25 to 64 and 31% for drivers age 65 to 74.

Younger drivers are more prone to risk-taking behavior and are subject to influences of youth culture and peer pressure. Many of these characteristics are evident in young visitors to Cape Cod.

YOUNGER DRIVER RECOMMENDATIONS

Recommendations to accommodate younger driver safety issues are divided between residents and visitors:

- Increased education for local young drivers.
- Additional enforcement and warnings during the busy traffic season to reach out to young visitor drivers.
- Develop and implement an advertising campaign and roadside signage reminding drivers that traffic and drunk-driving laws are strictly enforced on Cape Cod.

ADDITIONAL RECOMMENDATIONS

Additional recommendations include:

- Better signage for visitors directing them to popular destinations (e.g., larger, well-located signs to direct patrons of the Hyannis Transportation Center may improve safety at the driveway on Route 28).
- Signage explaining the rotary "rules of the road" and similar information to be included in visitor brochures and Cape-related websites

THE CAPE COD ROADWAY

There are nearly 3,900 miles of roadways in Barnstable County. These include 574 miles of Arterials and 213 miles of Collectors. The remaining 3,076 miles included local roads and the many miles of unimproved ways. The typical posted speed limit on the Cape is less than 40 miles per hour (mph) and, on average, the roadways carry 175% more traffic in July and August than they do in January and February.

The character of Cape Cod's rural roads includes narrow lanes and a typical speed limit of 35 mph. Most roads do not have shoulders and bicycles must often share the lanes with motorists. Many of the older roads evolved from Native American trails and stagecoach routes. Roadway geometry is therefore less accommodating than current state and federal standards. Included in the goals of this Plan is the preservation of the scenic and rural character of Cape Cod's narrow, winding roads. However, this must be accompanied by a program of enforcement and education especially for the drivers that visit the Cape in the summer. The following tables list crash rates for Routes 6, 6A, and 28, respectively. For comparison purposes, the latest available three years' data were from 2006-2008.

TABLE 8 - CRASH RATES (BASED ON YEARS 2009-2011): ROUTE 6

TOWN	ALL CRASHES (AVG. ANNUAL)	FATAL CRASHES (AVG. ANNUAL)	CRASHES PER MILLION VMT	FATAL CRASHES PER 100 MILLION VMT
Bourne	73	0.7	0.7	0.7
Sandwich	40	0.0	0.1	0.0
Barnstable	62	0.3	0.5	0.3
Yarmouth	28	0.3	0.4	0.4
Dennis	24	0.0	0.9	0.0
Harwich	31	0.0	0.6	0.0
Brewster	3	0.3	0.2	2.1
Orleans	15	0.0	0.7	0.0
Eastham	90	0.7	1.8	1.3
Wellfleet	39	0.0	0.6	0.0
Truro	24	0.0	0.5	0.0
Provincetown	6	0.3	0.5	2.9
Total	**435**	**2.7**	**6.1**	**3.8**

Registry of Motor Vehicles' Crash Records supplied by MassDOT
Vehicle Miles Traveled (VMT) calculated using Cape Cod Commission traffic data

TABLE 9 - CRASH RATES (BASED ON YEARS 2009-2011): ROUTE 28

TOWN	ALL CRASHES (AVG. ANNUAL)	FATAL CRASHES (AVG. ANNUAL)	CRASHES PER MILLION VMT	FATAL CRASHES PER 100 MILLION VMT
Bourne	182	1.7	1.9	1.7
Falmouth	353	0.7	4.1	0.8
Mashpee	51	0.3	2.2	1.5
Barnstable	101	1.7	1.7	2.7
Yarmouth	115	0.3	3.4	1.0
Dennis	64	0.3	5.5	2.9
Harwich	34	1.0	1.6	4.8
Chatham	31	0.0	0.8	0.0
Orleans	32	0.0	1.7	0.0
Total	**961**	**6.0**	**22.3**	**13.9**

Registry of Motor Vehicles' Crash Records supplied by MassDOT
Vehicle Miles Traveled (VMT) calculated using Cape Cod Commission traffic data

TABLE 10 - CRASH RATES (BASED ON YEARS 2009-2011): ROUTE 6A

TOWN	ALL CRASHES (AVG. ANNUAL)	FATAL CRASHES (AVG. ANNUAL)	CRASHES PER MILLION VMT	FATAL CRASHES PER 100 MILLION VMT
Bourne	26	0.0	9.9	0.0
Sandwich	43	0.0	2.1	0.0
Barnstable	6	0.0	0.3	0.0
Yarmouth	26	0.0	1.5	0.0
Dennis	40	0.0	2.6	0.0
Brewster	64	0.0	2.1	0.0
Orleans	35	0.0	5.0	0.0
Total	**241**	**0.0**	**14.6**	**0.0**

Registry of Motor Vehicles' Crash Records supplied by MassDOT
Vehicle Miles Traveled (VMT) calculated using Cape Cod Commission traffic data

SAFETY IMPROVEMENTS THROUGH INTERSECTION MODIFICATION

To help quantify the benefits of various safety treatments, several resources were consulted including *The Traffic Safety Toolbox: A Primer on Traffic Safety*, Chapter 28, Institute of Transportation Engineers, 2000; and *Prediction of the Expected Safety Performance of Rural*

Two-Lane Highways, Chapter 5, Federal Highway Administration, 2000. These reports include discussions on various vehicular access treatments and predictions of "Accident Reduction."

Modern Roundabouts v. Four-Way Intersections

A roundabout is a type of circular intersection with specific design and traffic control features. These features include yield control of all entering traffic, channelized approaches, and appropriate geometric curvature to ensure that travel speeds on the circulatory roadway are typically less than 20 mph. The decision to install a roundabout as a safety improvement should be based on a demonstrated safety problem of a type susceptible to correction by a roundabout. FHWA's *Roundabouts: an Informational Guide*, (FHWA –RD-00-067, June 2000) provides a review of the safety improvements afforded by roundabouts. For example, safety problems that could be improved by a roundabout include:

- High rates of crashes such as right angle, head-on, left/through, U-turns, etc.
- High crash severity that could be reduced by slower speeds
- Site visibility problems that reduce the effectiveness of stop sign control
- Inadequate separation of movements, especially on single-lane approaches

The following figure shows that roundabouts have fewer annual injury crashes than rural two-way stop-controlled (TWSC) intersections, and the total number of crashes at roundabouts is relatively insensitive to minor street demand volumes.

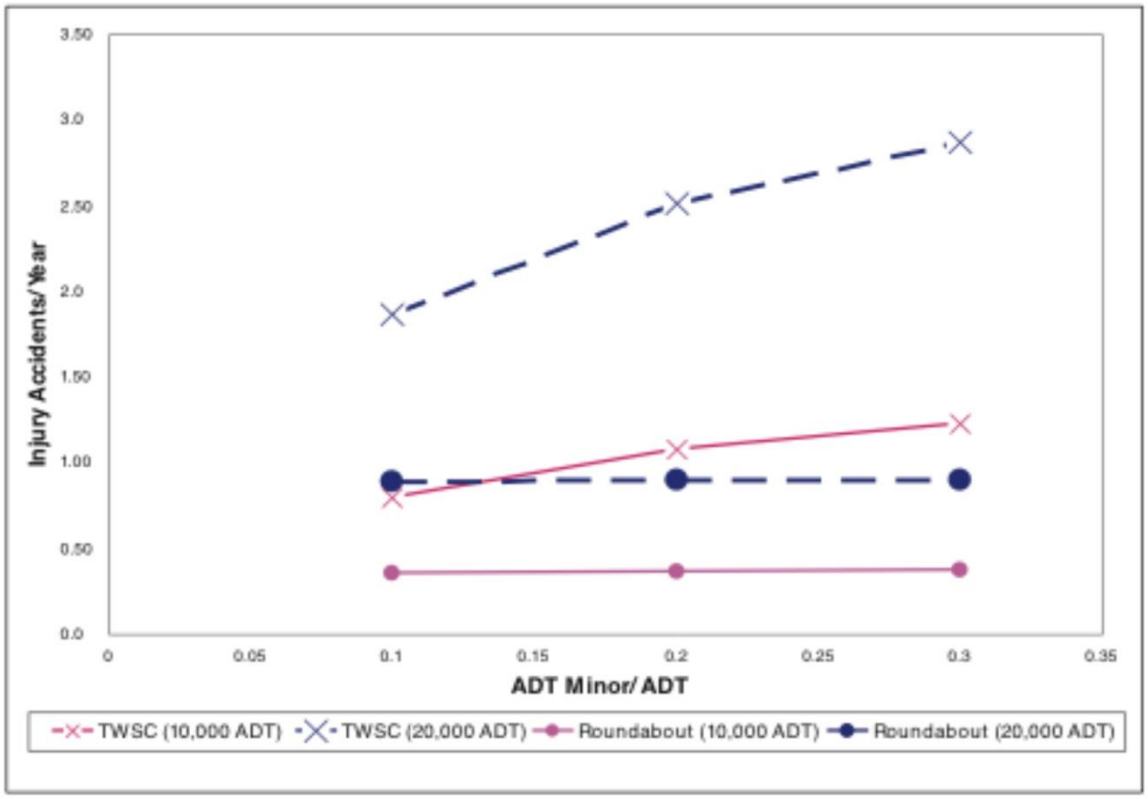

FIGURE 2 - COMPARISON OF PREDICTED ROUNDABOUT INJURY CRASHES WITH RURAL 2-WAY STOP - CONTROLLED INTERSECTIONS.

(Source: FHWA)

The Roundabout guide also includes information to compare roundabouts to signalized intersections. The following figure shows that roundabouts have fewer injury accidents per year than signalized intersections, particularly in rural areas. At volumes greater than 50,000 vehicles per day (shown on the figure as "ADT" – average daily traffic), urban roundabout safety may be comparable to that of urban signalized intersections.

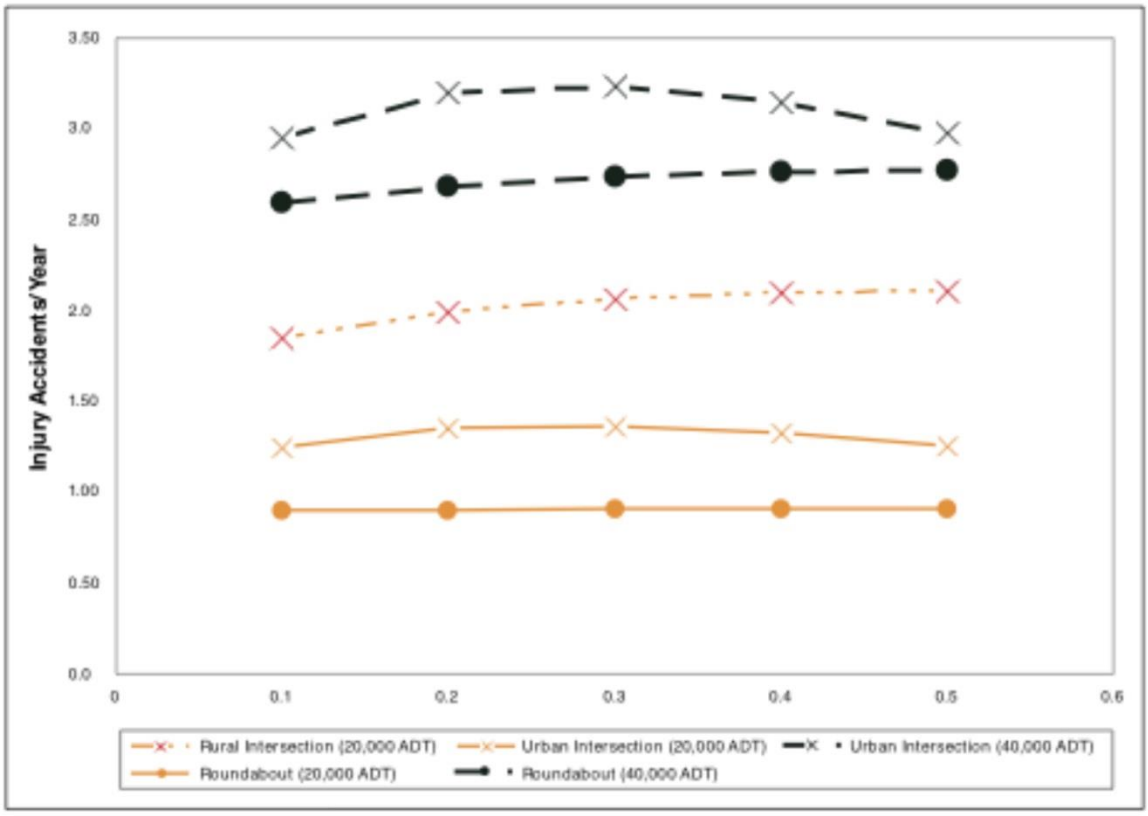

FIGURE 3 - COMPARISON OF PREDICTED INJURY CRASHES FOR SINGLE-LANE AND DOUBLE-LANE ROUNDABOUTS WITH RURAL OR URBAN SIGNALIZED INTERSECTIONS.

(Source: FHWA)

SAFETY-RELATED TECHNOLOGY

Improved technology provides new options for the enforcement of traffic laws and speed control. The Insurance Institute for Highway Safety (IIHS) and the FHWA have favorable reviews of applications such as red-light enforcement and photo radar. These techniques should be coupled with education as well, since a goal is to improve safety by deterring unsafe driving. The greatest benefit of these techniques has been a "halo effect" whereby drivers are complying

with traffic laws in un-monitored locations as well as those where the technology has been installed.

Red Light Enforcement

According to IIHS, nationwide, drivers who run red lights are responsible for 260,000 crashes each year. Of these, approximately 750 are fatal. Motorists are more likely to be injured in crashes involving red light running than in other types of crashes: occupant injuries occurred in 45% of red light running crashes compared with 30% for other crash types. Enforcing red light laws by traditional means poses special difficulties for police, who in most cases must follow a violating vehicle through a red light to stop it. This poses a danger to motorists, pedestrians, as well as the officers. Red light running violations typically decrease by as much as 60% at intersections where cameras automatically enforce the law.

In areas where red light cameras have been installed as well as areas without cameras, most drivers have supported the use of red light cameras, 80% in cities with cameras and 76% in cities without.

Opticom System

Many of the Cape's signalized intersections are equipped with the Opticom priority-based pre-emption system. Opticom includes infrared detection equipment installed adjacent to the signal heads. When an emergency vehicle (ambulance, fire engine, etc.) equipped with an Opticom infrared emitter approaches the intersection, the detector notifies the signal controller and a green phase is maintained for the emergency vehicle (other approaches are held under a red phase). Signal pre-emption is vital for emergency responders to safely and quickly travel to incident sites. Agencies responsible for intersection signal maintenance should also ensure continuous operation of the Opticom system. Upgrades to existing signals and new signal installations should be equipped with Opticom.

COORDINATION WITH MASSACHUSETTS' STRATEGIC HIGHWAY SAFETY PLAN

Building on the success of the 2006 "Strategic Highway Safety Plan" (SHSP), MassDOT released an update of the document in September 2013. The updated Massachusetts SHSP[1] is consistent with requirements outlined in the most recent Federal transportation legislation, Moving Ahead for Progress in the 21st Century (MAP-21). One requirement is to establish goals and performance measures. Goals in the Massachusetts SHSP include:

- Reduce motor vehicle fatalities and hospitalizations by 20 percent in the five-year period following adoption of the SHSP (Short-Term Goal);
- Halve the number of fatalities and serious injuries by 2030 (Interim Goal); and
- Move Toward Zero Deaths and eliminate fatalities and serious injuries on the roadways (Long-Term Goal).

[1] http://www.massdot.state.ma.us/Portals/8/docs/traffic/shsp/shspSeptember2013.pdf

The Massachusetts Strategic Highway Safety Plan update is organized to focus attention on the traffic safety problems exhibited by each emphasis area. An emphasis area is classified as Strategic, Proactive, or Emerging based on the number of fatalities, hospitalizations, or incapacitating injuries resulting from crashes related to the emphasis area.

Strategic Emphasis Areas

Each emphasis area listed here represents at least 10 percent of annual fatalities or severe injuries on Massachusetts roadways.[2]

- Impaired Driving
- Young Drivers
- Intersections
- Older Drivers
- Lane Departures
- Pedestrians
- Occupant Protection
- Motorcycles
- Speeding/Aggressive Driving

Proactive Emphasis Areas

Each of these emphasis areas represents less than 10 percent of annual fatalities or severe injuries on Massachusetts roadways. Strategies included within each emphasis area are designed to ensure fatalities and severe injuries for these areas are further reduced even though it may be more difficult in areas already experiencing very low crash rates.

- Bicycles
- At-Grade Crossings
- Truck/Bus-Involved Crashes
- Safety of Persons Working on Roadways

Emerging Emphasis Areas

These emphasis areas focus on continuously improving the data systems used to analyze traffic safety patterns and generate data on safety topics where the data currently are inconclusive.

- Data Systems
- Driver Inattention[3]

The safety goals, objectives, and performance measures of the Cape Cod RTP were developed to support the goals and performance measures of the Massachusetts SHSP.

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[2] Severe injuries are based on injuries requiring hospitalizations or defined as incapacitating injuries by police reporting

[3] http://www.massdot.state.ma.us/Portals/8/docs/traffic/shsp/shspSeptember2013.pdf

POLICIES & STRATEGIES

In the interest of preserving the character of Cape Cod and achieving safer roads, non-traditional methods of improving safety must be explored. The following recommendations for improving safety will not substantially change the character of the roadways on Cape Cod. Recommendations consistent with the Massachusetts' *Strategic Highway Safety Plan's* (SHSP) "Emphasis Areas" are indicated with an asterisk.

- Consider Traffic Calming measures such as 4-way stop signs and roundabouts.*
- Improve striping maintenance and use of more reflective treatments.*
- Increase enforcement and police presence on rural roads such as 6A.*
- Investigate photo enforcement of red light running and speeding.*
- Make physical improvements that improve the safety and security of the transportation network a priority.*
- Continuously monitor the condition of the transportation system to ensure that it is safe to travel on all modes throughout Cape Cod.*
- Continue to identify the high priority safety locations throughout Cape Cod and then determine measures to increase safety at those locations.*
- Separate high and low speed travel modes, so that those traveling at slower speeds, such as bicycles and pedestrians, do not conflict with those traveling at higher speeds, such as rail and automobile traffic.*
- Encourage safe use of the transportation network through public awareness campaigns, promoting such things as seatbelts for motorists and helmet use for bicyclists.*

*Supports Massachusetts' Strategic Highway Improvement Program "Emphasis Areas"

COMMUNITY CHARACTER/SAFETY ISSUES

The following recommendations are intended to preserve community character while addressing safety issues.

- Use alternative guardrail treatments, such as steel Corten or steel backed timber - all on wood posts, where guardrail is necessary.
- Consider roundabouts as an alternative to signalized intersections.
- Continue policies that disallow business logo signs on state highways in Barnstable County.
- Preserve all state owned/town owned land along roads and other transportation rights-of-way, for transportation uses and/or conservation.
- Prohibit pruning and clearing within state rights-of-way except for safety purposes, such as making sight distance improvements.
- Encourage ornamental signal posts and mast arms.
- Develop design guidelines for Cape Cod to document preferred treatments in design concepts and details.
- Encourage use of simulated brick crosswalks and other contrasting materials in order to provide drivers with better visual identification. Crosswalks should be considered for all projects to accommodate walking as a viable mode of travel.

- Promote "Share the Road" and other bicycle education programs.

ROADWAY SAFETY AUDITS

Since 2007 there have been eighteen Road Safety Audits (RSAs) completed for locations throughout Cape Cod. The Audit process is overseen by MassDOT and brings together community officials and others in an intensive review of high-crash locations' operational and geometric deficiencies. Each audit includes a review of traffic and crash information, an onsite field review.

It is important to note that the RSAs were borne directly from the U.S. DOT & MassDOT's Highway Safety Improvement Program (HSIP). This program was formally created by the federal transportation legislation (SAFETEA-LU) and these efforts are intended to align the use of data to identify the most serious safety deficiencies responsible for fatal accidents and serious injuries.

BARNSTABLE ROAD SAFETY AUDITS

There have been six completed audits within the town of Barnstable since 2007:

Iyannough Road (Route 132) at Cape Cod Community College/Cape Cod Conservatory Intersection

Completed in 2014, the audit includes five safety issues and identified enhancements for each:

Safety Issue #1. Intersection Geometry & Vehicle Conflicts

Enhancements:

- Provide more control and definition at the intersection. This may include a right-turn lane on northbound Route 132. Modify pavement marking to allow for through-traffic exiting the college driveway.
- For traffic calming and to reduce vehicle conflicts, consider installation of a modern roundabout.
- To reduce left-turning vehicle conflicts, consider installation of a traffic signal.

Safety Issue #2. Sight Distance and Vegetation

Enhancement:

- Trim vegetation to increase available sight distance and signage visibility.

Safety Issue #3. Signage and Lighting

Enhancement:

- Upgrade (replace) signs to improve retro-reflectivity.

- Add a white on green sign in advance of the intersection with "Cape Cod Community College next right".
- Consider installing overhead lighting at the utility pole on the northwest quadrant of the intersection.

Safety Issue #4. Pavement and Markings

Enhancement:

- With intersection improvements the pavement condition and markings should be improved, as feasible.

Safety Issue #5. Bicycle/Pedestrian Accommodations

Enhancement:

- Provide advance warning signage notifying motorists along Route 132 of the upcoming crosswalk.
- Install an accessible ramp on the western side of the Route 132 crosswalk.
- During intersection improvements, include accommodations for bicyclists such as widened shoulders or bike lanes on Route 132.
- Consider creating an accessible and well-lit unpaved path from Route 132 to Community College Parking Lot #2 to shorten walking distances between the college and the Park and Ride Lot; if warranted consider installation of a crosswalk on Route 132 on the northern leg of the Route 6A westbound ramps intersection to provide access to the path.

Route 28 at Osterville-West Barnstable Road

Completed in 2012, the audit includes seven safety issues and identified enhancements for each:

Safety Issue #1. Conflicting Movements

Enhancement:

- Provide more control and definition at the intersection and adjacent property driveways; consider installation of left turn lanes and phases on Route 28.

Safety Issue #2. Driver Behavior and Speed

Enhancements:

- Review signal timing to ensure that the clearance time (yellow and all red time) is adequate for the 85th percentile speeds and according to the Institute of Transportation Engineers (ITE) Traffic Engineering Handbook equation. When the intersection is reconstructed, consider providing dilemma zone detection.
- Provide periodic enforcement to provide visibility that promotes calming and improved behavior.

Safety Issue #3. Sight Distance and Vegetation

Enhancements:

- Trim vegetation for improved sight triangle at the intersection.
- Add black backplates to the signal heads for improved visibility.

Safety Issue #4. Signs

Enhancements:

- Upgrade signs for retro-reflectivity.
- Add a white on green sign in advance of the intersection with "Osterville-West Barnstable Road next signal".

Safety Issue #5. Pavement and Markings

Enhancement:

- With intersection improvements the pavement level and markings should be improved, as feasible.

Safety Issue #6. Bicycle/Pedestrian Accommodations

Enhancements:

- Upgrade bicycle and pedestrian accommodations with future maintenance and/or reconstruction efforts.
- Consider adding an island with the left turn lanes for a break in bicycle/pedestrian crossing of Route 28.

Safety Issue #7. Traffic Signal Equipment

Enhancements:

- Install pre-emption equipment in the traffic signal for emergency responders.
- Add black backplates to the signal heads.

Iyannough Road (Route 28) at Yarmouth Road

Completed in 2012, the audit includes ten safety issues and identified enhancements for each:

Safety Issue #1. Congestion and Driver Frustration

Enhancements:

- Consider the feasibility of improving traffic signal operations (e.g. traffic signal improvements, signal phasing changes, roadway widening, lane use modifications, etc.) to reduce queuing conditions and motorist frustration.
- Consider the appropriateness and safety benefits of providing a protected left-turn signal phase for Yarmouth Road northbound.
- Enforce red light running violations where possible.

- Review, and adjust as appropriate, clearance intervals per current standards in an effort to reduce rear-end and angle-type crashes.

Safety Issue #2. Unclear Lane Use

Enhancement:

- Review traffic volumes and operations at the Yarmouth Road northbound approach to evaluate the appropriateness of formalizing two lanes. Repaint and maintain lane use pavement markings along Yarmouth Road southbound.

Safety Issue #3. Intersection Geometry

Enhancements - Iyannough Road (Route 28) at Yarmouth Road:

- Consider the feasibility of increasing curb radii, particularly at the northeast corner of the intersection, and/or staggering stop bar placement to allow/ facilitate truck turns.
- Consider the appropriateness of replacing the current signalized intersection with a multilane modern roundabout to reduce the occurrence of angle type crashes.

Enhancements - Yarmouth Road /Camp Street:

- Explore the feasibility of making geometric changes, such as creating a 90 degree "T" intersection between Yarmouth Road and Camp Street, or a roundabout, to reduce conflicts, improve sightlines, reduce driver confusion, and improve overall safety. Consider emergency vehicle access/response times to Cape Cod hospital, queuing conditions along Yarmouth Road northbound at Route 28, and access to and from DJ's Family Sports Pub.
- Consider the appropriateness of adding a dotted double yellow center line and dotted white edge lines through the Camp Street/Yarmouth Road intersection to clarify the main road from the side street.

Safety Issue #4. Signage

Enhancements:

- Relocate "Left Lane Must Turn Left" (R3-7) sign along Route 28 eastbound so that it is visible to motorists.
- Consider improving guide signage for Route 28 eastbound to direct motorists to Route 6.
- Trim and maintain overgrown trees along Yarmouth Road northbound to improve visibility of Route 28 guide signage.
- Consider appropriateness for installing guide signage for Route 6 along Yarmouth Road northbound.
- Remove "Caution Crossing Traffic" sign near Dunkin Donuts/Hess driveway to reduce sign clutter.

Safety Issue #5. Access Management

Enhancements:

- Consider the appropriateness of physically precluding left turns out of Dunkin Donuts/Hess onto Yarmouth Road southbound through geometric changes and/or introduction of a median along Yarmouth Road as part of future reconstruction efforts.
- Explore the feasibility of prohibiting left turns out of the eastern Dunkin Donuts/Hess driveway if crash experience worsens. Consider fuel delivery requirements and the impacts of restricting all left turns out of the Dunkin Donuts/Hess site.

Safety Issue #6. Railroad Crossing

Enhancements:

- Consider the feasibility of providing preemption for the railroad crossing and ways to coordinate Route 28/Yarmouth Road signal to reduce/eliminate queuing within the intersection and to improve emergency vehicle response time.
- Consider the appropriateness of adding "Do Not Block Intersection" signage and appropriate pavement markings at Route 28/Yarmouth Road to discourage motorists from blocking the intersection during train crossings.
- Consider the long-term feasibility of creating grade separation between Route 28 and the railroad crossings.

Safety Issue #7. Signal Indications

Enhancements:

- Evaluate the visibility of the signal indications as part of the design process to ensure that it meets current Manual on Uniform Traffic Control Devices (MUTCD) standards. Relocate signal heads, and/or install additional overhead and/or post-mounted signal indications as appropriate to improve visibility.
- Consider the appropriateness of installing backplates on all traffic signal indications to reduce solar glare.
- Trim overgrown trees to improve visibility of the signal indications.

Safety Issue #8. Limited Bicycle Accommodations

Enhancements:

- Consider the feasibility/appropriateness of providing bicycle accommodations at the intersection (i.e., shared lanes and/or within a 4-foot shoulder, bicycle detection at signals, signage, and pavement markings) in accordance with the 2006 Project Development and Design Guide.
- As part of the design process and long-term planning efforts, include a Route 28 bicycle/pedestrian crossing to connect the future extension of the Cape Cod Rail Trail through the intersection.

Safety Issue #9. Limited Pedestrian Accommodations

Enhancement:

- Evaluate the feasibility and safety benefits of providing pedestrian accommodations at the Route 28/Yarmouth Road intersection, including crosswalks, accessible ramps, and pedestrian signal indications, and providing a connection between the intersection and the existing sidewalks on Camp Street and Yarmouth Road south of Route 28.

Safety Issue #10. Emergency Vehicles

Enhancements:

- Provide Opticom detection at the intersection of Route 28/Yarmouth Road to improve emergency vehicle response times.

Previous Barnstable Road Safety Audits

Audits listed below have been summarized in previous Regional Transportation Plans and are listed for convenience. Copies of Road Safety Audits are available from the Cape Cod Commission website at:

www.capecodcommission.org/safety

- Meetinghouse Way (Route 149)/Route 6 Ramps (2010)
- Route 28 (Falmouth Road)/Bearses Way (2009)
- Route 28 in Barnstable – Lane Departure Safety Audit (2007)

BOURNE ROADWAY SAFETY AUDITS

There have been two completed audits within the town of Bourne since 2012:

Route 28 between Bourne Rotary and Otis Rotary

Completed in 2013, the audit includes a number of safety issues and identified enhancements for specific locations:

Bourne Rotary

Enhancements:

- Consider the safety benefits of providing advance guide signage along the approaches to the rotary. Consider providing diagrammatic guide signs (D1-5 or D1-5A) for each individual approach so that motorists know which exit they need to take before entering the rotary.
- Remove the guide signage from the center island of the rotary.

- Remove guide signage that is too small for circulating traffic to read. Replace with MUTCD-compliant signage if the signage is deemed necessary. Ensure that all guide signage visible from the rotary or the approaches to the rotary is useful and necessary.
- Provide larger "Reduced Speed Ahead" signage (W3-5) along the Route 28 northbound approach to the rotary. Consider whether more gradually reducing the speed limit along the approach would reduce the number of rear-end crashes.
- Continue enforcing speeding violations within the rotary and along approaches to the rotary.
- As part of long-term planning efforts, consider the safety benefits of providing overhead signage to improve motorist visibility.
- Consider the safety benefits of providing longitudinal markings and arrow pavement markings within the rotary, including dashed pavement markings to assist entering and exiting vehicles, as part of the upcoming Route 28 corridor resurfacing project.
- Consider providing additional pavement markings along the Trowbridge Road eastbound and Sandwich Road westbound approaches to the rotary that clearly indicate that vehicles should form a single travel lane.
- Consider the safety benefits of removing large trees and trimming overgrown vegetation on the mound behind the "Cape Cod" topiary within the rotary. Consider the feasibility and safety benefits of restricting the two Gulf gas station driveways to either entrance- or exit only using signage and/or pavement markings.
- Consider the feasibility of closing the easternmost Gulf gas station driveway. The maneuverability of fuel delivery trucks should be taken into consideration.
- Consider the safety benefits of restricting left-turn movements into and out of the IHOP driveways along Route 28.
- Consider the feasibility of closing one of the two IHOP driveways located along the northern leg of Route 28, in the vicinity of the Bourne Bridge.
- Provide pavement markings along the Route 28 northbound approach to the rotary that would help to deflect and slow vehicles entering the rotary.
- As part of mid-term reconstruction efforts, evaluate the safety benefits of realigning the Route 28 northbound approach so that traffic is deflected at a greater angle in order to slow vehicles entering the rotary.
- In long-term planning efforts, consider the feasibility and safety benefits of replacing the Bourne Rotary with a grade-separated option, such as a diamond interchange.
- Install "Except Pedestrians" placards on the "Do Not Enter" signage at the State Police Barracks to encourage pedestrians to use the State Police Barracks driveway instead of the rotary to access Trowbridge Road.

Otis Rotary

Enhancements:

- Consider the safety benefits of providing warning signage, including yellow flashing beacons along the Route 28 northbound and southbound approaches to the rotary, similar to what is provided along the Route 28 southbound approach to the Bourne Rotary, in order to warn motorists to be more alert within the rotary.
- Add deflection along the Route 28 approaches to the rotary using pavement markings to encourage motorists to enter the rotary at slower speeds.

- As part of long-term planning efforts, consider the feasibility and safety benefits of altering the alignment of the Route 28 northbound and southbound approaches, so that they align with the center point of the central island within the Otis Rotary.
- Continue to enforce speeding violations within the rotary and on the approaches to the rotary.
- As part of long-term planning efforts, consider replacing the rotary with a grade-separated intersection, such as a diamond interchange. A team member stated during the RSA that a diamond alignment fits well within the footprint of the rotary.
- Consider the safety benefits of providing advance guide signage along the approaches to the rotary. Consider providing diagrammatic guide signs (D1-5 or D1-5A) for each individual approach so that motorists know which exit they need to take before entering the rotary.
- Remove guide signage that is too small for circulating traffic to read. Replace with MUTCD-compliant signage if the signage is deemed necessary. Ensure that all guide signage visible from the rotary or the approaches to the rotary is useful and necessary.
- As part of mid-term planning efforts, consider the safety benefits of providing overhead signage within the rotary to improve visibility for motorists.
- Consider providing curve warning signage and/or chevron signs at the Connery Avenue exit from the rotary.
- Consider the safety benefits of providing lane pavement markings and arrow pavement markings within the rotary, including dashed pavement markings to assist entering and exiting vehicles, as part of the upcoming Route 28 corridor resurfacing project.
- Consider the feasibility and safety benefits of replacing any damaged or previously removed lighting within the Otis Rotary.
- As part of mid-long-term reconstruction efforts, provide adequate drainage within the Otis Rotary, particularly between Route 28 northbound and Connery Avenue.

Route 28 at Waterhouse Road

Enhancements:

- Clear any vegetation in the median that may obstruct sight lines to the north of the turnaround near Waterhouse Road.
- Consider formalizing a deceleration lane along the Route 28 southbound approach to Waterhouse Road, if feasible.
- As part of long-term construction efforts, consider the feasibility of altering the alignment of Waterhouse Road in order to create a T-intersection with Route 28 southbound. This would improve sight lines to the north of the intersection and prevent vehicles from entering Route 28 from Waterhouse Road without stopping. It would also increase the distance between the Waterhouse Road eastbound approach and the Bayview Campground driveway. An acceleration lane should be provided for Waterhouse Road traffic to safely merge onto Route 28 southbound, and intersection warning signs should be provided along the Route 28 southbound approach to Waterhouse Road.
- Replace guide signage for Trading Post Corner with advance guide signage for Waterhouse Road along Route 28 northbound and southbound.
- Replace the conflicting sign for the Bayview Campground along the Waterhouse Road eastbound approach with MUTCD-compliant brown Recreational and Cultural Interest Area guide signage, if the signage is deemed necessary. Consider moving the "No Turns" sign (R3-3) northward to avoid confusion.

Corridor-Wide Issues

Enhancements:

- Trim any vegetation within the Route 28 median that may obstruct the sight lines of vehicles using turnarounds.
- Consider locations where adding acceleration lanes and/or extending deceleration lanes may be feasible. Consider reallocating space from breakdown lanes, if possible.
- As part of long-term planning efforts, evaluate the placement of all turnaround locations. Consider the distance between turnarounds and merging distance between turnarounds and points of interest such as intersections or commercial driveways. Ensure that all turnarounds are constructed to allow for heavy vehicle movements, particularly in the vicinity of the Bourne Town Landfill. All turnarounds should have adequate acceleration and deceleration lanes so that traffic can safely slow or merge with Route 28 traffic.
- Continue to enforce speed violations along Route 28, especially in inclement weather, where possible.
- Consider providing additional speed limit signage (R2-1) after major intersections and commercial driveways, and where excessive speeds are common. Consider the use of oversized speed limit signage in areas where the speed limit decreases significantly, or where speeding is common, such as at the bottom of crest vertical curves.
- Consider the appropriateness of using visual speed bars in deceleration lanes, including deceleration lanes for local businesses, to alert motorists of a change in roadway characteristics within the deceleration lane.
- Consider use of oversized "One Way" (R6-1) signs at intersections and driveways along Route 28 and "All Traffic Turn Left" (W19-5 mod) at turnarounds within Route 28, replacing or complementing the existing signage, to reduce the occurrence of wrong-way travel along Route 28. Also consider installing Wrong Way (R5-1a) signs, as appropriate, along Route 28.
- Consider the use of flexible delineators on the flush concrete median in the vicinity of Clay Pond Road to prevent wrong-way turns.
- As part of long-term reconstruction efforts, consider replacing the flush concrete median with a raised median to prevent wrong-way travel along Route 28.
- As part of long-term reconstruction efforts, repair or replace damaged drainage structures and ensure that all areas drain properly.
- As part of long-term reconstruction efforts, consider providing pedestrian and bicycle accommodations, such as the planned shared-use path parallel to Route 28. Consider
- pedestrian/bicycle crossing infrastructure in conjunction with the proposed Route 28 parallel shared-use path.
- Consider enlarging signs and sign legend/text, providing better lighting, and maintaining pavement markings to accommodate the rising population of older drivers on Cape Cod.

Sandwich Road at Cranberry Highway

Completed in 2012, the audit includes six safety issues and identified enhancements for each:

Safety Issue #1. Signage

Enhancements:

- The directional information should be enhanced through additional or revised signs. Adding the information on the signs "to Route 6 west" and/or "to the Sagamore Bridge" will clarify that Cranberry Highway is the roadway connecting to Route 6 westbound. Many drivers traveling on Sandwich Road may be looking to connect with Route 6.
- Since the Bourne Bridge is closer to 195 / 495 and connections to Providence, RI Intersection warning signs should be added to Sandwich Road for improved awareness of the Cranberry Highway intersection. It was suggested that the W2-3L sign, showing the angled intersection, should replace the existing W1-0L sign that includes the arrow turning left.
- In addition, it would assist certain motorists to include directional signs to Factory Outlet Road, where redevelopment of that area has added additional shopping attractions.
- All signs should be upgraded for retro-reflectivity as the MassDOT District Office maintenance schedule allows.
- It was suggested that having street signs with the roadway names may assist in alleviating confusion with the change in Route 6A and the corresponding roadway names.
- An effort should be made to contact online map companies to update name and Route numbers. As more people use Global Positioning Systems (GPS), there should be a check to ensure that the street signs and the GPS have the same directional information.

Safety Issue #2. Sight Distance and Vegetation

Enhancements:

- Trim or cut back the vegetation for improved visibility on the corner island of the gas station property.
- Trim the tree branches back on Sandwich Road and/or relocate the sign for improved prominence.

Safety Issue #3. Speed

Enhancements:

- Continue periodic police enforcement of traveling speeds along Sandwich Road and in the vicinity of the intersection to encourage compliance for improved safety.
- Consider additional measures in the long term, such as a roundabout to reduce speeding and enhance multi-modal safety.

Safety Issue #4. Geometry

Enhancement:

- Consider improving the geometric configuration of the intersection through adjustment of the Cranberry Highway approach and island, or through conversion to a roundabout. Consider shoulder widening on Sandwich Road in the vicinity of the intersection.

Safety Issue #5. Pavement Level and Markings

Enhancements:

- Consider raising the level of the Cranberry Highway approach as part of roadway improvements or maintenance efforts.

Safety Issue #6. Bicycle/Pedestrian Accommodations

Enhancement:

- Provide improved accommodation for pedestrians and bicyclists through roadway improvements or maintenance efforts.

DENNIS ROADWAY SAFETY AUDIT

The audit listed below has been summarized in a previous Regional Transportation Plan and are listed for convenience. Copies of Road Safety Audits are available from the Cape Cod Commission website at:

www.capecodcommission.org/safety

- Route 134 at the Route 6 Ramps (2009)

EASTHAM ROADWAY SAFETY AUDIT

Route 6 and Governor Prence Road

Completed in 2012, the audit includes six safety issues and identified enhancements for each:

Safety Issue #1. Speed

Enhancements:

- Continue police enforcement of traveling speeds along Route 6 and in the vicinity of the intersection to ensure compliance for improved safety.
- Consider additional measures, such as a roundabout at Governor Prence Road, or other traffic calming measures in certain areas to reduce speeding and enhance multi-modal safety. A partial median with a crossing for bicyclists and pedestrians in the vicinity of the information booth just north of the Gov. Prence Rd. intersection would calm traffic or that section.

Safety Issue #2. Conflicting Volumes

Enhancement:

- A partial median treatment or a roundabout concept may assist in calming traffic in the vicinity of the intersection. A roundabout, as a possible long-term improvement, would reduce intersection conflicts by removing left turns from the intersection; and slow traffic. This slowing of traffic would also benefit the information booth area.

Safety Issue #3. Bicycle and Pedestrian Accommodation

Enhancements:

- Consider a pedestrian beacon north of the intersection at the information booth.
- Discussion included the need for a sight distance measurement, and the possibility of a median in the vicinity to slow traffic at the Route 6 crossing.
- Consider improved bicycle/pedestrian accommodation when reconstruction for Route 6, or the intersection, is being considered.

Safety Issue #4. Signage

Enhancements:

- Reposition the STOP sign to face he vehicles approaching on Governor Prence Road, and install on both sides of the intersection.
- Trim brush for improved sight distance of the STOP signs. Trim on the eastbound Governor Prence Road approach for improved visibility of the flashing light.
- Relocate or add another "Fort Hill Area" sign for improved visibility of motorists looking for that destination.
- Street signs should be upgraded, with consideration of adding one of the Governor Prence Road street signs to the post for the flashing light.

Safety Issue #5. Pavement Level and Markings

Enhancements:

- Consider leveling the approach as part of roadway improvements or maintenance efforts.
- The right turn arrows directing traffic to exit should be repainted, and perhaps an earlier one added. In addition, a sign could be added prior to the turn, such as, an all traffic turn right sign.
- It may be possible to narrow he one-way section to further visually deter southbound vehicles.
- The mature trees provide much shade but make it difficult to perceive where to drive when acing "Do Not Enter" signs. Providing a sign, such as the "All Traffic ➡" sign, will assist in directing drivers to the appropriate path back to Route 6.

Safety Issue #6. Sight Distance

Enhancements:

- It was noted that further improvements may be required to improve sight distance from Governor Prence Road in the long term, but in the short term keeping the area mowed to reduce obstruction by the vegetative growth is desirable.
- The flashing light should be adjusted for improved alignment, and the vegetation trimmed on both approaches of Governor Prence Road.

MASHPEE ROADWAY SAFETY AUDITS

Mashpee has had three audits completed since 2007:

Nathan Ellis Highway (Route 151) at Old Barnstable Road Intersection

Completed in 2014, the audit includes five safety issues and identified enhancements for each:

Safety Issue #1. Speed & Driver Behavior

Enhancements:

- Remove the Route 151 eastbound "Speed Limit 50" sign from the western approach to the intersection. Consider additional advanced intersection warning signage
- Include "Don't Block the Box" signage on approaches to the intersection.
- Conduct traffic safety workshop to remind school bus drivers of the importance of obeying all traffic laws – especially stopping in advance of red signals.
- Consider intersection realignment to bring minor street approaches closer to 90-degree angles; also investigate feasibility of construction of a modern roundabout to lower travel speeds and improve safer merging.

Safety Issue #2. Bicycle & Pedestrian Accommodations

Enhancements:

- Realign the crosswalk on the northern leg to be parallel with Route 151; modify curbing on island to accommodate wheelchair users and meet ADA requirements.
- Replace pedestrian signal push buttons with APS vibro-tactile buttons (to accommodate senior residents.
- Schedule regular street sweeping to remove sand and debris from wheelchair ramps.
- Re-apply crosswalk markings.
- Consider construction of a crosswalk on Old Barnstable Road's southern leg to accommodate pedestrians traveling between the trailer park and the high school.
- During corridor-wide improvements, construct pedestrian and bicycle accommodations to the west of the intersection.

Safety Issue #3. Intersection Control & Auxiliary Lanes

Enhancements:

- Remove the "One Way" sign and replace the "Do Not Enter" sign currently located on the island on the western side of the southern leg of the intersection.
- Remove the left-turn prohibition sign from the east side of the southern leg of Old Barnstable Road
- Consider signalization modification to increase yellow times and include an advance green phase for southbound Old Barnstable Road.
- Consider lengthening storage areas of left-turn lanes on Route 151.
- Consider re-visiting lane allocation and revised signal timing and phasing.
- Consider intersection realignment; also investigate the feasibility of constructing a modern roundabout to improve safety and traffic flow.

Safety Issue #4. Lighting, Weather & Obstructions

Enhancements:

- Perform pavement rehabilitation during next intersection upgrade.
- Consider installation of larger signal heads and backplates on Route 151 approaches.
- Install street lighting on northern approach of Old Barnstable Road

Safety Issue #5. Animals

Enhancement:

- Explore techniques to reduce vehicular travel speeds to enhance safety for animals and other non-motorized travelers.

Previous Mashpee Road Safety Audits

Audits listed below have been summarized in previous Regional Transportation Plans and are listed for convenience. Copies of Road Safety Audits are available from the Cape Cod Commission website at:

www.capecodcommission.org/safety

- Great Neck Road North/Old Barnstable Road (2009)
- Route 130 Lane Departure Road Safety Audit (2007)

SANDWICH ROAD SAFETY AUDITS

Since 2009, two safety audits were completed in Sandwich. The audits listed below have been summarized in a previous Regional Transportation Plan and are listed for convenience. Copies of Road Safety Audits are available from the Cape Cod Commission website at:

www.capecodcommission.org/safety

- Cotuit Road/Harlow Road/South Sandwich Road (2009)
- Route 6: Major Highway Median Cross-Over Crashes (2009)

YARMOUTH ROAD SAFETY AUDITS

There have been two audits completed since 2010 in Yarmouth.

Route 6A – Willow Street to Union Street

- Completed in 2013, the audit includes a number of potential safety enhancements:
- Replace old non-compliant signs.
- Review locations of existing signs, especially advance warning signs.
- Investigate adding additional signage to alert motorists to crosswalks throughout the RSA corridor.
- Repaint existing crosswalks and consider upgrading crosswalk to "piano key" design.
- Trim trees to increase visibility of crosswalks.
- Review appropriateness of sidewalk locations and relocate as needed (would require full ADA compliance for new crosswalks).
- Install a double yellow centerline through the village to eliminate the existing passing zone.
- Additional edge line marking to delineate the Summer Street curve (dashed or full) to provide additional visual guidance to drivers. Install stop line on Summer Street.
- Install chevron and advisory speed limit signage on both approaches to the Summer Street curve.
- Relocate flashing sign approaching the Summer Street curve paying careful attention to ensure it is properly placed not to be too far in advance of the curve but to give sufficient warning of the curve. Replace damaged bulbs.
- Work with business owner at the Village Store to redesign site access using good access management principles.
- Investigate the feasibility of replacing existing lighting with LED.
- Evaluate the existing street lighting and the potential for additional street lighting, particularly for improved pedestrian safety.
- Conduct a further study of sight distance at Willow Street.
- Conduct formal study of intersections with Willow Street, Summer Street, and Union Street to determine if increased control (all way stop, signal, or roundabout) is warranted.
- Investigate installing textured pavement crosswalks or raised crosswalks in select locations understanding that they would require special approval and careful considerations of all safety impacts.
- Relocate utility poles behind sidewalks and add curbs where needed.
- Investigate modifying Old Church Street by closing it or making it one-way north with Playground Lane serving as the new connector.
- Consider developing on-street parking at select locations.
- Investigate town acquisition of rights to Route 6A from the state to allow for design flexibility.
- Consider geometric changes to the roadway such as bump outs to slow drivers down.

- Install digital speed limit signs to address speeding. Consider adding – "State Law" and – "$100 Fine" to the signs.
- Implement targeted police enforcement to address speeding and crosswalk compliance issues.
- Installation of small reflectors along the roadway (like the ones on the telephone poles) for additional roadway delineation.
- Install gateway treatments to visually identify the heart of the village for drivers and consider additional streetscape improvements to create a village feel to cue in drivers that they are entering a more populated and pedestrian oriented area.

Previous Yarmouth Road Safety Audit

The audit listed below has been summarized in a previous Regional Transportation Plan and is listed for convenience. Copies of Road Safety Audits are available from the Cape Cod Commission website at:

www.capecodcommission.org/safety

- Old Townhouse Road/Forest Road (2010)

MULTIMODAL TRANSPORTATION SAFETY

Safety information is readily available for several modes of travel. The following sections provide safety issue details on several transportation modes. Bicyclist and Pedestrian safety are discussed in the RTP Technical Appendix "Bicycle/Pedestrian Safety Plan."

PUBLIC TRANSIT SAFETY

Public transit vehicles are generally considered to operate at a higher level of safety in comparison to private automobiles. Drivers are required to have higher qualifications and are subject to strict safety guidelines. The Cape Cod Regional Transit Authority has provided safety data for the years 2012-2014 as shown in the following table:

TABLE 11 - INJURIES FROM COLLISIONS/SLIPS AND FALLS IN TRANSIT VEHICLES AND ON TRANSIT PROPERTY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2012						1						
2013							2					
2014						1	1					

(Source: Cape Cod Regional Transit Authority)

For the years 2012-2014, the values of property damage to CCRTA vehicles and private vehicles were $24,798.28 in July 2012 and $21,199.00 in June 2014 for a total of $45,997.24.

AIR TRAVEL SAFETY

The National Transportation Safety Board has assembled a database of safety incidents at Cape Cod airports (Hyannis and Provincetown). During the years 2008-2011, four incidents were listed for these airports. These data are summarized in the following table:

TABLE 12 – HYANNIS AIR TRAVEL SAFETY INCIDENTS

YEAR	FATAL	NON-FATAL	INCIDENT
2008	1	0	0
2009	0	0	0
2010	0	0	1
2011	0	0	0

(Source: National Transportation Safety Board)

TABLE 14 – PROVINCETOWN AIR TRAVEL SAFETY INCIDENTS

YEAR	FATAL	NON-FATAL	INCIDENT
2008	0	1	0
2009	0	0	0
2010	0	0	0
2011	1	0	0

(Source: National Transportation Safety Board)

SUMMARY OF GENERAL TRANSPORTATION SAFETY RECOMMENDATIONS

- Work with state and local agencies to improve the accuracy and timeliness (e.g., within 12 months of the end of each year) of crash data
- Consider protected left turn phases into signalized intersections
- Maintain delineation through more frequent restriping and street cleaning
- Improve signage standards to include larger lettering
- Improve lighting level standards, in particular at intersections. Consider placing utilities underground and installing breakaway safety poles for lighting
- Consider extension of "all red" phases for signalized intersections
- Establish driver education programs for older drivers
- Provide education on other options for mobility
- Increase education for local young drivers
- Support additional enforcement and warnings during busy traffic season to reach out to young visitor drivers
- Develop and implement an advertising campaign and roadside signage reminding drivers that traffic and drunk driving laws are strictly enforced on Cape Cod.
- Provide better signage for visitors directing them to popular destinations

- Install signage explaining the rotary "rules of the road" and disseminate similar information to be included in visitor brochures and Cape-related websites
- Consider conversion of conventional intersections (signalized or unsignalized) which have high crash rates to roundabouts
- Promote the use of red-light cameras at high crash rate signalized intersections
- Support road designs which are estimated to reduce crashes and improve safety for all users

INTELLIGENT TRANSPORTATION SYSTEMS

Intelligent Transportation Systems (ITS) are applications of advanced technology in the field of transportation, with the goals of increasing operation efficiency and capacity, improving safety, reducing environmental costs, and enhancing personal mobility. A policy of Cape Cod MPO is to advocate and endorse the consideration of Intelligent Transportation Systems solutions for transportation problems as a routine part of the transportation planning process. As a stakeholder in the Southeastern Massachusetts Regional ITS Architecture, the Cape Cod MPO is committed to continuing an active role in these ITS systems. This includes maintaining channels of communication between the Cape Cod Commission and other stakeholders, including but not limited to: the MassDOT; the Southeastern Regional Planning and Economic Development District (SRPEDD); the Old Colony Planning Council (OCPC), and the Cape Cod Regional Transit Authority (CCRTA). A regional ITS architecture is a framework that defines component systems and their interconnections. Successful ITS deployment requires an approach to planning, implementation, and operations that emphasizes collaboration between relevant entities and compatibility of individual systems. The regional architecture is a mechanism design to ensure this collaboration and compatibility occurs. Inputs into ITS systems can involve any variety of a range of collection devices, including:

- Loop detectors in the pavement and sophisticated ground level radar systems are able to collect real time traffic volume and speed data.
- Video equipment is often used to monitor the transportation system, which is useful in allowing system operators to immediately detect areas of congestion that may be forming. It is also used to detect incidents such as crashes and disabled vehicles, in turn accelerating emergency dispatch and the overall incident management process. Video surveillance is also a useful tool for security and incident management in transit vehicles and around stops and terminals.
- Automatic vehicle locators (AVL) on board transit vehicles, emergency response vehicles, and roadside assistance vehicles allow operators to know where vehicles are in real time that allows for more efficient dispatch and adjustment of traffic controls if necessary.
- Automated Fare Payment Systems that allow riders on transit systems to pay electronically using a "smart card" (prepaid balance) or in the future conventional credit/debit cards rather than cash.
- Transmitters onboard transit and emergency vehicles alike are used to pre-empt traffic signals ahead or to alert travelers at a transit stop that the vehicle is approaching.
- Remote weather stations and Doppler radar provide real time weather conditions occurring throughout the transportation network, and provide alerts regarding events such as icing or flooding that may be occurring. These are some of the technological

applications that can be utilized for managing the regional transportation network. All of this information travels over both hard-wired and wireless communication systems to systems that manipulate the data and distribute it to users of the transportation system. End users of ITS system and the output media include:

- Transit Operation Centers that monitor the transit system through video feed, radio communications, and AVL signals, allowing operators to make improved decisions regarding security, dispatch, and incident management.
- Traffic Operation Centers that monitor the roadway system through reports from systems like loop detection and video feed, allowing operators to make improved decisions regarding congestion management, incident management, security, and maintenance management.
- Traveler Information Services such as the national 511 System or SmarTraveler locally, which receive traffic data from traffic and transit operations centers and distribute it to users via hard line and wireless communications.
- Variable Message Signage that allows operators from traffic and transit operation centers to instantly relay messages to users on the system.
- Kiosks that receive information from transit operation centers and transit vehicles, relaying it to users of the transit system.

MassDOT owns and operates several permanent variable message signs and a large fleet of portable variable message signs throughout the Commonwealth. Permanent stations are used to alert drivers to major events affecting locations such as the Route 128 belt and Interstate 93, as well as the tunnels. Portable variable message sign trailers are located throughout the state and are able to be dispatched to locations wherever and whenever needed. Often they are used for a major local event, such as a road race or sidewalk carnival. They can also be dispatched for major unplanned events, such as a chemical spill that forces an extended closure of a highway. All variable message signs are controlled from the MassDOT Traffic Operations Center in South Boston. MassDOT is using automated vehicle locators on their snow removal and highway maintenance fleet, increasing the efficiency of dispatch of resources to where they are needed. Travelers are able to obtain real time traffic conditions for highways in the Commonwealth, including highway approaches to the Cape such as Routes 3 and 495 as well as the Cape Cod Canal bridges, through SmartRoutes phone and web links, and will soon be available through a statewide 511 system and MassDOT website.

CAPE COD COMMISSION'S LOCATION-SPECIFIC SAFETY STUDIES

The Cape Cod Commission has completed several safety-related studies. The following is a summary of the locations that were studied and highlights of recommended safety improvements. Full reports are available on the internet:

www.capecodcommission.org/safety

WELLFLEET: ROUTE 6 SAFETY STUDY

This study published in 2012 included potential safety countermeasures at four high-crash locations:

Route 6 at Main Street

- Apply vegetative management and access management practices. Reduce visual clutter approaching the intersection. Complete signal head LED retrofit of the intersection
- Consider moving Rt. 6 NB left turn lane stop bar back to improve sightlines for Rt. 6 SB left turning vehicles
- Consider Rt. 6 SB left turn restrictions or a left turn arrow
- Evaluate bicycle and pedestrian accommodations relative to such demands
- Consider complete reconstruction of the intersection to accommodate safe turning movements and bicycle and pedestrian needs

Route 6 at LeCount Hollow Road

- Discuss removal of the utility poles on the splitter island with the utility company.
- Consider a breakaway Stop Sign on the splitter island to increase visibility to motorists.
- Evaluate alternative parking and delivery options for the PB Bistro.
- Consider the installation of a traffic signal or roundabout understanding that the signal warrants are met based on the June 21, 2012 traffic volumes, but such a treatment is not necessitated in the offseason.
- Consider possible relocation of the old Route 6 layout/LeCount Hollow Road intersection to add separation from the Route 6/LeCount Hollow Road intersection.
- Evaluate bicycle and pedestrian accommodations relative to such demands

Route 6 at Cove Road

- Review School Bus stopping location and procedure and consider a "Bus Stop Ahead" sign or other treatments to alert they may need to stop
- Access management to reduce the number of conflict points and avoid driver confusion including the following features shown of the graphic on the next page:
- Install a new stop sign at the end of Cove Road
- Close northern Cove's Corner / Rt. 6 driveway
- Mark turn pocket for Cove Road left turns instead of long turn lane
- Restrict left turns from southern Cove's Corner / Rt. 6 driveway
- Align Cove's Corner / Cove Road driveway with the parking lot flow lines
- Mark turn pocket for Cove's Corner left turns instead of long turn lane (optional)
- If issues persist, consider closing both Cove's Corner driveways onto Rt. 6 and installing a signal or roundabout at the Cove Road and Rt. 6 intersection
- Evaluate bicycle and pedestrian accommodations relative to such demands

Route 6 Merge Area near Eastham Town Line

- Add/ update signage indicating lane drop
- Add pavement markings to indicate lane drop

- Continue dialogue with the Town of Eastham regarding the possibility of moving the Route 6 northbound merge back into Eastham and dedicating the left lane to vehicles turning left in Wellfleet Drive-In Theatre with additional guidance signage.

ANALYSIS OF HIGH-CRASH LOCATIONS IN DENNISPORT

This study published in 2012 included potential safety countermeasures at three high-crash locations:

Upper County Road at Depot Street

- Maintenance of sight lines, particularly vegetation management, can be a low-cost and effective safety countermeasure. As the parcels adjacent to the intersection are privately owned, it is important to engage the land owners and emphasize the importance of maintaining sightlines to the safety of the intersection.
- Installation of secondary stop sign on the left side of the road on the easterly approach similar to the installations currently on north and south approaches.
- Upkeep of advanced warning signs and markings is important to ensure their continued effectiveness. Easily visible warning signs and markings are important in altering motorists that they are approaching an intersection and should be prepared to act accordingly whether that means stopping or simply being aware of side street.
- Backplates with reflective borders on the warning beacon would make the warning beacon more visible and conspicuous in both daytime and nighttime conditions.
- Consider bicycle and pedestrian upgrades at the intersection consistent with the needs of the area.

If the safety issues persist, more expensive, long term solutions such as signalization or installation of a roundabout should be considered. At this time these measures are not warranted, but should be kept as options for the future.

Main Street (Route 28) at Sea Street

- Removal of site distance obstructions, particularly vegetation, can be a low-cost and effective safety countermeasure. As the parcels adjacent to the intersection are privately owned, it is important to engage the land owners and emphasize the importance of maintaining sightlines to the safety of the intersection.
- Advanced warning signs and markings are important tools in alerting motorists that they are approaching an intersection and should be prepared to act accordingly whether that means stopping or simply being aware of side streets. A more thorough analysis of the intersection crash reports will help reveal which approaches could benefit from these improvements.
- Traffic calming measures on Main Street (Route 28) would provide cues to drivers as to the appropriate speed to travel as they enter the village center. Drivers should understand that they are entering a village area where they must anticipate more frequent interactions with turning and parking vehicles as well as pedestrians and bicyclists. As drivers select more appropriate, slower speeds, the frequency and severity of accidents at the intersection could be reduced. To allow these slower speeds to be enforceable, the speed limit on this section of Main Street (Route 28) should be reduced.
- Improved access management in the vicinity of the intersection would reduce the number of conflict points and driver confusion around the intersection. There are a

number of expansive curb cuts within the functional area of the intersection that are negatively impacting the operation of the intersection. In close cooperation with the abutting land owners, an effort should be taken to reduce and/or eliminate curb cuts especially those nearest to the intersection. As much as possible, curb cuts should be limited to the minor street.

- Consider bicycle and pedestrian upgrades at the intersection consistent with the needs of the area.

Given that this intersection has proven to be a persistent safety hazard over the years, it would be prudent to further study this intersection to determine if long-term solutions such as a four-way stop, signalization, or installation of a roundabout should be considered. As a first step, a more intensive data collection should be performed including the following:

- Turning movement counts - weekday morning peak hour, afternoon peak hour, Saturday peak hour,
- Volume, speed , and classification data on Main Street (Route 28) and Sea Street,
- Measurements of sight lines, and
- Measurements of curb cuts in the vicinity of the intersection.

Main Street (Route 28) at Depot Street

- Removal of site distance obstructions, particularly vegetation, can be a low-cost and effective safety countermeasure. As the parcels adjacent to the intersection are privately owned, it is important to engage the land owners and emphasize the importance of maintaining sightlines to the safety of the intersection.
- Advanced warning signs and markings are important tools in alerting motorists that they are approaching an intersection and should be prepared to act accordingly whether that means stopping or simply being aware of side streets. A more thorough analysis of the intersection crash reports will help reveal which approaches could benefit from these improvements.
- Traffic calming measures on Main Street (Route 28) would provide cues to drivers as to the appropriate speed to travel as they enter the village center. Drivers should understand that they are entering a village area where they must anticipate more frequent interactions with turning and parking vehicles as well as pedestrians and bicyclists. As drivers select more appropriate, slower speeds, the frequency and severity of accidents at the intersection could be reduced. To allow these slower speeds to be enforceable, the speed limit on this section of Main Street (Route 28) should be reduced.
- Improved access management in the vicinity of the intersection would reduce the number of conflict points and driver confusion around the intersection. There are a number of expansive curb cuts within the functional area of the intersection that are negatively impacting the operation of the intersection. In close cooperation with the abutting land owners, an effort should be taken to reduce and/or eliminate curb cuts especially nearest to the intersection. As much as possible curb cuts should be limited to the minor street.
- Consider bicycle and pedestrian upgrades at the intersection consistent with the needs of the area.

Given that this intersection has proven to be a persistent safety hazard over the years, it would be prudent to further study this intersection to determine if long-term solutions such as a four-

way stop, signalization, or installation of a roundabout should be considered. As a first step, a more intensive data collection should be performed including the following:

- Turning movement counts - weekday morning peak hour, afternoon peak hour, Saturday peak hour,
- Volume, speed , and classification data on Main Street (Route 28) and Depot Street,
- Measurements of sight lines, and
- Measurements of curb cuts in the vicinity of the intersection.

PREVIOUS CAPE COD COMMISSION LOCATION-SPECIFIC SAFETY STUDIES

The following studies have been summarized in a previous Regional Transportation Plan and are listed for convenience. Copies of these reports are available on the Cape Cod Commission website at:

www.capecodcommission.org/safety

- Transportation Safety Report – Eastham: Route 6 at Brackett Road; Sandwich: Route 6 at Route 130 (Exit 2)(Westbound and Eastbound Ramps) (2008)
- Transportation Safety Report – Bourne: Route 28 at Otis Rotary; Harwich: Route 137 at Route 39; Orleans: Route 6A at Route 28 (2006)
- Route 28 Safety & Traffic Flow Study: Chatham, Harwich, Dennis, Yarmouth (2006)
- Route 6 Safety & Traffic Flow Study: Eastham, Wellfleet, Truro, Provincetown (2004)

CONCLUSION

Safety is the highest priority goal of the Regional Transportation Plan. The Cape's transportation system should ensure that travelers and their possessions will arrive at their destinations unharmed and undamaged. Travelers should be educated regarding transportation regulations and traffic laws, and these must also be enforced to prevent the improper use of the transportation system. The importance of safety requires a spectrum of strategies including education, enforcement, and engineering.

CAPE COD COMMISSION

3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

CAPE COD
COMMISSION

2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix D: Security

Draft
June 15, 2015

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Figure 1. Cape Cod Emergency Traffic Plan 1

Technical Appendix D: Security

The transportation system must prepare for natural disasters, such as hurricanes or flooding events. Moreover, post-September 11th, protecting users from man-made hazards is also a priority, as indicated by the increased emphasis on security in federal and state transportation regulations and guidelines. A variety of local, county, state, and federal agencies play key roles in ensuring the security of the Cape Cod transportation system.

EMERGENCY TRAFFIC PLANNING

The most frequently identified security concern is the threat of a weather-related event such as a hurricane. In many cases, Cape Cod residents and visitors "shelter in place," a term that refers to staying in homes or local shelters that are supplied with food, water, etc.

Residents should heed warnings of public safety officials and evacuate accordingly. A danger occurs out of panic when vast numbers of people get into their automobiles with the idea that they should "evacuate," clogging up the roadway network. These traffic jams pose a threat to those who truly need to access the network (persons with health problems, injuries, etc.). In the event of a mass exodus from Cape Cod (due to major weather-related, radiation event, etc.), planning is underway by the Barnstable County Emergency Planning Committee (BCREPC), in coordination with the Massachusetts Emergency Management Agency and implementation organizations such as the Massachusetts State Police and MassDOT. Planning for large-scale traffic flows leaving Cape Cod requires coordination with neighboring regions. For example, routing Cape Cod traffic to I-195 West during an impending hurricane may bring motorists closer to the hurricane's landfall. Landfall predictions always include some uncertainty, such as the exact time and path of impact. When the path of a storm is projected in a wide, imprecise area it can make the evacuation route itself a potentially hazardous area.

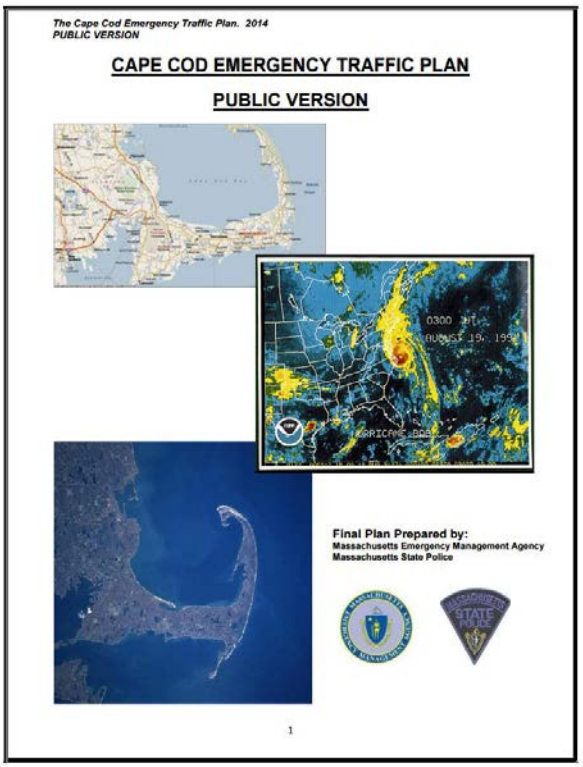

FIGURE 1. CAPE COD EMERGENCY TRAFFIC PLAN

The "Cape Cod Emergency Traffic Plan" (ETP) has been developed by the Massachusetts State Police in cooperation with the Massachusetts Emergency Management Agency (MEMA) and several other

agencies to facilitate the egress of a high volume of traffic from Cape Cod in the event of a hurricane, particularly during peak tourist season.[1] The design of the ETP is based upon the need to eliminate the causes of congestion in the area of the Bourne and Sagamore Bridges and the main arteries leading up to them, Routes 6 and 28. The following is a general outline of the plan's implementation:

- As traffic levels build before the hurricane arrives, direct access to and from off-Cape locations will be restricted at the bridges in order to allow vehicles to continue north from the bridges unimpeded.
- At higher traffic levels, and as bridge flows warrant (e.g., lower demand at Bourne Bridge than at Sagamore Bridge), traffic on Route 6 destined for Routes 25 & 495 would be diverted through the Massachusetts Military Reservation (MMR).
- When sustained winds reach 80 mph, the bridges will be closed and the motorists will have the option of going to designated emergency parking areas in the MMR and to be shuttled to shelter in the MMR.

The ready availability of advance information to the public is a vital component necessary to maximize the efficiency of the ETP. Traffic will flow only as fast as the slowest vehicles are traveling. The following measures are planned in order to provide a high level of public knowledge regarding the various aspects and the changes in traffic patterns that will be encountered during the ETP:

- Signage: MassDOT will erect ETP signs giving advance notice of all detours and changes in traffic flow. The signs will include a radio frequency for ETP information.
- FM Radio Broadcast: Changes in traffic patterns will be announced on WQRC (99.9 MHz). WQRC will continually play a variety of pre-recorded instructions geared to address the various phases of the ETP.
- Internet: Detour instructions and maps will be available on the Internet from the state police web site: www.state.ma.us/msp

It is extremely important that the public is informed of the need to evacuate only under a set of specific scenarios. For example, Hurricane events may only threaten certain coastal areas. For those residents in the affected areas, public safety officials would likely direct evacuees to local or regional shelters. By 'sheltering in place' or relocating to the nearest emergency shelter, impacts on the roadway network are minimized, freeing up capacity for emergency responders.

PUBLIC TRANSPORTATION SECURITY

Security of public transportation systems has been regarded with greater importance in recent years. The Federal Transit Administration (FTA) provides guidance and a wide variety of strategies to maintain and improve security. It is also important to note that public transit may serve an important role in evacuation (e.g., moving residents from nursing homes etc. to shelters). Also, verification and certification of public transit employees in security procedures is important to assure response capability.

[1] http://www.mass.gov/eopss/docs/mema/cape-cod-emergency-traffic-plan.pdf

AIR TRAVEL SECURITY

Security for travel by air is a primary function of the Transportation Security Administration (TSA). The TSA has been required to make a number of improvements to aviation security. The improvements included that by November 19, 2002, screening of individuals and property in the United States would be conducted by TSA employees and companies under contract with TSA. Federal law also requires enhanced qualifications training and testing of individuals who perform screening functions. It requires that Federal law enforcement officers be present at screening locations. More information is available at: http://www.tsa.gov

INTELLIGENT TRANSPORTATION SYSTEMS

Intelligent Transportation Systems (ITS) technologies are applied to vehicles and roadways that perform communications, data processing, traffic control, surveillance, navigation, sensing, and various other functions that aid in the management of the security process. ITS elements, such as traffic cameras, signal preemption devices and Variable Message Boards (VMB), would provide timely responses for emergency vehicles and the ability to monitor evacuations during times of natural, or other disasters.

The Massachusetts Department of Transportation's Traffic Operations Center (TOC) is located in South Boston. The TOC's primary mission is traffic incident management throughout the Commonwealth of Massachusetts. The MTOC is the headquarters for the application of Intelligent Transportation Systems (ITS) around the state. From the MTOC, reports on traffic incidents are relayed to the involved MassDOT district office, which assigns the necessary personnel and equipment, required to abate the incident.

The TOC integrates information from the Cape Cod Canal Area Intelligent Transportation System. The Cape's system will include about 10 adjustable (point-tilt-zoom) high definition cameras and supplemental speed detectors and fixed-view webcams. This system will yield travel time and incident data to travelers and emergency responders.

Security is a high priority goal of the Regional Transportation Plan. The transportation system must be prepared for natural disasters, such as hurricanes. This plan also adds emphasis on security from federal and state transportation regulations and guidelines.

The most pressing security issue facing Cape Cod is the heavy volume of traffic departing during weather events, such as impending hurricanes.

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3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
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2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix E: Freight

Draft
June 15, 2015

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Technical Appendix E: Freight

Freight transportation is the movement of goods in large quantity. The movements are generally split up in to four major categories, truck, rail, and water and air freight, each with their own types of contracts. On Cape Cod, freight travel mostly reaches its end point for goods to be bought by consumers or movements are internal to the region. Few goods are exported. Cape Cod exports including solid waste, parcel post and seafood products which are explored in the study.

Local economies typically depend on freight transportation to export and import goods. The freight industry on Cape Cod is different because of the seasonal tourist industry, abundance of waterways, and historic culture. The tourist industry creates more demand on goods in the summer months; the waterways create opportunities for sea freight, but also require crossings for truck freight. The historic character and geographic placement of Cape Cod limits the ability to create large-scale freight infrastructure.

In 2014 the Cape Cod Commission performed a regional freight study. The purpose of the study was to provide recommendations to improve freight flexibility, speed-efficiency, fuel-efficiency, and safety by transport method. The study overviewed freight infrastructure, featured data from a survey presented to local freight businesses, and finally provided recommendations for the improvement of freight operations and infrastructure on Cape Cod.

TRUCK FREIGHT

Vehicle transportation is the primary method of freight distribution in the region. It is important to note that all vehicle traffic on Cape Cod experiences two different seasons, extreme congestion in the summer or peak season, and normal congestion in the remaining seasons or off season.

Maintaining properly designed intersection controls is important for the freight industry to ensure safety, and minimize delays. At signalized intersections this may mean optimizing signal timing and phases and providing turning lanes. At roundabouts this may mean the provision of truck aprons adjacent to the center island and on exit/entrance shoulders.

The maximum legal speed limit on most Cape Cod highways is 55 mph. Exceptions include Route 3 (60 mph) and Route 25 (65 mph) in Bourne. The speed limits on the road affect the movement of freight traffic by governing travel time. In order to encourage truck freight to remain on the limited-access portions of freeways such as the Mid Cape Highway, an evaluation of safety and free-flow travel speeds should be performed – possibly leading to an increase in some speed limits (perhaps limited to daytime hours).

Freight traffic is affected by congestion on Cape Cod. At certain times of the year freight carriers are not able to make trips due to travel times. Congestion is found on almost all Cape Cod roads in the summer. Year round, heaviest travel occurs on the Cape Cod Canal roads and bridges and the Mid-Cape Highway. High volumes of traffic are also found on the roads leading to and within the Hyannis area (an area that receives/sends goods to/from many businesses, institutions such as Cape Cod Hospital and multimodal facilities such as the ferry ports).

Freight traffic has the most significant effect on pavement conditions because of the stress that truck weight causes on the pavement. Freight is also affected by pavement conditions because potholes and other pavement issues can create safety hazards for truck drivers and cargo. Pavement condition data are collected with the intent to keep the roadway system in the best possible condition with the most efficient use of available funds.

FIGURE 1: MASSDOT TRUCK ROUTES

Source: Massachusetts Roadway Inventory File 2013

MASSDOT DESIGNATED TRUCK ROUTES

There are over 200 miles of designated truck routes under state authority (shown in the following figure). These routes are only located on state highways (e.g., Routes 6, 28, 6A and 28A). There are several obvious gaps in connectivity, due to changes in jurisdiction (e.g., Route 6A in Barnstable Village, Route 28 in downtown Falmouth). Other gaps in connectivity occur between the truck route network and intermodal facilities such as the ferry ports in Hyannis and Provincetown.

CANAL BRIDGES

The largest bottlenecks on Cape Cod occur at the canal bridges during the summer season. The Bourne Bridge and Sagamore Bridge permit vehicular travel over the Cape Cod Canal. Summer time delays at the canal bridges can sometimes be measured in hours. Because of the unreliable travel time associated with crossing the canal bridges many freight companies will not locate or deliver on Cape Cod.

The Bourne Bridge and Sagamore Bridge are both under the jurisdiction of the Army Corp of Engineers (ACOE). One or the other of the two highway bridges may have restrictions on lanes and heavy vehicles during several weeks of the year to accommodate painting and structural maintenance activities. While avoiding the heavy summer traffic season, these lane closures have been observed to result in traffic backups of several hours.

The Bourne and Sagamore bridges provide the only crossings of the Cape Cod Canal for motorists, pedestrians and cyclists. Maintained by the U.S. Army Corps of Engineers, the geometric design of each bridge includes a roadway width of 40 feet (four 10 foot wide lanes) flanked by a 6-foot wide sidewalk on one side and a 2-foot wide safety curb on the other. The roadways are separated from the sidewalks and safety curbs by 16-inch high vertical granite curbing.

The bridges first opened to traffic in 1935. Historic records indicate a general upward trend in the annual bridge crossings and this traffic is currently approaching 100,000 vehicles per average day. Over the decades, the bridges have been exposed to deicing salts, the effects of which include progressive deterioration of the concrete deck and some steel members of the bridges. These effects are compounded by the fact that the bridges are located near salt water. An additional maintenance activity is the periodic painting of the exposed steel portions of the bridges.

For certain maintenance activities, including repairs to the concrete deck, the worksite requires the closures of two lanes. The ACOE is committed to minimizing these conditions by avoiding daytime lane reductions during the summer months and limiting work to one bridge at a time.

The Army Corps of Engineers established a website and email notification system for major maintenance efforts on the bridges. By providing timely warnings of impending closures, travelers may adjust travel mode, choice of bridge crossing and approach routes, or timing. The bridges do need to be maintained in order to continue to provide safe passage to and from the region. Foul weather may interfere sometimes in the maintenance efforts, and as a result the schedule prolonged. Some further strategies to minimize impacts are listed below.

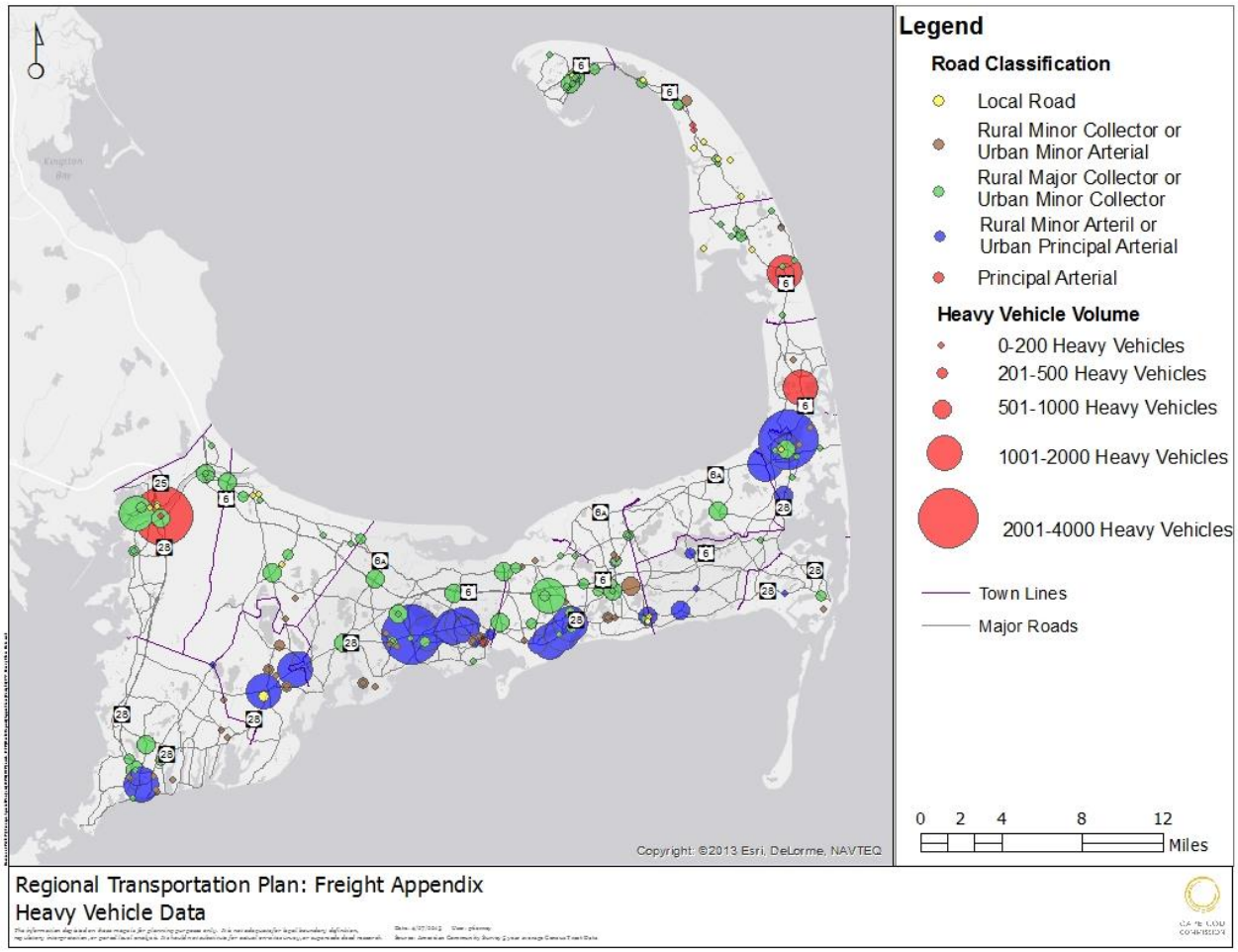
- Scheduling Maintenance Activities for Off-Peak Periods minimizes disruptions to traffic during heavy travel periods. The Army Corps is already making efforts to achieve this - and should continue to do so. To the greatest extent possible, lane closures should avoid summer months and daytime periods during the spring and fall.
- Intelligent Transportation Systems (ITS) is collection and dissemination of real-time information through means such as cameras and/or cell phone data collection. The information is available on the state traffic information website and 511 telephone system. This allows for travelers to check online or via cell phones on current traffic conditions at the bridges. Radio stations also look up and provide updates on bridge traffic. The Cape Cod Commission website provides links to transportation providers (www.capecodcommission.org) including a link to the ACOE website to provide travelers with the latest information on lane closures.
- Improve Transportation Alternatives to Offset Automobile Crossings by increasing express bus service, and improving marketing of bus and other alternatives. The marketing should inform travelers of the advantages of using alternatives and the disadvantages of driving during the lane closures. An additional strategy to enhance the attractiveness of buses and high-occupancy vehicles would be to allow travel on the shoulders (currently nonexistent on Route 6) of Routes 3, 6, 25, and 28 to bypass the queues (under police supervision). This concept would include construction of shoulders/breakdown lanes that could be used as a bus lane during peak times. This would encourage a shift from single-occupant vehicles and would likely result in an overall reduction of vehicles traveling through the lane closures.
- Traffic Management reduces traffic conflicts. During periods of traffic congestion at the Canal crossings, motorists seek alternate routes - regardless of whether or not such routes actually save travel time. In addition, such routings have effect on the capacity of the bridges, and may actually create bottlenecks in other locations such as the Exit One on-ramp at the approach of the Mid-Cape Highway westbound at the Sagamore Bridge. Techniques to be considered should include police officer traffic control, signage, and turn restrictions.

VEHICLE CLASSIFICATION DATA

The Cape Cod Commission data collection program deploys a number of automated traffic recorders that detect the classification of vehicles traveling at that location, including several types of heavy vehicles. Data collection is limited to non-access controlled roads due to the safety concerns of setting up equipment on limited-access highways such as the Mid-Cape Highway. Nodes on the map above show the relative truck traffic volumes for each location that data were collected. The sizes of the circles represent the relative volume of truck traffic (larger circles are more heavily traveled). The colors of the circles represent the functional classification of the roadway as follows:

- Red: Urban or Rural Principal Arterials (higher level)
- Blue: Urban Principal Arterial or Rural Minor Arterial (lower level)
- Green: Urban Minor Arterial or Rural Major Collector
- Brown: Urban Collector or Rural Minor Collector
- Yellow: Local

Most of the high volume truck traffic was measured on more important (collectors and arterials) functionally classified roads, showing that trucks are generally not driving on local roads. Data availability is limited – Cape Cod Commission technicians generally install automated traffic recorders at 200 locations during the summer – a subset of which are deployed as classification counts.



Source: Cape Cod Commission Traffic Counting Program

FIGURE 2: OBSERVED HEAVY VEHICLE TRAFFIC VOLUMES BY FUNCTIONS CLASS

RAIL FREIGHT

Freight service is the major user of Cape Cod's rail network in addition to scenic excursions and weekend passenger service. The Commonwealth of Massachusetts, through MassDOT, still owns most railroad tracks on Cape Cod today. Massachusetts Coastal Railroad (a company of Cape Rail, Inc.) operates under contract to provide freight service.

Currently, the primary use of Cape Cod's rails is for transporting solid waste by Mass Coastal Railroad. Mass Coastal is a short line freight railroad serving Cape Cod and southeastern Massachusetts between Middleboro, Otis Air Force Base, Hyannis, and South Yarmouth. The majority of Cape Cod's solid waste is transported to the SEMASS trash-to-energy plant in Rochester, MA via Mass Coastal's Energy Train. Other freight Mass Coastal carries includes food, construction materials, chemicals, heavy equipment amongst many other things.

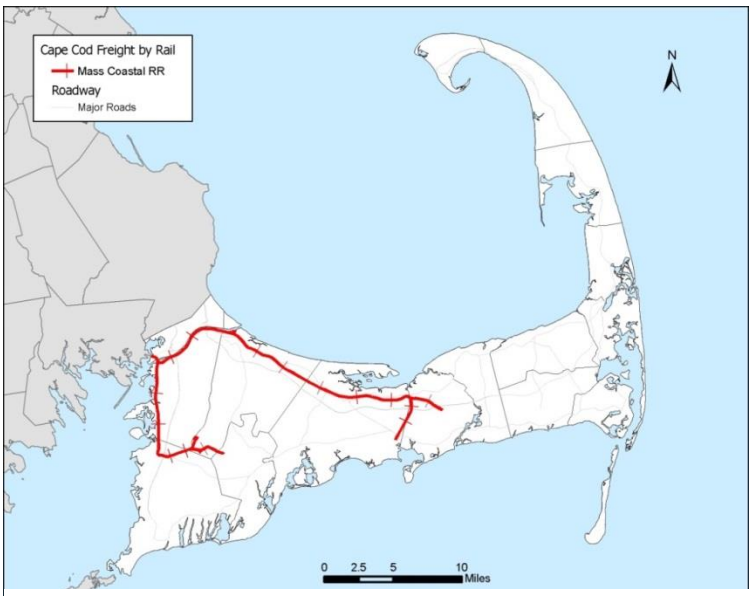


FIGURE 3: CAPE COD RAIL INFASTRUCTURE

RAIL CONNECTIVITY

Rail service has a long and rich history on Cape Cod. The region's early growth was in part brought about by the railroad. Many miles of usable track still exist on Cape Cod, intersecting the roads and waterways. MassDOT owns the majority of rail tracks on Cape Cod, but some tracks are owned by federal agencies. Currently though, only the Mass Coastal freight service, the Cape Cod Central Railroad scenic train service, and the Cape Flyer summer weekend passenger service operate on Cape Cod. Proposals currently exist to connect Buzzards Bay to Middleboro, which would give Cape passengers improved access to Boston. If freight rail service were to be expanded, upgrades would be necessary to the tracks, stations, and signals. Moreover, issues of accessibility, mobility and connectivity would need to be addressed. Funding for these improvements would need to be identified and secured. As many tracks are converted in bicycle paths, the future of rail on Cape Cod is still uncertain. A major advantage of rail freight is the movement of goods across the Cape Cod Canal without adding vehicle crossings to the congested highway bridges.

Cape Cod Commission staff met with a representative of Cape Cod's major rail operation: Mass Coastal Railroad. Mass Coastal operates the "Energy Train" transporting solid waste from the Yarmouth Transfer Station (and from the soon-to-close Otis transfer station at Joint Base Cape Cod) to the Southeastern Massachusetts Resource Recovery Facility – "SEMASS"), and an

excursion/tourist train identified as "Cape Cod Central Railroad." Freight issues and concerns affecting rail service highlighted at this meeting included:

- Energy Train service is affected by Cape Cod Canal rail bridge delays, and hours of operation at SEMASS and the Yarmouth transfer station
- Commercial marine shipping may have priority (especially eastbound in the canal – can restrict access to the rail bridge for over 1 ½ hours).
- The Otis transfer station will close in December 2014 resulting in:
- More Energy Train cars available for Yarmouth transfer station – resulting in fewer daily trips to SEMASS
- Opportunity to modify the Otis facility for trans-loading operations (e.g., propane, construction materials, etc.)
- Potential future rail shipments could include deliveries of construction materials to Hyannis.
- National (and global) freight trends are for containerization (freight is consolidated in large containers that can be stacked on ships or trains and then transported over the road by tractor trailers).
- Rail services between North Falmouth and Hyannis are restricted due to the absences of a "Y" rail connector in the vicinity of the rail bridge (currently, the rail bridge must be lowered and a train would have to partially cross the canal and then reverse)

WATER FREIGHT

Waterborne freight to and from Cape Cod uses a variety of vessel types and seaports. The primary form of public water transportation on Cape Cod is ferry service, carrying passengers between the mainland and the islands of Martha's Vineyard and Nantucket. A significant amount of freight is carried by water transportation as well. As a result, the region's seaports and channels are vital in addressing the economic and transportation needs of Cape Cod.

CAPE COD SEAPORTS

Cape Cod has 586 miles of tidal coastline, with many inlets and bays that provide marine access to the land. Seaports have been constructed along several of these bays and inlets to facilitate the transfer of people and goods from water to land transportation. Significant Cape Cod seaports are recognized in reports by the Army Corps of Engineers, the agency that maintains many of them. These and other seaports are discussed in the Existing Conditions appendix.

FERRY FREIGHT

The Steamship Authority records movements of trucks between Cape Cod and the Islands. Generally, these trucks are transporting goods from the mainland to the Islands. In 2013, truck movements exceeded 153,000 vehicles. The total number of trucks carried includes pick-up trucks, vans, and other commercial vehicles under 20' in overall length. In 2004, the Steamship Authority started classifying certain vehicles under 20' as trucks rather than automobiles. Some pick-up trucks and vans that were previously classified as automobiles are now being classified more consistently as trucks based on the make and model of the vehicle. SUVs, however, are still classified and counted as automobiles. This resulted in more trucks and fewer automobiles being carried starting in 2004. Also, the number of trucks in this category of under 20' represented 53% of the total trucks carried on the Woods Hole – Martha's Vineyard route and 36% of the total trucks carried on the Hyannis – Nantucket route during 2005. The numbers of trucks, automobiles, or passengers are reported as one-way segments or movements. A truck carried round trip is reported as two trucks carried. Roughly two-thirds of these shipments are made between Woods Hole and Martha's Vineyard. The remainder is made between Hyannis and Nantucket.

TABLE 1. TRUCKS CARRIED BY STEAMSHIP AUTHORITY FERRIES

Source: Steamship Authority

YEAR	TO AND FROM MARTHA'S VINEYARD	TO AND FROM NANTUCKET
2013	118,922	34,329
2012	112,958	39,657
2011	114,782	44,025
2010	116,461	49,547
2009	115,600	48,187
2008	98,393	44,537
2007	98,257	41,011
2006	103,939	40,175
2005	97,595	39,598
2004	87,166	40,799
2003	70,546	43,226

CHANNELS

Cape Cod Canal

The Cape Cod Canal is a signifagnt aspect freight infrastructure in the region. This channel allows safe passage from ports north and south of Cape Cod, relieving the hazard of navigation around the peninsula. Details on the Cape Cod Canal can be found in the Existing Conditions Sections.

The Cape Cod Canal is owned and operated by the Army Corps of Engineers. Over six thousand ships, tug and barge combinations and other large commercial vessels pass through the canal annually. In 2009 they carried over 8 million tons of cargo to ports along the east coast including 1.9 billion gallons of petroleum products and 380 million gallons of bio fuels.

Woods Hole Channel

The Woods Hole Connects Buzzards Bay with Great Harbor in Woods Hole. Freight vessels traveling to Boston and points north can also use the channel on their way to the Cape Cod Canal. The channel is used by seasonal passenger ferries from New Bedford to Martha's Vineyard. As a result, the channel is heavily traveled.

Nantucket Channel

The Nantucekt Channel provides passage through the Nantucket Sound and between Cape Cod and the Islands. Ferries, ships navigating around the Cape, and other vessels used this chanel.

FREIGHT SURVEY

The Cape Cod Commission sought input from users and providers of freight services on Cape Cod through an online questionnaire. The questionnaire included multiple-response and open-ended questions. The availability of the questionnaire was announced on the Cape Cod Commission and Cape Cod Chamber of Commerce websites and via a direct email announcement sent by the Cape Cod Chamber to its membership. Only seven responses were received as of the fall of 2014 and are summarized below

Question 1: Which Cape Cod town(s) is your company based in?

Three respondents indicated Barnstable, two each for Bourne and Mashpee, and one each for Yarmouth and Provincetown.

Question 2: What type of business do you operate?

There was one response in each of the following categories:

- Freight Shipper
- Entertainment/Recreation
- Manufacturing
- Professional Services
- Restaurant
- Other Retail

Comments included the statement "Cape Cargo we pickup and deliver freight on the Cape."

Question 3: How does your company use freight?

Five responses indicated that their company imports/receives goods. There was one response each for "transport goods (I operate a shipping company)" and "other."

There was one comment: "ship and receive goods"

Question 4: How frequently do you use freight?

Responses were organized into three categories as follows:

Importing

- One response for greater than three times per day
- One response for one-two times per day
- Two responses for three-five times per week
- One response for one-two times per week
- One response for less than once per week

Exporting

- One response for less than once per week

Transporting

- One response for greater than three times per day
- One response for one-two times per day

Question 5: Where does your freight come from or where does it go?

Responses were organized into three categories as follows:

Importing

- Five responses for "Off Cape" (mainland side of Cape Cod Canal)
- Two responses for "On Cape" (south/east of Cape Cod Canal)

Exporting

- No responses

Transporting

- One response for "Off Cape" (mainland side of Cape Cod Canal)
- Two responses for "On Cape" (south/east of Cape Cod Canal)
- One response for Islands (Nantucket or Martha's Vineyard)
- One response for International
- One response for Other

Question 6: What are some of the major commodities that your company imports/exports/transports (or relies upon)?

This was an open-ended question that received seven responses as follows:

- Lighting products
- Parts for repair of our video games. Prizes for our customers. Paper products plates, cups, napkins, paper towels, etc....
- Hardware, paint & sundries, power tools, hand tools, locks, plumbing supplies, electrical supplies, fasteners, housewares, lawn and garden supplies, fertilizers, automotive supplies, propane, cleaning supplies.
- Green Coffee - Import Ship off Cape Roasted Coffee USPS and UPS Daily, also self deliver in our own truck to on Cape customers
- Cabinets flooring retail goods
- We transport all types of freight except perishables and food. General freight, household goods, furniture, items for internet purchases, freight to from the Islands
- Food, kitchen equipment, restaurant supplies

Question 7: What types of shipping does your company use on Cape Cod?

All seven responses indicated that they use road (trucking) for their shipping needs. One response also indicated the use of waterborne freight.

Question 8: Please identify your primary shipping company (if applicable):

There was one response each for the following shipping companies

- Cape Cod Express
- FedEx
- UPS

There were two responses that indicated "Other."

Question 9: What issues regarding freight do you have (e.g., roadway safety, speed/fuel efficiency, flexibility, reliability)? How may these issues be addressed?

Responses included the following statements:

- Prices are so much higher for just 20 units
- Many carriers do not want to deliver to Cape Cod so they deliver to Cape Cod Express in Wareham who then delivers the freight locally. This adds time and the potential for damage.

Question 10: What types of policy changes or investments would you support or not support?

Responses were organized into a set of categories as follows:

Increase vehicular capacity across the Cape Cod Canal

- Tow responses were "Strongly Support"
- Two responses were "Neutral"

Rail investments

- Three responses were "Support"
- One response was "Neutral"
- One response was "Oppose"

Ferry ports (expansion or construction of new ports)

- Two responses were "Strongly Support"
- Three responses were "Support"
- One response was "Neutral"

Air freight (expansion of facilities)

- Five responses were "Support"
- One response was "Neutral"

Improved intermodal facilities (e.g., ferry to rail, air freight to truck, etc.)

- Five responses were "Support"
- One response was "Neutral"

Identification of appropriate trucking routes/trucking restrictions

- Two responses were "Strongly Support"
- Two responses were "Support"
- Two responses were "Neutral"

There was one comment: "convert South St Hyannis to 2 way traffic to allow for safer egress from WHMVNSSA terminal."

Question 11: Do you have any other comments, questions, or concerns?

This question had one response: "It is troublesome to hear that any wide load requires two state police escorts on the bridges. Trucking companies pay a four hour minimum to the state police for this service when the drive over the bridge takes 15 minutes!"

RECOMMENDATIONS

This 2015 Cape Cod Freight Study was the first attempt by the Cape Cod Metropolitan Planning Organization to bring a comprehensive assessment of issues facing freight haulers to, from and within Barnstable County. In order continue to make progress in improving freight safety and reliability, the following strategies were offered in the report:

Identify "Critical" Freight Commodities

Work with planners to identify commodities critical in all stages of emergency preparedness and response. These stages include advanced planning and resiliency preparations, emergency management during events, and follow-up/rehabilitation.

Encourage Specific Types of Freight Transportation

Freight modes that minimize travel over Cape Cod's narrow and congested roadways are to be encourages. Such modes include rail and waterborne. Trucking deliveries during off-peak times are also encouraged.

Make Infrastructure Improvements for Freight Industry

Maintain and rehabilitate bridges and roads – focusing on higher functional class facilities. During roadway and intersection rehabilitation on truck routes, include properly-engineered pavement, turning radii, and avoid height obstructions.

Update Truck Routes

Work with town and state officials to refine preferred truck routes. Currently, truck routes are based on a limited number of state roads and may be discontinuous based on jurisdiction. Refined truck routes would be included in the MassDOT's Roadway Inventory.

Bridge Maintenance Scheduling

To reduce impact to freight traffic, restructure Bourne and Sagamore bridge repair contracts (night work or 24-hour shift).

CAPE COD COMMISSION

3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

CAPE COD
COMMISSION

2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix F: Bicycle & Pedestrian

Draft
June 15, 2015

COUNTY OF BARNSTABLE
MASSACHUSETTS

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Technical Appendix F: Bicycle & Pedestrian

Bicyclists and pedestrians while having a minimal impact on the environment are our most vulnerable users and the most in need of providing a safe transportation network. This appendix presents a discussion of crashes, road safety audits, pedestrian safety and planning studies, planning tools, and planning efforts related to bicycles and pedestrians on Cape Cod.

CAPE COD BICYCLISTS AND PEDESTRIANS

To varying degrees, all travelers at some point in their journey are pedestrians. This occurs in the short walking trip from a parked car to a destination (or from a parked bicycle or after disembarking from a bus).

Bicyclists are often categorized into three subsets: (A) Experienced, long-distance riders, (B) Occasional riders, and (C) beginners and children. For the type-A rider, most of their travel is made along roadways because of the higher travel speed available and the fewer obstacles (driveways etc.) encountered on alternative routes. Type B riders prefer off-road opportunities such as bike paths, but can be comfortable in bike lanes or wide shoulders. Type C riders seek out the least busy sections of bike paths and sidewalks; these riders generally do not use biking for transportation purposes.

The U.S. Census Bureau provides information on means of transportation through the "American Community Survey" – the latest tabulation being available for 2006-2010. As presented in the Table 1, Provincetown had the largest number of people who commuted by bicycle (240) of any of the fifteen towns as well as the largest percentage (12.8%). Barnstable had the largest numbers of people walking to work (620) and Provincetown had the highest percentage (22.7%).

TABLE 1 – JOURNEY TO WORK BY TOWN - MEANS OF TRANSPORTATION

TOWN	BIKE TO WORK	WALK TO WORK	ALL WORKERS	PERCENTAGE BIKING	PERCENTAGE WALKING
Barnstable	80	620	22,535	0.4%	2.8%
Bourne	10	315	9,285	0.1%	3.4%
Brewster	75	160	4,630	1.6%	3.5%
Chatham	25	95	2,784	0.9%	3.4%
Dennis	0	155	6,105	0.0%	2.5%
Eastham	20	145	2,100	1.0%	6.9%
Falmouth	120	230	14,615	0.8%	1.6%
Harwich	0	75	5,270	0.0%	1.4%
Mashpee	0	85	6,905	0.0%	1.2%
Orleans	15	100	2,345	0.6%	4.3%
Provincetown	240	425	1,875	12.8%	22.7%
Sandwich	0	145	10,275	0.0%	1.4%
Truro	0	30	899	0.0%	3.3%
Wellfleet	0	135	1,603	0.0%	8.4%
Yarmouth	50	225	10,590	0.5%	2.1%
Barnstable County Totals	635	2,940	101,816	0.6%	2.9%

Source: U.S. Census Bureau, American Community Survey 2006-2010 Five-year estimates. (Workers 16 years and over).

VEHICULAR CRASH RECORDS

The following sections include discussions of vehicular crash records that include bicyclists or pedestrians.

BICYCLIST CRASH HISTORY

Bicycling on Cape Cod roadways can be a challenge. The mixture of narrow roadways, high traffic volumes, and pleasant summer weather creates a great deal of difficult vehicle-bicycle interaction. Cape Cod's pleasant summer weather brings bicyclists onto roadways at the time when vehicular traffic is at its peak. As a mode that can efficiently transport travelers pollution-free, it is worthy of our attention in providing facilities that are safe for cyclists, pedestrians, and other transportation users. Bicyclist and Pedestrian crashes are shown in the figure on the following page.

Table 2 includes a town-by-town breakdown of bicycle-vehicle crashes for the years 2010-2012. With 61 reported crashes over the three-year period, Barnstable had the greatest number of bicyclist-vehicle crashes (Falmouth was second with 43 crashes). Staff has observed numerous cyclists along Route 28 (where many of the identifiable crashes occurred) during the summer season. Comments at public meetings indicate that many summer workers in use bicycling to commute to work – many of these workers originate from outside of the United States and may be less familiar with our customary safe bicycling practices such as riding in the direction of traffic while wearing a helmet.

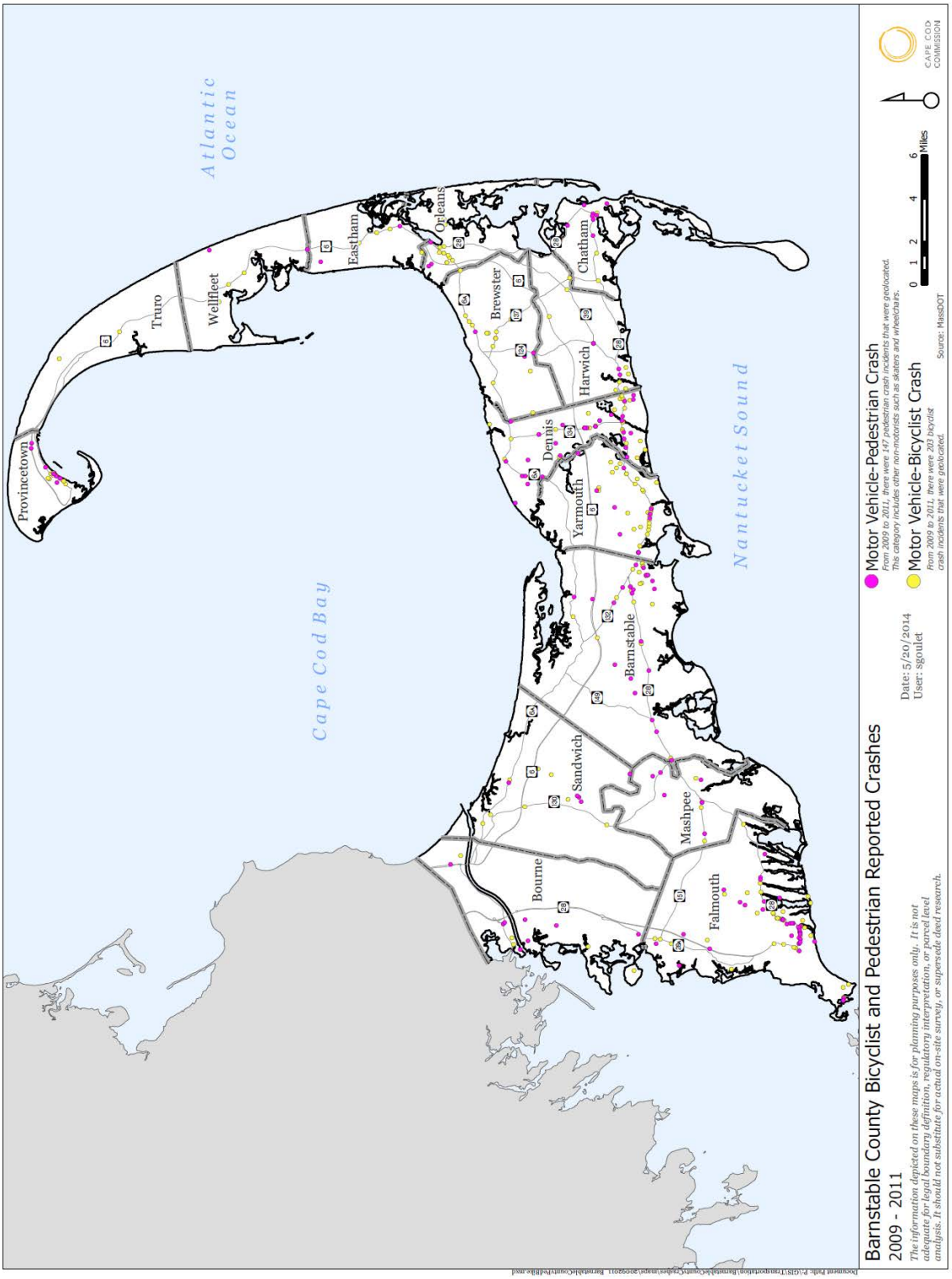

FIGURE 1 – BICYCLIST AND PEDESTRIAN VEHICULAR CRASHES

TABLE 2 - BICYCLIST-VEHICLE CRASH HISTORY (2010-2012)

TOWN	ALL CRASHES (3-YEAR TOTAL)	FATAL CRASHES (3-YEAR TOTAL)
Bourne	7	0
Sandwich	8	0
Falmouth	43	0
Mashpee	4	0
Barnstable	61	1
Yarmouth	35	0
Dennis	35	0
Harwich	8	0
Chatham	4	0
Brewster	17	0
Orleans	13	0
Eastham	12	0
Wellfleet	5	0
Truro	3	0
Provincetown	9	0
Total	**265**	**1**

(Source: MassDOT)

PEDESTRIAN – VEHICULAR CRASHES

Pedestrians are among the most vulnerable users of the transportation system, and yet it is important to remember that almost all travelers become pedestrians for at least part of every trip. Safe accommodations for walking can encourage a reduction in traffic congestion and air pollution and encourage a healthier alternate mode. Table 3 showns the number of vehicle-pedestrian crashes for each town. Falmouth had the highest number (52) of crashes reported from 2010 to 2012. This number represents two sides of an issue: the high number of pedestrians observed along Route 28 in the summer, representing peoples' willingness to walk for transportation, however it also shows the deficiencies in pedestrian accommodation (e.g., safe pedestrian crossings at intersections) resulting in the high crash history.

TABLE 3 – PEDESTRIAN-VEHICLE CRASH HISTORY (2010-2012)

TOWN	ALL CRASHES (3-YEAR TOTAL)	FATAL CRASHES (3-YEAR TOTAL)
Bourne	13	1
Sandwich	15	1
Falmouth	52	2
Mashpee	16	0
Barnstable	45	3
Yarmouth	17	1
Dennis	33	2
Harwich	2	0
Chatham	5	0
Brewster	1	0
Orleans	5	0
Eastham	3	0
Wellfleet	7	0
Truro	0	0
Provincetown	19	1
Total	**233**	**11**

(Source: MassDOT)

ROADWAY SAFETY AUDITS – BICYCLE/PEDESTRIAN RECOMMENDATIONS

Since 2007 there have been eighteen Road Safety Audits (RSAs) completed for locations throughout Cape Cod. The Audit process is overseen by MassDOT and brings together community officials and others in an intensive review of high-crash locations' operational and geometric deficiencies. Each audit includes a review of traffic and crash information, an onsite field review. The following sections provide an overview of the bicycle and pedestrian safety recommendations from the audits.

BARNSTABLE ROAD SAFETY AUDITS

There have been six completed audits within the town of Barnstable since 2007:

Iyannough Road (Route 132) at Cape Cod Community College/Cape Cod Conservatory Intersection

Completed in 2014, the audit includes recommendations to improve bicyclist and pedestrian safety:

- Provide advance warning signage notifying motorists along Route 132 of the upcoming crosswalk.
- Install an accessible ramp on the western side of the Route 132 crosswalk.
- During intersection improvements, include accommodations for bicyclists such as widened shoulders or bike lanes on Route 132.
- Consider creating an accessible and well-lit unpaved path from Route 132 to Community College Parking Lot #2 to shorten walking distances between the college and the Park and Ride Lot; if warranted consider installation of a crosswalk on Route 132 on the northern leg of the Route 6A westbound ramps intersection to provide access to the path.

Route 28 at Osterville-West Barnstable Road

Completed in 2012, the audit includes recommendations to improve bicyclist and pedestrian safety:

- Upgrade bicycle and pedestrian accommodations with future maintenance and/or reconstruction efforts.
- Consider adding an island with the left turn lanes for a break in bicycle/pedestrian crossing of Route 28.

Iyannough Road (Route 28) at Yarmouth Road

Completed in 2012, the audit includes recommendations to improve bicyclist and pedestrian safety:

- Consider the feasibility/appropriateness of providing bicycle accommodations at the intersection (i.e., shared lanes and/or within a 4-foot shoulder, bicycle detection at signals, signage, and pavement markings) in accordance with the 2006 Project Development and Design Guide.

- As part of the design process and long-term planning efforts, include a Route 28 bicycle/pedestrian crossing to connect the future extension of the Cape Cod Rail Trail through the intersection.
- Evaluate the feasibility and safety benefits of providing pedestrian accommodations at the Route 28/Yarmouth Road intersection, including crosswalks, accessible ramps, and pedestrian signal indications, and providing a connection between the intersection and the existing sidewalks on Camp Street and Yarmouth Road south of Route 28.

Previous Barnstable Road Safety Audits

Audits listed below have been summarized in previous Regional Transportation Plans and are listed for convenience. Copies of Road Safety Audits are available from the Cape Cod Commission website at:

www.capecodcommission.org/safety

- Meetinghouse Way (Route 149)/Route 6 Ramps (2010)
- Route 28 (Falmouth Road)/Bearses Way (2009)
- Route 28 in Barnstable – Lane Departure Safety Audit (2007)

BOURNE ROADWAY SAFETY AUDITS

There have been two completed audits within the town of Bourne since 2012:

Route 28 between Bourne Rotary and Otis Rotary

Completed in 2013, the audit includes recommendations to improve bicyclist and pedestrian safety:

- As part of long-term reconstruction efforts, consider providing pedestrian and bicycle accommodations, such as the planned shared-use path parallel to Route 28.
- Consider pedestrian/bicycle crossing infrastructure in conjunction with the proposed Route 28 parallel shared-use path.

Sandwich Road at Cranberry Highway

Completed in 2012, the audit includes recommendations to improve bicyclist and pedestrian safety:

- Provide improved accommodation for pedestrians and bicyclists through roadway improvements or maintenance efforts.

DENNIS ROADWAY SAFETY AUDIT

The audit listed below has been summarized in a previous Regional Transportation Plan and are listed for convenience. Copies of Road Safety Audits are available from the Cape Cod Commission website at:

www.capecodcommission.org/safety

- Route 134 at the Route 6 Ramps (2009)

EASTHAM ROADWAY SAFETY AUDIT

Route 6 and Governor Prence Road

Completed in 2012, the audit includes recommendations to improve bicyclist and pedestrian safety:

- Consider a pedestrian beacon north of the intersection at the information booth.
- Discussion included the need for a sight distance measurement, and the possibility of a median in the vicinity to slow traffic at the Route 6 crossing.
- Consider improved bicycle/pedestrian accommodation when reconstruction for Route 6, or the intersection, is being considered.

MASHPEE ROADWAY SAFETY AUDITS

Mashpee has had three audits completed since 2007:

Nathan Ellis Highway (Route 151) at Old Barnstable Road Intersection

Completed in 2014, the audit includes recommendations to improve bicyclist and pedestrian safety:

- Realign the crosswalk on the northern leg to be parallel with Route 151; modify curbing on island to accommodate wheelchair users and meet ADA requirements.
- Replace pedestrian signal push buttons with APS vibro-tactile buttons (to accommodate senior residents.
- Schedule regular street sweeping to remove sand and debris from wheelchair ramps.
- Re-apply crosswalk markings.
- Consider construction of a crosswalk on Old Barnstable Road's southern leg to accommodate pedestrians traveling between the trailer park and the high school.
- During corridor-wide improvements, construct pedestrian and bicycle accommodations to the west of the intersection.

Previous Mashpee Road Safety Audits

Audits listed below have been summarized in previous Regional Transportation Plans and are listed for convenience. Copies of Road Safety Audits are available from the Cape Cod Commission website at:

www.capecodcommission.org/safety

- Great Neck Road North/Old Barnstable Road (2009)
- Route 130 Lane Departure Road Safety Audit (2007)

SANDWICH ROAD SAFETY AUDITS

Since 2009, two safety audits were completed in Sandwich. The audits listed below have been summarized in a previous Regional Transportation Plan and are listed for convenience. Copies of Road Safety Audits are available from the Cape Cod Commission website at:

www.capecodcommission.org/safety

- Cotuit Road/Harlow Road/South Sandwich Road (2009)
- Route 6: Major Highway Median Cross-Over Crashes (2009)

YARMOUTH ROAD SAFETY AUDITS

There have been two audits completed since 2010 in Yarmouth.

Route 6A – Willow Street to Union Street

Completed in 2013, the audit includes recommendations to improve bicyclist and pedestrian safety:

- Investigate adding additional signage to alert motorists to crosswalks throughout the RSA corridor.
- Repaint existing crosswalks and consider upgrading crosswalk to "piano key" design.
- Trim trees to increase visibility of crosswalks.
- Review appropriateness of sidewalk locations and relocate as needed (would require full ADA compliance for new crosswalks).
- Work with business owner at the Village Store to redesign site access using good access management principles.
- Evaluate the existing street lighting and the potential for additional street lighting, particularly for improved pedestrian safety.
- Investigate installing textured pavement crosswalks or raised crosswalks in select locations understanding that they would require special approval and careful considerations of all safety impacts.
- Relocate utility poles behind sidewalks and add curbs where needed.
- Consider geometric changes to the roadway such as bump outs to slow drivers down.
- Implement targeted police enforcement to address speeding and crosswalk compliance issues.
- Install gateway treatments to visually identify the heart of the village for drivers and consider additional streetscape improvements to create a village feel to cue in drivers that they are entering a more populated and pedestrian oriented area.

Previous Yarmouth Road Safety Audit

The audit listed below has been summarized in a previous Regional Transportation Plan and is listed for convenience. Copies of Road Safety Audits are available from the Cape Cod Commission website at:

www.capecodcommission.org/safety

- Old Townhouse Road/Forest Road (2010)

CAPE COD COMMISSION'S LOCATION-SPECIFIC SAFETY STUDIES

The Cape Cod Commission has completed several location-specific safety studies. The following is a summary of the locations that were studied and highlights of recommended safety improvements. Full reports are available on the internet:

www.capecodcommission.org/safety

WELLFLEET: ROUTE 6 SAFETY STUDY

This study, published in 2012, focused on four locations along Route 6:

- LeCount Hollow Road
- Cove Road
- Main Street

The study mainly focused on reducing vehicular conflict with general recommendations to evaluate bicycle and pedestrian accommodations.

DENNIS: ANALYSIS OF HIGH-CRASH LOCATIONS IN DENNISPORT

This study, published in 2012, focused on two locations in town:

- Upper County Road at Depot Street
- Main Street (Route 28) at Sea Street

The study mainly focused on reducing vehicular conflict with general recommendations to evaluate bicycle and pedestrian accommodations.

PREVIOUS CAPE COD COMMISSION LOCATION-SPECIFIC SAFETY STUDIES

The following studies have been summarized in a previous Regional Transportation Plan and are available on the Cape Cod Commission website at:

www.capecodcommission.org/safety

2009 Transportation Safety Report

- Eastham: Eastham Rotary
- Truro: Truro Central School Zone
- Provincetown: Route 6/Shank Painter Road

2008 Transportation Safety Report

- Eastham: Route 6/Brackett Road
- Sandwich: Route 6/Route 130 (Exit 2)

2006 Transportation Safety Report

- Bourne: Route 28 Otis Rotary
- Harwich: Route 137/Route 39
- Orleans: Route 6A/Route 28

BICYCLE AND PEDESTRIAN PLANNING

Bicycles are a low cost, non-motorized form of transportation. Bicycle infrastructure and facilities require smaller right-of-ways and less overall investment than roadways. There are three basic types of bicycle infrastructure: paths, lanes, and routes. Paths generally have their own separated right-of-way and follow certain standards for width, grade, and accessibility. Bicycle lanes are separate lanes within roadways marked for bicycle use. There are currently no bicycle lanes on Cape Cod. Bicycle routes are roadways with wide shoulders that have been designated for bicycle use. Pedestrians can access shared use paths and sidewalks. Pedestrian facilities support village centers and local businesses, and encourage travelers to walk instead of driving. According to the Rails to Trails Conservancy, bicycle and pedestrian facilities can increase property values and make areas more attractive to new residents, businesses, and tourists.

This report includes descriptions of the Cape's existing bicycle and pedestrian infrastructure, introduces tools for bike route planning, and a section of strategies to improve biking on Cape Cod.

The Commission is currently involved in bicycle/pedestrian planning efforts with several Cape Cod communities. It is anticipated that recommendations from these studies will yield projects for inclusion in the Regional Transportation Plan. Summaries of some of these efforts are included in this report.

A major transportation planning effort is underway by the Cape Cod National Seashore in partnership with the Cape Cod Commission. The effort includes outreach throughout Barnstable County to key stakeholders. One result is an "Integrated Bicycle Plan for Cape Cod/Bicycle Feasibility Study" released in 2010 and forms the basis of recommended projects included in this chapter.

As an overall framework, the following figure represents an overall vision for bicycle path connections to and within Cape Cod. The segments shown in green represent existing bicycle paths. Orange line segments represent generalized routes; detailed alignments are to be defined. This figure represents the Cape Cod Commission's vision for expansion of the Cape's bicycle path infrastructure.

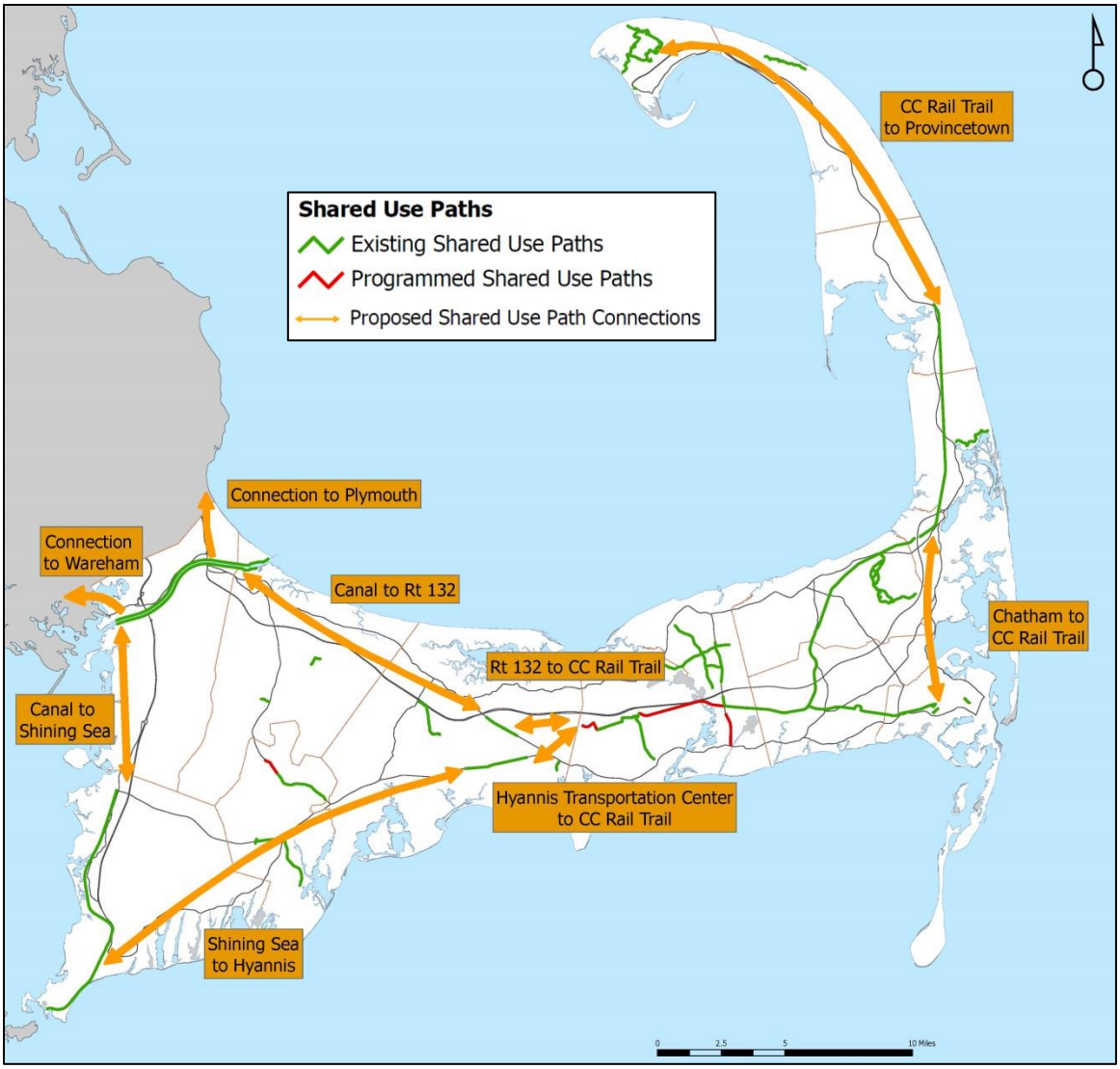

FIGURE 2 - SHARED USE PATH VISION MAP

The following subsections include text, figures and tables that define and describe the bicycle and pedestrian infrastructure of Cape Cod. This information forms the baseline of the existing system and helps planners identify gaps and opportunities to improve bicycling and walking on Cape Cod.

MULTI-USE PATHS

There are currently 91 miles of paved multi-use paths on Cape Cod.

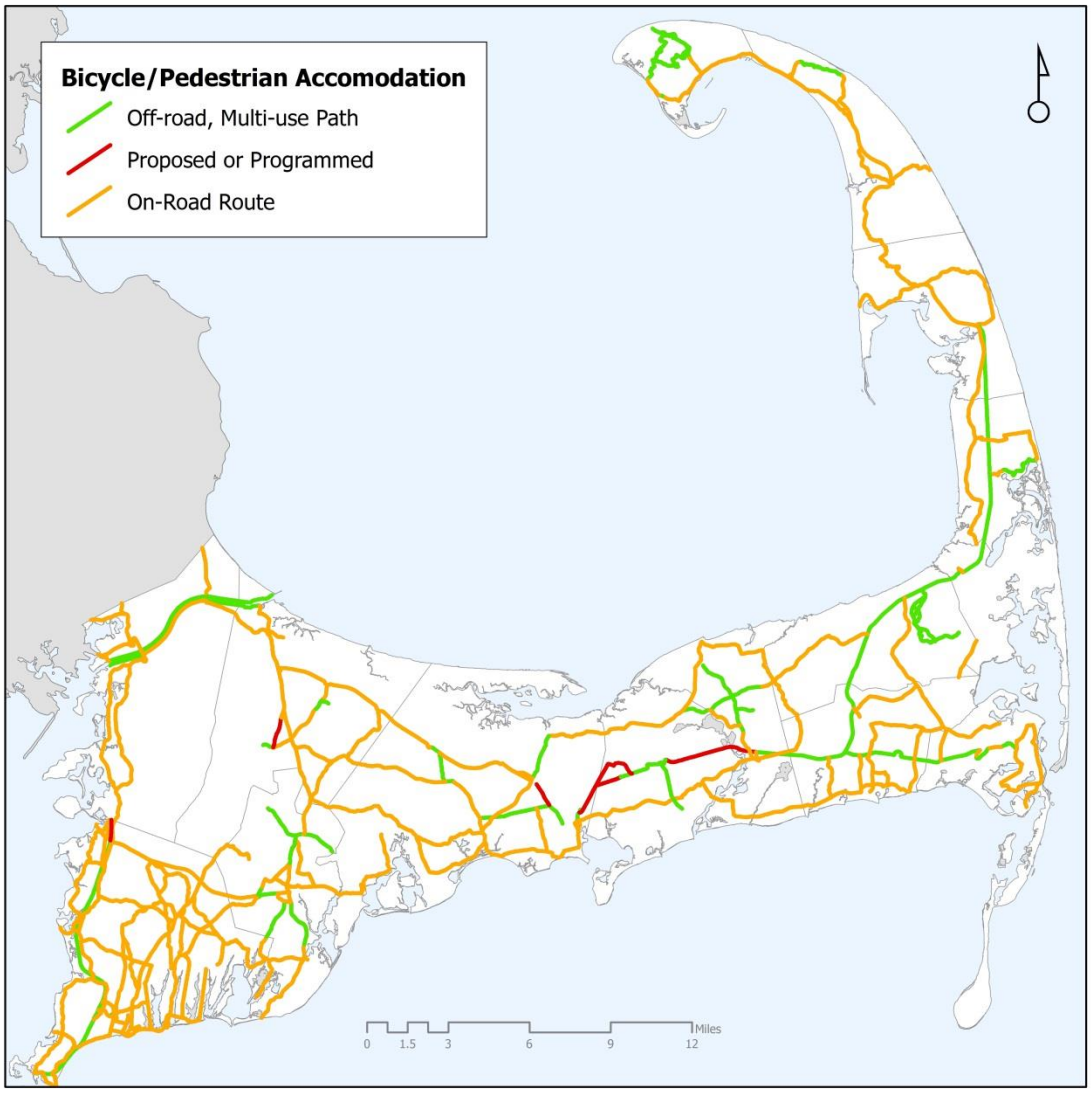

FIGURE 3 – MULTI-USE PATHS AND ROUTES ON CAPE COD

A multi-use path is a paved right of way, separate from roadways. A multi-use path (sometimes referred to as a bicycle path) is not a sidewalk. According to the American Association of State Highway and Transportation Officials (AASHTO), bicycle paths should have a paved surface 8-

10 feet wide, with a 4 inch wide center line. Shoulders of 2-feet should be placed on either side of the path, with signage placed no closer than 3 feet from the pavement. The cross slope of a bicycle path should be no more than 2%. Bicycle paths must also meet other standards for grading, accessibility, and roadway crossings that conform to AASHTO guidelines. There are many bicycle paths throughout Cape Cod. Some serve recreational needs, while others serve transportation needs.

Cape Cod Rail Trail

The Cape Cod Rail Trail was constructed in the 1970s from the out of service Cape Cod Line rail right-of-way. Since 1991, an extension, two bridges over Route 6, and a tunnel have been constructed. The Massachusetts Department of Conservation and Recreation (DCR) owns and maintains the Rail Trail.

The Rail Trail runs from Route 134 in Dennis, just north of Great Western Road, to LeCount Hollow Road in Wellfleet. All along the trail are seating areas and trash cans. An extension of the trail, from Harwich to Chatham, was completed around 2004 along the out-of-service Chatham Branch rail right-of-way. A bicycle roundabout was constructed at the intersection of the Rail Trail and the Harwich-Chatham extension. Currently, the main line of the Rail Trail is under renovation. The Rail Trail has been repaved and widened, graded to include a grassy shoulder and more amenities around 2007. A further extension of the Rail Trail from Route 134 to Peter Homer Park in Yarmouth is currently programmed in the TIP for FY 2015 (a crossing of the Bass River is included in the TIP for FY 2016). Continuation of the Rail Trail to Route 132 in Barnstable is programmed in the TIP for FY 2017. A further extension to the Hyannis Transportation Center is also under consideration and is a key recommendation of the Yarmouth Road Corridor Study Task Force.

The trail is currently 10 feet wide. The main line is 21.9 miles long, with 45 roadway crossings. The Harwich-Chatham Extension is 6.2 miles long with 15 roadway crossings. DCR estimates that 400,000 people use the rail trail annually. In addition, the rail trail is occasionally used for emergency vehicles. Given its length and location, the Cape Cod Rail Trail can be used to commute within the Lower and Outer Cape.

FIGURE 4 - CAPE COD RAIL TRAIL CROSSING AT MAIN STREET, HARWICHPORT

FIGURE 5 - CAPE COD RAIL TRAIL AT BRACKETT ROAD, EASTHAM

FIGURE 6 - HARWICH-CHATHAM RAIL TRAIL EXTENSION AT THE HARWICH-CHATHAM TOWN LINE

FIGURE 7 - END OF THE HARWICH-CHATHAM RAIL TRAIL EXTENSION AT CROWELL RD., CHATHAM

FIGURE 8 - BICYCLE ROUNDABOUT ON THE CAPE COD RAIL TRAIL, HARWICH

Cape Cod Canal Bike Paths

The Cape Cod Canal Bike Paths run along both sides of the Cape Cod Canal. The Army Corps of Engineers owns and maintains the paths as frontage roads for the Cape Cod Canal. Both sides have benches and sitting areas, and are lit at night. The southern-side path is 6.5 miles long, 8 feet wide and has 2 roadway crossings. The mainland-side path is 7 miles long, 8 feet wide and has 7 roadway crossings.

FIGURE 9 - SOUTHERN-SIDE OF THE CANAL BICYCLE PATH, EAST OF SAGAMORE BRIDGE

FIGURE 10 - MAINLAND-SIDE OF THE CANAL BICYCLE PATH, EAST OF RAILROAD BRIDGE

FIGURE 11 - SHINING SEA BICYCLE PATH AT TER HUEN DRIVE, FALMOUTH

FIGURE 12 - SHINING SEA BICYCLE PATH AT PALMER AVE., FALMOUTH

Shining Sea Bike Path

The Shining Sea Bike Path, located in Falmouth, was constructed from a portion of the out-of-service Woods Hole Branch rail right-of-way. The first phase of construction, which runs from the Steamship Authority terminal in Woods Hole to the Falmouth Bus Depot on Depot Street, was completed in 1976. The second phase, from Depot Street to the southern crossing of Palmer Avenue, was recently completed. The bike path has been extended northward over a series of phases to its current terminus at County Road (Route 151). The trail is currently 10.6 miles long.

Provincelands Trails and Herring Cove Beach Path

The Provincelands Trails are the set of trails at Race Point in Provincetown. They provide a path from near Route 6 to the Provincetown beaches and the Provincetown Municipal Airport. Travelers primarily use the Provincelands Trails for recreation and not to commute. The paths were built in the 1960s before bicycle path standards were developed. As a result they have many steep slopes, sharp curves and other hazards. Bicycle traffic is restricted to 10 MPH travel for safety. The Provincelands Trails are owned by the Cape Cod National Seashore. There are a total of 7.6 miles of bicycle paths, with a paved surface 8 feet wide, and 4 roadway crossings.

The Herring Cove Beach Path serves as a connection between the Herring Cove Beach parking lot and Province Land Road in Provincetown. There is also a connection to the Provincelands Trails through the parking lot. The Herring Cove Beach Path is 0.1 miles long, 8 feet wide, and has no roadway crossings.

FIGURE 13 - PROVINCELANDS TRAIL AT THE RACE POINT VISITORS CENTER, FACING WEST

Setucket Road and Dennis Paths

Several paths exist in Dennis, creating a network for bicyclists and pedestrians. The longest path runs along Old Bass River Road from just south of Bob Crowell Road. The portion south of Mayfair Street is designated as Bicycle Route 1, part of the Claire Saltonstall Bikeway. The Old Bass River Road Path is 3.1 miles long, 8.5 feet wide, and contains 18 roadway crossings. Another nearby path is the Setucket Road Path, which begins in Yarmouth at Route 6A and ends west of Airline Road. The path crosses Route 134 and Old Bass River Road. The western section of path, until Mayfair Road, is also designated as Bicycle Route 1. The Setucket Road Path is 3.2 miles long, 8.5 feet wide, and contains 19 roadway crossings. The third path in Dennis is located on Old Chatham Road between Old Bass River Road and Route 134. The Old Chatham Road

Path is 0.7 miles long, 8.5 feet wide, and contains 1 roadway crossing. All of these paths are owned and maintain by the Town of Dennis except for the section of path in Yarmouth, which is owned and maintained by that town. They provide a network of bicycle transportation for residents of Dennis. In total, these three paths are 7.0 miles long, and contain 38 roadway crossings.

FIGURE 14 - SETUCKET ROAD PATH EAST OF NORTH DENNIS ROAD, LOOKING EAST

FIGURE 15 - SETUCKET ROAD PATH EAST OF NORTH DENNIS ROAD, LOOKING WEST

Nickerson State Park Trails

Several bicycle paths are located within Nickerson State Park in Brewster. These paths are used for recreation, offering a scenic ride through the park. They are owned by the Massachusetts Department of Environmental Management. There are a total of 6.8 miles of bicycle path, with six roadway crossings.

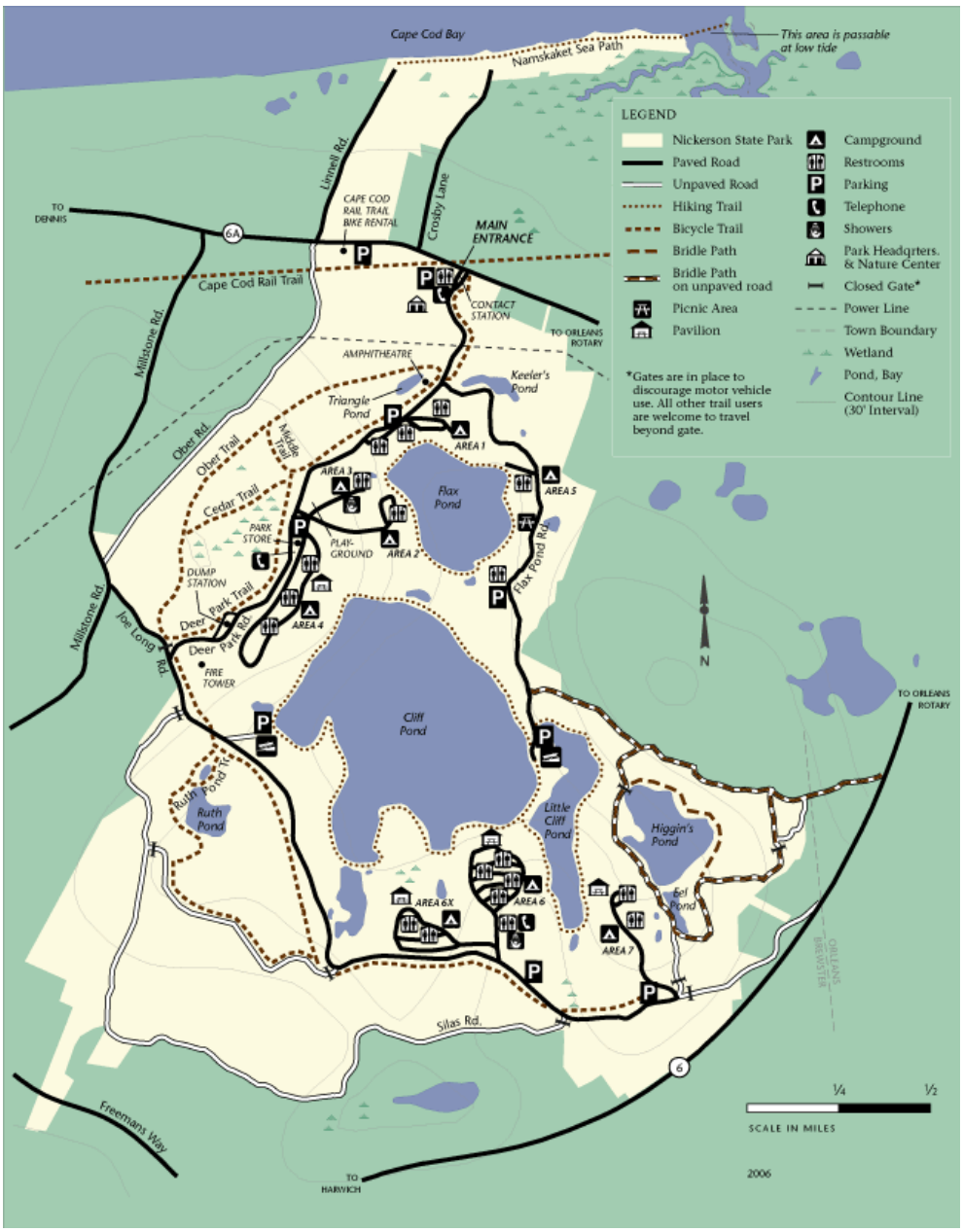

FIGURE 16 - MAP OF NICKERSON STATE PARK TRAILS
(Source: Massachusetts Department of Conservation and Recreation)

Nauset Trail

The Nauset Trail is located at the Cape Cod National Seashore in Eastham. It begins at Route 6 and the Salt Pond Visitors Center and runs to Coastguard Beach. A connection to the Cape Cod Rail Trail can be made via Bicycle Route 1. The Nauset Trail is owned by the Cape Cod National Seashore and used primarily for recreation. The Nauset Trail is 1.9 miles long, 8 feet wide, and has six roadway crossings.

FIGURE 17 - NAUSET TRAIL FROM THE SALT POND VISITOR'S CENTER LOOKING EAST

FIGURE 18 - NAUSET TRAIL FROM COASTGUARD BEACH PARKING LOT IN EASTHAM

Head of the Meadow Trail

The Head of the Meadow Trail is located in Truro in the Cape Cod National Seashore. It runs from Head of the Meadow Road to High Head Road in Pilgrim Heights. The trail is owned by the Cape Cod National Seashore. It is used primarily for recreational purposes. The Head of the Meadow Trail is 1.9 miles long, 8.5 feet wide, and has no roadway crossings.

FIGURE 19 - HEAD OF THE MEADOW TRAIL AT HEAD OF THE MEADOW ROAD, TRURO

Route 28 Path

The Route 28 Path runs along Route 28 in Barnstable from Bearses Way to Old Stage Road. The path was constructed in 1980 by the Town of Barnstable as a safe route to the middle and high schools. However, some sections of the path have not been designed to bicycle path standards, with narrow pavement, insufficient shoulders, and inadequate roadway crossings. The path is used primarily for commuting, as it connects residences, businesses, schools and other points of interest. The Route 28 Path is 2.5 miles long, 8 feet wide, and has 28 roadway crossings.

Route 130 Path

The Route 130 Path runs along Route 130 from Heritage Memorial Park to just north of Route 28 in Mashpee. The path is owned by the town of Mashpee. The Route 130 Path is 2.4 miles long and has 11 roadway crossings.

FIGURE 20 - LOOKING NORTH ON ROUTE 130 BICYCLE PATH AT LOVELLS LANE, MASHPEE

FIGURE 21 - LOOKING SOUTH ON ROUTE 130 BICYCLE PATH AT LOVELL'S LANE, MASHPEE

Old Townhouse Road Trail

The Old Townhouse Road Trail runs from near Station Avenue, along Old Townhouse Road, behind the Bayberry Hills Golf Course, to Higgins Crowell Road in Yarmouth. Currently, the Rail Trail Extension Feasibility Study being performed by the towns of Yarmouth and Dennis is looking at using the Old Townhouse Road Trail right-of-way to connect the Rail Trail to Hyannis and the Claire Saltonstall Bikeway. The Old Townhouse Road Trail is 2 miles long, 8 feet wide, and has three roadway crossings.

FIGURE 22 - OLD TOWNHOUSE ROAD PATH EAST OF WEST YARMOUTH RD., YARMOUTH

FIGURE 23 - OLD TOWNHOUSE ROAD PATH WEST OF WEST YARMOUTH RD., YARMOUTH

FIGURE 24 - OLD TOWNHOUSE ROAD PATH AT THE BAYBERRY GOLF COURSE IN YARMOUTH

FIGURE 25 - OLD STAGE ROAD PATH AT THE SERVICE ROAD IN BARNSTABLE

Old Stage Road Path

The Old Stage Road Path begins at Route 149 in Barnstable, continues along the Service Road, and then turns down Old Stage Road. The path ends at Oak Street, where travelers can continue by sidewalk to Route 28 and Centerville shopping areas. The path was constructed in the early 1980s and is owned by the Town of Barnstable. It is used for both recreation and commuting, connecting West Barnstable and Centerville. The Old Stage Road Path is 1.9 miles long, and has six roadway crossings.

Forest Road Path

The Forest Road Path was built alongside Forest Road in 2006. It runs from Old Townhouse Road to Winslow Gray Road in Yarmouth. Continuing south on Forest Road, users can reach South Yarmouth and Route 28. Although terminating at Old Townhouse Road, the Forest Road Path does not directly connect with the trail there. The Forest Road Path is 1.4 miles long, 8.5 feet wide, and has 8 roadway crossings.

FIGURE 26 - FOREST ROAD PATH, LOOKING NORTH

FIGURE 27 - FOREST ROAD PATH, LOOKING SOUTH

Route 151 Path

The Route 151 Path runs along Route 151 from Mashpee Commons to Old Barnstable Road in Mashpee. At Old Barnstable Road, 2 forks turn south to access Mashpee High School. A third fork turns north and provides a connection to the Golf Club at Southport. The Route 151 Path is owned by the Town of Mashpee. The path is 1.1 miles long and has 1 roadway crossing.

TABLE 4 - BICYCLE PATH MILEAGE BY PATH

Path Name		Length in Miles	Width in Feet	Number of Roadway Crossings
Cape Cod Canal Bike Path	*Mainland*	7.0	8	7
	Cape Cod	6.5	8	2
	Total	13.6	8	9
Cape Cod Rail Trail	*Main Path*	21.8	8.5 / 10	45
	Harwich-Chatham Ext.	6.9	8.5	15
	Total	28.7	8.5 / 10	60
Downtown Falmouth Path		0.2	-	0
Forest Road Path		1.4	8.5	8
Forestdale School Path		0.4	10	
Head of the Meadow Trail		1.9	8.5	0
Hyannis Transportation Center Path		0.4	-	3
Nauset Trail		1.9	8	6
Nickerson State Park Trails		6.8	-	6
Old Stage Road Path		1.9	-	6
Old Townhouse Road Path		2.0	8	3
Provincelands Trail		7.6	8	4
	Herring Cove Beach Path	0.1	8	0
Route 130 Path		2.4	-	11
Route 151 Path		1.3	-	1
Route 28 Path		2.6	8	28
Setucket Road and Dennis Paths		7.0	8.5	38
Shining Sea Bikeway		10.6	8.5	16

Hyannis Transportation Center Path

The Hyannis Transportation Center Path runs from Route 28 in Barnstable to Main Street Hyannis. The trail was built during the construction of the Hyannis Transportation Center in 2002. The Hyannis Transportation Center Path is 0.4 miles long and has three roadway crossings.

Forestdale School Path

The Forestdale School Path is located in Sandwich. It connects Route 130 to the Forestdale School. Given that one can walk or bicycle from the nearby neighborhoods, the shared-use path serves the needs of students traveling to and from the school. The Forestdale School Path is 0.4 miles long, 10 feet wide, and has two roadway crossings.

Downtown Falmouth Path

The Downtown Falmouth Path is located on Hamlin Street in Falmouth, between Dillingham Avenue and Katherine Lee Bates Road. The bicycle path is owned by the Town of Falmouth. As a connection to downtown Falmouth, the path is used to access town hall, the library, and businesses. The Downtown Falmouth Path is 0.2 miles long and has no roadway crossings.

BICYCLE ROUTES

A bicycle route is any road, path, or trail that has been designated for bicycle use. In many cases, these are side streets with a low volume of traffic, or roads with wide shoulders. In the context of this section, only those bicycle routes located on roadways are discussed. Roadways designated for bicycle usage have the ability to link paths where bicycle rights-of-way are limited or unavailable. Many bicycle routes exist on Cape Cod, some of which are better signed than others. They allow bicycle users a wide network of travel across Cape Cod.

Claire Saltonstall Bikeway

FIGURE 28 - SIGNAGE ON STATE BICYCLE ROUTE 1

The Claire Saltonstall Bikeway, or State Bicycle Route 1, is a series of bicycle paths and on-street routes that travel from Boston to both Provincetown and Woods Hole. The bikeway starts on Cape Cod at Route 3A in Bourne. It travels across the Sagamore Bridge, utilizing the bridge's sidewalk. After the Sagamore Bridge, the bikeway splits. One branch travels south, parallel to Route 28 and eventually joining with the Shining Sea Bikepath, until reaching Woods Hole. The main branch travels parallel to Route 6, joins with the Cape Cod Rail Trail, and then continues north to Provincetown. According to MassBike, the bikeway was mapped and established in 1978 by the Massachusetts General Court as a memorial to Claire Saltonstall, who died in a bicycle-motor vehicle accident. The Claire Saltonstall Bikeway, indicated by a green oval, is one of the best signed bicycle routes on Cape Cod. According to MassBike, however, many signs have disappeared and the route is impossible to follow without a map. The Cape Cod section of the Claire Saltonstall Bikeway is 98.3 miles in length. The Bourne to Provincetown portion is about 75.4 miles long, while the Bourne to Woods Hole portion is 22.9 miles long. Overall, the Claire Saltonstall Bikeway is about 165 miles long.

FIGURE 29 - CLAIRE SALTONSTALL BIKEWAY – CURRENT ROUTING

In February of 2015 the Cape Cod Commission published "Claire Saltonstall Memorial Bikeway: Cape Cod Segment –Recommended Route Revisions." The report is a result of collaboration between Commission staff and bikeway committee members in the affected towns.

The report includes recommendations to revise the route to create more comfortable conditions for bicyclists (e.g., lower volume roads, shared use paths). The report is available online at:

www.capecodcommission.org/bikeped

The following figures show details of the proposed realignment for the various segments of the route. The realignment maximizes use of shared-use paths where available and

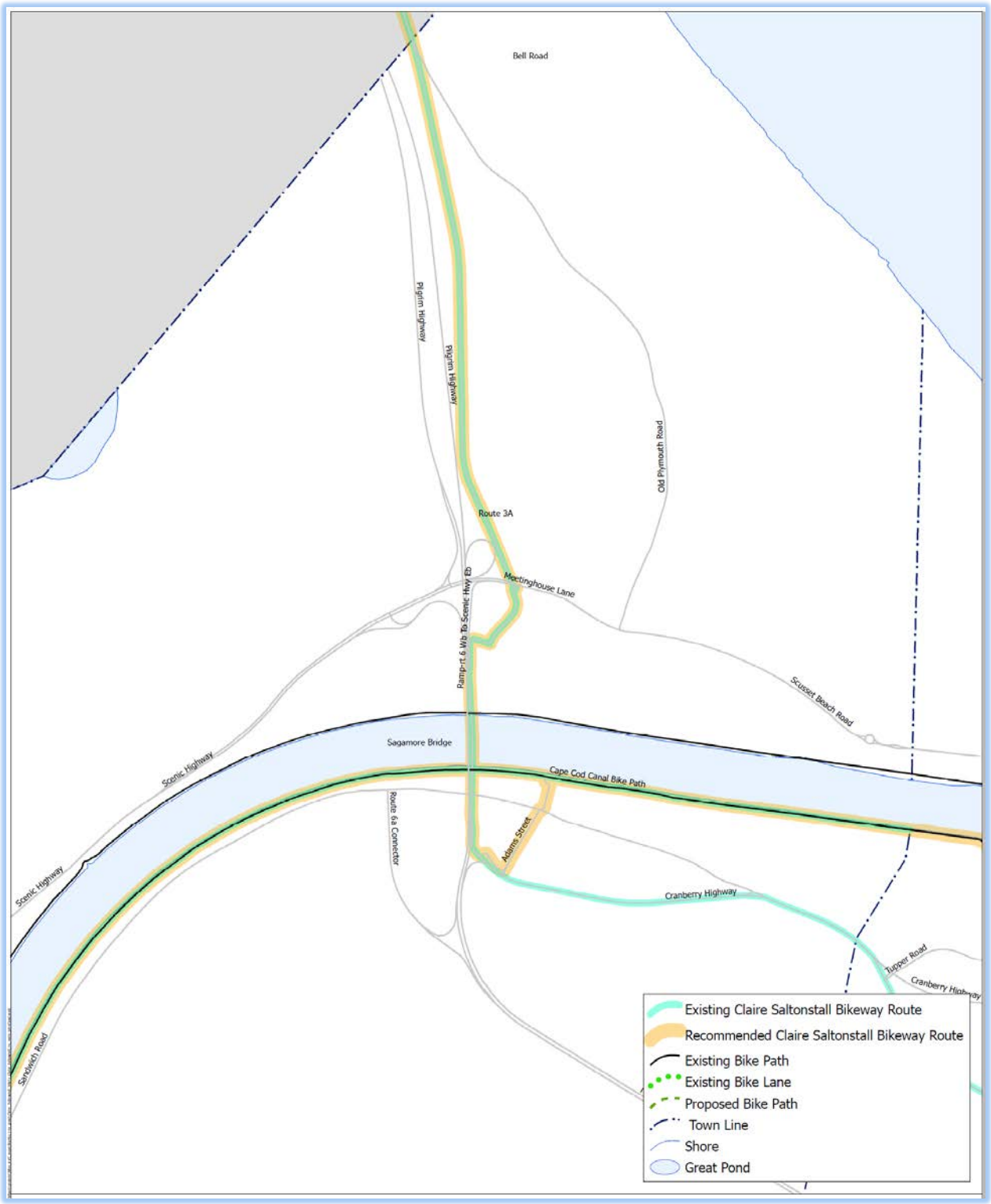

FIGURE 30 – RECOMMENDED SALTONSTALL ROUTE (BOURNE)

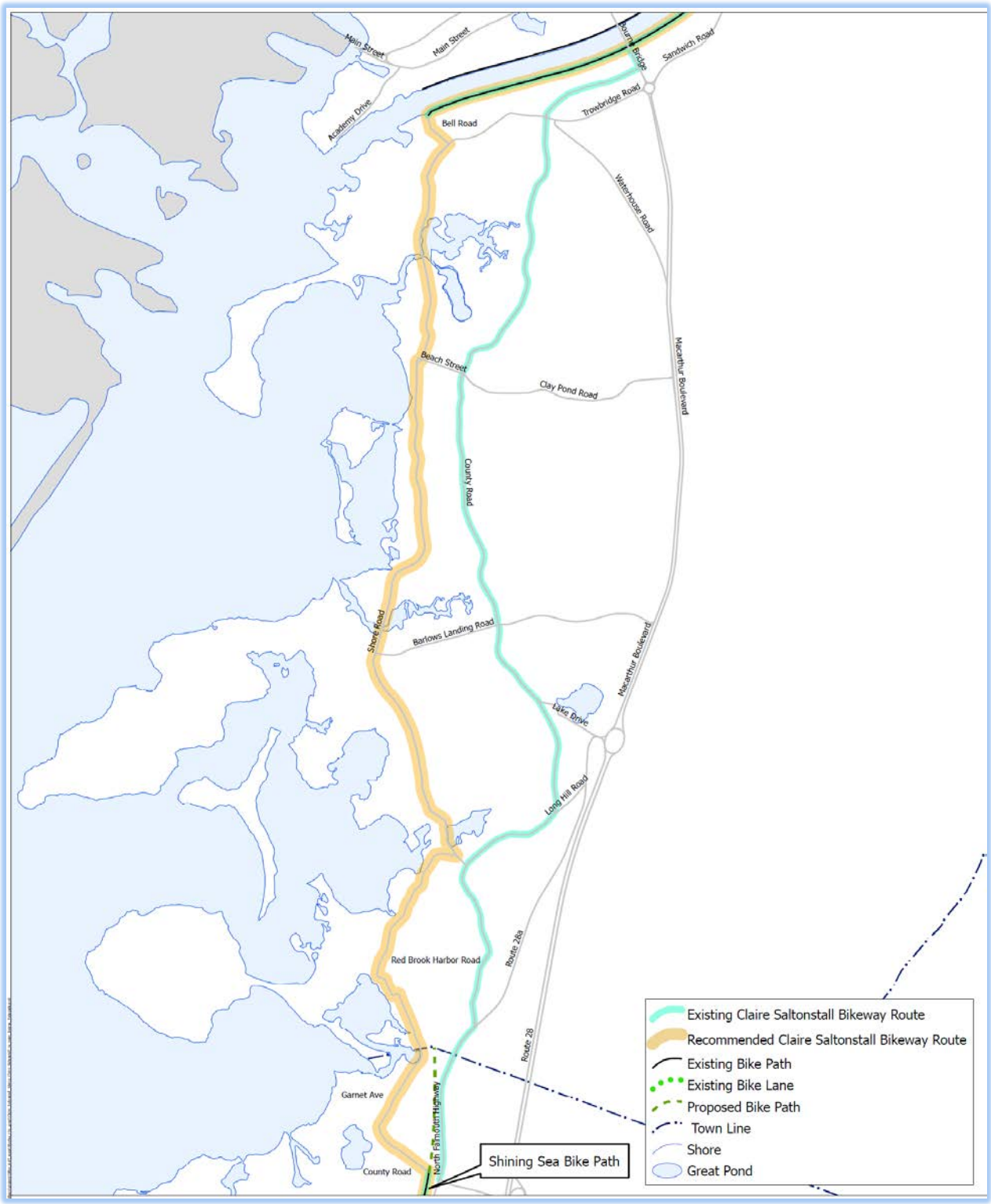

FIGURE 31 - RECOMMENDED SALTONSTALL ROUTE (BOURNE-FALMOUTH)

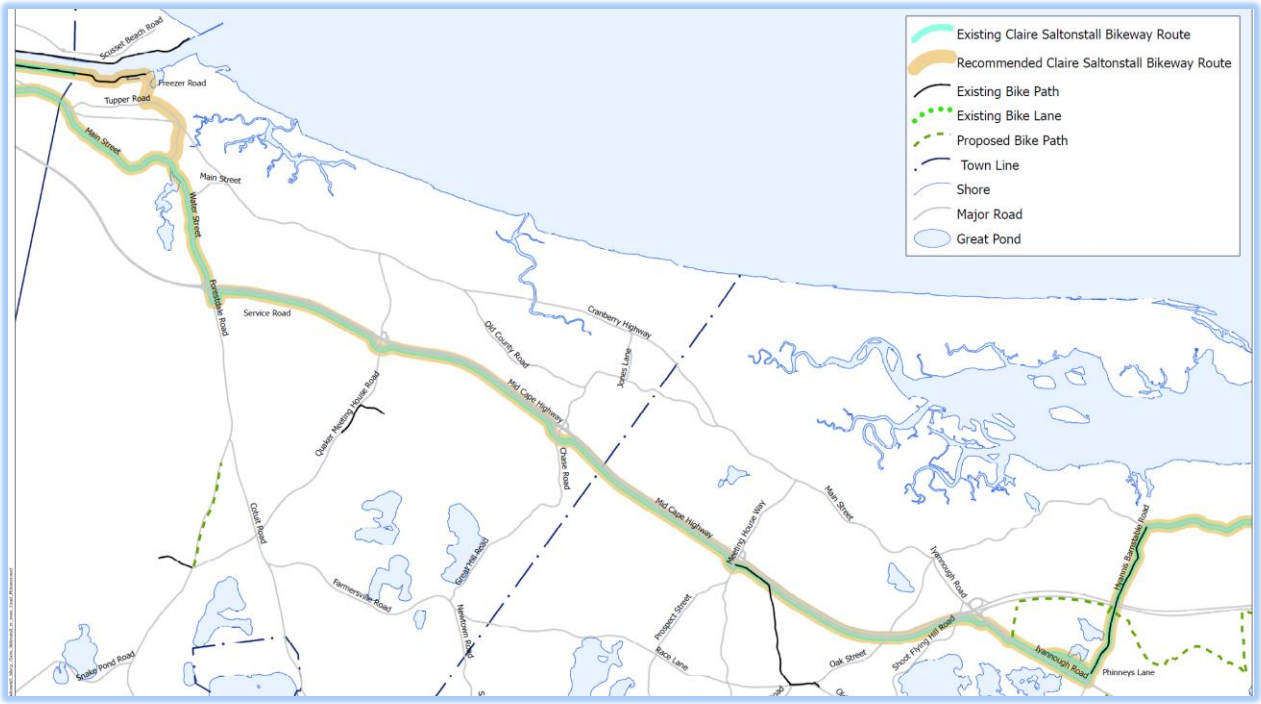

FIGURE 32 - RECOMMENDED SALTONSTALL ROUTE (BOURNE-SANDWICH-BARNSTABLE)

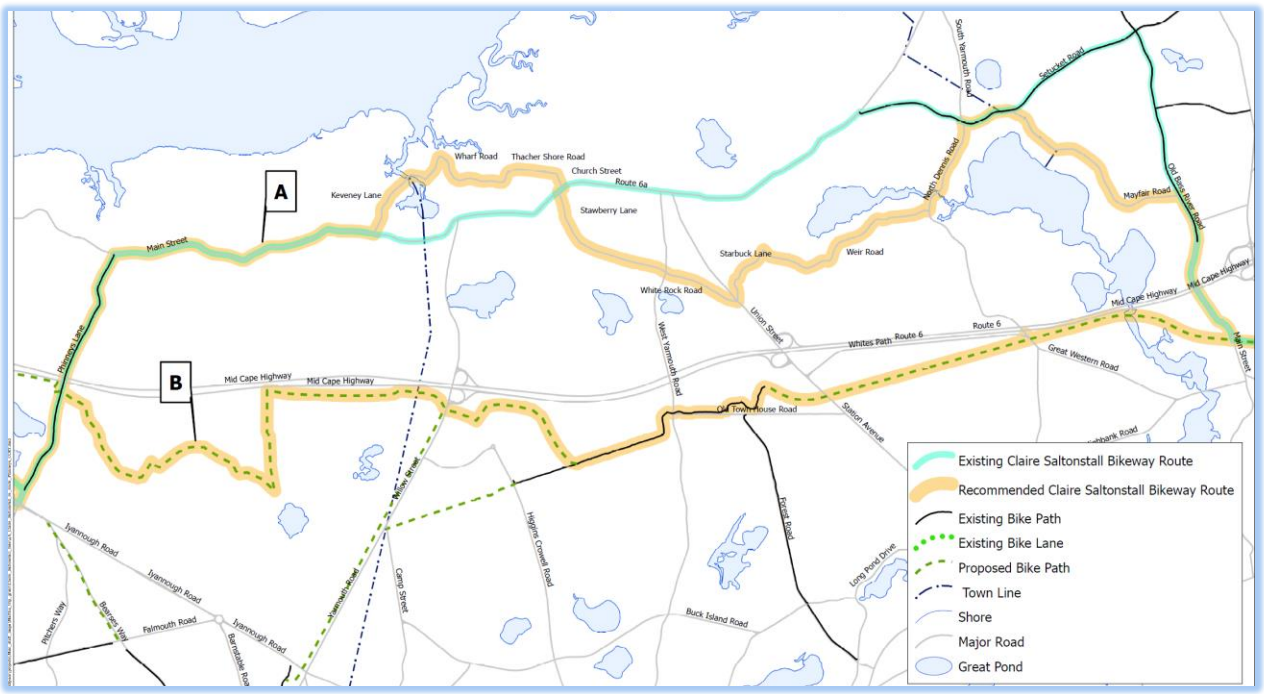

FIGURE 33 - RECOMMENDED SALTONSTALL ROUTE (BARNSTABLE-YARMOUTH-DENNIS)

FIGURE 34- RECOMMENDED SALTONSTALL ROUTE (DENNIS-HARWICH-BREWSTER-ORLEANS-EASTHAM)

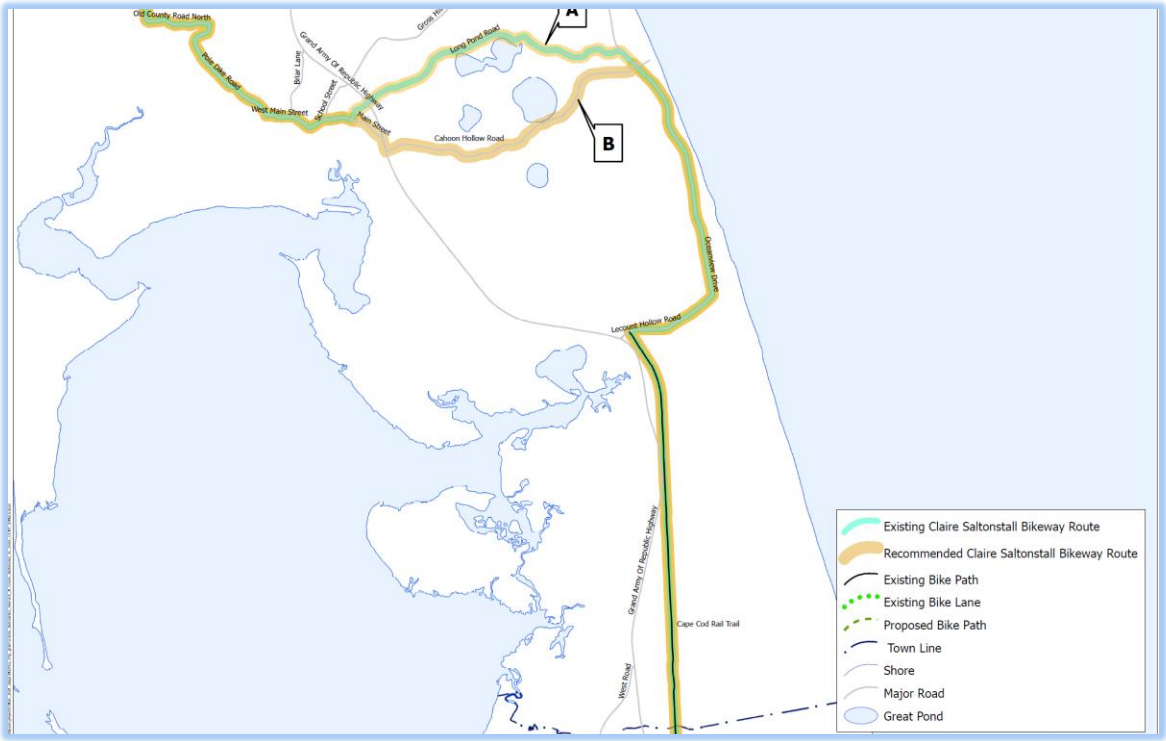

FIGURE 35 – RECOMMENDED SALTONSTALL ROUTE (WELLFLEET)

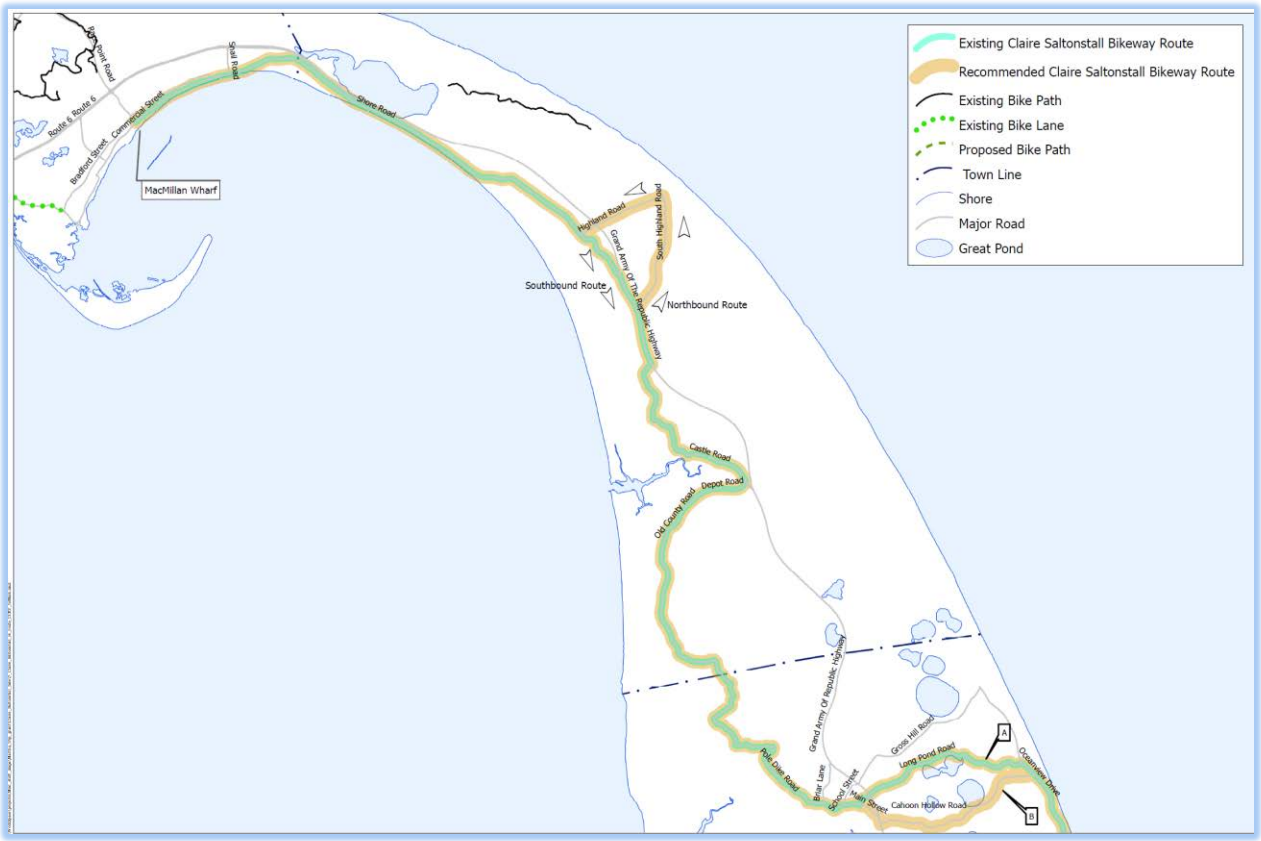

FIGURE 36 - RECOMMENDED SALTONSTALL ROUTE (WELLFLEET-TRURO-PROVINCETOWN)

State Bicycle Routes

MassGIS has also identified other bicycle routes throughout Cape Cod. Some examples are Buck Island Road in Yarmouth, Great Western Road in Dennis and Harwich, or Great Neck Road in. The Cape Cod Commission and AmeriCorps performed a survey of many of these roads in 2006. According to the survey, many of these roads are unsigned and some have sharp turns, no shoulders, or high traffic volumes. Evaluating existing bicycle routes, maintaining proper signage, and identifying possible new routes will help to encourage more bicycle use on Cape Cod, both commuter and recreational.

Falmouth Bicycle Routes

The Town of Falmouth has designated many of their roads to be bicycle routes. Some examples are Gifford Street, Sippewisset Road, Route 151, and Menauhant Road. According to a survey conducted by the Cape Cod Commission and AmeriCorps performed in 2006, many of these routes are signed and have sidewalks. In total, there are 101.8 miles of roadway in Falmouth designated as bicycle routes.

FIGURE 37 - ROUTE 28 NORTH OF THE DAVIS STRAITS INTERSECTION, A DESIGNATED BICYCLE ROUTE IN FALMOUTH

Low Volume Roads

Bicyclists and pedestrians can utilize low volume roads with minimal automobile conflicts. Cape Cod has 462.8 miles of major roads with summer average daily volumes (ADT) of 5,000 vehicles per day or less, and 91.2 miles of major roads with 1,000 vehicles per day or less. For reference, an ADT of 5,000 is equivalent to about one vehicle every seven seconds during daylight hours. An ADT of 1,000 is equivalent to about 1 vehicle every 35 seconds during daylight hours. Cape Cod also has about 1,803.4 miles of local paved roads that are suitable for safe bicycle and pedestrian traffic. These roads must be considered as part of the bicycle and pedestrian network, since trips usually begin or end on side streets or in low traffic residential neighborhoods.

FIGURE 38 - LOW VOLUME ROADS

SIDEWALK NETWORK

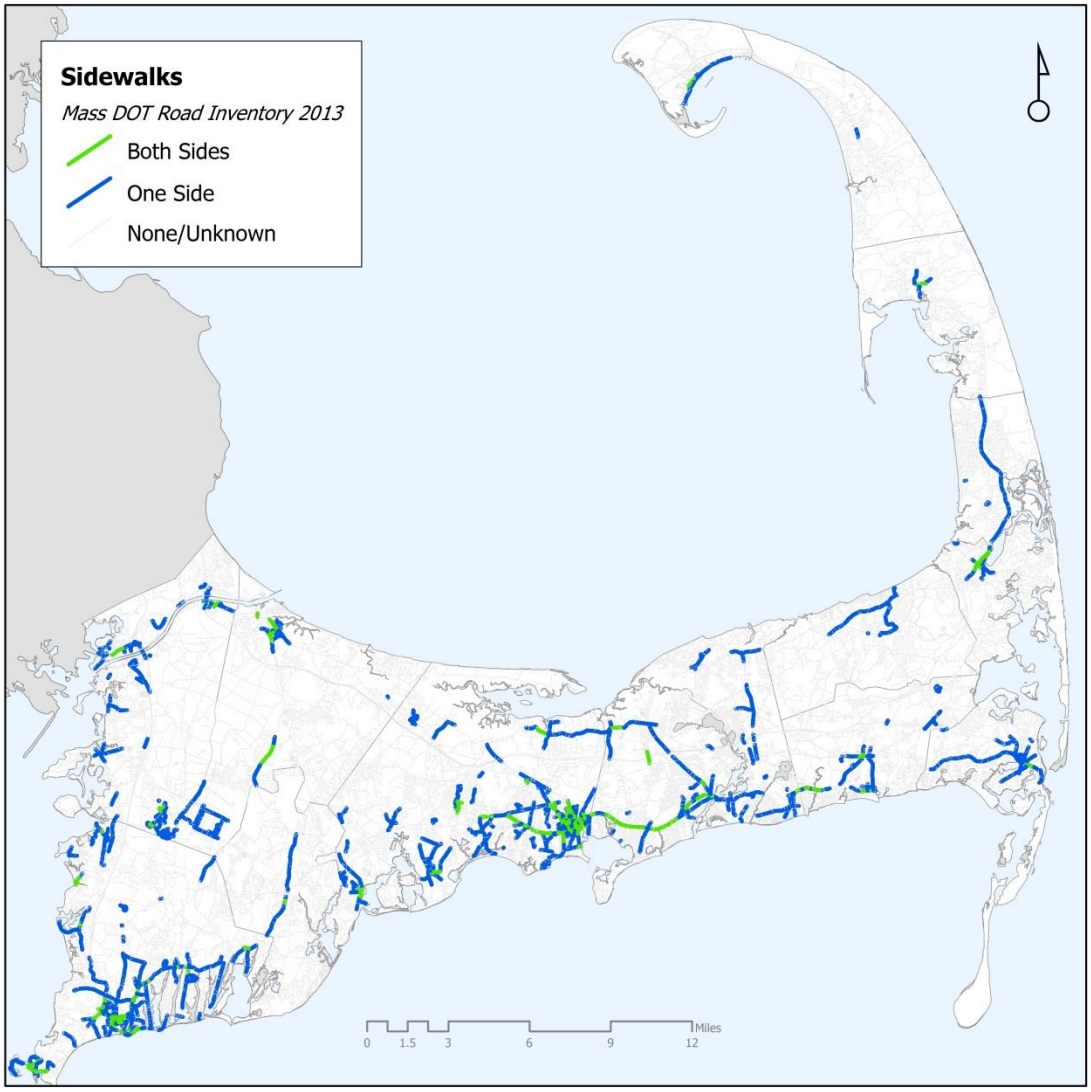

FIGURE 39 - SIDEWALK NETWORK

Sidewalks are paved surfaces, usually adjacent to roadways, which are designed primarily for pedestrian usage. Sidewalks are typically 4 to 6 feet wide, made with slabs of concrete, paved asphalt, bricks, or other hard substances. The Americans with Disabilities Act requires sidewalk curb cuts to be large enough and shallow enough for wheelchair usage. Telephone poles, road signs, and other architectural barriers must also be removed in order to create an unobstructed path for walking. In Massachusetts, bicyclists may ride on sidewalks outside business districts unless otherwise prohibited by local ordinances.

According to the 2008 Massachusetts Statewide Roadway Inventory File, there are 198.3 miles of sidewalk located on Cape Cod. In addition, 26.42 miles of road have sidewalks on either side.

These roads are concentrated primarily in Hyannis and downtown Falmouth. Of all paved roadways on Cape Cod, 5.1% have a sidewalk on at least one side. The average sidewalk width on Cape Cod by mileage is 4.4 feet.

All of these figures illustrate pedestrian issues that must be addressed by any review of bicycle and pedestrian transportation. Over 90% of Cape Cod roadways do not have sidewalks. While many of these streets are low volume and residential, some are not and do warrant sidewalks. On a street without sidewalks, pedestrians must walk in the shoulders or on private property. This is not only less safe, but it restricts access for the elderly and disabled. Moreover, some sidewalks on Cape Cod have architectural barriers, such as telephone poles, located within the sidewalk. Obstructions like these make sidewalk navigation more difficult, especially for the disabled. Expanding the existing sidewalk network and correcting improperly designed sidewalks will help to encourage pedestrian usage in, around, and between business and population centers.

The sidewalk network also includes crosswalks. Crosswalks provide a safe means for pedestrians and other sidewalk users to cross roadways. All crosswalks are marked on the roadway surface by white paint. Generally, crosswalks located on lower volume roads have no traffic control devices, or a sign telling motorists to yield to pedestrians. However, many crosswalks have crossing signals that stop traffic, allow pedestrians to cross, and warn pedestrians when traffic is about to resume. Typically, crossing signals are located with traffic signals at roadway intersections. However there are four pedestrian signals on Cape Cod that are not located at a roadway intersection. Ensuring that crosswalks are located at high pedestrian areas throughout Cape Cod will help to improve safety as well as access. Access can also be improved by ensuring that crosswalks accommodate all users, including the elderly and disabled. Properly designed curb cuts that are usable by wheelchairs, tones at crosswalk signals for the blind, and other amenities can significantly improve sidewalk access for the disabled.

CAPE COD PATHWAYS

The Barnstable County Commissioners and the Cape Cod Commission are working with citizens and organizations from across Cape Cod to create a Cape-wide network of walking trails. This network is called Cape Cod Pathways. When complete, Cape Cod Pathways will extend from Provincetown to Falmouth and Bourne and provide a connection between the Seashore and the Cape's wooded interior, between the peninsula's historic villages and remaining backcountry. Through the work of many volunteers and civic and environmental leaders, the Pathways east-west trail between Provincetown and the upper Cape is approximately now one-third dedicated.

Cape Cod Pathways was initiated in November 1993. Since then the project has garnered widespread support from the Barnstable County Assembly of Delegates, Cape Cod National Seashore, town officials, conservation organizations, businesses, and other groups. Trail planning currently under way in Cape Communities will result in newly dedicated trails in the years ahead.

The creation of a Cape-wide trail network is an ambitious undertaking that requires planning, mapping, community organizing, fundraising, special events, publicity, negotiation of land and easements, clearing, and construction work. More information about Cape Cod Pathways is available on the internet:

www.capecodcommission.org/pathways

Many of the trailheads have been mapped using Google mapping as shown in the following figure. The green trailhead symbols represent Cape Cod pathways that are accessible via public transportation. In addition to the larger goal of connecting trails throughout the Cape, natural attractions such as rivers, lakes and ponds are recognized as important features for the Pathways program to provide access.

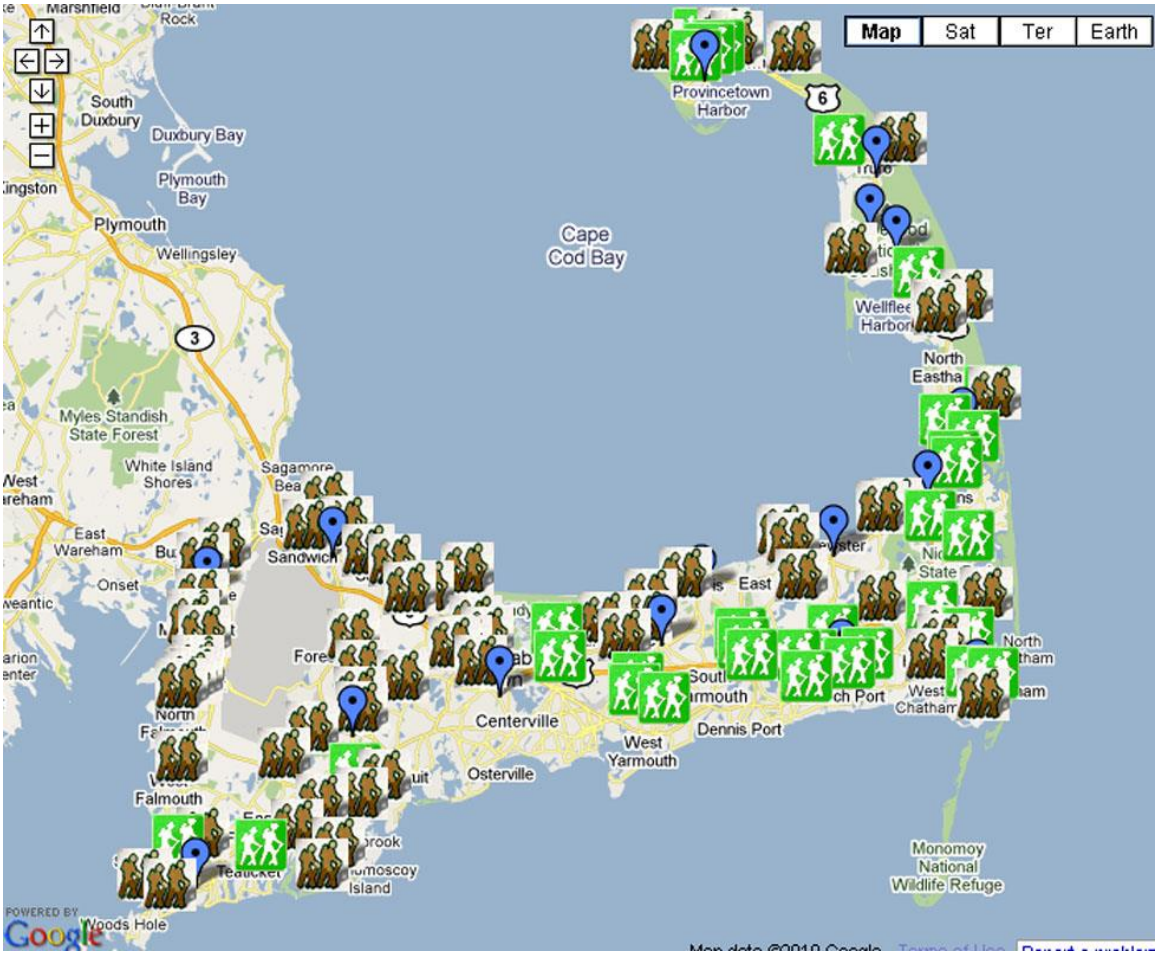

FIGURE 40 - CAPE COD PATHWAYS – Trail Head Locations/Transit Accessibility

BICYCLE AND PEDESTRIAN AMENITIES

Beyond bicycle and pedestrian infrastructure, there are various amenities that address the needs of the traveler. Employers and businesses almost always have enough automobile parking. The same does not always hold true for bicycles. Bicycle racks allow the traveler to securely park their property without fearing that it will be stolen or damaged. Water fountains, vending machines or nearby cafes provide the traveler with nourishment after their ride or walk. Public restrooms are also useful to both pedestrians and bicyclists. Showers and locker facilities allow employees to change into clean clothes. All of these amenities help to encourage non-motorized transportation.

There are many amenities available to bicyclists and pedestrians on Cape Cod. The Hyannis Transportation Center has bicycle racks, public restrooms, water fountains, vending machines and other user amenities. In addition, the Cape Cod Regional Transit Authority (CCRTA) offers bicycle racks with space for two bicycles on each CCRTA bus. Bicycle racks, restrooms, food, and other amenities are also available at the Exit 6 Rest Area near the Barnstable Park-and-Ride Lot. The Steamship Authority Piers in Hyannis and Woods Hole offer restrooms and vending machines to customers who arrive by bicycle. Moreover, some employers offer bicycle and pedestrian amenities to their employees. According to the Massachusetts State Bicycle Plan, all such amenities address the "destination barriers" that bicyclists and pedestrians perceive, such as not being able to safely park their bicycle, showing up to work sweaty, or arriving at their workplace hungry and thirsty. By making non-motorized travel more attractive to potential users, more people will be inclined to ride a bicycle and walk to work.

BICYCLE AND PEDESTRIAN FACILITY ACCESSIBILITY AND MOBILITY

Not everyone can ride a bicycle or walk as their primary mode of transportation. Users must live relatively close to where they work and shop in order to ensure a reasonable travel time. The low density of Cape Cod development is in this way not conducive to bicycle travel. Moreover, a certain level of fitness is necessary to deal with the physical exertion. On Cape Cod, where many residents are elderly, bicycling or walking may not be practical for some travelers. Despite these barriers, there are many potential users who can be targeted and encouraged to travel by bicycling or walking for its positive environmental, physical, and economic benefits.

Bicycle paths and routes can be made more accessible by ensuring that there are adequate entry points, safe roadway crossings, and proper signage. There is a tradeoff between entry points and roadway crossings, since roadways are often the place where bicyclists enter a bicycle path. As the number of entry points increase, so do the number of roadways bicyclists must cross in order to travel the path. Most Cape Cod bicycle path-roadway crossings have yellow stanchions or gates that encourage bicyclists to stop and watch for vehicles before crossing. Two roadway crossings of the Cape Cod Rail Trail in Harwich and Brewster have signals which warn oncoming vehicles when bicyclists or pedestrians are approaching the intersection. Signage is also important to accessibility, since it directs users to and along the path. Posted maps, street signs, and signs listing local points of interest also help to direct travelers to their destinations. By implementing safety and signage measures such as these, bicycle and pedestrian facilities can become more accessible to both first time and frequent users.

FIGURE 41 - WEST YARMOUTH ROAD CROSSING OF THE OLD TOWNHOUSE ROAD TRAIL

FIGURE 42 - MEETINGHOUSE ROAD CROSSING OF THE HARWICH-CHATHAM EXTENSION OF THE CAPE COD RAIL TRAIL

Bicycle paths on Cape Cod, with the exception of the Rail Trail and Shining Sea Bikepath, are generally too short, or the wrong location, to facilitate commuting. For example, the Nauset Trail only conducts travelers from Route 6 to the Cape Cod National Seashore. The Forest Road Path does not continue all the way to the commercial activity on Route 28. The key is to construct and connect paths in such a way as to link areas with residential, commercial, and recreational uses. Otherwise, bicyclists will only be able to use bicycle paths as part of a larger bicycle route or for recreational purposes.

Because bicycles are small and lightweight, they are very portable and easy to transfer from mode to mode. Bus services, such as the CCRTA, Plymouth and Brockton, and Peter Pan / Bonanza Bus Lines, can accommodate cyclists with racks and storage areas. The Steamship Authority and other ferry services allow passengers to bring their bicycles for a fee. Special reservations can also be made with air carriers in order to transport bicycles. For this reason, bicycle transportation can help to connect users to other modes of transportation.

BICYCLE AND PEDESTRIAN ROUTE PLANNING TOOLS

A key component of Cape Cod bicycle planning is to involve the public in identifying the “best” bicycle routes. The bikeways website includes links showing potential on-road bicycle routes connecting major destinations on Cape Cod using Google's mapping service. Some non-roadway alternatives (such as the Cape Cod Canal multi-use path are not shown). The goal of establishing these routes is to provide for the "best" bicycle travel within, among, and through the attractive areas of the Cape while avoiding narrow and busy roads such as Route 6A or Route 28.

These alternatives provides direct access to major roads and do not require cyclists to travel more than about one and a half times the distance that would be traveled if the cyclist stayed on

the major road. Additionally, the alternate route still provides a showcase for the scenic and historic qualities of the area.

Town planning officials and concerned citizens are invited to comment and provide suggestions on specific routing. The mid-term goal is to provide online maps and on-road signage to inform the public (both to help cyclists with way-finding and to alert motorists of potential bicyclists). Longer-term, those segments of the routes that pose the greatest difficulty in safely biking then will be considered for improvements or for the development of other alternatives. Two basic regional routes are explored: a Northside bike route complementary to Route 6A connecting the Cape Cod Canal in Bourne to Rock Harbor Road in Orleans (the so-called "Route 6B"); and, a Southside bike route complementary to Route 28 connecting Woods Hole in Falmouth to Chatham Light (the so-called "Route 28B").

"ROUTE 6B" – NORTHSIDE BICYCLE ROUTE

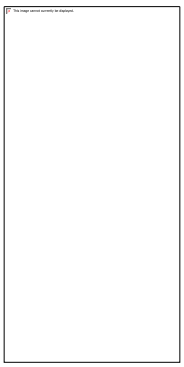

Figure 43 - Route "6B" logo

The following figure shows a potential on-road bicycle route from the Cape Cod Canal area in Sandwich to the area including the Eastham Rotary and Rock Harbor at the Orleans/Eastham town line. Some non-roadway alternatives (such as the Cape Cod Canal multi-use path are not shown). The goal of establishing the Northside Route is to provide for the "best" bicycle travel within, among, and through the areas north of Route 6 in the towns from Sandwich to Orleans - and to generally avoid the narrow and busy Route 6A.

This alternative provides direct access to Route 6A and does not require cyclists to travel more than about one and a half times the distance that would be traveled if the cyclist stayed on Route 6A. Additionally, the alternate route still provides a showcase for the scenic and historic qualities of the district.

This figure was developed as part of the Route 6A Corridor Management Plan update, released by the Commission in 2010. The maps indicate useful alternatives to Route 6A as well as connector routes. The sections of Route 6A identified in red indicate road segments where no viable alternative exists.

Town-by-town maps showing the main "Route 6B" route are shown in subsequent figures.

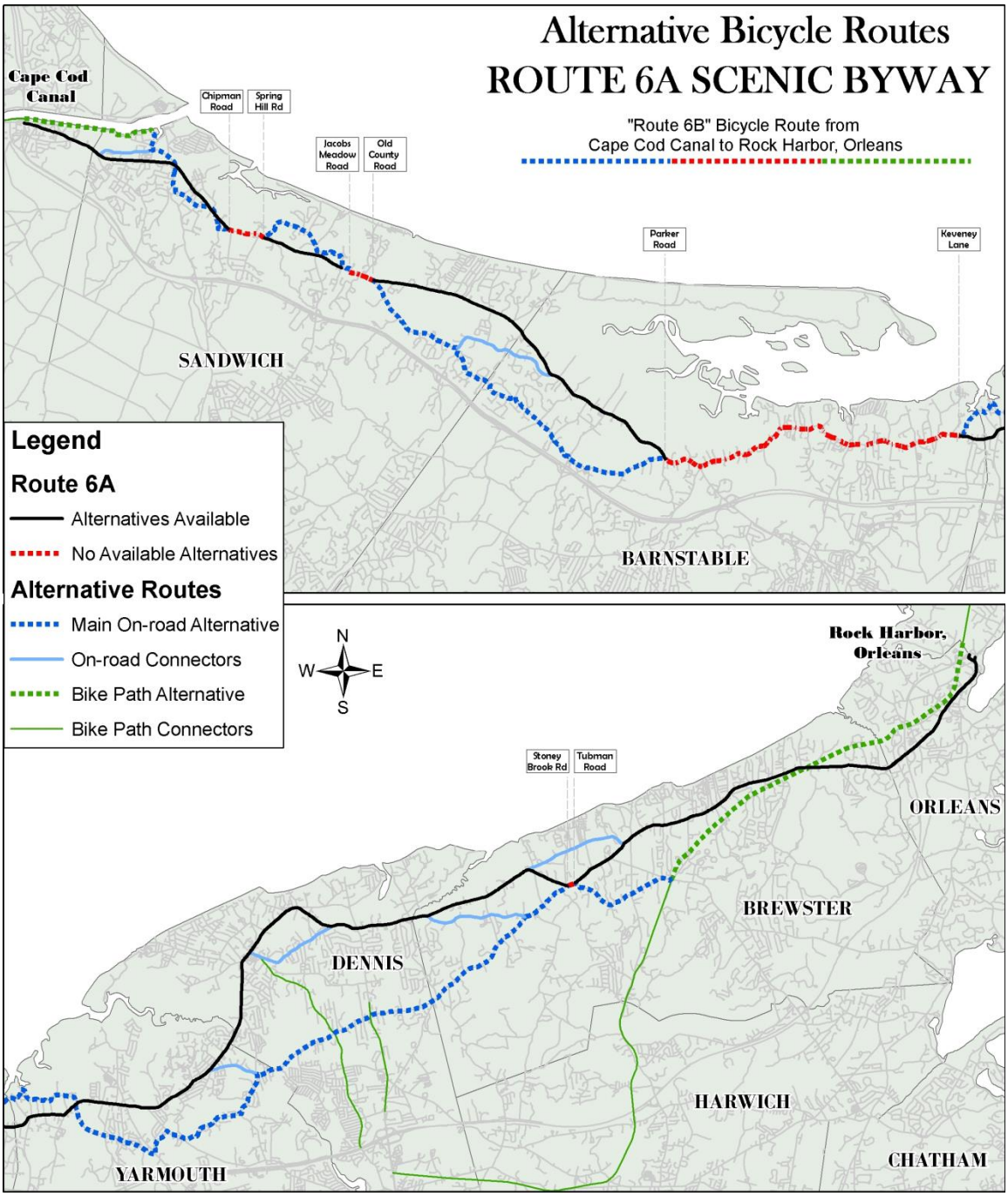

FIGURE 44 - ROUTE "6B" – NORTHSIDE BICYCLE ROUTE

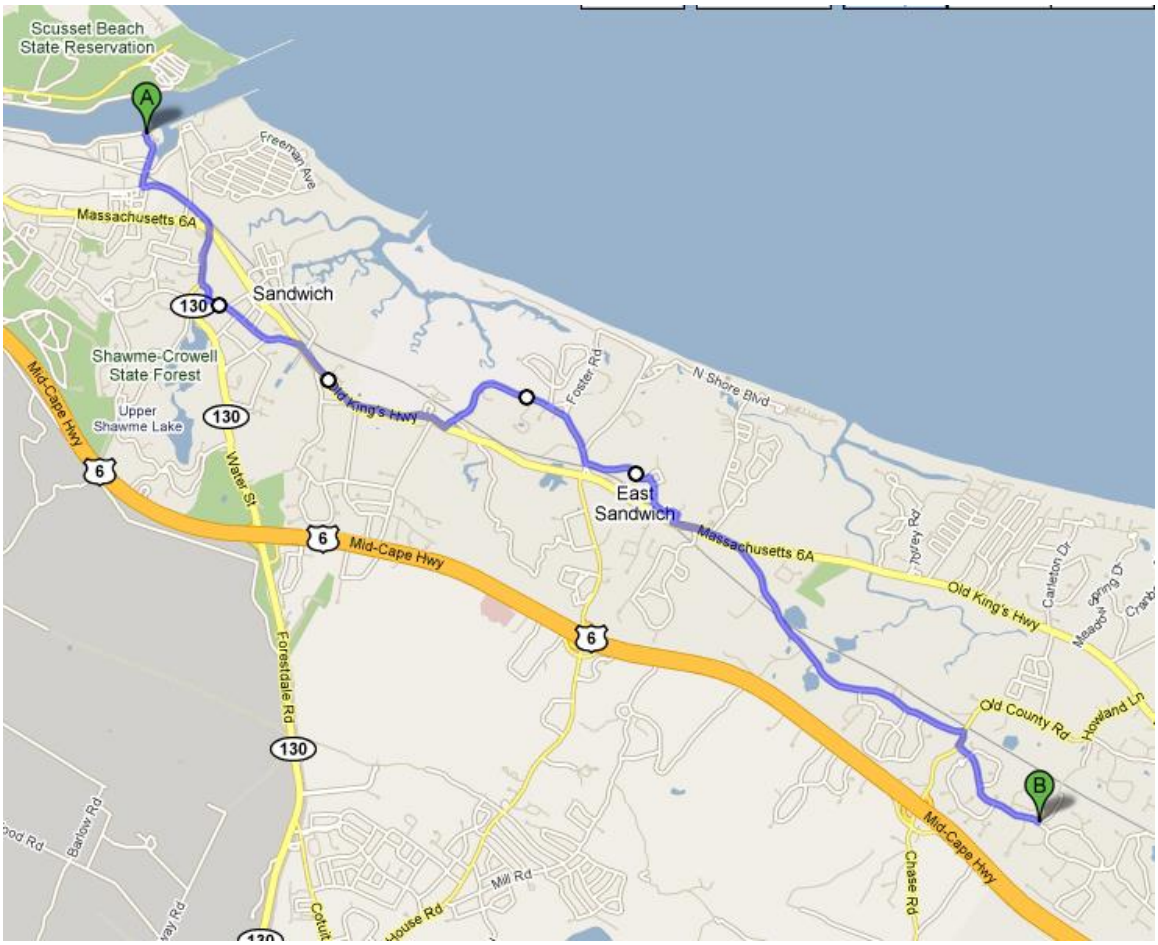

FIGURE 45 - POTENTIAL ROUTE "6B" IN SANDWICH
(Source: Cape Cod Commission, Google Maps)

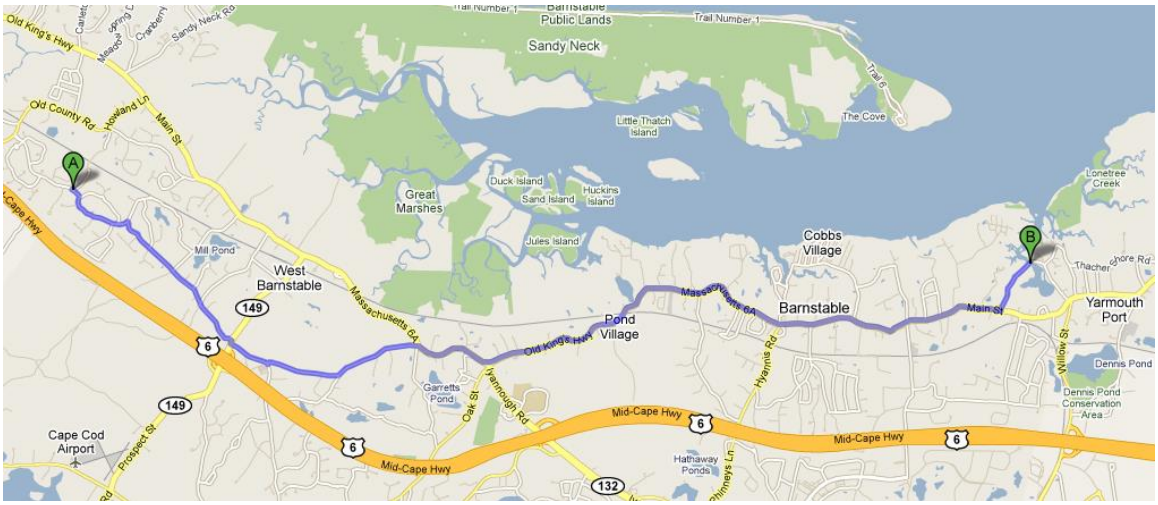

FIGURE 46 - POTENTIAL ROUTE "6B" IN BARNSTABLE
(Source: Cape Cod Commission, Google Maps)

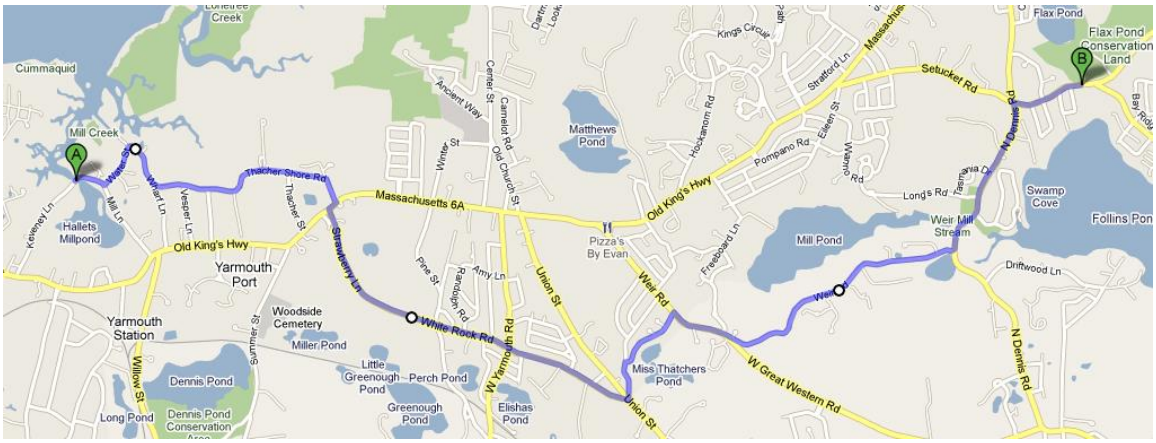

FIGURE 47 - POTENTIAL ROUTE "6B" IN YARMOUTH
(Source: Cape Cod Commission, Google Maps)

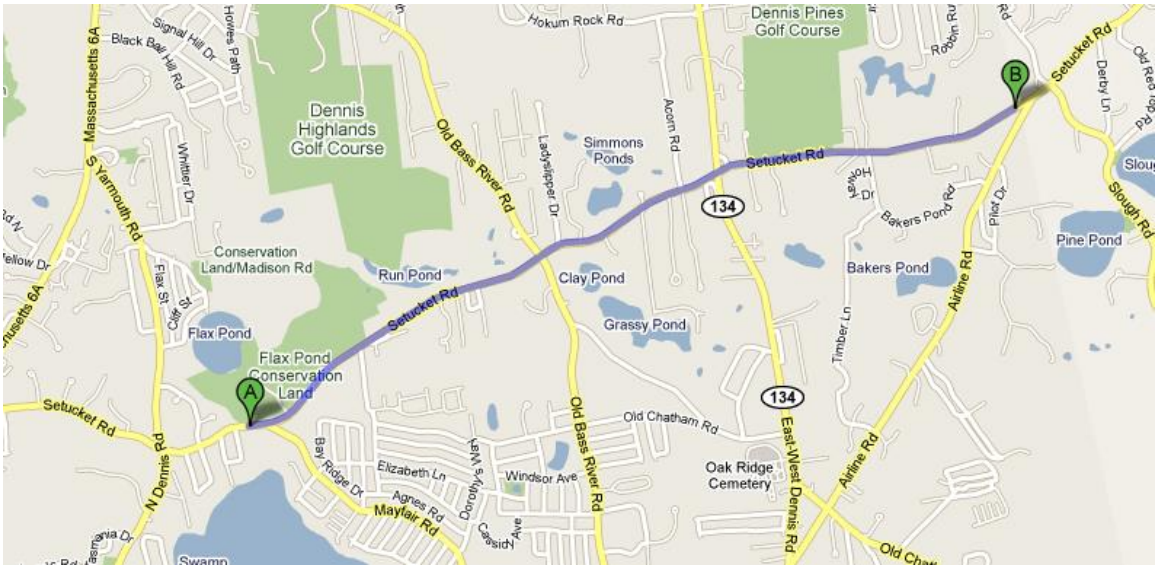

FIGURE 48 - POTENTIAL ROUTE "6B" IN DENNIS
(Source: Cape Cod Commission, Google Maps)

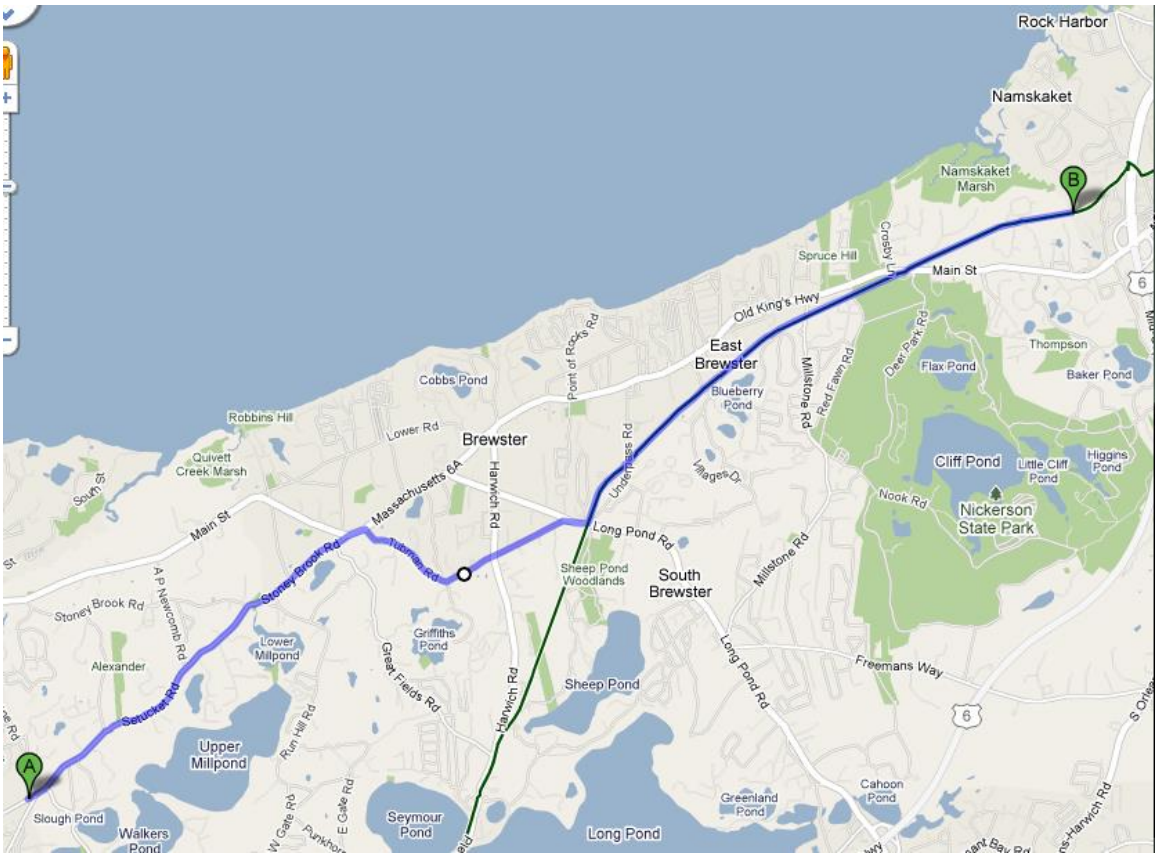

FIGURE 49 - POTENTIAL ROUTE "6B" IN BREWSTER
(Source: Cape Cod Commission, Google Maps)

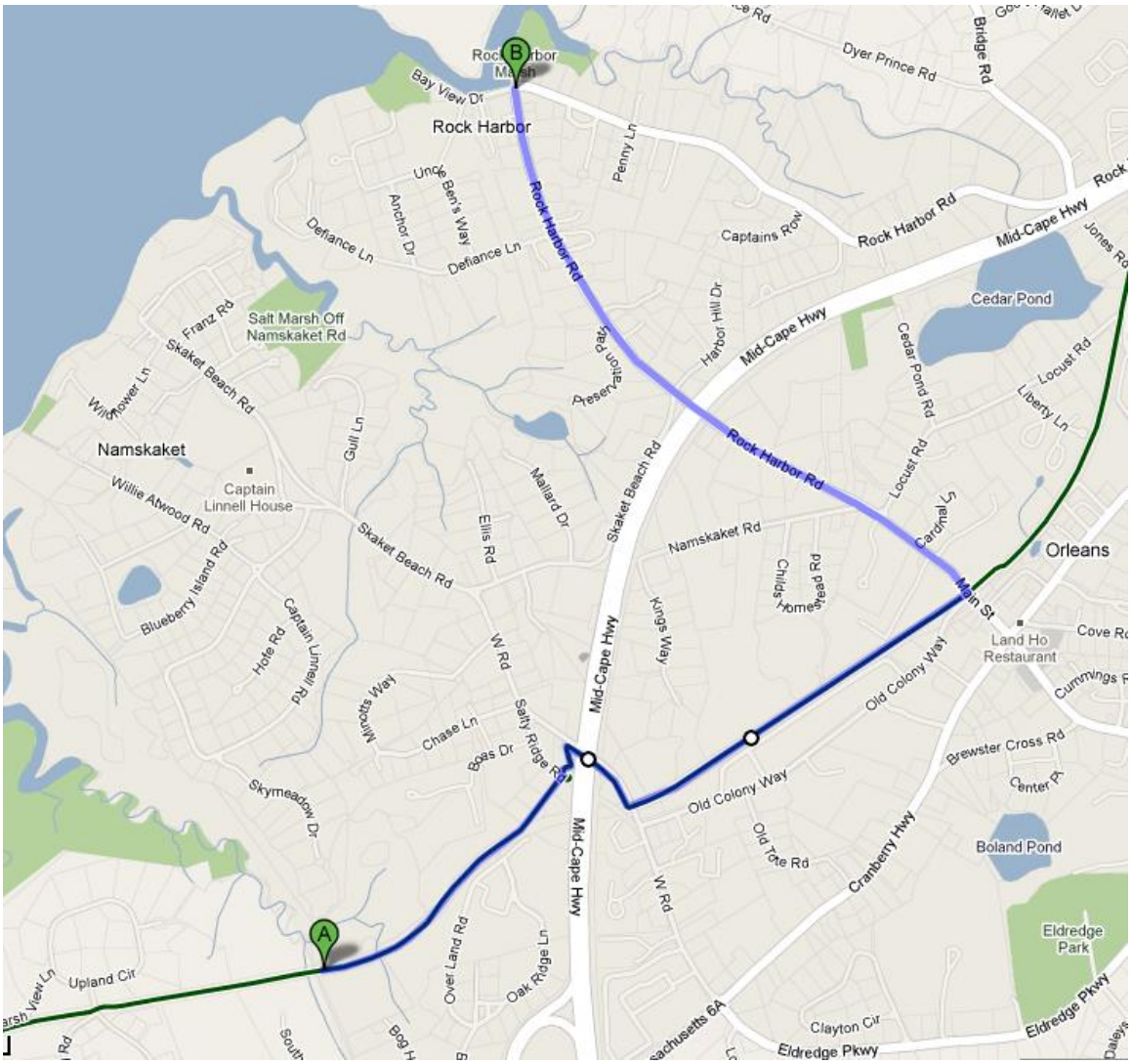

FIGURE 50 - POTENTIAL ROUTE "6B" IN ORLEANS
(Source: Cape Cod Commission, Google Maps)

"ROUTE 28B" – SOUTHSIDE BICYCLE ROUTE

Figure 51 - Route "28B" logo

The following figures show a potential on-road bicycle route from the Woods Hole in Falmouth to Chatham Light. The goal of establishing the Southside Route is to provide for the "best" bicycle travel within, among, and through the areas south of Route 6 in the towns from Falmouth to Chatham - and to generally avoid the narrow and busy Route 28.

This alternative provides direct access to Route 28 and does not require cyclists to travel more than about one and a half times the distance that would be traveled if the cyclist stayed on Route 28. Additionally, the alternate route still provides a showcase for the scenic and historic qualities of the area.

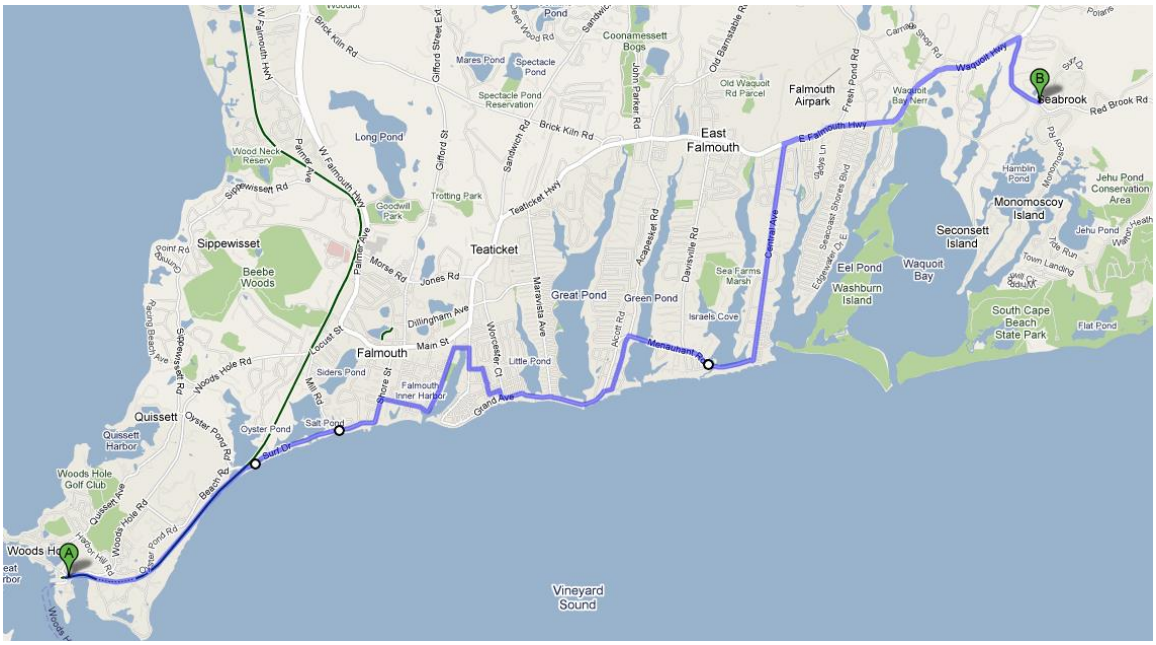

FIGURE 52 - POTENTIAL ROUTE "28B" IN FALMOUTH
(Source: Cape Cod Commission, Google Maps)

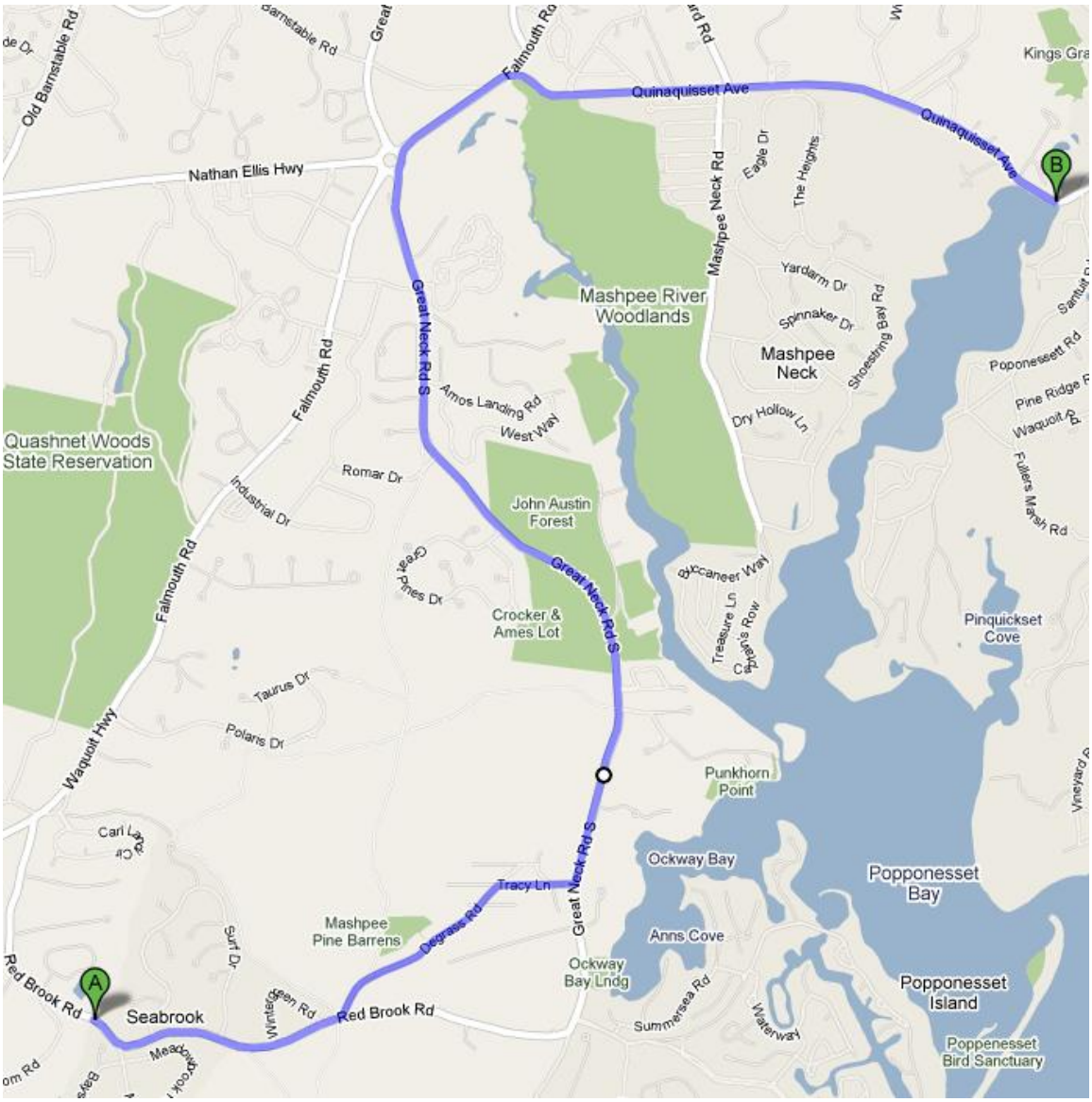

FIGURE 53 - POTENTIAL ROUTE "28B" IN MASHPEE
(Source: Cape Cod Commission, Google Maps)

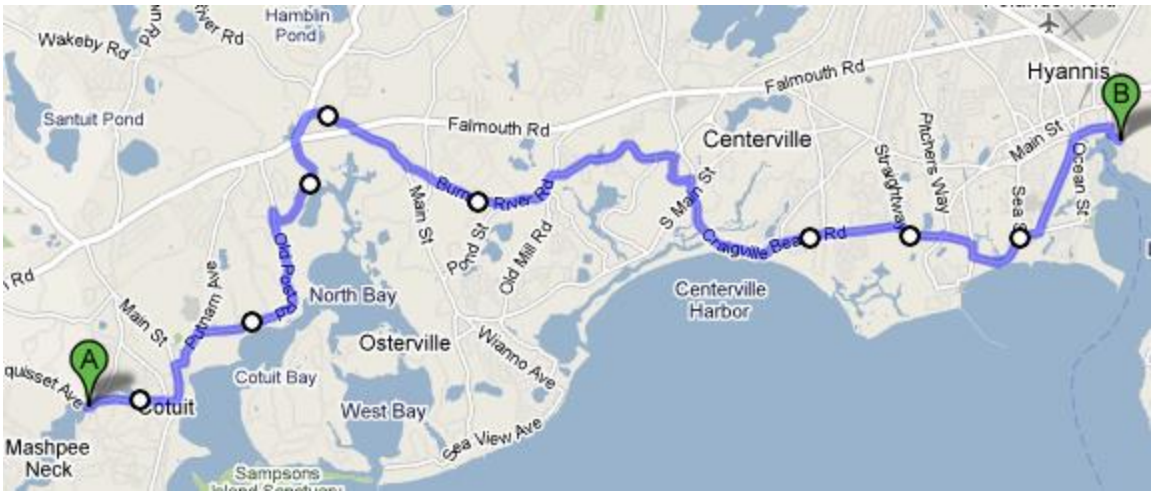

FIGURE 54 - POTENTIAL ROUTE "28B" IN BARNSTABLE
(Source: Cape Cod Commission, Google Maps)

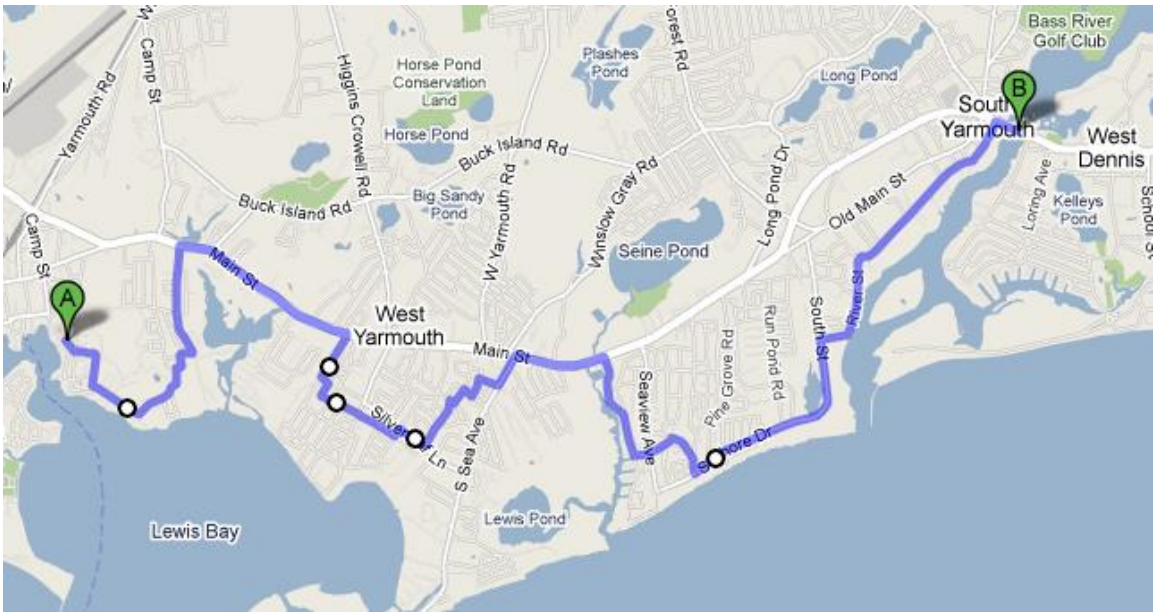

FIGURE 55 - POTENTIAL ROUTE "28B" IN YARMOUTH
(Source: Cape Cod Commission, Google Maps)

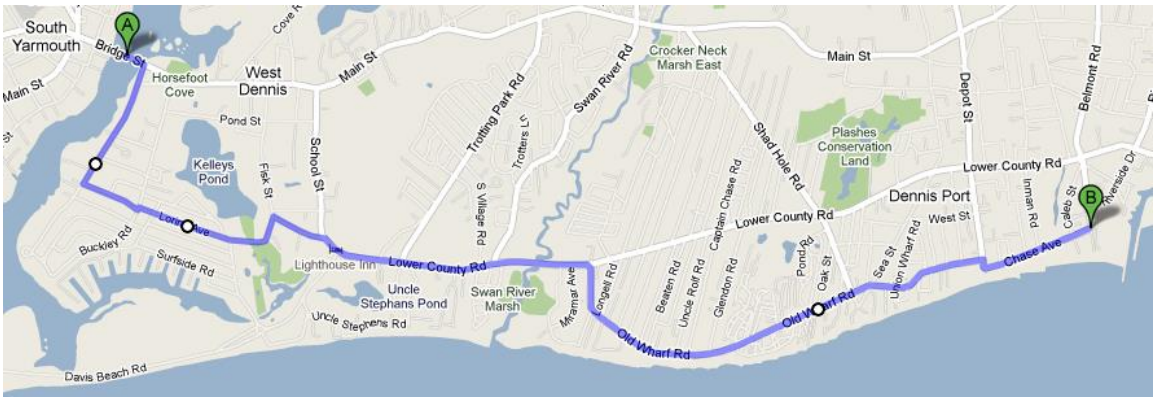

FIGURE 56 - POTENTIAL ROUTE "28B" IN DENNIS
(Source: Cape Cod Commission, Google Maps)

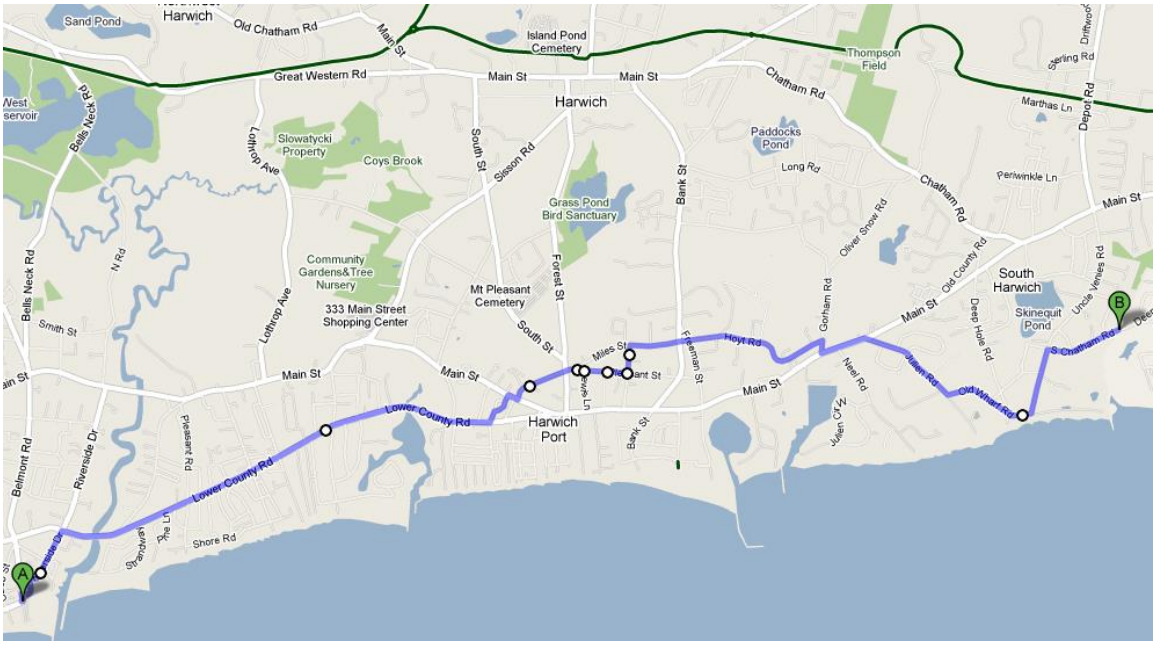

FIGURE 57 - POTENTIAL ROUTE "28B" IN HARWICH
(Source: Cape Cod Commission, Google Maps)

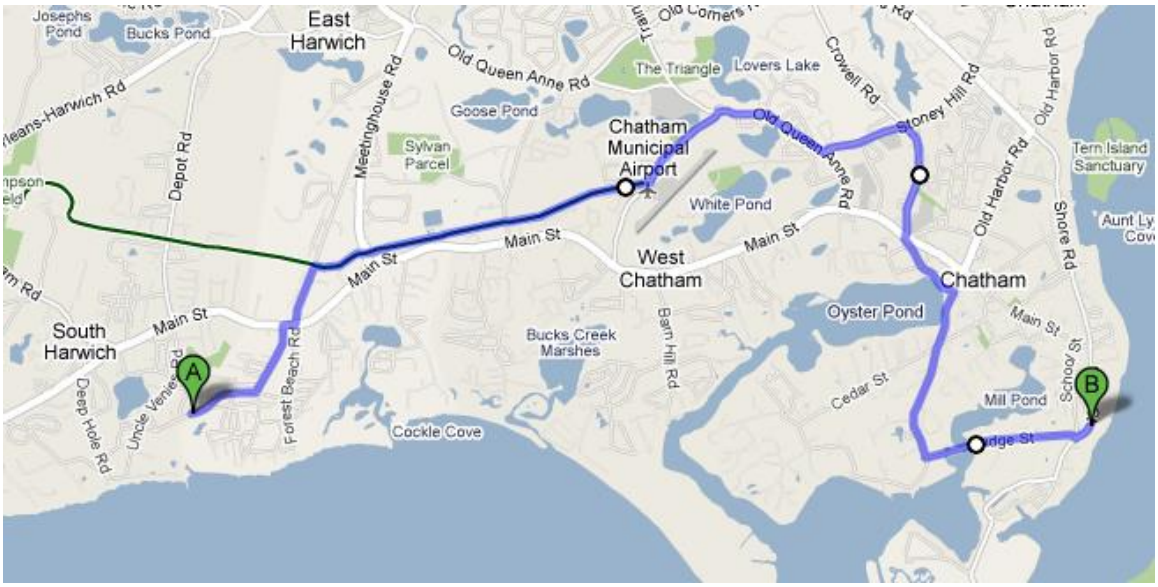

FIGURE 58 - POTENTIAL ROUTE "28B" IN CHATHAM
(Source: Cape Cod Commission, Google Maps)

RECENT & ONGOING BICYCLE/PEDESTRIAN PLANNING EFFORTS

This section summarizes recent and ongoing bicycle & pedestrian planning efforts underway by the Cape Cod Commission and/or bicycle planning groups in or adjacent to Barnstable County. More information is available for many of these efforts at:

www.capecodcommission.org/bikeped

CONNECTING TOWN CENTERS TO THE REGIONAL PEDESTRIAN & BICYCLING NETWORK ON CAPE COD

This study, produced in 2014 reviews connectivity between town center areas and existing bicycle paths and routes and includes identification of town center areas where sidewalks are needed. The purpose of the study is to identify key areas appropriate for new or improved bikeway connections, as part of the regional goal to facilitate bicycling and walking as viable transportation modes on Cape Cod.

The project team identified a "town center" location for each of the 15 Cape Cod towns and prepared maps of each location using Geographic Information Systems (GIS), to show existing bicycle paths, bicycle routes, and sidewalk (for main roads) data.

The following table presents a summary of recommended town center connectors to the existing bicycling network. (For town centers already connected to the existing network of bicycle routes or paths and no additional connection is identified, "N/A (Existing Connection)" is entered under Recommended Connectors column.

TABLE 5 - RECOMMENDED TOWN CENTER CONNECTORS

Town	Recommended Connectors	Description - Treatment	Notes
Barnstable	*Main Street/West Main Street* is shown as future multi-use path in town's bikeway network plan.	Proposed future multi-use path, but until then the connection is on road. Share the Road treatment options: signage (vertical signs and/or pavement markings) to guide bicyclists and to alert car drivers of cyclists' presence.	Downtown is connected to bike network but not on west end. This is an additional future connection.
Bourne	*Old Bridge Road* connects Cape Cod Canal bike path to Main Street.	0.3 mile segment length. Share the Road treatment options - signage (vertical signs and/or pavement markings) to guide bicyclists and to alert car drivers of cyclists' presence.	Main Street bypass is designated bike route. The town might want to consider designating Main Street as a designated on road route through Buzzards Bay instead.
Brewster	*Route 124 to Route 137* to CCRT. Connects Route 6A/town center to CCRT.	Approximately 1-mile connection (0.4 mile segment on Route 124, 0.6 mile segment on Route 137). Share the Road treatment options - signage (vertical signs and/or pavement markings) to guide bicyclists and to alert car drivers of cyclists' presence. .	Share the Road OK for experienced cyclists but less experienced might not feel comfortable without providing additional shoulder room which would require expansion of the road footprint. Lower volume/speed road connector is preferable but no such on-road connection from Route 6A in town center area.
	Underpass Road connects Route 6A to CCRT.	0.50 mile connection. Share the Road treatment options signage (vertical signs and/or pavement markings) to guide bicyclists and to	

Town	Recommended Connectors	Description - Treatment	Notes
		alert car drivers of cyclists' presence.	
Chatham	*Old Harbor Road - Depot Road - Hitching Post Road - Tip Cart Lane - Crowell Road* connects downtown to rail trail.	0.75 mile segment. Share the Road treatment options - signage (vertical signs and/or pavement markings) to guide bicyclists and to alert car drivers of cyclists' presence.	
	Chatham Bars Road connects downtown/Main Street to Shore Road/Road 28 bike route.	0.5 mile connection. Share the Road treatment options - signage, sharrows.	
Dennis	From *Sea Street/Route 28 – Upper County – Clipper –Stafford - Depot Street* to CCRT.	Share the Road treatment options: directional signage, (vertical signs and/or pavement markings) to guide bicyclists and to alert car drivers of cyclists' presence.	Speed limit on Depot Street is 30 MPH. Lacks room for adequate shoulders within existing road footprint. Combination of connected neighborhood streets provides partial alternative route to CCRT.
	Sea Street suggested connector between Route 28 and Lower County bike route.		
Eastham	*Samoset Road* connects town center/town hall area to CCRT.	Approximately 0.4 mile connection. Share the Road treatment options: signage (vertical signs and/or pavement markings) to guide bicyclists and to alert car drivers of cyclists' presence.	
Falmouth	N/A (Existing connection)		
Harwich	N/A (Existing connection)		
Mashpee	N/A (Existing connection)		
Orleans	N/A (Existing		

Town	Recommended Connectors	Description - Treatment	Notes
	connection)		
Provincetown	N/A (Existing connection)		
Sandwich	N/A (Existing connection)		
Truro	N/A (Existing connection)		
Wellfleet	N/A (Existing connection)		
Yarmouth	Connection from Route 28 to Forest Road bike path along low-volume neighborhood streets *Lyman lane, Mercury Drive, Hervey Lines Lane, Clifford Street and Historic Brook Road*.	Approximately 0.65 mile segment. Share the Road treatment options: signage (vertical signs and/or pavement markings) to guide bicyclists and to alert car drivers of cyclists' presence.	
	Additional connectors from Lyman Lane to Station Ave bike route: *Great Pond Drive –Icehouse Road –Wood Road – Lakeland Avenue – Indian Memorial Drive*.	Approximately 1 – mile segment. Share the Road treatment options: Signage (vertical signs and/or pavement markings) to guide bicyclists and to alert car drivers of cyclists' presence.	300 foot segment on Wood Road has sidewalk as an option for bicyclists not wanting to share the lane with cars.

SANDWICH PEDESTRIAN/BICYCLE PLANNING – IMPROVED PEDESTIRAN AND BICYCLE CONNECTIONS WITH THE CAPE COD CANAL MULTI-USE PATH

Released in early 2014, the goals of this effort included:

- Interpretive signage for the kiosk at the end of the Canal Path near the Marina.
- Completion of the bike route between the Canal and Tupper Road.
- Install a crosswalk across Tupper Road at Freezer Road.
- Develop the connection from Freezer Road to Route 6A.
- Strategies for Jarves Street need some more public discussion before a strategy can be developed. The proposed bike/pedestrian options for this roadway segment needs to be examined in terms of traffic and parking impacts.

As a result of the extensive public participation effort and refinement of alternatives by Cape Cod Commission Staff, a set of recommended improvements has been identified, according to the plan shown in the following figure:

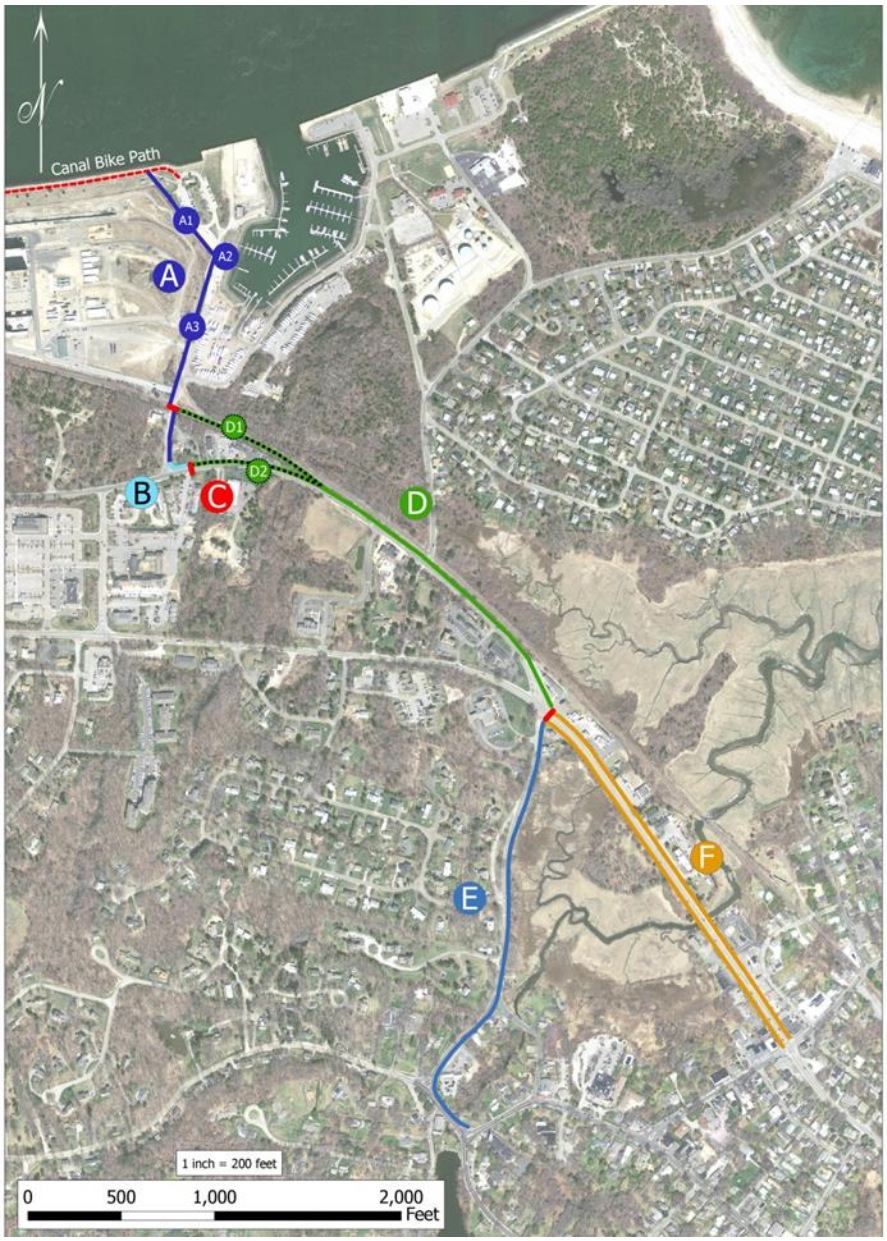

Figure 59 - Sandwich Bicycle/Pedestrian Planning - Recommended Routes

CLOSING THE GAPS: CONNECTING CAPE COD'S BICYCLE AND PEDESTRIAN NETWORK TO TRANSIT ROUTES

The purpose of this effort, released in late 2013, was to review connectivity of existing public transit (bus) routes with existing bicycle routes and paths and recommend improvements to eliminate gaps in connectivity. The review includes sidewalk accessibility along the bus routes. The report also provides an overview of bicycle and pedestrian planning on Cape Cod, building upon previous studies and plans and updating the region's bicycle route/path and sidewalk data. It includes town by town summaries of bicycle and pedestrian planning, accompanied by maps of transit routes, bicycle paths/routes, sidewalks and potential "connector" pieces.

The following table provides a compilation of potential transit route-bicycle path/route connectors.

TABLE 6 - TOWN SUMMARIES: RECOMMENDED BICYCLE CONNECTIONS TO TRANSIT ROUTES

Bike/Ped/Transit Connector	Description	Notes
Barnstable		
Route 28 sidewalks	Bus route pedestrian access	No sidewalks between Route 149 and Stop & Shop plaza or Marstons Mills Marketplace.
Bourne		
Perry Ave connector	Connects Canal bike path to Main Street (bus route). Share the road –striping, signage, sharrows.	Connects to 3 Mile Park, but not direct access to canal path.
Old Bridge Road connector	Connects Canal bike path to Main Street (bus route). Share the road –striping, signage, sharrows.	Direct connection.
County Road sidewalk	Bus route pedestrian access	Lacks sidewalks
Route 28A/Sandwich Road sidewalk	Bus route pedestrian access	Lacks sidewalk most of route.
Brewster		
Thad Ellis Road connector	Connects Route 6A (bus route) to CCRT. On road connection – striping, signage, sharrows. 1/4 mile direct connection.	
Underpass Road connector	Connects Route 6A (bus route) to CCRT. On road connection – striping, sharrows, signage	
Millstone Road connector	Connects Route 6A (bus route) to CCRT. On road connection – striping, sharrows, signage	
Route 137 connector	Connects Route 6A (bus route) to CCRT. On road connection – striping, signage, but paved shoulder may be feasible in sections	

Route 124 connector	Connects Route 6A (bus route) to CCRT. On road connection – striping, signage	
Route 137 sidewalk	Bus route pedestrian access	No sidewalks on Route 137
Chatham		

Bike/Ped/Transit Connector	**Description**	**Notes**
Route 137 connector	Connects Route 28 (bus route) to CCRT. On road, shoulders, striping, signage	
Sam Ryder Road connector	Connects Route 28 (bus route) to CCRT. On road connection – striping, signage, sharrows	
George Ryder Road connector	Connects Route 28 (bus route) to CCRT. On road connection with striping and shoulders or bike lane. Off road path may be feasible.	
Route 28 sidewalk	Connects Route 28 (bus route) to CCRT	Most of route has sidewalk but condition is poor in some locations. If enhanced could accommodate bikes.
Dennis		
Shad Hole Road connector	On road connection – striping, sharrows, signage	
Depot Street connector	Connects Route 28 (bus route) to Lower County Road bike route. On road connection – striping, sharrows, signage	
Sea Street connector	Connects Route 28 (bus route) to Lower County Road bike route. On road connection – striping, sharrows, signage.	
Route 134 sidewalk	Bus route pedestrian access.	Route 134 lacks sidewalk north of Patriot Square
Route 28 sidewalk	Bus route pedestrian access	Gaps in connectivity outside of Dennisport.
Eastham		
Governor Prence Road connector	Connects Route 6 (bus route) to CCRT. On road connection – striping, sharrows, signage. NPS received funding for flashing beacon crosswalk at Route 6 intersection for connection to Fort Hill.	
Samoset Road connector	Connects Route 6 (bus route) to CCRT. On road connection – striping, sharrows, signage	
Route 6 sidewalk	Bus route pedestrian access	East side of Route 6 lacks sidewalks, Town Hall and Brackett Road commercial areas are the bus stop locations.

Falmouth		
Bike/Ped/Transit Connector	**Description**	**Notes**
Route 151/Sandwich Road connector	Connects Route 151 (bus route) to Sandwich Road bike route. Signage to direct riders to bus stop location (at gas station set back from road).	
Harwich		
Route 28 sidewalk	Bus route pedestrian access.	Gaps in sidewalk connectivity outside of Harwichport to West Harwich. In 2010 bike/ped improvement plan.
Mashpee		
Route 28 sidewalk	Bus route pedestrian access	Some locations without sidewalk.
Route 151 sidewalk	Bus route pedestrian access	Sidewalk at school and Mashpee Commons. Town plans to extend bike path to Falmouth line.
Orleans		
Bay Ridge connector	Connects Route 6A (bus route) to CCRT. On road –striping, sharrows, signage.	Involves access through private property.
Route 28 sidewalk	Bus route pedestrian access	No sidewalks north of Finlay Road. Narrow shoulder width.
Main Street connector	Connects Route 6A (bus route) to CCRT. On road –striping, sharrows, signage	
West Road connector	Connects Route 6A (bus route) to CCRT. Also connects gap in bike path. On road –striping, sharrows, signage.	
Provincetown		
Shank Painter connector	Connects Shank Painter Road (bus route/stop) to Bradford Street bike route. On road. Bike lane or paved shoulders, striping.	Road lacks sidewalk in most locations Heavy volume of bike and pedestrian traffic.
Sandwich		
Merchants Square connector	Connects Route 6A bus route to proposed Tupper Road bike route. On road through plaza Signage, sharrows, striping	
Truro		
Route 6 sidewalk	Bus route pedestrian access	No sidewalks except for segment between school and police station. 4' shoulders along much of route. May be addressed in Outer Cape Bicycle Pedestrian Master Plan.
Wellfleet		
Bike/Ped/Transit Connector	**Description**	**Notes**

Old County/Blackfish Variety connector	Connects Route 6 (bus route) to CCRT. Crosswalk, striping to improve connection between CCRT and bus stop/Old County Road.	May be addressed in Outer Cape Bicycle Pedestrian Master Plan.
Springbrook connector	Connects Route 6 (bus route) to CCRT	Other options nearby to connect West Road and Audubon to CCRT cross private property.
Yarmouth		
Higgins Crowell connector	Connects Route 28 (bus route) to bike path and proposed CCRT extension. On road. Striping, sharrows, signage	

YARMOUTH ROAD CORRIDOR STUDY

Yarmouth Road in Barnstable experiences significant vehicle queues during peak hours of operation. The corridor is the primary access for some Cape towns to the Cape Cod Hospital. Seasonal and peak hour congestion often cause delays for emergency vehicles en route to the Hospital. The intersection of Yarmouth Road and Route 28 in Barnstable is a known high crash location and is identified in the Hyannis Access Study as an intersection in need of improvements. Yarmouth Road serves as an important access road into Hyannis Center, which accommodates both commercial and business development. Hyannis Center was recently approved as a Growth Incentive Zone. A viable Yarmouth Road corridor is significant for many modes of transportation, including walking, biking, automobile, transit and rail. The Hyannis Transportation Center is located off Route 28, a short distance from the Yarmouth Road/Route 28 intersection. The Yarmouth Road Corridor Study will examine each mode of transportation (walking, biking, automobile, transit and rail). Information on the study is available at:

www.capecodcommission.org/departments/technicalservices/transportation/projects/olderprojects

After many months of review and public input, one concept has been recommended: Concept 1a. This concept includes a multi-use path (bike path) connecting the Hyannis Transportation Center to a point just south of Route 6. The towns of Yarmouth and Dennis are currently planning to extend the existing Cape Cod Rail Trail just east of Willow Street (south of Route 6).

Concept 1a is a continuation of the four-lane divided Willow Street roadway that currently exists near Route 6 Interchange 7 to the Route 28/Yarmouth Road intersection in Barnstable and uses a westerly alignment at the Route 28/Yarmouth Road intersection. The cross section and concept plan are shown in the following figures:

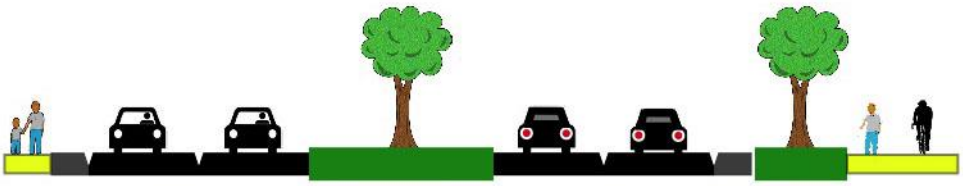

FIGURE 60 - YARMOUTH ROAD PROPOSED CROSS SECTION (LOOKING SOUTHERLY)

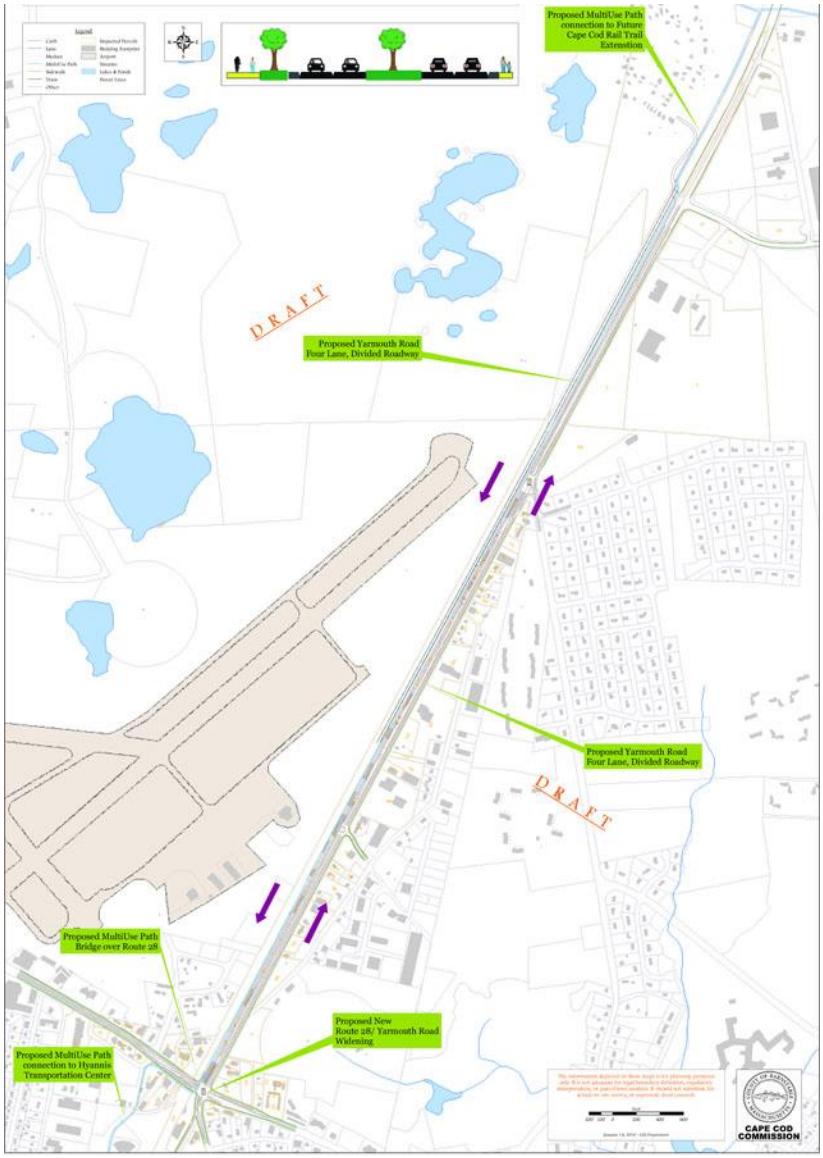

FIGURE 61 - YARMOUTH ROAD RECOMMENDED CONCEPT PLAN

HARWICH BICYCLE/PEDESTRIAN/TRANSIT

As part of an effort to enhance the economic development of Saquatucket Harbor in Harwich Port, the Town of Harwich is seeking to provide safe and effective pedestrian and bicycle facilities between the Cape Cod Rail Trail/Old Colony Rail Trail and Route 28, with a specific focus on a connection between Harwich Center and Harwich Port. In addition, the Town of Harwich is looking to provide safe pedestrian and bicycle connections as well as shuttle bus service between Wychmere Harbor and Saquatucket Harbor. A Cape Cod Commission/Town of Harwich effort is underway to meet the following goals:

- Identify safe and effective pedestrian and bicycle access between the Cape Cod Rail Trail/Old Colony Rail Trail and Route 28, with a specific focus on a connection between Harwich Center and Harwich Port.
- Identify safe and effective pedestrian and bicycle access between Wychmere and Saquatucket Harbors along Route 28 that would intersect with a connection to Harwich Center.
- Identify the potential for shuttle bus service between Wychmere and Saquatucket Harbors.
- Coordinate with the Regional Transportation Plan/Cape Cod Bike Plan. A goal of this effort is to construct new bicycle/pedestrian facilities using available funding sources source is the Cape Cod Transportation Improvement Program (TIP) administered by the Cape Cod Commission and funded by the Massachusetts Department of Transportation and Federal Highway Administration.
- Commission staff will work with the Town of Harwich to integrate these bicycle/pedestrian efforts into the current update of the RTP.

From public outreach to concerned citizens and input from town of Harwich officials, the following figure includes a summary of recommended bicycle and pedestrian enhancements in the study area:

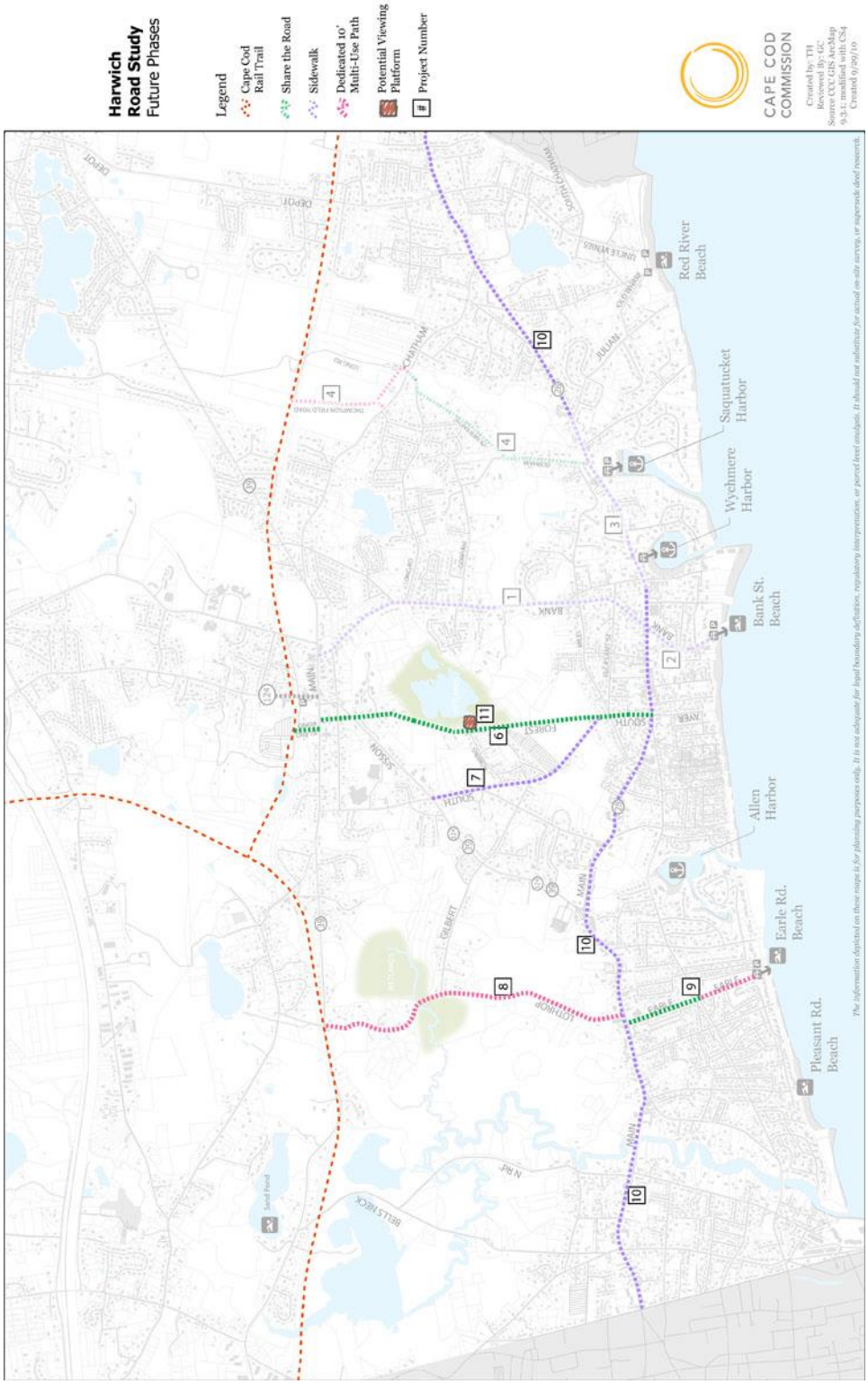

FIGURE 62 - HARWICH BICYCLE/PEDESTRIAN/TRANSIT STUDY RECOMMENDATIONS

BARNSTABLE

The town of Barnstable has a comprehensive Open Space and Recreation Plan. The plan is available from the Town of Barnstable's website at:

http://www.town.barnstable.ma.us/CommunityPreservation/CPA%20Plan.pdf

As part of this effort, town-wide mapping of existing and proposed improvements for bicycling & pedestrian accommodation are shown in the following figure:

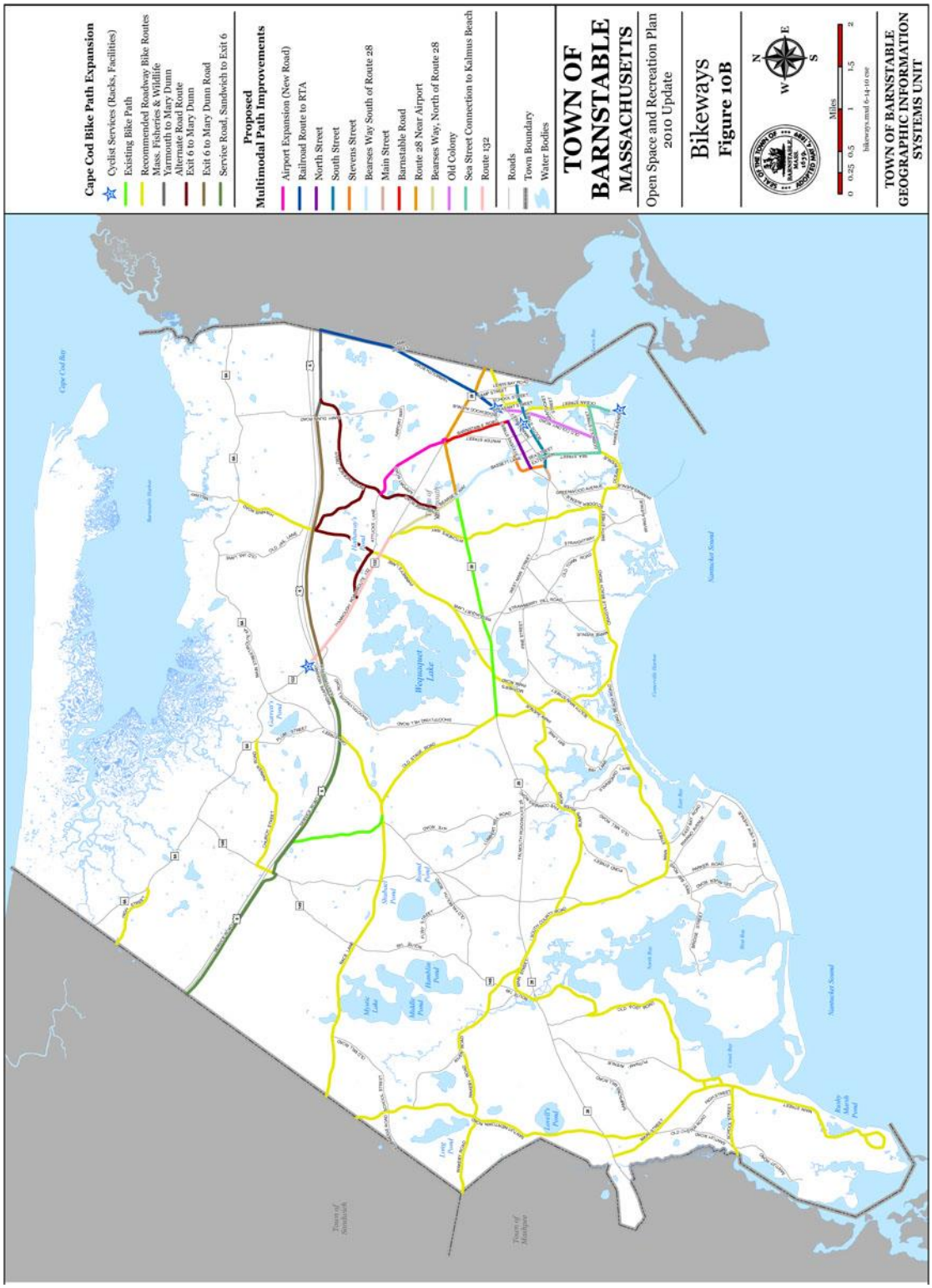

FIGURE 63 - BARNSTABLE BICYCLING & PEDESTRIAN PLANNING

The Dennis Port Revitalization Master Plan reflects the cumulative efforts of over two hundred individuals and over two years of effort. Looking forward 50 years, this plan is a road map and a critical resource for directing growth and rebuilding the heart of the community. Under the leadership of the Dennis Port Revitalization Committee, and with needed support from the Town of Dennis, this plan has taken shape. The Revitalization Master Plan illustrates physical solutions to Dennis Port's existing challenges, as related to the ten topic areas:

- transportation
- public safety
- economic development
- social services
- land use
- housing
- historic heritage
- arts & culture
- alternative energy
- stormwater & wastewater

Where possible, physical solutions have been incorporated into the Master Plan.

Implementation Strategies.

The Dennis Port revitalization planning effort focused on three primary nodes:

- the historic Village Center
- the hotel resort area along Chase Avenue
- the cottage colony resort area along Old Wharf Road

The design team also looked at the Route 28 corridor, to suggest interventions that could improve the character of this important gateway. While the provision of bikeways is the most visible element in any bikeway network, bicyclists must also have safe and convenient places to store their bicycles at a trip's end. Thus, providing bicycle parking and other "end-of trip" facilities is critically important in supporting bicycling as a viable mode of transportation. While parking solutions range from the basic bicycle rack to semi-enclosed bicycle shelters to full bicycle stations all bicycle parking facilities should be attractive and identifiable, space efficient and as close, if not closer, to the associated destination than any automobile parking. The Bike Way Plan also outlines several locations where the expansion of bicycle parking is needed for recreational and utilitarian use and is shown in the following figures:

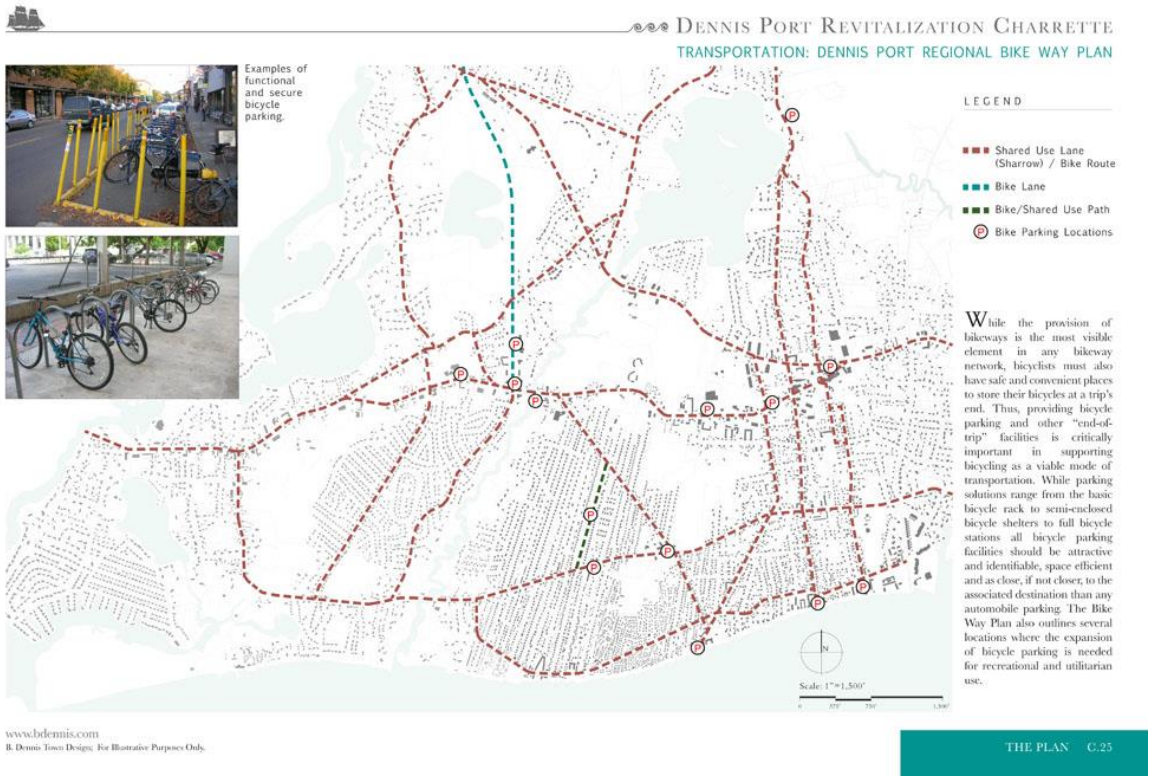

FIGURE 64 - DENNIS PORT REGIONAL BIKE WAY PLAN

ORLEANS ROUTE 28 BIKE PATH

The Town of Orleans recently completed a feasibility study for the creation of a safe and continuous bike and pedestrian facility that connects South Orleans to Orleans Center. Fay, Spofford, and Thorndike (FST) helped evaluate the Route 28 corridor and its potential to host such a facility. They met with members of the District 5 office to fully understand the challenges of constructing a facility of this type. At the completion of the study and after review and consideration of several off-road alternatives, the Town believes that the Route 28 corridor is the best option to connect the two villages. The study found that a Route 28 facility would be the most accessible bike and pedestrian facility and therefore serve the greatest number of residents and visitors. The following figure is a locus map showing select areas along the route that were examined closely. For each location, a conceptual cross section is included in the report showing both a shared use path and a side walk (some on either side of the road) to illustrate how it may work within the context of the road and its layout. A complete version of the report is available here:

www.town.orleans.ma.us/Pages/OrleansMA_Planning/bikefinal

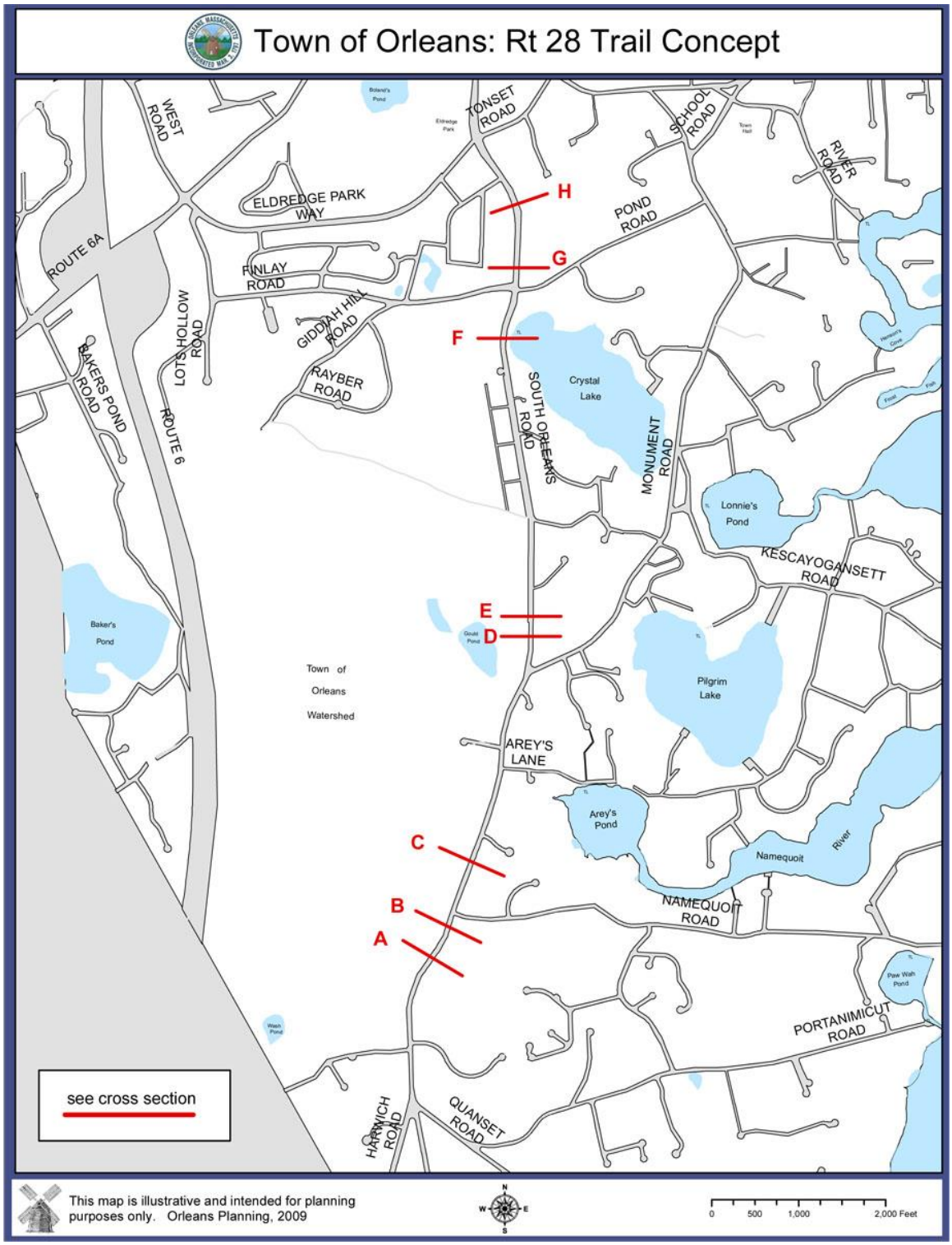

FIGURE 65 - ORLEANS ROUTE 28 BIKEWAY PROPOSAL

WAREHAM BICYCLE CONNECTIONS TO CAPE COD

A Bicycle planning committee for Wareham is proposing a connection from downtown Wareham to Buzzards Bay at the Route 6/28 crossing of Cohasset narrows. Information is available from the Wareham Community Pathway website:

http://www.warehambikepath.com

The following figure shows the potential alignment from Wareham to Buzzards' Bay:

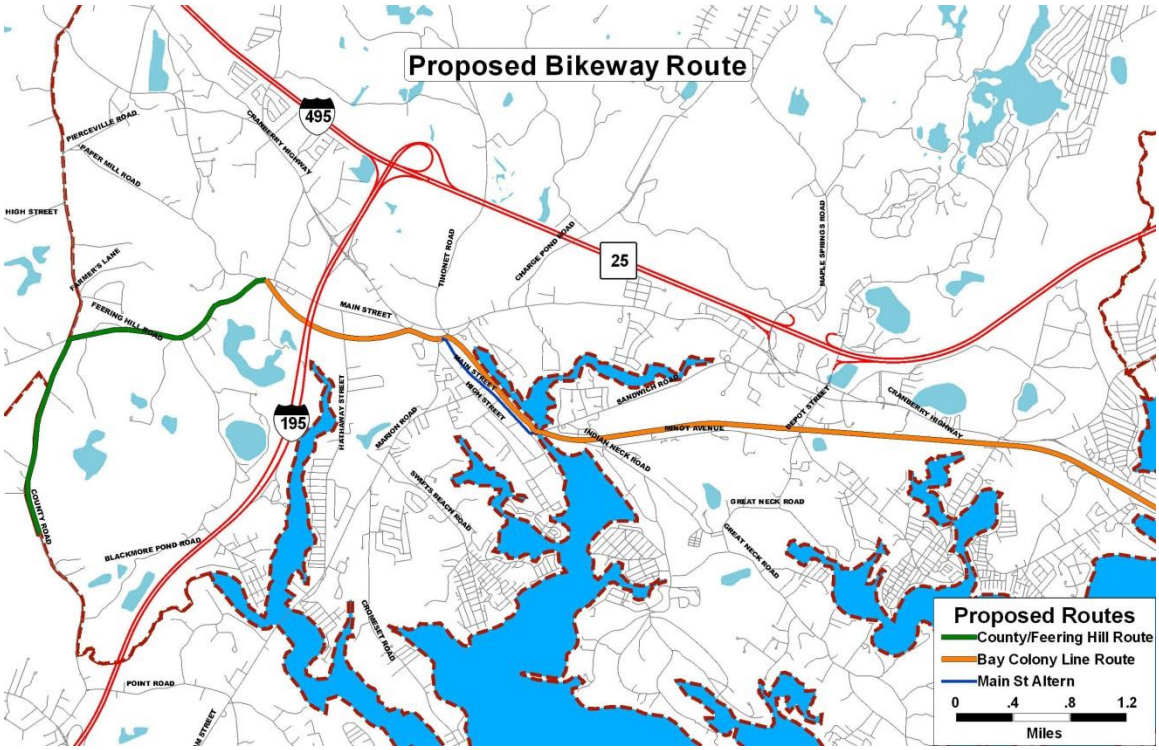

FIGURE 66 - POTENTIAL WAREHAM TO CAPE COD ROUTE

CCNS INTEGRATED BICYCLE PLAN FOR CAPE COD

In 2010, the Cape Cod National Seashore (CCNS) completed an Integrated Bicycle Plan ("Bicycle Feasibility Study") for Cape Cod. This feasibility study was undertaken by the National Park Service in partnership with the Cape Cod Commission to identify improvements necessary to develop an integrated bicycle network throughout Cape Cod. This approach will help to ensure an efficient, coordinated approach to addressing needed bicycle network improvements.

With active participation of Cape Cod Commission staff and many other stakeholders, the study helps lay the groundwork needed to improve bicycling conditions on Cape Cod by developing a comprehensive and connected bicycle network. Included are a list of both infrastructure improvements and programmatic initiatives to promote bicycling, enhance bicycle access and improve safety. This will help establish bicycling as a viable transportation option while reducing dependence on automobile transportation. This is to be accomplished by creating an integrated, multimodal transportation environment throughout Cape Cod. The study established an approach to identifying opportunities for projects and initiatives, and provides guidance on implementing them in an efficient and coordinated manner.

The three primary goals of the CCNS study are:

- To integrate regional planning and the regional bicycle network with Cape Cod bicycle facilities and CCNS attractions.
- To identify projects to improve Cape Cod bicycle facilities and facilitate integration with the regional bicycle trail network.
- To identify projects that would improve bicycle access to and within Cape Cod National Seashore (Seashore).

Projects and CCNS priority corridors are presented in maps at the end of this section. Links to the complete text of the CCNS report are available at:

www.capecodcommission.org/bikeped

DESCRIPTION OF PROJECT TYPES

The projects proposed to enhance the bicycling environment on Cape Cod were extremely varied in nature, ranging from programmatic initiatives such as education and outreach efforts and maintenance plans to infrastructure projects providing improvements to existing routes, as well as the construction of new facilities. The physical improvements themselves covered a broad spectrum of projects. They included improved signage, enhanced trail crossings at roadways, the creation of connector trails, and new facilities in corridors not currently served by bicycle routes or facilities. Three primary classifications were developed to categorize the proposed projects; improvements to existing facilities; new facilities; and other initiatives. These categories are described in more detail, as are the individual projects that were selected for inclusion in the study. Maps depicting the locations of the selected projects are included in this chapter along with a table for cross reference. Projects proposing regional corridor improvements have been mapped, however short corridor improvements with an undefined route have not been mapped. Several projects proposed development of routes following general corridors. Such routes have been depicted on the maps using broad arrows and do not indicate specific or preferred alignments, nor do they reflect environmental constraints or sensitive areas that may need to be avoided.

Improvements to Existing Facilities

The bicycling network on Cape Cod is comprised of many types of facilities of varying conditions. Though many miles of bicycling routes and paths exist many have deficient conditions relating to safety or usability by less experienced bicyclists such as basic wayfinding and signage, especially for visitors that may not be familiar with the Cape. Additionally, access to trip generators such as neighborhoods, major destinations, town centers, or commercial areas are often lacking. These elements would facilitate greater utilization of the bicycling network for travel throughout Cape Cod and less reliance on automobile travel. A number of proposed projects aim to improve the existing facilities on the Cape and to make uniform the conditions experienced by bicyclists, whether in the form of improved wayfinding signage, consistent pavement markings, improving on-roadway conditions along existing bike routes, or upgrading facility designs to current standards.

New Facility Construction

In order to provide for complete mobility for nonmotorized users a variety of new construction projects are needed to extend existing facilities, connect existing facilities to destinations and localities, close gaps in the bicycle network on Cape Cod, and enhance safety. This process has resulted in identifying many needed routes or facilities that will provide safer, more comfortable bicycling conditions for on-roadway routes, extend or connect facilities such as the Cape Cod Rail Trail extension and proposed spurs linking towns and destinations, and close gaps within the network by linking existing routes or facilities.

Other Initiatives – maintenance plans, new or revised programs and policies, outreach and education

Though a number of physical improvements have been identified to enhance and expand the network of bicycle routes throughout the Cape, many opportunities exist to improve bicyclist safety and to encourage the use of bicycling both for recreation and as a viable transportation option. Developing programmatic and policy elements will ensure a comfortable and consistent bicycling environment across the Cape for bicyclists of varying skills, abilities, and bicycling interests. Such programmatic elements will serve to address human factors, thereby creating a safer, more inviting bicycling environment, while also encouraging the use of a continually improving bicycle network as a means of routine travel throughout Cape Cod by both tourists and residents alike. Many of these proposed projects will work in tandem with projects aimed at improving infrastructure by ensuring awareness of bicycling transportation and recreation options, enhancing operational safety of bikeways and enhancing the utility of the bicycle network on Cape Cod. This will make the bicycle network more useable by a variety of visitors and residents, thereby alleviating the existing burden on the transportation network resulting from over-reliance on automobiles.

Selected Projects

The following lists of projects reflect those selected through the process described in Chapter 4 of the Feasibility Study. The sorting process did not assign a ranking or priority, but rather categorized them according to the level of benefit and the barriers to implementation. All proposed projects should be viewed as valid and potential projects that may be pursued for funding. Coordination between Cape Cod National Seashore, the Cape Cod Commission, and/or the respective municipality will need to coordinate selection and implementation of individual projects. A consolidated list of all proposed projects is included in the full report are available at:

www.capecodcommission.org/bikeped

Each of the 47 recommended projects listed here includes a basic project description, preliminary design concepts, a planning-level cost estimate, and recommendations for implementation. Some projects have more detailed cost estimates as a result of greater levels of detail relating to alignments, the type of facility, proposed configurations, and total distance. However many projects are merely conceptual, identifying only a corridor or general route in need of improvement without specifying the project length, type or level of accommodation to be provided. Estimates for general conceptual projects only include unit costs for the different types of possible accommodations and alignments that may be utilized.

The cost estimates were prepared in 2009/2010, based upon typical project costs in the Cape Cod region. Due to the variability of construction and materials costs over time, an appropriate inflation factor should be determined and applied when using these estimates in future years.

Each project will require varying levels of environmental compliance dependent upon the agency undertaking it and the scope of the project. An NPS Environmental Screening Form would be completed for any project arising from this study to determine the level of environmental compliance required. Projects undertaken within Cape Cod National Seashore would require NEPA (National Environmental Policy Act) and possibly MEPA (Massachusetts Environmental Policy Act) documents for environmental clearance; however the specific level of required compliance would be determined through the individual project scoping process. Projects developed by localities would comply with applicable environmental clearance requirements, also to be determined during the project scoping process.

The individual project descriptions included in this chapter are intended to provide stakeholders with a resource to be used in developing project proposals and funding requests through a variety of sources. Conceptual details and planning level cost estimates will provide a basis for further development of individual project scopes and proposals. A variety of funding opportunities exist, largely via state and federal grant programs. Some of the funding sources available include the NPS Park Roads and Parkways Program, Transportation Enhancement grants, Recreational Trails Program, Congestion Mitigation Air Quality, and several Federal Transit Administration programs, among others.

IMPROVEMENTS TO EXISTING FACILITIES

The following is a list of sixteen projects proposing improvements to existing facilities. This list was developed through an extensive public participation process involving all 15 Cape Cod towns and stakeholders including MassDOT. These projects are numbered 5.2.1 through 5.2.16.

Project 5.2.1: Design Alternatives for Cape Cod Rail Trail Extension to Provincetown

Project Description – The existing Cape Cod Rail Trail (CCRT), which is maintained by the Massachusetts Department of Conservation and Recreation, currently terminates in South Wellfleet, just north of the National Seashore Park headquarters. Bicycle and pedestrian access to the remainder of the Outer Cape is largely limited to US Route 6, the principal arterial providing motor vehicle (and motor freight) access to this region of the Cape. The estimated 400,000 annual users of the CCRT therefore have no access to the Outer Cape and many of the attractions within the National Seashore. Extending the CCRT to Provincetown would provide the following benefits:

- Continuity in access to over 40 miles of the Outer Cape by bicyclists and pedestrians
- Bicycle and pedestrian access to virtually all destinations and attractions within Cape Cod National Seashore

- Enhanced safety by eliminating the need for bicyclists and pedestrians to travel along Route 6 which has no accommodations for bikes or pedestrians.
- Provision of a transportation alternative that would facilitate nonmotorized mobility and access to a significant number of Outer Cape destinations, thereby reducing congestion, parking demand, and the associated environmental and sensitive lands impacts.

This project would include preparation of an environmental assessment (EA) in accordance with the National Environmental Policy Act (NEPA) process that includes a description of the proposed project; the reasonable alternatives under consideration; the social, economic and environmental impacts of the alternatives; mitigation measures and a section on comments and coordination. The project will evaluate alternative alignments and their respective costs, impacts, and connections/ accessibility provided.

Preliminary Design Concepts – The three alternative alignments and design concepts include:

- Eastern alignment
  - approximately 20 miles
  - largely through the National Seashore
  - consisting of both on-roadway and shared-use path segments
  - primarily undeveloped and natural environments
- Interior, or Bay alignment
  - mostly on secondary roadway alignments
  - via the towns and neighborhoods of Wellfleet, Truro, and Provincetown
  - primarily developed and largely residential) environments
- Abandoned railroad alignment
  - located along the western side of the Outer Cape
  - shared-use path with occasional road segments
  - a mix of natural landscapes in the National Seashore and developed areas of North Truro and Provincetown

Cost Estimate – Costs for 3 conceptual alignments

- Eastern Shore alignment: design cost $3,385,000
- Interior, or Bay alignment: design cost $1,100,000
- Rail alignment $2,911,000

Design cost estimates at 17% of NET construction costs

Recommendations for Implementation – The EA should be undertaken to fully determine the extent of all impacts associated with the three alternatives. A subsequent analysis of the alternatives to determine which, if any of the three options are feasible along with costs associated with possible right of way acquisitions, and public input should be undertaken to establish a preferred alignment. Mass DCR's maintenance responsibility for the CCRT requires close coordination between the state and CCNS.

Project 5.2.2: Wayfinding Signage and Pavement Markings on CCRT

Project Description – With an estimated 400,000 users annually the Cape Cod Rail Trail (CCRT) has the potential to serve as a significant alternative transportation facility, not merely a recreational route. Installation of consistent signage along the Cape Cod Rail Trail to include interpretive, directional, informational, and other wayfinding signage is needed to both enhance the trail user experience as well as facilitate use of the trail as a bicycle transportation corridor, especially by those that are not familiar with areas served by the facility. Additionally, improved pavement markings are needed, primarily at the 45 roadway crossings to enhance safety and communicate expected behaviors by both trail users and motorists at these conflict points. Motorist and trail user expectations and actions are not consistent, in part due to trail and roadway crossing designs that are inadequate and design treatments that are inconsistent and often don't comply with the MUTCD (the Manual on Uniform Traffic Control Devices) regulations or AASHTO guidelines.

Preliminary Design Concepts – The specific signage design and placement has to be determined, and avoidance of visual clutter is needed, however the primary information that needs to be considered for signage includes:

- Trail amenities including rest rooms & emergency services
- Historic resources
- Beaches
- National Seashore attractions
- Town centers and commercial destinations including restaurants, lodging, retail shopping, bike shops
- Distance signage (to destinations)
- Connections to intermodal transportation facilities including bus and ferry terminals
- Connections to other bicycle facilities & bike routes
- Communicating mobility issues for access by different users (including ADA issues)
- Safety information such as sand and other surface hazards

Cost Estimate – Complete signage at $18,400 per mile:

- $405,000.00 for the existing CCRT
- $129,000.00 for the Old Colony extension

Recommendations for Implementation – This approach will facilitate addressing the multiple locations that will be enhanced or addressed over time and in a phased manner, but this project provides a uniform protocol and design standards so that consistency is ensured.

Sign design, content, placement standards, measures to avoid visual clutter, installation and maintenance polices, and other considerations need to be established and agreed upon by stakeholders and responsible parties prior to implementation. The parties responsible for installation and maintenance need to be apprised of protocols including coordination of responsibilities when multiple agencies are involved. This needs to include entities with roadway construction authority so that roadway projects impacting trail crossings and intersections include appropriate and uniform design treatments and standards, regardless of locality. As development and implementation of Intelligent Transportation Systems occurs wayfinding resources could be added such as location-specific information via cell phone (based upon mile posts along bicycle routes and rail trails).

Project 5.2.3: Intersection Improvements on Setucket Road Path

Project Description – Intersection treatments along the Setucket Road and Old Chatham Road Paths are inconsistent and lacking in conspicuous pavement markings that comply with national standards and design guidelines. Designed primarily as a side path, there is a resultant 38 roadway crossings in only 7 miles, and as a result a need for high visibility crosswalks and other pavement markings to communicate to motorists and path users the presence of conflict points. Pavement markings and signage also communicate appropriate actions at intersections for both motorists and path users. Additionally, access to the paths needs to be upgraded to provide curb ramps and ADA-compliant detectable warning surfaces.

Preliminary Design Concepts – High visibility crosswalks and improved signage and intersection treatments that are consistent with MUTCD and ADA standards and AASHTO design guidelines need to be selected to be applied uniformly along the facility. Consideration should also be given to evaluating the existing configuration and geometrics for each of the intersections and changes made that will enhance safety. This review should include issues such as sight distance, bollard placement, path width, angle of approach/crossing (skewed crossings), etc.

Cost Estimate – Costs vary subject to existing conditions and improvements needed at individual locations. Unit costs for typical crossing improvements are provided.

- Residential Crossing – $1,500.00
- Signalized Crossing – $70,000.00

Assumes installation of signalized intersection on two-lane roadway with mast arms, signal heads, pedestrian signals, pavement markings, and appropriate pedestrian upgrades such as curb cuts and ADA curb ramps.

Recommendations for Implementation – A complete review of the existing conditions should be conducted and documented and feedback from users should be collected to identify deficient conditions and desired improvements. Existing elements that are not consistent with MUTCD standards, AASHTO guidelines, and current best practices should be considered for retrofits and improvements. Regulatory and advisory signage should also be consistent with state law (such as the existing signage instructing bicyclists to dismount to cross intersections). A policy by which the selected improvements are installed and maintained needs to be established. Uniform design treatments need to be consistently applied throughout the length of the facility.

Project 5.2.4: Enhance Bicycling Conditions by Providing Paved Shoulders

Project Description – Multiple locations were proposed for shoulder widening or the addition of paved shoulders throughout Cape Cod along roads appropriate for on-road bicycling in order to provide safer, more comfortable bicycling conditions while also reducing conflicts with motor vehicles. Routes favored by bicyclists and those roadways that serve as connections to destinations, neighborhoods, and existing bicycle facilities should be considered for shoulder

improvements when traffic conditions merit. Adding paved shoulders has additional benefits including pavement edge stabilization, the addition of a recovery area which reduces roadway departure crashes, and a breakdown area that allows disabled vehicles to be moved out of the travel lane, thereby mitigating congestion impacts from such incidents. These all result in safety, operational, and maintenance benefits which yield long-term cost savings.

Preliminary Design Concepts – Widening or the addition of paved shoulders should consider the existing roadway geometrics. In order to be useful for bicycle travel shoulders and the adjacent travel lane need to be of adequate widths to provide a degree of separation between the two modes; otherwise safety can be impaired by inviting motorists to pass too closely to bicyclists that attempt to hug the outside edge of the roadway. In general a four foot shoulder is desirable to provide adequate operating space for a bicyclist while allowing motorists unimpeded travel within the adjacent lane. On roads with curb and gutter, the gutter pan and the longitudinal joint effectively reduces the useable width of the shoulder and consideration needs to be given to the paved width of the shoulder exclusive of the gutter pan.

Cost Estimate – On-road improvements, unit costs per mile:

- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders along both sides of the road.

Recommendations for Implementation – A protocol for identifying and prioritizing roads that will receive shoulder improvements needs to first be established. Limited resources dictate that shoulder improvements need to be made to roads where the benefits are the most significant and needed. Conditions to be considered should include:

- Roads already heavily used by bicyclists
- Designated bike routes with unimproved conditions
- Roads connecting to destinations or bicycle facilities
- Roads that establish a network or close a network gap
- Motor vehicle and truck traffic volumes
- Possible alternate routes (that are more suitable or which can be improved at a lower cost)
- Existing right of way
- Need for relocation of ditches (trench widening or wedging)
- Concurrency (opportunities to include shoulders as part of planned or programmed road projects)
- Coordination across jurisdictions for route continuity

Following the identification of candidate roads opportunities should be sought to begin implementing improvements through coordination with other construction and maintenance projects. Policies and procedures should be established to ensure that construction and maintenance projects determine whether a road is listed as a priority route for paved shoulders and then scoped to include the improvements. Routine pavement overlay and resurfacing projects should include shoulder paving for the identified routes. Consideration should be given to establishing a goal of spending a set percentage of maintenance and/or paving funds on adding shoulders for bicycle improvements. Maintenance needs to be considered so that the

functionality of shoulders for bicycling purposes is retained as the natural sweeping action of vehicles often results in debris accumulating in the untraveled shoulder.

Project 5.2.5: Identify Possible Sidewalks and Pedestrian Crossings near Brackett Road & Route 6

Project Description – Brackett Road in Eastham intersects with the Cape Cod Rail Trail and connects a largely residential area east of the trail to a commercial center at the intersection with Route 6, approximately ¼ mile to the west of the trail. Some pedestrian improvements are partially constructed, however further funding is needed for completion. Additional sidewalks and pedestrian crossings need to be identified and designed to develop a complete network of pedestrian facilities to provide access and improve safety within this corridor.

Preliminary Design Concepts – Sidewalks should be provided to establish linkages between the commercial trip generators along Route 6 with the Cape Cod Rail Trail and the residential neighborhoods accessed via Brackett Road. Depending upon traffic volumes, speeds, and location of pedestrian trip generators, sidewalks should be considered along both sides of the street. Appropriate marked crosswalks and signage, consistent with the roadway geometrics and existing traffic patterns should be installed at intersections where the heaviest pedestrian movements are likely to occur. Additional pedestrian safety countermeasures should be considered where appropriate.

Cost Estimate – Sidewalks and crossing improvements, unit costs:

- 5' Sidewalks, bituminous, both sides of street – $120.00/linear foot
- 5' Sidewalks, concrete, both sides of street – $140.00/linear foot
- Marked Crossing – $1,500.00
- Signalized Crossing – $70,000.00

Assumes installation of signalized intersection with mast arms, signal heads, pedestrian signals, pavement markings, and appropriate pedestrian upgrades such as curb cuts and ADA curb ramps.

Recommendations for Implementation – A gap analysis should be undertaken to identify and prioritize sidewalks and crossings needed to develop a complete network which integrates the existing pedestrian infrastructure (such as the CCRT) with the surrounding pedestrian trip generators including both residential and commercial origins and destinations. Safety countermeasures should be considered for locations where potential exists for vehicle/pedestrian collisions, primarily at the intersection with the CCRT and along Route 6 where pedestrian travel may present multiple conflict points with vehicle ingress and egress. Access management should be considered at these locations, and improvements along Route 6 should also seek to improve access to transit stops.

Project 5.2.6: Western Extension of CCRT through Independence Park

Project Description – Located along Route 6 in Barnstable, Independence Park, a commercial and industrial business center, lies just to the north of the Hyannis Transportation Center and the Barnstable Municipal Airport. Providing a connection to the CCRT would

facilitate greater utilization of the trail for bicycle commuting trips, especially if coordinated with access to the Hyannis Transportation Center. Multimodal commute options would be greatly expanded as a result.

Preliminary Design Concepts – The extension should utilize current design guidelines for shared-use paths and rail-trails with a minimum 10' paved trail width. A wider paved surface should be considered along segments that are envisioned to have higher volumes of users. Current practices also consider separation of bicycle and pedestrian modes by providing a wider trail surface and designation of walking and bicycling lanes to make for a safer and more enjoyable environment along segments where there is considerable mixing of bike and pedestrian traffic. The proposed western extension of the CCRT linking the existing terminus in South Dennis to the Hyannis Transportation Center would likely utilize an alignment to the east of the regional airport that is proximate to Independence Park. A short spur, likely passing to the north of the airport would be needed to provide a connection between the business park and the extension of the CCRT. The actual alignment needs to be determined.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00

Recommendations for Implementation – This connection needs to be coordinated with planning or construction related to the western extension of the Cape Cod Rail Trail, most notably the extension to the Hyannis Transportation Center (Project 5.2.7) which would result in a CCRT alignment that is proximate to this location. Additionally, Project 5.2.13 should be considered for coordination since it may facilitate a logical termini for either a future extension of an off-roadway alignment linking the CCRT to the Cape Cod Canal Bikeway, or at least serving to access an on-roadway route.

Project 5.2.7: Western Extension of CCRT to Hyannis Transportation Center

Project Description – The current terminus of the Cape Cod Rail Trail in South Dennis lies approximately 8 miles to the east of the Hyannis Transportation Center. Connecting the CCRT to Hyannis is significant in that it is an urban center of Cape Cod with considerable population and commercial activity, and also the site of the Cape's primary multimodal center providing rail, air, bus, and ferry service. The CCRT serves as one of Cape Cod's primary bicycle facilities and by providing direct access to the transportation center bicycling can become a more integrated mode in the Cape's transportation network and linking the center and Hyannis to multiple communities and destinations in the Mid and Lower Cape.

Approximately 3.3 miles of the proposed extension are currently programmed, continuing along the existing abandoned rail bed. The proposed alignment could utilize the existing two mile long Old Townhouse Road Trail needing only to close a small .15 mile gap between those two alignments. Another 1.25 mile section of the Old Townhouse Road Trail is currently

programmed, which would extend the CCRT to Higgins Crowell Road leaving approximately a 2.5 mile gap to connect to the Hyannis Transportation Center. The most likely alignment from that point would continue along the Old Townhouse Road corridor and then in the proximity of Yarmouth Road which provides access the Hyannis Transportation Center. The proposed extension runs primarily through Yarmouth, with short segments at either termini in Dennis and Barnstable.

Preliminary Design Concepts – The extension should utilize current design guidelines for shared-use paths and rail-trails with a minimum 10' paved trail width. A wider paved surface should be considered along segments that are envisioned to have higher volumes of users. Current practices also consider separation of bicycle and pedestrian modes by providing a wider trail surface and designation of walking and bicycling lanes to make for a safer and more enjoyable environment along segments where there is considerable mixing of bike and pedestrian traffic. Utilization of any existing path segments should consider retrofitting to ensure continuity in design, including intersection treatments.

Cost Estimate – Shared-use path cost:

- utilizing combination of alignments noted – $5,200,800.00

Recommendations for Implementation –The proposed corridor and specific alignments have undergone conceptual design but it may be necessary to determine potential gaps, notably if any existing facilities are to be used. Further, if existing facilities are to be utilized and integrated into the extension they need to be evaluated for retrofits or improvements to provide consistency and continuity with the design standards employed for the remainder of the CCRT. An environmental assessment is needed before final design and construction can proceed. The extension should also be coordinated with planning or construction related to Projects 5.2.6 and 5.2.13.

Project 5.2.8: Connect Chatham Municipal Parking Lot and Old Colony Rail Trail and Old Queen Anne Road via Route 137 Improvements

Project Description – The Old Colony Rail Trail in Chatham lies along the north side of Route 28 with a trailhead located near the intersection of Route 28 (Main Street) and Route 137 (Meetinghouse Road). Access north to East Chatham and Brewster is needed and is proposed via roadway improvements including the addition of 4' paved shoulders along approximately 1.25 miles of Meetinghouse Road between Main Street and Queen Anne Road.

Preliminary Design Concepts – Roadway improvements along Route 137 to provide 11' travel lanes and 4' paved shoulders. On-roadway improvements and accommodations are needed to provide direct, comfortable bicycle routes. Shoulder widening, pavement markings, signage, intersection enhancements, and other safety countermeasures along with wayfinding measures would provide a convenient and comfortable route for cyclists of varying abilities. Specific design treatments should be sensitive to the particular needs and context of each road where improvements are made.

Cost Estimate – On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, signs, and pavement markings along both sides of the road.

Recommendations for Implementation – Opportunities should be sought to begin implementing improvements through coordination with other construction and maintenance projects. Routine pavement overlay and resurfacing projects should include shoulder paving for this route if adequate right of way exists or can be obtained. Maintenance needs to be considered so that the functionality of shoulders for bicycling purposes is retained since the natural sweeping action of vehicles often results in debris accumulating in the untraveled shoulder.

Project 5.2.9: Extension of the Old Colony Rail Trail from Volunteer Park to Schoolhouse Pond

Project Description – The existing Bicycle Spur from Volunteer Park is called the Old Colony Rail Trail and also the Chatham Spur. Currently the Chatham Spur ends in Chatham and utilizes a brief on-road alignment in the vicinity of the airport. In order to connect this trail to Schoolhouse Pond, an extension of the multi-use trail is required for a distance of approximately 3000 feet. Also, a "Share the Road" bike route or bike lane is required on Old Queen Anne Road for a distance of 4000 feet to make final connections to Sam Ryder Road, the access road to Schoolhouse Pond.

Preliminary Design Concepts – The extension should utilize current design guidelines for shared-use paths and rail-trails with a minimum 10' paved trail width. A wider paved surface should be considered along segments that are envisioned to have higher volumes of users. Current practices also consider separation of bicycle and pedestrian modes by providing a wider trail surface and designation of walking and bicycling lanes to make for a safer and more enjoyable environment along segments where there is considerable mixing of bike and pedestrian traffic.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Recommendations for Implementation – Landowner issues may present difficulty in acquiring the needed right of way for a trail alignment. Alternative alignments should be investigated to determine the most feasible connection.

Project 5.2.10: Connect Shining Sea Bikeway to Gifford Street

Project Description – This proposed connection has been conceived by the Falmouth Bikeways Committee. The goal is to provide bicycle access to Gifford Street, a major north/south local collector connection Brick Kiln Road to Main Street (Route 28). There are a number of local roads that can be used as a bike route to facilitate this connection including Pumping Station Road, Jones Road and Kathleen Lee Bates Road; the preferred alternative. The most challenging constrain is the crossing of State Highway Route 28. The Falmouth Bikeways Committee has made inquiries to MassDOT regarding this location to in hopes to having a pedestrian bridge constructed to facilitate a safe and convenient crossing.

Preliminary Design Concepts – The connection is envisioned to utilize local roads with several possible options including Pumping Station Road, Jones Road, and Katherine Lee Bates Road which is the preferred alternative. Two primary design issues entail identifying and designing a suitable crossing of Route 28, and access from the bikeway to Route 28 which may involve private property. Few streets provide a direct route from the bike way across Route 28 due to offset intersections. As a result a short shared-use path spur may be necessary to provide a connection between the bikeway and Route 28. Wayfinding signage should be installed along the selected route.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

Crossing improvements, unit costs:

- Marked Crossing – $1,500.00
- Signalized Crossing – $70,000.00

Assumes installation of signalized intersection with mast arms, signal heads, pedestrian signals, pavement markings, and appropriate pedestrian upgrades such as curb cuts and ADA curb ramps.

Recommendations for Implementation – Some have advocated for a pedestrian bridge for the Route 28 crossing, however such structures require significant right of way and are very costly. Crossing improvements will be needed at the location chosen and specialized pedestrian crossing signals should be considered such as a HAWK or the rectangular rapid flash beacon (RRFB)both of which are only activated when a pedestrian or bicycle is present, otherwise allowing the uninterrupted flow of traffic. The preferred alignment along surface streets will dictate where the crossing of Route 28 will need to occur and an evaluation will be needed to

determine the appropriate type and level of crossing accommodation and countermeasures needed. The alignment options should also consider the potential need for a path connection and related expenses.

Project 5.2.11: Extend Shining Sea Bikeway through Bourne to Cape Cod Canal Bikeway

Project Description – This proposed connection has been conceived by the Falmouth Bikeways Committee. The Route 28 state highway layout is approximately 200 feet wide and contains a very wide, wooded median separating the northbound road from the southbound road. The Committee envisions bridging the southbound road way and construction of a multi-use path through the wooded median for a distance of approximately 6 miles to make a final connection to the Cape Cod Canal Bikeway. This will provide an alternate route to a branch of Bike Route #1, located on County Road in Bourne.

It is important to note that the Town of Bourne is in support of an alternate concept for the connection to the Canal which utilizes a 'rails-with-trails' design along the Old Colony tracks. (See Project 5.3.8)

Preliminary Design Concepts – The extension should utilize current design guidelines for shared-use paths and rail-trails with a minimum 10' paved trail width. A spur linking the existing bikeway with the proposed alignment via the media will need to be identified, either within existing road right of way or along an independent alignment.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

Bike/pedestrian bridge, unit costs:

- Survey, design, geo-tech, permitting, etc. – $240,000.00
- Total lump sum (LS) construction – $1,200,000.00

Recommendations for Implementation – Due to the unique alignment through the Route 28 median Mass Highway Department will need to be consulted for approval of both the concept and specific design elements. Because of the cost of a flyover access to the median it will be important to indicate that this segment of the bikeway would have limited access points. Conceptual plans should incorporate at least a couple proposed access points to facilitate wider use of the corridor by bicyclists seeking to access nearby destinations. Routing of a shared-use path through an interchange can prove difficult and access to the median will also prove challenging. Opportunities such as utilizing the existing rail alignment south of Route 151 should be investigated to deem whether access could to the median could be achieved, mitigating the need for a flyover.

Project 5.2.12: Parking Improvements at Trailheads

Project Description – Significant usage of the trail facilities on Cape Cod results in inadequate parking capacity. Both existing and proposed facilities need to plan for and construct parking facilities for visitors accessing trailheads by car. Opportunities to utilize existing, but underused parking capacity should also be investigated.

Project Location Map – NA

Preliminary Design Concepts – Designs will be specific to individual trailheads, parking facilities, and parking demands.

Cost Estimate – Construction of parking lot at trailhead:

- $50,000.00

Recommendations for Implementation – Existing trailheads need to be identified which currently experience excessive parking demand and opportunities for expansion investigated. Possible locations of new trailheads where adequate right of way exists for parking should be identified. Opportunities for joint-use or facility sharing should be investigated. Cape Cod localities should investigate adoption of local ordinances to facilitate use of shared parking facilities. Model agreements and ordinances should be developed that can be shared among Cape Cod localities to facilitate use of shared facilities. This approach provides an opportunity for facility sharing which increases the utilization of existing infrastructure while reducing the need for construction of additional parking facilities, many of which will be unutilized much of the year.

Project 5.2.13: Connect Cape Cod Canal Bikeway to Hyannis Transportation Center

Project Description – Linking the developed areas of Bourne and Sandwich to the Hyannis Transportation Center, approximately 22 miles away would provide multimodal transportation options to the Upper Cape. Route 6 serves as the primary corridor facilitating travel between the Upper and Mid-Cape, though it is largely unsuitable to bicycle travel. Ultimately an extension of the Cape Cod Rail Trail along the entire length of Cape Cod is envisioned, though at this time that is not feasible due to costs and logistics. This project should identify off-roadway alignments to develop some shared-use path segments while utilizing secondary roads for other segments.

Preliminary Design Concepts – The design concepts are subject to determination of a feasible alignment, whether on-roadway or for share-use path segments. Since conditions will vary considerably throughout the region connections should consist of both on-road and shared-use path connections. The designs will need to consider the appropriate elements for the context in which the routing takes place. Secondary streets with low traffic speeds and volumes can provide adequate connections with minimal enhancements such as improved signage

and/or pavement markings. Shared-use path sections should utilize current design guidelines for shared-use paths and rail-trails with a minimum 10' paved trail width. A wider paved surface should be considered along segments that are envisioned to have higher volumes of users. Current practices also consider separation of bicycle and pedestrian modes by providing a wider trail surface and designation of walking and bicycling lanes to make for a safer and more enjoyable environment along segments where there is considerable mixing of bike and pedestrian traffic.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Recommendations for Implementation – Due to the length and multiple jurisdictions a coordinated planning effort will be required to identify a proposed route and facilities needed. A corridor approach should be adopted to identify potential shared-use path alignments throughout the region to ensure connectivity as the segments can be built in phases, perhaps by different agencies or municipalities. The desired conditions and accommodations to be provided along on-roadway segments need to be established and agreed upon by stakeholders so that conditions are consistent for bicyclists traveling between jurisdictions. Planning and construction should be coordinated with Projects 5.2.6 & 5.2.7 in order to link proposed projects and develop a wider bicycle network.

Project 5.2.14: Develop Plan for Intermodal Center in Falmouth

Project Description – This proposed connection has been conceived by the Falmouth Bikeways Committee. The intermodal center is proposed to be located at the former North Falmouth railroad station at the intersection of County Street with the Bay Colony Rail/ Commonwealth of Massachusetts Executive Office of Transportation Railroad right-of-way. At the present time this site is at the northern terminus of the Shining Sea Bike trail. This lot is unpaved and is currently used as a parking lot for trail users. The site supports an active section of Bay Colony Rail operations.

Preliminary Design Concepts – This lot is large enough to support a paved parking lot and bus stop operations. The improvement could include formal curb cuts, a paved parking field with internal circulation, a 'kiosk' type bus shelter mounted on a raised pedestrian island, and bike racks.

Cost Estimate – Multiple facility improvements:

- Parking lot – $50,000.00
- Bus shelters – $20,000.00
- Secure bicycle parking (unit cost)– $1,500.00

Recommendations for Implementation – Multiple entities need to coordinate efforts and agree upon the scope of the facility and operations proposed for the intermodal center. The specific configuration and ingress and egress to the facility would need to be evaluated and a possibly a traffic study conducted to determine traffic impacts. It has been proposed that the railroad could provide some level of funding for a shared facility.

Project 5.2.15: Improve Bicycle Facilities on Tupper Road South of Route 6A

Project Description – Tupper Road in Sandwich provides access to the terminus of the Cape Cod Canal Bikeway, paralleling much busier Route 6A which also serves as Mass Bike Route 1. Tupper Road then provides a north/south connection between Route 6A and Route 130, Main Street, but lacks any bicycle accommodations. Adding paved shoulders or other bicycle improvements would provide safer, more comfortable bicycling conditions while also reducing conflicts with motor vehicles. Adding paved shoulders has additional benefits including pavement edge stabilization, the addition of a recovery area which reduces roadway departure crashes, and a breakdown area that allows disabled vehicles to be moved out of the travel lane, thereby mitigating congestion impacts from such incidents. These all result in safety, operational, and maintenance benefits which yield long-term cost savings.

Preliminary Design Concepts – Road widening or the addition of paved shoulders should consider the existing roadway geometrics. In order to be useful for bicycle travel shoulders and the adjacent travel lane need to be of adequate widths to provide a degree of separation between the two modes, otherwise safety can be impaired by inviting motorists to pass too closely to bicyclists that attempt to hug the outside edge of the roadway. In general a four-foot shoulder is desirable to provide adequate operating space for a bicyclist while allowing motorists unimpeded travel within the adjacent lane. On roads with curb and gutter, the gutter pan and the longitudinal joint effectively reduces the useable width of the shoulder and consideration needs to be given to the paved width of the shoulder exclusive of the gutter pan. Realignment of Mass Bike Route 1 (the Claire Saltonstall Bikeway) onto this improved route, complete with appropriate signage would offer a more appealing route for long-distance bicyclists.

Cost Estimate – On-road improvements, unit costs per mile:

- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders along both sides of the road.

Recommendations for Implementation – Opportunities should be sought to begin implementing improvements through coordination with other construction and maintenance projects. Routine pavement overlay and resurfacing projects should include shoulder paving for this route if adequate right of way exists or can be obtained. Maintenance needs to be considered so that the functionality of shoulders for bicycling purposes is retained since the

natural sweeping action of vehicles often results in debris accumulating in the untraveled shoulder. In order to further develop an improved corridor and continuous route, and perhaps a resultant realignment of the Claire Saltonstall Bikeway, any improvements should be coordinated with Projects 5.3.15 and 5.3.17.

Project 5.2.16: Evaluate Use of Unpaved Roads for Bike Path Connections in Cape Cod National Seashore

Project Description – Within the National Seashore a number of unpaved roads currently exist which could be utilized to provide bicyclists with access to several popular bicycle trails. This would result in establishment of a unified network without having to travel on the more heavily traveled roadways, particularly Route 6, and which could be accomplished with minimal improvements, resulting in a low cost enhancement to the existing, but fragmented bicycle network in the Seashore.

Preliminary Design Concepts – Design issues would largely be limited to providing adequate wayfinding signage to direct bicyclists through the Seashore to popular destinations and trails. Such signage should follow the standards and protocol established via Project 5.2.2 (if implemented) to maintain consistency with bicycle wayfinding signage throughout the region.

Cost Estimate – NA

Recommendations for Implementation –Possible connector routes via existing unpaved roads should be identified, especially those that are likely to have the least impact to sensitive environmental or historical features within the Seashore. Existing conditions should be evaluated for compatibility with bicycle use and any needed improvements should be documented for consideration in the planning process including grading and additional loads of surface material. Should unpaved roads be used for this purpose a maintenance policy will be needed to ensure conditions suitable for bicycling are maintained and wayfinding signage will be needed to direct bicyclists to destinations and trails within the Seashore.

NEW FACILITIES

The following is a list of twenty two projects proposing construction of new facilities. These projects are number 5.3.1 through 5.3.22.

Project 5.3.1: Evaluate Local Roads and Establish Bicycle Connections between Cape Cod National Seashore and Neighboring Communities

Project Description – A two-phase project proposing to develop planning alternatives to improve bicyclist safety and access by providing connections between Cape Cod National Seashore and six neighboring communities followed by a pilot project implementation component.

Component A – Feasibility Study to include

- General overview, project purpose and need, local and regional perspectives;
- Project Description, including locus map, major constraints and opportunities;
- Corridor Right of Way: public vs. private property;
- Resources: GIS level environmental resources such as waterways, wetlands, vernal pools, wildlife habitat, management/refuge areas, historic areas/districts/sites, contaminated sites;
- Trail or route design criteria;
- Structures required; and
- Route and trail amenities: parking, access to attractions, wayfinding & interpretive signing.

Component B – Implementation of pilot project on 1 roadway

Preliminary Design Concepts – Conceptual design would include typical sections, alignment, road/water crossings, structures, trail amenities, impacts & mitigation, ROW actions, permitting requirements, and construction. Final design would include construction plans, specifications, right-of-way plans, and bidding documents for advertising by MassDOT or the municipality.

This project proposal assumes a 2 mile pilot project for cost estimating purposes consisting of minor roadway widening, and intersection and traffic signal improvements.

Cost Estimate –

- Feasibility Study – $20,000
- Pilot project design and construction – $3,471,046.66

Recommendations for Implementation – Prior to evaluating local roads for suitable bicycling conditions it will be necessary to establish evaluation criteria and metrics. Roadway geometrics, traffic volumes, prevailing speeds, the presence of trip generators including residential origins, and directness of travel should be considered. Subsequently, selection of neighboring communities and potential connector routes or corridors is needed before any feasibility study and analysis can proceed. The list of potential routes should be inclusive of a variety of roadways and conditions so that alternatives can be established and evaluated to determine opportunities and barriers to implementation of improvements and connections. Off-roadway alignments should be considered and evaluated as well including abandoned rail lines, utility line easements, conservation lands, or other possible alignments. Demonstration of the improvements resulting from the pilot project requires the collection of baseline (current conditions) data for comparison after implementation. Data to be collected will need to be determined specific to the community and route selected, however the following should be considered:

- Route / facility usage (bike/pedestrian trips)
- Type of trips made via corridor / route

- Crash data
- Perceived level of safety among facility users
- Perceived level safety among motorists encountering bicyclists and pedestrians
- Ease of wayfinding

Project 5.3.2: Feasibility Study and Design of Bike Path along Route 6 from Herring Cove Parking Lot to Race Point Road

Project Description – A two-phase project to develop a bicycle path connecting the CCNS parking facilities at Herring Cove to other National Seashore facilities, including the Province Lands Bicycle Trail at Race Point Road. The first phase is to conduct a Feasibility Study coordinated between the Cape Cod Commission, the State of Massachusetts, the National Park Service, and the town of Provincetown to identify dedicated alignment within the existing right of way along the north Side of Route 6 from Herring Cove to Race Point Road.

Route 6 is a principal arterial that provides direct access between Herring Cove and the National Seashore attractions at Race Point, including the Province Lands Bicycle Trail. Completely lacking in bicycle and pedestrian accommodations, Route 6 has only minimally paved shoulders, significant traffic volume, truck traffic, and posted speed limits varying between 35 MPH and 45 MPH. Though Herring Cove and Race Point are connected via the Province Lands Bicycle Trail, it is a circuitous path and doesn't facilitate convenient and expedient bicycle and pedestrian mobility between the two points. Additionally, bicycle access to these two locations from the commercial center and the neighborhoods of Provincetown is not available. As a result nonmotorized modes cannot be comfortably utilized to reach these nearby destinations, resulting in greater reliance on automobile travel within this region of Cape Cod.

Component A – Feasibility Study to include

- General overview, project purpose and need, local and regional perspectives;
- Project Description, including locus map, major constraints and opportunities;
- Corridor Right of Way: public vs. private property;
- Resources: GIS level environmental resources such as waterways, wetlands, vernal pools, wildlife habitat, management/refuge areas, historic areas/districts/sites, contaminated sites;
- Trail or route design criteria;
- Structures required;
- Trail amenities: parking, access to attractions, wayfinding & interpretive signing;
- Trail access points providing connections to on-roadway bicycle and pedestrian routes in Provincetown;
- Needed facilities and retrofits to connecting bicycle and pedestrian routes within Provincetown;
- Conceptual Design including typical sections, alignment, road/water crossings, impacts & mitigation, permitting requirements, construction costs; and
- Operations & Maintenance requirements.

Component B – Class III design and construction plans

Design cost estimates at 17% of NET construction costs

Preliminary Design Concepts – Conceptual design would include typical sections, alignment, road/water crossings including trail access points at intersections that provide connections to neighborhoods and the commercial center of Provincetown, structures, trail amenities, impacts & mitigation, ROW actions, permitting requirements, and construction. Final design would include construction plans, specifications, right-of-way plans, and bidding documents for advertising by MassDOT or the municipality. The envisioned project would be approximately 2 miles long.

Cost Estimate –

- Feasibility Study – $20,000
- Class III Design & Construction – $3,456,085

Recommendations for Implementation – Coordination of stakeholder interests is needed to fully develop the scope of the feasibility study component. Existing plans should be consulted to determine how related projects can contribute to the overall development of a facility that is integrated into the existing bicycle and pedestrian network in Provincetown. Planned or programmed projects that have the potential to impact concurrency issues, notably those on connector routes providing access to the proposed path should be investigated to determine possible synergies and cost savings with minimal changes to scopes of work. Specifically any improvements should be coordinated with Project 5.3.12 to integrate efforts at developing linkages throughout Provincetown and the Province Lands attractions within the Seashore.

Project 5.3.3: Identify Possible Connections between the Cape Cod Rail Trail and Cape Cod National Seashore Trails

Project Description – Envisioned primarily in Eastham where the Nauset Trail is proximate, but not connected to the Cape Cod Rail Trail, connections between the CCRT and trails within the Seashore are needed. The CCRT, located to the west of Route 6 is approximately ½ mile from the Salt Pond Visitor's Center but requires crossing Route 6 to facilitate a direct connection. Just north of the Salt Pond Visitor's Center (site of the trailhead) the CCRT passes underneath Route 6 and on-roadway routes could be designated without the need to cross Route 6 at-grade, though they would provide less direct access.

Preliminary Design Concepts – The design concepts are subject to determination of a feasible alignment to connect Seashore trails to the Cape Cod Rail Trail. Since conditions will vary considerably at each location the connections could consist of both on-road and shared-use path connections the designs will need to consider the appropriate elements for the context in which the routing takes place. Secondary streets with low traffic speeds and volumes can provide adequate connections with minimal enhancements such as improved signage and/or pavement markings. Shared-use path sections could utilize a paved surface, or a natural surface. Unpaved roads should also be considered to establish connections.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, striping and signage along both sides of the road.

Recommendations for Implementation – Locust Road provides the most direct access between the visitor's center and the rail-trail, however access via this route requires and at-grade crossing of Route 6. The intersection is controlled by a signal however, and if chosen as the alignment the signal operation should be evaluated for compatibility with bicycles (bicycle detection, appropriate timing and clearance intervals). An alternative route would utilize the CCRT underpass beneath Route 6 to access the neighborhood streets to the east via Old Orchard Road and School House Road. This option would avoid an at-grade crossing of Route 6 but would result in a longer, more circuitous route. Existing conditions on all potential roadway segments should be evaluated to determine the most feasible routing requiring the least infrastructure improvements to keep costs low.

Project 5.3.4: Regional and local Pedestrian and Bikeway connectivity to Dennis Port

Project Description – The Town of Dennis, through its Dennis Port Revitalization Committee, has established a prime objective of making pedestrian and bikeway connections to key destinations in the region surrounding the Dennis Port Village. These connections include (among others); providing links to the hotel / motel district located on Lower County Road; the playgrounds and historic sites located in South Dennis; the Cottage Colony located between Lower County Road and the beach / waterfront area; and a combination of shared routes and/or multi-use paths to provide connections to the Cape Cod Rail Trail at Route 134, and the Old Colony Rail Trail in Harwich. The various desired connections are identified and illustrated in the Dennis Port Master Plan which may be found online at:

www.dennisportrevitalization.org

Preliminary Design Concepts – On-roadway improvements and accommodations are needed to provide direct, comfortable bicycle routes and safe roadway crossings to access the rail trails. Shoulder widening, pavement markings, signage, intersection enhancements, and other safety countermeasures along with wayfinding measures would provide a convenient and comfortable route for cyclists of varying abilities. Sidewalks and improved crossings are needed

at various locations to establish pedestrian routes and connections. Specific design treatments should be sensitive to the particular needs and context of each road where improvements are made.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, signs, and pavement markings along both sides of the road.

Sidewalks and crossing improvements, unit costs:

- 5' Sidewalks, bituminous, both sides of street – $120.00/linear foot
- 5' Sidewalks, concrete, both sides of street – $140.00/linear foot
- Marked Crossing – $1,500.00
- Signalized Crossing – $70,000.00

Assumes installation of signalized intersection with mast arms, signal heads, pedestrian signals, pavement markings, and appropriate pedestrian upgrades such as curb cuts and ADA curb ramps.

Recommendations for Implementation – The feasibility of adding paved shoulders or bicycle lanes and improving conditions to one or more roads needs to be determined. Multiple connections should be considered to provide for access to both rail trails and destinations along the potential routes should be considered when selecting alignments. Routes that serve to connect multiple trip generators would serve to increase the utilization of bicycling for utility trips and multiple connections would establish a more complete route network in the region. A four foot shoulder is desirable to provide adequate operating space for a bicyclist while allowing motorists unimpeded travel within the adjacent lane.

Project 5.3.5: Identify Regional Connections between Existing Paths and Locations with High Pedestrian Traffic

Project Description – Sidewalks or shared-use paths should be provided to establish connected and contiguous pedestrian access routes between the commercial trip generators, residential neighborhoods, and existing pedestrian facilities where pedestrian traffic is currently high or for which there is significant latent demand. Pedestrian networks should be established on a regional basis to connect villages and towns when density and proximity warrant.

Preliminary Design Concepts – Depending upon traffic volumes, speeds, and location of pedestrian trip generators, sidewalks should be considered along both sides of the street. Appropriate marked crosswalks and signage, consistent with the roadway geometrics and existing traffic patterns should be installed at intersections where the heaviest pedestrian movements are likely to occur. Additional pedestrian safety countermeasures should be considered where appropriate.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

Sidewalks and crossing improvements, unit costs:

- 5' Sidewalks, bituminous, both sides of street – $120.00/linear foot
- 5' Sidewalks, concrete, both sides of street – $140.00/linear foot
- Marked Crossing – $1,500.00
- Signalized Crossing – $70,000.00

Assumes installation of signalized intersection with mast arms, signal heads, pedestrian signals, pavement markings, and appropriate pedestrian upgrades such as curb cuts and ADA curb ramps.

Recommendations for Implementation – A gap analysis should be undertaken to identify and prioritize sidewalks and crossings needed to develop a complete network which integrates the existing pedestrian infrastructure including sidewalks, paths, and neighborhood streets with the surrounding pedestrian trip generators including both residential and commercial origins and destinations. Safety countermeasures should be considered for locations where potential exists for vehicle/pedestrian collisions, primarily at the intersections with arterial and collector roadways and where commercial entrances or lack of access management results in frequent conflict points. Access management should be considered at these locations, and improvements should also seek to improve access to transit stops when appropriate.

Project 5.3.6: Identify a "Shore Route" South of Route 28 from Woods Hole in Falmouth to Stage Harbor in Chatham

Project Description – Identification of a "Shore Route" of approximately 45 miles providing bicycle access and connectivity across a region comprised of eight localities would link the many destinations and villages of this heavily developed region of the Cape. Proposed as an on-roadway route, it would closely follow the coastline along Nantucket Sound. Limited route options in many locations result from a fragmented road network that would require use of Rte 28 in many locations. In developed areas where Route 28 lies farther from the coast, more route permeability typically exists, allowing for more routing options, though this is intermittent throughout the corridor from Falmouth to Chatham.

Preliminary Design Concepts – On-roadway improvements and accommodations are needed to provide a relatively direct, comfortable, and connected bicycle route south of the Route 28 corridor. Shoulder widening, pavement markings, signage, intersection enhancements, and other safety countermeasures along with wayfinding measures should be utilized consistent with the context and conditions of the specific roadways where improvements are implemented. Because of the circuitous routing that would be required wayfinding is an essential element. Where the use of Route 28 is required careful consideration needs to be given to providing bicycle accommodations and countermeasures that facilitate bicyclists safely entering and departing this heavily traveled roadway.

Cost Estimate – On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, signs, and pavement markings along both sides of the road.

Recommendations for Implementation – Due to the regional nature of the proposed project, coordination among the eight localities and the Cape Cod Commission is needed. The large area and the lack of a connected network of candidate roadways pose significant barriers to implementation. Uniformity in accommodations through the corridor should be sought so that cyclists utilizing the route for travel across the Cape will encounter a unified and integrated route from one jurisdiction to the next. Local comprehensive plans and other local and regional plans should be reviewed and amended to reflect the proposed project, the desired level of accommodations, and means by which individual localities can implement improvements. The project should be coordinated with other proposed improvements where new routes might utilize Route 28 or parallel corridors such as the proposed improvement and designation of Route 28 as a bicycle route (Project 5.3.10) and the proposed "OBHC Triangle Route" (Project 5.3.18). Additionally, the improvements should be coordinated with the proposed connections between the Old Colony Rail Trail and Harwich Port and Dennis Port (Projects 5.3.9 & 5.3.4) in order to ensure linkages that will establish a connected network of bicycle routes.

Project 5.3.7: Identify a "Bay Route" from the Cape Cod Canal in Bourne to Orleans

Project Description – A "Shore Route" of approximately 30 miles is envisioned to provide continuous bicycle access and connectivity across the six localities along Cape Cod Bay. The route would link the villages and destinations of this developed region of the Cape similar to the proposed "Shore Route" paralleling it along the southern coast of the Cape. Likewise, the "Bay Route" is envisioned as an on-roadway route following the coastline along Cape Cod Bay, north of Route 6 and traversing the popular destinations along the coast. Limited route options in many locations result from a road network fragmented by both manmade and natural features, and which would require use of Route 6A in many locations. In developed areas where Route 6 lies farther from the coast more route options exist, most notably in West Barnstable and Dennis. Unlike the Rte 28 corridor of the "Shore Route" Route 6A parallels Route 6, providing a largely continuous route option with slower speeds and traffic volumes than the principal arterial Route 6, though it would still need infrastructure improvements to be a suitable route.

Preliminary Design Concepts – On-roadway improvements and accommodations are needed to provide a relatively direct, comfortable, and connected bicycle route north of Route 6. Shoulder widening, pavement markings, signage, intersection enhancements, and other safety countermeasures along with wayfinding measures should be utilized consistent with the context and conditions of the specific roadways where improvements are implemented. Because of the circuitous routing that might be utilized along secondary and residential streets wayfinding is an essential element.

Cost Estimate – On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, signs, and pavement markings along both sides of the road.

Recommendations for Implementation – Due to the regional nature of the proposed project, coordination among the six localities and the Cape Cod Regional Commission is needed. The large area and the limited network of connected candidate roadways pose significant barriers to implementation. Uniformity in accommodations through the corridor should be sought so that cyclists utilizing the route for travel across the Cape will encounter a unified and integrated route from one jurisdiction to the next. Local comprehensive plans and other local and regional plans should be reviewed and amended to reflect the proposed project, the desired level of accommodations, and means by which individual localities can implement improvements. The project should be coordinated with other proposed improvements within or adjacent to the Route 6 corridor such as the proposed route through the Sandwich Historic District (Project 5.3.27) and the "OBHC Triangle Route" (Project 5.3.18).

Project 5.3.8: Relocation of Existing Rail Line and Conversion to Trail

Project Description – This 6 mile project in the Town of Bourne proposes to create a rails-with-trail facility from the northern terminus of the Shining Sea Bike Path to the Cape Cod Canal Bikeway via the existing MassDOT/Bay Colony railroad right-of-way (ROW). This existing rail corridor parallels Shore Road in Bourne. Although the title suggests that the tracks require relocation, it is possible that the railroad ROW maintains sufficient width to support a new multi-use trail without the need to move the tracks.

It is important to note that the Town of Falmouth is in support of an alternate concept for the connection to the Canal which utilizes the Route 28 median for construction of a multi-use path to make the connection from the Shining Sea bike path to the Cape Cod Canal. (See Project 5.2.11)

Preliminary Design Concepts – The trail should utilize current design guidelines for shared-use paths and rail-trails with a minimum 10' paved trail width. A wider paved surface should be considered along segments that are envisioned to have higher volumes of users. A number of at grade crossings will require individual consideration based upon the conditions present and safety countermeasures required.

Cost Estimate – Shared-use path, unit costs per mile:

- Along abandoned RR bed – $660,000.00

Crossing improvements, unit costs:

- Marked Crossing – $1,500.00
- Signalized Crossing – $70,000.00

Assumes installation of signalized intersection with mast arms, signal heads, pedestrian signals, pavement markings, and appropriate pedestrian upgrades such as curb cuts and ADA curb ramps.

Rail relocation costs:

- TBD, if necessary

Recommendations for Implementation – Additional research is required to confirm the layout width of the railroad ROW. The project will also require the design of numerous at grade crossings at the various intersection with public and private streets. This would likely be a mega-project requiring significant funding and a phased approach. The initial phase should include linkages to existing trail or on-road routes to be an integrated facility, not a stand-alone facility.

Project 5.3.9: Connect Harwich Port to Old Colony Rail Trail

Project Description – Harwich Port is located approximately 1½ miles south of the center of Harwich and the Old Colony Rail Trail. Currently there are no bicycle routes or accommodations linking Harwich Port to the trail. Several potential routes exist, notably along Bank, Forest, and South Streets, that could be improved and designated by adding shoulders or bike lanes along with signage, including wayfinding aids.

Preliminary Design Concepts – On-roadway improvements and accommodations are needed to provide direct, comfortable bicycle routes and safe roadway crossings to access the rail trails. Shoulder widening, pavement markings, signage, intersection enhancements, and other safety countermeasures along with wayfinding measures will provide a convenient and comfortable route for cyclists of varying abilities. Specific design treatments should be sensitive to the particular needs and context of each road where improvements are made.

Cost Estimate – On-roadway improvements (1.5 miles):

- Signing and striping – $15,840.00
- Widening to add shoulders/bike lanes – $752,400.00

Assumes adding shoulders, striping and signage along both sides of the road.

Recommendations for Implementation – The feasibility of adding paved shoulders or bicycle lanes to one or more of the three likely candidate streets needs to be determined. Existing right-of-way, utilities, and/or the existence of undeveloped properties along the candidate routes will largely determine the preferred alignment of an improved bike route. A four foot shoulder is desirable to provide adequate operating space for a bicyclist while allowing motorists unimpeded travel within the adjacent lane. Coordination with Project 5.3.4 and 5.3.6 seeking to improve bicycling conditions in the Route 28 corridor will help to ensure connectivity.

Project 5.3.10 Designate Route 28 as a Bike Route and Improve Conditions

Project Description – Though Route 28 is mainly a secondary highway it serves as the primary corridor along Nantucket Sound linking 8 towns through the Upper, Mid, and Lower Cape. Approximately sixty miles of Route 28 provides access to a number of destinations across the Cape including villages, town centers, the Hyannis Transportation Center, and the Cape Cod/Old Colony Rail Trail. Despite being the primary route through this heavily developed area of Cape Cod the road is mostly a two-lane, undivided road, often lacking paved shoulders, and is heavily congested during peak season. Improvements would provide bicyclists with a convenient and comfortable route linking the many towns, villages, and destinations along Nantucket Sound. Improvements would also reduce conflicts between bicyclists and motorists and reduce congestion, both by encouraging greater use of bicycling for transportation and by reducing vehicle where passing opportunities don't currently exist.

Preliminary Design Concepts – On-roadway improvements and accommodations are needed to provide a direct, comfortable bicycle route through the Route 28 corridor. Shoulder widening, pavement markings, signage, intersection enhancements, and other safety countermeasures along with wayfinding measures should be utilized consistent with the context and conditions of the specific roadways where improvements are implemented. In some locations a shared-use path design may be appropriate or desirable if children and less experience adult bicyclists are intended users of the route.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Existing corridor (minor grading/clearing) – $792,000.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00

- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, striping and signage along both sides of the road.

Recommendations for Implementation – Due to the regional nature of the proposed project, coordination among the eight localities and the Cape Cod Regional Commission is needed. The large geographic area and the limited right of way in many locations pose many challenges to implementation. Uniformity in accommodations through the corridor should be considered so that cyclists utilizing the route for travel across the Cape will encounter a unified and integrated route from one jurisdiction to the next. Local comprehensive plans and other local and regional plans should be reviewed and amended to reflect the proposed project, the desired level of accommodations, and means by which individual localities can implement improvements. The project should be coordinated with other proposed improvements where new routes might utilize Route 28 or parallel corridors such as the proposed "Shore Route" (Project 5.3.6) and the proposed "OBHC Triangle Route" (Project 5.3.18).

Project 5.3.11 Establish Bicycle & Pedestrian Connections between Orleans Villages

Project Description – Sidewalks or shared-use paths providing connected and contiguous pedestrian access routes between the villages of Orleans and their respective trip generators will enhance mobility and increase safety. Bicycle connections also will facilitate greater mobility and less reliance on automobile travel, and the addition of on-road accommodations and shared-use path facilities should be considered based upon context and intended users. The Village Center, South Orleans, East Orleans, Rock Harbor, and Skaket need to be considered for both bicycle and pedestrian connections as called for in the Orleans Comprehensive Plan (OS22).

Preliminary Design Concepts – Depending upon traffic volumes, speeds, and the location of pedestrian trip generators, sidewalks should be considered along both sides of the street. Appropriate marked crosswalks and signage, consistent with the roadway geometrics and existing traffic patterns should be installed at intersections where the heaviest pedestrian movements are likely to occur. Additional pedestrian safety countermeasures should be considered where appropriate.

On-roadway accommodations, shared-use paths and linkages, bike route signage, and roadway widening and striping should be considered to provide enhanced conditions for bicyclists. Due to right of way concerns, on-roadway alignments will likely prove the most feasible options and can utilize secondary and neighborhood streets with lower speeds and moderate traffic with minimal improvements while still providing an adequate level of accommodation for most bicyclists.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Sidewalks and crossing improvements, unit costs:

- 5' Sidewalks, bituminous, both sides of street – $120.00/linear foot
- 5' Sidewalks, concrete, both sides of street – $140.00/linear foot
- Marked Crossing – $1,500.00
- Signalized Crossing – $70,000.00

Assumes installation of signalized intersection with mast arms, signal heads, pedestrian signals, pavement markings, and appropriate pedestrian upgrades such as curb cuts and ADA curb ramps.

Recommendations for Implementation – A gap analysis should be undertaken to identify and prioritize sidewalks, crossings, shared-use paths, and on-roadway improvements needed to develop a complete bicycle and pedestrian network which links the villages of Orleans to one another and to existing bicycle and pedestrian trip generators. Safety countermeasures should be considered for locations where potential exists for conflict points with the addition of bicycle and pedestrian facilities.

Project 5.3.12 Connect MacMillan Pier to Cape Cod National Seashore Bicycle Paths

Project Description – MacMillan Pier in the heart of Provincetown serves as a multimodal center with local and regional bus service as well as ferry service to Plymouth and Boston. Bicycle travel on the commercial and residential streets of Provincetown is manageable with lower traffic speeds; however access to the National Seashore becomes more difficult requiring riding along and crossing collectors and arterials since limited routes exist to link the two destinations. Enhancing the ability to access the National Seashore bike paths from Provincetown, and specifically MacMillan pier will improve multimodal options and facilitate greater use of bicycling to access the Seashore without requiring reliance on automobiles.

Preliminary Design Concepts – On-roadway improvements and accommodations are needed to provide direct, comfortable bicycle routes and safe roadway crossings. Shoulder widening, pavement markings, signage, intersection enhancements, and other safety countermeasures will provide bicyclists with wayfinding along a convenient and comfortable route for cyclists of varying abilities.

Cost Estimate – On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, signs, and pavement markings along both sides of the road.

Recommendations for Implementation – Due to the limited roads that will provide access to the Province Lands Bicycle Trail via Race Point Road several routing options should be established and existing conditions evaluated. Needed improvements should be determined and the most feasible route chosen for improvements. Coordination with Project 5.3.2, the proposed path linking Herring Cove's parking facilities with Race Point Road, will ensure that intersection improvements and logical connections between this on-road route and the proposed provide a continuous and integrated network linking Provincetown with the Seashore destinations. Coordination with Provincetown will be needed.

Project 5.3.13 Connect Province Lands Bicycle Trail and Head of the Meadow Trail

Project Description – The 7.6-mile Province Lands Bicycle Trail and the 2-mile Head of the Meadow Trail, two of the Seashore's most popular trails, lie approximately four miles apart on the Outer Cape. Currently the trails are not accessible from one another other than by transiting along Route 6. Though an alignment for a separate trail linking these two trails is desirable the dunes and other sensitive features make that difficult to achieve. Use of existing roads, paved or unpaved, is likely needed for at least part of the alignment. Connection of the two trails would reduce the need to access both trails by automobile, thereby helping to ease congestion and parking demand. If done in conjunction with proposed improvements to link the Province Lands Bicycle Trail with the commercial and residential center of Provincetown access throughout this region of the Seashore has the potential to significantly reduce reliance on automobiles for access to these Seashore trails.

Preliminary Design Concepts – The design concepts are subject to determination of a feasible alignment to connect the two trails. Likely consisting of both on-road and shared-use path connections, the designs will need to consider the appropriate elements for the context in which the routing takes place. If Route 6 is chosen appropriate accommodations and safety countermeasures will be needed due to the volume and speeds of traffic. Shared-use path sections could utilize a paved surface, or a natural surface, but any design chosen should provide a firm, stable surface that is compatible with bicycle use while also providing access to disabled visitors and complying with ADA.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, striping and signage along both sides of the road.

Recommendations for Implementation – Several existing unpaved trails located between the beach and the dunes, primarily in Truro, should be considered for enhancements to be made compatible with bicycle travel. However, the parabolic dunes and other sensitive natural features are of concern and impacts need to be avoided or mitigated. The paths could retain natural surfaces to avoid both visual and environmental impacts associated with hardening, though the environmental impacts of such use would need to be evaluated. Route 6 provides the only roadway alignment to connect the two trails and options to avoid an on-roadway facility should be considered since it would not be inviting to many less experienced bicyclists.

Project 5.3.14 Connect Truro Village Center to Truro Destinations

Project Description – Connecting the two villages and the destinations of Truro via a bicycle network is needed to facilitate nonmotorized mobility while also enhancing the visitor experience to this popular summer destination. Largely rural and comprised primarily of the National Seashore, Truro has a number of popular seasonal destinations including Head of the Meadow Trail, Coast Guard Beach, the Highlands Center, Hostel International, and three campgrounds. Truro's population and developed areas are largely located in two village centers; Truro and North Truro, both on Cape Cod Bay, and which are connected primarily via Routes 6 and 6A. Like many other parts of the Cape the developed areas are not well connected through a network of secondary roads suitable for bicycling, often requiring use of collectors and arterials for transit between destinations. Aside from destinations within the two village centers most of Truro's attractions are in the National Seashore and require access along and across Routes 6 and 6A. The village centers are currently connected via Mass Bike Route 1, primarily along Route 6A and Castle Road, both of which have minimal signage but no physical accommodations for bicycles.

Preliminary Design Concepts – Bicycle connections would largely consist of on-road improvements with some off-roadway alignments where needed, based upon the needs and bicycling experience of intended users. A number of unpaved roads within the Seashore could be utilized for connections with very low traffic volumes making bicycling comfortable for a variety of users; however hardening would be needed in some locations to provide an adequate surface, although annual grading would likely provide an acceptable surface on unpaved roads that experience very low vehicle use. Wayfinding signage should be added consistent with the protocols and designs developed elsewhere on the Cape.

Adequate shoulders exist on much of Route 6 in Truro, including the short section that is utilized for the Claire Saltonstall Bikeway (Mass Bike Route 1), but the shoulder with is reduced at the junction with Route 6A northward in North Truro. Though Mass Bike Route 1 diverts onto Route 6A at this point many bicyclists still use Route 6. Interchange improvements such as bike lane pockets and/or signage should be considered along Route 6 to mitigate potential for conflicts at these weave movements, including at this location which requires north-bound bicyclists to make a left turn at an uncontrolled intersection.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, striping and signage along both sides of the road.

Recommendations for Implementation – Coordination between Truro and the National Park Service will be needed to identify desired routes and to develop plans for connecting destinations within the village centers and the National Seashore. An Environmental Screening Form would need to be completed for the elements within the Seashore to determine the level of environmental compliance required. Because hunting is allowed in some parts of the Seashore consideration needs to be given to routing of bicyclists through those areas. Habitat fragmentation is also of concern to CCNS and needs to be considered. Coordination with Project 5.3.13 is needed to develop continuity between Truro destinations and the linkages that are proposed to provide access within the National Seashore and between the existing Seashore trails.

Project 5.3.15: Connect Shawme-Crowell State Forest to the Cape Cod Canal Bikeway

Project Description – Located in Sandwich, the Shawme-Crowell State Forest is proximate to the Cape Cod Canal Bikeway but lacks an improved route or facility to connect them. The forest has a variety of park and camping facilities and lies between Routes 6 and 6A with the main entrance off of Rte 130 (Main Street). The Claire Saltonstall Bikeway does pass the entrance to the forest though there are no bicycle accommodations or facilities.

Preliminary Design Concepts – The short linkage needed to connect the Cape Cod Canal Bikeway with the state forest allows for several design alternatives to be utilized. An unused alignment for Bayview Rd near the intersection of Route 6A and 130 could allow for a shared-use path that would access the back of the state forest. The alignment is currently cleared almost to the Cape Cod Canal Bikeway, though it would require access across a rail line. An on-road route could be established using secondary roadways, preferably with bicycle accommodations provided. The most likely alignment would utilize Tupper Road and Main Street although shoulders or bike lanes should be considered to improve the existing conditions to increase safety and reduce conflicts with automobiles on these narrow roads that lack paved shoulders. Other possible on-road routes could be utilized, but would be less direct. Any route established should utilize wayfinding signage to direct bicyclists to these two facilities.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00

- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, striping and signage along both sides of the road.

Recommendations for Implementation – Several improvements in or adjacent to this general area have been proposed and should be coordinated to develop a connected and integrated network of bicycle routes and facilities. Projects 5.2.15 (improvements on Tupper Rd. south of Rte 6A) and 5.3.17 (bicycle improvements through the Sandwich Historic District) propose improved bicycle facilities in this immediate area and could be combined into a larger project, especially if this proposed connection to the forest utilizes a route along Tupper Road. Data collected during this feasibility study also indicate that existing proposed improvements call for a shared-use path or on-road improvements on Route 6A which could also facilitate this needed connection. The Claire Saltonstall Bikeway should be realigned to utilize an improved route through this corridor if bicycle accommodations are provided as a result of these proposed projects.

Project 5.3.16: Connect Wellfleet Bay Wildlife Sanctuary to Cape Cod Rail Trail

Project Description – Mass Audubon's Wellfleet Bay Wildlife Sanctuary is located on Wellfleet Harbor and is a popular destination with 5 miles of natural walking trails. The sanctuary is approximately one mile due west of the Cape Cod Rail Trail at the point where the CCRT passes through the National Seashore, however the trail is located on the opposite side of Route 6. Further complicating connection of the CCRT to the sanctuary is the need for a connection across private property. Entrance Road provides access to the sanctuary and intersects Route 6 across from the Wellfleet Lodge and the Wellfleet Motel where the most direct connection could take place. However, the CCRT parallels Route 6 behind the hotels and access from the CCRT to Route 6 would require crossing private property.

Preliminary Design Concepts – A shared-use path design typical should be utilized to provide a short, approximately ¼-mile spur linking the CCRT to Route 6. More significantly consideration and installation the appropriate crossing treatments and countermeasures are needed at the intersection with Route 6. Route 6 is a 2-lane cross section with a posted speed of 45 MPH at this location. With the traffic volumes experienced during peak season and the bicycle and pedestrian access from the CCRT, significant bicycle/pedestrian conflicts with motor vehicles would likely result. Minor improvements might be needed along Entrance Road to include directional signage and possibly pavement markings to create awareness of a shared-road environment.

Cost Estimate – Shared-use path connection (0.25 miles):

- Path along new alignment – $217,800.00

On-roadway improvements (.35 miles):

- Signing and striping – $3,696.00

Improved crossing at Route 6:

- Marked Crossing – $1,500.00
- Signalized Crossing – $70,000.00

Assumes installation of signalized intersection with mast arms, signal heads, pedestrian signals, pavement markings, and appropriate pedestrian upgrades such as curb cuts and ADA curb ramps.

Recommendations for Implementation – Construction costs associated with the short spur would be minimal, however access across private property (one of the two hotel properties) could potentially increase the costs significantly. A trail easement would allow access without the need for costly right of way acquisition and the adjacent properties of the two lodging properties would provide an alignment directly across from Entrance Road. The somewhat remote location of this proposed spur and the trail traffic generated by the sanctuary would likely minimize any potentially undesirable traffic across the properties. Additionally, some businesses have welcomed access to regional trail facilities, recognizing that it has the potential to serve to attract patrons. Pending development of the connection, an engineering study should be conducted to determine the appropriate level of accommodations needed to facilitate safe crossing of Route 6.

Project 5.3.17: Identify Potential Bikeway Alignment through Sandwich Historic District

Project Description – The Sandwich Historic District lies just to the east of the terminus of the Cape Cod Canal Bikeway, though there are no designated bike routes through Sandwich. A shared-use path through the district likely holds appeal to many, however such an alignment would prove difficult due to lacking right of way. Old King's Highway (Route 6A) borders the district to the south and is the primary route through Sandwich. Roadways along Cape Cod Bay are discontinuous and limit the availability of alternate routes through town.

Preliminary Design Concepts – Largely consisting of on-road bike routes the alignment should consider the existing conditions and whether shared-road conditions and geometrics are adequate or in need of improvements. At the least wayfinding signage is needed, especially for any alignment along secondary roads. Cul-de-sacs and dead-end residential streets may present challenges in identifying a route, however short connections between these types of streets should be considered where appropriate to facilitate bicycle and pedestrian route connections while still preventing automobile through traffic.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, striping and signage along both sides of the road.

Recommendations for Implementation –The route alignment should consider directness, ability to access destinations, and the possibility of short connections between streets that are not currently linked. The Claire Saltonstall Bikeway, also known as Mass Bike Route 1 follows Route 6 to the south of the Sandwich Historic District. Due to the existing conditions along Route 6 any improved alignment through Sandwich should consider the realignment of this long-distance bike route along an improved route. Coordination with Projects 5.2.15, 5.3.15, and particularly 5.3.7 (the proposed "Bay Route") will help to ensure continuity and establishment of a connected bicycle network. Projects providing regional connections may also be viewed more favorably with regards to obtaining funding and can be implemented by multiple localities.

Project 5.3.18: Identify and Implement "OBHC Triangle" Route

Project Description – Orleans, Brewster, Harwich, Chatham constitute a roughly triangular area that occupies the region where the Outer Cape begins. Limited route availability due to a lack of a network of secondary roads that connect these towns will make difficult the development of a suitable bicycle route of approximately 30 miles constituting the "OBHC Triangle". The towns are largely interconnected via routes 6A, 39, 28, 137, and 124; all of which have little to no accommodations for bicycles and which have considerable vehicular traffic, especially during peak season. Nickerson State Park lies in the center of the region further contributing to the traffic in the region.

Preliminary Design Concepts – Envisioned as an on-roadway route linking the four towns, a designated route will need to consider roadway improvements in order to adequately accommodate bicycle travel, especially by cyclists other than experienced cyclists comfortably riding in a shared-roadway environment. Some paved shoulders exist, though in most instances they are inadequate to serve as a bicycle accommodation and are discontinuous. Addition of paved shoulders or traffic control devices highlighting a shared-roadway condition should be considered. Such measures could include "share the road" signage or use of "sharrows" officially known as shared lane markings. Along roadway segments where adequate paved width exists or may be easily added, designated bike lanes may be considered as appropriate.

Cost Estimate – On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, signs, and pavement markings along both sides of the road.

Recommendations for Implementation – Due to limited routing options implementation will require selection of a route and evaluation of existing conditions to determine needed improvements and countermeasures. Coordination with Projects 5.3.6, 5.3.7 (the proposed "Shore" and "Bay" routes respectively), and 5.3.10 will ensure that proposed improvements are consistent throughout the region. Since those proposed routes are of a regional nature segments of the "OBHC" route that are coordinated with these projects will likely receive greater priority for funding. Emphasis of the efforts to integrate these proposed routes into a cohesive network linking towns and destinations would likely increase the potential for funding.

Project 5.3.19 Improve Bicycling Conditions on Route 130 in Sandwich

Project Description – Bicycling conditions along Route 130 (Forestdale Road/Water Street/Main Street) in Sandwich are currently challenging with little or no paved shoulder, significant traffic volume, and a posted speed limit of 40 MPH. Adding paved shoulders or other bicycle improvements would provide safer, more comfortable bicycling conditions while also reducing conflicts with motor vehicles. Route 130 provides connections to destinations, neighborhoods and the adjacent town of Mashpee. Adding paved shoulders has additional benefits including pavement edge stabilization, the addition of a recovery area which reduces roadway departure crashes, and a breakdown area that allows disabled vehicles to be moved out of the travel lane, thereby mitigating congestion impacts from such incidents. These all result in safety, operational, and maintenance benefits which yield long-term cost savings.

Preliminary Design Concepts – Widening or the addition of paved shoulders should consider the existing roadway geometrics. In order to be useful for bicycle travel shoulders and the adjacent travel lane need to be of adequate widths to provide a degree of separation between the two modes, otherwise safety can be impaired by inviting motorists to pass too closely to bicyclists that attempt to hug the outside edge of the roadway. In general a four foot shoulder is desirable to provide adequate operating space for a bicyclist while allowing motorists unimpeded travel within the adjacent lane. On roads with curb and gutter, the gutter pan and the longitudinal joint effectively reduces the useable width of the shoulder and consideration needs to be given to the paved width of the shoulder exclusive of the gutter pan.

Cost Estimate – On-road improvements, unit costs per mile:

- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders along both sides of the road.

Recommendations for Implementation – Opportunities should be sought to begin implementing improvements through coordination with other construction and maintenance projects. Routine pavement overlay and resurfacing projects should include shoulder paving for this route. Maintenance needs to be considered so that the functionality of shoulders for bicycling purposes is retained since the natural sweeping action of vehicles often results in debris accumulating in the untraveled shoulder.

Project 5.3.20: Improve Bicycling Conditions on Quaker Meeting House Road in Sandwich

Project Description – Sandwich Quaker Meeting House Road is located in a heavy residential area and the roadway currently has intermittent facilities with short segments of shared-use paths connecting some subdivision developments. The roadway geometrics consist of a two-lane secondary roadway with minimal paved shoulders. As a result, the discontinuous nature of the infrastructure makes travel by bicycle difficult for anyone not comfortable with riding in a shared travel lane with automobile traffic. There are numerous points of destination along Quaker Meeting House Road including Sandwich High School, Oak Ridge School, and a municipal complex that justify the need for bicycle accommodations. The town is currently constructing a continuous sidewalk along the entire length of Quaker Meeting House Road from Route 6A to Route 130. The Town desires to widen the existing roadway to provide 11' lanes and 4' shoulders in both directions in conformance to state requirements for bicycle accommodations. The proposed projects are fully designed and are "shovel ready" but are unfunded.

Preliminary Design Concepts – Roadway improvements along Quaker Meeting House Road to provide 11' travel lanes and 4' paved shoulders. On-roadway improvements and accommodations are needed to provide direct, comfortable bicycle access to the many destinations in this residential area. Shoulder widening, pavement markings, signage, intersection enhancements, and other safety countermeasures along with wayfinding measures would provide a convenient and comfortable route for cyclists of varying abilities.

Cost Estimate – On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Sidewalks and crossing improvements, unit costs:

- 5' Sidewalks, bituminous, both sides of street – $120.00/linear foot
- 5' Sidewalks, concrete, both sides of street – $140.00/linear foot
- Marked Crossing – $1,500.00

Recommendations for Implementation – Identification of funding sources and programming of funds is needed to facilitate implementation since the projects are fully designed. Final designs should be reviewed for appropriate integration with the existing bicycle infrastructure on Quaker Meeting House Road and improvements to the existing infrastructure, if needed, should be considered in order to provide continuity in the accommodations.

Project 5.3.21: Establish a Bicycle & Pedestrian Connection from Fort Hill Area Trails to Governor Prence Road

Project Description – The Town of Eastham, through its Planning and Economic Development Department, has identified the Governor Prence Road, a major access to the Red

Maple Swamp and Fort Hill Trail, as the only major crossing of Route 6 that does not have a traffic signal. The Eastham Visitor's Center is also located at this intersection which maintains high traffic volumes, has significant left turns, and is a high crash location. As a result warrants should be easily met to justify a traffic signal. A pedestrian actuated traffic signal at this intersection will encourage residents and vacationers, who now drive to Fort Hill or Hemenway Beach to bike or walk to these popular destinations. Sidewalks or shared-use paths are needed to establish a connected and contiguous pedestrian access route between the Fort Hill trails and Governor Prence Road which intersects the Cape Cod Rail Trail less than one mile west of this intersection. Improved bicycle conditions linking the CCRT with Fort Hill are also needed.

Preliminary Design Concepts – Depending upon traffic volumes, speeds, and location of pedestrian trip generators, sidewalks should be considered along both sides of the street. Appropriate marked crosswalks and signage, consistent with the roadway geometrics and existing traffic patterns should be installed at intersections where the heaviest pedestrian movements are likely to occur. Additional pedestrian safety countermeasures should be considered where appropriate.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Sidewalks and crossing improvements, unit costs:

- 5' Sidewalks, bituminous, both sides of street – $120.00/linear foot
- 5' Sidewalks, concrete, both sides of street – $140.00/linear foot
- Marked Crossing – $1,500.00
- Signalized Crossing – $70,000.00

Assumes installation of signalized intersection with mast arms, signal heads, pedestrian signals, pavement markings, and appropriate pedestrian upgrades such as curb cuts and ADA curb ramps.

Recommendations for Implementation – Gaps within the existing pedestrian and bicycle network should be identified for improvements concurrent with the installation of a traffic signal. Appropriate safety countermeasures should be considered for locations where potential exists for vehicle/pedestrian collisions, primarily at the intersection of Governor Prence and Route 6, as well as along Governor Prence if a connection to the CCRT is desired. Improvements should also seek to improve access to transit stops when appropriate.

Project 5.3.22: Define Loops and Connections to Develop a "Grand Cape Tour" Along the Cape Cod Rail Trail

Project Description – The Cape Cod Rail Trail currently serves as a major bicycle facility stretching twenty two miles across six of Cape Cod's municipalities. Proposed extensions to the north and west would provide access to four additional localities. A Grand Cape Tour would provide visitors to Cape Cod with bicycle access to towns and Seashore destinations with the CCRT serving as the spine route. Loop routes and spurs that provide direct bicycle access would also result in a connected bicycle network throughout much of the lower and outer Cape that could be used for utility trips as well.

Preliminary Design Concepts – Loop routes and access routes would likely consist of on-road bike routes and shared-use paths depending upon the specific conditions. Each proposed alignment should consider the existing conditions and whether shared-road conditions and geometrics are adequate or in need of improvements, or whether a shared-use path would be most appropriate for the intended and likely user. Wayfinding signage is needed, especially for any alignment along secondary roads.

Cost Estimate – Shared-use path, unit costs per mile along varying alignments:

- Adjacent to roadway with utility relocation – $765,600.00
- Along new alignment – $871,200.00
- Existing corridor (minor grading/clearing) – $792,000.00
- Along abandoned RR bed – $660,000.00

On-road improvements, unit costs per mile:

- Signing and striping – $10,560.00
- Widening to add shoulders/bike lanes – $501,600.00

Assumes adding shoulders, striping and signage along both sides of the road.

Recommendations for Implementation –The route alignments should consider directness, ability to access destinations, and the potential to integrate with the larger bicycle network envisioned for Cape Cod. Though intended to serve as a contiguous route throughout the entire area of the existing and proposed CCRT, such a network would facilitate bicycle use for commuting and routine utility trips in addition to recreation and tourism. Linkages therefore should consider popular tourism sites as well as town centers and commercial areas. Coordination with projects that are proximate to the existing CCRT, as well as future extensions would ensure development of a connected network of bicycle routes and facilities. Coordination of multiple localities, the Cape Cod Commission, and Massachusetts Department of Conservation and Recreation will be required.

OTHER INITIATIVES

The following is a list of nine projects proposing various initiatives to support and improve bicycling on Cape Cod. These projects are number 5.4.1 through 5.2.9.

Project 5.4.1: Bike Route Brochure & Wayfinding Map

Project Description – A multi-phase project proposing to develop and maintain a brochure, including a wayfinding map that describes the primary destinations accessible by bicycle including recreation features of pocket parks, beaches, town landings, shopping districts, hiking areas, bike paths, and other facilities and attractions followed by a subsequent implementation phase with wayfinding improvements along a pilot route.

Currently inconsistent signage and pavement markings throughout the Cape results in impaired safety and a poor visitor experience. Destination access is difficult due to the lack of wayfinding and directional signage which contributes to low use of bicycling and bicycle facilities for basic mobility and transportation to access destinations, resulting in over-reliance on autos, especially by visitors not familiar with Cape Cod. This in turn contributes to congestion and excessive parking demand. By encouraging and facilitating the use of bicycling as an alternative transportation mode improvements to air quality (all of Cape Cod is a non-attainment area), reduced congestion, and reduced impacts to sensitive lands and natural features resulting from illegal spillover parking, especially in the National Seashore, can be achieved.

The project will also yield safety improvements by addressing existing conditions which include lacking or inconsistent signage, pavement markings, and inadequate design treatments at intersections. Motorist and bicyclist/pedestrian expectations and actions are not uniform, crossings are often inadequate, and design treatments are inconsistent and often don't comply with MUTCD (the Manual on Uniform Traffic Control Devices) standards.

Component A – Conduct a Pilot Study to apply signage to one connector route. This proposed element is a follow-on to Project 5.2.2 and would utilize the wayfinding standards and protocols established via that project.

This component would require the following steps:

- Identify candidate routes that facilitate mobility and connection to multiple destinations
- Identify the pilot route for implementation
- Establish baseline data collection needs for comparison after pilot implementation
- Collect baseline data

Component B – Implement signage and pavement markings along pilot route

Component C – Develop six wayfinding itineraries with maps for bicycling experiences on Cape Cod to facilitate connection via bike or walking to destinations and attractions within Seashore and local communities, to include:

- Cape historic resources
- trail amenities including restaurants, rest rooms, accommodations, retail shopping area, bike repair/rental shops and emergency services
- connections to intermodal transportation facilities including bus and ferry terminals/connections
- Sand (surface hazard) and other cautionary items
- connections to other bicycle facilities including the Pan Mass Challenge Route and the Mass Bike Route 1 (Claire Saltonstall Bike Route)

- connections to primary destinations (Seashore attractions, town centers)
- communicating mobility issues for access by different users (ADA issues)
- coordination of all 6 regions to create larger overall "regional experience"

The data collection needed for Component A should also consider surveying bicyclists and users of bicycle routes and facilities regarding needed or desired content and the ease with which they can currently navigate the bicycle network on Cape Cod.

Preliminary Design Concepts – Installation of signage and wayfinding amenities should follow the protocols and guidance established as a result of Project 5.2.2 for existing facilities, relating to signage and wayfinding on the CCRT. Wayfinding itineraries and maps should be printed on water resistant stock and be either pocket-sized allowing use by bicyclists or pedestrians. Maps and related print documents should be made available in electronic format as well and updated regularly. Electronic versions have the added benefit of being able to provide more current content, and even real-time information such as trail closings and conditions, and links to transit schedules.

Cost Estimate –

- Signage installation on pilot route – $18,400 per mile
- Maps and wayfinding itineraries – $120,000

Recommendations for Implementation – Signage, wayfinding, and pavement marking guidelines and protocol need to be established prior to implementation, either via Project 5.2.2 associated with signage of the CCRT, or as a separate effort. Pilot route selection should follow the implementation guidance established in Project 5.3.2 by identifying potential connector routes or corridors, evaluating the alternative, and determining the specific pilot route. It will also be necessary to determine the baseline data that needs to be captured or collected, and the process by which that will be accomplished before the second phase involving signage installation can proceed. Additionally, data collection should include bicyclist's perception of current wayfinding resources and their needs or desires for content in the printed product. An opportunity for feedback on the printed product should be included such as a survey or an online form that can capture impressions of the quality of the guide/map and needed changes or suggested improvements. Due to the regional focus and the implications for towns, coordination is needed between towns as well as with the Massachusetts Office of Travel and Tourism (MOTT). Coordination with Intelligent Transportation Systems could provide real-time information and enhance wayfinding and transit service integration.

Project 5.4.2: Establish Nonprofit for Stewardship of the Cape Cod Rail Trail

Project Description – Form a nonprofit 501(c) 3 alliance for stewardship of the entire & future Cape Cod Rail Trail. The CCRT currently provides a continuous 22 mile facility that serves as bike and pedestrian corridor through the Outer and Lower Cape, providing access to

communities and attractions on Cape Cod, including the National Seashore. However visions exist for a facility that will extend throughout the entire length of the Outer and Lower Cape, connecting Hyannis to Provincetown, and providing multimodal access to much of Cape Cod. A facility of this size would benefit from the guidance and stewardship of a nonprofit organization to ensure proper care and maintenance, address operational and safety considerations, especially those related to improvements and physical extensions to service new locations, and to help remove or reduce barriers within the community to expanding the facility to serve additional towns and destinations on Cape Cod via advocacy and generating support for the expansion of the facility.

Preliminary Design Concepts – NA

Cost Estimate –

- $70,000.00

Recommendations for Implementation – The primary focus of the no-profit needs to be established and a commensurate framework for the organization developed. Similar organizations have been developed for other trail facilities with widely varying missions, from safety patrols, to routine maintenance and caretaking efforts such as "adopt a trail" efforts, to broader advocacy and stewardship endeavors aimed at enhancing and expanding a facility and serving to raise funds and support from the local community, including elected officials and business leaders.

The scope of the organization needs to be determined along with establishment of a governing body to ensure proper management of both the organization as well as to provide direction for a course of action to be taken and sustained. A board or other body that is assembled for this purpose should consider carefully the makeup (members) needed to adequately address and achieve the desired functions.

Project 5.4.3: Cape Cod Nonmotorized Master Plan

Project Description – Develop a nonmotorized transportation master plan for Cape Cod that consolidates and integrates facilities, routes, and accommodations for bicyclists and pedestrians, including those owned or managed by localities, the National Park Service, and nonprofit organizations (such as conservation groups) into a single coherent network. Existing route and network plans, proposed facilities, identified gaps and gap analyses, policies for addressing the needs of bicyclists and pedestrians, and a prioritized list of projects and supporting initiatives across jurisdictions and stakeholder agencies needs to be established in order to adequately integrate and coordinate bicycle accommodations throughout Cape Cod.

Preliminary Design Concepts –The development of a master plan should seek to establish uniformity in standards and design guidelines, as well as consistency of policies and approaches to providing bicycle and pedestrian accommodations across Cape Cod. The plan should ensure continuity both in developing and connecting bicycle and pedestrian networks and in the actual design and construction of facilities, especially when they cross jurisdictional boundaries in

order to facilitate mobility and access by bicyclists and pedestrians as well as to provide a consistent level of service.

Cost Estimate – Subject to scoping details

Recommendations for Implementation – Of primary importance is coordination across municipalities, including funding requests and applications and regional prioritizing of projects. Existing plans should be evaluated for shared visions and desired projects, as well as to establish consistency in facility design especially at jurisdictional boundaries to ensure continuity of infrastructure and accommodations along bicycle routes.

Project 5.4.4: Development of Trail Access Parking Agreements

Project Description – Develop agreements with schools to use school parking lots during off-times for trail parking to in order to alleviate parking demands resulting from trail use. With limited parking available and thousands of daily users of trail facilities on Cape Cod during peak summer season, parking demand can create problems with finding adequate parking at or near trailheads. The use of public parking infrastructure at schools during non-school hours will mitigate excessive parking demand while also utilizing existing parking facilities, thereby eliminating the need to construct additional capacity specifically for trail access. Shared parking efforts similar to this have eliminated added expenses while also increasing the utilization of an existing public resource.

Preliminary Design Concepts – NA

Cost Estimate – NA

Recommendations for Implementation – A model agreement should be developed that can be shared among Cape Cod localities. Standard signage and policies should be developed to ease implementation and retain uniformity at multiple locations. Local political issues will need to be addressed, however this approach provides an opportunity for facility sharing which increases the utilization of existing infrastructure while reducing the need for construction of additional parking facilities, many of which will be unutilized much of the year. Use of school facilities could be limited to time of day and/or time of year to provide additional parking capacity during peak season which coincides with school closures for summer break.

Project 5.4.5: Safety Education & Outreach

Project Description – Develop and implement an education and outreach initiative aimed at bicyclists and motorists with the intent of improving safety for bicyclists. With bicycling on Cape Cod being popular for both recreation and transportation there is a significant need to ensure safety is improved by addressing the human factors related to bicycle crashes, bicycle/motor vehicle collisions, and interactions between roadway users. Since human factors are a major contributor to bicycle/motor vehicle crashes this is a low cost/high value project.

Preliminary Design Concepts – NA

Cost Estimate – NA

Recommendations for Implementation – Education and outreach initiatives can comprise a broad range of strategies. Cape Cod stakeholders should develop a strategic approach to developing and deploying resources by identifying the primary issues that need to be addressed, target populations, and the commensurate strategies that should be investigated. Overly broad approaches are likely to be less effective than those aimed at addressing specific challenges and problems that currently exist. A number of safety and educational initiatives and corresponding materials currently exist around Massachusetts and the U.S. Existing resources should be evaluated to determine which, if any can serve as a template for the materials and initiative to be utilized by Cape Cod communities.

Project 5.4.6: Maintenance Program Development & Implementation

Project Description – Develop and implement a maintenance program to ensure appropriate and routine maintenance is provided for bicycle facilities and accommodations. Because bicycle facilities and accommodations are often outside of the road right of way or at the least are located along the margins of transportation facilities, they often do not receive the maintenance that is provided to roadway networks. Additionally, bicycle facilities will have maintenance needs that are different than those of roadways by virtue of their use and operation. On-roadway facilities such as bike lanes and shoulders often accumulate debris as a result of the natural sweeping action of motor vehicles pushing debris outward from the travel lanes, but not beyond the shoulder or bike lane. On roads with shoulder typical sections debris, notably loose soils and sand, tends to encroach and collect on the shoulder as well. As a result the bicycle accommodation can become virtually impassable while also constituting a crash or tire puncture hazard.

Drainage grates also pose a significant hazard to bicyclists as a result of raised vertical edges which can damage tires and wheels or deflect a wheel sideways causing a crash. Worse are grates with longitudinal openings that can trap a bicycle wheel, throwing the rider from the bike. Grate installation, repair, and replacement policies and practices should utilize bicycle-friendly grate designs, location outside of the bicycle path of travel if possible, and maintenance which maintains a smooth, flush transition from pavement to grate.

Shared-use paths and rail-trails outside of road rights of way often do not receive routine maintenance. As a result conditions often deteriorate to the point that the facility is not inviting or perhaps even results in compromised safety. A routine maintenance program and budgeting enhances the utility of a facility and can serve to expand the service life through preventive maintenance.

Preliminary Design Concepts – NA

Cost Estimate – NA

Recommendations for Implementation – The many bicycle accommodations on Cape Cod are the responsibility of a variety of entities, including state and local government. Coordination between stakeholders, memorandums of understanding, and identification of funding sources will be needed in addition to the development of the policies and programmatic elements. If development of a 501(c)3 nonprofit trail advocacy group proceeds their role in maintenance should be incorporated into these efforts. Routine evaluation of conditions and planning for maintenance should be incorporated into other infrastructure maintenance policies, activities, and budgets.

Project 5.4.7: Interpretive Film Promoting Cape-Wide Bicycle Network and Bicycle Safety

Project Description – Many of the attributes that make Cape Cod a popular destination are accessible and enjoyable by bicycle. As efforts to expand the bicycle network on Cape Cod continue, bicycling as both recreation and a transportation mode on the Cape will continue to grow in popularity. Currently many of the bicycling resources on the Cape are not widely known and an interpretive film could serve to both increase awareness of bicycling options on the Cape, as well as aiding people navigate the Cape's bicycle network and utilize it for accessing destinations and increasing their mobility on the cape without reliance on automobiles. Additionally, interactions with pedestrians on shared-use paths and motorists on shared roadways results in unsafe conditions at times. Incorporating bicycle safety content into the film provides an opportunity to present safety information in a medium that would likely be better received than that of a stand-alone safety message.

Preliminary Design Concepts – NA

Cost Estimate – NA

Recommendations for Implementation – The proposed film should be available as an online resource and opportunities should be identified to publicize links to the website. MassBike, other bicycle advocacy or safety organizations, and bicycle clubs could assist in disseminating information on the availability of this resource once it is developed and available.

Project 5.4.8: Enhance Bicycle Shuttling Opportunities

Project Description – As a result of the many gaps in the existing bicycle infrastructure on the Cape, there is a need for convenient and widely accessible bicycle shuttling between destinations. Currently there are a number of transit services on Cape Cod and most buses and transit vans are outfitted with bicycle racks that can accommodate up to two bicycles. Long headways, infrequent service, and occasionally heavy demand during peak season however can significantly reduce the utility of these transit services, especially when considering the need for a family or group of bicyclists to use shuttle services. Increased capacity and more frequent service, especially in the areas of greatest demand is needed.

Preliminary Design Concepts – NA

Cost Estimate – NA

Recommendations for Implementation – This project would assume that bicycle shuttling is limited to bus services. The Cape Cod Regional Transit Authority should work with localities and the National Park Service to identify destinations, routes, and service times that are in need of augmentation. Options for outfitting shuttle vehicles with increased bicycle capacity should be investigated.

Project 5.4.9: Utilize Utility Easements and Infrastructure projects to Establish Bicycle Routes and Corridors

Project Description – Use of utility rights of way and easements for bicycle routes and corridors has the potential to both increase the options for bicycle routes, while also reducing costs related to acquisition of right of way. Existing utility corridors are also already free of many of the physical barriers that can make difficult the development of a bicycle network. Such corridors are often already cleared and may also have some degree of access, often in the form of unpaved roads or trails that are used for utility maintenance. Use of theses corridors also have the benefit of providing bicycle facilities that are largely free of conflicting vehicle movements as occur at intersections with roadways and commercial entrances when a path is located beside a roadway. In some instances utility corridors are the only feasible connections between communities and existing or proposed bicycle facilities, such as the proposed route across Harwich. There are numerous examples of co-use of utility corridors for transmission and recreational use including several in Massachusetts. Many utility corridors are currently used informally for recreational activities, however in most cases they are private property owned by the respective utility company or utility easements on private property. Several factors need to be considered when evaluating co-use of these corridors including:

- Public exposure- State and federal laws govern the separation distance between people, equipment and some utilities especially electrical transmission lines.

Recreational use cannot create additional risk of damage to utility structures or transmission facilities. Activities cannot preclude future construction or expansion of the utilities within the right-of-way. Access to/from, and along the right-of-way for maintenance, emergency repairs or future expansion cannot be impeded by recreational use. Recreational use must include a management plan that addresses trash collection and prevention/repair of erosion. Additional impacts to sensitive environmental resources will be viewed as a negative.

Preliminary Design Concepts – NA

Cost Estimate – variable

Recommendations for Implementation – Use of utility corridors can require complex legal agreements. Additionally, in some instances the utility has an easement but does not own

the right of way, requiring the involvement of multiple parties to include the actual land owner. Conservation easements should also be investigated to determine if these can be used to encourage dedication of right of way in the existing utility corridors, whether from the utility company or a third part landowner. Paved trails may enhance maintenance access in some corridors, thereby yielding a positive benefit to the utility company. The 48-mile W&OD Trail in northern Virginia is a prime example of a long-distance bike path that can be facilitated through the use of a utility corridor.

TABLE 7 - LIST OF MAPPED PROJECTS

Project	Project Description
5.2.1	Proposed shared-use path corridor for CCRT Extension to Provincetown
5.2.3	Setucket Road Path intersection improvements
5.2.5	Brackett Rd & Rte 6 sidewalks and improved crossings
5.2.6	Cape Cod Rail Trail extension to Independence Park
5.2.7	Cape Cod Rail Trail extension to Hyannis Transportation Center
5.2.8	Connect Old Colony Rail Trail and Old Queen Anne Road via Route 137
5.2.9	Old Colony Rail Trail extension from Volunteer Park and access to Schoolhouse Pond
5.2.10	Connect Shining Sea Bikeway to Gifford Street via on-road route
5.2.11	Extend Shining Sea Bikeway through Bourne to Cape Cod Canal Bikeway
5.2.13	Connect Cape Cod Canal Bikeway to Hyannis Transportation Center
5.2.14	Develop Plan for Intermodal Center in Falmouth
5.2.15	Improve Bicycle Facilities on Tupper Road South of Route 6A
5.3.2	Feasibility Study & Design of Bike Path along Route 6 from Herring Cove Parking to Race Point Road
5.3.3	Identify Possible Connections between the Cape Cod Rail Trail and National Seashore Trails
5.3.6	Identify a "Shore Route" South of Route 28 from Woods Hole in Falmouth to Stage Harbor in Chatham
5.3.7	Identify a "Bay Route" from the Cape Cod Canal in Bourne to Orleans
5.3.8	Relocation of Existing Rail Line and Conversion to Trail
5.3.9	Connect Harwich Port to Old Colony Rail Trail
5.3.10	Designate Route 28 as a Bike Route and Improve Conditions
5.3.12	Connect MacMillan Pier to National Seashore Bicycle Paths
5.3.13	Connect Province Lands Bicycle Trail and Head of the Meadow Trail
5.3.16	Connect Wellfleet Bay Wildlife Sanctuary to Cape Cod Rail Trail
5.3.17	Identify Potential Bikeway Alignment through Sandwich Historic District
5.3.18	Identify and Implement "OBHC Triangle" Route
5.3.19	Improve Bicycling Conditions on Route 130 in Sandwich
5.3.20	Improve Bicycling Conditions on Quaker Meeting House Road in Sandwich
5.3.21	Establish a Bicycle & Pedestrian Connection from Fort Hill Trails to Governor Prence Road

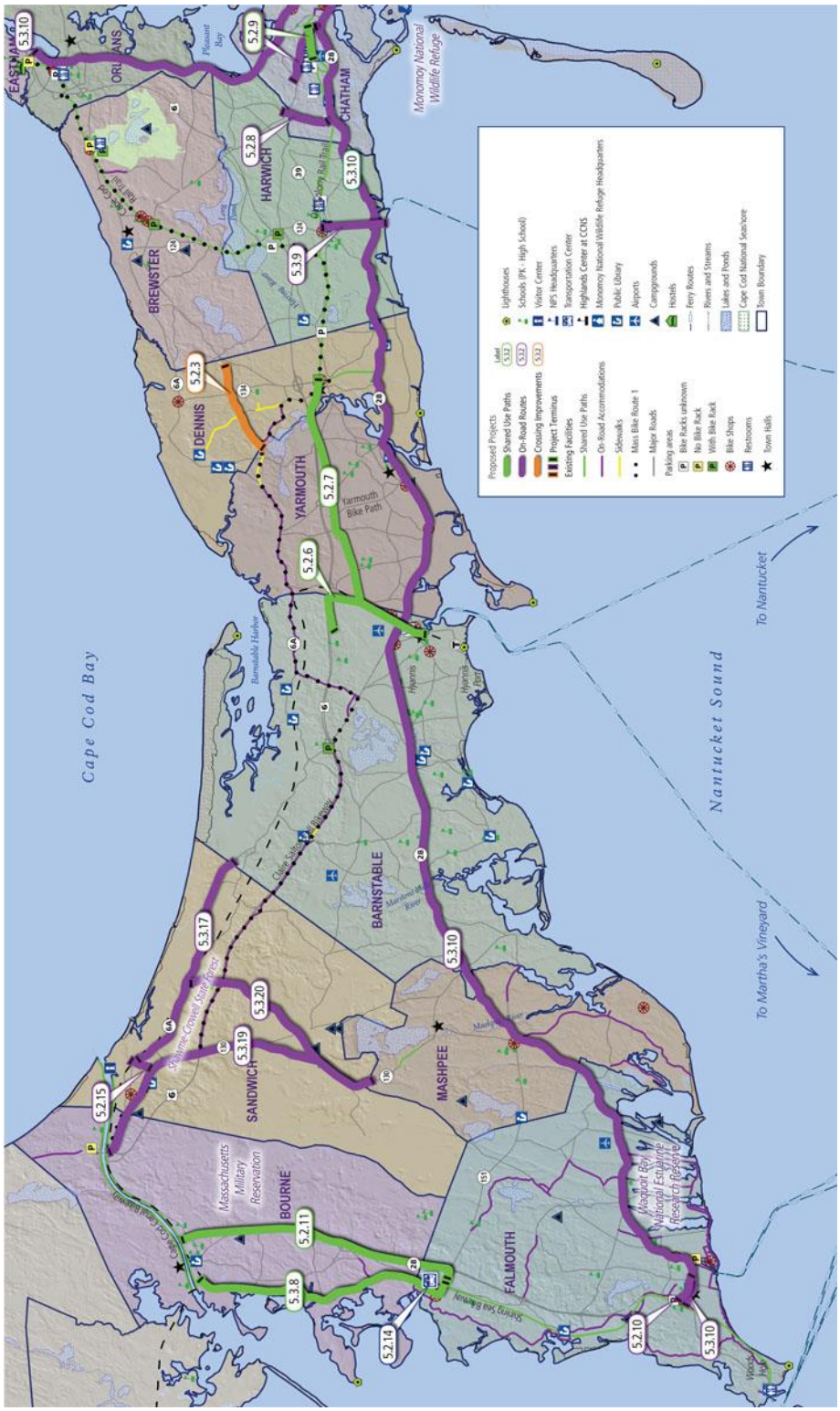

FIGURE 67 – CCNS UPPER/MID-CAPE MAPPED PROJECTS

FIGURE 68 - CCNS LOWER/OUTER-CAPE MAPPED PROJECTS

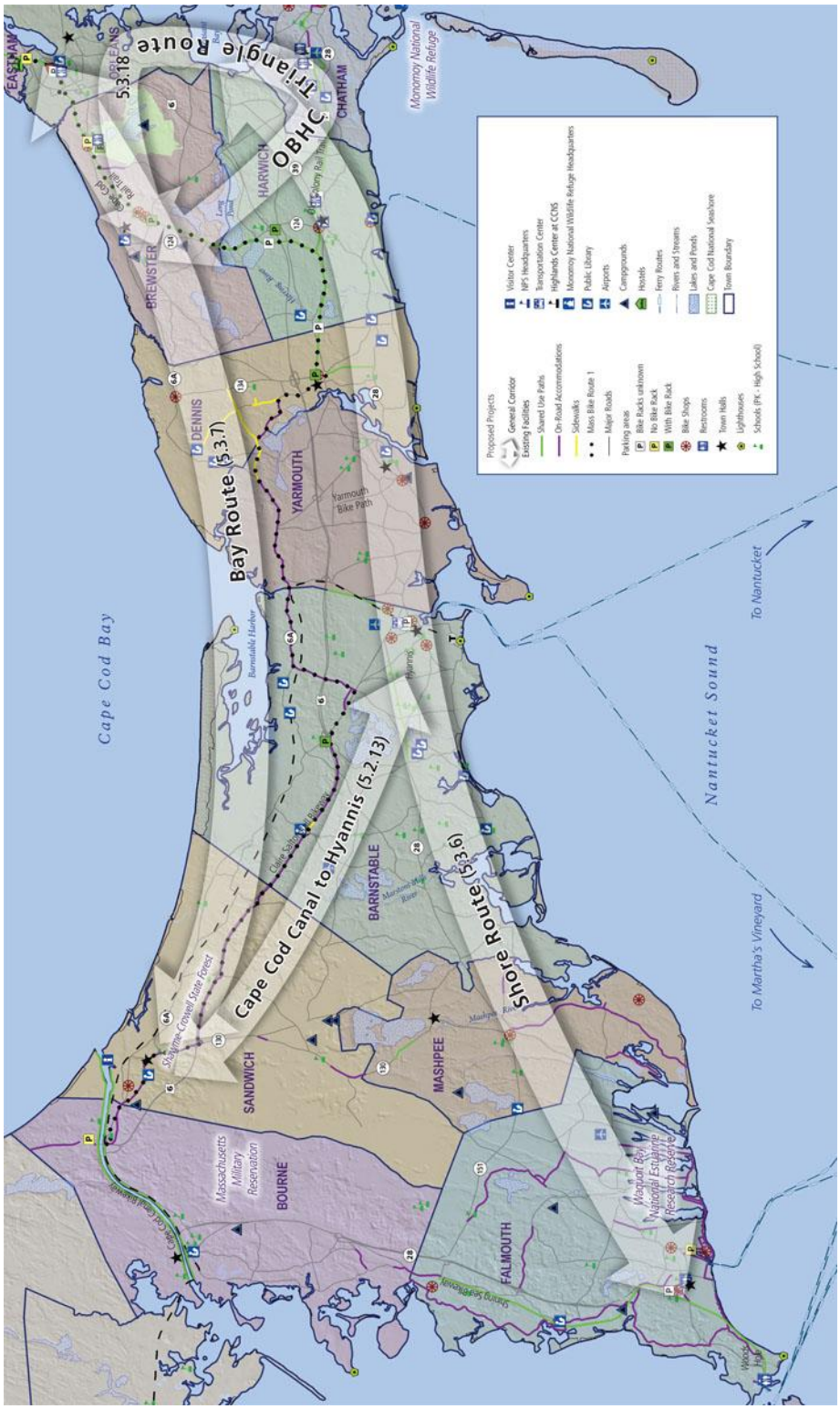

FIGURE 69 - CCNS UPPER/MID-CAPE PRIORITY CORRIDORS

FIGURE 70 – CCNS LOWER/OUTER-CAPE PRIORITY CORRIDORS

CONCLUSION

Safety is the highest priority goal of the Regional Transportation Plan. The Cape's transportation system should ensure that travelers and their possessions will arrive at their destinations unharmed and undamaged. Travelers should be educated regarding transportation regulations and traffic laws, and these must also be enforced to prevent the improper use of the transportation system.

Separate sidewalks and pathways are important to accommodate pedestrians. At intersection crossings, installation and maintenance of call buttons will provide for better compliance and safety of pedestrians. Research published by the Institute of Transportation Engineers ("Pedestrian Countdown Signals: Experience with an Extensive Pilot Installation," *ITE Journal*, January 2006) reports that the number of pedestrian injury crashes declined by 52 percent after the introduction of countdown signals. At the time when the pedestrian phase begins the flashing hand-symbol (i.e., flashing "Don't Walk") a numeric countdown signal shows the remaining number of seconds until the steady hand-symbol (i.e., steady "Don't Walk") is displayed. This provides the pedestrians with information necessary to determine whether they should start crossing or speed up their crossing.

Beyond the actual infrastructure, amenities such as bicycle racks, benches, restrooms, showers, and lockers help to encourage bicycle and pedestrian use. By connecting and extending bicycle paths, ensuring proper safety and signage on bicycle routes, and providing travelers with the proper amenities, bicycle and pedestrian transportation will continue to play an important role in the Cape Cod transportation system.

The importance of safety requires a spectrum of strategies including education, enforcement, and engineering. Specific programs and projects, such as roadway and intersection improvements, will be further refined in the alternatives analysis chapter of this RTP.

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3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

CAPE COD
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2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix G: Congestion Management Plan

Draft
June 15, 2015

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Technical Appendix G: Congestion Management Plan

Any urban area with a population over 200,000 is considered a Transportation Management Area, which subjects it to additional planning requirements under the U.S. DOT's Surface Transportation Program. The Cape Cod Region has been designated as a Transportation Management Area (TMA) following the 2000 Census. Under the federal statutes that define the MPO processes and requirements, these conditions make the establishment of a Congestion Management Program (CMP) a requirement of the Cape Cod Metropolitan Planning Organization (MPO).

CONGESTION MANAGEMENT AND MAP-21

Federal legislation that contains requirements for transportation plans, programs and projects includes the current legislation: *Moving Ahead for Progress in the 21st Century* (MAP-21) and the outgoing legislation: *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* (SAFETEA-LU) as well as the *Clean Air Act Amendments of 1990*. Following guidance developed under the current legislation, the Cape Cod MPO is in the process of updating the region's CMP. While the actions included in the existing CMP are generally in line with federal guidance the process will be updated to follow the structure of the following eight action items:

- Develop Regional Objectives
- Define CMP Network
- Develop Multimodal Performance Measures
- Collect Data/Monitor System Performance
- Analyze Congestion Problems and Needs
- Identify and Assess Strategies
- Program and Implement Strategies
- Evaluate Strategy Effectiveness[1]

CONGESTION MANAGEMENT PROGRAM BACKGROUND

Congestion Management Programs are intended to be a systematic way of:

- Monitoring, measuring, and diagnosing the causes of congestion on a region's multi-modal transportation system;
- Evaluating and recommending alternative strategies to manage or mitigate regional congestion; and

[1] Congestion Management Process: A Guidebook. Federal Highway Administration. April 2011. Report No. FHWA_HEP_11_011.

- Monitoring and evaluating the performance of strategies implemented to manage or mitigate congestion.

The CMP is also intended to be a planning tool to help reduce mobile source emissions and improve regional air quality. To support this planning tool, monitoring of transportation system performance is an ongoing activity for the Cape Cod region.

"Congestion" is defined as travel time or delay in excess of that normally incurred under light or free-flow travel conditions. There are two primary types identified for congestion and a successful congestion management program should address both types of congestion. The two types of congestion are:

1. Recurring congestion that tends to be concentrated into short time periods, such as "rush hours" and is caused from excessive traffic volumes resulting in reduced speed and flow rate within the system, and

2. Non-recurring congestion caused from unforeseen incidents (road accidents, spills, and stalls) which affect the driver behavior to a considerable extent.

Critical to the concept of congestion management is the understanding that the acceptable system performance may vary by type of transportation modes and systems, geographic location, season, and/or time of day. The CMP must reflect parameters that identify the degree to which travel time and/or delays are within locally acceptable standards of mobility to meet the needs of individual states or metropolitan areas.

Significant Legislative Elements:

The CMP shall be developed, established, and implemented as part of the metropolitan planning process in accordance with 23 CFR 450.320(c). The statute includes the following requirements:

1. Methods to monitor and evaluate the performance of the multimodal transportation system, identify the causes of congestion, identify and evaluate alternative actions, provide information supporting the implementation of actions, and evaluate the efficiency and effectiveness of implemented actions.

2. Definition of parameters for measuring the extent of congestion and for supporting the evaluation of the effectiveness of congestion-reduction and mobility-enhancement strategies for the movement of people and goods. Since levels of acceptable system performance may vary among local communities, performance measures and service thresholds should be tailored to the specific needs of the area and established cooperatively by the State, affected MPO(s), and local officials in consultation with the operators of major modes of transportation in the coverage area.

3. Establishment of a program for data collection and system performance monitoring to define the extent and duration of congestion, to help determine the causes of congestion, and to evaluate the efficiency and effectiveness of implemented actions. To the extent possible, existing data sources should be used, as well as appropriate application of the real-

time system performance monitoring capabilities available through Intelligent Transportation Systems (ITS) technologies.

4. Identification and evaluation of the anticipated performance and expected benefits of appropriate traditional and nontraditional congestion management strategies that will contribute to the more efficient use of existing and future transportation systems based on the established performance measures. The following categories of strategies, or combinations of strategies, should be appropriately considered for each area:
    - Transportation demand management measures, including growth management and congestion pricing;
    - Traffic operational improvements;
    - Public transportation improvements;
    - ITS technologies; and,
    - Where necessary, additional system capacity.

5. Identification of an implementation schedule, implementation responsibilities, and possible funding sources for each strategy (or combination of strategies) proposed for implementation.

6. Implementation of a process for periodic assessment of the efficiency and effectiveness of implemented strategies, in terms of the area's established performance measures. The results of this evaluation shall be provided to decision makers to provide guidance on the selection of effective strategies for future implementation.

Modeled after FHWA guidance, the Cape Cod CMP includes the following eight action items:

- Develop Regional Objectives
- Define CMP Network
- Develop Multimodal Performance Measures
- Collect Data/Monitor System Performance
- Analyze Congestion Problems and Needs
- Identify and Assess Strategies
- Program and Implement Strategies
- Evaluate Strategy Effectiveness [2]

<u>Air Quality Non-attainment Areas</u>

In a Transportation Management Area (TMA), such as the Cape Cod region which is designated as being a non-attainment area for ozone, the federal statute also requires that the CMP perform an analysis of all reasonable travel demand reduction and operational management strategies for a corridor in which a proposed project will result in a significant increase in capacity for single-occupant vehicles (SOVs). This includes adding general purpose lanes to an existing highway or constructing a new highway and should consider multimodal strategies. If the analysis demonstrates that travel demand reduction and operational management strategies

[2] Congestion Management Process: A Guidebook. Federal Highway Administration. April 2011. Report No. FHWA_HEP_11_011.

cannot fully satisfy the need for additional capacity in the corridor and additional SOV capacity is warranted, then the CMP shall identify all reasonable strategies to manage the SOV facility effectively, or to facilitate its management in the future.

Other travel demand reduction and operational management strategies appropriate for the corridor, but not appropriate for incorporation into the SOV facility itself shall also be identified through the CMP. All identified reasonable travel demand reduction and operational management strategies shall be incorporated into the SOV project or committed to by the State and MPO for implementation.

SYSTEM MONITORING AND DATA COLLECTION

A number of tasks are being performed annually to monitor traffic on Cape Cod.

The data collected in the monitoring process will be continually compared to the measures developed to define congestion. The comparison will be used to identify congested areas and trigger an investigation into the nature of the demand problems. These demand issues are expected to include regional traffic flows, local traffic generators, geometric problems, and access problems.

The following programs are currently underway and will continue. These existing programs are anticipated to provide the bulk of the data for the CMP.

Traffic Counting Program

The Cape Cod Commission, funded by MassDOT, has been collecting traffic data since 1984. This data includes traffic volumes on key roadway segments around Cape Cod and turning movement counts collected at key intersections. The traffic counting program is established in a systematic way to provide historic data at key locations as resources allow. Counts are also made to support traffic studies and, in areas of concern, to identify congested situations. Development of the annual traffic counting program is done in consultation with the Cape Cod Joint Transportation Committee. The principal product of this effort is the annual traffic counting report.

The traffic counting program will continue to provide data for the CMP. Examination of changes in traffic volume will be done and trends will guide further investigation of traffic problems as part of the CMP. As the traffic counting program is defined each spring, counts to investigate suspected or identified congestion areas will be included. In addition, counts will be programmed to monitor congestion in areas where CMP initiatives are in place.

Travel Time Analysis

Travel time has been monitored on a limited basis. Recently, GPS technology has made developing and recording travel time studies easier. Opportunities to use data provided by the automatic vehicle locators on all CCRTA vehicles is currently being explored. It is expected that this data will be useful in identifying congested areas and congested travel time periods on many

of the Cape's major traffic corridors. Additional GPS travel time studies will be recommended to support the CMP investigations especially in identifying problem areas within a corridor. For limited analyses the Cape Cod Commission is exploring the use of "Blue Toad" detection. This involves the installation of roadside Bluetooth detectors (Bluetooth is the name given to short-range wireless connectivity included in many portable communications devices such as cell phones). By recording the time and location of unique Bluetooth identifying codes, it is possible to automatically calculate the up-to-the-minute average time of travel between two points. These types of data are currently in use by MassDOT and provided to motorists via roadside message boards and signs.

Park-and-Ride Usage

Park and Ride lot counts are conducted routinely at the three MassDOT lots in the Cape Cod region and occupancy developed in terms of capacity. A detailed study was performed to determine use of the two primary lots in Barnstable and Sagamore including determining overnight use and use by the day of week and time of year. The use and occupancy of the Cape's park-and-ride lots will continue to be monitored.

Transit Usage

Ridership data is collected routinely by the mobile data computers linked to the fare boxes on the entire fixed route CCRTA system. The ridership on the demand response services (B-Bus) is also recorded by the CCRTA. This data has not been studied by the Cape Cod Commission and development of detailed transit use and patterns of travel will be incorporated into the CMP.

CRITERIA FOR MEASURING CONGESTION

Criteria, measures of congestion, and the CMP are currently under development and these must be designed to respect the Regional Transportation Plan (RTP) goals and the philosophy designed to preserve the valued aspects of Cape Cod. This will likely make the standards adopted in many other regions unacceptable for Cape Cod.

Cape Cod is a unique place with extreme fluctuations in traffic over the course of a year due to the recreational nature of the region. The sensitive ecologic and aesthetic nature of the region have long been cherished and this has been reflected in the goals developed for the RTP.

The philosophy of the Cape Cod RTP is not to build to accommodate the peak season demand but to provide adequate transportation for year-round travel and to provide and promote alternatives to the automobile. This philosophy is different from the majority of the regions in Massachusetts and across the nation. The philosophy of the Plan places much more emphasis on management of traffic and providing alternatives to the automobile for transportation rather than accommodating traffic demand.

The development of congestion criteria will be done initially as a separate exercise along with a public process to develop measures consistent with the philosophies in the RTP. The measures

will be included in the RTP to allow review of these measures and potential updates on a periodic basis in conjunction with the review of the RTP goals and objectives.

Measures of seasonal as well as year round congestion need to be developed through the traffic counting program in addition to monitoring of the travel times as well as transit usage. Development of relative conditions and trends between seasonal demand and winter demand periods must also occur to help determine appropriate strategies for addressing congestion

Develop Measures of Roadway Congestion

Thresholds for determining acceptable levels of service will be proposed on the basis of volume to capacity ratios and reviewed in terms of defining the extent of congestion or to what extent these levels of service are exceeded on the Cape. Additional measures of congestion are to be defined in terms of delay. Travel time analysis and intersection studies will be used to identify the locations and corridors that exceed these thresholds.

In addition to the levels of traffic, measures of scenic and ecologic value will be included in the criteria for defining congestion. These criteria will help guide the solutions proposed to resolve identified congestion.

Develop Measures of Public Transportation Congestion

Public transportation is becoming increasingly important for Cape Cod. More than half (51 percent) of Cape households are considered "low income" according to the *Barnstable County Affordable Housing Needs Analysis* (Barnstable County Human Services Department, 1999) and alternatives to owning cars is becoming more important. The percentage of the population over 65 was 23.1% in the 2000 census and this segment of the population is growing. Many elders have difficulty driving and are becoming reliant on alternative forms of transportation.

Development of measures of congestion and effectiveness for various modes of public transportation on Cape Cod and related solutions to identified problems must be consistent with the goals (shown in the following table) developed by the Cape Cod Transit Task Force in the 5-Year Plan for public Transportation developed in 2002.

Table 1 - Cape Cod Transit Task Suggested Measures of Effectiveness

Goal	Description
1.	Reduce automobile dependency by providing mobility options.
2.	Mitigate seasonal traffic by promoting travel to the region without cars, and by providing seasonal public transportation options.
3.	Meet the needs of the year-round population for public transportation, especially the needs of those who are "transit-dependent" and in need of human services.
4.	Develop coordination, communication, and cooperation between regional public transportation providers.
5.	Incorporate smart growth and land use planning decisions into the development of public transportation.

ANALYSIS

The data collected in the monitoring process will be continually compared to the measures developed to define congestion. The comparison will be used to identify congested areas and trigger an investigation into the nature of the demand problems.

These demand issues are expected to include regional traffic flows, local traffic generators, geometric problems, and access problems. The annual traffic studies pursued by the Cape Cod MPO staff will be guided by the CMP and target areas for further study.

- Identify Areas of Roadway Congestion
- Identify Areas of Transit Congestion

To further facilitate public comment, the Cape Cod Commission has created an online questionnaire to assist in identifying congested locations. The results of the questionnaire are included in the main body of the RTP.

DEVELOP STRATEGIES TO ADDRESS IDENTIFIED PROBLEMS

The following subsections include descriptions of the process to be used to produce CMP strategies.

RECOMMENDATIONS

The results of the CMP will include the generation of studies to address issues that exceed the criteria developed to define transportation congestion for the region. These studies will produce recommendations that will be included in the RTP and TIP processes to be considered for construction or implementation.

Proposed Products

Develop CMP projects from the CMP Study recommendations and include them in the evaluation process for the region's RTP and TIP.

RECOMMENDATIONS FOR LOCATION SPECIFIC ACTIONS/STUDIES

Recommendations to the MPO to address issues that exceed the criteria developed to define transportation congestion for the region will generally come from studies conducted by the Cape Cod Commission transportation staff. Recommendations may also be developed by the towns and the CCRTA. All recommended projects and strategies will be evaluated by the Commission and the Cape Cod Joint Transportation Committee using the MassDOT evaluation criteria and with the RTP goals. Based on these evaluations, the CMP projects will be considered by the MPO for inclusion in the RTP and compete for funding within the TIP.

RECOMMENDATIONS FOR REGIONAL ACTIONS/STUDIES

Some congestion problems will need to be addressed on a corridor-wide or system basis or require significant investments. Studies or remedial actions will be recommended to the MPO for their consideration and potential inclusion in the TIP or the UPWP. Projects with regional significance may become an initiative of the Statewide Transportation Program. These proposed projects may require a more extensive evaluation with regard to conformity with the Massachusetts State Implementation Plan (SIP). These projects may also become Transportation Control Measures (TCMs) and included as such in the SIP submitted to EPA.

CONGESTION MANAGEMENT REPORTING

The CMP is an ongoing program that documents the region's mobility concerns. The CMP contains the most recent performance monitoring information for the regional transportation system. The information and general analysis of the system, using the criteria defined in the CMP and RTP processes, will provide the basis for the Cape Cod Commission Transportation staff and the Cape Cod Joint Transportation Committee to make recommendations. These recommendations will be made to the Cape Cod MPO as congestion reducing and mobility enhancing actions to be considered in the MPO planning and programming processes. The main means of providing congestions information is via the Cape Cod Commission's Transportation Information Center on the internet:

www.capecodcommission.org/congestion

The following figure is a screen capture of the main Congestion Management webpage on the website. Users have access to traffic cameras, speed maps, automated bus locators, trip planners and a number of other tools to identify and avoid congestion.

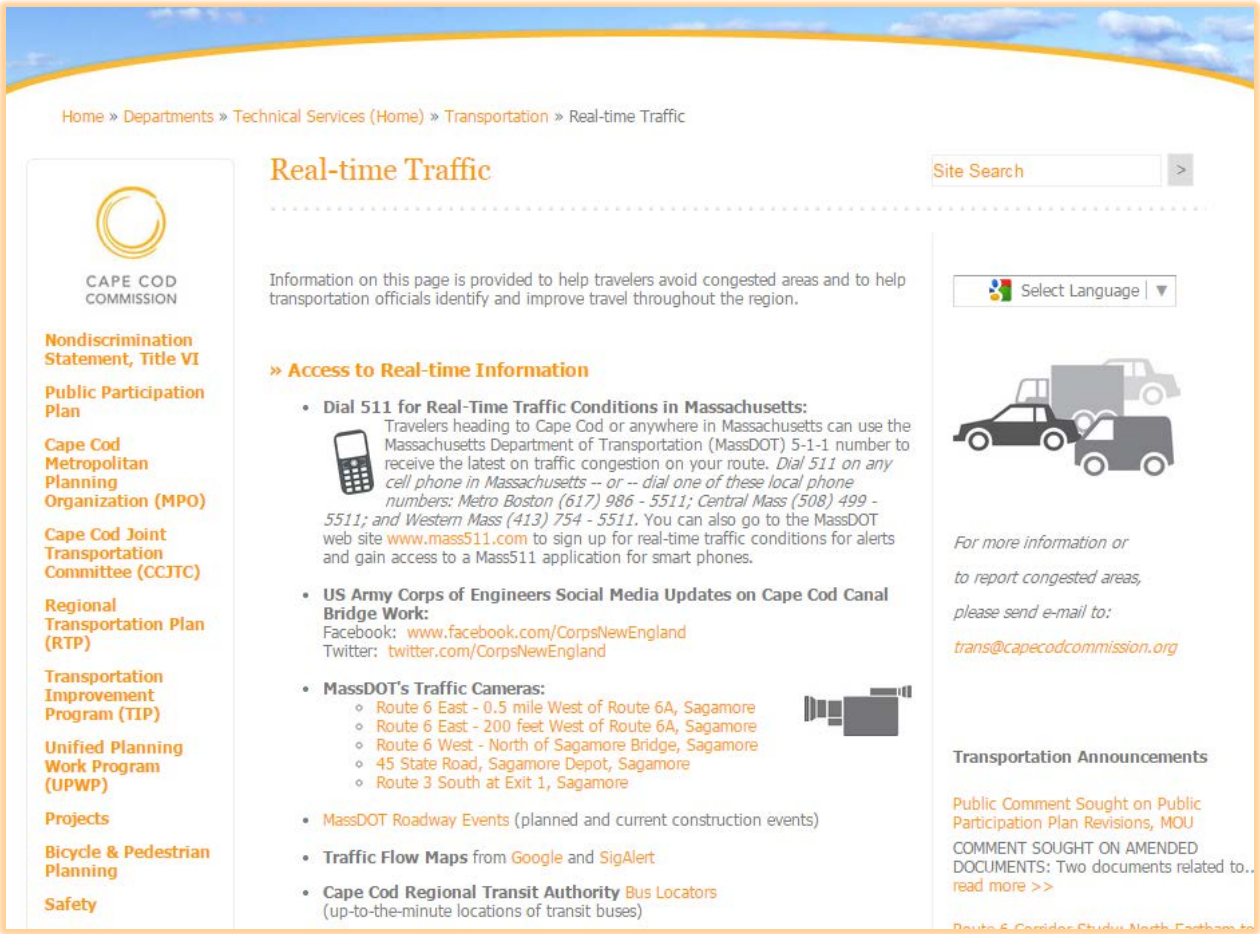

FIGURE 1 – CONGESTION MANAGEMENT WEBSITE MAIN PAGE

SUMMARY OF 2014 TRAFFIC COUNTING ACTIVITIES

The traffic counting program is the base data source for developing trends in traffic growth and potential for growth in traffic congestion. The following information is from the *Cape Cod 2014 Traffic Counting Report* to be published in early 2015. The full report and access to mapped traffic counts are available at:

www.capecodcommission.org/counts

The Massachusetts Department of Transportation (MassDOT) maintains six permanent counter locations on or near Cape Cod on some of the more heavily trafficked roads. The following table displays those six locations with their ten-year growth, ten-year average annual growth, and one-year growth rate (2013-2014).

TABLE 2 - GROWTH RATES - PERMANENT COUNTING STATIONS AND BRIDGE CROSSINGS

Permanent Traffic Counting Station	10 Year Total Growth	10 Year Average Annual Growth Rate	One Year Growth Rate 2013-2014
#15: Rt 6 E of Rt 149 (Ex. 5)	-6.76%	-0.70%	n/a
#20: Rt 3 N of Bourne TL	16.0%	1.49%	0.30%
#707: Bourne Bridge	-0.97	-0.10%	1.90%
#708: Sagamore Bridge	1.8%	0.17%	-2.32%
#709: Rt 28 E of Higgins Crowell	-11.2%	-1.19	-0.95
#7351: Rt 28 W of Old Post Rd	-7.03%	-0.73%	-1.67

Source: MassDOT

It is important to note that growth is based on summer traffic volumes, not off-season values.

TABLE 3 - CAPE COD SUMMER TRAFFIC GROWTH (2004-2014)

Region	Number of Comparisons	10 Year Total Growth	10 Year Average Annual Growth Rate
Upper Cape	115	1.23%	0.12%
Mid-Cape	113	-7.37%	-0.77%
Lower Cape	74	-5.66%	-0.59%
Outer Cape	68	-5.77%	-0.60%
All Roads	**370**	**-3.20%**	**-0.33%**

"Upper" = Bourne, Sandwich, Falmouth, Mashpee
"Mid" = Barnstable, Yarmouth, Dennis
"Lower" = Harwich, Chatham, Brewster, Orleans
"Outer" = Eastham, Wellfleet, Truro, Provincetown

Source: Cape Cod Traffic Counting Report

EXISTING CONGESTION INDICATORS

The Cape Cod Center for Sustainability in their *Cod Sustainability Indicators Report* has developed a number of factors that bring together social, economic, and environmental indicators to be tracked over time. While no single indicator is able to give the entire picture, tracking representative indicators in many areas provides an overall sense of trends and of the Cape's progress toward becoming a sustainable region. This report has developed the following indicators for traffic and transit.

TRAFFIC

The Cape Cod Center for Sustainability traffic congestion indicator is based on average annual daily bridge crossings over the Sagamore and Bourne bridges. While there are many possible indicators of congestion, bridge traffic is easy to measure, provides data on long-term trends, and has significant implications for traffic Cape wide, as many who bring their cars across the bridge use them for virtually all local or regional trips.

Bridge crossings have been rising steadily for most of the past 32 years.

Traffic data have been collected at permanent count stations at both bridges since 1972. Carrying roughly twice as many vehicles today as in 1972, the story of traffic over the bridges is the story of traffic on Cape Cod.

As shown in the figure below, both summer and annual average daily traffic (ADT) over the bridges showed an overall upward trend from the early 1970's through the early 2000's,

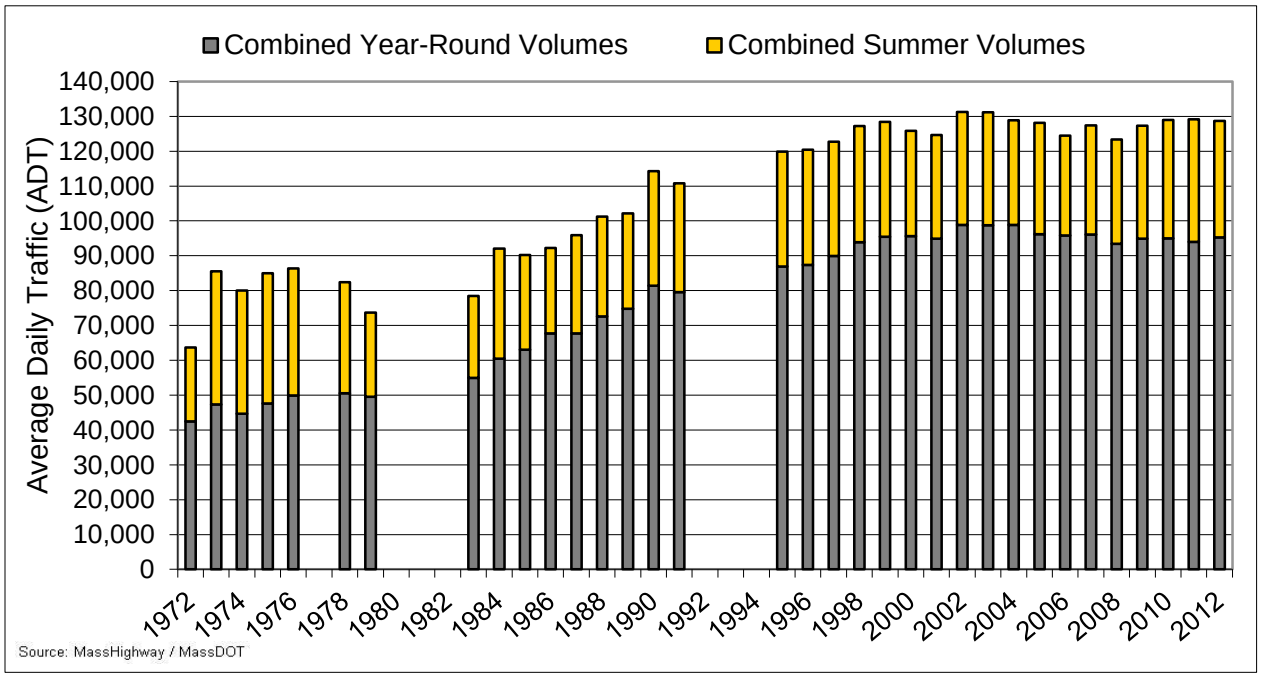

FIGURE 2 – COMBINED AVERAGE DAILY TRAFFIC OVER BOURNE AND SAGAMORE BRIDGES

reaching a maximum in 2002. Traffic volumes, on average, dropped from 2002 to 2007 before trending slightly upward in recent years. This figure has not been updated since 2012 because traffic counters have not been able to supply consistent data throughout the year.

Seasonal traffic trends over the bridges have also changed considerably over the years. Since 1972, traffic has tended to be more spread out over 12 months as opposed to concentrated during the summer months. As shown in the following figure this trend, along with the overall increase in traffic, has resulted in 2011 traffic volumes throughout almost the entire year in excess of 1972 traffic volumes in the summer.

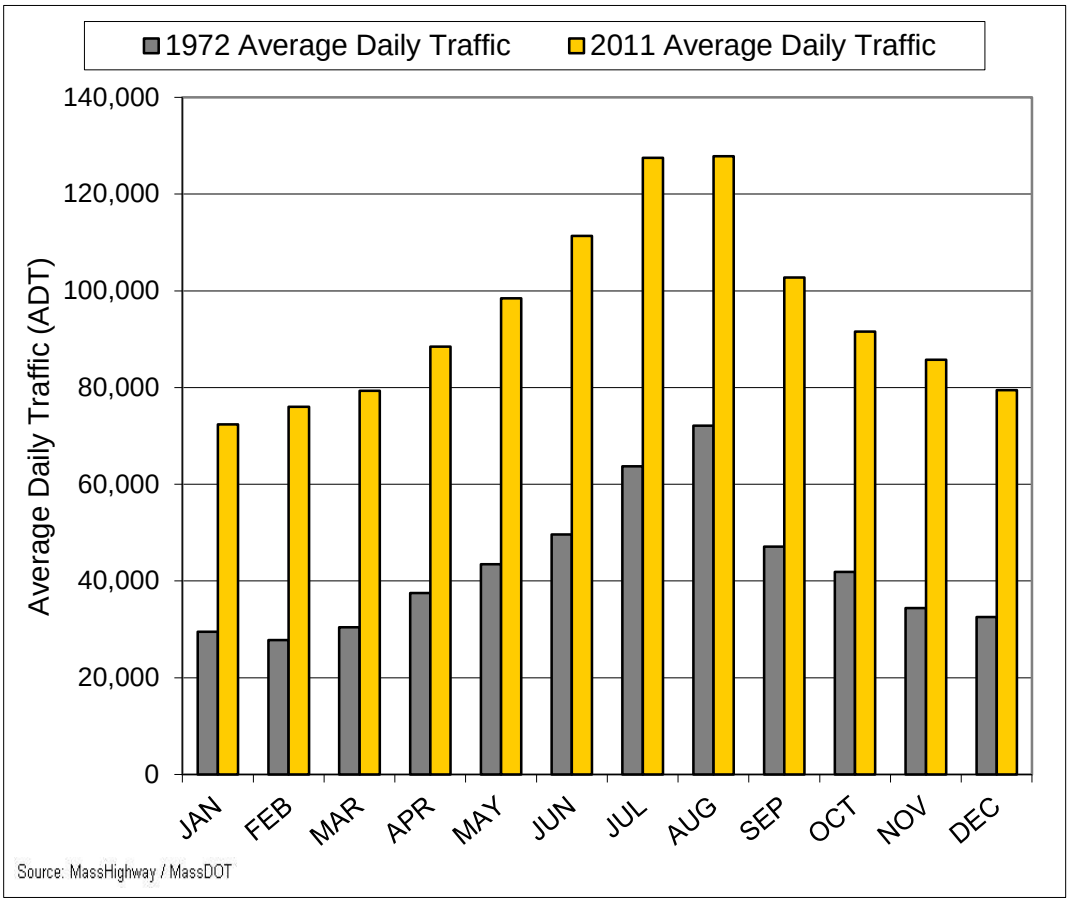

FIGURE 3 - HISTORIC MONTHLY ADT CHANGES AT THE CAPE COD CANAL BRIDGES

The figure below shows daily traffic volumes from Memorial Day in May until Labor Day in September at the Bourne and Sagamore Bridges. Weekend volumes are shown with shaded dark lines and weekday volumes are shown with lightly shaded lines. Weekends are defined as Friday through Sunday. Data suggests that traveling mid-week has the least chance for delays and traveling on Friday has the highest chance for delays. The highest summer volumes recorded were on August 8th at 65,686 crossings on the Bourne Bridge and 79,161 crossing on the Sagamore Bridge. The lowest summer volumes were recorded on July 4th at 35600 crossing on the Bourne Bridge and 41583 crossings on the Sagamore Bridge. The low vehicle volumes on July 4th contradict the extraordinary amount of people visiting Cape Cod that weekend, but suggest that travel on the day of holidays is relatively calm because most visitors travel in the days prior or afterwards.

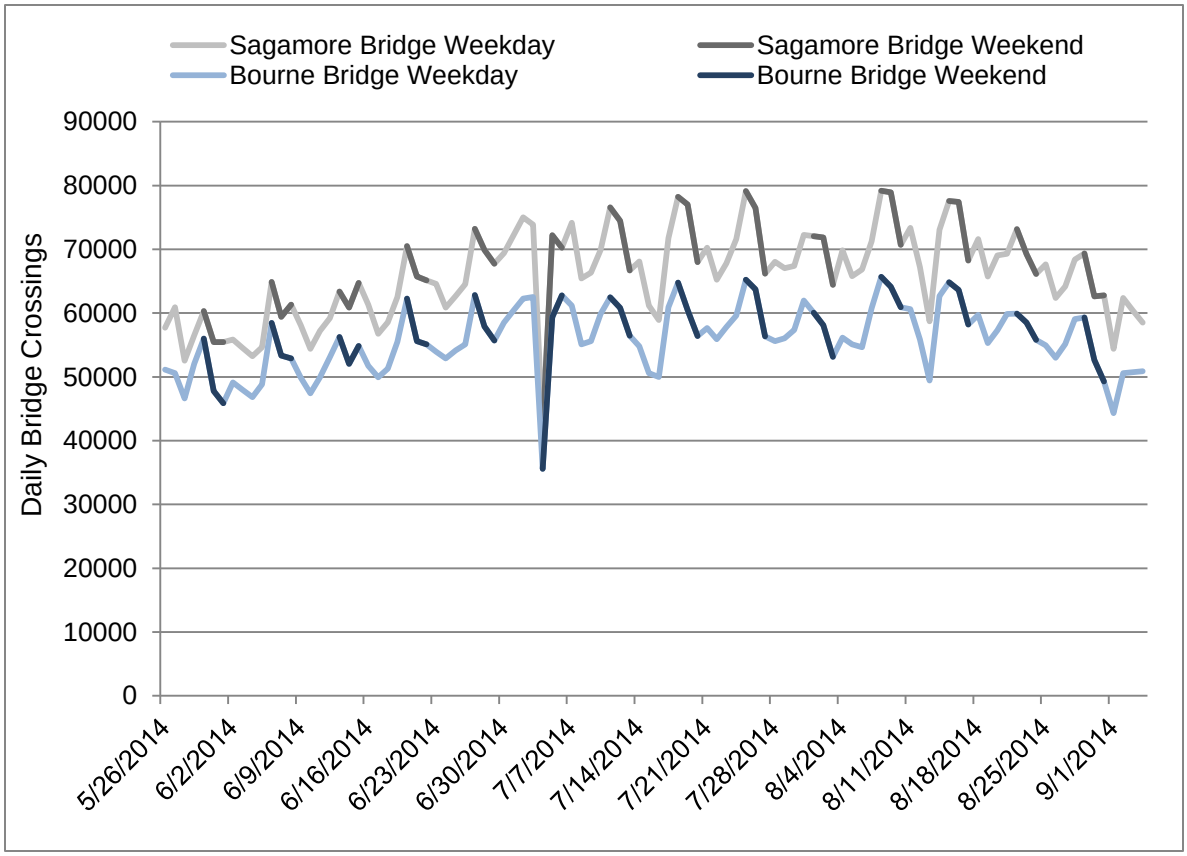

FIGURE 4: WEEKEND VS. WEEKDAY TRIPS ACROSS THE CAPE COD CANAL BRIDGES

The figure below compares the total monthly vehicle traffic in both directions on the Bourne and Sagamore Bridges in 2014. The Sagamore Bridge was consistently crossed more each month. In the summer months, both bridges received increased traffic and the difference in usage between the bridges increased. The Sagamore Bridge data are incomplete up to May 2014. The absence of data for the other months limited the extent of analysis.

The different usage of the two bridges shows a similar trend when examining directional volumes, as shown by the figure below. More vehicles cross the Sagamore Bridge than the Bourne Bridge each month. During certain months, the northbound traffic on the Bourne Bridge is comparable in number to the southbound traffic on the Sagamore Bridge. This could suggest that travelers may use different bridges to travel to and from their Cape Cod destination. The access to and from the Canal roadways to the bridges varies in each crossing direction

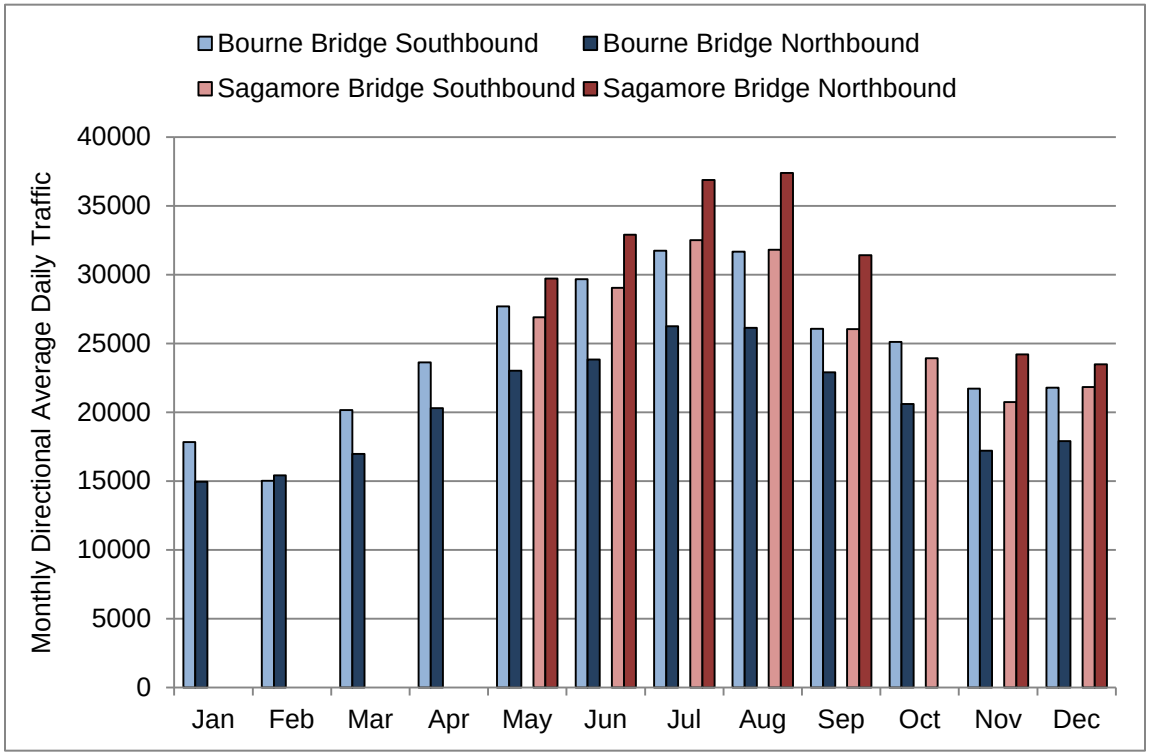

FIGURE 5: MONTHLY DIRECTIONAL AVERAGE DAILY TRAFFIC AT THE CAPE COD CANAL BRIDGES

MassDOT remote counting stations located on Route 28 in the towns of Barnstable and Yarmouth show useful insight into traffic trends in the Mid Cape area in 2014. The figure below show the summer average daily traffic (ADT) for each hour of the day at the locations of Route 28 east of Higgins Crowell Road and Route 28 west of Putnam Avenue. The data shows that during the summer there was typically more traffic on Route 28 at the location in Barnstable east of Putnam Avenue in Cotuit than in the Location in Yarmouth East of Higgins Crowell Road, except between the hours of 6pm and 9pm.

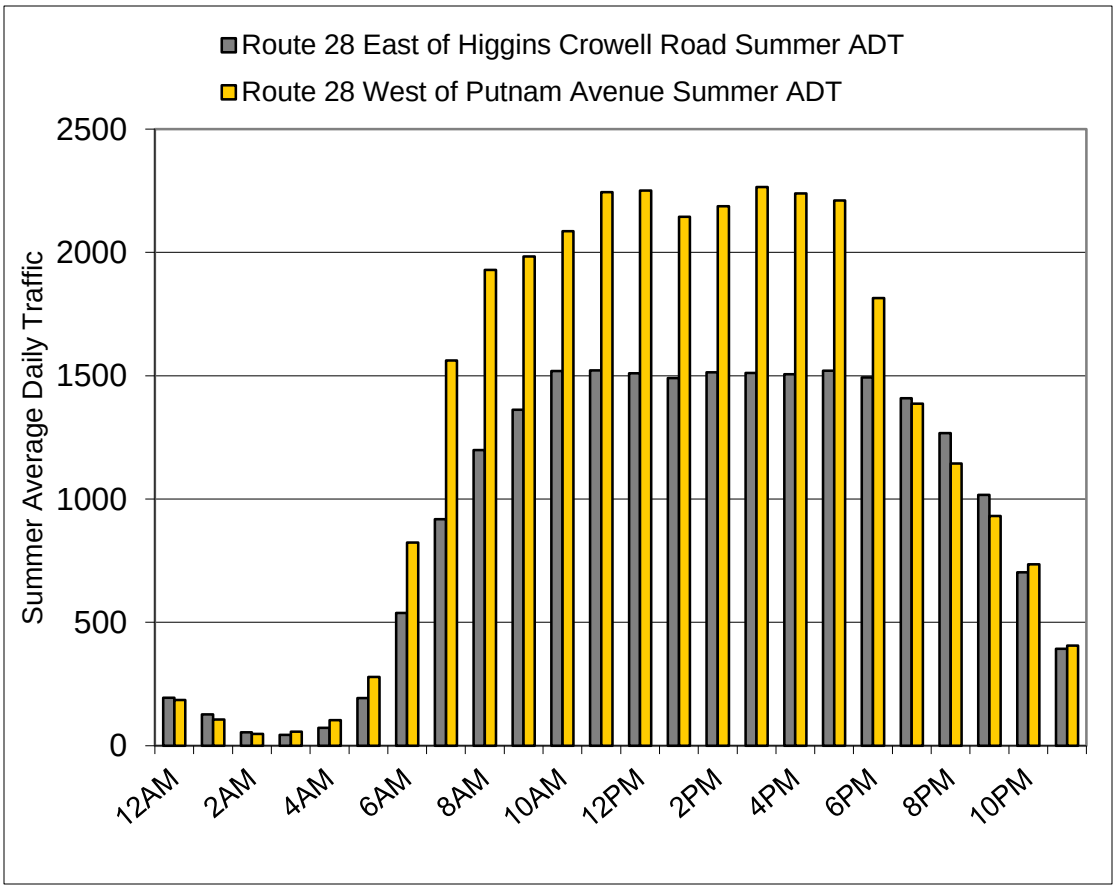

FIGURE 6: HOURLY SUMMER DATA AT MASSDOT PERMANENT COUNTING STATIONS ON ROUTE 28

The graph below shows the monthly volumes that were counted by Cape Cod Commission permanent counting stations. The chart only includes months that more than a day of missing data. The intersection at Route 28 and Lumbert Mill Road in Barnstable showed the highest volumes of the three locations in each month except July and August. This location had the most consistent volume year round. The intersections in Harwich, Route 124 at Queen Anne Road and Route 137 at Route 39 showed a larger increase in volume during the months of July and August. The monthly total for July and August for the Route 137 at Route 39 intersection showed highest volumes of the three locations.

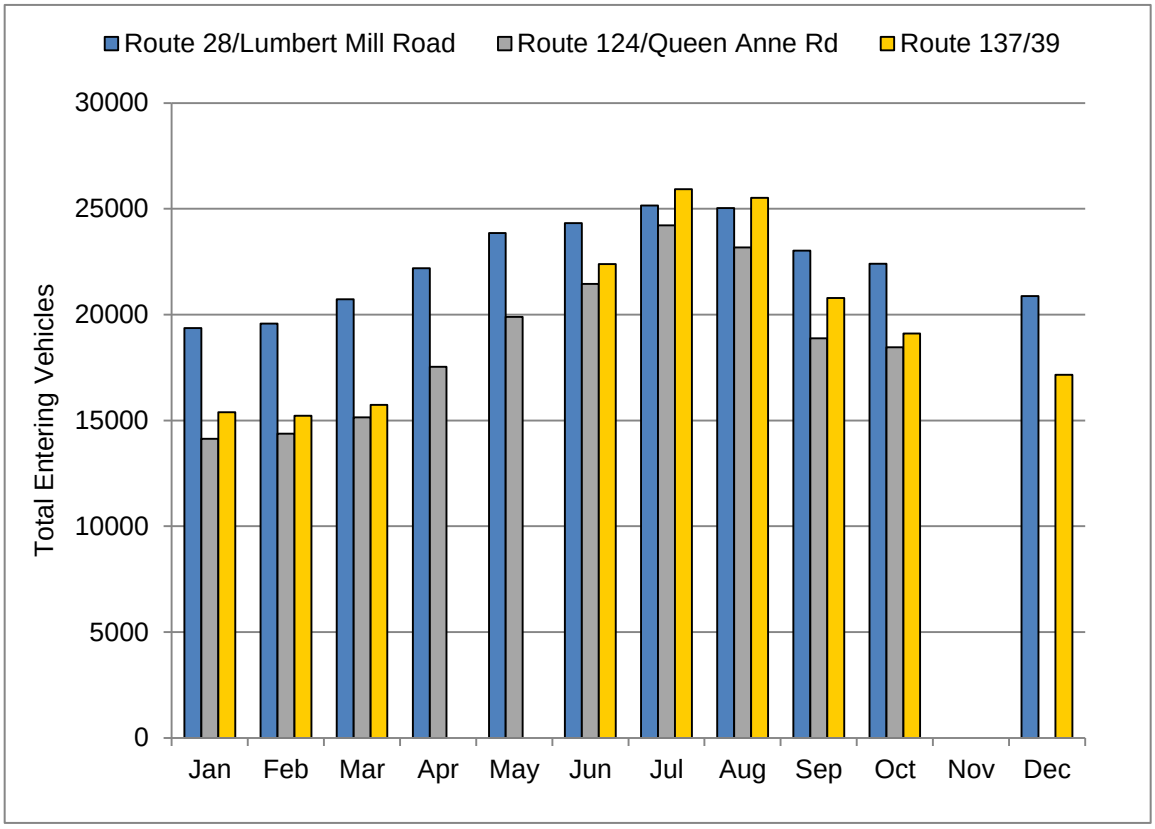

FIGURE 7: MONTHLY TRAFFIC VOLUMES RECORDED AT CAPE COD COMMISSION PERMANENT COUNTING STATIONS

GAS PRICES

Gas prices have varied significantly and affect the use of the automobile and transit. The following Massachusetts retail price/gallon data (as of April 2014) is from www.gasbuddy.com.

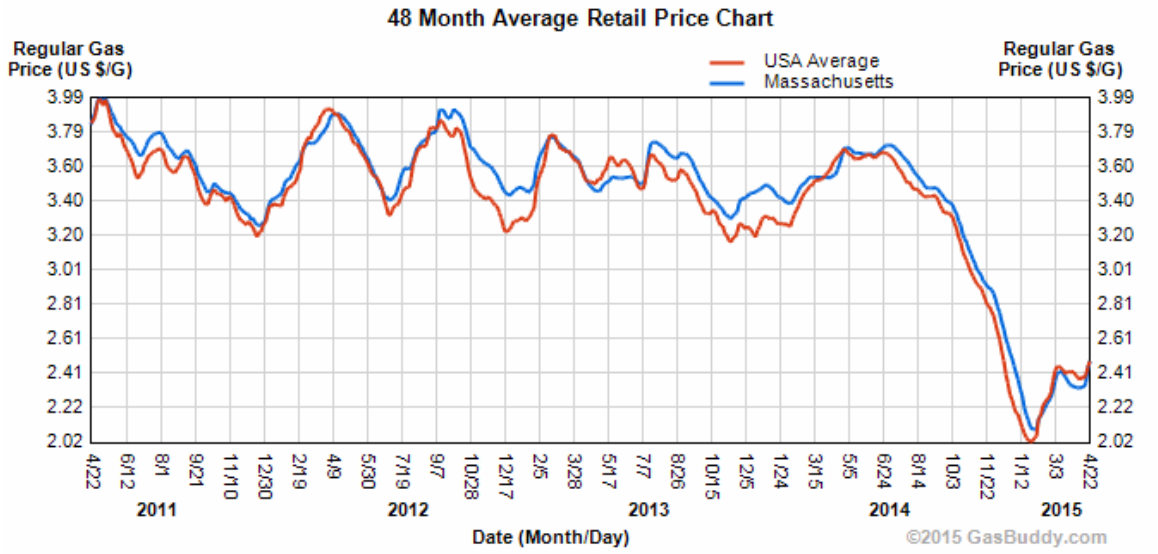

FIGURE 8 - MASSACHUSETTS AND USA GAS PRICES

VOLUME TO CAPACITY RATIO OF CAPE COD ROADS

The following figures present Level of Service information for many Cape Cod locations based on the volume to capacity ratio. The thresholds for these ratios are shown in the following table:

Symbol	V/C Ratio Threshold	Level of Service (LOS)
●	0.8	C or Better
●	0.9	D
●	1.0	E
●	>1.0	F

The Level of Service (LOS) calculations are performed for locations where the CCC has collected summer traffic counting data. The traffic volumes used represent a consistent summer weekday 4-5 p.m. peak hour. Roadway capacities were extracted from the Cape Cod travel demand forecasting model and originated from the Office of Transportation Planning at MassDOT.

Roadway LOS only shows part of the congestion picture. In many cases traffic congestion bottlenecks occur at intersections. Intersection analyses are more complicated and performed on a case-by-case basis. Such locations are often identified through public input and consultations with local traffic officials such as CCJTC members.

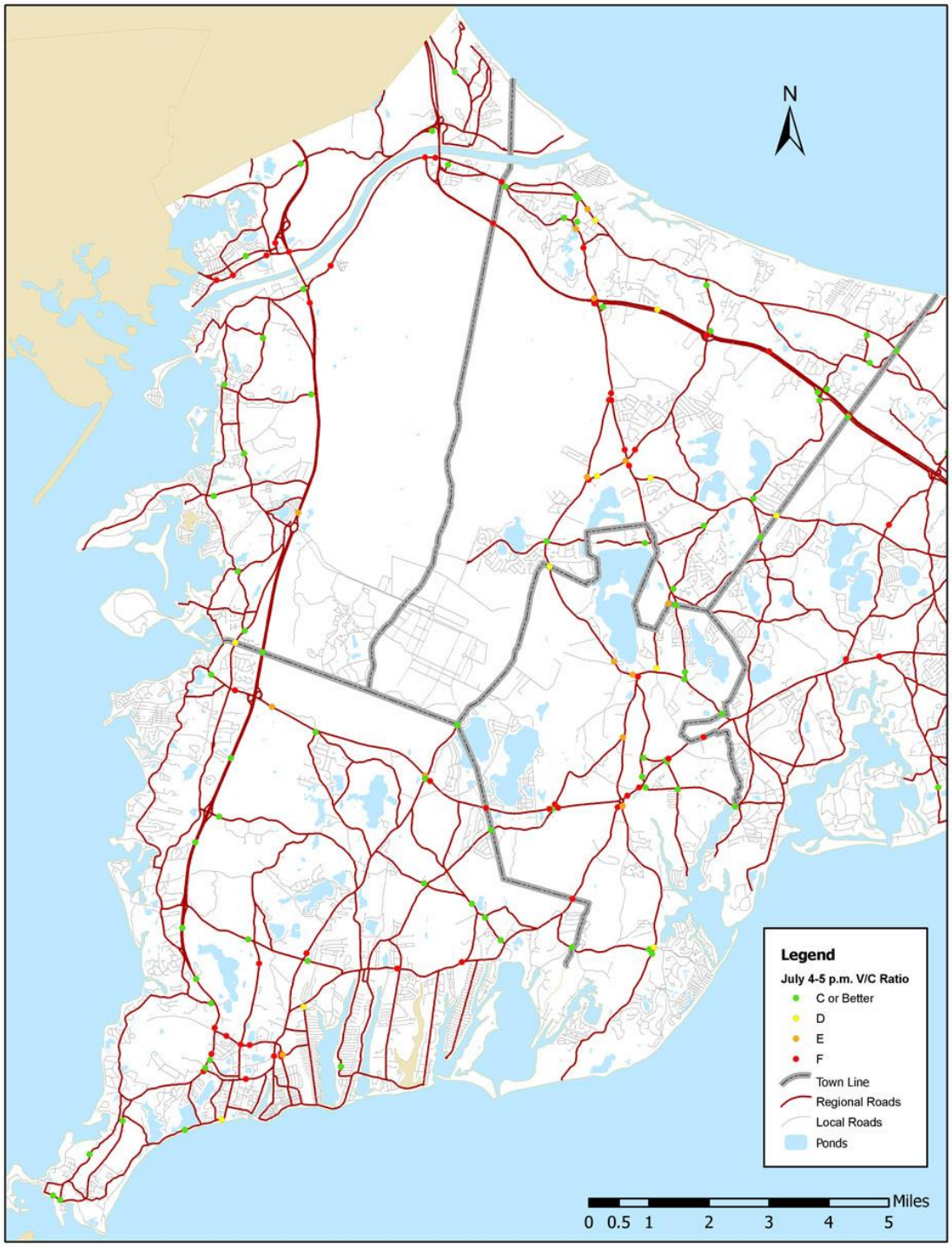

FIGURE 9 - UPPER CAPE COD V/C RATIOS

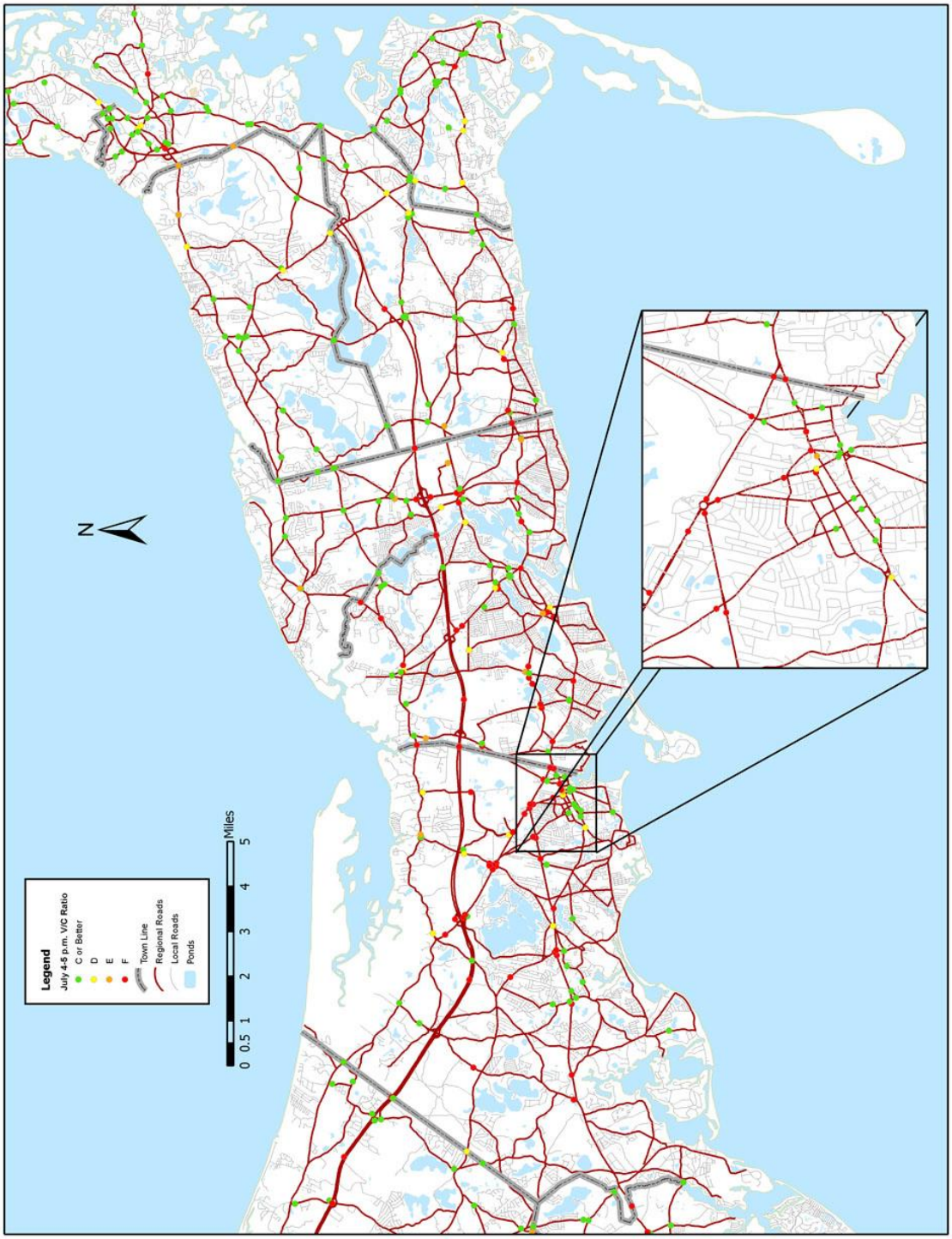

FIGURE 10 - MID-CAPE COD V/C RATIOS

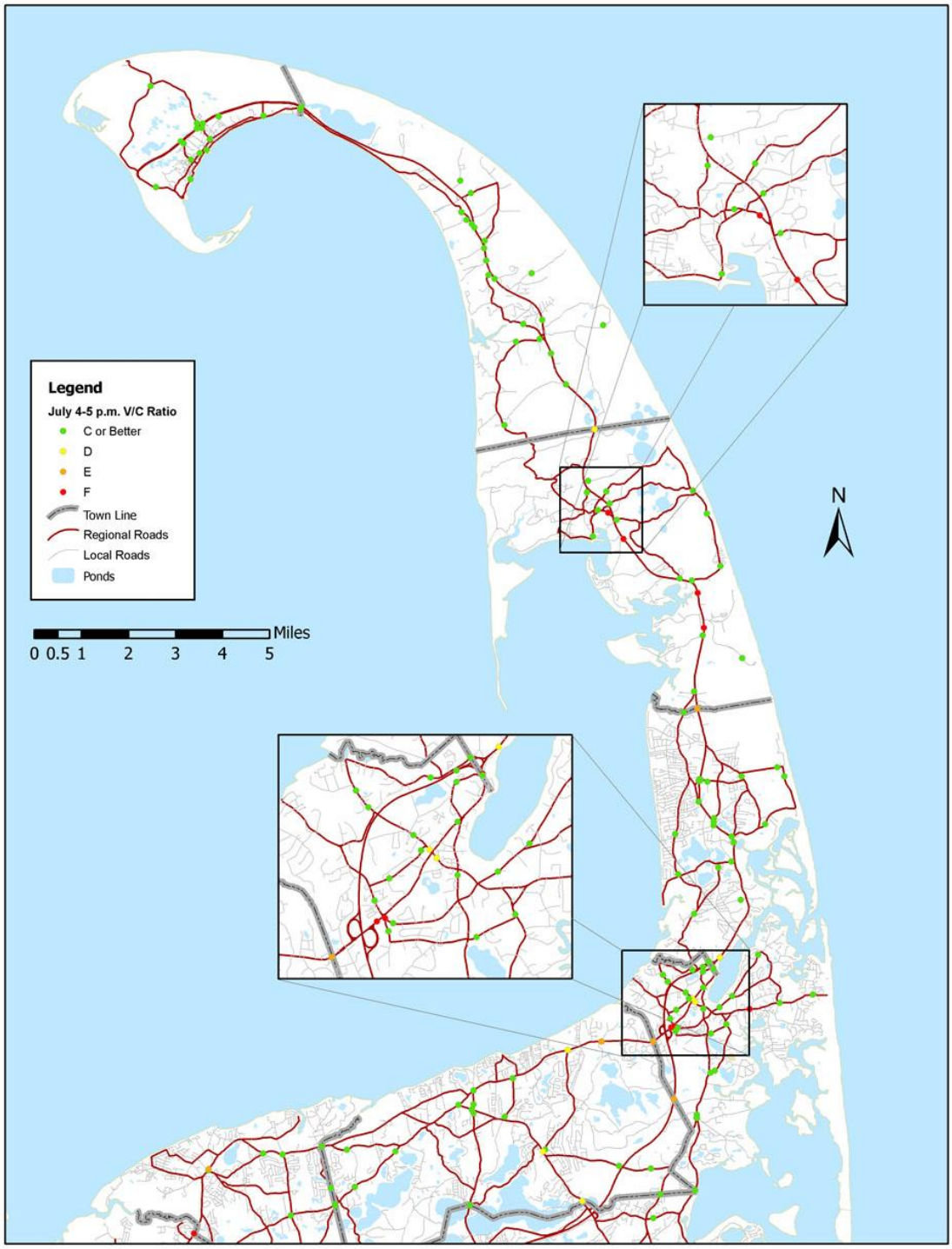

FIGURE 11 - OUTER CAPE COD V/C RATIOS

TRAVEL TIME CORRIDORS

The following figure shows travel time information on selected major corridors on Cape Cod (e.g., Route 28, Route 6A, and Route 6 in the Outer Cape). The CCC has collected speed data on the color-coded segments. The above graphic shows the observed speed divided by the speed limit of each road segment. (Observed speeds were collected at various times of the day during summer weekdays). Road segments color coded green include a ratio of 1.0 – this represents travel speeds matching the speed limit. Heavily congested roadways are represented in red (speed/speed limit ranges from 0.11-0.50).

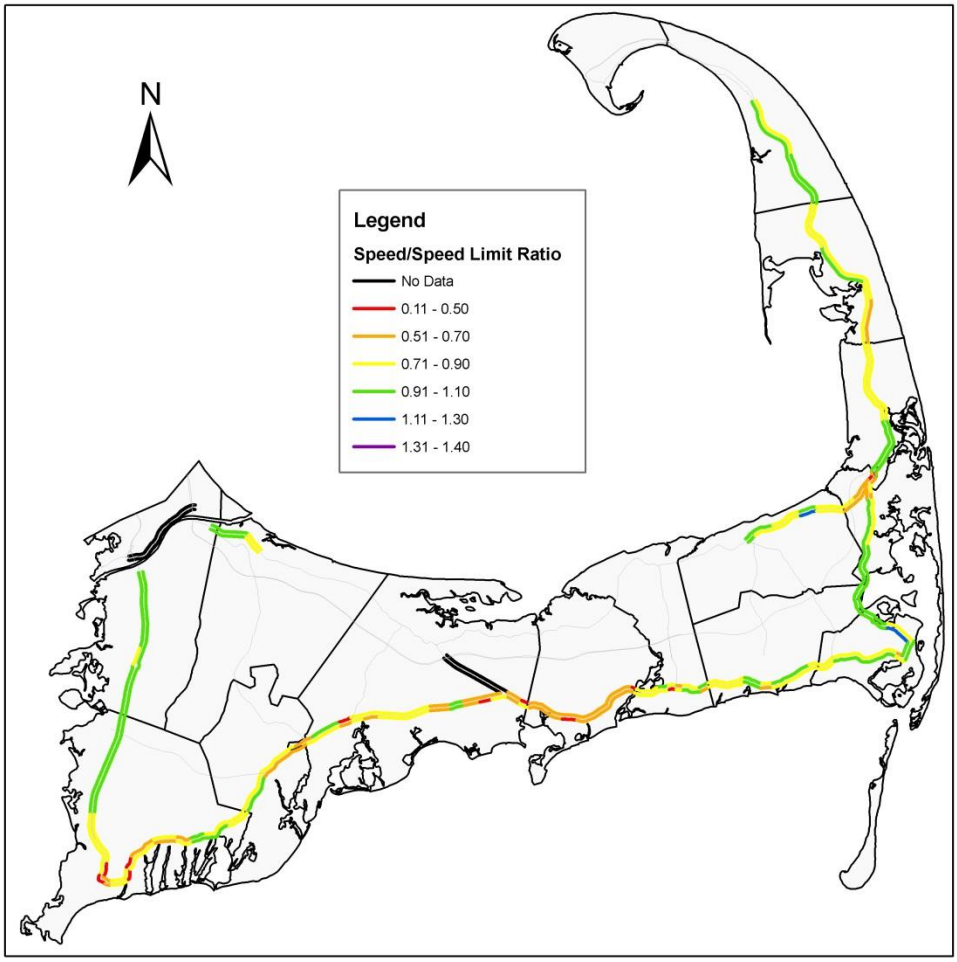

FIGURE 12 - RATIO OF SPEED/SPEED LIMIT ON SELECTED CAPE COD ROADS

TRANSIT GROWTH

The indicator used by the Cape Cod Center for Sustainability to monitor transit, measures the total number of riders using public transit annually. This indicator measures local and regional

(on-Cape) ridership on public transit systems, but does not measure the ridership on private carriers or commuters to Boston.

This measure of annual ridership documents one aspect of the alternatives to the automobile. The Outer Cape *Flex* service was introduced on June 1, 2006 and was more successful than anticipated and will be monitored for trends in future years.

System-wide Ridership

Transit has seen a steady growth in ridership over the past decades as shown in Figure 13.

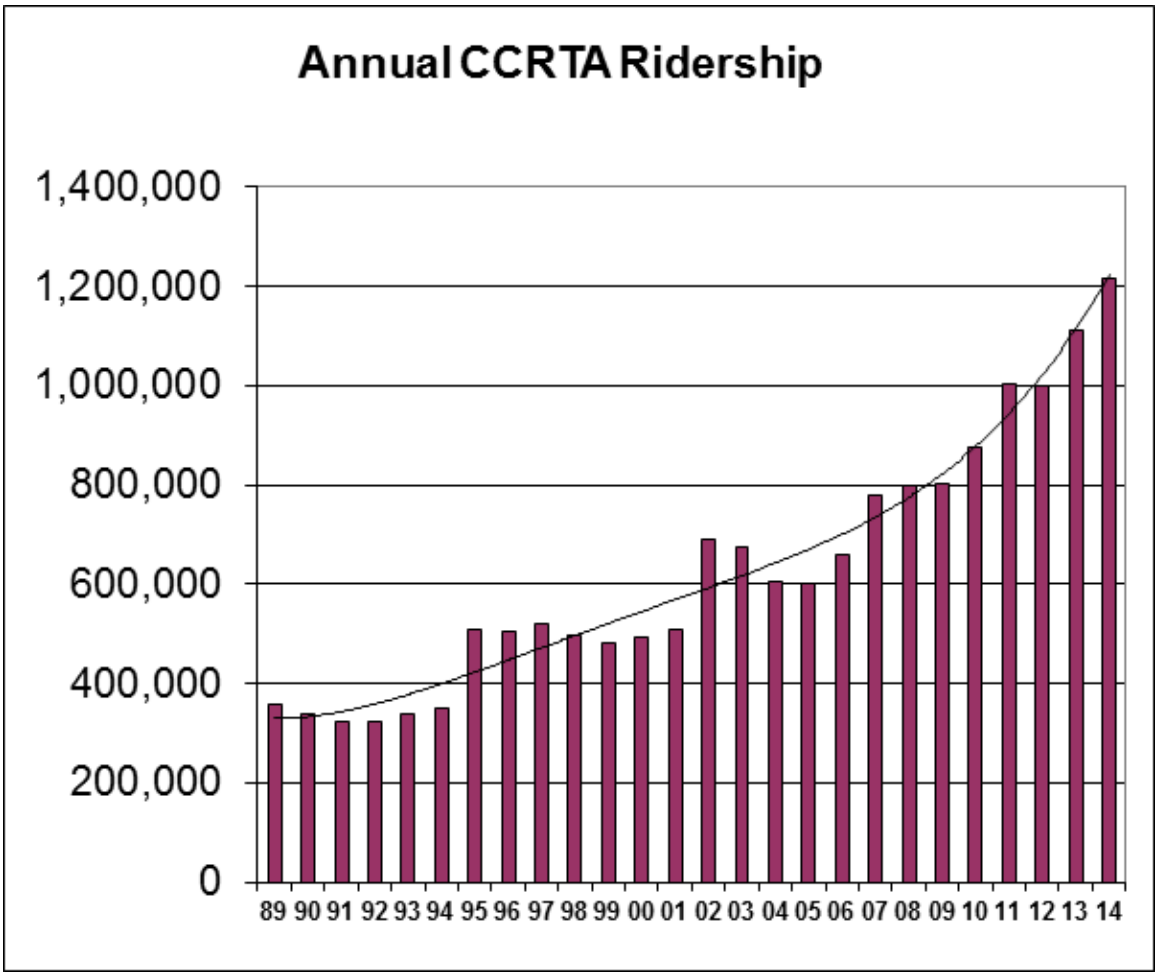

FIGURE 13 - RIDERSHIP ON CAPE COD REGIONAL TRANSIT AUTHORITY
Source: CCRTA

CAPE COD COMMISSION

3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

CAPE COD
COMMISSION

2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix H: Coastal Resiliency

Draft
June 15, 2015

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Technical Appendix H: Coastal Resiliency

To supplement the discussion provided in Chapter 4, this appendix provides additional information on the following:

- Climate Change Risk and Vulnerability Assessment of Regional Transportation Infrastructure
- Critical Transportation Assets and their Vulnerability to Sea Level Rise
- Restoring River and Stream Continuity

CLIMATE CHANGE RISK AND VULNERABILITY ASSESSMENT OF REGIONAL TRANSPORTATION INFRASTRUCTURE

As part of the 2013 Unified Planning Work Program, Cape Cod Commission staff conducted an assessment titled *Climate Change Risk and Vulnerability Assessment of Regional Transportation Infrastructure*.[1] The primary intent of this assessment is to identify critical transportation modes and assets that make up our regional transportation infrastructure and understand the potential vulnerabilities of those modes and assets to particular climate change threats. This assessment has been conducted as a research effort by Commission staff, and should be considered a preliminary step in addressing climate change vulnerabilities throughout our region. Intended users of this assessment include state and regional transportation officials, planners and decision makers.

This assessment has been conducted primarily by Commission staff as a research effort combining both the desk review and expert elicitation approaches to determine criticality, as outlined by FHWA's report, *Assessing Criticality in Transportation Adaption Planning* (June 2011). The expertise of regional and local planners', transportation engineers, and emergency response professionals contributed to the prioritization of a range of modes and assets determined to be critical to regional transportation infrastructure. However, it is important to note that this hybrid approach may be limited in determining the appropriateness of specific adaptation decisions. The authors of this assessment acknowledge that further study involving a more robust public process will be necessary in developing mitigation and adaptation strategies for specific assets.

For the purposes of this assessment, critical transportation infrastructure assets will be defined as infrastructure that comprises both significant regional modes of transportation, such as marine, air, bus and auto, as well as more traditional fixed infrastructure assets, such as road and railways, bridges, ports, and airports. The Hazard Identification section of this report provides an overview of the hazards the region faces under severe weather conditions. These

[1] http://www.capecodcommission.org/resources/transportation/UPWP_task2.5DraftReport111413.pdf

hazards are addressed more completely in the Regional Multi-Hazard Mitigation Plan; however climate impacts, particularly to transportation infrastructure, are not adequately addressed under that plan. This assessment builds upon the Regional MHM Plan by looking at the climate impacts of greatest concern to transportation assets in our region from flooding due to high precipitation events, storm surge and sea level rise. To examine the potential vulnerability of critical assets to these events, the following data sets were utilized; 2013 Preliminary FEMA Flood Insurance Rate Maps (FIRMs); 2013 Sea, Lake and Overland Surge from Hurricanes (SLOSH); NOAA's Digital Coast Sea Level Rise viewer and our own sea-level rise analysis based on further refined topographic data than was utilized by NOAA in developing the viewer. The rationale for choosing these data sets and mapping tools and their limitations is discussed further in the Data & Limitations section.

DEFINING STUDY SCOPE & AUDIENCE FOR VULNERABILITY ASSESSMENT

Fixed Assets include permanent, immovable infrastructure. The following fixed assets have been identified within our region using the best available Geographic Information Services (GIS) data:

- Bridges
- Regional Roadways (principal arterial and rural minor arterial)
- Transportation centers
- Bus routes
- Passenger rail
- Port and airport infrastructure
- Public landings

Soft assets can be manipulated and relocated (to some extent) and include the following:

- Key evacuation routes
- Transit system facilities and vehicles
- Back-up power, communication, fueling, and other emergency operations systems
- Intelligent Transportation Systems (ITS)
- Signs and other roadside assets

INVENTORY AND PRIORITIZATION OF ASSETS

While it is important to consider both public and private assets that are integral to our regional transportation infrastructure, only public assets were included at this preliminary level of analysis. Private assets should be assessed prior to developing a comprehensive mitigation and adaptation strategy for regional critical transportation infrastructure. Furthermore, assets deemed most critical and potentially vulnerable should be assessed according to the age of the asset, its geographic location, current condition, level of use, replacement cost and design lifetime. Assets deemed both potentially vulnerable and with medium to high regional significance are discussed in detail in this assessment. Commission staff presented a

preliminary assessment of the regional significance of assets and modes considered in this report to regional transportation planners and engineers. Comments from this review process were incorporated into the assessment and asset significance was revised accordingly.

Climate Change impacts threatens our region in many ways, but perhaps most significantly, by exacerbating the impacts from hazards the region is already subject to. Storm surge, erosion, wind damage and inland flooding from heavy precipitation events and coastal storms are no stranger to our region. However, as these hazards threaten to become more frequent and intense under climate change projections, our preparedness and response must also be considered with a heightened level of scrutiny.

The following climate change projections for our region were identified in the Massachusetts Climate Change Adaptation Plan (2011). These projections combined with the best available GIS data have been used to guide this assessment.

TABLE 1: REGIONAL CLIMATE CHANGE PROJECTIONS[2]

annual temperature increase	4 - 5° F (winter 2 - 5° F; summer 4 - 5° F)
annual seas surface temperature increase	3° F
annual precipitation increase	5% - 8% (winter 6% - 16%; summer -1% - 3%)
drought lasting 1 – 3 months	5 – 7 times every 30 years
snow days	- 2 days per month
sea-level rise	8 – 16 inches by 2050
increased hurricane intensity	
increased storm frequency and duration	

MULTI-HAZARD MITIGATION PLAN

The 2010 Multi-Hazard Mitigation Plan establishes the hazard ranking for Cape Cod, Massachusetts, and subsequently, this report. It is the basis for the county's determination of the most likely and most damaging natural hazards to which Cape Cod is vulnerable. This matrix was compiled based on the best judgment and knowledge of the members of the Regional Multi-Hazard Committee. Note that one hazard can be the result of numerous events. For example, flooding is a natural hazard that can be caused by a hurricane, winter storm, or nor'easter. Therefore, it is the potential impact of the damaging hazard—the flooding—and not the event—a hurricane or a nor'easter—that this matrix ranks. Climate change is an event to which Cape Cod has become vulnerable. The projected impacts of climate change are covered through existing events and hazards, such as hurricanes and intensification of coastal erosion. However, heavy downpours, a more recent phenomenon expected to worsen over time has been included as a hazard associated with climate change, as it can occur in any season, independent of a Nor'easter or hurricane.

[2] Massachusetts Climate Adaptation Plan, 2011

Using the rating system and the definition of ranges from the FEMA *Local Mitigation Planning Handbook* (2013), hazards are ranked from most likely and damaging to least likely and damaging. Generally, Cape Cod is subject to the following types of events that are expected to occur more frequently and with greater intensity under climate change projections:

- Hurricanes — which can cause hazards such as flooding and storm surge, shoreline change (episodic erosion), wind, tornadoes, water spouts, and heavy downpours
- Winter storms / Nor'easters — which can cause wind, snow and ice accumulation, shoreline change (episodic erosion), and flooding
- Sea level rise — which can cause shoreline change, long-term coastal erosion, and flooding

Hurricanes

Of all the natural threats that might affect Cape Cod, hurricanes have the potential to cause the most property damage and loss of life if adequate planning and preparation is not undertaken. Although hurricanes can produce tremendous damage they can, unlike other threats, be tracked for several days before impacting a community—giving residents and visitors time to prepare and evacuate if necessary. We cannot, however, plan to move or remove infrastructure when a hurricane is predicted. The Atlantic hurricane season runs from June 1st through November 30th. Based on the number and intensity of storms, mid-August through mid-October is defined as the peak period. However, hurricanes or other severe storms can occur at any time. During the months of June and July, hurricanes tend to form in the Caribbean and the Gulf of Mexico. By mid-August, as the waters of the tropical Atlantic warm, the focus turns to the Eastern Atlantic in the vicinity of the Cape Verde Islands off the African coast. The tropical waves intensify as they move westward, become tropical depressions, then tropical storms and finally hurricanes. Most of these storms turn northward around the peripheries of the semi-permanent Bermuda and Azores high-pressure areas, but in some cases can affect the Atlantic and Gulf Coast states. By early October, the waters over the Atlantic begin to cool and the focus for storm development shifts back to the Caribbean and the Gulf of Mexico. Climate change threatens to alter this cooling effect through warming ocean water temperatures. While it is impossible to pinpoint the exact impact this phenomenon will have on our region, both the intensity and frequency of hurricanes is expected to rise. Some of the main hazards that may occur during a hurricane event are wind, heavy downpours and storm surge.

Strong surface winds can cause a barrage of flying debris. Hurricanes are categorized by sustained winds of 74 mph to 200 mph, which can cause tremendous debris problems. The Barnstable County Multi-Hazard Mitigation Plan (2010) states that Southern New England has been affected by 41 tropical cyclones between 1900—2010. Twelve of these storms have caused significant landfall damage. Each of these storms brought high winds resulting in heavy precipitation and coastal flooding. The angle at which the majority of these storms made landfall was approximately 60 to 90 degrees—a storm track generally perpendicular to the coastline, worsening the storm surge in north-south orientated bays and inlets. As a result, much of the Nantucket Sound shoreline was adversely affected. Major storms of the last 100 years have behaved in a relatively consistent manner: each storm bringing the Cape high winds and heavy precipitation resulting in varying levels of coastal flooding. The time frame for their

arrival (August/September) coincides with the zenith of Cape Cod's tourist season. The potential damage that could be inflicted by a significant storm event on the surrounding environment will most likely be complicated by the burden of additional populations located in and around potential hazard areas.

Torrential rains are associated with slow moving or stationary tropical weather systems. In addition to flooding residences and businesses, heavy rain can overcome the Cape's storm drain systems and cause severe flooding or structural failure of roads or culverts. Climate change projections suggest an increase in frequency and occurrence of heavy rainstorms over the next 30 years. While these heavy rains can have a disastrous effect on agricultural interests by drowning crops and increasing the probability of disease and pest infestations in surviving crops, coastal flooding and storm surge inundation are of primary concern to Cape Cod. Coastal flooding is the main risk faced by Cape Cod's residents and visitors during a serious weather event such as a hurricane or winter storm. It doesn't take a major event for flooding to result in many areas—many of our storm drain systems are overcome during small rain events, which flood roadways and personal property.

Rapidly rising storm surge is the hurricane's main threat to life. Storm surge is a dome of water that moves ashore to the right of the hurricane eyewall. It can be the primary risk to life if adequate evacuations are not done. In the case of Cape Cod Bay, storm surge will actually affect the shoreline, and particularly Wellfleet Harbor, shortly *after* the storm has passed. Residents and visitors should be aware to remain well above surge elevations until all threats have passed. Damage amounts depend on the hurricane's intensity, size and its direction of movement. Storm surge causes salt water flooding that can render evacuation routes impassable, cripple communications, cause sewers and storm water basins to back up, and contaminate drinking water supplies. Storm surge flooding can wash out roads and leave streets filled with sand and debris, rendering them impassible long after surge waters have receded.

Winter Storms

In contrast to a hurricane, winter storms that affect Cape Cod tend to concentrate their effects on the north shore, where the normal tidal range is 8 feet (and up to 14 feet in some places). The geography on the north side often gains elevation more quickly as distance from the shore increases. A main thoroughfare and evacuation route, Route 6A, crosses tidal creeks and marshes in many locations and is subject to inundation during storms. The result is that isolated residential areas may be free of flooding but may still be entirely isolated in terms of evacuation and emergency services. These impacts are projected to worsen over time as climate change related impacts, such as flooding, storm surge and sea-level rise, are expected to intensify.

A winter storm can range from moderate snow to blizzard conditions. A severe winter storm deposits four or more inches of snow during a 12-hour period or six inches of snow during a 24-hour period. A blizzard is a snowstorm with sustained winds of 40 miles per hour (mph) or more or gusting up to at least 50 mph with heavy falling or blowing snow, persisting for one hour or more, temperatures of 10 degrees Fahrenheit or colder, and potentially life-threatening

traveling conditions. From 1971 to 2009 there were three ice storm events in Barnstable county causing major disruptions in power and transportation services.

A northeast coastal storm, known as a nor'easter, is typically a large counter-clockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain. The storm radius is often as much as 1000 miles, reaching from the Carolinas to the Gulf of Maine. These storms occur most often in Late fall and early winter. Sustained wind speeds of 20-40 mph are common during a nor'easter with short-term wind speeds gusting up to 50-60 mph. Nor'easters are among winter's most ferocious storms. These strong areas of low pressure often form either in the Gulf of Mexico or off the east coast in the Atlantic Ocean. The low will then either move up the east coast into New England and the Atlantic provinces of Canada or out to sea. These winter weather events are notorious for producing heavy snow, rain, and oversized waves that crash onto Atlantic beaches, often causing beach erosion and structural damage. Wind gusts associated with these storms can exceed hurricane force in intensity. Nor'easters may also sit stationary for several days, affecting multiple tide cycles and extended heavy precipitation. The level of damage in a strong hurricane is often more severe than a nor'easter but historically, Massachusetts has suffered more damage from nor'easters because of the greater frequency of these coastal storms (1 or 2 per year).[3]

Nor'easters are a common winter occurrence in New England and repeatedly result in flooding, various degrees of wave and erosion damage to structures, and erosion of natural resources, such as beaches, dunes and coastal bluffs. The erosion of coastal features commonly results in greater potential for damage to shoreline development from future storms.

Most winter storms bring to the Cape both storm surge and high winds, making our coastline particularly vulnerable to damage. Because the coastline is highly developed, infrastructure is at significant risk. If a storm should coincide with a high tide, an additional layer of vulnerability and associated risk is added. Infrastructure and critical facilities may be impacted by these events, with associated power outages and transportation disruptions (i.e., snow and/or debris-impacted roads, as well as hazards to navigation and aviation)

Sea Level Rise

Cape Cod's shore is, for the most part, eroding.[4] Of the 586 miles of Cape Cod's tidal shore, a shoreline change analysis of 238 miles of its outer shore, including the landward side of major barrier beaches was completed in 2002.[5]

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[3] MA Hazard Mitigation Plan, 2010.

[4] O'Connell, J.F., 2003, New Shoreline Change Data Reveal Massachusetts Is Eroding, WHOI Sea Grant and Cape Cod Cooperative Extension, Marine Extension Bulletin, March, 2003.

[5] O'Connell, J.F., Thieler, E.R., and Schupp, C, 2002, New Shoreline Change Data and Analysis for the Massachusetts Shore, with Emphasis on Cape Cod and the Islands: Mid 1800s-1994, Environment Cape Cod, Vol. 5, No. 1. See also Thieler, E.R., O'Connell, J.F., and Schupp, C., 2002, The Massachusetts Shoreline Change Project: 1800s – 1994, Technical Report, U.S.G.S. Administrative Report, Woods Hole, MA.

A 2003 study by the Barnstable County Extension and the WHOI Sea Grant program revealed that approximately 66% (157 miles) of Cape Cod's shore shows long-term erosion, 32% (76 miles) exhibits long-term accretion, while 2% (5 miles) shows no long-term net change. These figures of the linear length of shoreline changes closely match the state-wide averages. Twelve of the Cape's 15 communities exhibit a long-term erosion trend; while only three of those show long-term accretion (Figure B) in certain areas. It is important to note, however, that both erosion and accretion occur along a community's shoreline and site-specific shoreline change data need to be analyzed for planning purposes. This work is currently being undertaken by the Provincetown Center for Coastal Studies for several communities along Cape Cod bay. The result of this research establish quantities of sediment transport from certain locations and will further sediment management planning for areas most vulnerable to erosion. Communities that exhibit the highest erosion rates and linear length of eroding shore are primarily those that include shorelines facing the open ocean, such as Truro, Wellfleet, and Eastham. (Chatham also has a highly erosive shore but much of the shore was not included in the data analysis due to complex barrier beach migration and breaching.) Communities that exhibit the lowest shoreline change and erosion rates are those that generally are sheltered from significant storm waves, such as the Buzzards Bay and eastern Nantucket Sound areas. Significant accretion areas are generally at the ends of barrier beaches, the updrift side of jetties and groins, and downdrift of significant sediment sources.

The causes of shoreline change, particularly erosion, are both natural and human-induced. The primary natural causes of erosion in Massachusetts are relative sea-level rise. Records of tide gauges around Boston, Woods Hole, and Nantucket indicate that our relative sea level (the combination of a rising water surface with land subsidence) has risen approximately 10 inches over the past 100 years[6]. The most important cause of human-induced erosion is interruption of sediment sources and longshore sediment transport. Examples include the armoring of sediment source coastal bluffs (banks) with revetments, seawalls, and bulkheads, and interruption of longshore sediment transport by the construction of jetties and groins.

Natural coastal erosion is an important geologic process. Without erosion, flooding, storms, relative sea-level rise, and unimpeded longshore sediment transport, the beaches, dunes, barrier beaches, and biologically important bays and estuaries with their associated tidal flats would not exist today. Due to extensive armoring of sediment source coastal banks, beaches and dunes in areas of Cape Cod are slowly diminishing in size and volume. In fact, due to human activity in some areas of Cape Cod, beaches no longer exist at high tide due to a lack of sediment supply coupled with continuing relative sea-level rise (i.e. Surf Drive in Falmouth). The rate of sea-level rise is accelerating, and could possibly triple over the next century.[7]

Beaches, dunes, and barrier beaches are part of the environmental, ecological, and economic vitality of Cape Cod and its communities. They also provide storm damage reduction and flood control to landward resources and infrastructure. As part of on-going climate adaptation planning work, current projects to develop a better understanding of regional sediment

[6] MA Hazard Mitigation Plan, 2010.
[7] IPCC, 2007, Fourth Assessment – Climate Change 2007: A Report of the Intergovernmental Panel on Climate Change.

transport and established sediment budgets will be critical for prioritizing coastal nourishment, armoring and retreat decisions.

VULNERABILITY ASSESSMENT

The assessment utilized three approaches to determine a transportation asset's vulnerability to climate impacts: the Federal Emergency Management Agency's 2013 Preliminary Flood Insurance Rate Maps (FIRMs); the U.S. Army Corps of Engineers (USACE) 2013 Sea, Lake and Overland Surge from Hurricanes (SLOSH) model; and two methods for considering Sea-Level Rise - the National Oceanic Atmospheric Administration's (NOAA) Digital Coast Sea-Level Rise Viewer, and our own Digital Elevation Modeling approach to examine sea-level rise impacts.

TRANSPORTATION CENTERS

Of the three identified multi-modal transportation centers on Cape Cod; Woods Hole, Hyannis and Provincetown, only MacMillan Pier in Provincetown was identified as vulnerable. A 2006 feasibility study of MacMillan Pier estimated 120,000 ferry trips and approximately 90,000 – 110,000 bus trips during a 21 week summer season. The report estimated that these trips would grow in the future, and thus may be higher today. The pier was significantly renovated and expanded during 2003-2005 with USDA rural development funds. In 2005, the Provincetown Public Pier Corporation entered into a 20-year operational lease agreement. The pier is located in a Velocity Zone (or V-Zone) on both the existing and preliminary FEMA Flood Insurance Rate Maps (FIRMs) and in the Sea, Lake and Overland Surge from Hurricanes (SLOSH) zone for a category 1 hurricane. Given the marine use of the pier, this in not atypical, but noteworthy for the purposes of this assessment. Further, according to the sea level rise analysis conducted as part of this assessment, the pier and its continued function as a multi-modal transportation hub could become seriously jeopardized under a 3-foot sea level rise scenario, projected mid-to-late century, when coupled with the cumulative effects of interim storms during that time period.

Airports

The Barnstable Municipal Airport and the Otis Airfield located on Joint Base Cape Cod are the largest and most significant airports serving the region of Cape Cod. Both locations are proximate to areas expected to experience coastal flooding, storm surge inundation and sea-level rise, however the entirety of the airports is located outside these mapped hazard areas as examined through this assessment.

While less regionally significant than the Barnstable Municipal Airport and Otis Airfield, the Provincetown Municipal Airport is located on low lying, federally owned land within the Cape Cod National Seashore. It has serviced the Outer Cape since the 1940's. The runway, hangars and terminal building lie within the existing FIRM AE Zone with a base flood elevation (BFE) of 10 feet. Under the preliminary FIRMs, the zone designation remains the same, however the BFE has increased to 12. Under the SLOSH model, the airport would be completely inundated from storm surge under a category 3 hurricane. A 3' sea-level rise scenario could result in open water for the entirety of the airport property by mid-century.

A Capital Infrastructure Plan for the airport is being developed which will require an expansion of the terminal building to better meet TSA security requirements. Regulatory agencies involved in the permitting of that plan are examining ways to elevate the terminal building responsive to projected flood and storm surge conditions. These measures will help to reduce the vulnerability of the terminal building; however, other structures at the airport remain at risk and long-term operation of the airport under sea-level rise projections is grim unless significant and innovative infrastructure investments are made. Chatham's Municipal Airport is entirely upland of hazard areas identified through this assessment.

Regional Roadways

For the purposes of this assessment, two categories of roadway segments classified by the Massachusetts Department of Transportation (MassDOT) were selected; Class 2, principal arterial and Class 3, rural minor arterial.

The two classifications of road segments comprise all of the Cape's major, regional thoroughfares, including: Route 6, 6A, 28, 28A, 124, 130, 132, 134, 151 and the portion of Willow Street connecting Rote 6 with Iyannough Road in Yarmouth. The following table shows the miles of roadways located within flood and SLOSH zones.

TABLE 2: ROADWAY SEGMENTS IN VULNERABLE AREAS (MILES)

	CLASS 2	CLASS 3
Existing FIRM Total	2.69	5.24
Preliminary FIRM Total	4.72	10.82
SLOSH Total	11.60	17.08

Ferry Terminals

The network of piers, bulkheads and dredged harbors that make up the infrastructure needed to support a range of ferry operations are of significant concern for our region. They are a critical asset for both our tourist based economy, and for the delivery of goods and services to and from the Cape & Islands region. By virtue of their location in V-zones, these facilities are clearly vulnerable to present and future storm surge and sea-level rise, however, at this level of analysis there is great uncertainty as to the vulnerability of the assets that comprise this infrastructure. A greater level of analysis will be required to determine the age of the asset components, maintenance and repair costs, and replacement costs. Long range management strategies will be greatly informed by this cost analysis.

Marinas and Public Landings

Marinas and public landings were included in this assessment because they provide structured access to water for marine transportation (even though primarily recreational), and because cemented landings can act as funnels during storm surge events. While these characteristics are important for emergency planning and response, this assessment found no significant regional upland transportation assets vulnerable to the examined hazards.

Buses & Shuttles

The assessment examined the three major bus lines servicing the region, the Plymouth Brockton, Peter Pan and the Flex bus. The percentage of roadway in potentially vulnerable areas for these routes is relatively low, although worthy of note so that potential service disruptions can be properly planned for. Several sub regional bus services may be at a higher risk for service disruptions given the percentage of current routes that travel through flood zones and SLOSH areas (see Table 3).

TABLE 3: REGIONAL BUS ROUTE VULNERABILITY

BUS LINE	REGIONAL SIGNIFICANCE	TOTAL MILES	% IN SLOSH	% IN FIRM
Plymouth Brockton Line	High	101.6	8%	4%
Peter Pan Bus Line	High	85.77	4%	2%
Flex Line	High	53.31	11%	8%
GATRA	Medium	5.5	52%	31%
Sealine	Medium	25.9	12%	5%
H20 Line	Low	32.14	37%	17%
Provincetown Shuttle	Low	15.29	32%	30%
Barnstable Villager	Low	11.1	5%	3%
Bourne Run	Low	24.5	17%	4%
Sandwich Line	Low	24.2	4%	3%

GIS DATASETS AND ASSESSMENT TOOLS:

This assessment incorporated the best available GIS data sets and tools to determine vulnerability. It is important to note that modes and assets determined vulnerable to storm surge using the USACE SLOSH model, or located within flood hazard areas using the preliminary FEMA FIRMs, are vulnerable today. Neither of these data sets account for climate change projections intensifying the impacts they are modeling. To account for some level of analysis that takes into account future climate conditions on these modes and assets, the NOAA sea-level rise viewer was utilized along with our own methodology for creating digital elevation models to examine sea-level rise. However, both approaches utilize the "bathtub" model of future sea-level rise conditions, which doesn't reflect the dynamic changes that will occur on our coastline incrementally over time. While compelling graphically, the "bathtub" models project such little confidence in the already highly uncertain realm of anticipating impacts from se-level rise.

SLOSH maps represent potential flooding from "worst case" combinations of hurricane direction, forward speed, landfall point, and high astronomical tide. It does not include riverine flooding caused by hurricane surge or inland freshwater flooding. The mapping was developed

for the coastal communities in New England using the computer model (developed by the National Weather Service to forecast surges that occur from wind and pressure forces of hurricanes), Long Island Sound Bathymetry and New England coastline topography. In Massachusetts, hurricane category is the predominant factor in "worst case" hurricane surges. The resulting inundation areas are grouped into Category 1 and 2, Category 3, and Category 4 classifications. The hurricane category refers to the Saffir/Simpson Hurricane Intensity Scale.

USACE considered the highest wind speed for each category, the highest surge level, combined with worst case forward motion and developed a model to depict areas that would be inundated under those combined conditions for each category of storm. It should be noted that the model considers only storm surge height and does not consider the effects of waves, nor does it accurately reflect the onset direction of Nor'easters which are common events in our region that can result in significant storm surge.

NOAA's Digital Coast Sea-Level Rise viewer was one tool for assessing vulnerability of particular modes and assets to sea-level rise. This web mapping application allows users to examine their coastal region under sea-level rise scenarios of 1' – 6' of sea-level rise in 1' increments. For the purposes of this assessment, a 3' sea-level rise scenario was chosen for Barnstable County. This scenario is in the range of potential mid—to-late century sea-level rise impacts consistent with the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment (AR4) high emissions scenario. While the viewer is one of the best tools currently available for examining potential impacts of sea-level rise, there are three noteworthy disclaimers about the tool. One, the data in the map do not consider natural processes such as erosion or marsh migration that will be affected by future sea level rise. Two, there is not 100% confidence in the elevation data and/or mapping process. Three, the data may not completely capture an area's hydrology, such as canals, ditches, and storm water infrastructure. While this type of "bathtub" modeling approach is limited in its ability to provide a better understanding of sea-level rise impacts in a dynamic coastal region, it is a compelling visual aid and useful for inclusion in a baseline assessment. A recommendation of this report will be to examine more sophisticated sea-level rise mapping methodologies based on refined elevation data for our region for improve vulnerability assessments.

To map the predicted sea level rise for Barnstable County (Cape Cod) the most accurate elevation data was obtained and adjusted to account for vertical datum variations and localized tidal information. The adjusted data was separated into areas below sea level and into 1 ft increments (up to 6ft) above sea level. The process is detailed below. Topographical elevation data was sourced from remotely sensed LiDAR data collected in the Winter and Spring of 2011, while no snow was on the ground, rivers were at or below normal levels and within 90 minutes of the daily predicted low tide. For Barnstable County, the LiDAR was processed and classified to meet a bare earth Fundamental Vertical Accuracy (FVA) of 18.13 cm at a 95% confidence level. The sourced topological elevation data was in a grid format, as a Digital Elevation Model (DEM) with a cell size of 1 meter. In order to incorporate tidal variability within an area when mapping sea level rise, a "modeled" surface (or raster) is needed to represent this variability. In addition, this surface must be represented in the same vertical datum as the elevation data. To account for the datum and tidal differences across the county the DEM was adjusted to localized

conditions using the NOAA VDatum (Vertical Datum Transformation) software. The VDatum program was used to convert a 500m grid of points covering Barnstable County from the source of North American Vertical Datum 88 (NAVD 88) to Mean Higher High Water (MHHW). MHHW is the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. The 500m MHHW grid was then interpolated into a 1m grid identical in spatial extent to the 1m topographical DEM. The topographical DEM was adjusted on a cell-by-cell basis to account for the MHHW elevation. The MHHW adjusted DEM was separated into seven different dataset. One represented any area with an elevation value below 0. This area is expected to be inundated by tidal water at least once a day. Six additional datasets were created in 1ft increments to represent the inundated area at 1 to 6ft sea level rise. This data was compiled into an online web application called the Cape Cod Commission's Sea Level Rise Viewer. This application was released online in April 2014 and is available on the Commission's website (www.capecodcommission/sealevelrise/)

CRITICAL TRANSPORTATION ASSETS AND THEIR VULNERABILITY TO SEA LEVEL RISE

As part of the 2014Unified Planning Work Program, and as a follow-up to the previously discussed assessment, Cape Cod Commission staff conducted a vulnerability study titled *Critical Transportation Assets and Their Vulnerability to Sea Level Rise*.[8] The objective of this study was to understand the vulnerability of critical transportation assets to sea level rise, just one impact of climate change. Public transportation assets in each mode (air, highway, sea, transit and rail) were examined to determine whether the asset was critical to the network and/or the community and to assess the asset's vulnerability to sea level rise.

This study involved several activities: 1) developing online maps; 2) measuring criticality with stakeholders (defined below); 3) measuring vulnerability to sea level rise and 4) generating a list of transportation assets that are both critical to the modal system and vulnerable to sea level rise Figure 1.

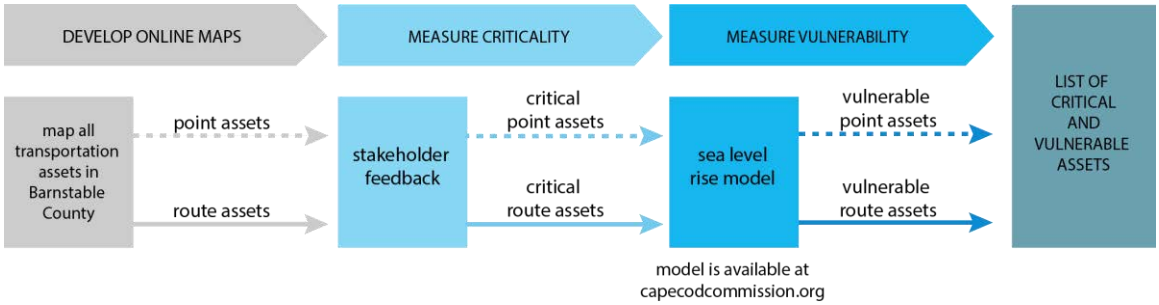

FIGURE 1. OUTLINE OF PROJECT ACTIVITIES AND DELIVERABLES

[8] http://www.capecodcommission.org/resources/transportation/UPWP3_4REPORTfinal.pdf

There are five transportation modes in Barnstable County - air, highway, rail, sea, and transit. Research was performed to determine which assets are important to the functioning on each transportation mode. This list includes point assets, such as bridges, runways, and passenger terminals that are fixed to a single point on the land as well as route assets, such as roadways, bus routes, and train lines. All point and route transportation assets were plotted on digital maps using ArcGIS online.

Representatives from the Barnstable Municipal Airport, the Highway Division of Massachusetts Department of Transportation (MassDOT), Mass Coastal Railroad, the Steamship Authority, and the Cape Cod Regional Transit Authority (CCRTA) were identified as stakeholders for this project. During stakeholder meetings, Commission Staff presented mode specific online maps. Stakeholders were asked to review the maps for errors and make additions or corrections where appropriate. They also commented on the criticality of each asset in their mode. Next, stakeholders were asked to provide volume and ridership data from the year 2013 to understand the functioning of an asset in the community. In addition to the stakeholder meetings, online maps were also presented at two Metropolitan Planning Organization meetings where the general public, members of Federal Highway Administration, and MassDOT had the opportunity to comment on the list of assets.

Commission Staff input all transportation assets into a Sea Level Rise Viewer developed by the Cape Cod Commission (http://www.capecodcommission.org/SeaLevelRise/). The model output is a list of point assets vulnerable at 1 - 6 feet of sea level rise. The model also identified portions of route assets that were vulnerable to rising sea levels. Specifically, sections of roads, train tracks, and bus routes, were identified as impassable at 3 and 6 feet of water rise. The list of vulnerable assets was then quality checked by Commission Staff to ensure the accuracy of the data.

This study defined a "critical" transportation asset as either:

- vital to the functioning of the modal transportation network (i.e. maintains the mobility and accessibility function of the network)
- important to the social and economic functioning of the community (i.e. provides access to employment centers or increases connectivity between community components)

This definition of criticality is similar to the one described in a recent study conducted in the Gulf Coast.[9]

AIR TRANSPORTATION

Stakeholders identified the runway as the most important asset to the functioning of the airport because planes cannot land safely without a runway or cleared strip of land. The air traffic

[9] Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2, Task 1: Assessing Infrastructure for Criticality in Mobile, AL, U.S. Department of Transportation, September 2011, FHWA-HEP-11-029

control tower was ranked second and the passenger terminal was identified as the third most important asset.

Stakeholders identified the Barnstable Municipal Airport as a critical airport on Cape Cod. It is the third busiest commercial airport in Massachusetts, behind Logan Airport and Nantucket Airport. Barnstable Municipal Airport plays an important role in the community; it provides access to, from and within the region, all-season emergency transportation, and full-time jobs to area residents. The present study used emplanement and employment data to quantitatively assess criticality of the airport. In 2013, the airport had over 85,000 emplanements (the number of people departing on a commercial aircraft) and provided over 2,000 jobs. For comparative purposes, Provincetown Municipal Airport had 11,288 emplanements and generated 343 jobs. It is important to note that the Provincetown Municipal Airport is also critical, but stakeholders ranked it under the Barnstable Municipal Airport because there is no control tower and it has less emplanements.

HIGHWAY TRANSPORTATION

Highway stakeholders classified Routes 6, 6A, 28, 132 and Woods Hole Road as critical to the functioning of the highway network and to the community of Barnstable County. Urban Principal Arterial Roads, Willow Street and Route 134 were also considered critical. This study used AADT (Annual Average Daily Traffic) from 2013 to quantify network criticality. Routes 6, 28 and 132 have higher AADT than other roads on the Cape. Routes 6, 28, and 132 were considered important to the connectivity of Cape Cod because they provide access to town economic centers, villages, town facilities and emergency shelters. While Route 6A has a lower AADT than other roadways, stakeholders identified it as critical because it provides access to village centers across several towns in Barnstable County. Woods Hole Road has a lower AADT than other roadways on the Cape, but it is considered critical because it provides access to village centers and technology hubs located in Woods Hole, such as the Woods Hole Oceanographic Institution, ferry service to Martha's Vineyard the Steamship Authority, the National Marine Fisheries Service and U.S. Coast Guard.

RAIL TRANSPORTATION

Stakeholders identified the railroad bridge as the most critical asset to the functioning of the rail transportation system. The railroad bridge provides the only entry/exit point for trains in Barnstable County. The Yarmouth Line was identified by stakeholders as the second most critical asset because it carries more freight and passengers than the Otis line. The Otis line was also identified as critical because it carries over 35,000 tons of solid waste off of Cape Cod each year.

SEA TRANSPORTATION

Stakeholders identified navigational aids (bells and buoys) as the primary critical asset to the functioning of the ferry system. These instruments are located in coastal waters and provide

directional assistance to ferries coming into port. Ferry slips were ranked as the second most critical asset, the passenger terminal as third, and passenger parking lots as fourth.

Stakeholders considered the Steamship Authority, which operates out of Woods Hole and Hyannis, as highly critical to the network and community of Cape Cod. In 2013, the Steamship Authority ferry service carried over 2 million people, over 450,000 automobiles, and over 162,000 other vehicles (including trailers, pickups, vans, buses, campers, trucks of all sizes) between Cape Cod and the Islands. The Island Queen, which provides ferry service between Falmouth and Oak Bluffs, was also identified by stakeholders as a critical asset because it is one of the larger ferry services out of Falmouth with a 100+ occupancy. Stakeholders also ranked Patriot Party Boats as critical. This ferry service is small with a <40 person occupancy, but it is vital to the island communities since it runs early in the morning bringing over commuters and freight.

TRANSIT TRANSPORTATION

The Cape Cod Regional Transit Authority (CCRTA) is unique compared to other modes of transportation in Barnstable County because it offers two types of services: fixed route services and on-demand services. The demand response line, called the DART bus, provides 1100 rides per day and operates on every roadway on Cape Cod, including dirt roads. The DART bus is highly critical to the functioning of the community because it provides transportation to those with limited mobility options.

Stakeholders identified the fixed route H_2O Line and the Sealine as highly critical route assets in Barnstable County. Within the CCRTA network, the H_2O Line and Sealine are the most robust services, carrying 155,717 and 132,406 people, respectively. Transit stakeholders also identified Routes 6, 28, 132, 134, and Woods Hole Road as highly critical to the operation of the CCRTA buses. There are several transportation hubs located throughout the Cape; the largest is located in Hyannis. Stakeholders identified the Hyannis hub as highly critical to the transit system because it is used by CCRTA, Plymouth & Brockton, Peter Pan, and the Steamship Authority Shuttle.

VULNERABILITY TO SEA LEVEL RISE

All point assets identified in this study were run through the Cape Cod Commission's Sea Level Rise Viewer to determine whether the assets were submerged at 1 - 6 feet of water rise. Figure 2 shows the transportation assets that are vulnerable to sea level rise in Barnstable County and Figure 3 shows how many vulnerable assets are located in each town.

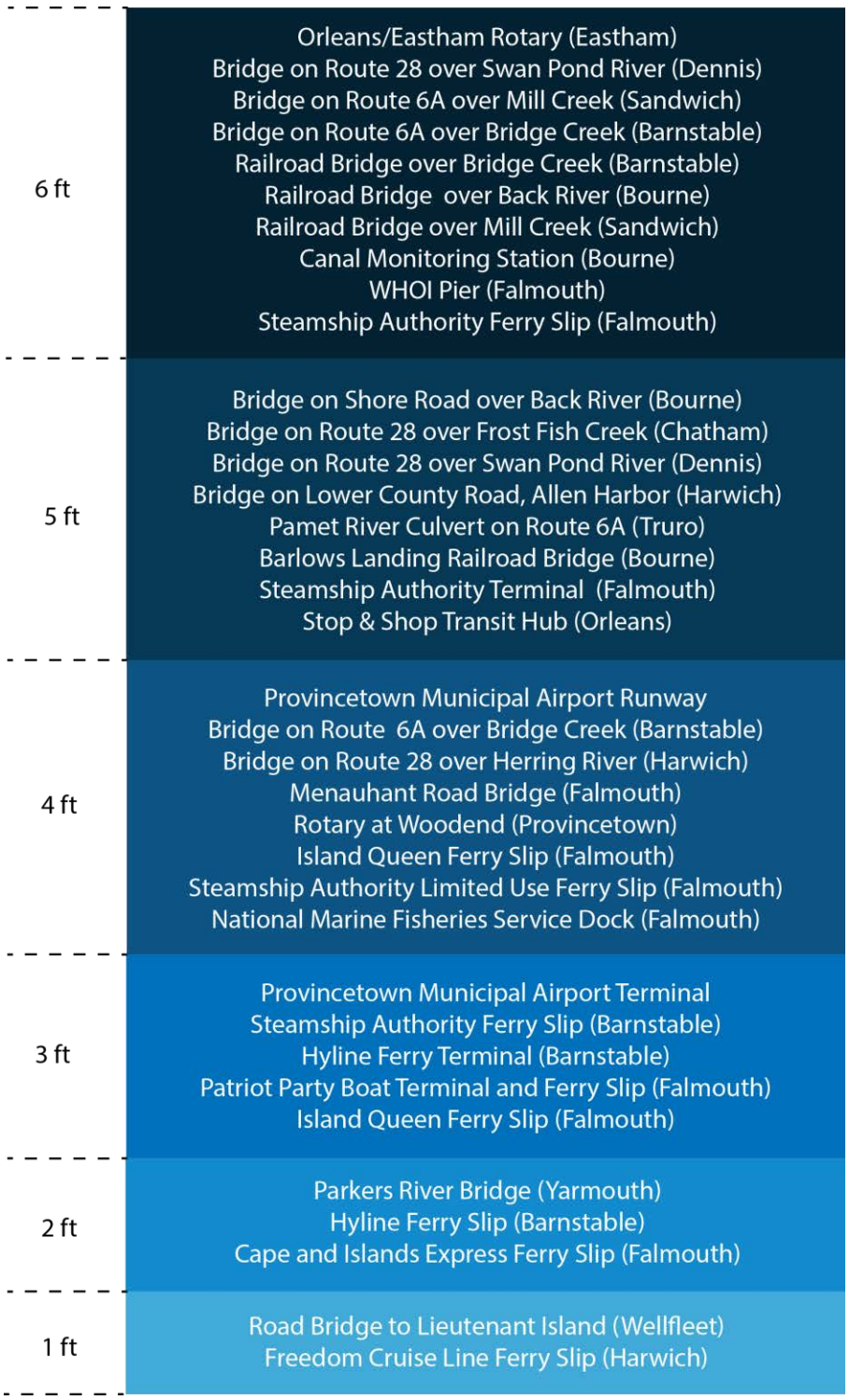

FIGURE 2. TRANSPORTATION POINT ASSETS THAT ARE VULNERABLE TO 1-6 FEET OF SEA LEVEL RISE

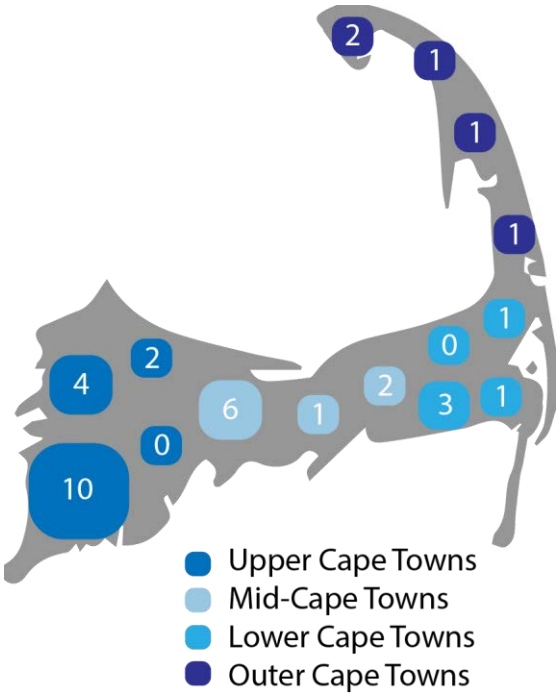

FIGURE 3. VULNERABLE TRANSPORTATION POINT ASSETS BY TOWN

The Sea Level Rise Viewer also identified areas of roads and track that are vulnerable to 3 and 6 feet of water rise. Figure 4 and Figure 5 show areas of impassable roadways at 3 feet and 6 feet of rise, respectively. Figure 6and Figure 7 highlight portions of transit routes that are impacted at 3 feet and 6 feet of water rise, respectively. Figure 8 shows the portions of track that will be submerged at 6 feet of water rise. According to the Cape Cod Commission's Sea Level Rise Viewer, track lines are not vulnerable at 3 feet of sea level rise; although stakeholders reported seeing water in the rail ballast during full moon high tides.

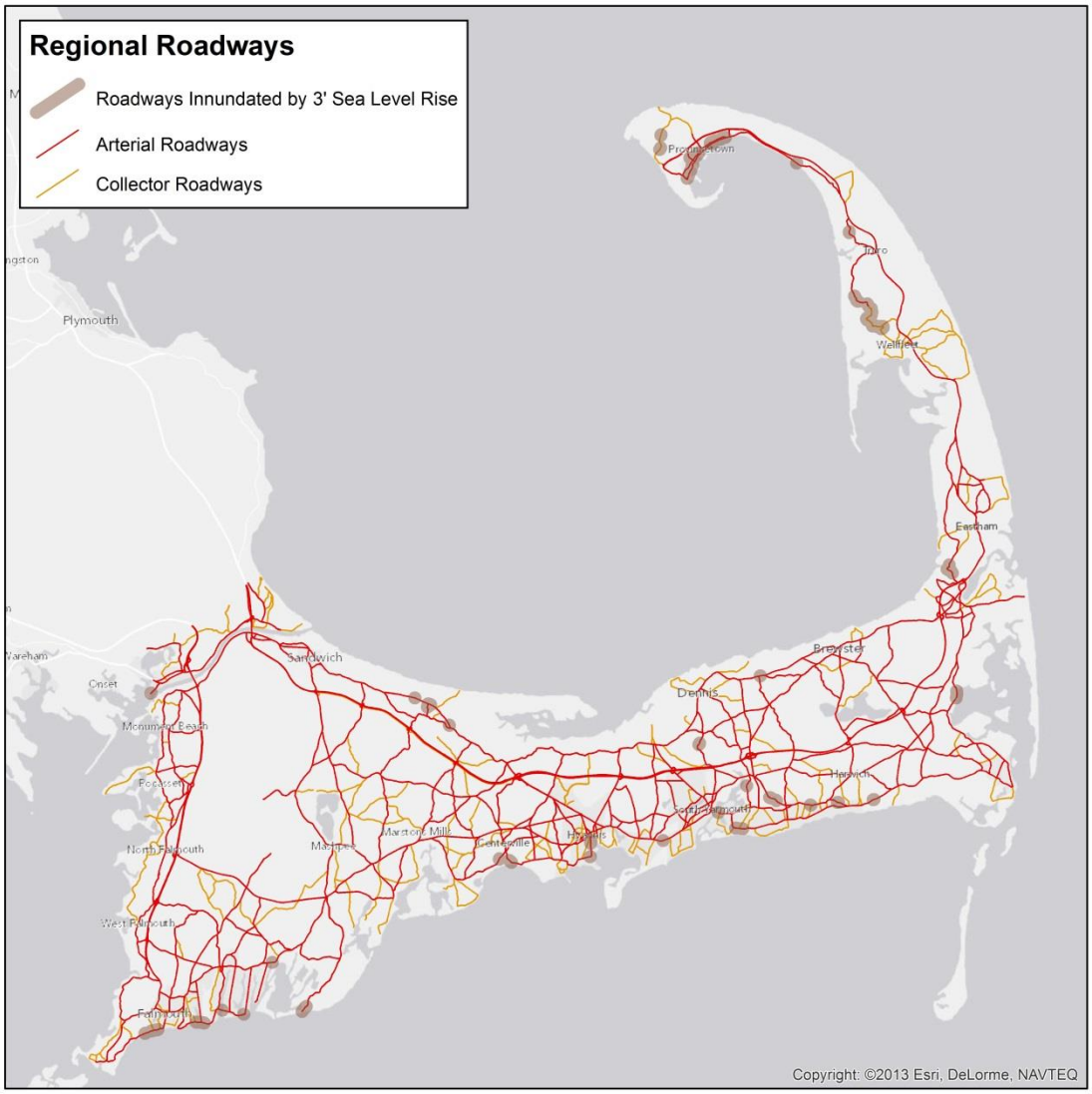

FIGURE 4. SUBMERGED REGIONAL ROADWAYS AT 3 FEET OF SEA LEVEL RISE

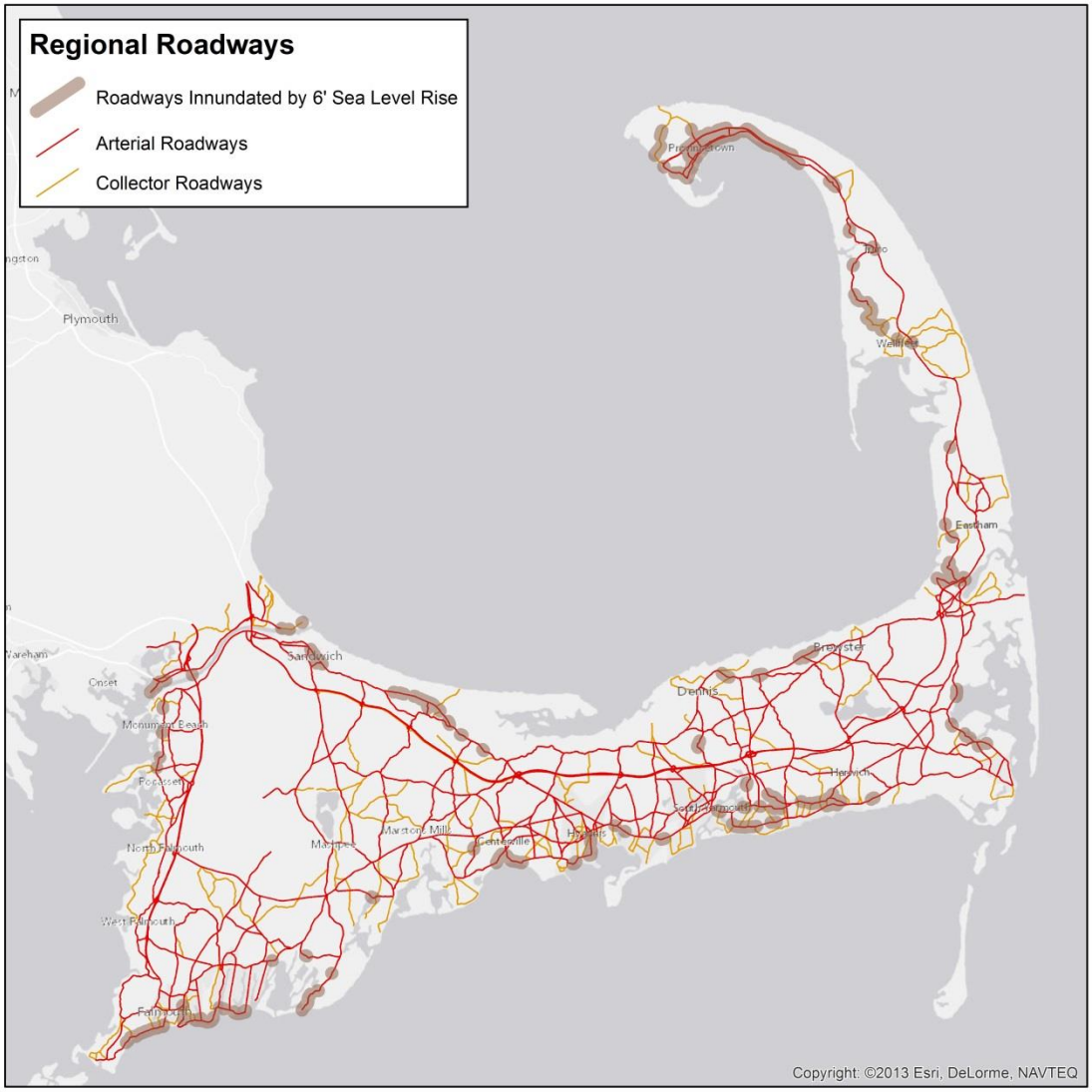

FIGURE 5. SUBMERGED REGIONAL ROADWAYS AT 6 FEET OF SEA LEVEL RISE

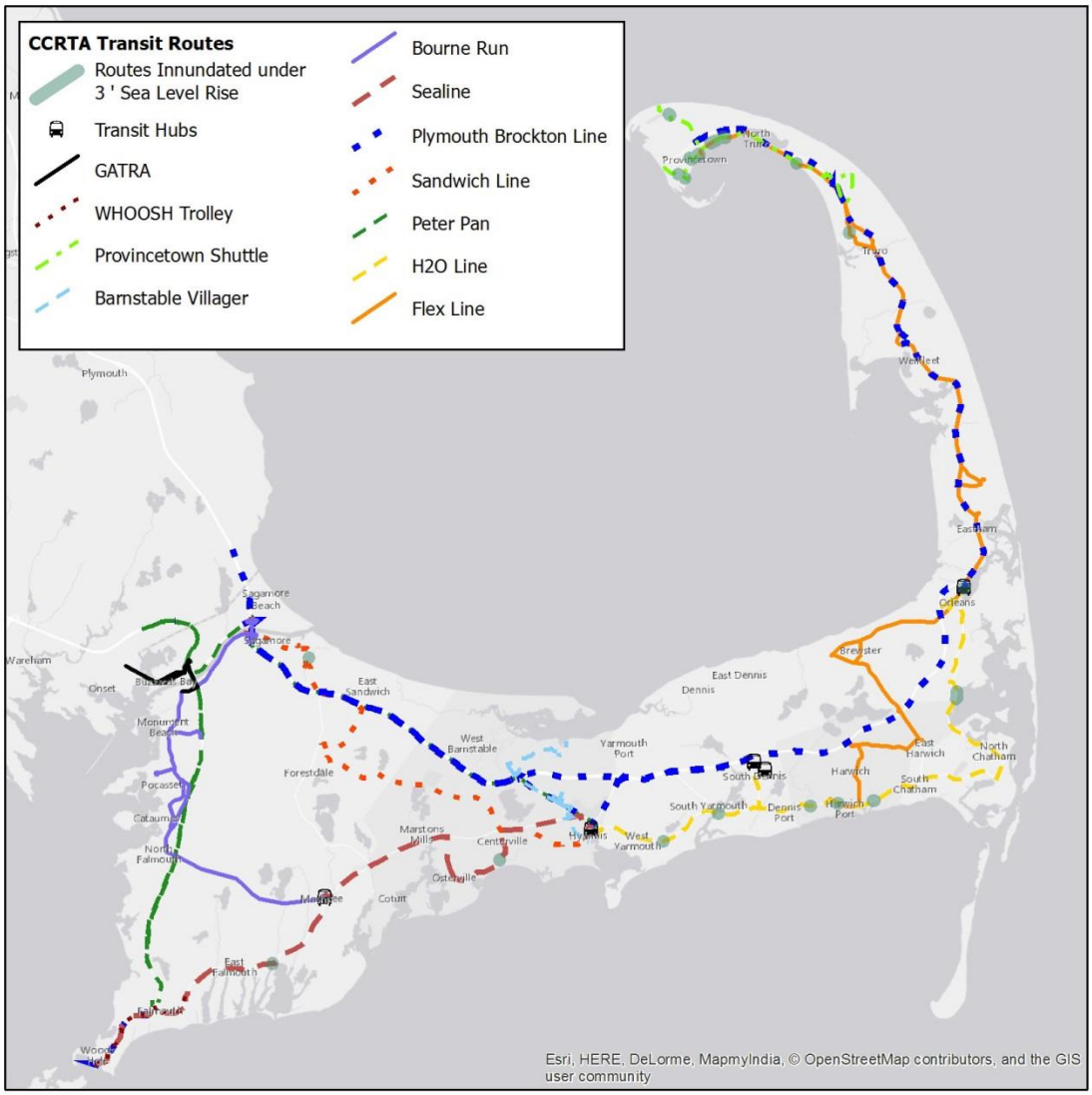

FIGURE 6. SUBMERGED TRANSIT ROUTES AT 3 FEET OF SEA LEVEL RISE

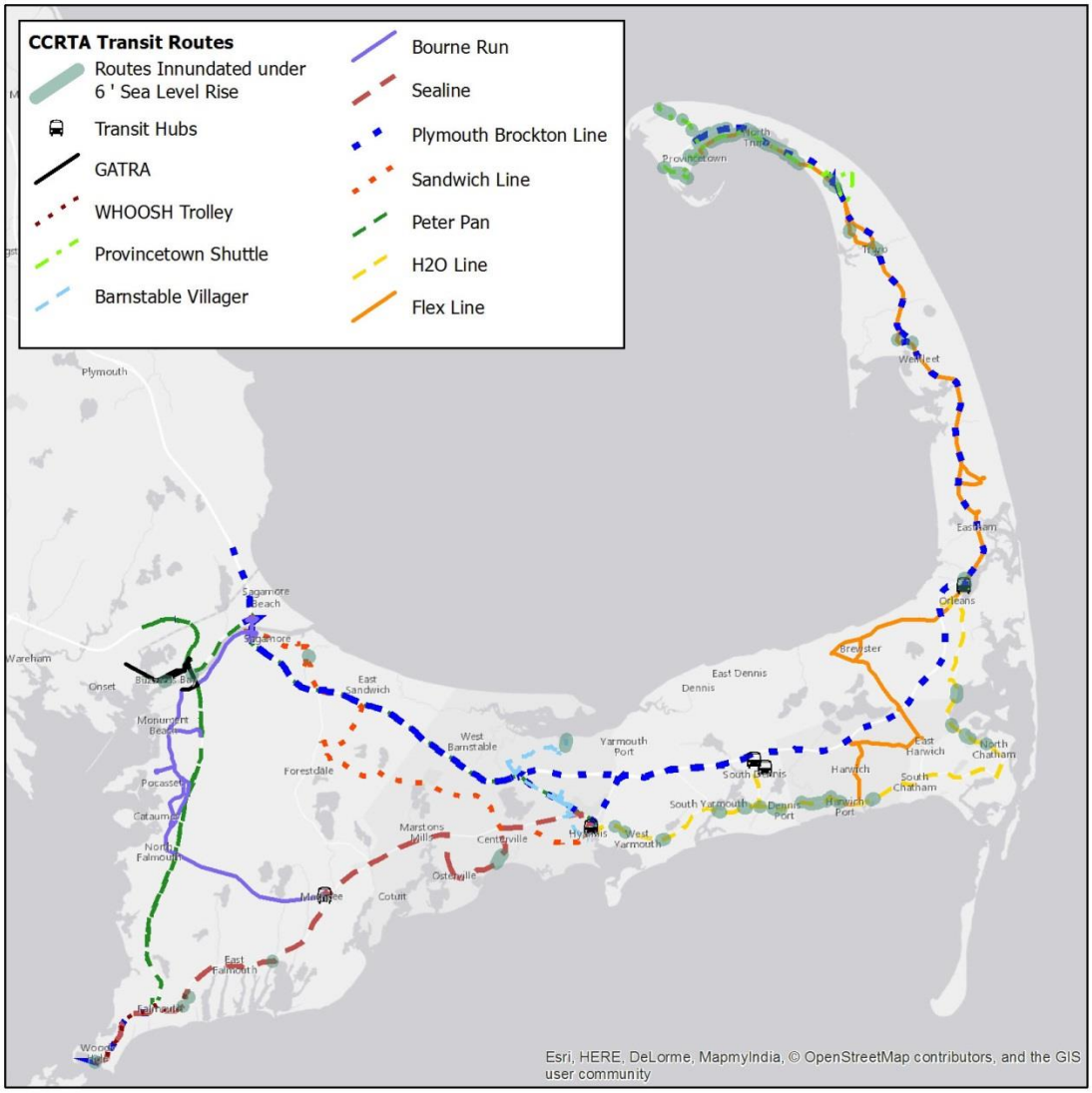

FIGURE 7. SUBMERGED TRANSIT ROUTES AT 6 FEET OF SEA LEVEL RISE

FIGURE 8. SUBMERGED TRACK AT 6 FEET OF SEA LEVEL RISE

The data collected in this study shows that Cape Cod has many transportation assets that are vulnerable to sea level rise (Figures 5-11). During the drafting of this report, MassDOT announced they are constructing a dynamic sea level rise model for the coastline of Massachusetts. While the Cape Cod Commission's Sea Level Rise Viewer is an excellent first-step, the dynamic model generated by MassDOT will be more accurate in predicting asset vulnerability. Given the number of assets vulnerable to sea level rise on Cape Cod; it is critical that this dynamic model become available to Planning and GIS Staff in Barnstable County as soon as possible. Commission staff and several Barnstable County Commissioners advocate that MassDOT construct the model starting with the southern coastline of Massachusetts.

This study identified several transportation assets that are both vulnerable to sea level rise and critical to the community and the transportation network, including:

- AIR: The runway and passenger terminal at the Provincetown Municipal Airport will likely be submerged at 3 - 4 feet of sea level rise. This asset was also identified as vulnerable in the UPWP 2.5 Report from 2013.
- HIGHWAY and TRANSIT: The Orleans/Eastham Rotary on Route 6 will likely be submerged at 6 feet of sea level rise. Once this asset is submerged, the Outer Cape will essentially become an island, completely isolating Route 6 in Eastham, Wellfleet, Truro and Provincetown from other regions. When the Rotary becomes submerged, both Highway and Transit infrastructure will be affected.
- RAIL: Portions of the Yarmouth rail line in Sandwich will likely be submerged at 6 feet of water rise. In this area, the track traverses marsh areas in the Town of Sandwich. This site was also identified as vulnerable in a report generated by the Provincetown Center for Coastal Studies[10].
- SEA: The Steamship Authority ferry slip in Barnstable will likely be submerged at 3 feet of sea level rise.

RESTORING RIVER AND STREAM CONTINUITY[11]

Where roads, rail lines, and bike paths cross freshwater streams and tidal creeks, a bridge or a culvert stream crossing carries the waterway underneath. Stable, appropriately-sized stream crossings maintain the natural hydrology and ecology of rivers and tidal wetlands. Stream crossings that are improperly sized or placed, however, often negatively impact river and stream ecosystems. To maintain healthy conditions, rivers and tidal creeks must be able to convey water, sediment, and organic material without artificial restriction, and allow fish and wildlife to move through unimpeded. When stream crossings are undersized or improperly placed, water flow and wildlife are disrupted and habitats can become degraded.

Well-designed crossings not only enhance habitat for fish and wildlife but also improve infrastructure resiliency during storms and floods. Over the last 40 years, floods and severe storms have become more frequent in New England. Climate change predictions suggest that this trend will continue. Research by The Nature Conservancy, UMass-Amherst, and others has demonstrated that undersized crossings are more likely to fail during large storms. In addition, a recent study commissioned by the Massachusetts Division of Ecological Restoration (DER) found that proactively upgrading deficient crossings to meet stream crossing standards can be more cost-effective over a 30 year period than maintaining the existing structures. Significant

[10] A Proposal to Assess Inundation Vulnerability of CCRTA Rail Infrastructure to Coastal Flooding Associated with Tides, Storms and Sea Level Rise, prepared by the Provincetown Center for Coastal Studies

[11] Information in this provided by Mr. Hunt Durey of the Massachusetts Division of Ecological Restoration, replicated with permission

long-term savings can be realized by reducing repair costs and preventing storm damage caused by road and culvert failures.

Over the past decade, resources have been developed to help transportation planners assess, prioritize, and upgrade stream crossings to protect and improve environmental health. To help identify tidal stream crossing replacement needs, towns and other partners have developed an inventory of tidal restrictions that can be obtained by contacting the Association to Preserve Cape Cod[12]. DER, UMass-Amherst, the Nature Conservancy, and others have also developed a series of tools and trainings to help communities locate and assess non-tidal stream crossings and replace undersized crossings with improved structures. More information is available at the Stream Continuity website[13]. UMass has also developed data that prioritizes road-stream crossings by ecological importance. These data are available at the Critical Linkages website.[14]

The following sections summarize the impacts of transportation infrastructure on rivers and tidal systems and propose Cape Cod RTP objectives to protect and restore river and stream continuity.

TIDAL STREAM CROSSINGS

Culverts and bridges that are too small to pass the full tidal range are known as tidal restrictions, and their impacts can be severe. Many stream crossings on Cape Cod restrict tidal flow. By limiting tidal flow, restrictions alter water levels and chemistry, diminish exchange of ocean nutrients, and can degrade entire upstream aquatic systems. Tidal restrictions often impair water quality, block the passage of fish and other aquatic life, and impede a marsh's ability to build elevation in response to sea level rise. They may also create favorable conditions for invasive species such as *Phragmites australis*. When properly designed, replacing a tidally-restrictive crossing with a larger culvert or bridge restores the natural tidal flow needed to sustain healthy tidal wetland habitats.

FRESHWATER STREAM CROSSINGS

Undersized or improperly placed crossings impact natural stream processes and prevent fish and wildlife from moving about the watershed. Streams and rivers are long, linear ecosystems that connect and nourish wetlands and other aquatic habitats. Small streams carry water, sediment, and organic material downstream into larger rivers that discharge into estuaries and the ocean, creating an interconnected and interdependent system of aquatic life. Fish and wildlife use rivers as migration corridors. Fish such as river herring and Eastern brook trout need to access different parts of the watershed at different points in their life cycles.

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12 http://www.apcc.org/
13 http://www.streamcontinuity.org/index.htm
14 http://www.umasscaps.org/applications/critical-linkages.html

Amphibians such as salamanders, turtles, and frogs spend much of their lives near streams and travel near and along a stream's length.

Stream crossings can disrupt stream continuity and impact freshwater ecosystems in the following ways:

- Undersized crossings restrict water flow, particularly during storms. These crossings may contribute to extensive channel scour, bank erosion, flooding, and crossing failure. Undersized crossings may be too small, and the flow may be too fast, to pass fish or wildlife.
- Shallow crossings have water depths that are too shallow for fish and other aquatic life to migrate through.
- Perched crossings have an outlet that is elevated above the level of the stream bed at the downstream end. Perched crossings block fish and wildlife from moving upstream.

CURRENT REGULATIONS

Massachusetts developed Stream Crossing Standards for freshwater streams to protect and restore aquatic habitats and fish and wildlife populations. The MA Wetlands Protection Act and Water Quality Standards now require that all new crossings meet the Standards. Existing crossings that are being repaired or replaced must also meet the Standards to the maximum extent practicable. See this handbook for more information on the Standards.[15]

OBJECTIVES TO PROTECT AND RESTORE RIVERS AND TIDAL SYSTEMS

The following objectives will help reduce the impacts of transportation stream crossings on the natural environment while also contributing to the resiliency of coastal communities facing climate change.

<u>Objectives for the restoration and protection of freshwater river and stream continuity</u>

- Assess existing freshwater stream crossings for stream habitat continuity using the Massachusetts Stream Continuity Assessment Protocol.[16] Contact DER[17] for additional information about assessment approaches and resources.
- Proactively replace deficient freshwater crossings with those that meet the optimal stream crossing standards at sites identified by the Critical Linkages data as having high ecological importance.
- When freshwater stream crossings require significant maintenance or replacement, upgrade with structures that meet the stream crossings standards.
- When designing new or replacement stream crossings, use current precipitation data such as that available at http://precip.eas.cornell.edu/. Data from older sources such as TP-40 may no longer be accurate and can significantly under-predict the amount of rainfall generated by storm events.

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[15] http://www.mass.gov/eea/docs/dfg/der/pdf/stream-crossings-handbook.pdf
[16] http://www.streamcontinuity.org/assessing_crossing_structures/index.htm
[17] http://www.mass.gov/eea/agencies/dfg/der/

To date, few freshwater stream crossings on Cape Cod have been field evaluated for stream continuity. The Critical Linkages Project[18] identifies the locations of road-stream crossings and predicts the relative ecological importance of each crossing. The Critical Linkages data set can be used as a tool to locate crossings and prioritize their field assessment and replacement.

Freshwater Stream Crossing Highlight

The Route 6 crossing over Fresh Brook in Wellfleet has been identified as a barrier to fish and wildlife passage. Fresh Brook has been identified by the MA Division of Fisheries and Wildlife and others as a high priority for ecological restoration, as it is one of the only coldwater streams in the Outer Cape. Any work on Route 6 in the vicinity of this crossing should evaluate the potential of installing a larger culvert that meets stream crossing standards.

Objectives for the restoration and protection of tidal systems:

- When replacing crossings on tidal creeks, evaluate the need for, feasibility of, and potential benefits of installing crossings that restore passage of the full natural tidal flow (Table 4).
- Provide financial support for ongoing tidal restoration projects that have already been evaluated for restoration potential and have Town and partner support (Table 5).

The following tidal crossings have been identified by DER and others as sites for further evaluation for restoration potential. DER, the Towns, or other partners may have data and plans for many of these sites but may not have initiated a tidal restoration project yet, and potential costs have not yet been determined. Any planned road, bridge, or culvert work at these sites provides an opportunity to evaluate the degree to which tidal hydrology is currently restricted and to assess the feasibility and cost of installing an upgraded crossing that restores natural tidal flow.

[18] http://www.umasscaps.org/applications/critical-linkages.html

TABLE 4. TIDAL CROSSINGS FOR FURTHER EVALUATION AND POTENTIAL REPLACEMENT

TOWN	LOCATION (LAT. LON.)	ATLAS ID	DESCRIPTION	POTENTIAL ACRES OF TIDAL WETLAND RESTORATION
Barnstable	Lat 41.701171 Lon -70.352397	BA-4	Penn Central Railroad restriction of Brickyard Creek	8.5 acres
Barnstable	Lat 41.703529 Lon -70.288247	BA-6	Commerce Road restriction of Maraspin Creek	5 acres
Barnstable	Lat 41.639179 Lon -70.361022	BA-12	Bay Lane restriction of unnamed channel off Bumps River	10 acres
Chatham	Lat 41.667230 Lon -69.966274	CH-5	Stage Harbor Road restriction of Champlain Creek	5 acres
Chatham	Lat 41.702256 Lon -69.969693	CH-6	Route 28 restriction of Frost Fish Creek	42 acres
Harwich	Lat 41.677695 Lon -70.098274	HA-4	Lothrop Road restriction of a tributary to the Herring River.	14 acres
Truro	Lat 41.993728 Lon -70.050225	TR-3	Route 6A Restriction of Pamet River	150 acres (Inclusive of TR-4)
Truro	Lat 41.993551 Lon -70.048038	TR-4	Route 6 Restriction of Pamet River	150 acres (inclusive of TR-3)
Truro	Lat 42.050591 Lon -70.116993	TR-6	Route 6A and Route 6 obstruction of Pilgrim Lake	300 acres
Wellfleet	Lat 41.91435 Lon -69.987383	WE-3	Route 6 Restriction of Blackfish Creek	17 acres
Yarmouth	Lat 41.707358 Lon -70.249647	YA-3	Thacher Shore Road restriction of Short Warf Creek	4 acres
Several sources of information were used to inform the list above including: the 2001 Cape Cod Atlas of Tidally Restricted Marshes prepared by the Cape Cod Commission, the 2008 Atlas Update prepared by DER, the Cape Cod Conservation District (CCCD) Cape Cod Water Resources Restoration Project List, and the draft update to the Cape Cod Water Resources Restoration Plan currently under development by the CCCD, Association to Preserve Cape Cod, and MassBays Program.				

The tidal restoration projects listed in Table 5are actively in development, have Town support, partner interest, significant data, and in some cases feasibility or design-level information, but are in need of funding.

TABLE 5. ONGOING TIDAL CROSSING REPLACEMENT PROJECTS WITH HIGH RESTORATION BENEFIT

TOWN	TITLE	DESCRIPTION	ESTIMATED COST
Truro	Mill Pond	Mill Pond in Truro has been severely degraded by a tidal restriction beneath Mill Pond Road for over 150 years. The project will restore tidal flow to this 13-acre system and will benefit shellfish and finfish species while encouraging a more natural wetland plant community.	$750,000
Truro	Eagle Neck Creek	Eagle Neck Creek is a 16-acre degraded tidal marsh that flows into Pamet Harbor and Cape Cod Bay. A road and culvert crossing the creek obstruct tidal flushing of the system. The project will remove the tidal restriction to restore salt marsh functions and benefit associated shellfish, finfish, and other coastal wildlife.	$1 Million
Wellfleet	Mayo Creek	Mayo Creek is a 30-acre tidal restoration opportunity. By re-establishing tidal flow, this project will reduce invasive plant growth, improve water quality for shellfishing, and enhance fish and wildlife habitat. The Town is evaluating options for providing town water and sewer to area residents to address concerns about salt water intrusion.	$500,000
Harwich	Cold Brook	Restoration of Cold Brook will transform 66-acres of retired cranberry bogs into a diverse, self-sustaining fresh and brackish wetland. The site is located at the head of tide, and culverts under Hoyt Road and Route 28 limit tidal exchange. Increasing the hydraulic capacity of these two crossings would promote tidal restoration today and future marsh migration in response to sea level rise.	$1.5 Million
Wellfleet	Herring River	This project will replace the Chequessett Neck Road Dike with a bridge and water control structures to restore tidal flow to the 1,000-acre Herring River Estuary. Other restrictions to tidal flow will also be removed or modified.	$44 Million

Tidal River Crossing Highlight

Listed in Table 5, the Herring River Estuary Restoration Project[19] in Wellfleet and Truro is the largest, highest priority estuary restoration in the Northeastern United States. Restoration of tidal flow to this river and adjacent wetlands will generate significant social, environmental, and economic benefits. The project is currently developing engineering designs and proceeding through multiple environmental reviews. Construction is anticipated to commence in the 2018-2020 timeframe and significant funding will be needed to cover the estimated $40-$50 million construction cost.

[19] http://www.mass.gov/eea/docs/dfg/der/pdf/herringriver-project-sheet.pdf

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CAPE COD COMMISSION

3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

CAPE COD
COMMISSION

2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix I: Stormwater Management

Draft
June 15, 2015

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Technical Appendix I: Stormwater Management

Stormwater runoff is caused by precipitation from rain and snowmelt events which flow over land or impervious surfaces and is unable to percolate into the ground. In natural systems, precipitation may be directly infiltrated subsurface, stored in natural depressions, or reintroduced to the atmosphere through evapotranspiration. However, development such as buildings, roads, sidewalks, and paved driveways increases impervious surface area and alters natural hydrology. The increase in impervious cover that accompanies development results in two main issues related to stormwater: 1) greater volume and peak flows of runoff and 2) transportation of contaminants into water bodies.

In natural ecosystems, runoff is infiltrated into groundwater and discharged to freshwater streams, ponds, lakes, rivers and marine estuaries. Flooding is less significant in these natural systems because greater volumes of stormwater are able to infiltrate through the soil, passing it from the surface to the groundwater. In urbanized areas, dense impervious cover reduces the amount of infiltration that can occur. The increase in stormwater runoff volume results in increased ponding, flooding, and hydroplaning potential on roadways, which makes roadways unsafe for travel.

Stormwater runoff flushes pollutants and debris from impervious areas and discharges them in to local waterways. Common pollutants found in stormwater runoff include oil; grease and metals from vehicular traffic; salts and other deicing agents used to maintain safe roadway operation under winter weather conditions; pesticides and fertilizers from landscaping activities; sediments from various activities; altered water temperatures and litter. When conveyed by stormwater runoff these pollutants impair waterways, degrade natural habitat, pollute groundwater, increase flooding, cause erosion of streambeds or siltation of waterways, and decrease the amount of water recharged to aquifers. Transported by stormwater runoff, pollutants find their way into the ground and surface waters throughout Cape Cod. These waters with increased pollutant loads ultimately discharge to coastal embayments.

STORMWATER MANAGEMENT CHALLENGES ON CAPE COD

What makes Cape Cod a unique area for stormwater management is the combination of highly porous native soils left by the retreating glaciers and shallow groundwater levels, which are especially prevalent in coastal communities. Well-drained soils readily infiltrate runoff, providing excellent volume reduction of stormwater. However, the combination of highly permeable soils and a high water table results in rapid infiltration of contaminated stormwater runoff in to the groundwater. Because groundwater on Cape Cod travels towards nutrient-sensitive coastal embayments, the quality of stormwater runoff is a concern.

Where most efforts to manage stormwater focus on moving the volume of water off roadways, stormwater management on Cape Cod also requires addressing the quality of stormwater that infiltrates to the Cape's groundwater (drinking water) resources and the Cape's coastal estuaries.

STORMWATER AND DRINKING WATER PROTECTION

Drinking water on Cape Cod is provided by a sole source aquifer and because of the hydrogeology of Cape Cod, the aquifer is sensitive to stormwater runoff. Areas of land that receive precipitation to recharge drinking water wells are called Wellhead Protection Areas (WPAs). Stormwater management is particularly important in these areas because contaminated stormwater runoff can potentially contaminate drinking water supply. Because of this threat, WPAs have specific regulations in place to protect the Cape's drinking water supply. Potential Water Supply Areas (PWSAs) have also been identified on Cape Cod to ensure consideration and possible protection of suitable land for drinking water wells. WPAs and PWSAs are mapped water resources areas in the Cape Cod Commission's Regional Policy Plan (RPP) and have specific regulatory review standards.

TMDLS AND IMPAIRED WATERSHEDS ON CAPE COD

The allowable load of a particular contaminant that changes a healthy system to a deteriorating system is defined as a critical threshold, which under the federal Clean Water Act is referred to as a Total Maximum Daily Load (TMDL). TMDLs determine the maximum allowable load of a pollutant to a water body that still enables that water body to meet state water quality standards. Establishing a TMDL includes identifying and quantifying sources of the pollutant of concern (from both point and non-point sources), taking into consideration a margin of safety, seasonal variations, and several other factors. Communities are required to restore impaired surface water bodies where a TMDL is determined. TMDLs are determined for specific pollutants such as nitrogen, phosphorous, and pathogens.

Nitrogen

Coastal embayments are nitrogen-limited systems. Due to the Cape's unique geology, the presence of increased nitrogen loading from development has a particularly significant effect on the nitrogen-limited coastal embayments of Cape Cod. When an excess of nitrogen is introduced to an embayment, changes in the natural ecology will occur. A common result from excess nitrogen loading is eutrophication, which causes overgrowth of plant species (e.g. algae) which often outcompete other life forms resulting in the loss of species diversity and community richness. In some severe cases eutrophication creates anoxic environments resulting in fish kills, loss of eel grass, and aesthetically unpleasant conditions.

Nitrogen sources include septic systems, fertilizer, stormwater, atmospheric nitrogen, sediment nitrogen, and natural background.

As of February 2015, the Massachusetts Estuaries Project has studied 36 Cape Cod embayments. Of the 36 studied embayments, 32 are considered "impaired" and have a nitrogen TMDL that have been approved by the Massachusetts Department of Environmental Protection (MassDEP) and the U.S. Environmental Protection Agency (EPA). Though the majority of nitrogen reaching the coastal embayments originates from septic systems, a reasonable percentage of all controllable nitrogen sources originate from impervious surfaces (i.e. stormwater). The Waste Load Allocation (WLA) calculations in the Nitrogen TMDLs consider runoff from the entire impervious area within a 200 foot buffer zone around all waterbodies.

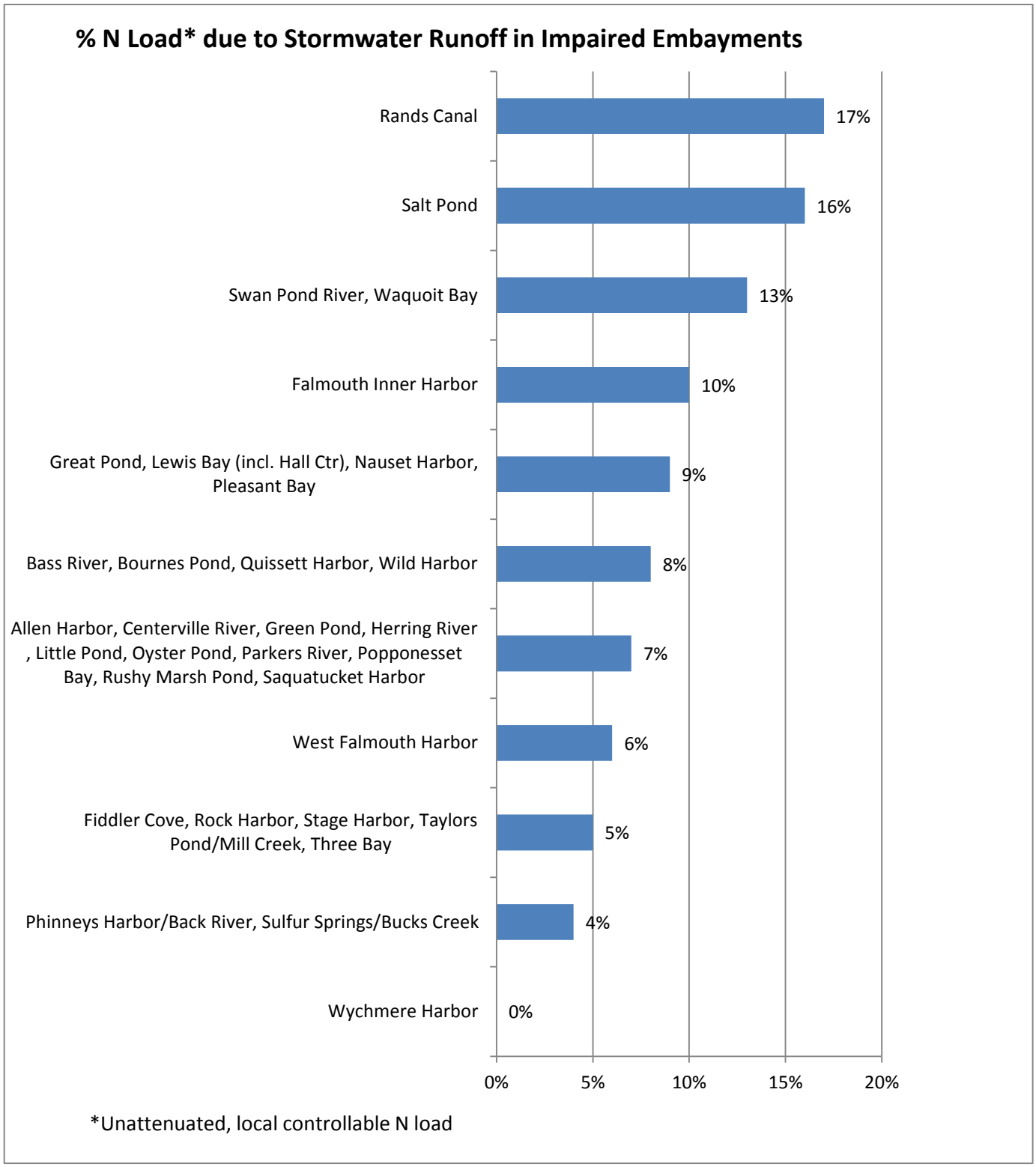
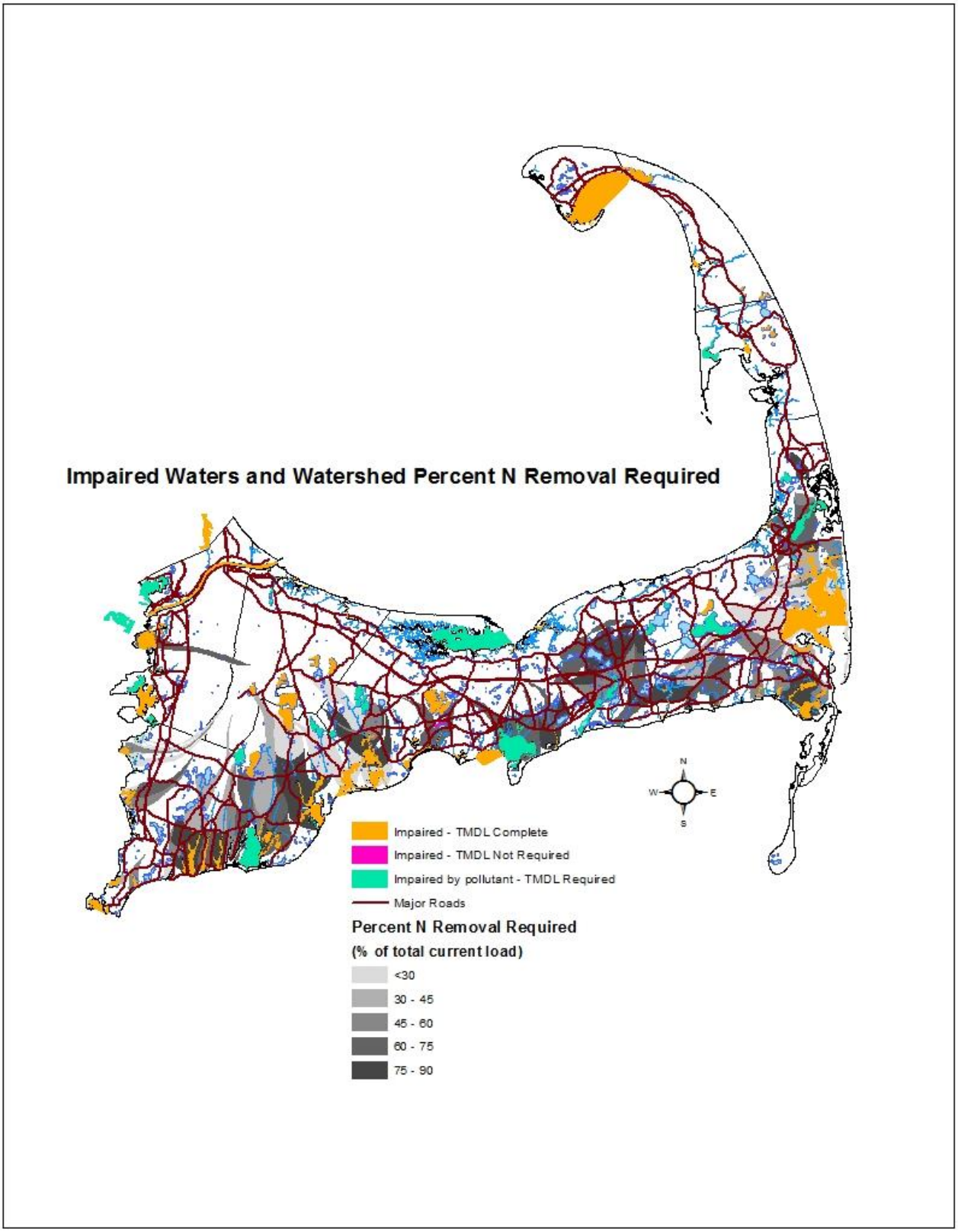


FIGURE 1. STORMWATER RUNOFF NITROGEN LOAD TO IMPAIRED EMBAYMENTS

FIGURE 2 – IMPAIRED WATERS AND % NITROGEN REMOVAL REQUIRED IN SUBEMBAYMENTS



Bacteria

Pathogens can pose a risk to human health due to gastrointestinal illness through exposure via ingestion, contact with recreational waters, and consumption of filter-feeding shellfish. Waterborne pathogens enter surface waters from a variety of sources including sewage, the feces of warm-blooded wildlife, pets, geese, gulls, and illicit discharges of boat wastes. Areas of elevated bacteria levels in Cape Cod watersheds are believed to be primarily from boat wastes, pets, wildlife, birds, stormwater, and failing septic systems. 85% of Cape Cod's watershed populations (residences and businesses) have individual septic systems for disposal of human wastes. Septic system failures or poorly performing systems play an important part to the bacterial contamination throughout the Cape.

Pathogen TMDLs were developed for all Cape Cod Watersheds using fecal coliform as an indicator bacterium for shellfish areas, enterococci for bathing in marine waters, and E. *coli* for fresh waters. Understanding sources of bacteria is essential while selecting appropriate stormwater management strategies.

Pathogen TMDLs exist for 86 pathogen-impaired water body segments on Cape Cod, defined through the following TMDL documents:

- Final Pathogen TMDL Report for the Cape Cod Watershed (49 segments) - 2009
- Addendum to Final Cape Cod Pathogen TMDL Report (17 segments) – 2012
- Final Pathogen TMDL for Buzzards Bay Watershed (14 segments) - 2009
- Final Pathogen TMDL for Three Bays Watershed, Barnstable, MA (4 segments) - 2009
- Bacteria TMDL for Muddy Creek - 2005
- Bacteria TMDL for Frost Fish Creek, Chatham, MA - 2005

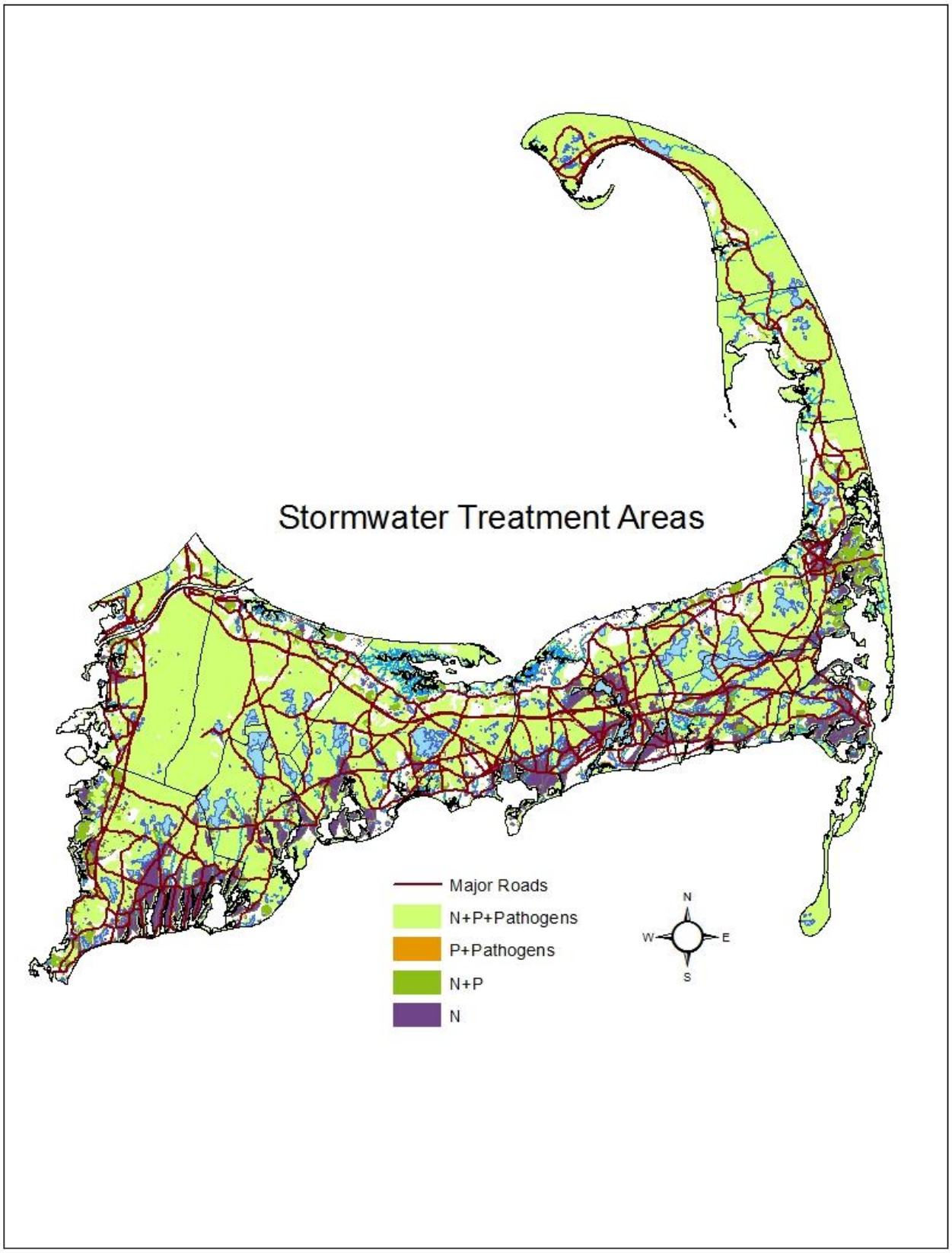
The WLA calculation for the pathogen TMDL assumes a 200-ft buffer zone around embayments as the contributing area for stormwater. According to the Cape Cod Watershed TMDL, data indicate that in general, two to three orders of magnitude (i.e., greater than 90%) reductions in stormwater fecal coliform loading will be necessary, especially in developed areas.

STORMWATER RUNOFF AND SENSITIVE RESOURCE AREAS

The map, below, identifies resource-sensitive areas (and buffers around those areas) that can be sensitive to pollutants in stormwater runoff. The map identifies areas where Nitrogen, Phosphorous, and/or Pathogens could be mitigated in stormwater runoff in order to protect sensitive resources areas on the Cape. Existing roadways and future roadway development should consider treatment of these pollutants in the identified areas.

Because different resource areas are sensitive to certain kinds of pollutants, the table, below, outlines the resources areas mapped and their associated pollutants of concern. Buffer distances around resource areas were chosen by considering where stormwater runoff from roads may impact sensitive natural habitats and are derived from TMDL considerations and the RPP. In general, buffers are required to protect surface water bodies from sedimentation, erosion, and pollution; they are also needed to maintain wildlife habitat. In WLA calculations used for both the Nitrogen and Pathogen TMDLs on Cape Cod, a 200 foot buffer was considered as the contributing area for stormwater runoff. The RPP designates buffer distances around Sensitive Natural Resource Areas (SNRA), where development should be located outside of these buffer zones. Buffers include a 300 foot buffer around ponds, a 350 foot buffer around certified vernal pools, and a 200 foot buffer around rivers.

FIGURE 3 - STORMWATER TREATMENT AREAS



The following table shows the resource areas considered in Figure 3.

TABLE 1 –SENSITIVE RESOURCE AREAS AND ASSOCIATED POLLUTANTS OF CONCERN

Sensitive Resource Area	Notes	Pollutants to Reduce
Watersheds requiring N removal	Indicates to what level watersheds must reduce current nitrogen loading	N
Impaired Waters	Impaired for pollutants (nutrients, metals, pesticides, solids, and pathogens) or impaired for pollution (e.g. low flow, habitat alteration, non-native species infestations). "Impaired" defined by Section 305 (b) and 303 (d) of the CWA.	P, N, Pathogens
Impaired Waters Buffer	300 foot buffer around impaired waters	P, N, Pathogens
Outstanding Resource Waters	Considered a "Critical Area" according to MA Stormwater Standards. Stormwater discharges to Outstanding Resource Waters shall be removed (and set back from the receiving water or wetland) and receive the highest and best practical method of treatment	N, P, Pathogens
WPAs & IWPAs	Considered a: - "Critical Area" according to MA Stormwater Standards. - "Water Quality Improvement Area" in the RPP which have associated minimum performance standards related to nitrogen loading - "Significant Natural Resource Area" according to RPP	N, P, Pathogens
Coldwater Fisheries	200 foot buffer. Overall sensitive habitat that requires maintenance of cold temps and high dissolved oxygen.	P, N, Pathogens
National Heritage and Endangered Species Program (NHESP) Certified Vernal Pool buffers	350 foot buffer required per RPP. Considered a SNRA (per RPP). EPA recommends managing a 1000 foot radius area beyond the edge of a vernal pool basin as vernal pool upland habitat.	P, N
Ponds Buffer	300 feet	P, Pathogens
River Buffer	200 feet	P, N
MassDEP Wetland Areas	Considered a SNRA (per RPP).	N
NHESP Priority Habitats	Considered a SNRA (per RPP).	P, N, Pathogens
Freshwater Recharge Area	Considered a "Water Quality Improvement Area" in the RPP which have associated MPS related to nitrogen loading	P, N, Pathogens
Potential Public Water Supply Area	Considered a SNRA (per RPP).	P, N, Pathogens

CLIMATE CHANGE CONSIDERATIONS IN STORMWATER MANAGEMENT

Recent storm records and predictions for storm activity in the coming years suggest that roadways in New England will trend towards more extreme events. Accordingly, Massachusetts transportation infrastructure should be designed to accommodate higher intensity storm events. The Massachusetts Climate Change Adaptation Report also cites evidence that by 2050, annual precipitation in Massachusetts may increase by 8%, with a winter increase of 16% (accompanied by a decrease in snow days and an increase in winter rain precipitation). These climate predictions suggest that future planning for stormwater management should consider increased volumes of water (and stormwater runoff) on Massachusetts roadways.

DESIGN CRITERIA FOR MANAGING STORMWATER VOLUME

FIRST FLUSH

The Water Quality Volume (WQV) represents the runoff generated by a design depth of rainfall from a given drainage area. This provides a minimum quantity (ft^3) of water to capture and treat for the constituents of concern. To capture the full volume of each rain event would be costly and require large dedicated portions of land. In its essence, the goal of stormwater management is twofold and includes treating contaminated runoff and minimizing flooding issues for the majority of storm events. The WQV calculation guarantees that the most contaminated runoff, or the "first flush," of each event is captured. The first flush typically includes the most polluted runoff of an event as it re-suspends contaminants that have been gathering on impervious surfaces during dry periods. Therefore, guaranteeing the capture and treatment of this initial runoff stream is the most important from a water quality standpoint.

As defined by the Massachusetts Stormwater Design Handbook, the required WQV for the below land use types equals 1.0" of runoff times the total impervious area.

- from a land use with a higher potential pollutant load;
- within an area with a rapid infiltration rate (greater than 2.4 inches per hour);
- within a Zone II or Interim Wellhead Protection Areas (IWPAs)
- near or to the following critical areas:
    - Outstanding Resource Waters
    - Special Resource Waters,
    - bathing beaches,
    - shellfish growing areas
    - cold-water fisheries.

The remaining land use types not listed here require a design depth of 0.5."

For the purposes of this report the WQV is calculated following Equation 1 and is defined below.

Equation 1: WQV Calculation

$$WQV = P * Rv * I * A$$

Where:

P = precipitation (in.)

Rv = unitless volumetric runoff coefficient

I = percent impervious cover draining to structure

A = contributing drainage area to BMP (acre)

GREATER DESIGN FLOOD FREQUENCY

As discussed in the 2011 Massachusetts Climate Change Adaptation Report, addressing the resiliency and adaptability of infrastructure in the face of global climate change is of paramount concern. A 2010 study from the University of New Hampshire discussing trends in precipitation in the Northeastern United States indicates "that the occurrences of extreme precipitation events, and the intensity of rainfall, are increasing." The study shows that annual precipitation has increased since the late 1940's with the largest increases occurring in recent years. Researchers with the University of Massachusetts Boston Environmental, Earth and Ocean Science Department analyzed trends in precipitation from 1954 to 2008. Findings in the study strongly suggest the need for updating design storm estimates in Maine, New Hampshire and Massachusetts.

The table below is an excerpt from Chapter 8 of the Mass Highway Design Manual, 2006 Edition and shows the recommended design flood frequencies for drainage systems by highway functional class. With trends showing an increase in event intensity and frequency, consideration should be taken to use greater design flood frequency values in areas of increased hydroplaning risk.

TABLE 2 – RECOMMENDED DESIGN FLOOD FREQUENCY (EXCERPT FROM MASSHIGHWAY DESIGN MANUAL)

Highway Functional Class	Urban/Rural	Type of Installation		
		Cross Culverts	Storm Drain System[2]	Open Channels[3]
Interstate/Freeway/Expressway	Both	50-yr	10-yr[4]	50-yr
Arterial	Urban	50-yr	10-yr[4]	50-yr
	Rural	50-yr	10-yr[4]	50-yr
Collectors/Local	Urban	25-yr[5]	5-yr	25-yr[5]
	Rural	10 or 25-yr	2 or 5-yr	10 or 25-yr

1. The values in the table are typical ranges. The selected value for a project is based on an assessment of the likely damage of a given flow and the costs of the drainage facility.
2. This includes pavement drainage design.
3. This includes any culverts which pass under intersecting roads, driveways, or median crossings.
4. Use a 50-yr frequency at underpasses or depressed sections where ponded water can only be removed through the storm drain system.
5. The selected frequency depends on the anticipated watershed development and potential property damage.

Source: HEC #1, March, 1969. Design of Highway Pavements, pp. 12-5 to 12-6. Note: HEC #12 — Revised, March, 1984.

Note: 100-year requirements must be checked if the proposed highway is in an established regulatory floodway or floodplain, or resource area is defined by the April, 1983 revisions to Ch. 131 MGL, Section 40. See Section 10.1.2.

PAVEMENT CROSS SLOPE AND EXPANDED SHOULDER

Providing adequate cross slope on a roadway surface and expanding the road shoulder are effective ways to manage runoff. Assuming shoulders are properly sloped to drain away from pavement, both help convey design runoff from driving lanes. Because adjusting roadway cross slopes is expensive and results in significant disruption to vehicular travel, such an approach would be considered only if a segment of roadway was already slated for reconstruction and resources like historic character and critical vegetation would not be damaged with inclusion of an expanded shoulder.

MINIMIZE DRAINAGE PATH LENGTHS

Long downhill grades where water is channelized through raised shoulders or berms increases stormwater velocity and quantity until release points are reached, such as a curb cut or a curve transition where flow turns to sheet flow across the roadway. As drainage path lengths increase, the effects of channelization are compounded. By minimizing drainage path lengths through frequent curb cuts, runoff velocity, volume, and associated ponding are minimized. Catch basins, while a useful management tool for overall runoff reduction, should not be relied upon to minimize drainage path lengths. Due to improper placement, clogging and infrequent maintenance, catch basins are often unable to capture design volumes on busy roadways.

CURBING AND BERMING

Curbing is primarily used at the outside edge of pavement to contain surface runoff within the roadway and away from adjacent properties. Secondary and tertiary benefits of curbing include the prevention of slope erosion, roadside delineation, and pedestrian sidewalk protection.

In many instances, preventing runoff from exiting the road surface is an important goal when large quantities of runoff have the potential to affect adjacent property owners and protected natural resources. However, curbing and berming may be unnecessary in areas where there are sufficient median and adjacent rights of way to capture roadway runoff. Where there is sufficient land area to capture roadway runoff excess curbing and berming may be an unnecessary preventative measure and counterproductive when attempting to minimize the potential for hydroplaning. Intermittent or complete removal of curbing and berms in applicable areas will reduce runoff build up and minimize drainage path lengths.

When combined with a properly designed cross slope, the complete removal of curbing and berms will promote country drainage and have minimal risk for slope erosion. Where curbing and berming must remain, drainage pathways should still be minimized by frequent curb cuts. Curb cuts capturing runoff from large drainage areas and long drainage path lengths must account for the increased energy and velocity of runoff to prevent erosion. This may be accomplished through a variety of energy dissipaters such as vegetated filter strips, riprap aprons and riprap outlet basins. Curb cuts capturing runoff within nitrogen sensitive watersheds could utilize specific stormwater controls that address nutrient reduction. The targeted controls should be placed down gradient of energy dissipaters to accept a more controlled flow.

DESIGN CRITERIA FOR WATER QUALITY

Pollutants in stormwater fall into two groups: suspended solids and dissolved pollutants. Particle sizes greater than 0.45 micron are considered suspended solids. Pretreatment devices, such as a sediment forebay or oil grit separator, are ordinarily designed to remove suspended solids that have larger particle sizes. Dissolved solids, however, are removed by treatment practices that rely on settling (e.g. extended dry detention basins and wet basins) or filtration (e.g. sand filters and filtering bioretention areas).

If stormwater runoff will affect surface water that is subject to a TMDL, proponents must design, construct, operate and maintain a stormwater management system that is consistent with the TMDL. Currently, there are TMDLs for both nitrogen and bacteria on Cape Cod.

TREATING NITROGEN

There are a growing number of stormwater management technologies which effectively remove nitrogen from stormwater. Stormwater BMPs equipped with vegetation can remove nitrogen through nutrient uptake, while other BMPs create an anoxic, or oxygen free, environment for denitrifying bacteria to convert nitrogen in stormwater to inert nitrogen gas. BMPs that can effectively remove nitrogen include bioretention systems, tree box filters, sub-surface

constructed wetlands and retention ponds. Nitrogen removal efficiencies of chosen BMPs can be found in TableV.

TREATING BACTERIA

In shellfish growing areas and public swimming beaches, bacterial contamination is of concern. Therefore, designers should evaluate BMPs for their ability to capture bacteria or limit their growth. BMP technologies that retain water under conditions that promote bacteria growth (such as enclosed spaces that can become "septic" during extended no flow periods) should be avoided in these areas. For example, identification and remediation of dry weather bacteria sources is usually more straightforward and successful than tracking and eliminating wet weather sources. Only segments that remain impaired during wet weather should be evaluated for stormwater BMP implementation opportunities. Bacterial removal efficiencies for some chosen BMPs can be found in Table V.

ENVIRONMENTALLY-SENSITIVE ROADWAY DESIGN

Low impact development (LID) techniques are innovative stormwater management systems that are modeled after natural hydrologic features. Environmentally sensitive roadway design involves incorporating LID techniques to prevent the generation of stormwater and non-point source pollution by reducing impervious surfaces, disconnecting flow paths, treating stormwater at its source, maximizing open space, minimizing disturbance, protecting natural features and processes, and/or enhancing wildlife habitat.

BEST MANAGEMENT PRACTICES FOR ROADWAYS

Best management practices (BMPs) are control measures to limit untreated, polluted stormwater runoff from reaching waterbodies. BMPs can be categorized in to two categories: structural and non-structural BMPs. Structural BMPs are physical interventions in the landscape, while non-structural BMPs are administrative measures/requirements, such as trainings and operating procedures.

STRUCTURAL BMPS

Structural BMPs are physical interventions for stormwater management that can be used alone or together to convey, treat, and/or infiltrate stormwater runoff. Structural BMPs can be classified in one or several of the following categories:

- Pretreatment
- Treatment
- Conveyance
- Infiltration
- Other

Pretreatment

Pretreatment BMPs are typically the first BMPs in a treatment train and typically remove coarse sediments that can clog other BMPs. The settling process generates sediment that must be routinely removed. Maintenance is especially critical for pretreatment BMPs, because they receive stormwater containing the greatest concentrations of suspended solids during the first flush. Pretreatment BMPs can be configured as on-line or off-line devices. On-line systems are designed to treat the entire WQV. Off-line practices are typically designed to receive a specified discharge rate or volume. A flow diversion structure or flow splitter is used to divert the design flow to the off-line practice.

- Deep Sump Catch Basins
- Oil Grit Separators
- Proprietary Separators
- Sediment Forebays
- Vegetated Filter Strips

Treatment

Stormwater Treatment Basins provide peak rate attenuation by detaining stormwater and settling out suspended solids. The basins that are most effective at removing pollutants have either a permanent pool of water or a combination of a permanent pool and extended detention, and some elements of a shallow marsh. Stormwater basins include:

- Extended Dry Basins (Detention Ponds)
- Wet Basins (Retention Ponds)

Constructed stormwater wetlands are designed to maximize the removal of pollutants from stormwater runoff through wetland vegetation uptake, retention and settling. Gravel wetlands, however, remove pollutants by filtering stormwater through a gravel substrate.

- Constructed Stormwater Wetland
- Gravel Wetland

Other filtration BMPs include:

- Filtering Bioretention Areas and Rain Gardens
- Proprietary Media Filter
- Sand Filters/Organic Filters
- Treebox Filter

Conveyance

These BMPs collect and transport stormwater, usually to other BMPs for treatment and/or infiltration. Conveyance BMPs may also treat runoff through infiltration, filtration, or temporary storage. For example, a vegetated swale functions both as a runoff conveyance channel and the vegetation prevents erosion, filters sediment, and provides some nutrient uptake benefits.

- Drainage Channels
- Grass Channels
- Water Quality Swales
    - Dry
    - Wet

Infiltration

Infiltration techniques reduce the amount of surface flow and direct the water back into the ground.

- Exfiltrating Bioretention Areas and Rain Gardens
- Dry Wells
- Infiltration Basins
- Infiltration Trenches
- Leaching Catch Basins
- Subsurface Structures

Other

- Dry Detention Basins
- Green Roofs
- Porous Pavement
- Rain Barrels and Cisterns

BMP accessories are devices that enable BMPs to operate as designed. BMP accessories include the following:

- Check Dams
- Level Spreaders
- Outlet Structures
- Catch Basin Inserts

Treatment Trains

A BMP "treatment train" incorporates several stormwater treatment mechanisms in sequence to enhance the treatment of runoff. A series, rather than using a single method of treatment, improves the levels and reliability of pollutant removal. The effective life of a BMP can be extended by combining it with pretreatment BMPs, such as a vegetated filter strip or sediment forebay, to remove sediment prior to treatment in the downstream "units." Sequencing BMPs can also reduce the potential for re-suspension of settled sediments by reducing flow energy levels or providing longer flow paths for runoff.

Examples of treatment trains:

- A sediment forebay discharging to a wet basin flowing into a constructed stormwater wetland
- A water quality swale flowing into a wet basin or a constructed stormwater wetland
- An oil grit separator connected to a sand or organic filter
- A sediment forebay discharging to an extended dry detention basin connected to a sand filter
- A water quality swale discharging to a vegetated filter strip connected to an infiltration trench

NON-STRUCTURAL BMPS

Non-structural BMPs are policies, educational efforts, and housekeeping efforts that can help mitigate stormwater runoff. Because nonstructural practices can reduce stormwater pollutant loads and quantities, the size and expense of structural BMPs can be reduced, thereby affording substantial cost savings. Below are two BMPs that can be used to reduce the amount of contaminants in roadway stormwater runoff.

Street Sweeping

Street sweeping programs have the capacity to be effective in removing pollutants, primarily total suspended solids (TSS), from stormwater.

Three factors that can have an influence on the effectiveness of a street sweeping program are:

(1) Access - Studies have shown that up to 95% of the solids on a paved surface accumulate within 40 inches of the curb, regardless of land use. Those responsible for stormwater maintenance have the ability to impose parking regulations to facilitate proper sweeping so that sweepers can get as close to curbs as possible.

(2) Type of sweeper - There are three types of sweepers: Mechanical, Regenerative Air, and Vacuum Filter. Each has a different ability to remove TSS.

- Mechanical: use brooms or rotary brushes to scour the pavement. They are not effective at removing TSS (0% to 20% TSS removal).
- Regenerative Air: blow air onto the road or parking lot surface, causing fine particles to rise where they are vacuumed. Regenerative air sweepers may blow particulates off the vacuumed portion of the roadway or parking lot, where they contaminate stormwater when it rains.
- Vacuum filter: Two types, wet and dry. The dry type uses a broom in combination with the vacuum. The wet type uses water for dust suppression. Research indicates vacuum sweepers are highly effective in removing TSS.

Regardless of the type chosen, the efficiency of street sweeping is increased when sweepers are operated in tandem.

(3) Frequency of sweeping - TSS removal efficiency is determined based on annual loading rates. If a road were swept only once a year with a sweeper that is 100% efficient, it would remove only a small fraction of the annual TSS load. Many studies and reports suggest that optimum pollutant removal occurs when surfaces are swept every two weeks.

TABLE 3 – TSS REMOVAL CREDITS FOR STREET SWEEPING

TSS Removal Rate	High Efficiency Vacuum Sweeper – Frequency of Sweeping	Regenerative Air Sweeper – Frequency of Sweeping	Mechanical Sweeper (Rotary Broom)
10%	Monthly Average, with sweeping scheduled primarily in spring and fall.	Every 2 Weeks Average, with sweeping scheduled primarily in spring and fall.	Weekly Average, with sweeping scheduled primarily in spring and fall.
5%	Quarterly Average, with sweeping scheduled primarily in spring and fall.	Quarterly Average, with sweeping scheduled primarily in spring and fall.	Monthly Average, with sweeping scheduled primarily in spring and fall.
0%	Less than above	Less than above	Less than above

It has been found that street sweeping programs may NOT be effective due to the following:

- The period immediately following winter snowmelt, when road sand and other accumulated sediment and debris is washed off, is frequently missed by street sweeping programs.
- Larger particles of street dirt may prevent smaller particles from being collected.

- The entire width of roadway may not be swept.
- Sweepers may be driven too quickly to achieve maximum efficiency.
- Land surfaces along the paved surfaces may not be entirely stabilized.

Successful street sweeping programs should consider factors such as whether road and parking lot shoulders are stabilized, the speed at which the sweepers will need to be driven (safety factor such as along a highway), whether access is available to the curb (whether vehicles parked along the curb line will preclude sweeping of the curb line), the type of sweepers, and whether the sweepers will be operated in tandem. Municipalities or private developers that are planning to purchase a new street sweeper should consider vacuum sweepers, because they are the most consistently effective.

Road Salting

The application and storage of deicing materials, most commonly salts such as sodium chloride, can lead to water quality problems for surrounding areas. Salts, gravel, sand, and other materials are applied to highways and roads to reduce the amount of ice or to provide added traction during winter storm events. Salts lower the melting point of ice, allowing roadways to stay free of ice buildup during cold winters. Sand and gravel increase traction on the road, making travel safer.

As snow melts, road salt, sand, litter, and other pollutants are transported into surface water or through the soil where they may eventually reach the groundwater. Road salt and other pollutants can contaminate water supplies and may be toxic to aquatic life. Sand washed into waterbodies can create sand bars or fill in wetlands and ponds, impacting aquatic life, causing flooding, and affecting our use of these resources.

To prevent increased pollutant concentrations in stormwater discharges, the amount of road salt applied should be reduced. Calibration devices for spreaders in trucks aid maintenance workers in the proper application of road salts, so the amount of salt applied could be varied to reflect site-specific characteristics such as road width and design, traffic concentration, and proximity to surface waters. Alternative materials, such as sand or gravel, calcium chloride, and calcium magnesium acetate may be used in especially sensitive areas.

BMPS FOR CAPE ROADWAYS

The following BMPs are discussed in more detail, as they are suitable for construction on the Cape considering the Cape's permeable soils and more rural, semi-urban landscape.

- Porous pavement (other)
- Leaching Catch Basins (infiltration)/ Infiltration Basins (infiltration)
- Sub-surface Sediment Chambers (pretreatment + infiltration)
- Retention Pond (treatment)
- Bioretention (treatment)

- Advanced Bioretention (treatment)
- Water Quality Swales (conveyance, treatment, infiltration)
- Constructed Stormwater Wetlands (treatment)

Porous Pavement

FIGURE 4 – POROUS PAVEMENT ADJACENT TO TRADITIONAL IMPERVIOUS ASPHALT PAVEMENT (FOREGROUND)
(Source: Virginia Asphalt Association)

Porous pavement, also known as pervious, permeable, or open-graded asphalt, is a standard hot-mix asphalt with reduced sand or fines allowing stormwater to infiltrate through a permeable surface. The reduced fines provide air pockets in the pavement creating interconnected void space allowing stormwater to flow through the pavement and into a sand and crushed stone aggregate bedding layer base supporting the pavement. The sub-base provides storage and runoff treatment without requiring additional land area to do so. Porous pavement over an aggregate storage bed will reduce stormwater runoff volume, and pollutants. When properly constructed, porous pavement is a viable alternative to traditional pavement especially in areas where green space and/or additional land area to capture and treat stormwater is limited. Porous pavement may also be incorporated into sidewalks and bike lanes to further reduce site runoff.

Porous pavement has been shown to remove high levels of TSS and petroleum hydrocarbons. When designed correctly, porous pavements may also reduce bacteria contamination.

Leaching Catch Basins/Infiltration Basins

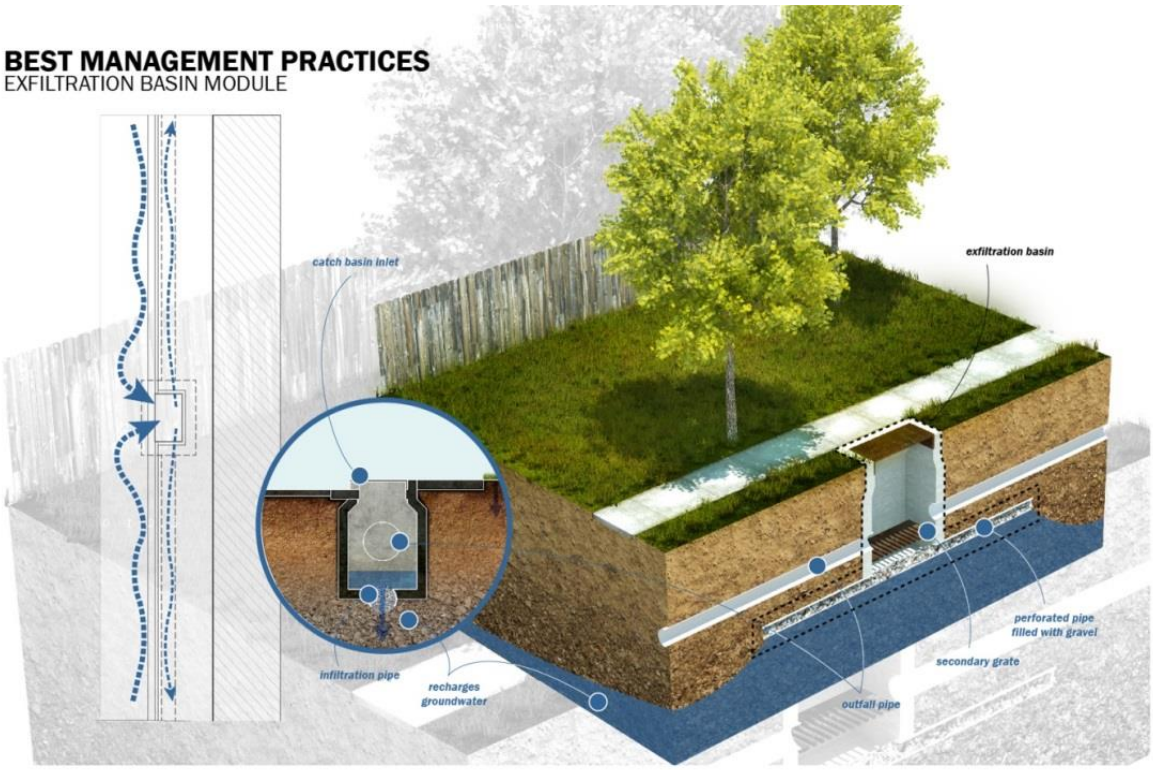


FIGURE 5 – LEACHING CATCH BASIN
(Source: Waggonner and Ball Architects)

A leaching catch basin is similar to a traditional catch basin with the added ability to permit the infiltration of captured runoff. Leaching basins are often installed in series with a deep sump catch basin that provides pretreatment. Because of this pretreatment, the catch basin/leaching basin combination is preferable to the leaching catch basin as a higher removal of TSS may be achieved while also extending the life and minimizing maintenance on the leaching catch basin. Leaching catch basins and leaching basins should only be used in areas with highly permeable soils, making these basins a popular stormwater control throughout the Cape.

Leaching catch basins, in series with pre-treatment catch basins, achieve excellent TSS removal in addition to constituents that sorb to fine particulates including petroleum hydrocarbons and metals.

Sub-surface Sediment Chambers/Underground Sand Filters

FIGURE 6 – SUB-SURFACE TREATMENT CHAMBERS
(Source: Lindsay Cook, Cape Cod Conservation District Intern)

Sub-surface sediment chambers function similarly to surface sedimentation systems. Sediment trapping systems remove pollutants (mainly particulates) from stormwater runoff through a pretreatment sedimentation area followed by an outflow mechanism returning treated flow to a stormwater conveyance system.

In a treatment train, the outflow from the sedimentation area can be followed by an infiltration bed containing filter media (typically sand, soil, gravel or a combination of media). This infiltration bed removes fines and the pollutants sorbed, or attached, to these particulates. Various contaminants including, but not limited to metals, petroleum hydrocarbons and bacteria may sorb to fines allowing infiltration systems to achieve removal efficiencies in these categories though the physical process of filtration.

FIGURE 7 – RETENTION POND
(Source: U.S. EPA)

Retention Ponds

Retention ponds, or "wet ponds," are a widely used conventional stormwater management tool. They are designed to retain a permanent pool of runoff allowing for continuous water quality treatment. Unlike detention basins, or dry basins, which detain runoff only for a limited period of time, retention ponds may be retrofitted from a flood control measure to a water quality treatment system through the installation of additional outlets. As retention ponds contain an active aquatic ecosystem frequent maintenance is required to prevent the buildup and export of contaminants.

Limitations include standing water increasing the risk of drowning and creating mosquito habitat. As mentioned above, retention ponds also may contain excess nutrients that, without proper maintenance, may lead to harmful algal blooms.

Retention ponds remove TSS, petroleum hydrocarbons, nitrogen (with proper maintenance), metals and in some cases bacteria.

Bioretention

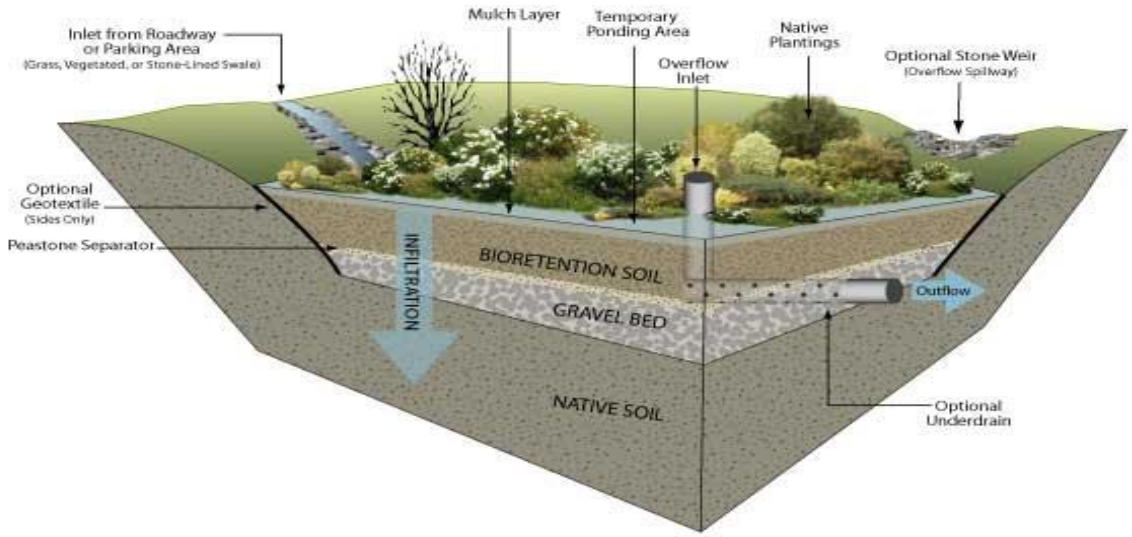


FIGURE 8 – BIORETENTION
(Source: Douglas County Environmental Services)

Bioretention is a method of treating stormwater by ponding water in shallow depressions underlain by a sandy engineered soil media through which most of the runoff passes.

Bioretention systems can easily be incorporated into the landscape to address and maintain many of the natural hydrologic functions. Pollutants within these systems are removed through both chemical and physical means within the bioretention soil mix. Bioretention systems also encourage biological treatment of nutrients, such as nitrogen, through nutrient uptake by vegetation within the system. Bioretention tends to work best in sandy soils, such as are present in many areas of Cape Cod.

Bioretention systems achieve excellent removal efficiencies for a wide range of pollutants including TSS, petroleum hydrocarbons, nitrogen, metals, phosphorus and bacteria. Typical removal efficiencies are shown in Table V.

Advanced Bioretention

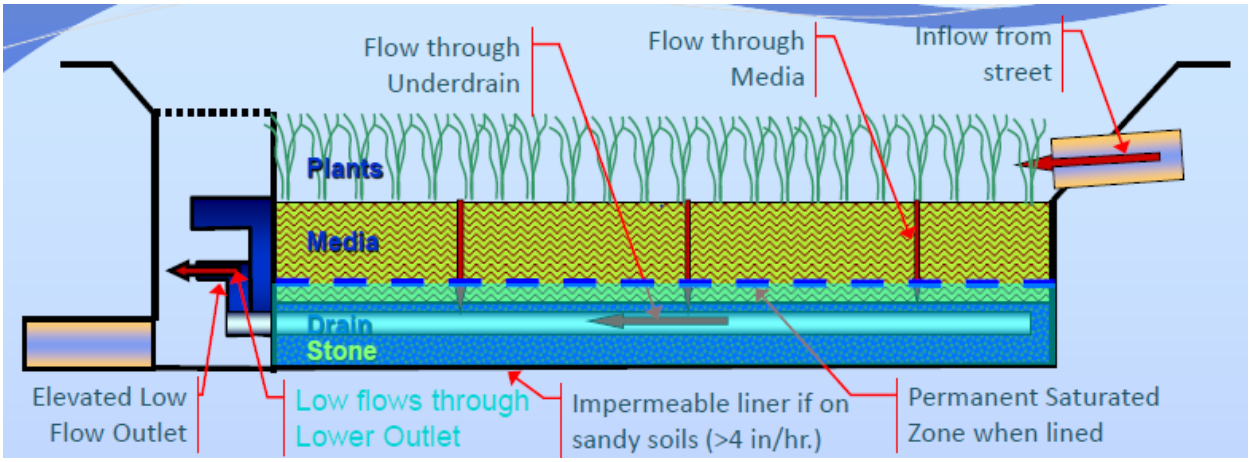


FIGURE 9 – ADVANCED BIORETENTION
(Source: Washington Stormwater Center)

Advanced bioretention systems provide additional treatment through increased travel and residence time of stormwater. As runoff infiltrates vertically through the soil media, an impermeable liner intercepts and redirects the flow horizontally. This horizontal flow increases contact between runoff, bioretention soil media and root vegetation thereby attaining a reduction in nutrients and various other contaminants greater than traditional bioretention systems. Advanced systems are often lined at the bottom of excavation preventing infiltration and rerouting water once again on a horizontal flow path prior to discharge.

Other modifications to bioretention systems aimed at improving performance include adding supplements to the soil media. Additives such as activated charcoal, sawdust and shredded paper have been shown to improve removal of certain constituents from stormwater runoff. Another approach employs modifications to the configuration of the bioretention system to retain a portion of the accumulated stormwater. This internal water storage design has been shown to reduce soluble nitrogen levels by inducing an anaerobic condition within the bioretention facility itself. Research advances in bioretention system design are continuing to emerge, with promising new methods of increasing pollutant removal.

Water Quality Swales

FIGURE 10 – WATER QUALITY SWALES
(Source: Washington Stormwater Center)

Water quality swales are channels providing conveyance, water quality treatment, and flow attenuation of stormwater runoff. Water Quality Swales provide pollutant removal through vegetative filtering, sedimentation, biological uptake, and infiltration into the underlying soil media. Both wet and dry water quality swales can be implemented with the appropriate type being dependent upon site soils, topography, and drainage characteristics. Water quality swale stormwater practices work best with well-drained soils that encourage infiltration as part of the water quality treatment approach. Recommended cross section of water quality swales includes a ¾ - 1" stone sub base covered with Type A native soils and vegetation.

A variety of shrubs, grasses, and ground covers are acceptable vegetation in both sun and shade conditions for the above mentioned stormwater technologies. Vegetation should designed to maximize pollutant removal and contribute to native ecological systems and selected based on its tolerance to flooding and its ability to survive with little or no fertilizers and pesticides. This vegetation should preferably be native, but at very least not be invasive.

Roadside water quality swales paired with country drainage provide increased water quality benefits, mimic the natural landscape, are highly compatible with LID design,

have minimal impact on wildlife and reduce driving hazards by keeping stormwater flows off of the roadway surface.

Water quality swales achieve adequate removal efficiencies for TSS, petroleum hydrocarbons, and metals. Typical removal efficiencies are shown in Table V.

Constructed Stormwater Wetlands

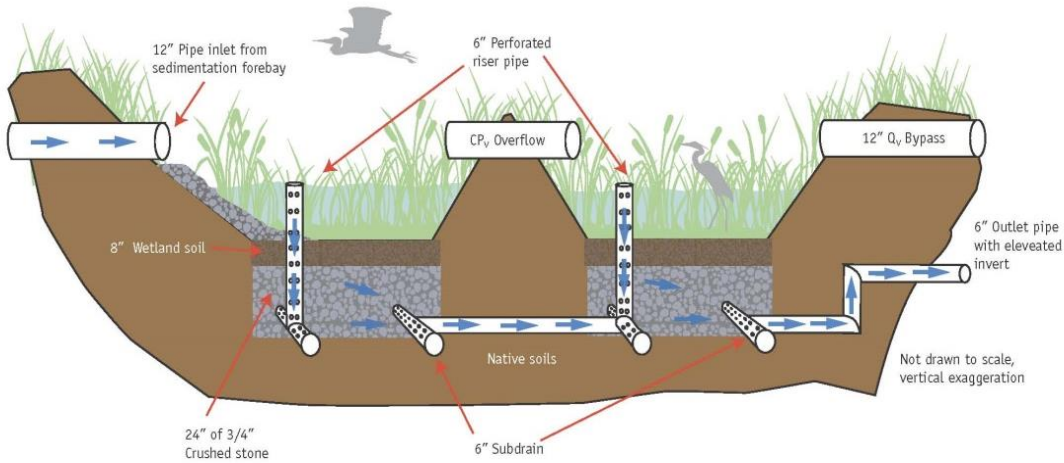


FIGURE 11 – CONSTRUCTED STORMWATER WETLANDS
(Source: University of Idaho)

Constructed wetlands are intended to simulate the functions of natural wetlands by utilizing vegetation, soils, and microbial activity. Constructed wetlands are typically separated into surface flow wetlands and subsurface flow wetlands. These wetland systems have the ability to treat wastewater from a range of pollutant sources, utilize few to no chemicals, have a lower carbon footprint and may be less expensive in both capital costs and operation and maintenance than conventional treatment options.

The subsurface gravel wetland is designed as a series of flow-through treatment cells, preceded by a sedimentation basin. It is designed to attenuate peak flows and provide subsurface anaerobic treatment. The subdrains distribute the incoming flow, which then passes through the gravel substrate, and then to the opposite subdrains, into the adjacent cell, and then exits the treatment system. In the event of a high intensity event, the WQV is stored above the wetlands, and drains into the perforated riser on one end of the wetland, and into the substrate. Biological treatment occurs through plant uptake and soil microorganism activities. This is followed by physical-chemical treatment within the soil including filtering and absorption with organic matter and mineral complexes.

Sub-surface gravel wetlands consistently achieve the highest removal efficiencies of any stormwater management system for a wide range of pollutants including TSS, petroleum hydrocarbons, nitrogen, metals, phosphorus and bacteria. Typical removal efficiencies are shown in Table V.

Maintenance of Preferred BMPs

It is important to note that these systems may require different maintenance and ongoing care regimes than what has been traditionally provided for stormwater management and landscape systems in the past. However, many of these systems do not require more time or cost intensive care than typical regimes; the care is instead is just a different type of maintenance practice and these learning hurdles need to be overcome. For example, weekly mowing of traditional grass strips between roadways and sidewalks is both cost and time and fossil fuel resource intensive. In liu of mown grass strips, Water Quality Swales could instead be constructed to provide contaminant removal benefits in addition to desired green aesthetics. Water Quality Swales may require less overall mowing than traditional grass strips, however, trash may need to be removed in monthly intervals. Overall, the amount of maintenance may be the same or less, but the ongoing care practices are different than what road maintenance crews may be used to. Introduction of preferred BMPs should be accompanied by an educational program that emphasizes how maintenance practices are not more intensive, just different, and educates maintenance personnel to ensure long-term maintenance adjustment to provide functional systems.

Below, a typical maintenance summary is provided for the vegetated systems described in the previous section.

Year 1 & 2- Establishment

Just like any landscape installation, correct moisture levels following construction are essential to plant survival. The first ninety (90) days after planting is the critical time for watering. Young plants require heavy watering to establish. This is the same maintenance as required for traditional roadway edges such as mown grass strips.

The plants in a vegetated stormwater system need to be monitored to make sure they become established. It is suggested that this be specified as part of the original construction contract. A two year maintenance period is suggested to be added onto the construction contract to ensure plant survival. Monitoring points should be set up to photograph and document progress of re-vegetation at 3 month intervals. The maintenance contractor would monitor and water the plants, be responsible for replacing any plants that have died and would control weeds when needed.

Throughout the establishment phase it may be necessary to review individual species tolerance. Some planted species may need to be replaced with species that are performing well. A small allowance should be left in the project budget to perform adjust the species as needed during the 2 year establishment phase if needed.

During the 2 year establishment phase, it is suggested that the following maintenance procedures be put in place as part of the original construction contract:

First 90 days, Bi-Weekly:
1. Weed
2. Water as needed
3. Check for and fix erosion
4. Inspection for good general appearance of area/gardens, remove trash as needed

Rest of 2 year Establishment Period, Monthly:
1. Regularly inspect for signs of erosion, obstructions, and unhealthy vegetation.
2. Remove weeds and invasive plants.
3. Remove any trash that has washed into the vegetation areas or the inlet channels or pipes.
4. Check the facility a few days after a rain storm to observe drainage and infiltration as required.

Rest of 2 year Establishment Period Seasonally (Spring and Fall):
1. Replace mulch and finish surfaces where needed
2. Plant/replant as needed. Adjust replacement species if required.
3. Scratch surface to prevent "crust"
4. Check pH; adjust as indicated

Once the vegetated systems are established during the maintenance contract, the ongoing maintenance required can actually be less than a typical mown area. The key is that it is a different kind of maintenance that need to be performed by trained personnel.

Ongoing Maintenance After Establishment Phase

The below seasonal maintenance schedule reflects the maintenance needed after the two year establishment period. Bi-weekly mowing would NOT be required unless grass species are specified as part of a mown Water Quality Swale. Water Quality Swales may require bi-weekly mowing (just like regular grass) in addition to the schedule noted below. Other than the necessary sediment and debris removal 4x per year, the maintenance required would be the same as a mown lawn strip.

TABLE 4. RECOMMENDED TIME FRAMES FOR TYPICAL MAINTENANCE OF VEGETATED STORMWATER BMPS

	JAN	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
Post Establishment:												
Remove sediment, leaves, debris and weeds		**X**			**X**			**X**			**X**	
Pruning/Cutback		**X**									**X**	

Table 4B– Typical Maintenance Schedule for Vegetated Stormwater BMPS
(Source: Offshoots, Inc.)

TABLE 5 – COMPARISON OF SELECTED BMPS

BMP	Source	Cost/Metric	% Pollutant Removal						Maintenance Notes
			TSS	N	P	Metals	Organic C	Other % Removal	
Sub surface sediment chambers/Underground sand filters	EPA (1999)	$6,600 to $18,500 / acre drainage area	70%	46% (TKN)	33% (Total P)	45%	48%	76% Fecal Coliform	Routine inspections (after major storms) that include trash and debris removal. Lifespan 3-5 yrs. before corrective maintenance red: removal and replacement of top layers of sand, gravel, or filter fabric.
	NPREPD (2007)		86%	32% (Total N)	59% (Total P)	37% Cu; 87% Zn		37% Bacteria	
Retention pond (Wet Detention Ponds)	EPA (1999)	$0.50 - $1.00/cubic ft.	50-90%	40-80% (soluble nutrients)	30-90% (Total P)	40-80%	20-40%	40-90% Pathogens (source: MA Stormwater Handbook)	Routine inspections (after major storms) that include trash and debris removal. Maintenance includes repairs to embankment, sediment removal, and control of algae, insects, and odors.
	NPREPD (2007)		80%	31% (Total N)	52% (Total P)	57%(Cu); 64% (Zn)		70% Bacteria	
Bioretention	EPA (1999)	$1.25/sq. ft. (installation cost)	90%	68-80% (TKN)	70-83% (Total P)	93-98%	90%	90% Bacteria	Biannual inspection of trees and shrubs, pruning and weeding, alkaline application.
	NPREPD (2007)		59%	46% (Total N)	5% (Total P)	81%Cu;79%Zn			
Water Quality Swales	EPA (1999)	$8.50 -$50.00/ linear ft. (capital cost)	81%	38% (Nitrate)	9% (Total P)	42 - 71%	67%	62% Hydrocarbons	Periodic mowing, weed control, watering, reseeding of bare areas, mulch and fertilizer application, clearing of debris and sediment. Inspect four times per year. Indefinite lifespan, if properly maintained.
	NPREPD (2007)		81%	39% (Nitrate&Nitrite)	24% (Total P)	65% Cu; 71%Zn			
Porous Pavement	EPA (1999)	$0.50 to $1.00 / sq. ft. (installation cost)	94%	43% (Nutrients)		76-93%	N/A	N/A	Vacuum sweeping and high-pressure hosing at least four times a year. Annual inspections. Longer lifespan than regular pavement: 30 yr. lifespan in Northern climates due to reduced freeze/thaw stress.
	NPREPD (2007)		89%	42% (Total N)	65% (Total P)	86% Cu; 66%Zn			
Constructed Stormwater Wetlands	EPA (1999)	$26,000 - $55,000 per acre (construction cost)	67%	28% (Total N)	49% (Total P)	36 - 62%	34%	77% Bacteria; 87% Hydrocarbons	Replanting, sediment removal, plant harvesting. Biannual inspections for first few years, annual inspections thereafter. >20 yr. lifespan
	NPREPD (2007)		72%	24% (Total N)	48% (Total P)	47% Cu; 42%Zn		78% Bacteria	

REGULATIONS AND PERMIT CONDITIONS

MASSACHUSETTS STORMWATER MANAGEMENT STANDARDS

Many transportation projects in Massachusetts require adherence to MassDEP's Massachusetts Stormwater Management Standards. Specifically, the standards apply to transportation projects that require either a Massachusetts wetlands permit and/or require a Water Quality Certification. Through the State's Water Quality Certification, the general permit for municipal separate storm sewer systems (MS4) requires compliance with the Stormwater Management Standards. As an MS4 permit operator, the Massachusetts Department of Transportation (MassDOT) must abide by the Massachusetts Stormwater Management Standards.

The Massachusetts Stormwater Standards are comprised of 10 standards that:

1. Prohibit untreated stormwater discharges
2. Ensure peak discharge rates do not increase with development
3. Encourage infiltration by ensuring annual recharge does not decrease with development
4. Require stormwater management systems are designed to remove 80% of the average annual post-construction load of TSS.
    a. A long-term pollution prevention plan is implemented and maintained
    b. BMPs are sized to capture required volume (per Massachusetts Stormwater Handbook)
    c. Pretreatment is provided (per Massachusetts Stormwater Handbook)
5. Eliminate or reduce stormwater discharges to the maximum extent practicable (MEP) for land uses with higher potential pollutant loads.
6. Require the use of the specific source control and pollution prevention measures for discharges in Zone IIs, IWPAs, and near/to "critical areas" (defined below).
7. Require a redevelopment project to meet some of the Stormwater Management Standards and improve existing conditions. Existing stormwater discharges shall comply with Standard 1 only to the MEP.
8. Develop and implement a construction period erosion, sedimentation, and pollution prevention plan.
9. Develop and implement a long-term operation and maintenance to ensure that stormwater management systems function as designed.
10. Prohibit all illicit discharges to the stormwater management system.

Demonstrating compliance with the Stormwater Management Standards to the MEP requires:

1. Making all reasonable efforts to meet each of the Standards

2. Conducting a complete evaluation of possible stormwater management measures (e.g. LID techniques that minimize land disturbance and impervious surfaces, BMPs, pollution prevention, erosion and sedimentation control, and proper operation and maintenance of stormwater BMPs)

3. That if full compliance with the Standards cannot be achieved, they are implementing the highest practicable level of stormwater management.

Critical Areas

According to Standard 6, specific source controls and pollution prevention measures are required for "critical areas," as defined in MassDEP's Stormwater Management Handbook. MassDOT needs to identify discharges to the following resources areas as a priority and indicate in their stormwater management plan how storm water controls will be implemented. The "Critical areas" defined in MassDEP's Stormwater Management Handbook, with associated references to the Code of Massachusetts Regulations (CMR), are as follows:

- Outstanding Resources Waters (314 CMR 4.00)
- Special Resources Waters (314 CMR 4.00)
- Recharge areas for public water supplies as defined in 310 CMR 22.02 (Zone Is, Zone IIs and IWPAs for groundwater sources and Zone As for surface water sources)
- Bathing beaches (105 CMR 445.000)
- Cold-water fisheries (310 CMR 10.04 and 314 CMR 9.02)
- Shellfish growing areas (310 CMR 10.04 and 314 CMR 9.02)

Designers of roadway improvements should recognize the special nature of "Critical Areas" (especially surface water drinking water reservoirs and other ORWs). In general, roadway improvements in these areas warrant additional efforts to protect water quality than may apply in other less sensitive areas.

Certain BMP design considerations are important to ensuring adequate performance in critical resource areas. The MassDEP Stormwater Management Policy uses TSS removal as an indicator for BMP performance. In some critical areas, however, TSS may not be the only parameter (or even the primary parameter) of concern. For example:

In shellfish growing areas and public swimming beaches, bacterial contamination is of concern. Therefore, designers should evaluate BMPs for their ability to capture bacteria or limit their growth. BMP technologies that retain water under conditions that promote bacteria growth (such as enclosed spaces that can become "septic" during extended no flow periods) should be avoided in these areas.

In cold water fisheries, water temperature is a critical parameter. Therefore, if a BMP discharges directly to temperature sensitive waters, the BMP should not retain water in such a manner that

raises its temperature (as may occur in a shallow wet pond, for instance). Alternatively, BMPs can sometimes be designed to account for the temperature effects; for example, in a deeper wet pond, water can be discharged from lower levels of the pond, or re-introduced to the downstream resource area through groundwater recharge.

MassHighway Stormwater Handbook

MassDEP and MassHighway collaborated on the MassHighway Stormwater Handbook, which provides guidance on developing storm water management strategies for highway projects in order to comply with the Massachusetts Stormwater Management Standards. The handbook describes how to determine whether the MassDEP Stormwater Management Policy applies to a particular project and how standards may apply to particular projects. The handbook also addresses design strategies that may facilitate compliance, and source control measures for controlling stormwater pollutant loads from stormwater runoff. Also provided is a process for screening and selecting BMPs for roadway improvement projects that meet the objectives of the MassDEP Stormwater Management Policy. The handbook is primarily intended for roadway designers, public works personnel, and other persons involved in the design, permitting, review, and implementation of highway and bridge improvement projects in Massachusetts.

MASSDOT MS4 PERMIT

Phase II of EPA's National Pollutant Discharge Elimination System (NPDES) program applies to both roadway construction and existing roadways. Construction projects exceeding one acre of soil disturbance require filing a Notice of Intent with EPA under the NPDES Construction General Permit. NPDES Phase II Rule also applies to MassHighway, as it considers MassDOT to be an operator of an MS4. MassDOT currently holds an EPA NPDES Phase II Small MS4 General Permit (Permit #: MA043025), with a new MassDOT MS4 permit to be issued sometime in 2015. The MS4 general permit requires MassDOT to:

- Develop and implement a storm water management program to reduce discharge of pollutants to the MEP.
- Develop measurable goals for the implementation of the stormwater management program and report on its progress on meeting those goals.
- Implement 6 "minimum control measures" :
    - Public education and outreach
    - Public involvement and education.
    - Illicit discharge detection and elimination.
    - Construction site runoff control program.
    - Post-Construction stormwater management.
    - Pollution prevention and good housekeeping in municipal operations.

MassDOT's Stormwater Management Plan

In MassDOT's *NPDES Stormwater Management Plan for MassHighway Owned and Operated Highways*, MassDOT explains how BMPs and associated goals are addressing each of the six minimum control measures laid forth in the MS4 permit. MassDOT's MS4 Permit also requires MassDOT to evaluate its discharges that fall within a watershed of a 303(d) listed water body.

When a discharge drains to a listed waterbody for which a TMDL has been developed, the MS4 Permit requires MassDOT to comply with additional requirements. Discharges to impaired and TMDL watersheds are being addressed by MassDOT's Impaired Waters Program and MassDOT's TMDL Watershed Review Program, respectively.

Impaired Waters Program

Starting in June 2010, MassDOT committed to assess all impaired water body segments that receive (or potentially receive) stormwater runoff from MassDOT roadways located in urban areas within five years. "Impaired" water body segments are those listed as Category 4a or 5 in MassDEP's Integrated List of Waters (referred to as the 303(d) list). MassDOT plans to complete assessment of all the identified impaired waters by June 2015. The program initially included approximately 684 impaired waters, which include all 303(d) waters whose sub-basins contain some portion of MassDOT's urbanized area roadways. To date, MassDOT has assessed 561 water bodies, 82 assessments have moved into design, 11 sites are under construction and 16 are completed. By identifying 303(d) waters that lie within 500 feet of at least one stormwater outfall from an urbanized roadway, MassDOT prioritized assessment by the total number of outfalls within this 500-feet area.

The assessment includes identifying impairments related to highway stormwater runoff, mapping locations of MassDOT outfalls relative to 303(d) waters, conducting site survey of discharge points and drainage infrastructure, identifying control measures and BMPs to ensure stormwater discharges will not cause exceedances in water quality standards, and designing and implementing BMPs.

The assessment also determines whether stormwater runoff from the roadways drains to the water body, and whether existing BMPs effectively treat runoff from the roadways. The assessment then sets a treatment target. When the target is not met, MassDOT will design and construct additional water quality BMPs where technically feasible. MassDOT is implementing this program through two initiatives: the Retrofit Initiative and the Programmed Projects Initiative. The Retrofit Initiative identifies locations where BMPs could be added along existing roadways, while the Programmed Projects Initiative explores where BMPs are warranted within planned roadway construction projects. MassDOT has developed an impaired waters geospatial database to track BMP design and construction, as well as the status of water body assessments.

TMDL Watershed Review

MassDOT will assess TMDL reports wherever a TMDL has been approved for a water body into which MassDOT's urbanized roadways discharges storm water.

MassDOT has conducted an initial review of these 41 final TMDL reports to determine whether the TMDL WLA, BMP recommendations, or other performance requirements for storm water discharges that are applicable to MassDOT.

The assessment includes identifying TMDL Waters to which MassDOT's urbanized roadways may potentially discharge stormwater, conducting a site survey of discharge points and drainage infrastructure, calculating loading from MassDOT Stormwater as it compares to the WLA, assessing whether the WLA is being met through existing storm water control measures or if additional control measures may be necessary, and finally selecting, designing, and implementing BMPs.

Prioritization of BMP Installation

MassDOT has developed a BMP Summary Matrix, comparing BMPs as they perform in regards to managing peak flows, recharge, TSS removal, pollutant loadings, and soil infiltration capacity, as well as other parameters such as drainage area, clearance to bedrock, clearance to high water table, setback requirements, land area, slope, and maintenance sensitivity.

MassHighway's policy is to give "critical" waters (which includes Class A waters and Zone I WPAs) higher priority in terms of implementing storm water BMPs.

MassDOT Efforts Related to Cape Cod TMDLs

According to MassDOT's most current MS4 Annual Report for Permit Year 11 (April 2013 – March 2014), there were no projects completed within the Cape Cod Basin. Table VI, adapted from a table in the PY11 Annual Report, shows MassDOT stormwater work that has been completed or is planned in TMDL watersheds.

As of the PY11 Annual Report, MassDOT is currently drafting a methodology to assess water bodies covered by a nitrogen TMDL located on Cape Cod (and other parts of southeastern Massachusetts) which are located in watersheds that are mainly driven by groundwater. MassDOT is determining whether or not revisions need to be made to the MassDOT TMDL methodology for water bodies without surface water hydrology and expects the methodology to be finalized in Permit Year 12.

TABLE 6 – MASSDOT ACTIONS IN CAPE COD TMDL WATERSHEDS

Basin/TMDL Name	Pollutant	MassDOT actions completed	To Do
Final Pathogen TMDL for the Buzzards Bay Watershed	Pathogens	hired a consultant to review illicit discharges and committed to reviewing 10% of urbanized areas each year	Will review TMDL and determine if additional controls are needed
Final Pathogen TMDL Report for the Cape Cod Watershed	Pathogens		MassDOT has plans to SW problems coming off Route 28
Final Bacteria TMDL Report for the Three Bays System	Pathogens		Will review TMDL and determine if additional controls are needed. Should determine drainage area discharging to Marston mills River and install BMPs that are designed to meet TMDL.
Final TMDL Report of Bacteria for Frost Fish Creek, Chatham	Bacteria		Will review TMDL and determine if additional controls are needed. Should determine drainage area discharging to Frost Fish Creek and install BMPs that are designed to meet TMDL.
Final TMDL Report of Bacteria for Muddy Creek, Chatham	Bacteria		Will review TMDL and determine if additional controls are needed. Should determine drainage area discharging to Muddy Creek and install BMPs that are designed to meet TMDL.
Final Nutrient TMDL for Centerville River/East Bay	Total Nitrogen		
Final Nitrogen TMDL for Little Pond	Total Nitrogen		
Final Nitrogen TMDL for Oyster Pond	Total Nitrogen		
Final Nitrogen TMDL for Phinneys Harbor	Total Nitrogen		
Final Nitrogen TMDL for Pleasant Bay System	Total Nitrogen		
Final Nitrogen TMDL Report for Five Sub-Embayments of Popponesset Bay	Total Nitrogen		
Final Nitrogen TMDL Report for the Quashnet River, Hamblin Pond, Little River, Jehu Pond, and Great River in the Waquoit Bay System	Total Nitrogen		
Final Nitrogen TMDL Report for the Three Bays System	Total Nitrogen		
Final Nitrogen TMDL for West Falmouth Harbor	Total Nitrogen		
Final Nitrogen TMDL Report for Five Chatham Embayments (Stage Harbor, Sulphur Springs, Taylors Pond, Bassing Harbor and Muddy Creek)	Total Nitrogen		
Final TMDLs of Nitrogen for Great, Green, and Bournes Pond Embayment Systems	Total Nitrogen		

COORDINATING TRANSPORTATION STORMWATER INFRASTRUCTURE WITH THE 208 PLAN

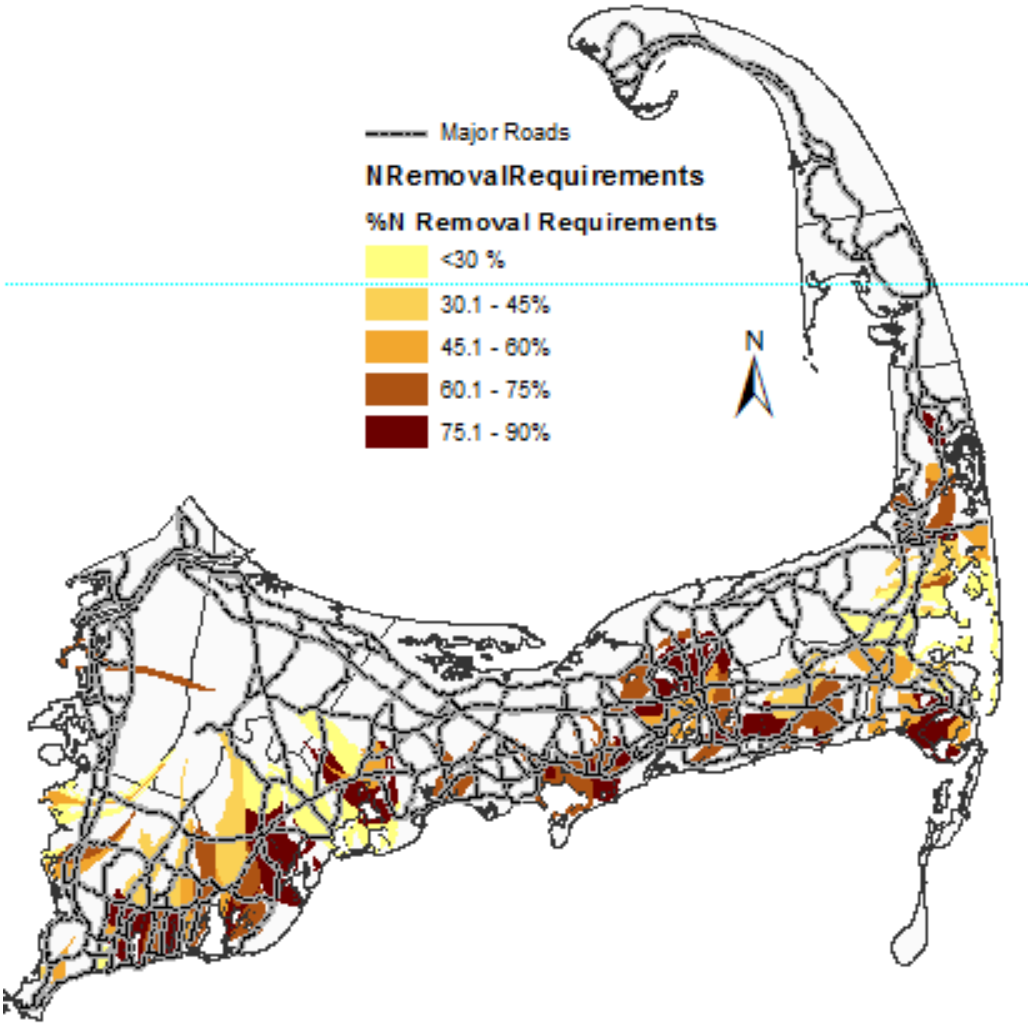
The Cape Cod Area Water Quality Management Plan Update, also known as the "208 Plan," addresses options for Cape Cod communities to address nitrogen loading from controllable sources in Cape Cod watersheds. The 208 Plan outlines many options for addressing nitrogen loading that include the traditional approach of sewering, as well as many alternative approaches such as installing permeable reactive barriers, constructed wetlands, ecotoilets, aquaculture and shellfish bed restoration. There are ample opportunities where stormwater management design on Cape Cod roadways should be coordinated with nitrogen reduction goals of the 208 Plan.

Cape Cod communities that consider constructing sewers as part of their nitrogen mitigation strategy can simultaneously incorporate stormwater management efforts on Cape Cod roadways. For example, as roads are repaved, communities can inspect water and sewer conduits, storm drains, remove illicit connections to sewers and storm drains, repair leaks, and make any other necessary repairs.

Some of the alternative technologies in consideration for nitrogen management on Cape Cod as part of the 208 Plan are actually stormwater treatment systems that also provide significant nutrient removal. Examples of stormwater BMPs proposed for nitrogen management are bioretention/soil media filters, phytobuffers, vegetated swales, and stormwater constructed wetlands. All of these technologies provide physical filtration, uptake of pollutants within plant tissue, nitrification and denitrification, and other microbial biochemical processes that effectively remove a broad range of pollutants from the water column. According to the Draft MS4 Permit, Cape Cod communities need to consider installing BMPs that significantly reduce nitrogen where discharges occur in nitrogen TMDL watersheds.

For optimal effectiveness, sewer infrastructure and alternative nitrogen reduction technologies should be located in areas that contribute the most nitrogen loading to impaired embayments. Roadway development or upgrades within watersheds that require a high amount of nitrogen removal should consider opportunities to (1) include sewer infrastructure alongside current roadway plans and (2) implement stormwater BMPs to remove nitrogen.

FIGURE 12 – NITROGEN REMOVAL REQUIREMENTS IN SUBEMBAYMENTS



REGIONAL POLICY PLAN CONSIDERATIONS FOR STORMWATER MANAGEMENT

Transportation infrastructure related to development or redevelopment may be subject to regional regulation by the Cape Cod Commission. If the development project meets a specific size or other threshold identified in the Cape Cod Commission's "Enabling Regulations for the Purpose of Reviewing Proposed Developments of Regional Impact (DRIs)," the project will be subject to review. In order for the project to be granted approval, the project must be consistent with Minimum Performance Standards (MPSs) of the RPP (as well as local comprehensive plans, zoning, etc.). In its review, the Commission must also find that the probable benefits of

the proposed project outweigh the probable detriments. The Commission may consider best practices that exceed MPSs in this analysis.

MPSs related to Stormwater Quality are applicable to all DRI projects. Standards related to roadway runoff dictate on-site infiltration practices and devices, bioinfiltration practices, minimum of 2-foot separation to groundwater for infiltration basins or other stormwater leaching structures, and development of maintenance and operation plans. Additionally, the standards require limiting impervious surfaces by constructing overflow peak parking areas from pervious materials (porous pavement, permeable pavers, or grass pavers), and that bioremediation should be incorporated in to parking islands and roadway perimeters. Stormwater management systems that are proposed within 300-feet of the spring high water contour shall achieve a three-foot separation from groundwater (RPP Goal CR3.4). Also in the RPP is the Best Development Practice of limiting roadway lane widths to 9 feet to minimize runoff from impervious surfaces.

CAPE COD COMMISSION

3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

CAPE COD
COMMISSION

2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix J: Pavement Management

Draft
June 15, 2015

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Technical Appendix J: Pavement Management

As an essential task required by the Cape Cod Metropolitan Planning Organization (MPO) through its Unified Planning Work Program, this report provides the status of pavement condition assessment activities on Cape Cod. The objectives of this effort are to collect data and implement a regional pavement management system for Cape Cod to provide an objective rating of pavement conditions and needs.

The pavement management process is conducted with the intent to keep the roadway system in the best possible condition with the most efficient use of available funds. There are distinct advantages to managing pavement condition and significant cost savings that can take place with preventative or rehabilitation measures rather than waiting until a road is in need of reconstruction. As stated in the MPO-approved Cape Cod Regional Transportation Plan, the goal of the pavement management process is for all federal aid-eligible roads to be maintained in "excellent" condition. Of course, due to the reality of limited financial resources, it is necessary to prioritize pavement repair based on affordability. Deciding which roads to improve and by what technique in a fiscally responsible manner is the essence of Pavement Management.

PAVEMENT MANAGEMENT SYSTEMS - BACKGROUND

Pavement Management is the practice of planning for pavement repairs and maintenance with the goal of maximizing the value and life of a pavement network.

To accomplish this, a community needs to have several repair techniques in its arsenal and the knowledge of when to apply them. This is where pavement management comes into play. With a comprehensive database of road conditions, the pavement management software can model when to perform which repairs on a road network. Of course, engineering judgment is required to finalize any list of street repairs, as no computer model can take every variable analyzed in making a repair decision into account. The computer system is a great springboard to help a community start its repair program for each year and is an excellent method of storing the repair data.

Below is a model of how a street's pavement deteriorates over time. Interpreting the curve, a street starts out in excellent condition when it is newly constructed. Midway through its life, a low cost repair such as crack seal and full depth patch will cost approximately a dollar a square yard. It takes only a few years for the window of opportunity to perform this low cost maintenance to pass after which the road would need an overlay costing $13 - $17 per square yard. By performing timely maintenance, road conditions can be improved today thereby extending the life of the road.

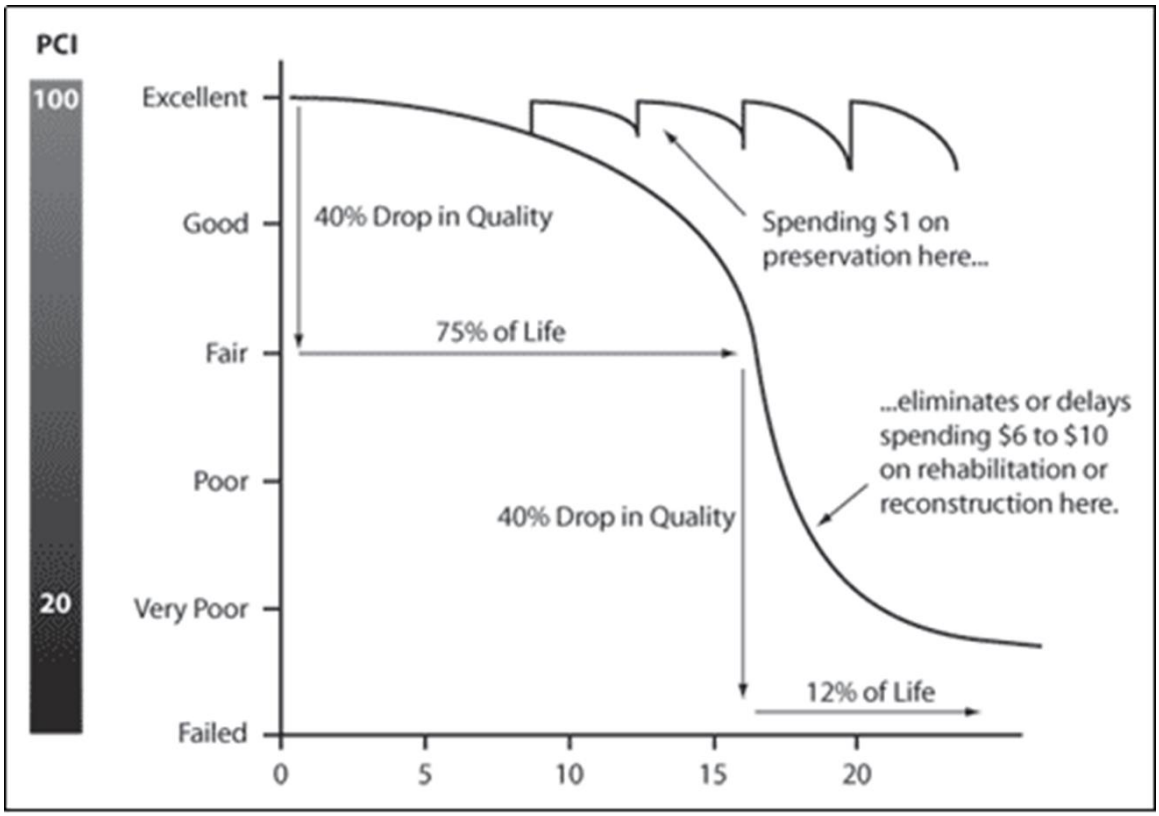

FIGURE 1 - PAVEMENT DETERIORATION CURVE

Source: Federal Highway Administration

EVALUATION CRITERIA FOR CCC DATA COLLECTION

The Cape Cod Commission has continues to collect pavement condition data in 2011 and 2012 through two distinct efforts: a series of "Windshield Surveys" and spot observations at specific locations where the seasonal traffic technicians were installing Automatic Traffic Recorders (ATRs). In both cases observers were given photographs and descriptions of example pavement distresses. Observers used a 1 – 5 rating system and made notations of particular distresses. Copies of the observations are provided in the appendix of this report. The following table is a summary of the guidance given to observers:

TABLE 1 - CCC EVALUATION CRITERIA

CONDITION	DESCRIPTION	CRITERIA
1	Very Good to Excellent	No cracking rutting, raveling/ signs of wear
2	Good to Very Good	No cracking, rutting, showing a little wear
3	Fair to Good	Showing evidence or more wear and possibly repairs that are in good condition
4	Poor to Fair	Evidence of cracking, rutting, serious wear
5	Poor	Severe cracking, rutting, potholes

SURVEY OF CAPE COD COMMUNITIES' PMS ACTIVITIES

In early September 2011, and email survey was sent to each of the 15 towns' Department of Public Works directors. Follow-up inquiries were made in following years. The survey included the following questions:

1. Do you maintain records of pavement quality on your community's roadways?
2. Can you send [electronically preferred] summaries of pavement quality assessments?
3. What system/method do you use to assess pavement quality?
4. Can you send us a report/documentation of methods used?
5. What method do you use to determine repair strategies?
6. Do you have estimated costs for implementing various repair strategies?
7. Can you forward us cost estimates sheets?
8. Do you have a capital plan for pavement improvement?
9. Can you forward us a copy of the capital plan?

Several communities have responded as summarized in the following sections.

BARNSTABLE PMS ACTIVITIES

The Town of Barnstable utilizes detailed survey and analysis performed by VHB as a Consultant. Their work is entered onto Barnstable's database and periodic reports are provided and discussed. The DPW participates in the data analysis, particularly in the cost analysis. DPW reviews project bids received by the Town and establishes base line costs for each pavement treatment band, these costs are discussed with the town's consultant - then utilized in the pavement conditions report. In addition to the VHB work, the DPW maintains a record of roadway repairs and relies upon experienced field personnel to assist in planning for individual maintenance tasks such as crack & chip seal. DPW also informally monitors the performance of all treatments. Key to the pavement management program is coordination with other utilities and proposed roadway rehabilitation information is passed to utility companies. A moratorium is in place for 5 years after application of a new surface. The Town of Barnstable does not maintain a public "5 year plan" - because of political considerations.

Submitted materials include:

- VHB-prepared "2010 Pavement Management Report." See section 1.4.1 for discussion of VHB Pavement Management Systems.

- Excel workbook containing typical costs for various items involved in pavement repair and related road work.

BOURNE PMS ACTIVITIES

Bourne is currently doing road resurfacing on an as-needed basis. The town tries to repave four to five miles of roadway each year. In doing that, the town has kept their main roads as their top priority and then broken off into the subdivisions. Bourne does not currently have a capital plan. The town is in discussion with a consultant to look at Bourne's roads and begin working toward a formal pavement management plan.

BREWSTER PMS ACTIVITIES

Brewster worked with CDM Smith to develop a Pavement Management Plan that will be managed in a MicroPaver database. The Plan, completed in January, outlined road improvement alternatives and the resulting PCI of each. The most proactive plan, approximately $10 million over 5 years, was ultimately approved by voters at the Spring 2015 town meeting. The plan indicated that this level of planning will improve the overall PCI from 73 to 80.

DENNIS PMS ACTIVITIES

The Town of Dennis uses VHB's Pavement Management for guidance. The term "guidance" is used because while VHB keeps Dennis' pavement quality records, does field verification on a 1/5th per year basis, grades the town's roads and makes recommendations for repairs, the town has to spend road funds based on several factors that the program is not designed to consider. These local parameters are: some work in each of Dennis' 5 villages each year, reconstruction of failed roads, resurfacing of dirt roads and lumping the type of repair to give off-cape vendors enough to give the town a reasonable rate.

The town has not had an assessment prepared of estimated costs for various repair strategies for several years. The town's capital plan for pavement improvement allocates $600,000 per year for "secondary roads." Chapter 90 funds are used exclusively for primary roads.

EASTHAM PMS ACTIVITIES

The Town of Eastham is developing a pavement management system. Current efforts include detailed spreadsheets identifying treatment strategies.

Submitted materials include:

- Spreadsheet listing of town roads with summary of face type
- Spreadsheet listing of Town & Private Roads in Town of Eastham with summary of surface type
- Spreadsheet listing of town roads with itemized surface type

FALMOUTH PMS ACTIVITIES

Falmouth uses VUEWorks Asset Management Software to track their Public Works Assets. Falmouth has just begun to use the Pavement Condition rating system that is a module of the system. It is based on the ASTM rating system. Falmouth has provided a copy of their Pavement Manual, a report of the roads they have rated so far, and a sample report of one of the roads. Falmouth uses a couple of strategies to determine their repair schedule. The town has a 10-year roadway plan for major repairs. This is funded by the town operating budget and a Capital Plan. Falmouth has provided both of these documents. The town also has a service call/ work order system to take requests from the public for signs, potholes, sweeping and grading, etc.

Falmouth does not have cost estimate sheets. The town does some work in-house and contracts its crack sealing and large repairs out. These are covered by the town operating budget and Capital Plan.

Submitted materials include:

- Sample Pavement Condition Form
- VUEWorks Pavement Management System Training Guide
- FY 2013-2022 Capital Improvement Program summary form
- Public Works Department Roadway Maintenance Program FY 2012-2023

HARWICH PMS ACTIVITIES

The Town of Harwich DPW utilizes an online database that was developed with Bonsai Logic (a small local software developer) to maintain a road inventory, to develop cost estimates, to reconcile DPW estimates against actual expenses and to maintain a roadwork history. The DPW does not utilize the database to develop a PCI (Pavement Condition Index). The town rates roads in 1 of 4 structural conditions: good, fair, deficient, intolerable

The DPW does have a 5 year road maintenance plan that is updated every few years and is available on the Harwich website. The town uses Chris Nickerson, Highway Road Manager who is a certified pavement inspector, to develop a plan based on his experience, training and knowledge of Harwich's 481 public roads (142 miles). The town attempts to balance maintenance with repair in an attempt to avoid costly

reconstruction utilizing many different processes and procedures. For costs, the town utilizes county bid pricing (p. 2 of the town's Five Year Maintenance Plan).

Submitted materials include:

Summary of roadwork since 2005: excludes any TIP projects

- FY 12-18 Capital Plan – Proposed spending for town capital improvements including pavement maintenance/repair
- Roadwork job examples - Detailed itemized breakdown at pavement repair work at two town locations.
- 5 Year Road Maintenance Plan FY11-FY15 – detailed plan of various repair proposals for many town roads, including itemized costs.
- Harwich Road Inventory – 2010 listing of all town roads. Includes information such as surface width and type, condition (scale of 1 to 4), and length.

MASHPEE PMS ACTIVITIES

Mashpee has provided a list of recent paving projects completed between 2008 and 2013. Paving has occurred on over 8 miles of roads and bike paths on municipal roadways during this timeframe.

SANDWICH PMS ACTIVITIES

The Town of Sandwich retained the firm of Vanasse Hangen Brustlin (VHB) to perform pavement management services. A comprehensive study was undertaken to re-evaluate pavement conditions in Sandwich and to allow for the analysis of various funding scenarios. VHB performed a detailed inspection of the condition of the pavement on all town-maintained roads and updated a database of this information using VHB's "Road Manager" software.

To determine road repair strategies, the town mainly uses PCI (Pavement Condition Index) and Benefit. For estimated costs for implementing various repair strategies, the town uses the County's bid process and incorporates these into their own spreadsheets. The town's 5-Year plan changes dramatically year-to-year but provides a guide to follow as funds become available.

Submitted materials included the following:

- VHB Presentation on Sandwich Pavement Management
- Road Program Map – color coded map of town roads assigned to years (2006 – 2010)
- Excel workbook listing town roads with PCI, Benefit, and Repair Alternative information
- Excel workbook itemizing bid costs for various repairs by various vendors

- Excel workbook itemized by road, listing planned paving projects
- Excel workbook itemizing repair type, treatment, and comments for town roads, separately for each year 2007-2011
- Pavement Management Update Study – VHB-prepared 2006 report. See section 1.4.1 for discussion of VHB Pavement Management Systems.

TRURO PMS ACTIVITIES

Truro uses local knowledge to determine pavement repair priorities.

YARMOUTH PMS ACTIVITIES

The Town of Yarmouth retained the firm of Vanasse Hangen Brustlin (VHB) to perform pavement management services. VHB services consist of performing a comprehensive study to evaluate pavement conditions in Yarmouth and to allow for the analysis of various funding scenarios; perform a detailed inspection of the condition of the pavement on all town-maintained roads and update a database of this information using VHB's "Road Manager" software.

To determine repair strategies, the town reviews an initial list generated by the software and then decides whether to apply chip seal, double ship seal, or overlay. Main roads are treated with rubber chip seal or overlay. In the town's capital plan, annual spending ranges from $1.3 million to $1.5 million for roadway maintenance.

SUMMARY OF TOWN PMS EFFORTS

Based on responses from the September 2011 email survey and subsequent follow-up, the following table summarizes the techniques that responding towns use for pavement management.

TABLE 2 - SUMMARY OF RESPONDING TOWNS' PMS TECHNIQUES

Town	Pavement Management Technique
Barnstable	VHB Pavement Management System
Bourne	Local knowledge – as needed basis
Brewster	MicroPaver database
Dennis	VHB Pavement Management System
Eastham	Locally developed -spreadsheets
Falmouth	VUEWorks Asset Management Software
Harwich	Bonsai Logic Roadway Inventory
Mashpee	Local knowledge
Sandwich	VHB Pavement Management System
Truro	Local knowledge
Yarmouth	VHB Pavement Management System

VHB PAVEMENT MANAGEMENT SYSTEM

The most prevalent technique (as identified by many of the towns responding to the email survey) is the Pavement Management System developed by Vanasse Hangen Brustlin (VHB). The following sections contain excerpts describing the VHB techniques. These techniques are included in the reports submitted by the various towns:

Methodology

VHB performed a detailed condition evaluation of each town's public roadways to build the pavement management system. The first step was to identify the roadway network. The second step was to further break each street in the roadway network into pavement management sections. The third step was to carefully categorize, measure, and record the individual pavement distresses within each pavement management section and perform the inventory of sidewalks, curbs, and ramps. Finally, the fourth step was to customize the road repair treatment selection and unit costs within the pavement management software through discussions with Town officials. All these steps were performed prior to the study of future funding scenarios.

Network Identification

Network Identification builds an inventory of streets that describe the municipality's complete roadway network. The direction of travel, street length, width, ownership, classification, zone and pavement type are among the items identified at this initial phase in the pavement management process. This integral step ensures the streets surveyed are the definitive set to be analyzed.

Pavement Management Section Identification

Once the Network Identification is complete, the field work begins. Each street contains one or more pavement management sections. A pavement management section defines the limits of previous construction or maintenance activities within each street. Sections are defined by having the same width, typical distresses, functional class, etc. The goal is to set up homogenous areas of pavement to aid in assigning the appropriate repair. A street may be one section, or it may be comprised of several pavement management sections, depending on its construction history.

Surface Distress Assessment

For each pavement management section, the severity and extent of nine major pavement distresses are recorded, and then entered into a weighted formula to arrive at a Pavement Condition Index (PCI). The distresses are categorized as base related or surface related distresses. Base related distresses indicate that the pavement structure is inadequate for the existing traffic load and soil conditions. Streets that show significant

base related distresses may need to have the pavement structure strengthened with either thicker or stronger base or pavement materials. Surface related distresses are caused by age and weathering of the pavement. Streets that have predominantly surface related distresses are excellent candidates for maintenance sealing to inhibit further pavement oxidization (the main effect of aging). Streets with more of the base related distresses will most likely need some full depth patching, structural overlays or reclamation/reconstruction.

The four base related distresses are:

- Potholing or non-utility patching
- Alligator cracking
- Distortion
- Rutting

The five surface related distresses are:

- Block cracking
- Transverse or longitudinal cracking
- Bleeding or polished aggregate
- Surface wear or raveling
- Shoving, slippage or corrugation

PCI Defined

A PCI is generated for each inventoried pavement management section in the town using the surface distress data collected by VHB. PCI is measured on a scale of zero to one hundred, with one hundred representing a pavement in perfect condition and zero describing a road in impassable condition. Each type of observed pavement distress is assigned a deduct value based on the type, severity and extent of the distress. A weighted sum of the deduct points is subtracted from the perfect "one hundred" road in order to generate a PCI for each pavement management section. In general, base related (pavement foundation) distresses are weighted more heavily than surface related distresses. For example, if 15% of a road section had medium severity "Alligator Cracking" it would receive a deduct of 40 points. Whereas the same area of "Block Cracking" would only receive a deduct of 15 points. The actual PCI calculation follows:

PCI = 100 – (Highest Deduct Value) – (25% of remaining base related deduct values) – (10% of remaining surface related deduct values)

The Five Treatment Bands

The pavement management system uses broad ranges to group the individual repair types into five major treatment bands. Treatment bands are a useful tool to summarize data on a Town-wide basis. An individual road segment will fall into a particular category based on the strategy table's output of repair types and will vary due to functional classification. The goal is to gain a broad understanding of the existing conditions in simple yet meaningful terms.

TABLE 3 - TREATMENT BAND DESCRIPTIONS

TREATMENT BAND	PCI*	DESCRIPTION
DO NOTHING	93-100	Excellent condition - in need of no maintenance.
ROUTINE MAINTENANCE	86-92	Good condition – may be in need of crack sealing or minor localized repair.
PREVENTIVE MAINTENANCE	76-85	Fair condition – pavement surface may be in need of surface sealing, full depth patch and/or crack sealing.
STRUCTURAL IMPROVEMENT	56-75	Deficient condition – pavement surface structure in need of added strength for existing traffic. Typical repairs are overlay with or without milling.
BASE REHABILITATION	0-55	Poor condition – in need of base improvement. Typical repairs are reclamation or full depth reconstruction.

**Note: Treatment bands are defined below. These are only general PCI ranges for reference purposes, and represent only one pavement type. There are several fields considered by the strategy table when assigning repair types to each individual street. Source: VHB*

Do Nothing

The Do Nothing category exhibits roads which are in need of no maintenance. These roads are in excellent condition and existing distresses generally do not need to be addressed.

Routine Maintenance

Routine maintenance activities are those which are taken to correct a specific pavement distress. Routine maintenance usually addresses localized pavement defects and includes activities such as:

- Full depth patching;
- Skin patching;
- Crack sealing.

Preventive Maintenance

Preventive maintenance activities are those which are performed at planned intervals to protect and seal the pavement. Seals are designed to provide one or more of the following benefits:

- Prevent the intrusion of air and moisture;
- Fill small cracks and voids;
- Rejuvenate an oxidized binder;
- Provide a new wearing surface.

Structural Improvement

Structural improvement includes the work necessary to restore the pavement to a condition that will allow it to perform satisfactorily for several years. Generally a structural improvement will consist of a milling the existing pavement down and applying a new Hot Mix Asphalt Overlay allowing existing grades to be maintained. When the existing grade can be increased a new Hot Mix Asphalt course can simply be placed upon the existing surface. Structural improvements also include the work necessary to prepare the pavement for an overlay, either with or without milling. The major activities involved in the rehabilitation process are:

- Partial depth patching;
- Full depth patching;
- Joint and crack sealing;
- Grinding and milling;
- Hot Mix Asphalt Leveling Courses.

Base Rehabilitation

Base rehabilitation utilizes one of two methods:

- Reclamation;
- Reconstruction.

Reclamation is the process of rehabilitating existing deteriorated pavements. The existing pavement and base, subbase, and possibly subgrade are pulverized and blended to create a homogenous pavement base. This reclaimed pavement base is then paved with a new Hot Mix Asphalt surface. Reconstruction is the complete removal and replacement of a failed pavement, and might also involve widening, realignment, traffic control devices, safety hardware, and major base and drainage work.

Customizing Repair Strategies

VHB meet with the Town DPW to review VHB's typical repair strategies, and to learn how to customize these strategies to meet the Town's specific needs. VHB also refines repair unit costs. VHB's goal was to understand the town's decision making process and simulate that process in the budget analysis software based on the pavement condition and other criteria of each pavement section.

Preparing Budget Scenarios

Once the roadway conditions are inventoried and analyzed, and the repair strategies are defined, the impact of various spending programs on the roadway network is assessed. These studies can range from 1 to 20 years; typically 5-year studies are used. The purpose of the budget planning process is to determine the impact of various spending levels to find a funding level that will best meet the town's needs. The budget analysis

software uses pavement deterioration curves, unit costs, and the strategy tables developed in the repair strategy definition phase to assign each street a repair type and associated cost for each year of the study. The software also assigns each street a benefit value that is used to prioritize which streets the software will select for repair each year. It is important to understand that a pavement management system is a network-wide planning tool, and is not intended to give definitive street-by-street repair data. Field verification and testing are recommended to confirm any street repair list generated.

Deterioration Curves

In order to properly plan for future repairs, the budget analysis feature of the pavement management system uses deterioration curves. The deterioration curves estimate the rate at which the pavement condition decreases over time. These pavement deterioration curves depict two major categories of functional classification - arterials and collectors in one curve and local roads in the other. An example deterioration curve is presented in the following figure:

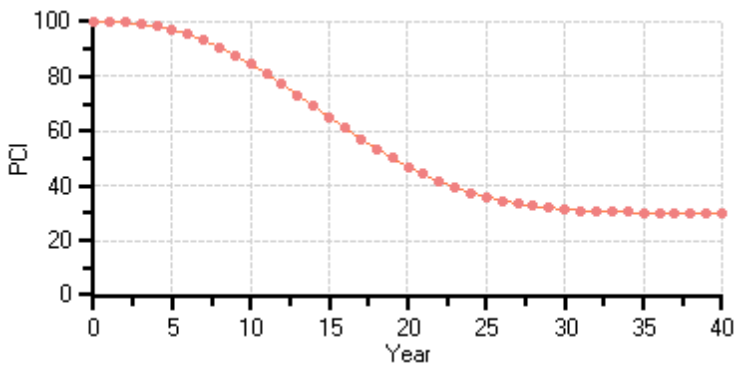

FIGURE 2 - SAMPLE DETERIORATION CURVE

Source: VHB

Strategy Table

The pavement management system uses a table of repair strategies to assign specific road repair types to individual roadway segments. The repair strategy table incorporates PCI ranges as well as functional class and pavement type to simulate decisions consistent with Barnstable's repair practices and procedures.

Project Prioritization

The budget analysis software prioritizes needed system repairs based on the estimated "Benefit Value". The Benefit Value formula is calculated using variables representing traffic volume, repair service life, PCI, and unit repair costs for each pavement management section. For each plan year, the software prepares a future roadway

condition projection, exhausts the assigned budget, and then produces an annual list of roads included in the repair program. The system also allows the user to enter an inflation rate to account for estimated increases in future year construction costs. A 4% inflation rate is typically used.

The Benefit Value prioritization process generally favors cost effective maintenance alternatives. Repair actions are typically delayed on those sections that require reconstruction or major rehabilitation because the benefits for dollars spent are generally lower than maintenance candidates. After the relatively good roads are "saved," improvements are directed towards the poorer arterial and collector roads, and then to the local roads in need of major rehabilitation.

ANALYSES

The data collected in the monitoring process will be continually compared to the measures developed to define congestion. The comparison will be used to identify congested areas and trigger an investigation into the nature of the demand problems

MASSDOT EVALUATIONS OF PAVEMENT CONDITIONS

As seen in the following table presented in the Cape Cod Regional Transportation Plan, the Cape Cod Region possesses 738.98 miles of roadway eligible for federal funding. Of those miles, 541.19 are under the jurisdiction of the Cape's local communities.

TABLE 4 – RTP MASSDOT DATA AVAILABLE BY JURISDICTION

		Jurisdiction - Ownership				Available Data for Local Jurisdiction	
	Total Miles	MassDOT	%	Municipal	%	Data Miles	%
Cape Cod	738.98	197.79	26.77%	541.19	73.23%	85.25	15.75%

MassDOT evaluates roads under their own jurisdiction and a selection of municipally-owned roadways. The following table lists the corresponding rating from Excellent to Poor, based on a "PSI" (Pavement Serviceability Index) rating – roughly analogous to the "Pavement Condition Index" (PCI) commonly used.

Pavement Condition	Excellent	Good	Fair	Poor
"PSI" Range	PSI >=3.5	PSI 2.8-3.5	PSI 2.3-2.8	PSI < 2.3

The following map identifies the roadways that have been evaluated (shown in red) and those that lack evaluation (shown in blue).

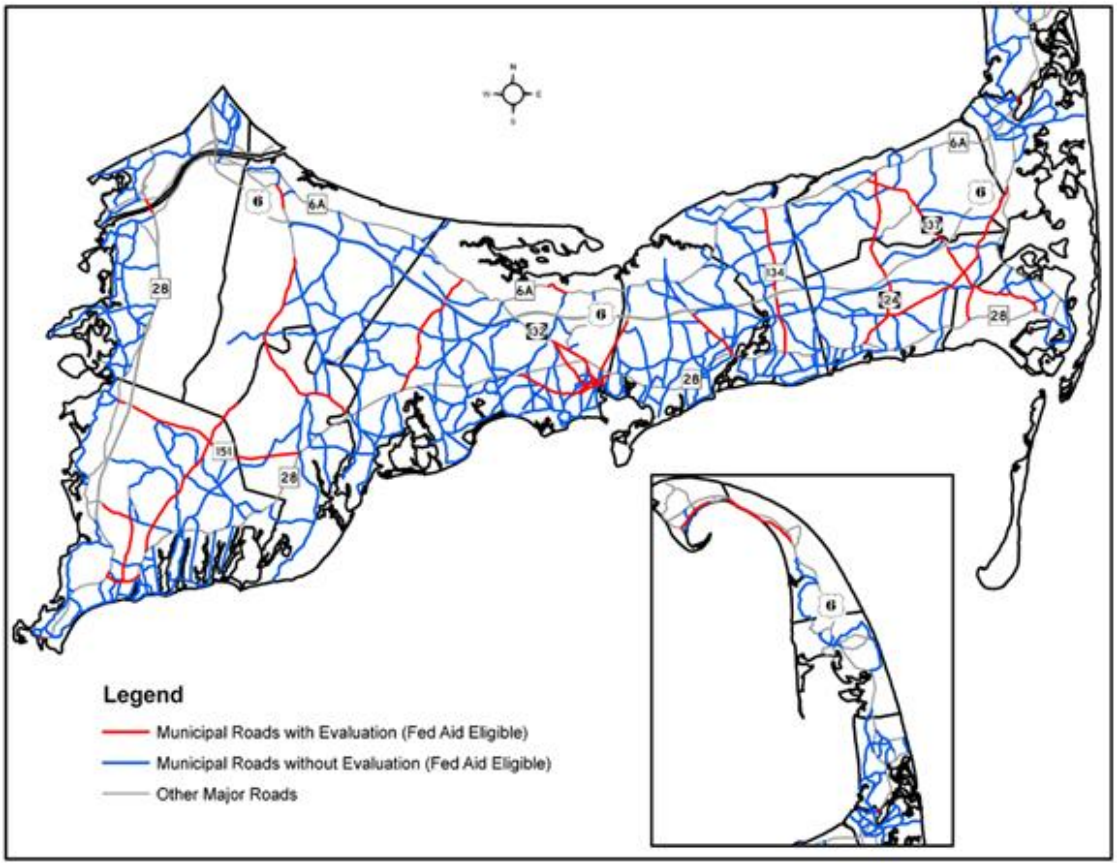

FIGURE 3 - MASSDOT EVALUATION OF MUNICIPAL ROADS

Source: MassDOT 2006-2009

CCC EVALUATIONS OF PAVEMENT CONDITIONS – WINDSHIELD SURVEYS

Using the MassDOT pavement evaluation discussed in the previous section as a basis for new data collection, CCC staff undertook a series of "windshield" surveys throughout Barnstable County. Data collection began in 2011 with a goal of evaluating approximately one-third of the mileage of federal-aid eligible municipal roadways each year. Roadway selection and segmentation was not-standardized at that time which made data processing time-consuming and inefficient. Much of the route selection and data recording were done using paper maps and field sheets.

Starting in 2014, a new data collection strategy was deployed, based on Geographic Information Systems' needs and strengths. Data-collection regions of each town were identified which contained roughly one-third of the mileage of federal-aid eligible municipal roadways. The quality and accuracy of the data collection was greatly improved through the use of GPS-capable tablet computers. The following chart identifies the data collection cycle (data collected in 2014 corresponds to the blue-colored roadways.

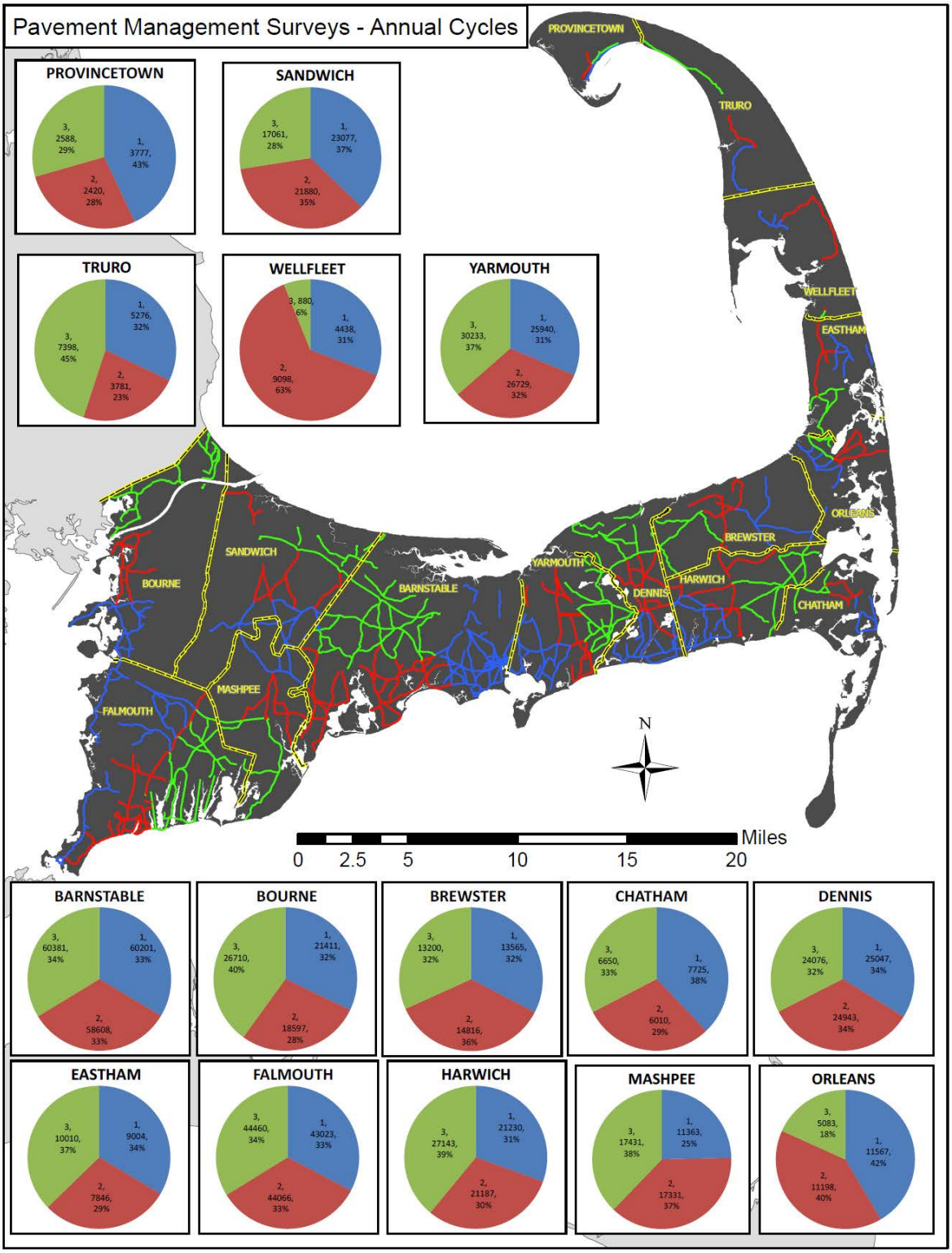

FIGURE 4 - PAVEMENT DATA COLLECTION CYCLES

The following table provides a summary by town of CCC windshield survey data.

TABLE 5 – 2011-2014 CCC SURVEYS OF PAVEMENT CONDITION - MILES

Town	Very Good to Excellent	Good to Very Good	Fair to Good	Poor to Fair	Poor	Totals
Barnstable	3.7	16.0	56.5	28.7	0.9	105.8
Bourne	3.6	3.5	26.3	5.7	1.0	40.1
Brewster	1.3	9.3	7.2	7.3	0	25.0
Chatham	2.6	2.8	6.3	0.4	0	12.1
Dennis	6.5	11.0	24.7	2.8	0	44.9
Eastham	0	1.9	10.4	3.9	0	16.1
Falmouth	2.8	19.5	24.0	12.2	0.1	58.5
Harwich	2.9	19.6	13.8	2.0	0	38.3
Mashpee	1.5	8.2	19.1	0.1	0	29.0
Orleans	0	5.1	6.2	5.2	0	16.4
Provincetown	0	1.1	1.4	2.8	0	5.3
Sandwich	6.0	4.1	13.4	8.7	0.8	33.0
Truro	1.2	2.1	5.0	1.7	0	10.0
Wellfleet	0	1.7	3.1	1.5	0	6.2
Yarmouth	1.2	9.4	32.1	7.2	0.6	50.6
Totals	33.3	115.3	249.3	90.0	3.5	491.3

As shown in the table above, almost 500 miles of survey data were collected throughout the 15 towns of Barnstable County from 2011-2014. The most common rating "Fair to Good" yielded almost 250 miles. This is followed by almost 115 miles of "Good to Very Good", 90 miles of "Poor to Fair," over 33 miles for both "Very Good to Excellent" and slightly over three miles of "Poor."

The following figures provide a graphic of the CCC survey data in a series of four maps (Upper Cape, Mid-Cape, Lower Cape and Outer Cape). The CCC evaluations are shown as colored parallel lines ranging from Blue (Very Good to Excellent) to Red (Poor).

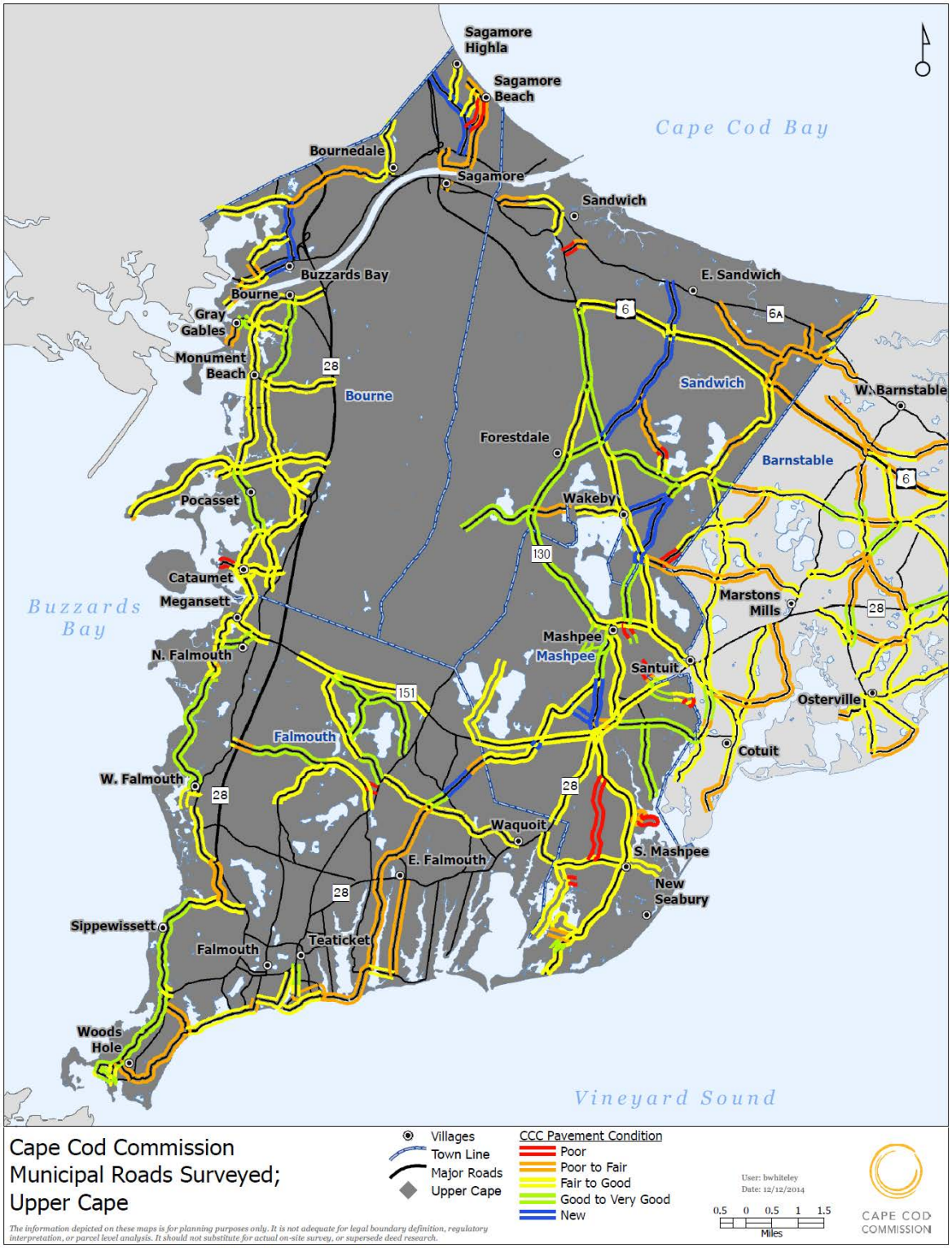

FIGURE 5 - 2011-2014 CCC PAVEMENT CONDITION SURVEYS: UPPER CAPE

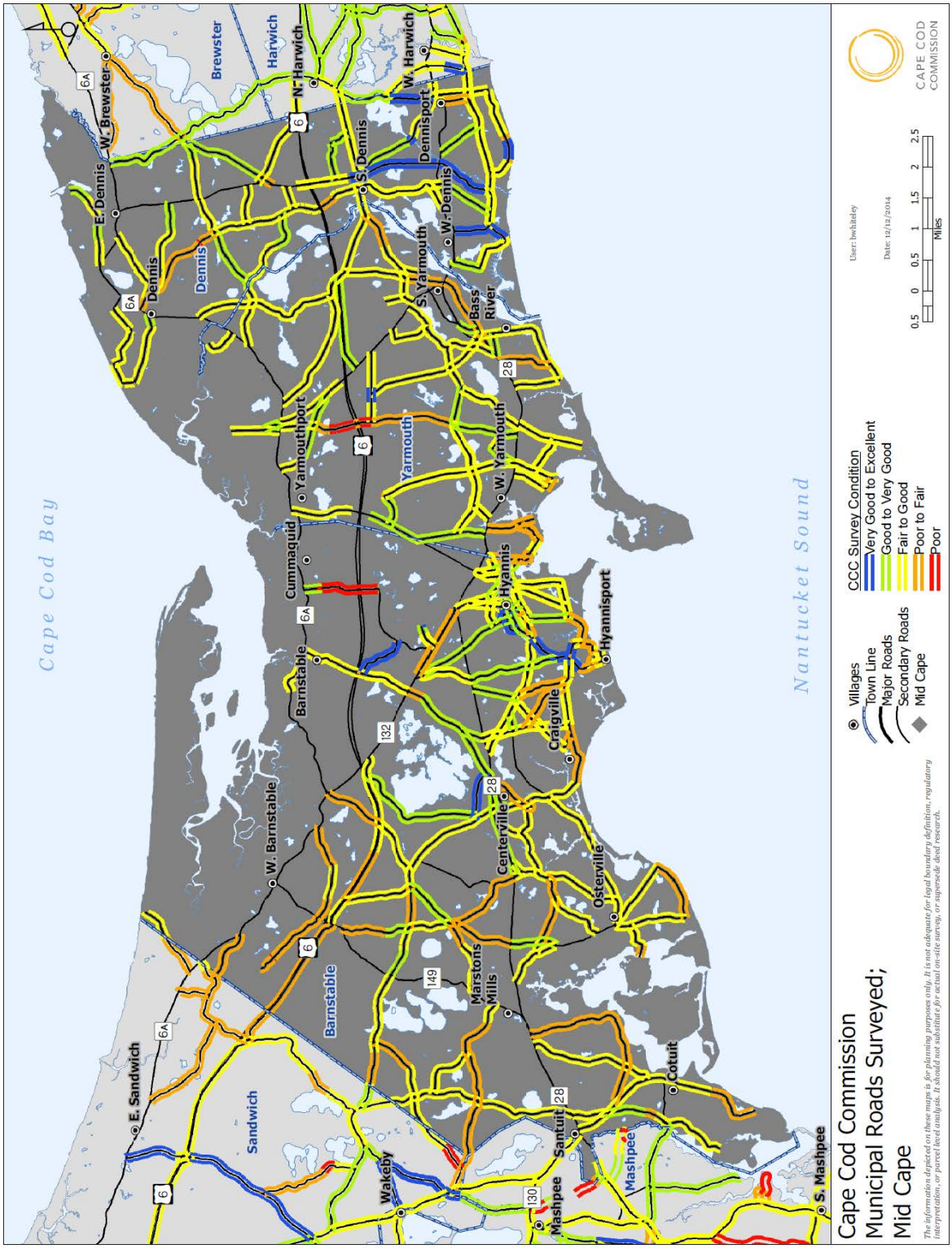

FIGURE 6 - 2011-2014 CCC PAVEMENT CONDITION SURVEYS: MID-CAPE

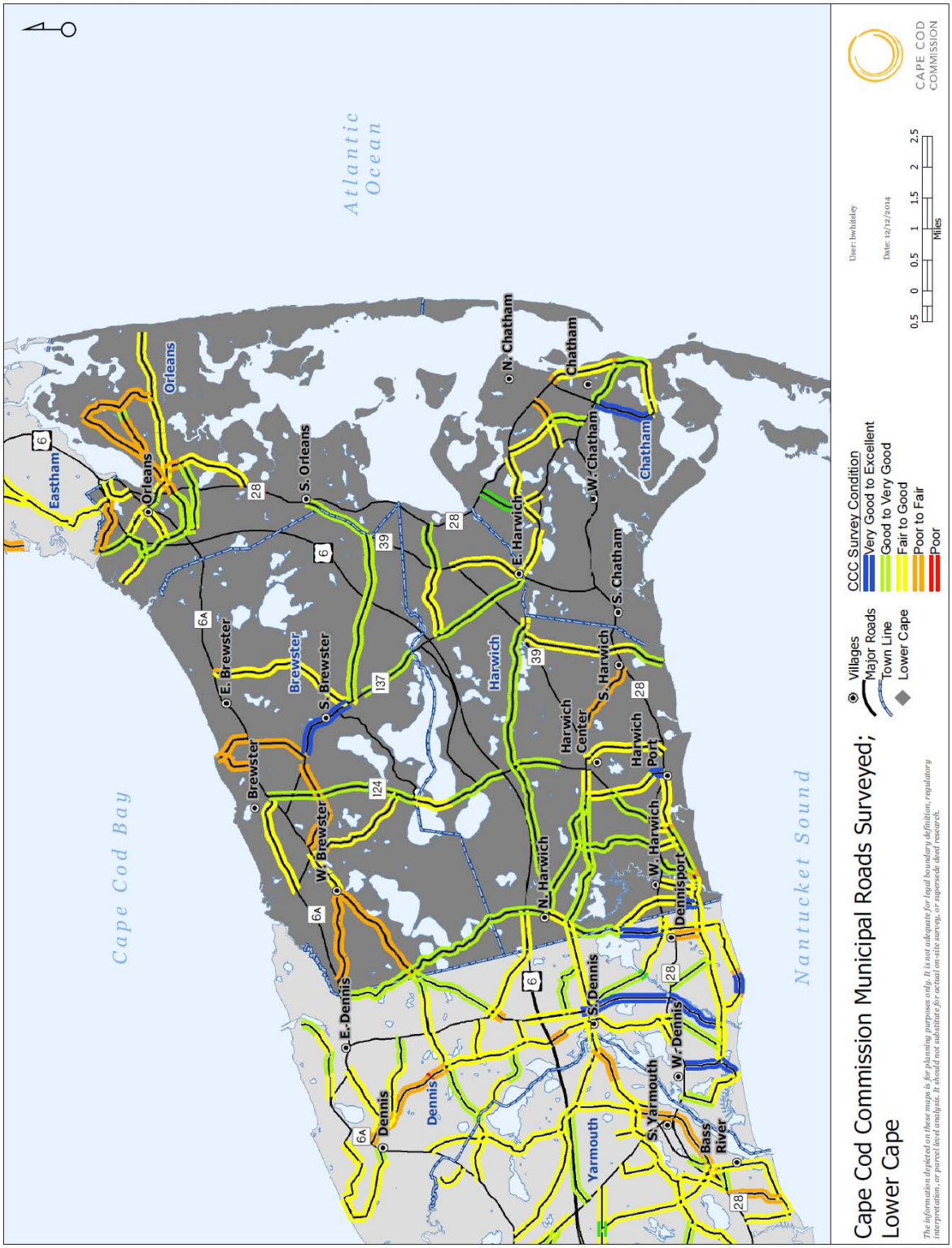

FIGURE 7 - 2011-2014 CCC PAVEMENT CONDITION SURVEYS: LOWER CAPE

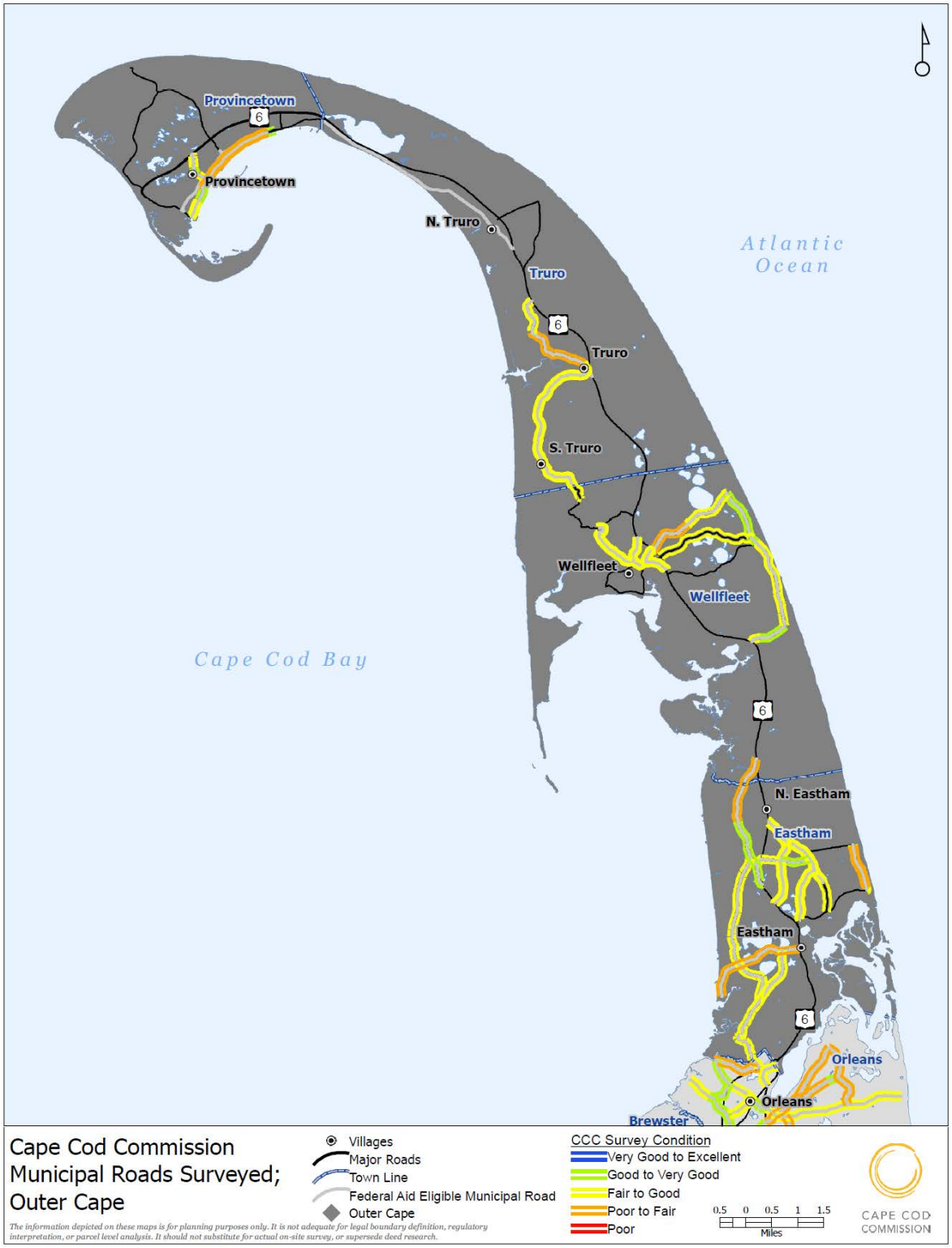

FIGURE 8 - 2011-2014 CCC PAVEMENT CONDITION SURVEYS: OUTER CAPE

CAPE COD COMMISSION

CCC EVALUATIONS OF PAVEMENT CONDITIONS – ATR SITES

Starting in mid-summer of 2011, CCC traffic technicians were tasked with collecting pavement condition data as part of their work in setting up Automatic Traffic Recorders (ATRs). Including data collected in 2012 and 2013, this yielded pavement condition data at 410 unique locations throughout the Cape's 15 towns. Also, since a 48-hour traffic count was collected from each ATR, results include a "Weighted" pavement condition for each town. By multiplying the Annual Average Daily Traffic at each location times that locations' observed pavement condition, we then totaled these results and divided by the sum of Annual Average Daily Traffic from that town's ATR's. Annual Average Daily Traffic is calculated by multiplying the appropriate MassDOT monthly adjustment factor times the observed average daily traffic over the 48 hour ATR data collection period. The following table presents town-wide averages of the pavement condition information collected at ATR sites.

TABLE 6 - SUMMARY OF PAVEMENT CONDITIONS AT ATR SITES

TOWN	# OF SITES	AVG. AADT	AVG. CONDITION	WEIGHTED CONDITION
Barnstable	56	8,145	2.84	2.85
Bourne	36	6,067	2.92	2.92
Brewster	13	6,000	3.38	3.41
Chatham	25	5,915	3.08	3.14
Dennis	39	6,197	2.79	2.87
Eastham	18	3,032	2.94	2.49
Falmouth	62	6,844	3.00	2.91
Harwich	31	7,152	2.71	2.61
Mashpee	28	7,145	2.82	2.93
Orleans	26	6,187	2.88	2.97
Provincetown	19	3,496	3.16	3.46
Sandwich	47	5,724	2.83	2.76
Truro	25	2,766	3.00	2.75
Wellfleet	26	3,130	2.88	2.86
Yarmouth	55	7,001	2.62	2.71

See Table 1 for descriptions of pavement conditions (ranging from "Excellent" = 1 to "Poor"=5). Pavement conditions including comments and other ATR data for each of the 250 collection sites are presented in the appendix. The following figures are a graphical display of the individual site data for sections of Barnstable County (Upper Cape, Mid-

Cape, and Lower Cape). The pavement condition at each ATR site is shown as a colored circle ranging from Blue (Very Good to Excellent) to Red (Poor).

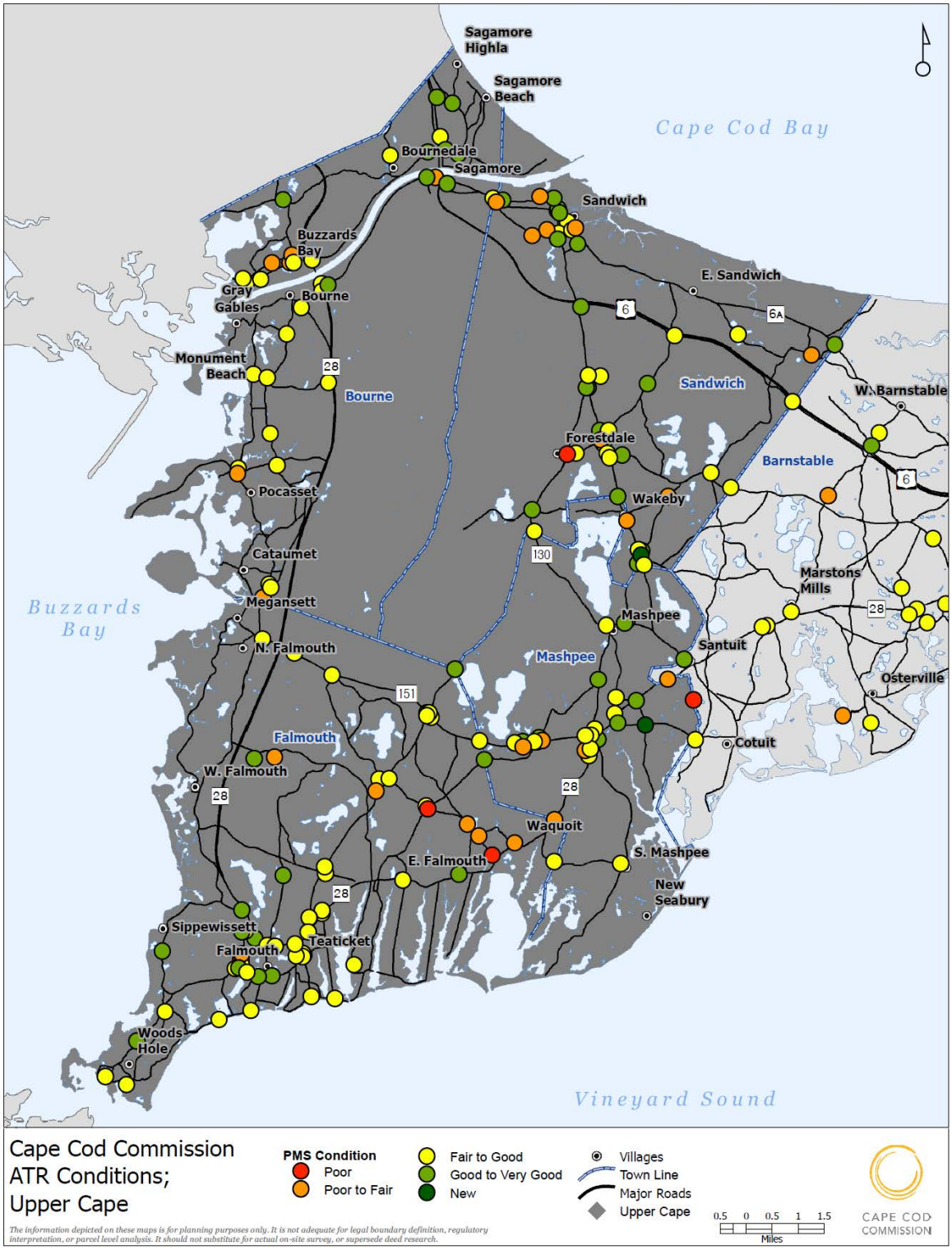

FIGURE 9 - 2011-2014 PAVEMENT CONDITIONS AT ATR LOCATIONS: UPPER CAPE

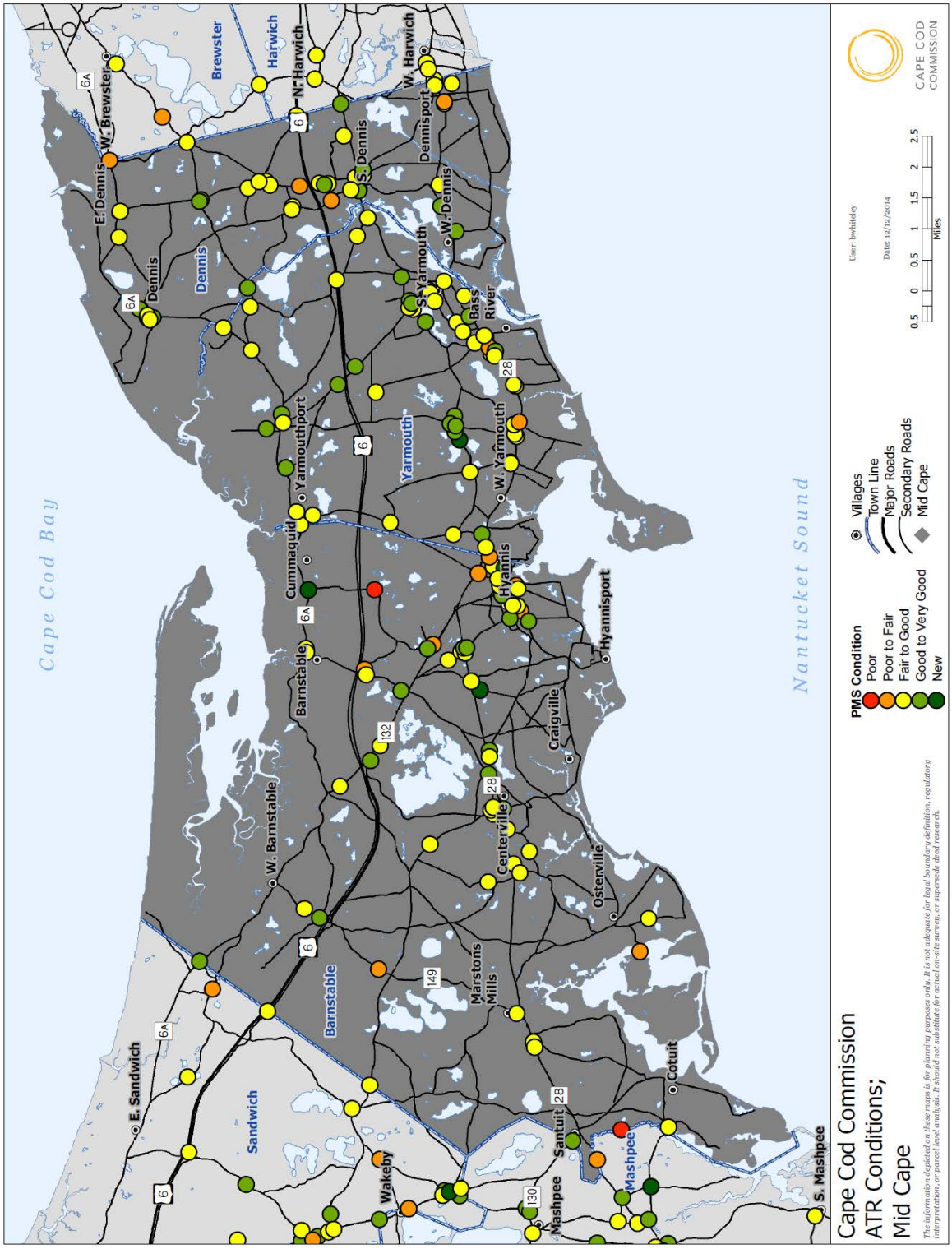

FIGURE 10 - 2011-2014 PAVEMENT CONDITIONS AT ATR LOCATIONS: MID-CAPE

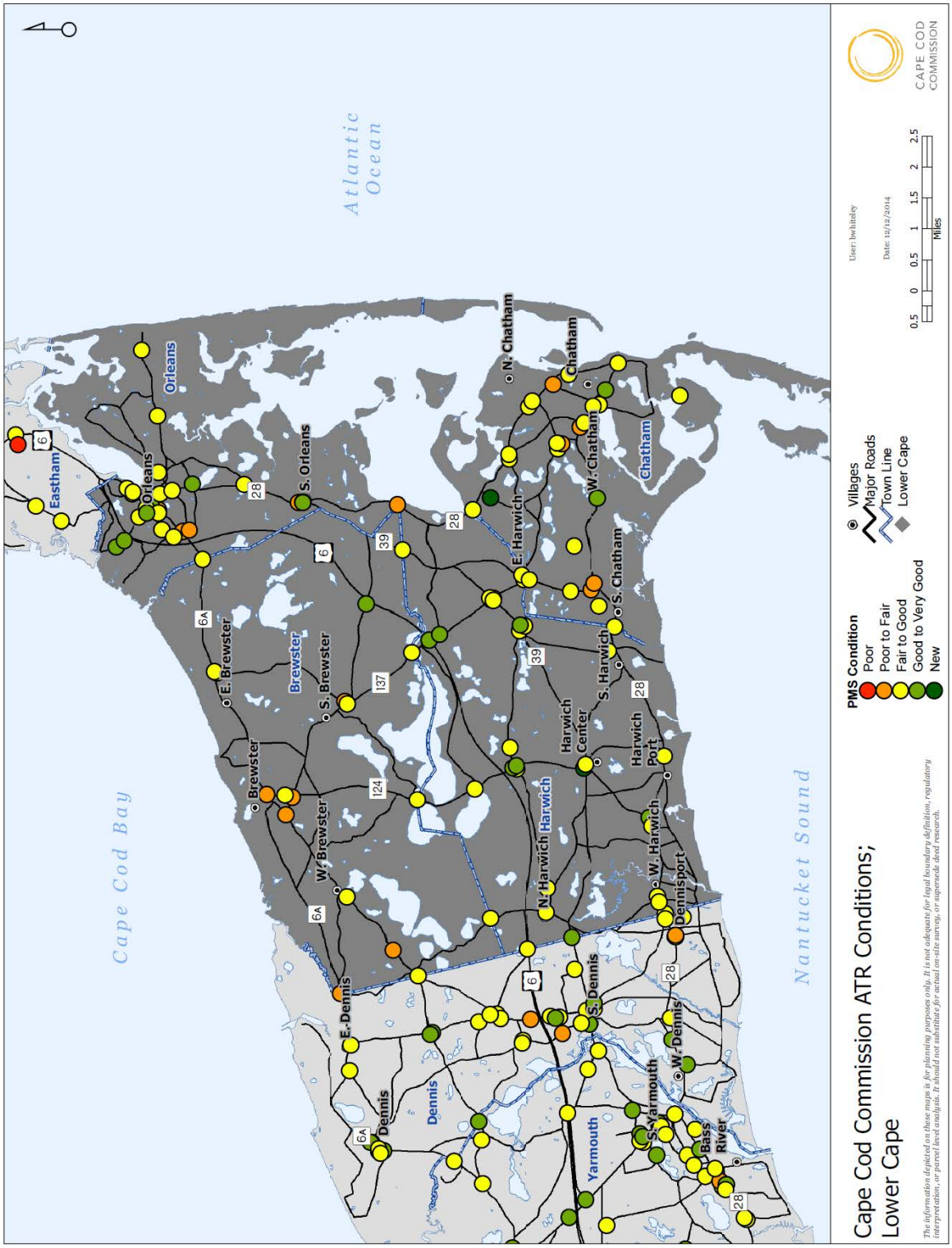

FIGURE 11 - 2011-2014 PAVEMENT CONDITIONS AT ATR LOCATIONS: LOWER CAPE

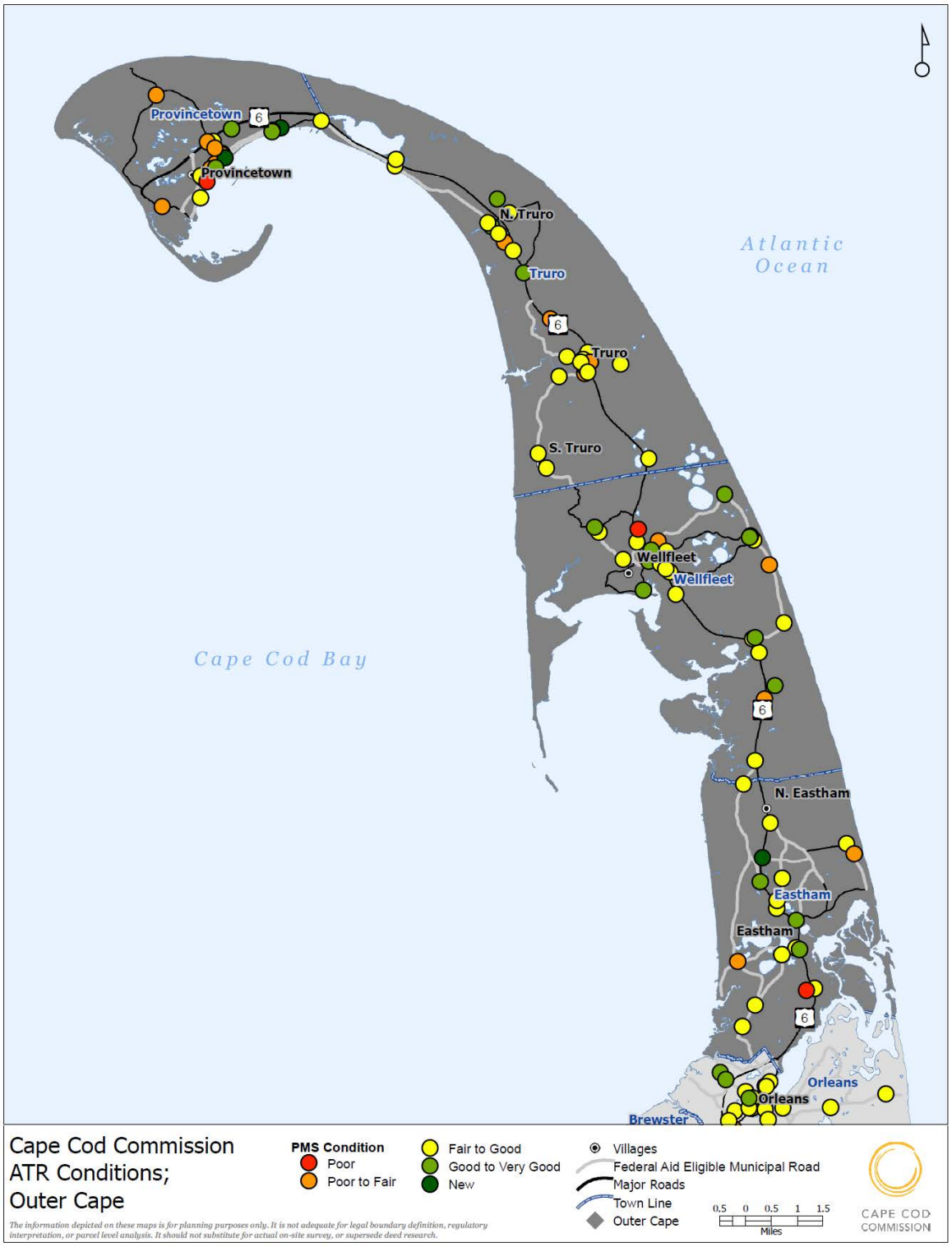

FIGURE 12 - 2011-2013 PAVEMENT CONDITIONS AT ATR LOCATIONS: OUTER CAPE

CAPE COD COMMISSION

RECOMMENDATIONS FOR ACHIEVING IMPROVED PAVEMENT CONDITION

The pavement deterioration curve shown in Figure 1 demonstrates the advantages of maintaining good roads in order to avoid expensive rehabilitation and reconstruction. For each level of Pavement Condition there is a corresponding Pavement Condition Index (PCI) – indicated by the column "PCI Start" in the table below.

By plotting the PCI for each condition level on the deterioration curve we are able to estimate the PCI after 5 years (this number corresponds to the 5-year "time bands" used in the Regional Transportation Plan for programming transportation projects). This is indicated by the column "5 Year – PCI No Repair" in the table below.

Repair strategies for each pavement "Starting Condition" vary according to starting PCI. For example, pavement currently categorized as "Good" or better (PCI greater than 89.0) may undergo "Maintainance" (e.g. crack sealing, cleaning catch basins, etc.) with an associated modest cost per mile. Pavement currently categorized from Fair to Good (PCI of 80.5) would undergo "Rehabilitation" and a higher cost and pavement below Fair condition (PCI below 65.5) would require the most expensive repair of "Reconstruction." The estimated costs per mile for each repair strategy were originally estimated by the Old Colony Planning Council.

On average, pavement categorized as Good or above that is maintained would retain the same PCI. Pavement that is rehabilitated or reconstructed would on average achieve a PCI equal to "Very Good – Excellent" (PCI 96.5).

Therefore, it is possible to calculate a "Benefit" (i.e., the difference in the PCI between performing a repair and doing nothing). For example, if a segment of road is currently assessed to be at a PCI of 80.5 (Fair to Good) there are two possibilities: (1) rehabilitate the pavement resulting in an average PCI of 96.5 or (2) allow the pavement to deteriorate over the five year time span down to a PCI of 29.7. In this case, the benefit of performing the repair (i.e., rehabilitation) is calculated to be the difference from 96.5 minus 29.7, or 66.8.

By relating the PCI Benefit of performing roadway repairs to the repair cost per mile, it is possiblible to calculate a Benefit/Cost ratio. These ratios are shown in the right-most column of the table below. To make the comparisons easier to review, the Benefit/Cost ratio of all of the pavement conditions have be factored by 10,000.

TABLE 7 - CHANGE IN PAVEMENT CONDITION – IMPROVEMENT STRATEGY

STARTING CONDITION	PCI START	5 YEAR - PCI NO REPAIR	REPAIR STRATEGY	REPAIR COST PER MILE	5 YEAR PCI REPAIR	PCI BENEFIT	BENEFIT / COST (SCALED BY 10,000)
Very Good to Excellent	96.5	83.6	Maintenance	$35,000	96.5	12.9	3.69
Good to Very Good	89.0	54.6	Maintenance	$45,000	89	34.4	7.64
Fair to Good	80.5	29.7	Rehabilitation	$100,000	96.5	66.8	6.68
Poor to Fair	65.5	22.2	Reconstruction	$550,000	96.5	74.3	1.35
Poor	27.5	16.6	Reconstruction	$554,000	96.5	79.9	1.44

The table above indicates that the most cost-effect repair strategy would be focused on performing maintenance on "Good to Very Good" roads with an estimated Benefit/Cost of 7.74, closely followed by performing rehabilitation on "Fair to Good" roads with an estimated Benefit/Cost of 6.68.

As a matter of policy, it is also recommended that funds be reserved to reconstruct a subset of "Poor to Fair" and "Poor" Roads.

The Cape Cod MPO is committed to exploring improved pavement management strategies and techniques to help optimize investment and achieve maximum improvement in overall PCIs.

CONCLUSION/RECOMMENDATIONS FOR PMS ENHANCEMENT

During FY 2015, Cape Cod Commission staff will continue advance PMS activities throughout the 15 towns of Barnstable County. Efforts will continue such as:

- Identify individual towns' methods for pavement condition evaluation and programming for improvements
- Identify "gaps" in pavement condition information on Municipally-owned Federal Aid eligible roadways – and – prioritize and implement CCC data collection activities on these roadways
- Improve CCC skills in performing pavement evaluations
- Analyze local communities' bid prices to develop Cape-specific improvement costs of various pavement conditions

CAPE COD
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CAPE COD COMMISSION

3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

CAPE COD
COMMISSION

2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix K: Access to Essential Services and Regional Cooperation

Draft
June 15, 2015

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Technical Appendix K: Access to Essential Services and Regional Cooperation

ACCESS TO ESSENTIAL SERVICES

The essential housing, employment, healthcare, education, recreation and transportation services or facilities on Cape Cod are defined in this appendix chapter. The location of each service or facility is identified. Access to each service or facility for personal vehicles, transit, bicyclists or pedestrians is discussed. Transportation facilities and services are discussed in detail in the Existing Conditions appendix.

In order to improve access to and between these essential services the following will be address through various efforts outlined in this plan:

- Reduce congestion for all modes,
- Improve travel time reliability for all modes,
- Improve safety for all modes,
- Increase connections opportunities between different modes,
- Closing gaps in the bicycle and pedestrian network, and
- Improving transit options.

Vehicle Access on Cape Cod experiences distinct seasonal changes. During the summer months, July and August, roads are congested. The congestion is a result of the tourism industry and numerous second homes in the region. The winter months have less congestion, however roads can become dangerous in times of heavy snow. During spring and fall roads are less congested except during holidays. Many of the issues with vehicle access results from congestion or unsafe intersections. Congestion issues are discussed in the Congestion Management appendix item including maps that detail approximate Level of Service (LOS) at counted locations. Safety issues are discussed in the Safety appendix including a list of the top crash locations in the region.

The Cape Cod Regional Transit Authority (CCRTA) provides transit services on Cape Cod. Details on each of type of service can be found in the Existing Conditions Appendix. Total ridership for the CCRTA in FY2014 was over 1.2 million passengers The CCRTA offers year round fixed routes, seasonal fixed routes, demand response and paratransit service trips. The fixed routes abide by a "flag system" policy, meaning that the bus can stop to pick passengers up if the passenger waves to the driver from a safe location along the route. Demand response services provide door to door trips at the prior request of a customer. Paratransit service provides door to fixed route bus stop trips or door to medical appointment trips. Fixed route

stops are detailed in the discussion of access in this appendix but it is likely that other means of transit are available.

Bicycle and Pedestrian accommodation on Cape Cod consists of sidewalks, wide shoulders and multi-use paths. There are no existing designated bike lanes on Cape Cod. Two separated bike paths have frequent use and provide long distance connections, the Cape Cod Rail Trail (CCRT) extending from Dennis to Wellfleet and Shining Sea Bikeway extending through Bourne.

ACCESS TO AND FROM CAPE COD

All long distance trips by vehicle, from outside the Cape Cod region are limited by functionally obsolete Sagamore and Bourne bridges that cross the Cape Cod Canal. The Sagamore and Bourne bridges are the only access point for vehicles, cyclists and pedestrians for long distance trips. During the summer and times which the bridges are under maintenance or in emergency situations multi-mile backups are common. This limits travel for those living near the bridges, commuters and vacationers. In this chapter interregional access to essential services is mostly discussed, however there is also access issues associated with travel in and out of the region.

HOUSING

Housing on Cape Cod is defined by the high percentage of seasonal homes or second homes, the high percentage of single family units and the reality that the average income of year round residents is well below the income necessary to own a home. This makes affordable housing facilities and services that help people find affordable living spaces essential. Four housing service organizations and three of the largest housing facilities are detailed below in terms of location and access.

Services

Housing Assistance Corporation (HAC) is located on west road in Hyannis on West Main Street south of Route 28. Access to this location by automobile is affected by congestion. Several measured locations, including west of the intersection at West Main Street at Route 28 and locations near the Barnstable Municipal Airport received an LOS F rating. The CCRTA Sandwich line stops nearby on West Main Street at the Star Market approximately one quarter mile to the north. There are sidewalks on both sides of West Main Street.

Harwich Ecumenical Council for Housing (HECH) is located in Harwich on Sission Road (Route 124 and Route 39) south of Route 6. Access to this location by automobile is not affected by congestion. The nearest fixed route transit connection is at the Star Market stop on the H2O bus provided by the CCRTA approximately quarter mile to the south. This portion of Sission Road has sidewalks on the west side of the road and the Cape Cod Rail Trail (CCRT) is located approximately three quarters of a mile to the north.

Community Development Partnership in Eastham is located on Route 6 in Eastham. This portion of Route 6 is two lanes in each direction undivided and affected by summer congestion.

It is dangerous to turn left into the business due to the two lanes of opposing traffic. The nearest fixed route transit connection is on the Flex Route at Seaman's Bank under quarter mile to the north for southbound travel. For northbound travel the Flex Route stops at Bracket Road under a quarter mile to the north. This portion of Route 6 has sidewalks on the west side of the road. The Cape Cod Rail Trail is also located approximately a quarter mile from this location to the east.

Community Housing Resource Inc. in Provincetown is located on Commercial Street in Provincetown. This portion of Commercial Street in Provincetown is a one way street. In the summer Commercial Street is congested with pedestrians and bicyclist restricting access for vehicles. This location does not have parking and parking elsewhere Provincetown is limited and often at capacity. There is a transit stop located about quarter mile to the west at First Pilgrims Park and there is a sidewalk on the north side of the road.

Facilities

Cromwell Court is located in Hyannis on Barnstable Road and has 124 units. Access to this location by automobile is affected by congestion. The majority of roadway volume measurements within a quarter-mile received an LOS F. The Hyannis Transportation Center is approximately quarter mile from this location and both sides of the road have a sidewalk. The Hyannis Transportation Center is a stop for the Barnstable Villager, H2O, Sealine and Sandwich Line year round fixed routes, Hyannis Trolley seasonal fixed route and intercity buses.

The Rock Harbor Village located in Orleans on Rock Harbor Road includes 100 affordable units. Access to this location by automobile is not affected by congestion. There are fixed transit stops approximately quarter mile to the south at the CVS on the H2O route and FLEX. Both sides of the road have sidewalks and the Cape Cod Rail Trail is located nearby.

Senior Living Residences in Bourne is another large housing facility with 84 units located on County Road near the Otis rotary. Access to this location by automobile is not typically affected by congestion. The facility is located near the limited access portion of Route 28. There is a fixed route transit stop at the Senior Living Residences on the Bourne Run.

Employment on Cape Cod is defined by the seasonal economy and several large employers. The table to the right identifies the top 10 employers on Cape Cod. The two facilities that employ between 1,000 and 4,999 people according to the Massachusetts database are Cape Cod Health Cape and Woods Hole Oceanographic Institution. Facilities that employ between 500 and 999 people according to the Massachusetts database are Air National Guard, Cape Cod Community College, Nantucket Airlines, Ocean Edge Resort, Steamship Authority, and the Woods Hole Steamship Authority. All other employers on Cape Cod are not recognized to have over 500 employees. Retail Centers also have a high number of employees. Many locations increase employment or are only open in the summer months. Accesses to facilities that employ over 1000 people and large retail centers are discussed below.

TABLE 1: LARGEST EMPLOYERS ON CAPE COD

Employer	Range of Employees
Cape Cod Healthcare Inc.	1,000-4,999
Woods Hole Oceanographic Inst.	1,000-4,999
Air National Guard	500-999
Cape Cod Community College	500-999
Nantucket Airlines	500-999
Ocean Edge Resort	500-999
Steamship Authority	500-999
Woods Hole Steamship Authority	500-999

Source: Infogroup

Large Employers

Cape Cod Health Care has several locations including the Cape Cod Hospital, Falmouth Hospital. There are 20 total locations that include outpatient centers, cancer centers, senior services, Visiting Nurse Associations, and rehab centers across the Cape. Access to the two hospitals is detailed in the Healthcare Facilities sections below.

Woods Hole Oceanographic Institution (WHOI) is located in Woods Hole in Falmouth. Access to Woods Hole by personal vehicle can be difficult due to the geographic location. Woods Hole is the southwestern most part of the region and only road accessing this area is Woods Hole Road which deviates south from Route 28. Both Route 28 and Woods Hole Road experience year round congestion and several traffic volume measurements indicate a LOS F. Woods Hole is accessible by fixed route transit on the Sealine and seasonally on the WOOSH Trolley. The majority roads surrounding the WHOI have sidewalks and the Shining Sea Bike Path is located under one quarter of a mile from the facility. There is ferry service to Martha's Vineyard from the Woods Hole Steamship Authority Terminal.

The employers with over 500 employees are listed below:

- The Air National Guard located on Joint Base Cape Cod and is accessed from various points in Bourne, Mashpee, Falmouth and Sandwich. The main access point to Joint Base Cape Cod is through the Otis Rotary in Bourne.

- Community College is located on Route 132 in Barnstable. Access issues associated with this facility are detailed in the Educational Facilities section of this appendix.

- Nantucket Airlines is located in Hyannis at the Hyannis Airport. Access issues associated with this facility are detailed in the Transportation Services section of this appendix.

- Ocean Edge Resort is located in Brewster on Route 6A. There are not significant access issues to this location.

- Steamship Authority is located in Hyannis and the Woods Hole Steamship Authority Terminal is located in Woods Hole. Access associated with both the Steamship Terminal locations are identified in the Transportation Services section of this appendix.

Retail Centers

The Hyannis area is home to high density retail. The center of retail is at the Cape Cod Mall located on Route 132. Also there are several shopping strip malls in the Hyannis area. Access by vehicle is limited by year round congestion. Numerous traffic volume measurements in Hyannis show a roadway LOS of F. There is transit service to many retail locations in Hyannis on the Barnstable Villager. Intercity busses and numerous other CCRTA fixed routes access the Hyannis Transportation Center. The Hyannis area is not assessable by bicycle but many of the roads have sidewalks.

Mashpee Commons is another high density retail location. The shopping center is located by the Masphee Rotary on both sides of Route 151. Access to this location by personal vehicle is affected by congestion. Numerous traffic volume measurements near the Mashpee Rotary show a roadway LOS of F. There is a fixed bus stop on the Bourne Run and the Sealine at Mashpee Commons. Many roads around Mashpee Commons do not have sidewalks bicycle accommodations.

HEALTHCARE

There are numerous health care services on Cape Cod including large and small practices. The location and access to the two largest hospitals and access to Boston Medical facilities are detailed below.

Hospitals

The Cape Cod Hospital is located in Hyannis south of Route 28 on Lewis Bay Road. In 2014, according to statistics provided by Cape Cod Health the hospital maintained 342 staffed beds, discharged 22,256 patients and handled over 118,000 emergency visits. Access by vehicle to this location is difficult due to year round congestion from all directions. The long distance travel has the most access issues because the majority of traffic accesses Cape Cod Health Care from Route 6 at Exit 7 to the north, then travels down Yarmouth road/Willow Street and Camp Street. The intersection of Yarmouth Road and Route 28 is one of the most congested and poorly functioning intersections on Cape Cod. There is not signal priority for emergency vehicles at this intersection. There fixed route transit stop located at Cape Cod Health Care on the H2O Route. The Hyannis Transportation Center, where numerous local and regional busses stop, is located a few blocks from the Hospital. The majority of roads in surrounding the Cape Cod Hospital have sidewalks. The steamship authority and Hyline ferry's terminals are located a few blocks away connecting patients from Nantucket and Martha's Vineyard.

Falmouth Hospital is located on Te Heun Drive west of Route 28 in Falmouth. This hospital treats approximately 40,000 total patients per year. Access to this location by personal vehicle is affected by congestion. Traffic volume measurements on the majority of roads near the Falmouth Hospital including Route 28 and Jones Road showed roadway LOS of F. The intersection of Route 28 and Jones Road/Te Heun Drive does prioritizing for emergency vehicles. The closest fixed route transit stop is at the Falmouth Bus Depot on the Sealine, over a half a mile away. Like the Cape Cod Hospital there are demand response services available to bring patients to the hospital. Te Huen Drive and Route 28 do have sidewalks on one or both sides and the Shining Sea Bikeway is located under a quarter mile away.

Many Cape Cod residents also travel to Boston for medical service. Different methods of access include personal vehicle, transit. Severe cases are transported by medical flight using a helicopter. Demand response transit services are offered by the CCRTA that travel directly to the Boston Hospital for $15.00 each way. There are also numerous demand response services that will transport patients to health services on Cape Cod.

EDUCATION

Education facilities on Cape Cod include private and public K-12 school, technical high schools, higher education, and continued education. The table to the right shows the largest school districts or independent schools by number of teachers and students. Access to the largest Cape Cod Community College, Massachusetts Maritime Academy and the high schools or independent schools in districts that enroll over 3,000 students is discussed below.

In terms of transit access, school busses exclusively transport students to and from school. Regional Transit Authorities are not legally able to provide trips to and from public schools. Private schools and colleges are allowed to use RTA bus systems as a means to transport students.

TABLE 2: ENROLLMENT AT CAPE COD SCHOOLS

School District/ Independent School	Teachers	Students
Barnstable	370	4,900
Falmouth	282	3,541
Dennis-Yarmouth	303	3,044
Sandwich	157	3,017
Bourne	157	2,045
Monomoy	181	1,869
Mashpee	133	1,670
Nauset	129	1,584
Sturgis	82	803
Upper Cape Tech	49.8	677
Cape Cod Voc Tech	70	654
Lighthouse	18	239
Provincetown	19	109

Source: Massachusetts Department of Education

Higher Education

Cape Cod Community College is located in Barnstable on Route 132 north of Route 6. The programs offered include 32 associates in arts degrees, 32 associates in science degrees and 56 career certificates. The college estimates that approximately 7,300 individuals from all over southern Massachusetts enroll in courses each year. The college is located about one quarter mile north of Route 6 at Exit 6. Access by personal vehicle is limited by congestion and the nearest traffic volume measurement on Route 132 indicated a roadway LOS of F. The entrance and exit points on Route 132 have been identified as dangerous in a Road Safety Audit (RSA). The study recommended considering a modern roundabout or traffic signal, providing a walking path and sidewalks to connect the facility with the Exit 6 Park and Rider Lot, and improving signage and lighting. Currently the Barnstable Villager stops at the college and intercity buses stop at the park and ride lot located less than a mile to the south at the Route 6 Exit 6 park and ride lot. Route 132 has a sidewalk on the west side near the college.

Massachusetts Maritime Academy is located in Buzzards Bay, Bourne. Access to Buzzards Bay by automobile is limited by congestion. Numerous traffic volume measurements indicate a roadway LOS of F. The geographic location of Massachusetts Maritime provides only one access road, Taylor Point. There is a stop on the Bourne Run approximately one quarter mile from the Academy. Regional Buses and the weekend summer train the CapeFLYER stop at the same place the Bourne Run does. There are not sidewalks or bike paths on the roads that access Massachusetts Maritime Academy.

Access to K-12 Schools

Barnstable School District is the largest school district with 4,900 students. The high school is located on West Main Street in Hyannis. Access by vehicle is limited by congestion during the school year due to the schools proximity to Hyannis. The Sandwich Line and Sealine stop about one quarter mile to the west at the intersection of Route 28 and West Main Street. The Sandwich Line also stops about one quarter mile to the east at the Star Market on West Main Street. There are sidewalks in both directions and there is not bike accommodation along West Main Street. There is a second entrance to the north on Route 28 that provides connection to residential neighborhoods. The entrance on Route 28 also provides access to the Barnstable Senior Center and Barnstable Intermediate School. There is a multi-use path on the south side of Route 28 but there not safe crossing for those walking to school. The town of Barnstable is currently doing a study identify ways to improve access from Route 28.

Falmouth School district is the second largest school district with 3541 students enrolled. The high school is located on Gifford Street Extension, north of Brick Kiln Road. There is not a fixed route transit stop near this school. Access by vehicle to this location is not limited by congestion. There are sidewalks along the west side of Gifford Street Extension that terminates at the intersections to the north and south of the school.

Dennis-Yarmouth School District is the third largest school district in the region with 3044 students enrolled. The high school is located on Station Avenue Road. Route 6 is located to the north and Route 28 is located to the south. Access by vehicle can be limited by congestion. Traffic volume measurements near the intersection of Gifford Street at Brick Kiln Road show a roadway LOS of F. The closest transit stop is located on Route 28 over three quarters of a mile away. There is a sidewalk on the west side of Station Avenue.

Sandwich School District is the fourth largest school district with 3,017 enrolled students. The high school is located on Quaker Meeting House Road between Route 6A from to the north and Route 6 to the south. Access by vehicle to this location is not limited by congestion. The closest transit stop is located three quarters of a mile to the south on Quaker Meeting House Road. There is sidewalk on the east side of Quaker Meeting House Road.

TRANSPORTATION

There are numerous transportation services provided by both private and public agencies on Cape Cod. Transportation services are essential to the region for reasons including the number of seniors needing assistance to medical appointments, congestion in the summer months or at the canal bridges, and access to the islands across the water. Access to services provided by the Cape Cod Regional Transit Authority, intercity and commuter buses, ferries and airports are discussed below.

Cape Cod Regional Transit Authority

The fixed routes had a ridership of 600,000 passengers in FY2014. Access to this type of service requires that passengers get to the stop locations without parking. In a survey conducted by the

Regional Coordinating Committee, lack of sidewalks and other pedestrian facilities was identified by consumers as the number one barrier to transit services. Pedestrian access to transit stops varies at each location. The number of amenities such as shelters or bike racks also varies. The Cape Cod Commission staff is performing a study in 2015-2016 to identify locations to improve pedestrian access to transit stops.

The CCRTA offers several types of demand response services including Dial-A-Rider Transportation, Paratransit Service and coordinated service with health care facilities and Councils on Aging. Assess to the services depends on the type of service, however the bus will typically arrive curbside at houses or businesses if a request is made in the day prior.

The CCRTA office and the major transit hub on Cape Cod are located at the Hyannis Transportation Center. Access by vehicle to this location is limited by year round congestion. There are several access points to this location. From the north access is off Route 28 west of the Yarmouth Road at Route 28 intersection. Yarmouth Road and Route 28 is one of the worst functioning intersections on Cape Cod. The access point is unsignalized and does not provide an aesthetic entrance to the facility. It is difficult to take a left hand turn into this entrance because of the high volume of traffic on Route 28. The second access point is on Ridgewood Avenue. Access to Ridgewood Avenue is affected by congestion. The third access point is on Center Street north of the Main Street intersection. This location does not have significant access issues but it is less direct than the other access points. The CCRTA has conducted a Transit Oriented Development study to identify ways to improve the Hyannis Transportation Center in terms of access and development. The recommendations in this study include building a village center around the transit hub that includes commercial, residential and recreational facilities. Currently there are sidewalks on the roads accessing the Hyannis Transportation Center.

Intercity and Commuter Services

Intercity and commuter buses are essential to the Cape Cod economy because it allows individuals to live in the region and work in a location with more financial opportunity. Each carrier and bus facility is discussed in more detail in the Existing Condition Appendix of this report. Access to bus terminal and park and ride lots are detailed below. The intercity bus carriers on the cape are listed below.

- Megabus/DATTCO operates form Hyannis to New York City in the summer months
- Plymouth and Brockton operates from Hyannis to Boston and Hyannis to Provincetown
- Peter Pan operates between Woods Hole and Boston, and Hyannis to Providence

The Falmouth Bus terminal is located on Depot Avenue west of North Main Street at the elbow of Route 28 in Falmouth near the Falmouth Hospital. Peter Pan Buses depart from this location. The Falmouth Bus Depot has limited parking and a poorly functioning facility. Access to this location by vehicle can be affected by congestion. There are sidewalks on both sides of Depot Avenue in this location and on both sides of North Main Street. The CCRTA busses that stop at this location include the Sealine and the WHOOSH Trolley in the summer months.

Macmillan Pier is located in Provincetown south of Commercial Street. This location is extremely congested with bicyclist and pedestrians in the summer months and parking is limited. The Plymouth and Brockton services this location with a connection to the Hyannis Transportation Center. There are sidewalks on the roads that access Macmillan Pier and the CCRTA FLEX route access the bus terminal.

The Park and Ride lots on Cape Cod are located north of the Sagamore Bridge, at Exit 6 on Route 6 and Exit 10 on Route 6. These lots are free to park in, resulting in frequent use by carpoolers that are not commuting. Parking at the Exit 6 and Sagamore lots is often at capacity. The Exit 6 and Sagamore Lots are serviced by intercity buses traveling to Boston. The exit 10 is a stop on the Plymouth and Brockton Hyannis to Provincetown route. Vehicle accesses to the lots are not affected by congestion because the lots are located near limited access highways. The Sagamore Lot has CCRTA service on the Sandwich Line and Bourne Run. The Exit 6 Lot the does not have a fixed route CCRTA transit stop. The exit 10 lot does not have CCRTA fixed route service.

The CapeFLYER train is available for people traveling from Boston to Cape Cod in the summer months on the weekends. The train includes bicycle storage and dining services. The train travels from the city, stops at several locations on the way to Cape Cod. On Cape it stops in Buzzards Bay and in Hyannis at the Hyannis Transportation Center. The stop in Buzzards Bay has access restrictions including congestion and limited parking. There is a stop on the Bourne Run transit route and there is a service that connects this parking location to the Falmouth Bus Depot.

Commuters also have access to commuter rail stations in Kingston and Lakeville provided by the MBTA. These stations are outside of the MPO region. The trip to both can be affected by congestion due to the issues crossing the Cape Cod Canal.

Ferries

The Woods Hole Steam Ship Authority Terminal is located in Falmouth on Woods Hole Road near the Woods Hole Oceanographic Institute. Access by vehicle is limited by congestion and parking. There are sidewalks on the roads that access the Woods Hole Steamship Authority Terminal. The CCRTA fixed route Sealine and seasonal fixed route WHOOSH Trolley access this location. The Boston to Woods Hole commuter bus stops at this location. The Shining Sea Bike Path terminated at this location.

The Hyannis Steamship Authority and Highline Ferry terminals are located in Hyannis on the Lewis Bay Waterfront near the Cape Cod Hospital. Access by vehicle is limited parking and congestion. There are sidewalks on the roads that access both ferry terminals. The CCRTA does not have year round fixed route transit stops at this location but does offer seasonal stops at both ferry terminals on the Hyannis Trolley.

Macmillan Pier is another location that has ferry service provided by Bay State Cruise Company. The Provincetown Ferry travels from Provincetown to Boston. This access to this location was discussed in the Intercity and Commuter Bus section of this appendix.

Airports

Cape Cod has two airports with several scheduled passenger service and several smaller airports. Access to the commercial airports is detailed below. The functionality of the airports is discussed in the Existing Conditions Appendix.

Barnstable Municipal Airport is the largest airport on Cape Cod. It is located in Hyannis north of the Airport Rotary. There are several access points for vehicles including through airport road north of Route 132, through Hinckely Road north of Route 132, or the terminal entrance east of the airport rotary on Route 28. Traffic leaving the airport can join airport rotary traffic through a one way street. Congestion associated with Hyannis affects vehicle access. There are not sidewalks on many of the roads accessing the airport including Route 28 and Route 132. There is not a fixed route transit stop provided at this location by the CCRTA. A prior transit stop was discontinued due to low ridership generation at the airport.

Provincetown Municipal Airport is located on Province Lands Road in Provincetown. Access by vehicle is not affected by summer congestion. There are not sidewalks on the roads near the airport but the Province Lands Bike Path crossed the vehicle entrance to the airport. There is not a CCRTA year round fixed route stop here but there is a stop on the seasonal fixed route service the Provincetown Beach Shuttle.

ACCESS IMPROVEMENTS

The essential services on Cape Cod can be limited by congestion or unsafe conditions as identified in this appendix item. The location of essential services and a brief description on the access for vehicles, pedestrians, transit and bicyclists has been identified. There are several transportation projects that would significantly improve access to the essential services.

Access restrictions due to the functionally obsolete Sagamore and Bourne Bridges are identified as a barrier to the entire region. During summer months and periods of bridge maintenance the bridge traffic can be backed up multiple miles. Projects which could improve access across the Cape Cod Canal are regarded as improving access to essential services including improvements to the Bourne Rotary, Belmont Circle, Sandwich Road, and projects including Route 6 exit 1 reconfiguration, replacement bridges, or an additional crossing.

Hyannis is the most urbanized region of Cape Cod and home to several essential services identified in this appendix including:

- Housing Assistance Corporation (HAC),
- Cromwell Court housing facility,
- Dense retail shopping centers
- Cape Cod Hospital and other Cape Cod Health Care Facilities
- Barnstable High School
- Hyannis Transportation Center,
- Barnstable Municipal Airport
- Steamship Authority and Hy-Line ferry terminals.

Projects have been identified that could improve access to Hyannis in recent studies including the Hyannis Access Study, Hyannis Access Implementation Study, and Yarmouth Road Study. The Yarmouth Road Study identified the potential improvements along Yarmouth Road between Higgins Crowell Road and Route 28, including a multi-use path and two additional lanes of travel. The Hyannis access study and Hyannis Access Implementation Study identified improvements at the intersection at Yarmouth Road and Route 28, Route 28 between Yarmouth Road and the Airport Rotary, and at the Airport Rotary. The improvements at the Airport Rotary include an underpass for critical directional volumes. The intersection of Yarmouth Road and Route 28 is currently programed through the Transportation Improvement Program (TIP).

Other areas that were identified to have access issues to essential services include at the Mashpee Rotary, in the Woods Hole Area, the southwest elbow of Route 28 in Falmouth, Provincetown, and along Route 6 in the Outer Cape. These roadways should be further investigated for proposed improvements and opportunities to study.

REGIONAL COOPERATION

REGIONAL PARTNERS

Development of the RTP and other planning efforts include consultation with or consideration of a wide-range of federal, state, and local agencies and organizations including:

- Barnstable County Government
- Bay Colony Railroad
- Cape Air
- Cape Cod Central Railroad
- Cape Cod Commission
- Cape Cod Joint Transportation Committee
- Cape Cod Metropolitan Planning Organization
- Cape Cod National Seashore (National Park Service)
- Cape Cod Regional Transit Authority
- Cape Cod Towns
- Federal Highway Administration
- Federal Transit Administration
- Hy-Line Cruises
- Joint Base Cape Cod
- Martha's Vineyard Commission
- Massachusetts Department of Recreation and Conservation
- Massachusetts Department of Transportation
- MassBike
- MassRides
- Nantucket Air
- Nantucket Planning and Economic Development Commission
- Old Colony Planning Council
- Freight Companies
- Peter Pan – Bonanza Bus Lines
- Plymouth and Brockton Street Railway Company
- Southeastern Regional Planning and Economic Development District
- U.S. Army Corps of Engineers
- Woods Hole, Martha's Vineyard and Nantucket Steamship Authority

URBANIZED AREA BOUNDARIES

Cooperation across Cape Cod Metropolitan Planning Organization (MPO) Boundaries occurs through meeting and consultation on studies. The Cape Cod borders both the towns of Wareham and Plymouth. The Barnstable Town Urbanized Area, defined by the 2010 census, extends into the abutting regional planning districts, Old Colony Planning Council (OCPC) and Southeastern Regional Planning and Economic Development District (SRPEDD). In some cases federal funds are distributed to Urbanized Area (UZA) requiring coordination on planning efforts. When this occurs coordination meeting are organized and Cape Cod Commission Staff may attend MPO meetings in these MPO districts.

The neighboring regional transit authority, Greater Attleboro Taunton Regional Transit Authority (GATRA) operated a fixed route service into the Buzzards Bay area. This agency is consulted when planning studies reach across the MPO boundary. Most recently this occurred in the Coordinated Public Transit- Human Service Transportation Plan because this plan released transit funds that were distributed to UZA districts, of which the GATRA and CCRTA service area are included.

METROPOLITAN PLANNING ORGANIZATION

There are several meetings facilitated or frequently attended by the Cape Cod Metropolitan Planning Organization Staff that promote coordination.

Cape Cod MPO meeting are held monthly and in attendance representatives from four sub regions in Barnstable County, MassDOT Secretary/CEO, MassDOT Highway Division Administrator, Chair of the Cape Cod Commission Chair of the Cape Cod Regional Transit Authority Advisory Board, President of the Barnstable Town Council, and the Tribal Chairman of the Masphee Wampanoag Tribal Council. Sub region A consists of the town of Bourne, Falmouth, Mashpee, and Sandwich. Sub region B includes the town of Yarmouth and Dennis. Sub region C includes the towns of Brewster, Harwich and Orleans. Sub region D includes the town of Eastham, Wellfleet, Truro and Provincetown. The MPO is formed and abides by rules established under a formal agreement in the form of a Memorandum of Understanding (MOU). MPO meetings are attended by the public.

The Joint Transportation Advisory Committee (JTC) is an advisory committee to the Cape Cod MPO. The committee is made up of representatives from each town, often a director of the town Department of Public Works (DPW) or the town engineer. Materials presented before the MPO are often presented first to the JTC to receive local feedback and to recommend action by the MPO. JTC meetings are attended by the public.

COORDINATION ON CAPE COD

The CCRTA hosts monthly Multi-Modal Meetings, quarterly advisory board meetings and Regional Coordination Committee (RCC) which Cape Cod MPO staff attends. The Multi-Modal meetings are regularly attended by representatives from the Barnstable Municipal Airport, Steamship Authority, Hy-line, Plymouth and Brockton Street Railway Company, Town of Barnstable, Cape Cod Chamber of Commerce, State Legislation Representatives. The advisory

board consists of representatives from each town and meetings are attended by various interested agencies. The RCC includes various members of human service agencies on Cape Cod. CCRTA staff and Cape Cod MPO staff also meet as frequently as bi-weekly to discuss planning efforts.

The majority of the east coast of Cape Cod is owned and managed by the National Park Service. Transportation issues that affect the National Park are discussed with their staff. Recently this agency was engaged to coordinate data collection for bicycles, the conduction of the Outer Cape Bicycle and Pedestrian Master Plan and for safety upgrades for Route 6 in Wellfleet resulting in the implementation of rumble strips on the centerline of the roadway.

STATEWIDE COORDINATION

Coordination with the state transporation department, MassDOT occurs through many means including MPO and JTC meetings. Conversation with the state department is constant in planning efforts to determine scopes of work, or impacts to local character. There are been several recent large studies that have been performed in coordination between the MPO staff and MassDOT including the Hyannis Access Study, Bourne Rotary Study and the Canal Area Study. In all three of these studies data collection, public outreach was coordinated in addition to consistent consultation on the outcomes and conduction of the study.

The Cape Cod MPO staff also coordinates with other state departments. In planning efforts to extend commuter rail to Buzzards Bay the Cape Cod MPO staff consulted with the Central Transportation Planning Staff and the MBTA. These groups lead their own investigation into the feasibility of providing the service.

The Cape Cod MPO staff attends state wide meetings with the Massachusetts Association of Regional Planning Agencies (MARPA) and Transportation Managers Group (TMG). MARPA meetings are attended executive directors from each of the thirteen planning agencies in Massachusetts and statewide and local planning issues including but not limited to transportation are discussed. TMG meetings are attended by transportation directors at regional planning agencies to discuss statewide and local transportation issues. The islands south of the Cape Cod region, Nantucket and Martha's Vinyard have representation at these meetings. At this time critical transportation coordination with these regions may be discussed.

Road Saftey Audits (RSA) is performed by Cape Cod MPO staff or private consultants. A RSA is performed to identify problems are intersection and roadways and establish long and short term solutions. At these events Cape Cod Commission staff, MassDOT staff, and town staff are present. The resent RSAs performed on Cape Cod are listed in the Saftey appendix item.

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2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix L: Title VI/ Nondiscrimination Program

Draft
June 15, 2015

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Technical Appendix L: Title VI/Nondiscrimination Program

The MPO follows federal and state non-discrimination laws and seeks to ensure that all interested parties in Barnstable County have access to the MPO's activities and services and that public involvement in the MPO's decision making comes from a diverse socioeconomic group that is representative of the county's population. The MPO has developed a nondiscrimination program, in accordance with federal and state requirements, to encourage broad public participation, representation, and equity in the region's transportation planning.

TITLE VI

Title VI of the Civil Rights Act of 1964 prohibits discrimination based on race, color, or national origin.[1] Organizations that receive Federal funds are obligated to assure nondiscrimination in their programs and activities and are required to have a comprehensive Title VI enforcement program to prevent and eliminate discrimination in their federally funded programs. FHWA and FTA set forth Title VI compliance requirements for "primary" funding recipients such as MassDOT and sub-recipients such as the MPOs to follow. Effective transportation decision making depends upon understanding and properly addressing the needs of different socioeconomic groups. The MPO's Title VI program includes identifying the demographic distribution of minority and limited English proficiency populations within the region and implementing a comprehensive strategy to ensure that the MPO conducts effective outreach to encourage their involvement in and access to the transportation planning and decision-making process.

MassDOT is responsible for ensuring that the state's MPOs comply with federal program requirements. Following MassDOT's 2013 Title VI program update, the Cape Cod MPO developed and adopted a Title VI Program in 2014 (see **Error! Reference source not ound.**). The Title VI plan provides information about beneficiaries' rights, how to file a complaint, regional demographic data, maps, a public participation plan, a language access plan, and analyses of transportation spending in the region, project locations and potential impacts from projects to ensure equity in the planning and implementation process for the region.

Although Title VI is the focal point of non-discrimination law in the United States, FHWA incorporates a broader spectrum of statutes, executive orders, and regulations into its requirements for states and MPOs. For example, Section 324 of the Federal-Aid Highway Act of

[1] "No person in the U.S. shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under a program or activity receiving financial assistance." [Civil Rights Act 1964]

1973 prohibits discrimination based on sex; Section 504 of the Rehabilitation Act of 1973 prohibits discrimination on the basis of disability status, as does the Americans with Disabilities Act of 1990; and the Age Discrimination Act of 1975 prohibits age discrimination. In addition, the Civil Rights Restoration Act of 1987 (FHWA Notice 4720.6) clarified the original intent of Congress with respect to Title VI by restoring the broad, institution-wide scope and coverage of the nondiscrimination statutes to include all programs and activities of federal-aid recipients and enforcing the application of the laws that include nondiscrimination on the basis of race, color, national origin, age, gender, or disability.

ENVIRONMENTAL JUSTICE

The concept of environmental justice is part of the MPO's nondiscrimination program. Environmental justice became a federal policy initiative in 1994 under President Clinton's Executive Order 12898 that requires each Federal agency to make achieving environmental justice part of its mission "by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Environmental justice policy for the US DOT is based on the following three principles:

1. "To avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations;
2. to ensure the full and fair participation by all potentially affected communities in the transportation decision-making process;
3. To prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority and low income populations."[2]

The MPO addresses environmental justice through its Title VI/Nondiscrimination program, as discussed above. In addition to mapping demographic data that identifies areas (census blocks) in the county with higher proportions of low income and minority populations, the staff conducts analyses on the geographic distribution region's transportation spending and project construction, to ensure equity in the distribution of transportation improvements. The analysis also includes a review of potential project impacts – positive and negative – to ensure that that potentially underserved areas neither adversely impacted by, nor denied the benefits of, transportation projects. A key piece of the program is engaging such communities in the MPO's activities and decision making through expanded and targeted public outreach. The Public Participation Plan, as discussed below, establishes the MPO's public involvement goals and strategies.

[2] http://www.fhwa.dot.gov/environment/environmental_justice/ej_at_dot/

PUBLIC PARTICIPATION PROCESS

To ensure an inclusive and accessible public engagement processes for development of the RTP, staff looked to the framework established in the Cape Cod MPO Public Participation Plan (PPP). Goals of the PPP are to:

1. Obtain Quality Input and Participation
2. Establish Consistent Commitment
3. Increase Diversity
4. Ensure Accessibility
5. Provide Relevance
6. Foster Participant Satisfaction
7. Clearly Define Potential for Influence
8. Establish and Maintain Partnerships
9. Provide Opportunities to Build Consensus

The PPP in available in English and Portuguese at www.capecodcommission.org/ppp

ANALYSIS OF HIGHWAY REGIONAL TARGET PROJECTS

An analysis of potential impacts (positive or negative) on low income, minority, and LEP populations was conducted on regional target projects and is presented in Table 1. Of the approximately $304 million in highway regional target funding, approximately $218 is programmed for specific projects while the remainder will go to "Other TIP Projects." Analysis was limited to the specific projects, with existing TIP analysis procedures ensuring that the "Other TIP Projects" will be programmed in an equitable way.[3]

[3] A recent review of the past ten years of highway projects in the Cape Cod TIP indicated that approximately 59% of spending was on projects within and proximate to low income, minority, and LEP populations. This represents an investment in transportation infrastructure serving these areas that is proportionally higher than other areas on Cape Cod.

TABLE 1. HIGHWAY REGIONAL TARGET PROJECTS – INCOME, MINORITY, AND LEP POPULATION IMPACTS

PROJECT	LOW INCOME [I], MINORITY [M], OR LIMITED ENGLISH PROFICIENCY [LEP] POPULATION AREA PROXIMATE	NATURE OF IMPACT ON LOW INCOME, MINORITY, OR LEP AREA
Barnstable: Hyannis Access Improvements	I, M, LEP	Improved bicycle/ pedestrian access, safety, traffic flow
Route 28 Multimodal Improvements: Various Locations	I, M, LEP	Improved bicycle/ pedestrian access, safety
Route 6 Outer Cape Safety Improvements	I, LEP	Improved bicycle/ pedestrian access, safety, traffic flow
Canal Area: Belmont Circle/ Route 25 Ramp Improvements		
Canal Area: Route 6 Exit 1C Reconfiguration		
Cape Cod Rail Trail Expansion: S. Wellfleet to Provincetown	I, LEP	Improved bicycle/ pedestrian access, safety
Infrastructure Improvements (Platform, Parking, etc.) for Buzzards Bay Commuter Rail Service		
Cape Cod Rail Trail Expansion: Barnstable to Sandwich	I, M, LEP	Improved bicycle/ pedestrian access, safety
Shining Sea Bikepath Extension to Cape Cod Canal Bikepath		

Of the approximately $218 million programmed for specific projects, approximately 60% was on projects within and proximate to minority populations, 77% was on projects within and proximate to low income populations, and 77%, was on projects within and proximate to LEP populations. This represents an investment in transportation infrastructure serving these areas proportionally higher than other areas on Cape Cod. In summary, the areas with higher proportions of low income and minority populations see more transportation dollars spent than other areas on Cape Cod.

For reference, demographics maps are included on the following page.

DEMOGRAPHICS MAPS

Insert Map

Insert Map

Insert Map

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2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix M: Transportation Project Analysis

Draft
June 15, 2015

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Technical Appendix M: Transportation Project Analysis

UNIVERSE OF PROJECTS

The universe of projects identified for funding can be divided into one of four funding categories:

- Transportation Projects
- Transportation Programs
- Smart Solutions
- Transportation Studies

A "**transportation project**" is specific in the location and nature of construction or other activity that is anticipated. Examples of potential transportation projects include the reconfiguration of Exit 1C on Route 6 and the construction of a new multi-use trail from the end of the existing Shining Sea Bikepath to the Cape Cod Canal Path. Any project over $20 Million in total cost must be included in the RTP to receive federal funding. Projects under $20 Million may be included in the RTP depending on the level to which the project has been developed.

Given that the RTP, covers a 25-year time-span it beyond our ability to define every specific transportation project that will implemented. Therefore, "**transportation programs**" identifying categories of specific transportation projects that are anticipated to be implemented and identifying funds to pay for these bundles of transportation projects. Examples of potential transportation programs include roadway resurfacing, intersections improvements, and transit operating assistance and capital needs.

"**Smart solutions**" are initiatives that do not require major investments in capital or operations. Examples of potential smart solutions include coordination of Cape Cod Regional Transit Authority and ferry schedules with each other and the development of a Cape-wide bicycle route system.

Finally, "**transportation studies**," seek to solve problems through planning efforts that focus on analysis of alternatives and public participation. These transportation studies ultimately identify solutions to problems that may be in the form of future transportation projects, programs, and/or smart solutions.

The Universe of Projects for the 2016 RTP are shown on the following pages.

Type	TOWN	Title	Description	Category	Ann. Cost /yr ($K)	Start Cost ($K)	Total Cost ($K)
Project	Falmouth and Hyannis to New Bedford	2 New Ferry Services	Provide new ferry services: New Bedford-Woods hole, New Bedford-Hyannis	Ferry	2,000	100,000	146,000
Project	Bourne	Bourne Rotary Improvements	Reconfigure Bourne rotary to allow direct connection between Bourne Bridge to Route 28 (MacArthur Blvd). Interim improvements to improve flows at rotary entrances and exits by widening and pavement markings/signage.	Highway		50,000	50,000
Project	Barnstable	Hyannis Access Improvements	Improve access to downtown Hyannis per Hyannis Access Study. Construct 2 additional travel lanes w/landscaped median on Yarmouth Road to connect from existing 4-lanes in Yarmouth to Route 28 in Hyannis. Includes multi-use path and sidewalk.	Highway		43,154	43,154
Project	Sandwich	Interchange Improvements Rte 6	Mid-Cape Hwy - Implement improvements to Route 6 Interchanges	Highway		38,200	38,200
Project	Bourne	Sandwich Road Parkway	Develop Sandwich Road into a 4 lane parkway with a landscaped median.	Highway		35,000	35,000
Project	Wellfleet, Truro, Provincetown	Cape Cod Rail Trail Extensions	Extend Cape Cod Rail Trail from S. Wellfleet to Provincetown	Bicycle/ Pedestrian		20,000	20,000
Project	Mashpee	Mashpee Rotary Ring Roads	Construct connector roads outside of the Mashpee Rotary: from Great Neck Road South to Route 28 East Leg; from Great Neck Road North to Route 151	Highway		20,000	20,000
Project	Bourne	Rte 28 MacArthur Boulevard Improvements	Bourne - Construction of 2 new northbound lanes on Rte 28, reverse existing northbound, existing southbound becomes frontage road	Highway		20,000	20,000
Project	Yarmouth Dennis Harwich Chatham	Rte 28 Multimodal Improvements	Multimodal improvements on of Route 28 from Falmouth to Orleans potentially markings, signage, minor widening, sidewalk construction, and improvements per the Rte 28 Safety and Traffic Flow Study including turning lanes, signal optimization.	Multi-Modal		20,000	20,000
Project	Barnstable, Sandwich	Cape Cod Rail Trail Extensions	Extend Cape Cod Rail Trail from Barnstable to Cape Cod Canal Bikepath	Bicycle/ Pedestrian		15,000	15,000
Project	Barnstable Boston	Barnstable-Boston Ferry Service	Ferry service: Barnstable to Boston	Ferry		15,000	15,000
Project	Dennis Harwich Brewster Orleans	Rt 6 Reconstruction	Route 6 National Highway System NHS, section with failing pavement	Highway		15000	15,000
Project	Barnstable Yarmouth	Hyannis Access Bicycle/Pedestrian Improvements	Regional bicycle/pedestrian access in the Route 28/Yarmouth Road and Willow Street area between Hyannis Transportation Center and planned extension of the existing Cape Cod Rail Trail in Dennis-Yarmouth; Design build grade crossings of Willow Street and Railroad	Bicycle/ Pedestrian		13000	13,000
Project	Bourne	Scenic Highway Median Barrier	Complete construction of median barrier along Route 6 Scenic Highway from Edge Hill Road to Belmont Circle in Bourne	Safety		12,000	12,000
Project	Chatham	Bridge St Bridge Replacement	Replace Bridge Street/Mitchell River Bridge (Chatham)	Bridge		12,000	12,000
Project	Wellfleet	Chequessett Bridge	Chequessett Bridge Rehabilitation	Bridge		12000	12,000
Project	Bourne	Rte 6 Reconfigure Interchange One	Improve westbound on-ramp near Sagamore Bridge during peak times for off-cape traffic flow: Route 6, Exit 1: Reconfigure WB on-ramp	Highway		11,500	11,500
Project	Sandwich Barnstable Yarmouth	Route 6 Hydroplaning	Route 6 stormwater improvements to remove runoff from traveled way, including construction of shoulders as needed	Safety		10,000	10,000
Project	Bourne	Scenic Highway/Rte 25 Connector Ramp	Develop a direct connection from Scenic Highway to Rte. 25 to divert traffic from the Belmont Circle.	Highway		10,000	10,000
Project	Capewide	HOV Lanes	Construct High-Occupancy Lanes at key segments of freeways such as Route 6, 3, 25, and 28.	Highway		10,000	10,000
Project	Provincetown	Provincetown Intermodal Gateway Project - Construction	Construct the Gateway	Enhancements		8,000	8,000
Project	Bourne	Shining Sea Bikepath Extension	Extend the Shininig Sea Bikepath to the Cape Cod Canal Bikepath	Bicycle/ Pedestrian		8,000	8,000
Project	Bourne Sandwich	Rt 6 Resurfacing	Resurfacing and related work on Rt 6 from Sagamore Bridge to Sandwich/Barnstable TL	Highway		8000	8,000
Project	Barnstable	Independence Park Bikepath	Connect western extension of Cape Cod Rail Trail through Independence Park (Barnstable) to Service Rd at Exit 6	Bicycle/ Pedestrian		7,000	7,000
Project	Brewster	Rt 6A Resurfacing	Coldplaning/resurfacing of Rt 6A from Dennis T.L to Orleans T.L. in Brewster	Highway		6500	6,500

Type	TOWN	Title	Description	Category	Ann. Cost /yr ($K)	Start Cost ($K)	Total Cost ($K)
Project	Capewide	Transportation Management Center	Design & construct Operations Center to monitor traffic operations, issue real-time reports to traveling public, control variable message signs and coordinated traffic signals	ITS/ Management		6,450	6,450
Project	Bourne	Bourne Rotary - Falmouth /Sandwich Bus Services	Introduce public transit bus service between the Bourne Bridge area and Sandwich/ Falmouth (CMAQ funding)	Transit	276		6,351
Project	Dennis	Rte 28 Main St Bridge Rehabilitation	Rehabilitate Route 28 Main Street/Swan Pond River Bridge (Dennis)	Bridge		6,000	6,000
Project	Capewide	Rail Upgrade (Bourne +)	Buzzards Bay to Middleborough capital improvements for rail upgrade	Rail		6000	6,000
Project	Capewide	MV Eagle Refurbishment	Woods Hole, Martha's Vineyard, and Nantucket Steamship Authority (SSA) MV Eagle Mid-Life Refurbishment	Ferry		5900	5,900
Project	Bourne	Route 25 Access Ramp Widening/Belmont Circle Modification	Route 25 Access Ramp Widening/Belmont Circle Modification	Highway		5000	5,000
Project	Bourne	Infrastructure Improvements for Buzzards Bay Commuter Rail Service	Infrastructure Improvements (Platform, Parking, etc.) for Buzzards Bay Commuter Rail Service	Rail		5,000	5,000
Project	Orleans, Eastham, Wellfleet, Truro, Provincetown	Rte 6 Improvements Orleans to Provincetown	Implement safety improvements in the corridor between Orleans and Provincetown	Highway		5,000	5,000
Project	Bourne	Otis Rotary Area Improvements	Construct safety improvements on Route 28/Connery Avenue/Route 28A at the Otis Rotary	Safety		5,000	5,000
Project	Sandwich, Bourne	Bus-Only Lanes for Rte 3 & Rte 6	Provide bus-only lanes between both Exits "2" and the Sagamore Bridge for both Rte. 3 and Rte. 6. This is expected to be achieved by widening and strengthening the shoulder section	Transit		5,000	5,000
Project	Barnstable	Route 132 Access Management	Construct traffic channelization, land acquisition, combine/eliminate driveways to improve traffic flow and safety from CC Mall to Phinneys Lane	Safety		5,000	5,000
Project	Eastham	Route 6 Complete Street	Route 6 in Eastham: add bike accommodation, improve sidewalks, bus turnouts & stops to create "Complete Street"	Highway			5,000
Project	Bourne	Reconfigure Route 6/28 Bypass (Buzzards Bay)	Reduce road width to 1 travel lane in each direction; provide local access to cross-streets; construct multi-use path from Memorial Circle to Belmont Circle. Per 2007 "Buzzards Bay Village Comprehensive Transportation Plan."	Highway		4455	4,455
Project	Harwich	Rt 124 (Harwich) Reconstruction	Reconstruction of Rt 124 from Headwaters Dr to Brewster T.L. in Harwich	Highway		4000	4,000
Project	Capewide	Intercity Seasonal Connector-demonstration	Intercity Seasonal Rail Connector-demonstration	Transit		4000	4,000
Project	Provincetown	Commercial St (Provincetown) Reconstruction	Commercial Street Reconstruction	Highway		3500	3,500
Project	Falmouth	Cross-Falmouth Bikepath	Bike path connection from E. Falmouth to Gifford St. to Shining Sea Bike Path	Bicycle/ Pedestrian		3,000	3,000
Project	Capewide	Canal Area Intelligent Transportation System	Expand transportation monitoring system to improve congestion & safety while providing real-time information Capewide & beyond	ITS/ Management		3,000	3,000
Project	Barnstable	Truck Staging at Route 6 Interchange	Construct truck transfer staging area near a Route 6 (e.g., Exit 6 or Exit 7) interchange for transfer of freight from large trucks to smaller trucks for destinations in the Hyannis Area. Consider rail freight transfer.	ITS/ Management		3,000	3,000
Project	Dennis	Upper County Rd Bridge Rehabilitation	Rehabilitate Upper County Road/Swan Pond River Bridge (Dennis)	Bridge		3,000	3,000
Project	Sandwich	Rt 6A over Scorton River Bridge	Replace bridge: Rt 6A over Scorton River in Sandwich	Bridge		3000	3,000
Project	Barnstable Bourne	Upper/Mid Cape Real Time Traffic Information System	Real Time Traffic Information System -- Design Build of year-round 24/7 Web based traffic information system based on cameras, sensors, with 511 to reduce road rage, congestion, and improve mobility and incident management through improved information	ITS/ Management		3000	3,000
Project	Sandwich	Rt 130 Exit 2 Rt 6 Intersection Improvements phase 2	Route 130 Exit 2 Phase 2, WB exit ramp and Service Road intersection improvements	Safety		3000	3,000
Project	Capewide	Ferry Sewage Pump-out Systems	Vessel Sewage Pump-out Systems -- Installation of 3 land-side pump-out systems and vessel modifications in Woods Hole, Vineyard Haven, and Nantucket	Ferry		2700	2,700
Project	Barnstable	Route 28/Bearses Way Access Improvements	Intersection improvements including accommodation of bike/ped & public transportation amenities	Highway		2500	2,500
Project	Barnstable	Osterville-Cotuit Bike Connection	Construct off-road connection south of Route 28 for bicycle-pedestrian access between Osterville and Cotuit	Bicycle/ Pedestrian		2,000	2,000

Type	TOWN	Title	Description	Category	Ann. Cost /yr ($K)	Start Cost ($K)	Total Cost ($K)
Project	Provincetown	Shank Painter Rd Corridor Improvements	Corridor improvements including new sidewalks, curb cut consolidation, landscaping, bicycle lanes, etc.	Bicycle/ Pedestrian		2000	2,000
Project	Barnstable	Rt 28/Yarmouth Rd Intersection Improvements	Construction of turning lanes and signal upgrades per Hyannis Access Study	Highway		2000	2,000
Project	Dennis	Rt 6A (Dennis) Sidewalks	Route 6A sidewalks Yarmouth TL to Sesuit Neck Road	Bicycle/ Pedestrian		2,000	2,000
Project	Brewster	Rt 137(Brewster) Reconstruction	Full depth reclamation Long Pond Road / Rte 137	Highway		1900	1,900
Project	Bourne	Memorial Circle Reconfiguration (Routes 6/28, Main Street Buzzards Bay)	Convert Memorial Circle to 4-way Intersection; includes slip lane connection for eastbound Routes 6/28 to Main Street. Per 2007 "Buzzards Bay Village Comprehensive Transportation Plan."	Highway		1802	1,802
Project	Capewide	Passenger Loading Ramps	Passenger loading ramp modifications in Woods Hole, Vineyard Haven, Oak Bluffs, and Nantucket	Ferry		1600	1,600
Project	Falmouth	Rt 28/Jones Rd/Worcester Ct Intersection Improvements	Intersection improvements at Rt 28/Jones Rd/Worcester Ct in Falmouth	Highway		1500	1,500
Project	Brewster	Rt 124(Brewster) Reconstruction	Full depth reclamation Harwich Road / Rte 124	Highway		1500	1,500
Project	Capewide	Variable Message Signs	Remote operated variable message signs installed along all major routes - Rte 6, Rte 28 in Bourne & Falmouth, Rte 25 Extension, Rte 3	ITS/ Management	10	1,000	1,230
Project	Bourne, Sandwich	Cape Cod Canal Park-and-Ride Lot(s) Improvements	Construct new and/or expand existing Park-and-Ride facilities on both sides of the Cape Cod Canal near highway bridges	Multi-Modal		1,150	1,150
Project	Truro	Bus Stop Livability Enhancements	Livability enhancements / Improvements for bus stop area	Enhancements			1,000
Project	Eastham	Route 6/Gov. Prence Road Intersection Improvements	Install improvements at Route 6/Governor Prence Road intersection in Eastham	Safety		1,000	1,000
Project	Provincetown	Provincetown Bicycle Path Ext	Develop ped/bicycle facility using a portion of the Rte. 6 ROW	Bicycle/ Pedestrian		1,000	1,000
Project	Orleans	Rt 6A/Rt 28 Intersection Improvements	Per recommendations of 2006 Safety Study, install traffic signal or roundabout at intersection of Route 6A/Route 28/Canal Street in Orleans	Highway		1,000	1,000
Project	Barnstable	Barnstable Roundabout	Improve traffic flow and safety of the Route 6A/Route132 intersection through channelization of traffic movements (roundabout)	Safety		1,000	1,000
Project	Falmouth	Dillingham Av/Davis Straights Signalization	Install traffic signal at Dillingham Avenue/Davis Straights intersection in Falmouth	Highway		1,000	1,000
Project	Yarmouth	Route 6A/Union Street Intersection Improvements	Route 6A/Union Street intersection improvements in Yarmouth	Highway		1,000	1,000
Project	Yarmouth	West Yarmouth Rt 28 Intersection Improvements	Construct intersection improvements at Route 28 & East Main Street in West Yarmouth	Safety		1,000	1,000
Project	Eastham	Align Roadways: Aspinet /Nauset	Align Aspinet Rd with Nauset Rd at Route 6(Eastham)	Safety		1,000	1,000
Project	Provincetown	Provincetown Bicycle Path Ext - Phase I	Develop an extension from Race Point to McMillan Pier.	Bicycle/ Pedestrian		1,000	1,000
Project	Capewide	Renewable Fuels Pilot Stations	Develop pilot stations for renewable fuels such as biodiesel and ethanol. Proposal includes one station in the Mid-Cape area and one in the Outer Cape area	Enhancements		999	999
Project	Sandwich	Quaker Meetinghouse Rd Resurfacing	Sandwich, Quaker Meetinghouse Road - 2 miles long, mill and pave	Highway		925	925
Project	Barnstable	Villager Bus (Red Line) Phinneys Lane	Reroute CCRTA Villager service (Red Line) to include direct service to or from Barnstable Village directly to Route 132 via Phinneys Lane	Transit	40		920
Project	Barnstable	Airport Rotary Traffic Improvements	Reconfigure Airport Rotary to improve traffic flow and safety. May include realignment of approaches and reduction of diameter to conform to modern roundabout design	Safety		900	900
Project	Sandwich	Quaker Meetinghouse Rd Sidewalk	Quaker Meetinghouse Road Pedestrian Accessibility 3 miles of sidewalk	Bicycle/ Pedestrian		800	800
Project	Yarmouth	South Shore Dr (Yarmouth) Sidewalks	Yarmouth, Sidewalk improvements: South Shore Drive sidewalk- from Sea View Ave. to South Middle Beach	Bicycle/ Pedestrian		650	650
Project	Brewster	Stony Brook Rd, Rt 6A, Satucket Rd (Brewster) Reconstruction	Full depth reclamation Stony Brook Road, Rte 6A - Satucket Rd	Highway		600	600
Project	Dennis	Rt 134/Airline Rd Roundabout	Route 134 at Airline Road, Intersection Improvements (roundabout)	Highway		600	600
Project	Orleans	Rock Harbor Rd (Orleans) Reconstruction	Rock Harbor Road drainage improvements and roadway reconstruction	Highway		600	600
Project	Wellfleet	Cemetery Road & Old Wharf Road/Route 6 Improvements	Reconstruct intersections to consolidate Cemetery & Old Wharf Rd at Route 6 in Wellfleet	Highway		500	500
Project	Mashpee Barnstable	Left-Turn Lanes - Route 28	Construct turning lanes on Rte 28 from Route 130 to Orchard Road in Mashpee (esp. at Bowdoin Road)	Highway		500	500
Project	Capewide	Coast Guard Beach Shuttle Replacement - Phase 2	Replace existing vehicles - National Park Service	Transit		500	500

Type	TOWN	Title	Description	Category	Ann. Cost /yr ($K)	Start Cost ($K)	Total Cost ($K)
Project	Capewide	Variable Message Signs - Phase 1	Permit, and install variable message signs for the Outer Cape.	ITS/ Management		500	500
Project	Capewide	Variable Message Signs - Phase 2	Permit, and install variable message signs for the Outer Cape.	ITS/ Management		500	500
Project	Harwich	Bike Path Connector	Bike Path Connection from Old Colony Rail Trail to Rt 28 & Beaches (Harwich)	Bicycle/ Pedestrian		500	500
Project	Sandwich	Canal Connector Bike Path	Bike Path Connection from Cape Cod Canal to Sandwich Center	Bicycle/ Pedestrian		500	500
Project	Dennis	Old Wharf Rd (Dennis) reconstruction	Old Wharf Road, reconstruction, sidewalks, and drainage improvements	Highway		450	450
Project	Capewide	Beach Shuttle Expansion	Acquire additional buses to accommodate inland National Seashore parking needs - National Park Service.	Transit		400	400
Project	Yarmouth	Winslow Gray Rd (Yarmouth) Sidewalks	Yarmouth, Sidewalk improvements: Winslow Gray Rd. sidewalk 0.75 miles long from Buck Island Rd. to Long Pond Dr.	Bicycle/ Pedestrian		400	400
Project	Bourne	Cohasset Narrows Bridge Improvements & Traffic Management. Includes multi-use path	Repair bridge abutments, prepare and implement traffic management plans as part of repairs to the Cohasset Narrows Bridge in Bourne [***review schedule]	Bridge		300	300
Project	Orleans	Main Street (Orleans) Improvements	Main Street Sidewalk extension and reconstruction of Meeting House Road intersection	Bicycle/ Pedestrian		300	300
Project	Dennis	Rt 134 (Dennis) Bike/Ped Accommodation	Route 134 state section sidewalks / pedestrian bicycle accommodation, existing gap	Bicycle/ Pedestrian		300	300
Project	Capewide	Permanent Traffic Counting Stations	Install permanent traffic counting stations at strategic locations Cape-wide, including remote-accessible detection at signalized intersections	ITS/ Management	5	175	290
Project	Capewide	Cape-wide Highway Advisory Radio	Provide travel information cape-wide via AM radio	ITS/ Management		250	250
Project	Capewide	Outer Cape ITS Operations Control Center	Design and build an initial control center to accommodate ITS deployment for the Outer Cape	ITS/ Management		250	250
Project	Capewide	Information Kiosks	Procure, install, and enable public transportation information kiosks	ITS/ Management		200	200
Project	Capewide	Highway Advisory Radio System	Permit and install a highway advisory system for the lower/outer Cape area.	ITS/ Management		200	200
Project	Capewide	Emergency Routes & Shelters Signage	Install signage indicating emergency routes and shelter locations	Security		150	150
Project	Capewide	Upgrade Radio System for CCRTA Service	Improve communications systems and provide capacity to accommodate ITS components /Narrowband Radio.	ITS/ Management		150	150
Project	Capewide	Parking Improvement Implementation - Phase 1	Develop inland parking for the National Seashore	Park & Ride		150	150
Project	Barnstable	Villager Bus Service (Red Line) Split	Add CCRTA Villager service into two separate, coordinated lines	Transit	5		115
Project	Falmouth	Left Turn Phase - Gifford/Jones	Add left-turn phase Gifford St/Jones Rd (Falmouth)	Highway		50	50
Project	Capewide	Surveillance Cameras	Permit, and install surveillance cameras for the Outer Cape to observe traffic conditions and monitor Nat'l Seashore parking facilities.	ITS/ Management		50	50
Project	Wellfleet	Marconi Beach Road/Route 6 Intersection Signage	Add correct signage indicating "disappearing lane" at Marconi Beach Road/Route 6 intersection in Wellfleet	Highway		5	5
Project	Barnstable	CCRTA Bike Rental	Provide bike rental service at Hyannis Transportation Center	Bicycle/ Pedestrian			0
Project	Eastham Orleans	Eastham Rotary Bike/Ped Accommodation	Add bike/ped accommodation to connect Orleans to Rock Harbor Rd & Rt 6 in Eastham via periphery of rotary	Bicycle/ Pedestrian			0
Project	Sandwich	Bike Information Kiosk	Construct informational kiosk by Canal bikeway near Sandwich Marina	Bicycle/ Pedestrian			0

Type	TOWN	Title	Description	Category	Ann. Cost /yr ($K)	Start Cost ($K)	Total Cost ($K)
Project	Bourne	Rail Connection at "Y"	Construct direct connection from Canal-side rail to Falmouth rail (eliminating need to lower Canal rail bridge)	Rail			0
Project	Barnstable	West Main St Transit	Provide transit service along West Main Street from SeaLine connection at Rt 28 to downtown Hyannis	Transit			0
Project	Falmouth	Falmouth Transit Improvements	Add service/stops to Surf Drive, Maravista Ave, Brick Kiln Rd, Jones Rd.	Transit			0
Project	Capewide	Mobility Management Call Center	One-stop traveler call center to coordinate all travel modes and to manage eligibility and special requirements for human services.	Transit			0
Project	Capewide	Expansion of Next-Gen Mobile Data Terminals to Paratransit	State-of-the-art displays, global positioning systems (GPS), automatic vehicle location (AVL) systems, in-vehicle navigation systems, digital driver manifests and mobile data collection.	Transit			0
Project	Capewide	Next Bus Stop Announcements and Automatic Passenger Counting	Add technology to Mobile Data Terminals (MDTs) to provide next bus stop announcements/displays onboard. Includes automatic passenger counters.	Transit			0
Project	Capewide	Web 2.0 Integrated Intermodal Traveler Information over the Web	Internet-based intermodal trip planning, displays at malls and terminals to provide real-time mapping of transit vehicles, estimated time of arrival (ETA). Includes real-time displays for major destinations and terminals, ETA displays at bus shelters, and smartphone applications	Transit			0
Project	Brewster	Rt 124/Tubman Safety Improvements	Context-sensitive improvements to improve intersection safety	Highway			0
Project	Barnstable	Rt 6A W. Barnstable Sidewalk	Construct sidewalk along Route 6A in W. Barnstable	Bicycle/ Pedestrian			0
Project	Bourne	Main Street (Buzzards Bay) Streetscaping Phase 3	Continue streetscaping improvements along Route 6/28 Main Street in Buzzards Bay	Enhancements			0
Project	Dennis Harwich Brewster Orleans Eastham Wellfleet Truro Provincetown	Route 6 Stormwater Improvements	Route 6 stormwater improvements to remove runoff from traveled way, including construction of shoulders as needed from Dennis to Provincetown	Safety			0
Project	Chatham	Rt 28/Crowell Rd/Depot Rd/Queen Anne Rd Intersection Improvements	Intersection improvements at Rt 28/Crowell Rd/Depot Rd/Queen Anne Rd in Chatham	Highway			0
Project	Chatham	Rt 28 Corridor improvements	Access management improvements along Rt 28 from George Ryder Rd to Barnhill Rd	Highway			0
Project	Falmouth	Rt 28/Old Meetinghouse Rd Intersection Improvements	Intersection improvements at Rt 28/Old Meetinghouse Rd in Falmouth	Highway		0	0
Project	Harwich	Rt 39 (Harwich) Reconstruction	Reconstruction of Rt 39 from Oak St to Brewster T.L. in Harwich	Highway			0
Project	Orleans	Rt 6A/Main St Intersection Improvements	Intersection improvements at Rt 6A/Main St in Orleans	Highway			0
Project	Orleans	Rt 28/Main St Intersection Improvements	Intersection improvements at Rt 28/Main St in Orleans	Highway			0
Project	Yarmouth	Old Townhouse Rd/Forest Rd Intersection Improvements	Intersection improvements at Old Townhouse Rd/Forest Rd in Yarmouth	Highway			0
Project	Eastham	Governor Prence Road reconstruction and improvements	Reconstruction to improve sub-surface, pavement, and multimodal accommodation	Safety			0
Program	Capewide	Roadway Rehabilitation & Reconstruction	Roadway resurfacing, rehabilitation, and reconstruction	Highway	360,000		8,280,000
Program	Capewide	Street Lighting	Install street lighting in woody areas where appropriate	Safety	10,000		230,000
Program	Capewide	Bridge	Bridge Replacement/Reconstruction	Bridge	9,000		207,000
Program	Capewide	Transit Operating	Transit Operating Assistance	Transit	3,050		70,150
Program	Capewide	Underground Utilities/Pole Relocation	Remove above ground utilities adjacent to roadways and install them underground or away from roadsides to improve safety where appropriate	Safety	3,000		69,000
Program	Capewide	Cape-wide Intelligent Transportation Systems (ITS)	Design and implement real-time transportation monitoring and notification technologies at facilities throughout Cape Cod. Includes highway and transit users traveling to and within Barnstable County.	ITS/ Management	2,500		57,500
Program	Capewide	Transit Capital	Transit Capital Needs	Transit	2,150		49,450
Program	Capewide	Bicycle/Pedestrian Projects	Bicycle and/or pedestrian facilities and programs. Includes development of a regional bike network, bike lane construction, bicycling accessibility improvements and amenities, pedestrian accessibility improvements and sidewalk network expansion.	Bicycle/ Pedestrian	2,000	3,125	49,125
Program	Capewide	Railway Infrastructure	Maintain & provide rail infrastructure	Rail	2,000		46,000
Program	Capewide	Low-Floor Loading Buses	Purchase/acquire low-floor loading buses for Cape Cod services	Transit	1,125		25,875

Type	TOWN	Title	Description	Category	Ann. Cost /yr ($K)	Start Cost ($K)	Total Cost ($K)
Program	Capewide	Land Conservation	Strategic purchase of land to reduce sprawl and inefficient allocation of transportation resources. Also used to acquire land for improvement of intersections and protection of operations at new interchanges	ITS/ Management	1,000		23,000
Program	Capewide	Intersection Improvements	Intersection Improvements, including roundabouts, to address safety and congestion relief. Includes left-turn lanes & phases at signalized intersections	Highway	800		18,400
Program	Capewide	Additional CCRTA Service	Public transit shuttles connecting villages along Route 6A from Sandwich to Orleans, Provincetown-Orleans Shuttle, etc.	Transit	750		17,250
Program	Capewide	Vegetation Management	Implement a comprehensive program to trim/remove vegetation from encroaching areas	Safety	450		10,350
Program	Capewide	Access Management	Eligible for all state and local numbered routes. Curb cut consolidation, medians, other access improvements	ITS/ Management	300		6,900
Program	Capewide	New Ferry Service	Passenger ferries connecting Cape Cod harbors	Ferry	250		5,750
Program	Capewide	Signal Preemption	Install and maintain signal preemption hardware at traffic signals to improve public safety vehicle access	Safety	225		5,175
Program	Capewide	MBTA-Compatible Electronic Fare Systems on Transit and Inter-City Buses	Electronic fare system (EFS) on all CCRTA vehicles, interoperable with Massachusetts Bay Transit Authority.	Transit	200		4,600
Program	Capewide	Red Light Running Cameras	Support legislation to allow installation of red-light running cameras at high-crash signalized intersections	Safety	200		4,600
Program	Capewide	Mashpee Wampanoag Roadway & Transit Projects	Implement roadway& transit improvements to improve accessibility & mobility to and within tribal lands in Mashpee	Multi-Modal	200		4,600
Program	Capewide	Local Transportation Centers	Construct intermodal transportation centers in Buzzards Bay, Orleans, etc.	Transit	166		3,818
Program	Capewide	Bus Service Amenities	Provide bus schedule signage & related amenities	Transit	150		3,450
Program	Capewide	Traffic Calming	Promote the installation of Traffic Calming features at appropriate locations	Safety	100		2,300
Program	Capewide	Cape-wide Flex Service	Expand Flex bus service throughout Cape Cod	Transit	100		2,300
Program	Harwich to Truro	Flex Parking	Construct or designate parking areas for The Flex transit service	Multi-Modal	75		1,725
Program	Capewide	Travel Demand Management/Transportation Systems Management (TDM/TSM)	Travel Demand Management/Transportation Systems Management projects (TDM/TSM). Includes support of Transportation Management Associations (TMAs). Provide assistance to employers and institutions for the development and coordination of alternative transportation options for employees and patrons.	ITS/ Management	50		1,150
Program	Capewide	Transit Marketing & Education	Implement education programs and marketing activities to support public transit	Transit	50		1,150
Program	Capewide	Construction of Enhanced Bus Shelters	Build intelligent, accessible, and energy efficient Cape Cod style bus shelters that provide real-time customer information and amenities.	Transit	36		900
Program	Capewide	Safe Routes to Schools	Installation of sidewalks and provide other improvements and programs to promote safe routes to schools	Bicycle/ Pedestrian	30		690
Program	Sandwich, Barnstable, Yarmouth, Dennis, Brewster, Orleans	Route 6A/Scenic Byways	Corridor Management Plan update and implement recommended improvements. Includes connection of sidewalks (on both sides in villages), "Sharrow" pavement markings for bike accommodation. For report, see www.gocapecod.org/6Away	Highway	10	125	355
Program	Capewide	Park-and-Ride Lot Management	Monitor parking usage of parking facilities at Barnstable (Exit 6), Sagamore, Harwich (Exit 10); identify & acquire new facilities, expansions as necessary	Multi-Modal	10		230
Program	Capewide	Congestion Management	Consider peak period pricing at strategic locations to provide funding for transportation needs	ITS/ Management	-47,000	5,000	-1,076,000
Study	Bourne, Army Corps	Cape Cod Canal Bridges Replacement/Expansion/Addition. Includes evaluation of Belmont Circle and Buzzards Bay Bypass and other roads.	Evaluation of future needs for highway crossings of Cape Cod Canal. Includes consideration of replacement or expansion of existing bridges; additional crossings	Highway		1,000	1,000
Study	Barnstable	Rt 28 Corridor Study	Identify multimodal corridor improvements from Mashpee T.L. to Yarmouth T.L. along Route 28	Multi-Modal		750	750
Study	Falmouth, Mashpee, Barnstable, Yarmouth, Dennis, Harwich, Chatham	Southside Bike Route	Identify network (on- and off-road) for bike route from Woods Hole to Chatham	Bicycle/ Pedestrian		500	500

Type	TOWN	Title	Description	Category	Ann. Cost /yr ($K)	Start Cost ($K)	Total Cost ($K)
Study	Capewide	Disaster/Emergencies/Security Plan	Develop plans to address disasters, emergencies, and security issues	Security		500	500
Study	Barnstable, Mashpee, Falmouth	Hyannis-Falmouth Transportation Study	Identify needed roadway, public transit, and other modes' needed improvements for future travel demands between Hyannis and Falmouth	Highway		500	500
Study	Bourne	Sagamore Bridge Speed Management	Identify measures to encourage safe speeds on Route 3 and Route 6 approaches to the Sagamore Bridge	Safety		350	350
Study	Capewide	Freight Study	Conduct a study of freight (quantities, origins, destinations, etc.)	ITS/ Management		250	250
Study	Barnstable	Exit 6 Park-and-Ride Lot Expansion	Examine options at Exit 6 Park-and-Ride Lot such as parking structure or surface lot expansion to expand parking supply	Park & Ride		250	250
Study	Capewide	Develop Origin/Destination Transit Mode Split Model	Create a transit model for Cape Cod	Transit		250	250
Study	Capewide	Evaluation of Existing Transit Info Software/Procurement	Evaluate customer information software to be used for a web-based system to support CCRTA operations	ITS/ Management		250	250
Study	Capewide	Renewable Fuels Partnership Strategic Implementation Plan	Identify potential renewable fuel options, technologies, markets, and infrastructure needs to make use of biofuels both viable and sustainable	Enhancements		200	200
Study	Capewide	Update 5-Year and Long Range Cape Cod Public Transportation Plans	Update the 2002 5-Year Plan and the 2003 Long Range Public Transportation Plan.	ITS/ Management		175	175
Study	Capewide	ITS Evaluation and Phase II Recommendation study	Evaluate ITS deployment and make recommendations.	ITS/ Management		150	150
Study	Orleans	Rt 28/Rt 39 Intersection Improvements	Identify safety improvements at Route 28/Route 39/Quanset Road intersection in Orleans	Safety		100	100
Study	Capewide	Evaluation and refinement of Partner Program	Develop recommendations based on the public/private transportation provider coordination efforts.	ITS/ Management		100	100
Study	Capewide	Smart Card Study	Investigate current technologies, compatibilities with local planning, define potential partners, and make recommendations.	ITS/ Management		75	75
Study	Capewide	Railways for Transporting Emergency Supplies	Develop contingency plan to use railways for transporting supplies during emergencies	Security		75	75
Study	Capewide	Flex Phase II Evaluation Study	Evaluate improvements and expansion of the Flex transit service.	Transit		30	30
Study	Capewide	Evaluation of Customer Information Systems	Evaluate Customer Information Systems and make recommendations.	ITS/ Management		25	25
Study	Capewide	Evaluation of Partner Program II	Continue the evaluation of the public/private carrier coordination program.	ITS/ Management		15	15
Study	Sandwich Mashpee	Rt 130 Road Diet	Narrow travel lane width to reduce speeds and accommodate bicycles/ pedestrians	Safety			0
Study	Eastham Orleans	Eastham Rotary Bypass	Relocate Rock Harbor Road access from Rotary to new Bridge Rd/Rt 6 signalized intersection. Convert rotary to roundabout	Highway			0
Study	Wellfleet	Rt 6 at Wellfleet/Eastham TL	Congestion mitigation where two NB lanes merge to one	Highway			0
Study	Capewide	Mashpee Wampanoag Roadway & Transit Study	Identify roadway& transit improvements to improve accessibility & mobility to and within tribal lands in Mashpee	Multi-Modal			0
Study	Bourne Falmouth	Falmouth-Wareham Bike Connection	Connect Falmouth bike paths to Bourne/Wareham town line at William Dalton Bridge including connection to Cod Canal bike paths	Bicycle/ Pedestrian			0
Smart Solution	Capewide	Zoning/Planning Support for Sidewalks	Improve zoning regulations & planning efforts to invest in sidewalks	Bicycle/ Pedestrian			0
Smart Solution	Capewide	Remote Continuous Traffic Counting	Encourage installation of equipment at signalized intersections and other locations to conduct traffic counts throughout Cape Cod throughout the year using remotely-accessible detection equipment	ITS/ Management			0
Smart Solution	Capewide	CCRTA/Steamship Authority Coordination	Coordinate schedules among the CCRTA SeaLine (Blue Line) and Steamship Authority Ferries	Transit			0
Smart Solution	Bourne Wareham	CCRTA-GATRA Coordination	Coordinate schedules and service between GATRA and CCRTA	Transit			0

Type	TOWN	Title	Description	Category	Ann. Cost /yr ($K)	Start Cost ($K)	Total Cost ($K)
Smart Solution	Capewide	Bicycling & Motorist Traffic Law Enforcement	Enforce traffic laws on bicyclists and motorists	Safety			0
Smart Solution	Boston	Logan Intercity Bus Information	Provide real-time bus location information, schedules, fares etc. for service from Logan to Cape Cod	ITS/ Management			0
Smart Solution	Capewide	Redesignate 195 & 495	Redesignate Route 25 Extension as Route 195 or Route 495 or Route 195/495	ITS/ Management			0
Smart Solution	Capewide	Employer TDM Plans	Create incentives for employers to prepare and implement Travel Demand Management (TDM) plans (>25 Employees)	ITS/ Management			0
Smart Solution	Falmouth	New Bedford-Martha's Vineyard Freight	To reduce traffic on Woods Hole Rd, operate barges between New Bedford and Martha's Vineyard to carry fuel trucks and garbage trucks.	Ferry			0
Smart Solution	Capewide	Speed Management	Implement education, signage and enforcement to lower traffic speeds on roadways with speed-related safety problems	Safety			0
Smart Solution	Capewide	Transit Education & Marketing on Local TV	Implement education programs and marketing activities on community-access television to support public transit	Transit			0
Smart Solution	Capewide	Right-of-Way Preservation	Maintain rights-of-way for future transportation uses and to avoid future traffic generation	ITS/ Management			0
Smart Solution	Capewide	Bus Users Incentives: Shopping Discounts	Provide shopping discounts to bus users	Transit			0
Smart Solution	Capewide	Wi-Fi Hotspots	Install wireless internet services at strategic locations throughout Cape Cod	ITS/ Management			0
Smart Solution	New Bedford	Promote Ferry Service from New Bedford		Ferry			0
Smart Solution	Capewide	Vanpooling & Carpooling Incentives	Provide incentives to increase vanpooling and carpooling	ITS/ Management			0
Smart Solution	Capewide	Carpooling "Stands/Stops"	Install signage and implement education & marketing program for the use of carpooling stands/stops" to promote higher occupancy vehicle use	ITS/ Management			0
Smart Solution	Capewide	Rail Line Buffer Zone	Implement zoning protections to reduce future development for a distance of 100' along rail lines	Rail			0
Smart Solution	Capewide	Vanpooling at Steamship Authority Lots	Permit use of Steamship Authority parking facilities for vanpooling	Multi-Modal			0

PROJECT ANALYSIS

In order to determine the projects to be contained within the financially constraint of the document analysis was conducted on the universe of projects. Analysis of projects was limited to projects $5 million or greater with the expectation that smaller projects could be programmed in the bundle of "other TIP projects" included in the financial constraint of this document. Analysis was conducted with a subcommittee of the CCJTC where each project was considered for potential benefit, estimated cost, consistency with the objectives of the RTP, equity as it relates to minority, low income, Limited English Proficiency (LEP) and other protected populations, and GHG reduction potential. Considering these factors and the anticipated available funding, a financially-constrained program of projects was developed with the CCJTC subcommittee and reviewed and approved by the Cape Cod MPO.

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CAPE COD COMMISSION

3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

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2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix N: Air Quality Conformity

Draft
June 15, 2015

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Technical Appendix N: Air Quality Conformity

The transportation system is a critical component of the Commonwealth of Massachusetts' infrastructure; it facilitates economic development, access to goods and services, and social interaction and enrichment. While the system has numerous benefits that users depend upon daily, it also contributes over one third of the Bay State's greenhouse gas (GHG) emissions, a key cause of climate change. Sprawling development patterns and automobile dependence also contribute to physical inactivity, which is associated with various negative health outcomes, while motor vehicle pollution contaminates the air, causing respiratory and other health conditions.

LEGISLATIVE BACKGROUND

In 2010, the Massachusetts Department of Transportation (MassDOT) responded to these challenges by launching its comprehensive sustainability initiative, the GreenDOT Policy. GreenDOT was born of numerous state laws and policies aimed at reducing GHG emissions, improving public health, and leading on environmental stewardship. The Global Warming Solutions Act (GWSA), which Governor Deval Patrick signed into law in 2008, set legally-enforceable goals of reducing GHG emissions by 25 percent below 1990 levels by 2020, and 80 percent below 1990 levels by 2050. The Healthy Transportation Compact, created by the 2009 Transportation Reform Law, is a coordinated multi-agency effort to encourage the healthy transportation modes of walking, bicycling, and public transit, and to ensure that public health factors are taken into account in transportation decision-making. In addition, Executive Orders 484 and 515, known as Leading by Example and Environmental Purchasing Policy respectively, require state agencies to invest public resources in ways that support environmental sustainability by conserving energy and water, implementing efficiency measures, and producing or purchasing renewable energy. Taken together, the Global Warming Solutions Act, Healthy Transportation Compact, and Leading by Example policy form the foundation for the GreenDOT Policy.

The GreenDOT Policy Directive, released in June 2010, set forth the primary goals of reducing GHG emissions; promoting the healthy transportation modes of walking, bicycling, and public transit; and supporting smart growth development. The 2012 GreenDOT Implementation Plan then outlined specific tasks and targets for achieving these goals, including the Mode Shift Goal, which calls for a tripling of the amount of walking, bicycling, and public transit ridership in Massachusetts between 2010 and 2030. The Cape Cod Regional Transportation Plan (RTP) reflects the vision of the GreenDOT with the Multimodal Options/Healthy Transportation Goal including a Performance Measure reflecting the state Mode Shift Goal.

GREENHOUSE GAS (GHG) ANALYSIS

Under MassDOT guidance, the impacts of RTP projects on GHG emissions have been be evaluated and considered as a part of the project selection process. The anticipated GHG impacts from projects specifically identified in the RTP are as follows.

TABLE 1. HIGHWAY REGIONAL TARGET PROJECTS – ANTICIPATED GHG IMPACTS

PROJECT	ANTICIPATED GHG IMPACT
Barnstable: Hyannis Access Improvements	Quantified Decrease in Emissions from Traffic Operational Improvement – To be verified by statewide modeling
Route 28 Multimodal Improvements: Various Locations	Assumed Nominal Decrease in Emissions from Sidewalk and Bicycle Infrastructure
Route 6 Outer Cape Safety Improvements	Assumed Nominal Decrease in Emissions from Sidewalk and Bicycle Infrastructure
Canal Area: Belmont Circle/ Route 25 Ramp Improvements	Quantified Decrease in Emissions from Traffic Operational Improvement – To be verified by statewide modeling
Canal Area: Route 6 Exit 1C Reconfiguration	Quantified Decrease in Emissions from Traffic Operational Improvement – To be verified by statewide modeling
Cape Cod Rail Trail Expansion: S. Wellfleet to Provincetown	Assumed Nominal Decrease in Emissions from Bicycle Infrastructure
Infrastructure Improvements (Platform, Parking, etc.) for Buzzards Bay Commuter Rail Service	Assumed Nominal Decrease in Emissions from Other Improvements
Cape Cod Rail Trail Expansion: Barnstable to Sandwich	Assumed Nominal Decrease in Emissions from Bicycle Infrastructure
Shining Sea Bikepath Extension to Cape Cod Canal Bikepath	Assumed Nominal Decrease in Emissions from Bicycle Infrastructure

More detailed GHG analysis of projects is conducted as they are considered for inclusion in the Transportation Improvement Program.

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2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix O: Survey Results

Draft
June 15, 2015

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Technical Appendix O: Survey Results

To facilitate public input in the development of the Regional Transportation Plan (RTP), and online survey was developed and advertised through a number of outreach techniques. The RTP survey was advertised at RTP and other local and regional meetings and open houses distributed through the extended email distribution list, social media platforms, and picked up by a number of local media outlets.

The survey was open from March 20, 2105 through May 10, 2105 and a total of 125 responses were received.

QUESTION 1 – LIVE-WORK-PLAY

Respondents were asked to identify the town in which they live, such as visiting or shopping. The responses to this question and sample size (n) are summarized in Table 1.

TABLE 1. TOWN OF HOME, WORK, AND ACTIVITIES

TOWN	HOME	WORK	DO MOST OTHER ACTIVITIES (I.E. VISIT, SHOP)
n	124	113	123
Barnstable	25%	33%	31%
Bourne	6%	6%	4%
Brewster	7%	1%	1%
Chatham	3%	4%	0%
Dennis	2%	4%	7%
Eastham	2%	7%	1%
Falmouth	19%	13%	20%
Harwich	3%	2%	4%
Mashpee	5%	1%	3%
Orleans	2%	4%	9%
Provincetown	6%	7%	5%
Sandwich	6%	1%	4%
Truro	1%	0%	2%
Wellfleet	3%	2%	5%
Yarmouth	4%	4%	1%
Outside of Cape Cod	6%	12%	5%

Respondents were further asked to identify their primary mode of transportation. The responses to this question and sample size (n) are summarized in Table 2.

TABLE 2: PRIMARY MODE OF TRANSPORTATION

MODE	PERCENT OF RESPONSES
n	110
Personal Automobile	90%
Bicycle	7%
Walk	1%
Other	2%

Respondents where asked to identify the age bracket to which they belong (optional question). The responses to this question and sample size (n) are summarized in Table 3.

TABLE 3: AGE DISTRIBUTION

AGES OF AGE	PERCENT OF RESPONSES
n	110
Under 18 years	1%
18 to 35 years	11%
36 to 49 years	16%
50 to 64 years	45%
Age 65 or older	27%

QUESTION 2 – PROBLEM IDENTIFICATION

Question 2 was a mapped-based exercise where respondents were asked to identifying problem location they experience both locally and across the region. A total of 235 data points where entered as part of this exercise with good geographic distribution across the region.

Figure 1 shows problem locations identified by respondents by the type of issue identified. Commentary respondents provided along with the location identification will be made available to the general public with the opportunity to add new comments as an ongoing opportunity for public comment.

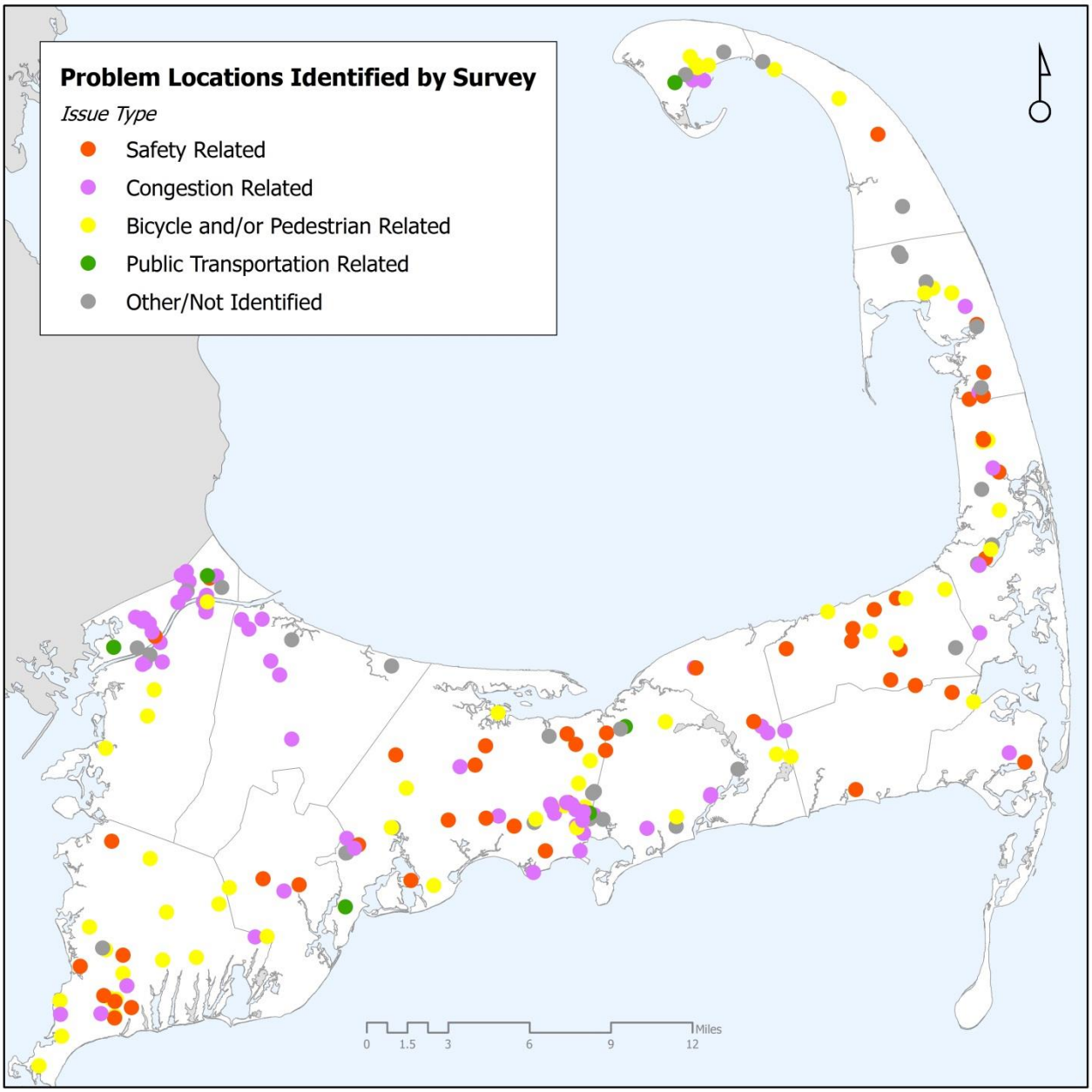

FIGURE 1. PROBLEM LOCATIONS IDENTIFIED

QUESTION 3 – GOALS AND OBJECTIVES

Question 3 shared the draft vision statement and goals with the respondents and asked respondents for any feedback or suggestions for additional goals. The following responses were provided to this question:

- Economic vitality and sustainability of Cape Cod as a whole should be priority.
- Safety should be a primary consideration.
- Does multi-modal include transit? Need to focus on how to get people to jobs and shopping etc by ways other than car - we have the Flex bus but almost no transit service to get Outer Cape people up-Cape.
- Public Transportation, in the form of buses, are underutilized and will remain so; they are a waste of money. The biggest single problem is parking, not transportation. Everything that is a problem on Cape Cod in the summer, which is what we are talking about, is all about parking. Other than that, it is getting all the cars to be able to move as smoothly as possible. That means the major arteries and access points have to be improved and choke-points relieved. You are not ever going to get the tourist and nonresident population to change-over to public transportation; it is just never going to happen. They want the freedom to come and go where and when they want; they will not sit around and wait on bus schedules. I just got to your section about the bridges; STUPID! If you want a "fix" then you better be prepared to spend huge. The best bet would be a single 5-lane tunnel, with Rte. 3 and 25 coming together and channeling into a single access point. Once in the tunnel, split 3 lanes West and 3-lanes East to connect to Rte 6 (Sandwich) and 28 (Falmouth). Good luck finding the money for that sort of project, but that's what it will take. An extra bridge is goofy and improving the two that exist will compromise access for too long to satisfy any one.
- Better signage and consistent traffic lights.
- More Intelligent Transportation Planning might help motorists to flatten peak traffic times.
- Discourage tractor trailer traffic on Rt.6A from Rt. 132 west!
- Looks good but the Metropolitan label doesn't apropriate
- Not available at this time
- I think the definition of congestion is an important thing to understand. Congestion to some people means a line of cars 6 long. For others it means "I couldn't go wicked fast in my Ford F250 Super Duty so that means that there is too much congestion". For others, it means that they had to tap the brakes to slow down to let someone cross a cross walk. One thing is certain, the faster cars go through neighborhoods, the more hazardous and less liveable it is. More speed equals more danger, more noise and lower property values. ↵Tax Harley Davidson Motorcycles per Decibel. ↵↵We need congestion, it's the ONLY effective way to slow traffic down. Roads can be designed to increase flow but to keep speeds safer.
- You should be aware that nearly all of your draft goals relate directly to bicycling:↵* Safety: I am a vehicle on the road, but am often ignored or put in danger by other drivers.↵* Environment and economic vitality: Bicyclists and bicycle infrastructure have demonstrably added to the economic vitality of Falmouth (look at home price in relation to the bike path) and livability↵* Multimodal options/Healthy transportation: Obvious↵* Congestion reduction: More bikes=fewer cars↵* System preservation: Bicycling presents less of an impact on infrastructure

- Fine
- It's good.
- The vision should support a transportation system that preserves the traditional character of Cape Cod, and retains its rural qualities where those qualities still exist.
- No it's decent.
- raise number of safe bike routes and walking possibilities. ↲make Route 6 service road a bike path
- add aftere preservation of character... and sensitive resources
- the goal of increasing transportation modes that promote wellness and physical activity (i.e. walking and bicycling)↲↲Special attention paid to Cape Cod's demographics (i.e. services for seniors)
- No. I think goals are fine. I have not seen any progress or positive impact yet in villages near me.
- Fairly allocate chapter 90 and other funds funds to reflect actual use of infrastructure in this seasonal economy
- Environmental impact -- widening/improving roads should not impact wetlands or nearby waterways or woodlands.
- Rail should be explicitly mentioned if part of TIP.
- Third vehicle bridge over the canal is a must.
- Mode shift should be a goal - moving as many people as possible away from single-occupancy autos and into non-motorized or public transit.
- Please include the effect on local including town and state economy on increasing bike friendly transport. Cape cod is really the worst place ive ever been for a bike commuter.
- Aging population should be specifically addressed. East of the Bass River, they are are far more significant issue than economic vitality, desirable though that may be.
- perhaps include system resilience (from extreme weather events) under system preservation
- Use rail trail as a route 6 bypass of Eastham.
- bike lanes and sidewalks!!!!
- Fiscal RESPONSIBILITY:↲Any and EVERY 'pot' of money you propose using has originally come out of the pockets of the local taxpayers (whether federal or state). Do not pretend a 'grant' for a project does not garner it's funds originally from the people.
- Every bus on Cape Cod will be outfitted with the capacity to hold 3 bikes via a front end rack (including those regularly transporting people from off-Cape).↲↲A ride-share program (modeled after others with a rating system of drivers and passengers) will be set up.↲↲Towns will narrow travel lanes to 10 or 10.5 feet on streets where the speed limit is 35 mph or less and widen shoulders or put in bike lanes.↲↲Towns will enforce speed limits.

QUESTION 4 – CAPE COD CANAL CROSSING

Question 4 presented respondents with the following information:

> Built 80 years ago, the Bourne and Sagamore highway bridges over the Cape Cod Canal require frequent maintenance to remain in service. Both seasonal and maintenance-related congestion at the bridges and on surrounding roadways have a significant impact on safety, emergency access, and overall economic activity of the Cape Cod communities.
>
> The Massachusetts Department of Transportation is currently undertaking a 18-month Cape Cod Canal Transportation Study to identify potential improvements to the transportation system surrounding the Cape Cod Canal in Bourne and Sandwich.

Respondents where first asked whether "regarding any potential bridge project coming out of Cape Cod Canal Transportation Study" they would oppose bridge project no matter the conditions or support bridge project with appropriate conditions. Results are summarized in Table 4. The conditions that would be required for support of the projects, responses are presented in Table 5.

TABLE 4. OPPOSITION OR SUPPORT OF A CAPE COD CANAL CROSSING PROJECT

RESPONSES	
n	11
I would OPPOSE a bridge project no matter the conditions	23%
I would SUPPORT a bridge project with appropriate conditions	77%

TABLE 5. CAPE COD CANAL CROSSING PROJECT CONDITIONS FOR SUPPORT

REPLACEMENT VS. ADDITIONAL CROSSING	NUMBER OF RESPONSES	PERCENT OF RESPONSES
Bridge replacement (up to current design standards, but no increase in the total number of lanes)	40	42%
Additional bridge crossing (increase in total number of travel lanes - additional capacity)	56	58%
FUNDING		
No tolls (funding through public sources e.g. taxes)	57	64%
Tolls (cost of construction reimbursed by users)	32	36%
FINANCING		
Private financing (reimbursed through tolls, known as a Public-Private Partnership)	15	18%
Public financing (reimbursed from public sources e.g. tolls or taxes)	70	82%
OTHER CONSIDERATIONS		
A focus on the aesthetics even if it increases cost	71	-
Improved bicycle and pedestrian accommodations	25	-
Other (specify below)	20	-

The "other" considerations that were specified and general comments presented on this question are presented below:

- I do not believe other issues have been addressed. Why can't we start with closing the onramp at exit 1 and see what happens. If people are inconvenienced a little so be it. Why does the entire Cape have to be inconvenienced.
- I oppose the construction of a 3rd bridge due to potential environmental impacts and induced growth
- It is insane to think that adding lane capacity will not create more traffic coming on-Cape. More traffic will worsen congestion elsewhere on the Cape. The only way I would support a new bridge is if one of the existing bridges is to be replaced.
- Full time cape residents free.
- Vastly improve utilization of railroad (bridge) for transport on/off cape
- Bring the train to Cape Cod year round with commuter schedules.
- Toll to come on Cape, no toll to leave, or a toll focused on high traffic months.
- Bridge replacement or new bridge should also be considered within the context of any evacuation plan required by either a natural or manmade disaster.
- Consideration should be given to the towns closest to the bridges, where people may need to cross the bridges more frequently for work or doctor visits or other reasons. There should be significant discounts for these travelers.
- A new bridge should only be considered in conjunction with improved public transit options, included enhanced seasonal rail service and Buzzards Bay commuter rail.
- Without EQUAL access for Bicycles and Pedestrians I would absolutely not support a third bridge. Check out Belle Island Pedestrian Bridge in Richmond VA.
- Must address Cape-side traffic impact
- Lanes are adequate if access is improved, the Bourne rotary is a bottleneck.
- I would only support a new bridge if it took into account really safe bike/pedestrian access, not just over the bridge, but getting to safe routes on either side. Also, I'd support combo of public and priv finance
- Where will all the cars go if we do have more bridges? Another bridge would simply shift the traffic jam.When you consider the number of hours when more lanes would improve traffic getting on the Cape or off the Capeyou also need to look at that cos
- Longevity and amount of lanes
- no increase in the number of lanes as it will only make problem on Cape worse!
- Safety is large factor, wider lanes
- not to increase the number of vehicles that transit per hour
- Need to avoid financial and travel barriers for town residents to go to and from Buzzards Bay. Third bridge for access to midCape and express to 28 to Falmouth with tolls OK and keep existing without tolls for local.
- Propper width travel lanes and a shoulder wide enough to accomdate additional traffic only in emergency situations, ie. other bridge out, emergency evacuation
- Multi-lane / Divided roadway
- Minimal environmental impact
- No mid-canal crossing! Minimize environmental impacts. In favor of double-barreling Sagamore, new bridge w/ tolls.
- Equal amount of study, focus and investment in the surrounding roadway system

- Restrict truck traffic to a new third vehicle bridge and allow autos. Add bicycle lanes to the Bourne and Sagamore bridges following the completion of the new third bridge.
- Additional travel lanes. Bridges. Tunnels. Fill in the canal even??? I lived in Bourne and worked in Hyannis. My kids still live there half the time and I am in Barnstable - my life is planned around the bridge, seasonal traffic and bridge work.
- A zipper lane to allow heavy traffic direction always has 2 full highway speed lanes
- I would only support a new bridge if it included protected bicycle and pedestrian lanes.
- Why is a tunnel not being considered? Far lower maintenence issues once built.
- Unless the rest of the main thoroughfares and 6 are widened, any bridge enlargement will be pointless. More cars on roads with the same capacity will only worsen congestion.
- I think it is insane to think of evacuation of cape cod should it be necessary using current infrastructure. I also think a high speed train from boston, providence even new york to extended parts of cape cod would be a huge benefit resident/tourist
- I would support a bridge with tolls as long as it was in addition to the existing bridges. 3rd bridge idea still needs more information regarding location, potential impacts on the area and connection to existing roadways
- Put in the middle of the canal.
- NO NEW BRIDGE- Keep current bridges up to date as needed. NO TOLLS onto or off of Cape Cod

QUESTION 5 – PROJECTS AND POLICIES LEVEL OF SUPPORT

Question 5 asked respondents to rate their level of support for a number of projects or polices that had been developed in previous planning efforts. Responses are summarized in Table 6.

TABLE 6: RPP SURVEY RESULTS – PROJECT AND POLICY LEVEL OF SUPPORT

PROJECT DESCRIPTION	n	GREATLY SUPPORT	SUPPORT	NEUTRAL	OPPOSE	GREATLY OPPOSE
Route 28: Falmouth-Chatham improved bicycle accommodation (e.g., bike lanes, wider shoulders, "share the road" program)	111	55%	24%	13%	6%	2%
Expand Cape-wide year-round bus service	113	46%	31%	18%	4%	2%
Shining Sea Bike path: Extension to Bourne (with connection to Cape Cod Canal Path)	113	59%	18%	19%	2%	3%
Cape Cod Rail Trail: Expansion from S. Wellfleet to Provincetown	112	47%	29%	18%	4%	1%
Commuter Rail Service to Buzzards Bay (to/from Boston)	112	49%	25%	19%	4%	3%
Commuter Rail Service to Hyannis (to/from Boston)	114	40%	32%	18%	4%	5%
Cape Cod Rail Trail: Expansion from Yarmouth to Bourne	114	53%	19%	22%	4%	2%
Yarmouth Rd/Willow St: Additional travel lanes and multi-use path	109	36%	32%	28%	3%	2%
Bourne Rotary: replacement (similar to Sagamore Rotary project)	111	29%	27%	23%	16%	5%
Route 6: Reconfigure Route 6 Exit 1C interchange (move westbound ramps away from Sagamore Bridge)	108	25%	30%	34%	7%	4%
Transportation management center (facility to monitor and coordinate traffic & transit operations)	110	21%	31%	32%	15%	2%
Route 6: Upgrade of interchanges (Exit 1C to Exit 12)	111	28%	23%	37%	6%	5%
Barnstable Airport Rotary: replacement with underpass of major traffic flows	110	29%	20%	28%	16%	6%
Sandwich Road (Bourne): median separation, 2 lanes in each direction	111	19%	30%	41%	6%	5%
Falmouth Transportation Center	111	23%	19%	51%	5%	1%
Otis Rotary: replacement	109	11%	12%	54%	17%	6%
OTHER SUPPORT QUESTIONS	**n**	**GREATLY SUPPORT**	**SUPPORT**	**NEUTRAL**	**OPPOSE**	**GREATLY OPPOSE**
Prioritize Complete Streets projects to better accommodate all users including bicyclists and pedestrians	111	58%	28%	11%	3%	1%
Prioritize improved stormwater treatment to help improve water quality	112	53%	22%	21%	3%	1%
Consider roundabouts at appropriate locations as a means of improving intersection safety	110	25%	35%	25%	14%	2%

Responses submitted as other suggested projects as part of this question are presented below:

- Paved shoulders/bike lane Route 6 Wellfleet to Provincetown
- park & ride lot in Orleans with regular bus service
- I don't want to see new bike paths til the safety issues at road crossings are addressed.
- Upgrade of MacArthur Blvd & safety of median u-turns. Improve Belmont Circle. Improve safety on Route 6 in Eastham/Wellfleet
- Adequate roadside vegetation to offset carbon emissions and where appropriate site solar or wind adjacent to roads. Make parking available for ride sharing services and encourage EV charging stations.

- Enhanced summertime rail service (Cape Flyer), with an expanded schedule. Track speeds on Cape should be increased to match that of the Amtrak service of the 1980s-90s (40 mph).
- The state designed and built drainage system at the intersection of Rt.132 and 6A fdumps untreated road waste directly into the great marsh just west of Buttonwood Lane
- Bike path extension/expansion CANNOT come at the expense of safety on streets to which I have a lawful right to use a bicyclist
- no new traffic lanes - bike and ped safe "lanes" instead!
- Strongly support building resilient transpo infrastructure
- Coordinate Transportation projects with town projects
- rail to truck freight yard in Yarmouth & Falmouth
- Examine alternative access to local beaches- Brewster and Dennis
- Anything to increase stormwater & wastewater improvements
- Rail trails are recreational; focus on transportation for residents
- IM BEHIND ALL OF THIS! GO YOU GUYS
- Create disability access, create wheelchair/scooter access
- Build more paved bicycle paths.

QUESTION 6 – BUDGET ALLOCATION

Question 6 presented respondents with the following information:

> A limited amount of funding is available to address the transportation problems in the region. Along with Federal and State regulations, the RTP defines where transportation funding is allocated. Assuming the region receives $1 Billion between now and 2040, use the sliders below to adjust where YOU think the funding should be allocated. The sliders are initially set to funding levels generally consistent with past practice. Notice the effect of your changes below each funding category. Since the RTP must be fiscally constrained, you must make sure you keep within the overall budget available.

Table 7 presents the default funding allocation (based on recent of transportation spending[1]) the average funding allocation by survey respondents.

TABLE 7: RTP SURVEY RESULTS – BUDGET ALLOCATION

SPENDING CATEGORY	HISTORICAL ALLOCATION	RESPONDENT AVERAGE ALLOCATION	DIFFERENCE
Roadway Projects Safety	6%	7%	+1%
Congestion/Air Quality	10%	9%	-1%
Roadway Maintenance	26%	24%	-3%
Bridge Maintenance	20%	18%	-2%
Bicycle/Pedestrian Improvements	8%	13%	+5%
Transit Service	27%	27%	-1%
Intelligent Transportation Systems	2%	3%	+1%

Table 8 presents present the respondents that suggested increasing, decreasing, or maintaining the existing level of funding for each category.

TABLE 8: RTP SURVEY RESULTS – BUDGET ALLOCATION

SPENDING CATEGORY	DECREASE	MAINTAIN EXISTING LEVEL	INCREASE
Roadway Projects Safety	23%	58%	18%
Congestion/Air Quality	9%	66%	25%
Roadway Maintenance	3%	66%	30%
Bridge Maintenance	4%	66%	30%
Bicycle/Pedestrian Improvements	38%	50%	11%
Transit Service	21%	58%	22%
Intelligent Transportation Systems	14%	66%	21%

[1] Transportation Improvement Program for FFY 2011-2016

QUESTION 7 – ADDITIONAL QUESTION OR COMMENTS

The final question provided respondents an opportunity to provide any additional comments or suggestion. Below are the responses to this question:

- Need an overall traffic study/plan. There has been much discussion on an additional bridge and the impact that may have on bringing additional traffic to the Cape - don' t know if that will be true or not, but a complete impact study should be conducted. The bridges are congested, however the roadways on cape are as well. I avoid Route 28 (Harwich to Hyannis) at ALL times except in the dead of winter or I have to travel there for a specific purpose. ↵
- If the "T" is to come to Bourne it should cross the Canal.
- The Flex bus should include stops at all public affordable housing complexes in order to make the Cape truly accessible to low-income residents
- Good Luck...
- The CCC is doing a great job performing various transportation studies on the Cape and keeping projects moving forward in our region. Keep up the good work!
- Make sure any long term plan is fully vetted through a transparent and inclusive process.
- Look forward to your April meetings
- transportation is one of the foundations important in defining the product (Caoe COd when out reaching for economic development purposes
- The best transportation survey I have taken. Thanks.
- Tough job, but glad you are doing it
- There should be no more removal of existing rail lines on the Cape for construction of recreational bike trails. Projects like the extension of the Shining Sea Bikeway to the canal should only be considered as a rail-WITH-trail. Many residents of Falmouth and Woods Hole raise legitimate concerns about heavy traffic to the Woods Hole ferry terminal, but with the rail line to the terminal now long gone, there are no good options to address the traffic concerns.
- Tractor trailers on Rt.6A are a safety issue. Road runoff from Rt.132 and 6A are a huge pollution problem. The Bourne rotary badly needs to be replaced by a flyover.
- Please narrow percieved lanes, design and implement roads to calm traffic and reduce speeds. Create an environment where all road users can feel equal and feel safer. Massively increase penalties for speeding, massively increase bicycle and pedestrian infra on roads that go to places where people would normally drive. Make cape cod a place to bike, walk and enjoy moving slowly, peacefully and efficiently. No new bridge without EQUAL access for Pedestrians and bicyclists. Create more pedestrian only areas. Link local public transport to beaches, stores and tourist attractions, bring the commuter train to Falmouth. Make it easy for people to choose public transport by making it the best way to go. Do not widen lanes, otherwise the cape will look like Orlando Florida or Long Island, NY. 132 in Hyannis is an example of how NOT to do things.
- The very high usage of the Shining Path and rRail Trail bike ways shows the importance of safe bike facilities to tourists. People really appreciate them, both for recreation and transportation..
- Recent time spent in Germany and Davis, CA provides a glaring contrast to the Cape. Bike accommodations in both places are staggering. Bike lanes (and separate traffic lights for bikes) everywhere in cities, dedicated bike paths for hundreds of miles in the outlying and countryside areas, dedicated railway cars for bikes. Commuting by bike

and/or public transport becomes a totally realistic option and most people do it. Davis even has rotaries for bikes on UCD campus because so many people ride! The difference in lifestyle this results in is just amazing, and really something to strive for here.↵Public transport in Germany is also amazing. Everyone uses it because it's safe, frequent, and gets you where you want to go. It gives older people and kids an huge amount of freedom, frees up parents form the chauffeur role, relieves traffic congestion, etc. (not to mention health and env benefits).

- People come to Cape Cod for the quality of life. A sustainable transportation plan will support the unique characteristics of Cape Cod.
- new miles of multi-use paths should be supplemented with 1) safe crossings, 2) sidewalks, 3) easy and safe bike & ped connections to transit and services and 4) amenities
- We do not need a third bridge! Bridge congestion is something we Cape Codders know how to plan around. In a way it helps limit additional cars coming to Cape Cod. If the promoters of a third bridge get their way, we will have even worse traffic problems. Also, beware of any private investment in infrastructure - profit is the motivation. Thanks for the opportunity to comment!
- I appreciate the opportunity to voice my opinion concerning transportation on the Cape.
- Prioritizing Quality of life for year round residents and quality of experience for seasonal guests is paramount for the region. Good traffic flow for getting people to and from destinations as well as encouraging bike and pedestrian modes of transportation for local activities would be beneficial for Cape Cod Life as well as air quality. Many seem to want to use bicycle as transportation but safety questions remain as roads used for bikes and cars are relatively narrow and may have poor visibility around curves.
- When doing road projects make sure to include wider shoulders or bike lines for safer bicycle accommodation. It should add a minimal amount to a project. Thank you for your work on these issues.
- Budget needs to be increased
- If there was an increase in providing public transportation and making it available for more residents we would decrease the usage of the roads by not having so many operators thereby decreasing the amount of vehicles and the amount of pollution and the need for more highway lanes. This is a no brainer, there are 3 vehicles in my family and if we could catch the bus at the end of the street daily we would most likely eliminate 2 of our vehicles and this would also free up some of our finances so that we could spend the money within our community, not being tied down to vehicle payments and repairs...LETS DO IT!!
- Nothing that another $1B couldn't fix.
- BIKES WE NEED BIKE SAFETY MEASURES PLEASE LESS CARS MORE BIKES, MORE OPTIONS FOR TOURISTS TO DAY TRIP AND LEAVE CARS BEHIND AND DONT FORGET THOSE OF US CRAZY ENOUGH TO TOUGH OUT WINTER ON OUTER CAPE!
- The agency would be happy to offer advice and input, and to put the CCC in touch with other experts on disability travel issues, especially as it pertains to vision loss and blindness. Making accommodations up front is vastly superior and far cheaper than retrofitting.
- Let's help fat lazy americans get off their asses and into alternate modes of transportation (bikes, walking, etc) by providing the infrastructure (bike lanes, walking paths) to make these activities safe and productive.
- Please, do not propose to spend money we do not have.

CAPE COD COMMISSION

3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

CAPE COD
COMMISSION

2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix P: Statewide Tables

Draft
June 15, 2015

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Technical Appendix P: Statewide Tables

ESTIMATED AVAILABLE FUNDS

In March 2015, the Massachusetts Department of Transportation (MassDOT) provided estimated available funds by region from Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) including the state matching funds. A summary of the funds for the Cape Cod region are presented in Chapter 5 along with a description of the funding programs. The funding tables for all regions are presented on the following pages.

massDOT

	Federal funding in today's dollars w/ 1.5% increase starting in 2021	GANs repayment	Funding less GANs repayments	Funding w/ non-federal match	Statewide infrastructure, bridge & other items	Funding available for MPOs	Berkshire	Boston	Cape Cod	Central Mass	Franklin	Martha's Vineyard	Merrimack Valley	Montachusett	Nantucket	Northern Middlesex	Old Colony	Pioneer Valley	Southeast Mass
						MARPA formula ►	3.5596%	42.9671%	4.5851%	8.6901%	2.5397%	0.3100%	4.4296%	4.4596%	0.2200%	3.8096%	4.5595%	10.8099%	8.9601%
2016	$ 600,000,000	$ 44,440,000	$ 555,560,000	$ 694,450,000	$ 519,875,000	$ 174,575,000	$ 6,214,172	$ 75,009,815	$ 8,004,438	$ 15,170,742	$ 4,433,681	$ 541,183	$ 7,732,974	$ 7,785,347	$ 384,065	$ 6,825,184	$ 7,959,747	$ 18,871,383	$ 15,642,095
2017	$ 600,000,000	$ 59,150,000	$ 540,850,000	$ 676,062,500	$ 469,487,500	$ 206,575,000	$ 7,353,244	$ 88,759,287	$ 9,471,670	$ 17,951,574	$ 5,246,385	$ 640,383	$ 9,150,446	$ 9,212,419	$ 454,465	$ 8,076,256	$ 9,418,787	$ 22,330,551	$ 18,509,327
2018	$ 600,000,000	$ 68,463,700	$ 531,536,300	$ 664,420,375	$ 448,845,375	$ 215,575,000	$ 7,673,608	$ 92,626,326	$ 9,884,329	$ 18,733,683	$ 5,474,958	$ 668,283	$ 9,549,110	$ 9,613,783	$ 474,265	$ 8,428,120	$ 9,829,142	$ 23,303,442	$ 19,315,736
2019	$ 600,000,000	$ 73,525,150	$ 526,474,850	$ 658,093,563	$ 442,518,563	$ 215,575,000	$ 7,673,608	$ 92,626,326	$ 9,884,329	$ 18,733,683	$ 5,474,958	$ 668,283	$ 9,549,110	$ 9,613,783	$ 474,265	$ 8,428,120	$ 9,829,142	$ 23,303,442	$ 19,315,736
2020	$ 600,000,000	$ 77,951,600	$ 522,048,400	$ 652,560,500	$ 436,985,500	$ 215,575,000	$ 7,673,608	$ 92,626,326	$ 9,884,329	$ 18,733,683	$ 5,474,958	$ 668,283	$ 9,549,110	$ 9,613,783	$ 474,265	$ 8,428,120	$ 9,829,142	$ 23,303,442	$ 19,315,736
						1st five years ►	$ 36,588,239	$ 441,648,079	$ 47,129,097	$ 89,323,365	$ 26,104,941	$ 3,186,413	$ 45,530,751	$ 45,839,114	$ 2,261,325	$ 40,185,801	$ 46,865,961	$ 111,112,260	$ 92,098,628
2021	$ 620,000,000	$ 82,588,050	$ 537,411,950	$ 671,764,938	$ 449,845,703	$ 221,919,234	$ 7,899,437	$ 95,352,259	$ 10,175,219	$ 19,285,003	$ 5,636,083	$ 687,950	$ 9,830,134	$ 9,896,710	$ 488,222	$ 8,676,154	$ 10,118,407	$ 23,989,247	$ 19,884,185
2022	$ 629,300,000	$ 94,420,950	$ 534,879,050	$ 668,598,813	$ 447,725,516	$ 220,873,297	$ 7,862,206	$ 94,902,850	$ 10,127,262	$ 19,194,110	$ 5,609,519	$ 684,707	$ 9,783,804	$ 9,850,066	$ 485,921	$ 8,635,262	$ 10,070,718	$ 23,876,183	$ 19,790,468
2023	$ 638,739,500	$ 114,931,804	$ 523,807,696	$ 654,759,620	$ 438,458,135	$ 216,301,485	$ 7,699,468	$ 92,938,475	$ 9,917,639	$ 18,796,815	$ 5,493,409	$ 670,535	$ 9,581,291	$ 9,646,181	$ 475,863	$ 8,456,523	$ 9,862,266	$ 23,381,974	$ 19,380,829
2024	$ 648,320,593	$ 138,111,750	$ 510,208,843	$ 637,761,053	$ 427,075,088	$ 210,685,966	$ 7,499,578	$ 90,525,650	$ 9,660,162	$ 18,308,821	$ 5,350,791	$ 653,126	$ 9,332,546	$ 9,395,751	$ 463,509	$ 8,236,979	$ 9,606,227	$ 22,774,942	$ 18,877,673
2025	$ 658,045,401	$ 144,321,750	$ 513,723,651	$ 642,154,564	$ 430,017,191	$ 212,137,373	$ 7,551,242	$ 91,149,277	$ 9,726,711	$ 18,434,950	$ 5,387,653	$ 657,626	$ 9,396,837	$ 9,460,478	$ 466,702	$ 8,293,723	$ 9,672,404	$ 22,931,838	$ 19,007,721
						2nd five years ►	$ 38,511,930	$ 464,868,512	$ 49,606,993	$ 94,019,700	$ 27,477,455	$ 3,353,944	$ 47,924,611	$ 48,249,186	$ 2,380,218	$ 42,298,641	$ 49,330,022	$ 116,954,184	$ 96,940,877
2026	$ 667,916,082	$ 167,280,246	$ 500,635,836	$ 625,794,796	$ 419,061,913	$ 206,732,882	$ 7,358,864	$ 88,827,124	$ 9,478,909	$ 17,965,294	$ 5,250,395	$ 640,872	$ 9,157,440	$ 9,219,460	$ 454,812	$ 8,082,429	$ 9,425,986	$ 22,347,618	$ 18,523,473
2027	$ 677,934,824	▲ GANs conclude	$ 677,934,824	$ 847,418,530	$ 567,471,690	$ 279,946,839	$ 9,964,988	$ 120,285,038	$ 12,835,843	$ 24,327,660	$ 7,109,810	$ 867,835	$ 12,400,525	$ 12,484,509	$ 615,883	$ 10,944,802	$ 12,764,176	$ 30,261,973	$ 25,083,517
2028	$ 688,103,846		$ 688,103,846	$ 860,129,807	$ 575,983,765	$ 284,146,042	$ 10,114,463	$ 122,089,314	$ 13,028,380	$ 24,692,575	$ 7,216,457	$ 880,853	$ 12,586,533	$ 12,671,777	$ 625,121	$ 11,108,974	$ 12,955,639	$ 30,715,903	$ 25,459,770
2029	$ 698,425,404		$ 698,425,404	$ 873,031,755	$ 584,623,522	$ 288,408,233	$ 10,266,179	$ 123,920,654	$ 13,223,806	$ 25,062,964	$ 7,324,704	$ 894,066	$ 12,775,331	$ 12,861,854	$ 634,498	$ 11,275,608	$ 13,149,973	$ 31,176,642	$ 25,841,666
2030	$ 708,901,785		$ 708,901,785	$ 886,127,231	$ 593,392,875	$ 292,734,356	$ 10,420,172	$ 125,779,464	$ 13,422,163	$ 25,438,908	$ 7,434,574	$ 907,477	$ 12,966,961	$ 13,054,781	$ 644,016	$ 11,444,742	$ 13,347,223	$ 31,644,291	$ 26,229,291
						3rd five years ►	$ 48,124,665	$ 580,901,594	$ 61,989,101	$ 117,487,402	$ 34,335,940	$ 4,191,102	$ 59,886,790	$ 60,292,381	$ 2,974,330	$ 52,856,555	$ 61,642,997	$ 146,146,427	$ 121,137,716
2031	$ 719,535,312		$ 719,535,312	$ 899,419,139	$ 602,293,768	$ 297,125,371	$ 10,576,475	$ 127,666,155	$ 13,623,495	$ 25,820,492	$ 7,546,093	$ 921,089	$ 13,161,465	$ 13,250,603	$ 653,676	$ 11,616,414	$ 13,547,431	$ 32,118,956	$ 26,622,730
2032	$ 730,328,341		$ 730,328,341	$ 912,910,426	$ 611,328,174	$ 301,582,252	$ 10,735,122	$ 129,581,148	$ 13,827,848	$ 26,207,799	$ 7,659,284	$ 934,905	$ 13,358,887	$ 13,449,362	$ 663,481	$ 11,790,660	$ 13,750,643	$ 32,600,740	$ 27,022,071
2033	$ 741,283,266		$ 741,283,266	$ 926,604,083	$ 620,498,097	$ 306,105,986	$ 10,896,149	$ 131,524,865	$ 14,035,266	$ 26,600,916	$ 7,774,174	$ 948,929	$ 13,559,271	$ 13,651,103	$ 673,433	$ 11,967,520	$ 13,956,902	$ 33,089,751	$ 27,427,402
2034	$ 752,402,515		$ 752,402,515	$ 940,503,144	$ 629,805,569	$ 310,697,576	$ 11,059,591	$ 133,497,738	$ 14,245,795	$ 26,999,930	$ 7,890,786	$ 963,162	$ 13,762,660	$ 13,855,869	$ 683,535	$ 12,147,032	$ 14,166,256	$ 33,586,097	$ 27,838,813
2035	$ 763,688,553		$ 763,688,553	$ 954,610,691	$ 639,252,652	$ 315,358,039	$ 11,225,485	$ 135,500,204	$ 14,459,481	$ 27,404,929	$ 8,009,148	$ 977,610	$ 13,969,100	$ 14,063,707	$ 693,788	$ 12,329,238	$ 14,378,750	$ 34,089,889	$ 28,256,396
						4th five years ►	$ 54,492,821	$ 657,770,110	$ 70,191,885	$ 133,034,066	$ 38,879,486	$ 4,745,695	$ 67,811,383	$ 68,270,644	$ 3,367,912	$ 59,850,863	$ 69,799,982	$ 165,485,432	$ 137,167,413
2036	$ 775,143,881		$ 775,143,881	$ 968,929,852	$ 648,841,442	$ 320,088,410	$ 11,393,867	$ 137,532,707	$ 14,676,374	$ 27,816,003	$ 8,129,285	$ 992,274	$ 14,178,636	$ 14,274,663	$ 704,195	$ 12,514,176	$ 14,594,431	$ 34,601,237	$ 28,680,242
2037	$ 786,771,040		$ 786,771,040	$ 983,463,799	$ 658,574,063	$ 324,889,736	$ 11,564,775	$ 139,595,698	$ 14,896,519	$ 28,233,243	$ 8,251,225	$ 1,007,158	$ 14,391,316	$ 14,488,783	$ 714,757	$ 12,701,889	$ 14,813,348	$ 35,120,256	$ 29,110,445
2038	$ 798,572,605		$ 798,572,605	$ 998,215,756	$ 668,452,674	$ 329,763,082	$ 11,738,247	$ 141,689,633	$ 15,119,967	$ 28,656,742	$ 8,374,993	$ 1,022,266	$ 14,607,185	$ 14,706,114	$ 725,479	$ 12,892,417	$ 15,035,548	$ 35,647,059	$ 29,547,102
2039	$ 810,551,194		$ 810,551,194	$ 1,013,188,993	$ 678,479,465	$ 334,709,528	$ 11,914,320	$ 143,814,978	$ 15,346,767	$ 29,086,593	$ 8,500,618	$ 1,037,600	$ 14,826,293	$ 14,926,706	$ 736,361	$ 13,085,804	$ 15,261,081	$ 36,181,765	$ 29,990,308
2040	$ 822,709,462		$ 822,709,462	$ 1,028,386,828	$ 688,656,656	$ 339,730,171	$ 12,093,035	$ 145,972,202	$ 15,576,968	$ 29,522,892	$ 8,628,127	$ 1,053,164	$ 15,048,688	$ 15,150,607	$ 747,406	$ 13,282,091	$ 15,489,997	$ 36,724,492	$ 30,440,163
						5th five years ►	$ 58,704,244	$ 708,605,218	$ 75,616,595	$ 143,315,472	$ 41,884,248	$ 5,112,461	$ 73,052,118	$ 73,546,873	$ 3,628,198	$ 64,476,378	$ 75,194,404	$ 178,274,809	$ 147,768,260
						Total ►	$ 236,421,899	$ 2,853,793,513	$ 304,533,670	$ 577,180,005	$ 168,682,070	$ 20,589,614	$ 294,205,654	$ 296,198,197	$ 14,611,984	$ 259,668,237	$ 302,833,366	$ 717,973,112	$ 595,112,895
						Non-Federal Aid System Preservation 1st five years (bridges and roadways) ►	$ 17,798,000	$ 214,835,500	$ 22,925,500	$ 43,450,500	$ 12,698,500	$ 1,550,000	$ 22,148,000	$ 22,298,000	$ 1,100,000	$ 19,548,000	$ 22,797,500	$ 54,049,500	$ 44,800,500
						Non-Federal Aid System Preservation 2nd five years (bridges and roadways) ►	$ 18,064,970	$ 218,058,033	$ 23,269,383	$ 44,102,258	$ 12,888,978	$ 1,573,250	$ 22,480,220	$ 22,632,470	$ 1,116,500	$ 19,841,220	$ 23,139,463	$ 54,860,243	$ 45,472,508
						Non-Federal Aid System Preservation 3rd five years (bridges and roadways) ►	$ 18,331,940	$ 221,280,565	$ 23,613,265	$ 44,754,015	$ 13,079,455	$ 1,596,500	$ 22,812,440	$ 22,966,940	$ 1,133,000	$ 20,134,440	$ 23,481,425	$ 55,670,985	$ 46,144,515
						Non-Federal Aid System Preservation 4th five years (bridges and roadways) ►	$ 18,598,910	$ 224,503,098	$ 23,957,148	$ 45,405,773	$ 13,269,933	$ 1,619,750	$ 23,144,660	$ 23,301,410	$ 1,149,500	$ 20,427,660	$ 23,823,388	$ 56,481,728	$ 46,816,523
						Non-Federal Aid System Preservation 5th five years (bridges and roadways) ►	$ 18,865,880	$ 227,725,630	$ 24,301,030	$ 46,057,530	$ 13,460,410	$ 1,643,000	$ 23,476,880	$ 23,635,880	$ 1,166,000	$ 20,720,880	$ 24,165,350	$ 57,292,470	$ 47,488,530

	Federal funding in today's dollars w/ 1.5% increase starting in 2021	GANs	repayment	Funding less GANs repayments	Funding w/ non-federal match	Statewide infrastructure, bridge & other items	Funding available for MPOs	Berkshire	Boston	Cape Cod	Central Mass	Franklin	Martha's Vineyard	Merrimack Valley	Montachusett	Nantucket	Northern Middlesex	Old Colony	Pioneer Valley	Southeast Mass
							MARPA formula ►	3.5596%	42.9671%	4.5851%	8.6901%	2.5397%	0.3100%	4.4296%	4.4596%	0.2200%	3.9096%	4.5595%	10.8099%	8.9601%
2016	$ 600,000,000	$ 44,440,000		$ 555,560,000	$ 694,450,000	$ 519,875,000	$ 174,575,000	$ 6,214,172	$ 75,009,815	$ 8,004,438	$ 15,170,742	$ 4,433,681	$ 541,183	$ 7,732,974	$ 7,785,347	$ 384,065	$ 6,825,184	$ 7,959,747	$ 18,871,383	$ 15,642,095
2017	$ 600,000,000	$ 59,150,000		$ 540,850,000	$ 676,062,500	$ 469,487,500	$ 206,575,000	$ 7,353,244	$ 88,759,287	$ 9,471,670	$ 17,951,574	$ 5,246,385	$ 640,383	$ 9,150,446	$ 9,212,419	$ 454,465	$ 8,076,256	$ 9,418,787	$ 22,330,551	$ 18,509,327
2018	$ 600,000,000	$ 68,463,700		$ 531,536,300	$ 664,420,375	$ 448,845,375	$ 215,575,000	$ 7,673,608	$ 92,626,326	$ 9,884,329	$ 18,733,683	$ 5,474,958	$ 668,283	$ 9,549,110	$ 9,613,783	$ 474,265	$ 8,428,120	$ 9,829,142	$ 23,303,442	$ 19,315,736
2019	$ 600,000,000	$ 73,525,150		$ 526,474,850	$ 658,093,563	$ 442,518,563	$ 215,575,000	$ 7,673,608	$ 92,626,326	$ 9,884,329	$ 18,733,683	$ 5,474,958	$ 668,283	$ 9,549,110	$ 9,613,783	$ 474,265	$ 8,428,120	$ 9,829,142	$ 23,303,442	$ 19,315,736
2020	$ 600,000,000	$ 77,951,600		$ 522,048,400	$ 652,560,500	$ 436,985,500	$ 215,575,000	$ 7,673,608	$ 92,626,326	$ 9,884,329	$ 18,733,683	$ 5,474,958	$ 668,283	$ 9,549,110	$ 9,613,783	$ 474,265	$ 8,428,120	$ 9,829,142	$ 23,303,442	$ 19,315,736
							1st five years ►	$ 36,588,239	$ 441,648,079	$ 47,129,097	$ 89,323,365	$ 26,104,941	$ 3,186,413	$ 45,530,751	$ 45,839,114	$ 2,261,325	$ 40,185,801	$ 46,865,961	$ 111,112,260	$ 92,098,628
2021	$ 620,000,000	$ 82,588,050		$ 537,411,950	$ 671,764,938	$ 449,845,703	$ 221,919,234	$ 7,899,437	$ 95,352,259	$ 10,175,219	$ 19,285,003	$ 5,636,083	$ 687,950	$ 9,830,134	$ 9,896,710	$ 488,222	$ 8,676,154	$ 10,118,407	$ 23,989,247	$ 19,884,185
2022	$ 629,300,000	$ 94,420,950		$ 534,879,050	$ 668,598,813	$ 447,725,516	$ 220,873,297	$ 7,862,206	$ 94,902,850	$ 10,127,262	$ 19,194,110	$ 5,609,519	$ 684,707	$ 9,783,804	$ 9,850,066	$ 485,921	$ 8,635,262	$ 10,070,718	$ 23,876,183	$ 19,790,468
2023	$ 638,739,500	$ 114,931,804		$ 523,807,696	$ 654,759,620	$ 438,458,135	$ 216,301,485	$ 7,699,468	$ 92,938,475	$ 9,917,639	$ 18,796,815	$ 5,493,409	$ 670,535	$ 9,581,291	$ 9,646,181	$ 475,863	$ 8,456,523	$ 9,862,266	$ 23,381,974	$ 19,380,829
2024	$ 648,320,593	$ 138,111,750		$ 510,208,843	$ 637,761,053	$ 427,075,088	$ 210,685,966	$ 7,499,578	$ 90,525,650	$ 9,660,162	$ 18,308,821	$ 5,350,791	$ 653,126	$ 9,332,546	$ 9,395,751	$ 463,509	$ 8,236,979	$ 9,606,227	$ 22,774,942	$ 18,877,673
2025	$ 658,045,401	$ 144,321,750		$ 513,723,651	$ 642,154,564	$ 430,017,191	$ 212,137,373	$ 7,551,242	$ 91,149,277	$ 9,726,711	$ 18,434,950	$ 5,387,653	$ 657,626	$ 9,396,837	$ 9,460,478	$ 466,702	$ 8,293,723	$ 9,672,404	$ 22,931,838	$ 19,007,721
							2nd five years ►	$ 38,511,930	$ 464,868,512	$ 49,606,993	$ 94,019,700	$ 27,477,455	$ 3,353,944	$ 47,924,611	$ 48,249,186	$ 2,380,218	$ 42,298,641	$ 49,330,022	$ 116,954,184	$ 96,940,877
2026	$ 667,916,082	$ 167,280,246		$ 500,635,836	$ 625,794,796	$ 419,061,913	$ 206,732,882	$ 7,358,864	$ 88,827,124	$ 9,478,909	$ 17,965,294	$ 5,250,395	$ 640,872	$ 9,157,440	$ 9,219,460	$ 454,812	$ 8,082,429	$ 9,425,986	$ 22,347,618	$ 18,523,473
2027	$ 677,934,824	▲ GANs conclude		$ 677,934,824	$ 847,418,530	$ 567,471,690	$ 279,946,839	$ 9,964,988	$ 120,285,038	$ 12,835,843	$ 24,327,660	$ 7,109,810	$ 867,835	$ 12,400,525	$ 12,484,509	$ 615,883	$ 10,944,802	$ 12,764,176	$ 30,261,973	$ 25,083,517
2028	$ 688,103,846			$ 688,103,846	$ 860,129,807	$ 575,983,765	$ 284,146,042	$ 10,114,463	$ 122,089,314	$ 13,028,380	$ 24,692,575	$ 7,216,457	$ 880,853	$ 12,586,533	$ 12,671,777	$ 625,121	$ 11,108,974	$ 12,955,639	$ 30,715,903	$ 25,459,770
2029	$ 698,425,404			$ 698,425,404	$ 873,031,755	$ 584,623,522	$ 288,408,233	$ 10,266,179	$ 123,920,654	$ 13,223,806	$ 25,062,964	$ 7,324,704	$ 894,066	$ 12,775,331	$ 12,861,854	$ 634,498	$ 11,275,608	$ 13,149,973	$ 31,176,642	$ 25,841,666
2030	$ 708,901,785			$ 708,901,785	$ 886,127,231	$ 593,392,875	$ 292,734,356	$ 10,420,172	$ 125,779,464	$ 13,422,163	$ 25,438,908	$ 7,434,574	$ 907,477	$ 12,966,961	$ 13,054,781	$ 644,016	$ 11,444,742	$ 13,347,223	$ 31,644,291	$ 26,229,291
							3rd five years ►	$ 48,124,665	$ 580,901,594	$ 61,989,101	$ 117,487,402	$ 34,335,940	$ 4,191,102	$ 59,886,790	$ 60,292,381	$ 2,974,330	$ 52,856,555	$ 61,642,997	$ 146,146,427	$ 121,137,716
2031	$ 719,535,312			$ 719,535,312	$ 899,419,139	$ 602,293,768	$ 297,125,371	$ 10,576,475	$ 127,666,155	$ 13,623,495	$ 25,820,492	$ 7,546,093	$ 921,089	$ 13,161,465	$ 13,250,603	$ 653,676	$ 11,616,414	$ 13,547,431	$ 32,118,956	$ 26,622,730
2032	$ 730,328,341			$ 730,328,341	$ 912,910,426	$ 611,328,174	$ 301,582,252	$ 10,735,122	$ 129,581,148	$ 13,827,848	$ 26,207,799	$ 7,659,284	$ 934,905	$ 13,358,887	$ 13,449,362	$ 663,481	$ 11,790,660	$ 13,750,643	$ 32,600,740	$ 27,022,071
2033	$ 741,283,266			$ 741,283,266	$ 926,604,083	$ 620,498,097	$ 306,105,986	$ 10,896,149	$ 131,524,865	$ 14,035,266	$ 26,600,916	$ 7,774,174	$ 948,929	$ 13,559,271	$ 13,651,103	$ 673,433	$ 11,967,520	$ 13,956,902	$ 33,089,751	$ 27,427,402
2034	$ 752,402,515			$ 752,402,515	$ 940,503,144	$ 629,805,569	$ 310,697,576	$ 11,059,591	$ 133,497,738	$ 14,245,795	$ 26,999,930	$ 7,890,786	$ 963,162	$ 13,762,660	$ 13,855,869	$ 683,535	$ 12,147,032	$ 14,166,256	$ 33,586,097	$ 27,838,813
2035	$ 763,688,553			$ 763,688,553	$ 954,610,691	$ 639,252,652	$ 315,358,039	$ 11,225,485	$ 135,500,204	$ 14,459,481	$ 27,404,929	$ 8,009,148	$ 977,610	$ 13,969,100	$ 14,063,707	$ 693,788	$ 12,329,238	$ 14,378,750	$ 34,089,889	$ 28,256,396
							4th five years ►	**$ 54,492,821**	**$ 657,770,110**	**$ 70,191,885**	**$ 133,034,066**	**$ 38,879,486**	**$ 4,745,695**	**$ 67,811,383**	**$ 68,270,644**	**$ 3,367,912**	**$ 59,850,863**	**$ 69,799,982**	**$ 165,485,432**	**$ 137,167,413**
2036	$ 775,143,881			$ 775,143,881	$ 968,929,852	$ 648,841,442	$ 320,088,410	$ 11,393,867	$ 137,532,707	$ 14,676,374	$ 27,816,003	$ 8,129,285	$ 992,274	$ 14,178,636	$ 14,274,663	$ 704,195	$ 12,514,176	$ 14,594,431	$ 34,601,237	$ 28,680,242
2037	$ 786,771,040			$ 786,771,040	$ 983,463,799	$ 658,574,063	$ 324,889,736	$ 11,564,775	$ 139,595,698	$ 14,896,519	$ 28,233,243	$ 8,251,225	$ 1,007,158	$ 14,391,316	$ 14,488,783	$ 714,757	$ 12,701,889	$ 14,813,348	$ 35,120,256	$ 29,110,445
2038	$ 798,572,605			$ 798,572,605	$ 998,215,756	$ 668,452,674	$ 329,763,082	$ 11,738,247	$ 141,689,633	$ 15,119,967	$ 28,656,742	$ 8,374,993	$ 1,022,266	$ 14,607,185	$ 14,706,114	$ 725,479	$ 12,892,417	$ 15,035,548	$ 35,647,059	$ 29,547,102
2039	$ 810,551,194			$ 810,551,194	$ 1,013,188,993	$ 678,479,465	$ 334,709,528	$ 11,914,320	$ 143,814,978	$ 15,346,767	$ 29,086,593	$ 8,500,618	$ 1,037,600	$ 14,826,293	$ 14,926,706	$ 736,361	$ 13,085,804	$ 15,261,081	$ 36,181,765	$ 29,990,308
2040	$ 822,709,462			$ 822,709,462	$ 1,028,386,828	$ 688,656,656	$ 339,730,171	$ 12,093,035	$ 145,972,202	$ 15,576,968	$ 29,522,892	$ 8,628,127	$ 1,053,164	$ 15,048,688	$ 15,150,607	$ 747,406	$ 13,282,091	$ 15,489,997	$ 36,724,492	$ 30,440,163
							5th five years ►	$ 58,704,244	$ 708,605,218	$ 75,616,595	$ 143,315,472	$ 41,884,248	$ 5,112,461	$ 73,052,118	$ 73,546,873	$ 3,628,198	$ 64,476,378	$ 75,194,404	$ 178,274,809	$ 147,768,260
						$ 20,339,360,755	Total ►	**$ 236,421,899**	**$ 2,853,793,513**	**$ 304,533,670**	**$ 577,180,005**	**$ 168,682,070**	**$ 20,589,614**	**$ 294,205,654**	**$ 296,198,197**	**$ 14,611,984**	**$ 259,668,237**	**$ 302,833,366**	**$ 717,973,112**	**$ 595,112,895**

Federal funding in today's dollars w/ 1.5% increase starting in 2021	GANs repayment	Funding less GANs repayments	Funding w/ non-federal match	Statewide infrastructure, bridge & other items	Funding available for MPOs	Berkshire	Boston	Cape Cod	Central Mass	Franklin	Martha's Vineyard	Merrimack Valley	Montachusett	Nantucket	Northern Middlesex	Old Colony	Pioneer Valley	Southeast Mass
					% of IM lane miles ►	0.0000%	37.7160%	0.0000%	10.9488%	3.7808%	0.0000%	14.2058%	1.9892%	0.0000%	3.8868%	0.3095%	8.4544%	18.7088%
Statewide Interstate Maintenance					*Statewide Interstate Maintenance 1st five years (bridges and roadways)* ►	$ -	$ 132,718,262	$ -	$ 38,527,505	$ 13,304,221	$ -	$ 49,988,572	$ 6,999,796	$ -	$ 13,677,041	$ 1,089,136	$ 29,750,182	$ 65,834,112
					Statewide Interstate Maintenance 2nd five years (bridges and roadways) ►	$ -	$ 125,611,486	$ -	$ 36,464,440	$ 12,591,809	$ -	$ 47,311,792	$ 6,624,972	$ -	$ 12,944,665	$ 1,030,816	$ 28,157,124	$ 62,308,837
					Statewide Interstate Maintenance 3rd five years (bridges and roadways) ►	$ -	$ 156,964,626	$ -	$ 45,566,114	$ 15,734,776	$ -	$ 59,121,009	$ 8,278,593	$ -	$ 16,175,706	$ 1,288,111	$ 35,185,257	$ 77,861,377
					Statewide Interstate Maintenance 4th five years (bridges and roadways) ►	$ -	$ 177,735,163	$ -	$ 51,595,706	$ 17,816,899	$ -	$ 66,944,269	$ 9,374,068	$ -	$ 18,316,176	$ 1,458,562	$ 39,841,190	$ 88,164,480
					Statewide Interstate Maintenance 5th five years (bridges and roadways) ►	$ -	$ 191,471,248	$ -	$ 55,583,228	$ 19,193,861	$ -	$ 72,117,990	$ 10,098,533	$ -	$ 19,731,724	$ 1,571,286	$ 42,920,276	$ 94,978,184
					Total ►	$ -	$ 784,500,786	$ -	$ 227,736,993	$ 78,641,565	$ -	$ 295,483,631	$ 41,375,962	$ -	$ 80,845,312	$ 6,437,912	$ 175,854,029	$ 389,146,990
					% of NHS lane miles ►	7.2969%	31.7288%	9.1502%	12.2071%	2.5370%	0.1462%	2.8516%	5.5292%	0.0000%	3.8068%	5.9107%	10.9602%	7.8754%
Statewide National Highway System					*Statewide NHS 1st five years (bridges and roadways)* ►	$ 13,030,503	$ 56,659,837	$ 16,340,015	$ 21,798,880	$ 4,530,507	$ 261,064	$ 5,092,297	$ 9,873,857	$ -	$ 6,798,072	$ 10,555,012	$ 19,572,131	$ 14,063,595
					Statewide NHS 2nd five years (bridges and roadways) ►	$ 12,619,886	$ 54,874,370	$ 15,825,108	$ 21,111,953	$ 4,387,742	$ 252,838	$ 4,931,828	$ 9,562,712	$ -	$ 6,583,850	$ 10,222,402	$ 18,955,373	$ 13,620,422
					Statewide NHS 3rd five years (bridges and roadways) ►	$ 15,769,861	$ 68,571,238	$ 19,775,119	$ 26,381,582	$ 5,482,940	$ 315,947	$ 6,162,832	$ 11,949,604	$ -	$ 8,227,206	$ 12,773,955	$ 23,686,712	$ 17,020,135
					Statewide NHS 4th five years (bridges and roadways) ►	$ 17,856,627	$ 77,645,011	$ 22,391,886	$ 29,872,558	$ 6,208,477	$ 357,755	$ 6,978,337	$ 13,530,850	$ -	$ 9,315,882	$ 14,464,285	$ 26,821,085	$ 19,272,346
					Statewide NHS 5th five years (bridges and roadways) ►	$ 19,236,659	$ 83,645,728	$ 24,122,421	$ 32,181,229	$ 6,688,293	$ 385,404	$ 7,517,651	$ 14,576,568	$ -	$ 10,035,850	$ 15,582,143	$ 28,893,926	$ 20,761,790
					Total ►	$ 78,513,536	$ 341,396,184	$ 98,454,549	$ 131,346,201	$ 27,297,960	$ 1,573,008	$ 30,682,944	$ 59,493,591	$ -	$ 40,960,860	$ 63,597,797	$ 117,929,228	$ 84,738,287
					% of bridges ►	9.3641%	26.3810%	1.7532%	14.4149%	6.8318%	0.1948%	3.6176%	8.2093%	0.0557%	2.8802%	3.1167%	14.3732%	8.8076%
Statewide Bridge					*Statewide Bridge 1st five years (bridges and roadways)* ►	$ 68,689,942	$ 193,515,796	$ 12,860,227	$ 105,739,644	$ 50,114,059	$ 1,428,914	$ 26,536,976	$ 60,218,523	$ 408,261	$ 21,127,516	$ 22,862,626	$ 105,433,448	$ 64,607,330
					Statewide Bridge 2nd five years (bridges and roadways) ►	$ 66,525,382	$ 187,417,718	$ 12,454,975	$ 102,407,572	$ 48,534,863	$ 1,383,886	$ 25,700,742	$ 58,320,914	$ 395,396	$ 20,461,745	$ 22,142,178	$ 102,111,025	$ 62,571,422
					Statewide Bridge 3rd five years (bridges and roadways) ►	$ 83,130,390	$ 234,197,948	$ 15,563,788	$ 127,968,921	$ 60,649,363	$ 1,729,310	$ 32,115,752	$ 72,878,053	$ 494,088	$ 25,569,080	$ 27,668,956	$ 127,598,354	$ 78,189,505
					Statewide Bridge 4th five years (bridges and roadways) ►	$ 94,130,720	$ 265,188,478	$ 17,623,285	$ 144,902,565	$ 68,674,864	$ 1,958,143	$ 36,365,509	$ 82,521,731	$ 559,469	$ 28,952,540	$ 31,330,284	$ 144,482,963	$ 88,536,027
					Statewide Bridge 5th five years (bridges and roadways) ►	$ 101,405,519	$ 285,683,306	$ 18,985,283	$ 156,101,216	$ 73,982,333	$ 2,109,476	$ 39,175,981	$ 88,899,341	$ 602,707	$ 31,190,108	$ 33,751,614	$ 155,649,185	$ 95,378,445
					Total ►	$ 413,881,954	$ 1,166,003,246	$ 77,487,557	$ 637,119,917	$ 301,955,482	$ 8,609,729	$ 159,894,960	$ 362,838,563	$ 2,459,922	$ 127,300,987	$ 137,755,658	$ 635,274,975	$ 389,282,729

Federal funding in today's dollars w/ 1.5% increase starting in 2021	GANs repayment	Funding less GANs repayments	Funding w/ non-federal match	Statewide Infrastructure, bridge & other items	Funding available for MPOs	Berkshire	Boston	Cape Cod	Central Mass	Franklin	Martha's Vineyard	Merrimack Valley	Montachusett	Nantucket	Northern Middlesex	Old Colony	Pioneer Valley	Southeast Mass
					MARPA formula ►	3.5596%	42.9671%	4.5851%	8.6901%	2.5397%	0.3100%	4.4296%	4.4596%	0.2200%	3.9096%	4.5595%	10.8099%	8.9601%
Statewide Infrastructure					*Statewide Infrastructure 1st five years (bridges and roadways)* ►	$ 1,389,390	$ 16,771,002	$ 1,789,665	$ 3,391,937	$ 991,301	$ 121,000	$ 1,728,970	$ 1,740,680	$ 85,871	$ 1,526,003	$ 1,779,673	$ 4,219,341	$ 3,497,324
					Statewide Infrastructure 2nd five years (bridges and roadways) ►	$ 1,345,607	$ 16,242,513	$ 1,733,269	$ 3,285,050	$ 960,063	$ 117,187	$ 1,674,487	$ 1,685,827	$ 83,165	$ 1,477,915	$ 1,723,592	$ 4,086,381	$ 3,387,116
					Statewide Infrastructure 3rd five years (bridges and roadways) ►	$ 1,681,477	$ 20,296,711	$ 2,165,900	$ 4,105,012	$ 1,199,698	$ 146,437	$ 2,092,445	$ 2,106,617	$ 103,923	$ 1,846,809	$ 2,153,807	$ 5,106,359	$ 4,232,554
					Statewide Infrastructure 4th five years (bridges and roadways) ►	$ 1,903,980	$ 22,982,498	$ 2,452,506	$ 4,648,212	$ 1,358,450	$ 165,815	$ 2,369,331	$ 2,385,377	$ 117,675	$ 2,091,190	$ 2,438,813	$ 5,782,064	$ 4,792,632
					Statewide Infrastructure 5th five years (bridges and roadways) ►	$ 2,051,127	$ 24,758,678	$ 2,642,045	$ 5,007,445	$ 1,463,436	$ 178,629	$ 2,552,442	$ 2,569,729	$ 126,769	$ 2,252,806	$ 2,627,294	$ 6,228,925	$ 5,163,025
					Total ►	$ 8,371,581	$ 101,051,403	$ 10,783,385	$ 20,437,656	$ 5,972,948	$ 729,068	$ 10,417,675	$ 10,488,230	$ 517,403	$ 9,194,723	$ 10,723,178	$ 25,423,069	$ 21,072,650
					% MARPA formula ►	3.5596%	42.9671%	4.5851%	8.6901%	2.5397%	0.3100%	4.4296%	4.4596%	0.2200%	3.9096%	4.5595%	10.8099%	8.9601%
Remaining Statewide Programs					*Remaining Statewide Programs 1st five years (bridges and roadways)* ►	$ 31,625,375	$ 381,742,510	$ 40,736,461	$ 77,207,458	$ 22,564,042	$ 2,754,204	$ 39,354,916	$ 39,621,452	$ 1,954,597	$ 34,734,960	$ 40,509,017	$ 96,040,886	$ 79,606,282
					Remaining Statewide Programs 2nd five years (bridges and roadways) ►	$ 33,420,997	$ 403,417,051	$ 43,049,392	$ 81,591,136	$ 23,845,181	$ 2,910,582	$ 41,589,406	$ 41,871,075	$ 2,065,575	$ 36,707,139	$ 42,809,034	$ 101,493,887	$ 84,126,160
					Remaining Statewide Programs 3rd five years (bridges and roadways) ►	$ 41,763,015	$ 504,111,598	$ 53,794,696	$ 101,956,618	$ 29,797,036	$ 3,637,076	$ 51,970,292	$ 52,322,267	$ 2,581,150	$ 45,869,391	$ 53,494,344	$ 126,827,176	$ 105,124,394
					Remaining Statewide Programs 4th five years (bridges and roadways) ►	$ 47,289,357	$ 570,818,784	$ 60,913,145	$ 115,448,152	$ 33,739,965	$ 4,118,356	$ 58,847,325	$ 59,245,875	$ 2,922,704	$ 51,939,114	$ 60,573,049	$ 143,609,738	$ 119,035,108
					Remaining Statewide Programs 5th five years (bridges and roadways) ►	$ 50,944,068	$ 614,933,945	$ 65,620,757	$ 124,370,448	$ 36,347,525	$ 4,436,639	$ 63,395,282	$ 63,824,634	$ 3,148,583	$ 55,953,177	$ 65,254,377	$ 154,708,473	$ 128,234,618
					Total ►	$ 205,042,813	$ 2,475,023,888	$ 264,114,451	$ 500,573,813	$ 146,293,750	$ 17,856,858	$ 255,157,221	$ 256,885,304	$ 12,672,609	$ 225,203,781	$ 262,639,820	$ 622,680,160	$ 516,126,560
					MARPA formula ►	3.5596%	42.9671%	4.5851%	8.6901%	2.5397%	0.3100%	4.4296%	4.4596%	0.2200%	3.9096%	4.5595%	10.8099%	8.9601%
Non-Federal Aid Preservation (bridges and roadways)					*Non-Federal Aid System Preservation 1st five years (bridges and roadways)* ►	**$ 17,798,000**	**$ 214,835,500**	**$ 22,925,500**	**$ 43,450,500**	**$ 12,698,500**	**$ 1,550,000**	**$ 22,148,000**	**$ 22,298,000**	**$ 1,100,000**	**$ 19,548,000**	**$ 22,797,500**	**$ 54,049,500**	**$ 44,800,500**
					Non-Federal Aid System Preservation 2nd five years (bridges and roadways) ►	**$ 18,064,970**	**$ 218,058,033**	**$ 23,269,383**	**$ 44,102,258**	**$ 12,888,978**	**$ 1,573,250**	**$ 22,480,220**	**$ 22,632,470**	**$ 1,116,500**	**$ 19,841,220**	**$ 23,139,463**	**$ 54,860,243**	**$ 45,472,508**
					Non-Federal Aid System Preservation 3rd five years (bridges and roadways) ►	**$ 18,331,940**	**$ 221,280,565**	**$ 23,613,265**	**$ 44,754,015**	**$ 13,079,455**	**$ 1,596,500**	**$ 22,812,440**	**$ 22,966,940**	**$ 1,133,000**	**$ 20,134,440**	**$ 23,481,425**	**$ 55,670,985**	**$ 46,144,515**
					Non-Federal Aid System Preservation 4th five years (bridges and roadways) ►	**$ 18,598,910**	**$ 224,503,098**	**$ 23,957,148**	**$ 45,405,773**	**$ 13,269,933**	**$ 1,619,750**	**$ 23,144,660**	**$ 23,301,410**	**$ 1,149,500**	**$ 20,427,660**	**$ 23,823,388**	**$ 56,481,728**	**$ 46,816,523**
					Non-Federal Aid System Preservation 5th five years (bridges and roadways) ►	**$ 18,865,880**	**$ 227,725,630**	**$ 24,301,030**	**$ 46,057,530**	**$ 13,460,410**	**$ 1,643,000**	**$ 23,476,880**	**$ 23,635,880**	**$ 1,166,000**	**$ 20,720,880**	**$ 24,165,350**	**$ 57,292,470**	**$ 47,488,530**
					Total ►	$ 91,659,700	$ 1,106,402,825	$ 118,066,325	$ 223,770,075	$ 65,397,275	$ 7,982,500	$ 114,062,200	$ 114,834,700	$ 5,665,000	$ 100,672,200	$ 117,407,125	$ 278,354,925	$ 230,722,575

	Federal funding in today's dollars w/ 1.5% increase starting in 2021	GANs repayment	Funding less GANs repayments	Funding w/ non-federal match	Funding available for MPOs	Statewide Programs	Interstate Maintenance	Berkshire	Boston	Cape Cod	Central Mass	Franklin	Martha's Vineyard	Merrimack Valley	Montachusett	Nantucket	Northern Middlesex	Old Colony	Pioneer Valley	Southeast Mass
							Lanes Miles	0.0000%	37.7160%	0.0000%	10.9488%	3.7808%	0.0000%	14.2058%	1.9892%	0.0000%	3.8868%	0.3095%	8.4544%	18.7088%
2016	$ 600,000,000	$ 44,440,000	$ 555,560,000	$ 694,450,000	$ 174,575,000	$ 519,875,000	$ 75,934,289	$ -	$ 28,639,349	$ -	$ 8,313,872	$ 2,870,925	$ -	$ 10,787,062	$ 1,510,490	$ -	$ 2,951,376	$ 235,025	$ 6,419,809	$ 14,206,380
2017	$ 600,000,000	$ 59,150,000	$ 540,850,000	$ 676,062,500	$ 206,575,000	$ 469,487,500	$ 70,544,016	$ -	$ 26,606,355	$ -	$ 7,723,703	$ 2,667,130	$ -	$ 10,021,332	$ 1,403,266	$ -	$ 2,741,870	$ 218,342	$ 5,964,092	$ 13,197,926
2018	$ 600,000,000	$ 68,463,700	$ 531,536,300	$ 664,420,375	$ 215,575,000	$ 448,845,375	$ 66,992,127	$ -	$ 25,266,726	$ -	$ 7,334,815	$ 2,532,840	$ -	$ 9,516,758	$ 1,332,612	$ -	$ 2,603,817	$ 207,348	$ 5,663,800	$ 12,533,411
2019	$ 600,000,000	$ 73,525,150	$ 526,474,850	$ 658,093,563	$ 215,575,000	$ 442,518,563	$ 72,058,080	$ -	$ 27,177,399	$ -	$ 7,889,475	$ 2,724,374	$ -	$ 10,236,416	$ 1,433,384	$ -	$ 2,800,718	$ 223,028	$ 6,092,097	$ 13,481,189
2020	$ 600,000,000	$ 77,951,600	$ 522,048,400	$ 652,560,500	$ 215,575,000	$ 436,985,500	$ 66,360,317	$ -	$ 25,028,433	$ -	$ 7,265,640	$ 2,508,952	$ -	$ 9,427,004	$ 1,320,044	$ -	$ 2,579,260	$ 205,393	$ 5,610,384	$ 12,415,207
						1st five years ►		$ -	$ 132,718,262	$ -	$ 38,527,505	$ 13,304,221	$ -	$ 49,988,572	$ 6,999,796	$ -	$ 13,677,041	$ 1,089,136	$ 29,750,182	$ 65,834,112
2021	$ 620,000,000	$ 82,588,050	$ 537,411,950	$ 671,764,938	$ 221,919,234	$ 449,845,703	$ 68,313,259	$ -	$ 25,765,004	$ -	$ 7,479,463	$ 2,582,789	$ -	$ 9,704,435	$ 1,358,892	$ -	$ 2,655,166	$ 211,437	$ 5,775,494	$ 12,780,578
2022	$ 629,300,000	$ 94,420,950	$ 534,879,050	$ 668,598,813	$ 220,873,297	$ 447,725,516	$ 67,991,288	$ -	$ 25,643,570	$ -	$ 7,444,211	$ 2,570,616	$ -	$ 9,658,697	$ 1,352,487	$ -	$ 2,642,652	$ 210,441	$ 5,748,273	$ 12,720,342
2023	$ 638,739,500	$ 114,931,804	$ 523,807,696	$ 654,759,620	$ 216,301,485	$ 438,458,135	$ 66,583,950	$ -	$ 25,112,778	$ -	$ 7,290,125	$ 2,517,408	$ -	$ 9,458,773	$ 1,324,492	$ -	$ 2,587,952	$ 206,085	$ 5,629,291	$ 12,457,046
2024	$ 648,320,593	$ 138,111,750	$ 510,208,843	$ 637,761,053	$ 210,685,966	$ 427,075,088	$ 64,855,329	$ -	$ 24,460,812	$ -	$ 7,100,862	$ 2,452,052	$ -	$ 9,213,209	$ 1,290,107	$ -	$ 2,520,765	$ 200,735	$ 5,483,146	$ 12,133,642
2025	$ 658,045,401	$ 144,321,750	$ 513,723,651	$ 642,154,564	$ 212,137,373	$ 430,017,191	$ 65,302,114	$ -	$ 24,629,322	$ -	$ 7,149,780	$ 2,468,944	$ -	$ 9,276,678	$ 1,298,994	$ -	$ 2,538,130	$ 202,118	$ 5,520,919	$ 12,217,230
						2nd five years ►		$ -	$ 125,611,486	$ -	$ 36,464,440	$ 12,591,809	$ -	$ 47,311,792	$ 6,624,972	$ -	$ 12,944,665	$ 1,030,816	$ 28,157,124	$ 62,308,837
2026	$ 667,916,082	$ 167,280,246	$ 500,635,836	$ 625,794,796	$ 206,732,882	$ 419,061,913	$ 63,638,453	$ -	$ 24,001,856	$ -	$ 6,967,629	$ 2,406,044	$ -	$ 9,040,342	$ 1,265,900	$ -	$ 2,473,468	$ 196,968	$ 5,380,266	$ 11,905,979
2027	$ 677,934,824	▲ GANs conclude	$ 677,934,824	$ 847,418,530	$ 279,946,839	$ 567,471,690	$ 86,175,860	$ -	$ 32,502,056	$ -	$ 9,435,198	$ 3,258,139	$ -	$ 12,241,958	$ 1,714,216	$ -	$ 3,349,441	$ 266,724	$ 7,285,675	$ 16,122,453
2028	$ 688,103,846		$ 688,103,846	$ 860,129,807	$ 284,146,042	$ 575,983,765	$ 87,468,498	$ -	$ 32,989,587	$ -	$ 9,576,726	$ 3,307,011	$ -	$ 12,425,587	$ 1,739,929	$ -	$ 3,399,682	$ 270,725	$ 7,394,960	$ 16,364,290
2029	$ 698,425,404		$ 698,425,404	$ 873,031,755	$ 288,408,233	$ 584,623,522	$ 88,780,525	$ -	$ 33,484,431	$ -	$ 9,720,377	$ 3,356,616	$ -	$ 12,611,971	$ 1,766,028	$ -	$ 3,450,678	$ 274,786	$ 7,505,884	$ 16,609,754
2030	$ 708,901,785		$ 708,901,785	$ 886,127,231	$ 292,734,356	$ 593,392,875	$ 90,112,233	$ -	$ 33,986,697	$ -	$ 9,866,183	$ 3,406,965	$ -	$ 12,801,151	$ 1,792,519	$ -	$ 3,502,438	$ 278,908	$ 7,618,472	$ 16,858,901
						3rd five years ►		$ -	$ 156,964,626	$ -	$ 45,566,114	$ 15,734,776	$ -	$ 59,121,009	$ 8,278,593	$ -	$ 16,175,706	$ 1,288,111	$ 35,185,257	$ 77,861,377
2031	$ 719,535,312		$ 719,535,312	$ 899,419,139	$ 297,125,371	$ 602,293,768	$ 91,463,917	$ -	$ 34,496,498	$ -	$ 10,014,176	$ 3,458,070	$ -	$ 12,993,168	$ 1,819,406	$ -	$ 3,554,974	$ 283,091	$ 7,732,750	$ 17,111,784
2032	$ 730,328,341		$ 730,328,341	$ 912,910,426	$ 301,582,252	$ 611,328,174	$ 92,835,875	$ -	$ 35,013,945	$ -	$ 10,164,388	$ 3,509,941	$ -	$ 13,188,065	$ 1,846,698	$ -	$ 3,608,299	$ 287,338	$ 7,848,741	$ 17,368,461
2033	$ 741,283,266		$ 741,283,266	$ 926,604,083	$ 306,105,986	$ 620,498,097	$ 94,228,413	$ -	$ 35,539,154	$ -	$ 10,316,854	$ 3,562,590	$ -	$ 13,385,886	$ 1,874,398	$ -	$ 3,662,423	$ 291,648	$ 7,966,472	$ 17,628,988
2034	$ 752,402,515		$ 752,402,515	$ 940,503,144	$ 310,697,576	$ 629,805,569	$ 95,641,840	$ -	$ 36,072,241	$ -	$ 10,471,607	$ 3,616,029	$ -	$ 13,586,675	$ 1,902,514	$ -	$ 3,717,360	$ 296,023	$ 8,085,969	$ 17,893,423
2035	$ 763,688,553		$ 763,688,553	$ 954,610,691	$ 315,358,039	$ 639,252,652	$ 97,076,467	$ -	$ 36,613,325	$ -	$ 10,628,681	$ 3,670,269	$ -	$ 13,790,475	$ 1,931,052	$ -	$ 3,773,120	$ 300,463	$ 8,207,258	$ 18,161,824
						4th five years ►		**$ -**	**$ 177,735,163**	**$ -**	**$ 51,595,706**	**$ 17,816,899**	**$ -**	**$ 66,944,269**	**$ 9,374,068**	**$ -**	**$ 18,316,176**	**$ 1,458,562**	**$ 39,841,190**	**$ 88,164,480**
2036	$ 775,143,881		$ 775,143,881	$ 968,929,852	$ 320,088,410	$ 648,841,442	$ 98,532,614	$ -	$ 37,162,525	$ -	$ 10,788,111	$ 3,725,323	$ -	$ 13,997,332	$ 1,960,017	$ -	$ 3,829,717	$ 304,970	$ 8,330,367	$ 18,434,251
2037	$ 786,771,040		$ 786,771,040	$ 983,463,799	$ 324,889,736	$ 658,574,063	$ 100,010,603	$ -	$ 37,719,963	$ -	$ 10,949,933	$ 3,781,203	$ -	$ 14,207,292	$ 1,989,418	$ -	$ 3,887,163	$ 309,544	$ 8,455,323	$ 18,710,765
2038	$ 798,572,605		$ 798,572,605	$ 998,215,756	$ 329,763,082	$ 668,452,674	$ 101,510,763	$ -	$ 38,285,762	$ -	$ 11,114,182	$ 3,837,921	$ -	$ 14,420,401	$ 2,019,259	$ -	$ 3,945,470	$ 314,188	$ 8,582,153	$ 18,991,427
2039	$ 810,551,194		$ 810,551,194	$ 1,013,188,993	$ 334,709,528	$ 678,479,465	$ 103,033,424	$ -	$ 38,860,049	$ -	$ 11,280,895	$ 3,895,490	$ -	$ 14,636,707	$ 2,049,548	$ -	$ 4,004,652	$ 318,900	$ 8,710,885	$ 19,276,298
2040	$ 822,709,462		$ 822,709,462	$ 1,028,386,828	$ 339,730,171	$ 688,656,656	$ 104,578,925	$ -	$ 39,442,949	$ -	$ 11,450,108	$ 3,953,922	$ -	$ 14,856,258	$ 2,080,291	$ -	$ 4,064,722	$ 323,684	$ 8,841,548	$ 19,565,443
						5th five years ►		$ -	$ 191,471,248	$ -	$ 55,583,228	$ 19,193,861	$ -	$ 72,117,990	$ 10,098,533	$ -	$ 19,731,724	$ 1,571,286	$ 42,920,276	$ 94,978,184
							Total ►	*$ 2,080,023,179*	**$ 784,500,786**	**$ -**	**$ 227,736,993**	**$ 78,641,565**	**$ -**	**$ 295,483,631**	**$ 41,375,962**	**$ -**	**$ 80,845,312**	**$ 6,437,912**	**$ 175,854,029**	**$ 389,146,990**

	Federal funding in today's dollars w/ 1.5% increase starting in 2021	GANs repayment	Funding less GANs repayments	Funding w/ non-federal match	Funding available for MPOs	Statewide Programs	National Highway System	Berkshire	Boston	Cape Cod	Central Mass	Franklin	Martha's Vineyard	Merrimack Valley	Montachusett	Nantucket	Northern Middlesex	Old Colony	Pioneer Valley	Southeast Mass
							Lane Miles	7.2969%	31.7288%	9.1502%	12.2071%	2.5370%	0.1462%	2.8516%	5.5292%	0.0000%	3.8068%	5.9107%	10.9602%	7.8754%
2016	$ 600,000,000	$ 44,440,000	$ 555,560,000	$ 694,450,000	$ 174,575,000	$ 519,875,000	$ 26,700,000	$ 1,948,278	$ 8,471,591	$ 2,443,105	$ 3,259,296	$ 677,386	$ 39,033	$ 761,383	$ 1,476,306	$ -	$ 1,016,425	$ 1,578,150	$ 2,926,360	$ 2,102,742
2017	$ 600,000,000	$ 59,150,000	$ 540,850,000	$ 676,062,500	$ 206,575,000	$ 469,487,500	$ 43,665,000	$ 3,186,200	$ 13,854,383	$ 3,995,437	$ 5,330,231	$ 1,107,793	$ 63,835	$ 1,245,161	$ 2,414,342	$ -	$ 1,662,255	$ 2,580,897	$ 4,785,750	$ 3,438,810
2018	$ 600,000,000	$ 68,463,700	$ 531,536,300	$ 664,420,375	$ 215,575,000	$ 448,845,375	$ 38,750,000	$ 2,827,557	$ 12,294,912	$ 3,545,705	$ 4,730,252	$ 983,098	$ 56,650	$ 1,105,004	$ 2,142,580	$ -	$ 1,475,149	$ 2,290,387	$ 4,247,058	$ 3,051,732
2019	$ 600,000,000	$ 73,525,150	$ 526,474,850	$ 658,093,563	$ 215,575,000	$ 442,518,563	$ 35,000,000	$ 2,553,922	$ 11,105,082	$ 3,202,572	$ 4,272,486	$ 887,960	$ 51,167	$ 998,068	$ 1,935,233	$ -	$ 1,332,392	$ 2,068,737	$ 3,836,053	$ 2,756,403
2020	$ 600,000,000	$ 77,951,600	$ 522,048,400	$ 652,560,500	$ 215,575,000	$ 436,985,500	$ 34,460,385	$ 2,514,547	$ 10,933,869	$ 3,153,196	$ 4,206,614	$ 874,270	$ 50,379	$ 982,680	$ 1,905,397	$ -	$ 1,311,850	$ 2,036,842	$ 3,776,910	$ 2,713,906
					1st five years ►			$ 13,030,503	$ 56,659,837	$ 16,340,015	$ 21,798,880	$ 4,530,507	$ 261,064	$ 5,092,297	$ 9,873,857	$ -	$ 6,798,072	$ 10,555,012	$ 19,572,131	$ 14,063,595
2021	$ 620,000,000	$ 82,588,050	$ 537,411,950	$ 671,764,938	$ 221,919,234	$ 449,845,703	$ 35,474,532	$ 2,588,548	$ 11,255,646	$ 3,245,993	$ 4,330,412	$ 899,999	$ 51,861	$ 1,011,600	$ 1,961,471	$ -	$ 1,350,457	$ 2,096,785	$ 3,888,062	$ 2,793,775
2022	$ 629,300,000	$ 94,420,950	$ 534,879,050	$ 668,598,813	$ 220,873,297	$ 447,725,516	$ 35,307,336	$ 2,576,348	$ 11,202,596	$ 3,230,694	$ 4,310,003	$ 895,757	$ 51,617	$ 1,006,832	$ 1,952,226	$ -	$ 1,344,092	$ 2,086,902	$ 3,869,737	$ 2,780,608
2023	$ 638,739,500	$ 114,931,804	$ 523,807,696	$ 654,759,620	$ 216,301,485	$ 438,458,135	$ 34,576,516	$ 2,523,021	$ 10,970,716	$ 3,163,822	$ 4,220,791	$ 877,216	$ 50,548	$ 985,992	$ 1,911,818	$ -	$ 1,316,271	$ 2,043,706	$ 3,789,638	$ 2,723,052
2024	$ 648,320,593	$ 138,111,750	$ 510,208,843	$ 637,761,053	$ 210,685,966	$ 427,075,088	$ 33,678,857	$ 2,457,519	$ 10,685,899	$ 3,081,685	$ 4,111,212	$ 854,442	$ 49,236	$ 960,394	$ 1,862,184	$ -	$ 1,282,099	$ 1,990,648	$ 3,691,253	$ 2,652,358
2025	$ 658,045,401	$ 144,321,750	$ 513,723,651	$ 642,154,564	$ 212,137,373	$ 430,017,191	$ 33,910,869	$ 2,474,449	$ 10,759,514	$ 3,102,914	$ 4,139,534	$ 860,328	$ 49,575	$ 967,010	$ 1,875,012	$ -	$ 1,290,931	$ 2,004,362	$ 3,716,682	$ 2,670,630
					2nd five years ►			$ 12,619,886	$ 54,874,370	$ 15,825,108	$ 21,111,953	$ 4,387,742	$ 252,838	$ 4,931,828	$ 9,562,712	$ -	$ 6,583,850	$ 10,222,402	$ 18,955,373	$ 13,620,422
2026	$ 667,916,082	$ 167,280,246	$ 500,635,836	$ 625,794,796	$ 206,732,882	$ 419,061,913	$ 33,046,943	$ 2,411,409	$ 10,485,400	$ 3,023,863	$ 4,034,074	$ 838,410	$ 48,312	$ 942,374	$ 1,827,244	$ -	$ 1,258,043	$ 1,953,298	$ 3,621,995	$ 2,602,592
2027	$ 677,934,824	▲ GANs conclude	$ 677,934,824	$ 847,418,530	$ 279,946,839	$ 567,471,690	$ 44,750,439	$ 3,265,404	$ 14,198,780	$ 4,094,757	$ 5,462,732	$ 1,135,331	$ 65,422	$ 1,276,114	$ 2,474,358	$ -	$ 1,703,576	$ 2,645,053	$ 4,904,716	$ 3,524,293
2028	$ 688,103,846		$ 688,103,846	$ 860,129,807	$ 284,146,042	$ 575,983,765	$ 45,421,696	$ 3,314,385	$ 14,411,762	$ 4,156,179	$ 5,544,673	$ 1,152,361	$ 66,403	$ 1,295,255	$ 2,511,473	$ -	$ 1,729,129	$ 2,684,729	$ 4,978,286	$ 3,577,158
2029	$ 698,425,404		$ 698,425,404	$ 873,031,755	$ 288,408,233	$ 584,623,522	$ 46,103,021	$ 3,364,101	$ 14,627,938	$ 4,218,521	$ 5,627,843	$ 1,169,647	$ 67,399	$ 1,314,684	$ 2,549,146	$ -	$ 1,755,066	$ 2,725,000	$ 5,052,961	$ 3,630,815
2030	$ 708,901,785		$ 708,901,785	$ 886,127,231	$ 292,734,356	$ 593,392,875	$ 46,794,567	$ 3,414,562	$ 14,847,357	$ 4,281,799	$ 5,712,261	$ 1,187,191	$ 68,410	$ 1,334,405	$ 2,587,383	$ -	$ 1,781,392	$ 2,765,875	$ 5,128,755	$ 3,685,277
					3rd five years ►			$ 15,769,861	$ 68,571,238	$ 19,775,119	$ 26,381,582	$ 5,482,940	$ 315,947	$ 6,162,832	$ 11,949,604	$ -	$ 8,227,206	$ 12,773,955	$ 23,686,712	$ 17,020,135
2031	$ 719,535,312		$ 719,535,312	$ 899,419,139	$ 297,125,371	$ 602,293,768	$ 47,496,485	$ 3,465,781	$ 15,070,068	$ 4,346,026	$ 5,797,945	$ 1,204,999	$ 69,436	$ 1,354,421	$ 2,626,193	$ -	$ 1,808,113	$ 2,807,363	$ 5,205,686	$ 3,740,557
2032	$ 730,328,341		$ 730,328,341	$ 912,910,426	$ 301,582,252	$ 611,328,174	$ 48,208,933	$ 3,517,767	$ 15,296,119	$ 4,411,216	$ 5,884,914	$ 1,223,074	$ 70,478	$ 1,374,737	$ 2,665,586	$ -	$ 1,835,235	$ 2,849,474	$ 5,283,772	$ 3,796,665
2033	$ 741,283,266		$ 741,283,266	$ 926,604,083	$ 306,105,986	$ 620,498,097	$ 48,932,067	$ 3,570,534	$ 15,525,560	$ 4,477,385	$ 5,973,187	$ 1,241,420	$ 71,535	$ 1,395,358	$ 2,705,570	$ -	$ 1,862,763	$ 2,892,216	$ 5,363,028	$ 3,853,615
2034	$ 752,402,515		$ 752,402,515	$ 940,503,144	$ 310,697,576	$ 629,805,569	$ 49,666,048	$ 3,624,092	$ 15,758,444	$ 4,544,545	$ 6,062,785	$ 1,260,042	$ 72,608	$ 1,416,288	$ 2,746,154	$ -	$ 1,890,705	$ 2,935,599	$ 5,443,474	$ 3,911,419
2035	$ 763,688,553		$ 763,688,553	$ 954,610,691	$ 315,358,039	$ 639,252,652	$ 50,411,038	$ 3,678,453	$ 15,994,820	$ 4,612,714	$ 6,153,727	$ 1,278,942	$ 73,697	$ 1,437,533	$ 2,787,346	$ -	$ 1,919,065	$ 2,979,633	$ 5,525,126	$ 3,970,090
					4th five years ►			**$ 17,856,627**	**$ 77,645,011**	**$ 22,391,886**	**$ 29,872,558**	**$ 6,208,477**	**$ 357,755**	**$ 6,978,337**	**$ 13,530,850**	**$ -**	**$ 9,315,882**	**$ 14,464,285**	**$ 26,821,085**	**$ 19,272,346**
2036	$ 775,143,881		$ 775,143,881	$ 968,929,852	$ 320,088,410	$ 648,841,442	$ 51,167,204	$ 3,733,630	$ 16,234,743	$ 4,681,904	$ 6,246,033	$ 1,298,126	$ 74,803	$ 1,459,096	$ 2,829,156	$ -	$ 1,947,851	$ 3,024,328	$ 5,608,003	$ 4,029,642
2037	$ 786,771,040		$ 786,771,040	$ 983,463,799	$ 324,889,736	$ 658,574,063	$ 51,934,712	$ 3,789,635	$ 16,478,264	$ 4,752,133	$ 6,339,723	$ 1,317,598	$ 75,925	$ 1,480,982	$ 2,871,594	$ -	$ 1,977,069	$ 3,069,692	$ 5,692,123	$ 4,090,086
2038	$ 798,572,605		$ 798,572,605	$ 998,215,756	$ 329,763,082	$ 668,452,674	$ 52,713,733	$ 3,846,479	$ 16,725,438	$ 4,823,415	$ 6,434,819	$ 1,337,362	$ 77,064	$ 1,503,197	$ 2,914,667	$ -	$ 2,006,725	$ 3,115,738	$ 5,777,504	$ 4,151,438
2039	$ 810,551,194		$ 810,551,194	$ 1,013,188,993	$ 334,709,528	$ 678,479,465	$ 53,504,439	$ 3,904,176	$ 16,976,319	$ 4,895,766	$ 6,531,342	$ 1,357,423	$ 78,220	$ 1,525,745	$ 2,958,387	$ -	$ 2,036,826	$ 3,162,474	$ 5,864,167	$ 4,213,709
2040	$ 822,709,462		$ 822,709,462	$ 1,028,386,828	$ 339,730,171	$ 688,656,656	$ 54,307,005	$ 3,962,739	$ 17,230,964	$ 4,969,203	$ 6,629,312	$ 1,377,784	$ 79,393	$ 1,548,631	$ 3,002,763	$ -	$ 2,067,378	$ 3,209,911	$ 5,952,130	$ 4,276,915
					5th five years ►			$ 19,236,659	$ 83,645,728	$ 24,122,421	$ 32,181,229	$ 6,688,293	$ 385,404	$ 7,517,651	$ 14,576,568	$ -	$ 10,035,850	$ 15,582,143	$ 28,893,926	$ 20,761,790
							Total ► $ 1,075,981,826	**$ 78,513,536**	**$ 341,396,184**	**$ 98,454,549**	**$ 131,346,201**	**$ 27,297,960**	**$ 1,573,008**	**$ 30,682,944**	**$ 59,493,591**	**$ -**	**$ 40,960,860**	**$ 63,597,797**	**$ 117,929,228**	**$ 84,738,287**

	Federal funding in today's dollars w/ 1.5% increase starting in 2021	GANs repayment	Funding less GANs repayments	Funding w/ non-federal match	Funding available for MPOs	Statewide Programs	Statewide Bridges	Berkshire	Boston	Cape Cod	Central Mass	Franklin	Martha's Vineyard	Merrimack Valley	Montachusett	Nantucket	Northern Middlesex	Old Colony	Pioneer Valley	Southeast Mass
							Bridges	9.3641%	26.3810%	1.7532%	14.4149%	6.8318%	0.1948%	3.6176%	8.2093%	0.0557%	2.8802%	3.1167%	14.3732%	8.8076%
2016	$ 600,000,000	$ 44,440,000	$ 555,560,000	$ 694,450,000	$ 174,575,000	$ 519,875,000	$ 148,729,824	$ 13,927,254	$ 39,236,364	$ 2,607,480	$ 21,439,279	$ 10,160,894	$ 289,720	$ 5,380,514	$ 12,209,628	$ 82,777	$ 4,283,717	$ 4,635,520	$ 21,377,196	$ 13,099,482
2017	$ 600,000,000	$ 59,150,000	$ 540,850,000	$ 676,062,500	$ 206,575,000	$ 469,487,500	$ 149,172,983	$ 13,968,752	$ 39,353,273	$ 2,615,249	$ 21,503,160	$ 10,191,169	$ 290,583	$ 5,396,546	$ 12,246,008	$ 83,024	$ 4,296,481	$ 4,649,332	$ 21,440,892	$ 13,138,514
2018	$ 600,000,000	$ 68,463,700	$ 531,536,300	$ 664,420,375	$ 215,575,000	$ 448,845,375	$ 148,079,233	$ 13,866,331	$ 39,064,732	$ 2,596,074	$ 21,345,497	$ 10,116,447	$ 288,453	$ 5,356,978	$ 12,156,219	$ 82,415	$ 4,264,979	$ 4,615,243	$ 21,283,686	$ 13,042,181
2019	$ 600,000,000	$ 73,525,150	$ 526,474,850	$ 658,093,563	$ 215,575,000	$ 442,518,563	$ 146,006,530	$ 13,672,241	$ 38,517,933	$ 2,559,736	$ 21,046,718	$ 9,974,844	$ 284,415	$ 5,281,995	$ 11,986,065	$ 81,261	$ 4,205,281	$ 4,550,642	$ 20,985,772	$ 12,859,626
2020	$ 600,000,000	$ 77,951,600	$ 522,048,400	$ 652,560,500	$ 215,575,000	$ 436,985,500	$ 141,554,691	$ 13,255,365	$ 37,343,494	$ 2,481,688	$ 20,404,990	$ 9,670,704	$ 275,743	$ 5,120,943	$ 11,620,602	$ 78,784	$ 4,077,059	$ 4,411,890	$ 20,345,902	$ 12,467,527
						1st five years ►		$ 68,689,942	$ 193,515,796	$ 12,860,227	$ 105,739,644	$ 50,114,059	$ 1,428,914	$ 26,536,976	$ 60,218,523	$ 408,261	$ 21,127,516	$ 22,862,626	$ 105,433,448	$ 64,607,330
2021	$ 620,000,000	$ 82,588,050	$ 537,411,950	$ 671,764,938	$ 221,919,234	$ 449,845,703	$ 145,720,555	$ 13,645,462	$ 38,442,489	$ 2,554,722	$ 21,005,495	$ 9,955,307	$ 283,858	$ 5,271,649	$ 11,962,589	$ 81,102	$ 4,197,044	$ 4,541,729	$ 20,944,669	$ 12,834,439
2022	$ 629,300,000	$ 94,420,950	$ 534,879,050	$ 668,598,813	$ 220,873,297	$ 447,725,516	$ 145,033,753	$ 13,581,149	$ 38,261,304	$ 2,542,682	$ 20,906,493	$ 9,908,386	$ 282,520	$ 5,246,803	$ 11,906,208	$ 80,720	$ 4,177,263	$ 4,520,323	$ 20,845,953	$ 12,773,948
2023	$ 638,739,500	$ 114,931,804	$ 523,807,696	$ 654,759,620	$ 216,301,485	$ 438,458,135	$ 142,031,728	$ 13,300,035	$ 37,469,341	$ 2,490,051	$ 20,473,754	$ 9,703,295	$ 276,672	$ 5,138,201	$ 11,659,763	$ 79,049	$ 4,090,798	$ 4,426,758	$ 20,414,467	$ 12,509,543
2024	$ 648,320,593	$ 138,111,750	$ 510,208,843	$ 637,761,053	$ 210,685,966	$ 427,075,088	$ 138,344,366	$ 12,954,746	$ 36,496,580	$ 2,425,406	$ 19,942,224	$ 9,451,382	$ 269,490	$ 5,004,805	$ 11,357,058	$ 76,997	$ 3,984,595	$ 4,311,832	$ 19,884,476	$ 12,184,776
2025	$ 658,045,401	$ 144,321,750	$ 513,723,651	$ 642,154,564	$ 212,137,373	$ 430,017,191	$ 139,297,415	$ 13,043,991	$ 36,748,003	$ 2,442,114	$ 20,079,605	$ 9,516,492	$ 271,346	$ 5,039,283	$ 11,435,296	$ 77,527	$ 4,012,045	$ 4,341,536	$ 20,021,460	$ 12,268,716
						2nd five years ►		$ 66,525,382	$ 187,417,718	$ 12,454,975	$ 102,407,572	$ 48,534,863	$ 1,383,886	$ 25,700,742	$ 58,320,914	$ 395,396	$ 20,461,745	$ 22,142,178	$ 102,111,025	$ 62,571,422
2026	$ 667,916,082	$ 167,280,246	$ 500,635,836	$ 625,794,796	$ 206,732,882	$ 419,061,913	$ 135,748,622	$ 12,711,677	$ 35,811,797	$ 2,379,898	$ 19,568,050	$ 9,274,047	$ 264,433	$ 4,910,900	$ 11,143,966	$ 75,552	$ 3,909,832	$ 4,230,930	$ 19,511,385	$ 11,956,154
2027	$ 677,934,824	▲ GANs conclude	$ 677,934,824	$ 847,418,530	$ 279,946,839	$ 567,471,690	$ 183,823,673	$ 17,213,487	$ 48,494,460	$ 3,222,733	$ 26,498,028	$ 12,558,428	$ 358,081	$ 6,650,084	$ 15,090,576	$ 102,309	$ 5,294,490	$ 5,729,303	$ 26,421,296	$ 16,190,397
2028	$ 688,103,846		$ 688,103,846	$ 860,129,807	$ 284,146,042	$ 575,983,765	$ 186,581,028	$ 17,471,689	$ 49,221,877	$ 3,271,074	$ 26,895,498	$ 12,746,805	$ 363,453	$ 6,749,835	$ 15,316,934	$ 103,844	$ 5,373,907	$ 5,815,243	$ 26,817,615	$ 16,433,253
2029	$ 698,425,404		$ 698,425,404	$ 873,031,755	$ 288,408,233	$ 584,623,522	$ 189,379,744	$ 17,733,765	$ 49,960,205	$ 3,320,140	$ 27,298,931	$ 12,938,007	$ 368,904	$ 6,851,083	$ 15,546,688	$ 105,401	$ 5,454,516	$ 5,902,471	$ 27,219,880	$ 16,679,752
2030	$ 708,901,785		$ 708,901,785	$ 886,127,231	$ 292,734,356	$ 593,392,875	$ 192,220,440	$ 17,999,771	$ 50,709,608	$ 3,369,942	$ 27,708,415	$ 13,132,077	$ 374,438	$ 6,953,849	$ 15,779,889	$ 106,982	$ 5,536,334	$ 5,991,009	$ 27,628,178	$ 16,929,948
						3rd five years ►		$ 83,130,390	$ 234,197,948	$ 15,563,788	$ 127,968,921	$ 60,649,363	$ 1,729,310	$ 32,115,752	$ 72,878,053	$ 494,088	$ 25,569,080	$ 27,668,956	$ 127,598,354	$ 78,189,505
2031	$ 719,535,312		$ 719,535,312	$ 899,419,139	$ 297,125,371	$ 602,293,768	$ 195,103,746	$ 18,269,768	$ 51,470,252	$ 3,420,491	$ 28,124,041	$ 13,329,058	$ 380,055	$ 7,058,157	$ 16,016,587	$ 108,587	$ 5,619,379	$ 6,080,874	$ 28,042,601	$ 17,183,898
2032	$ 730,328,341		$ 730,328,341	$ 912,910,426	$ 301,582,252	$ 611,328,174	$ 198,030,303	$ 18,543,814	$ 52,242,306	$ 3,471,799	$ 28,545,901	$ 13,528,994	$ 385,755	$ 7,164,029	$ 16,256,836	$ 110,216	$ 5,703,669	$ 6,172,087	$ 28,463,240	$ 17,441,656
2033	$ 741,283,266		$ 741,283,266	$ 926,604,083	$ 306,105,986	$ 620,498,097	$ 201,000,757	$ 18,821,972	$ 53,025,941	$ 3,523,876	$ 28,974,090	$ 13,731,929	$ 391,542	$ 7,271,490	$ 16,500,688	$ 111,869	$ 5,789,225	$ 6,264,668	$ 28,890,188	$ 17,703,281
2034	$ 752,402,515		$ 752,402,515	$ 940,503,144	$ 310,697,576	$ 629,805,569	$ 204,015,768	$ 19,104,301	$ 53,821,330	$ 3,576,734	$ 29,408,701	$ 13,937,908	$ 397,415	$ 7,380,562	$ 16,748,199	$ 113,547	$ 5,876,063	$ 6,358,638	$ 29,323,541	$ 17,968,830
2035	$ 763,688,553		$ 763,688,553	$ 954,610,691	$ 315,358,039	$ 639,252,652	$ 207,076,005	$ 19,390,866	$ 54,628,650	$ 3,630,385	$ 29,849,832	$ 14,146,976	$ 403,376	$ 7,491,271	$ 16,999,422	$ 115,250	$ 5,964,204	$ 6,454,018	$ 29,763,394	$ 18,238,362
						4th five years ►		$ 94,130,720	$ 265,188,478	$ 17,623,285	$ 144,902,565	$ 68,674,864	$ 1,958,143	$ 36,365,509	$ 82,521,731	$ 559,469	$ 28,952,540	$ 31,330,284	$ 144,482,963	$ 88,536,027
2036	$ 775,143,881		$ 775,143,881	$ 968,929,852	$ 320,088,410	$ 648,841,442	$ 210,182,145	$ 19,681,729	$ 55,448,079	$ 3,684,841	$ 30,297,579	$ 14,359,181	$ 409,427	$ 7,603,640	$ 17,254,413	$ 116,979	$ 6,053,667	$ 6,550,828	$ 30,209,845	$ 18,511,938
2037	$ 786,771,040		$ 786,771,040	$ 983,463,799	$ 324,889,736	$ 658,574,063	$ 213,334,877	$ 19,976,955	$ 56,279,801	$ 3,740,113	$ 30,752,043	$ 14,574,569	$ 415,568	$ 7,717,694	$ 17,513,229	$ 118,734	$ 6,144,472	$ 6,649,090	$ 30,662,993	$ 18,789,617
2038	$ 798,572,605		$ 798,572,605	$ 998,215,756	$ 329,763,082	$ 668,452,674	$ 216,534,900	$ 20,276,609	$ 57,123,998	$ 3,796,215	$ 31,213,324	$ 14,793,187	$ 421,802	$ 7,833,460	$ 17,775,928	$ 120,515	$ 6,236,639	$ 6,748,827	$ 31,122,938	$ 19,071,461
2039	$ 810,551,194		$ 810,551,194	$ 1,013,188,993	$ 334,709,528	$ 678,479,465	$ 219,782,924	$ 20,580,758	$ 57,980,858	$ 3,853,158	$ 31,681,523	$ 15,015,085	$ 428,129	$ 7,950,961	$ 18,042,566	$ 122,322	$ 6,330,189	$ 6,850,059	$ 31,589,782	$ 19,357,533
2040	$ 822,709,462		$ 822,709,462	$ 1,028,386,828	$ 339,730,171	$ 688,656,656	$ 223,079,668	$ 20,889,469	$ 58,850,570	$ 3,910,956	$ 32,156,746	$ 15,240,311	$ 434,551	$ 8,070,226	$ 18,313,205	$ 124,157	$ 6,425,141	$ 6,952,810	$ 32,063,628	$ 19,647,896
						5th five years ►		$ 101,405,519	$ 285,683,306	$ 18,985,283	$ 156,101,216	$ 73,982,333	$ 2,109,476	$ 39,175,981	$ 88,899,341	$ 602,707	$ 31,190,108	$ 33,751,614	$ 155,649,185	$ 95,378,445
						Total ►	$ 4,419,865,678	$ 413,881,954	$ 1,166,003,246	$ 77,487,557	$ 637,119,917	$ 301,955,482	$ 8,609,729	$ 159,894,960	$ 362,838,563	$ 2,459,922	$ 127,300,987	$ 137,755,658	$ 635,274,975	$ 389,282,729

	Federal funding in today's dollars w/ 1.5% increase starting in 2021	GANs repayment	Funding less GANs repayments	Funding w/ non-federal match	Funding available for MPOs	Statewide Programs	Statewide Infrastructure	Berkshire	Boston	Cape Cod	Central Mass	Franklin	Martha's Vineyard	Merrimack Valley	Montachusett	Nantucket	Northern Middlesex	Old Colony	Pioneer Valley	Southeast Mass
							MARPA formula ►	*3.5596%*	*42.9671%*	*4.5851%*	*8.6901%*	*2.5397%*	*0.3100%*	*4.4296%*	*4.4596%*	*0.2200%*	*3.9096%*	*4.5595%*	*10.8099%*	*8.9601%*
2016	$ 600,000,000	$ 44,440,000	$ 555,560,000	$ 694,450,000	$ 174,575,000	$ 519,875,000	$ 17,500,000	$ 622,930	$ 7,519,243	$ 802,393	$ 1,520,768	$ 444,448	$ 54,250	$ 775,180	$ 780,430	$ 38,500	$ 684,180	$ 797,913	$ 1,891,733	$ 1,568,018
2017	$ 600,000,000	$ 59,150,000	$ 540,850,000	$ 676,062,500	$ 206,575,000	$ 469,487,500	$ 7,000,000	$ 249,172	$ 3,007,697	$ 320,957	$ 608,307	$ 177,779	$ 21,700	$ 310,072	$ 312,172	$ 15,400	$ 273,672	$ 319,165	$ 756,693	$ 627,207
2018	$ 600,000,000	$ 68,463,700	$ 531,536,300	$ 664,420,375	$ 215,575,000	$ 448,845,375	$ 7,000,000	$ 249,172	$ 3,007,697	$ 320,957	$ 608,307	$ 177,779	$ 21,700	$ 310,072	$ 312,172	$ 15,400	$ 273,672	$ 319,165	$ 756,693	$ 627,207
2019	$ 600,000,000	$ 73,525,150	$ 526,474,850	$ 658,093,563	$ 215,575,000	$ 442,518,563	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2020	$ 600,000,000	$ 77,951,600	$ 522,048,400	$ 652,560,500	$ 215,575,000	$ 436,985,500	$ 7,532,194	$ 268,116	$ 3,236,365	$ 345,359	$ 654,555	$ 191,295	$ 23,350	$ 333,646	$ 335,906	$ 16,571	$ 294,479	$ 343,430	$ 814,223	$ 674,892
					1st five years ►			$ 1,389,390	$ 16,771,002	$ 1,789,665	$ 3,391,937	$ 991,301	$ 121,000	$ 1,728,970	$ 1,740,680	$ 85,871	$ 1,526,003	$ 1,779,673	$ 4,219,341	$ 3,497,324
2021	$ 620,000,000	$ 82,588,050	$ 537,411,950	$ 671,764,938	$ 221,919,234	$ 449,845,703	$ 7,753,862	$ 276,006	$ 3,331,609	$ 355,522	$ 673,818	$ 196,925	$ 24,037	$ 343,465	$ 345,791	$ 17,058	$ 303,145	$ 353,537	$ 838,185	$ 694,754
2022	$ 629,300,000	$ 94,420,950	$ 534,879,050	$ 668,598,813	$ 220,873,297	$ 447,725,516	$ 7,717,317	$ 274,706	$ 3,315,907	$ 353,847	$ 670,643	$ 195,997	$ 23,924	$ 341,846	$ 344,161	$ 16,978	$ 301,716	$ 351,871	$ 834,234	$ 691,479
2023	$ 638,739,500	$ 114,931,804	$ 523,807,696	$ 654,759,620	$ 216,301,485	$ 438,458,135	$ 7,557,577	$ 269,020	$ 3,247,272	$ 346,522	$ 656,761	$ 191,940	$ 23,428	$ 334,770	$ 337,038	$ 16,627	$ 295,471	$ 344,588	$ 816,967	$ 677,166
2024	$ 648,320,593	$ 138,111,750	$ 510,208,843	$ 637,761,053	$ 210,685,966	$ 427,075,088	$ 7,361,371	$ 262,035	$ 3,162,968	$ 337,526	$ 639,711	$ 186,957	$ 22,820	$ 326,079	$ 328,288	$ 16,195	$ 287,800	$ 335,642	$ 795,757	$ 659,586
2025	$ 658,045,401	$ 144,321,750	$ 513,723,651	$ 642,154,564	$ 212,137,373	$ 430,017,191	$ 7,412,083	$ 263,841	$ 3,184,757	$ 339,851	$ 644,117	$ 188,245	$ 22,977	$ 328,326	$ 330,549	$ 16,307	$ 289,783	$ 337,954	$ 801,239	$ 664,130
					2nd five years ►			$ 1,345,607	$ 16,242,513	$ 1,733,269	$ 3,285,050	$ 960,063	$ 117,187	$ 1,674,487	$ 1,685,827	$ 83,165	$ 1,477,915	$ 1,723,592	$ 4,086,381	$ 3,387,116
2026	$ 667,916,082	$ 167,280,246	$ 500,635,836	$ 625,794,796	$ 206,732,882	$ 419,061,913	$ 7,223,250	$ 257,119	$ 3,103,621	$ 331,193	$ 627,708	$ 183,449	$ 22,392	$ 319,961	$ 322,128	$ 15,891	$ 282,400	$ 329,344	$ 780,826	$ 647,210
2027	$ 677,934,824	▲ GANs conclude	$ 677,934,824	$ 847,418,530	$ 279,946,839	$ 567,471,690	$ 9,781,347	$ 348,177	$ 4,202,761	$ 448,485	$ 850,009	$ 248,417	$ 30,322	$ 433,275	$ 436,209	$ 21,519	$ 382,412	$ 445,981	$ 1,057,354	$ 876,418
2028	$ 688,103,846		$ 688,103,846	$ 860,129,807	$ 284,146,042	$ 575,983,765	$ 9,928,067	$ 353,399	$ 4,265,803	$ 455,212	$ 862,759	$ 252,143	$ 30,777	$ 439,774	$ 442,752	$ 21,842	$ 388,148	$ 452,670	$ 1,073,214	$ 889,565
2029	$ 698,425,404		$ 698,425,404	$ 873,031,755	$ 288,408,233	$ 584,623,522	$ 10,076,988	$ 358,700	$ 4,329,790	$ 462,040	$ 875,700	$ 255,925	$ 31,239	$ 446,370	$ 449,393	$ 22,169	$ 393,970	$ 459,460	$ 1,089,312	$ 902,908
2030	$ 708,901,785		$ 708,901,785	$ 886,127,231	$ 292,734,356	$ 593,392,875	$ 10,228,143	$ 364,081	$ 4,394,737	$ 468,971	$ 888,836	$ 259,764	$ 31,707	$ 453,066	$ 456,134	$ 22,502	$ 399,879	$ 466,352	$ 1,105,652	$ 916,452
					3rd five years ►			$ 1,681,477	$ 20,296,711	$ 2,165,900	$ 4,105,012	$ 1,199,698	$ 146,437	$ 2,092,445	$ 2,106,617	$ 103,923	$ 1,846,809	$ 2,153,807	$ 5,106,359	$ 4,232,554
2031	$ 719,535,312		$ 719,535,312	$ 899,419,139	$ 297,125,371	$ 602,293,768	$ 10,381,565	$ 369,542	$ 4,460,658	$ 476,005	$ 902,168	$ 263,661	$ 32,183	$ 459,862	$ 462,976	$ 22,839	$ 405,878	$ 473,347	$ 1,122,237	$ 930,199
2032	$ 730,328,341		$ 730,328,341	$ 912,910,426	$ 301,582,252	$ 611,328,174	$ 10,537,289	$ 375,085	$ 4,527,567	$ 483,145	$ 915,701	$ 267,616	$ 32,666	$ 466,760	$ 469,921	$ 23,182	$ 411,966	$ 480,448	$ 1,139,070	$ 944,152
2033	$ 741,283,266		$ 741,283,266	$ 926,604,083	$ 306,105,986	$ 620,498,097	$ 10,695,348	$ 380,712	$ 4,595,481	$ 490,392	$ 929,436	$ 271,630	$ 33,156	$ 473,761	$ 476,970	$ 23,530	$ 418,145	$ 487,654	$ 1,156,156	$ 958,314
2034	$ 752,402,515		$ 752,402,515	$ 940,503,144	$ 310,697,576	$ 629,805,569	$ 10,855,778	$ 386,422	$ 4,664,413	$ 497,748	$ 943,378	$ 275,704	$ 33,653	$ 480,868	$ 484,124	$ 23,883	$ 424,418	$ 494,969	$ 1,173,499	$ 972,689
2035	$ 763,688,553		$ 763,688,553	$ 954,610,691	$ 315,358,039	$ 639,252,652	$ 11,018,615	$ 392,219	$ 4,734,379	$ 505,215	$ 957,529	$ 279,840	$ 34,158	$ 488,081	$ 491,386	$ 24,241	$ 430,784	$ 502,394	$ 1,191,101	$ 987,279
					4th five years ►			**$ 1,903,980**	**$ 22,982,498**	**$ 2,452,506**	**$ 4,648,212**	**$ 1,358,450**	**$ 165,815**	**$ 2,369,331**	**$ 2,385,377**	**$ 117,675**	**$ 2,091,190**	**$ 2,438,813**	**$ 5,782,064**	**$ 4,792,632**
2036	$ 775,143,881		$ 775,143,881	$ 968,929,852	$ 320,088,410	$ 648,841,442	$ 11,183,894	$ 398,102	$ 4,805,395	$ 512,793	$ 971,892	$ 284,037	$ 34,670	$ 495,402	$ 498,757	$ 24,605	$ 437,246	$ 509,930	$ 1,208,968	$ 1,002,088
2037	$ 786,771,040		$ 786,771,040	$ 983,463,799	$ 324,889,736	$ 658,574,063	$ 11,351,653	$ 404,073	$ 4,877,476	$ 520,485	$ 986,470	$ 288,298	$ 35,190	$ 502,833	$ 506,238	$ 24,974	$ 443,804	$ 517,579	$ 1,227,102	$ 1,017,119
2038	$ 798,572,605		$ 798,572,605	$ 998,215,756	$ 329,763,082	$ 668,452,674	$ 11,521,927	$ 410,135	$ 4,950,638	$ 528,292	$ 1,001,267	$ 292,622	$ 35,718	$ 510,375	$ 513,832	$ 25,348	$ 450,461	$ 525,342	$ 1,245,509	$ 1,032,376
2039	$ 810,551,194		$ 810,551,194	$ 1,013,188,993	$ 334,709,528	$ 678,479,465	$ 11,694,756	$ 416,287	$ 5,024,898	$ 536,216	$ 1,016,286	$ 297,012	$ 36,254	$ 518,031	$ 521,539	$ 25,728	$ 457,218	$ 533,222	$ 1,264,191	$ 1,047,862
2040	$ 822,709,462		$ 822,709,462	$ 1,028,386,828	$ 339,730,171	$ 688,656,656	$ 11,870,178	$ 422,531	$ 5,100,271	$ 544,260	$ 1,031,530	$ 301,467	$ 36,798	$ 525,801	$ 529,362	$ 26,114	$ 464,076	$ 541,221	$ 1,283,154	$ 1,063,580
					5th five years ►			$ 2,051,127	$ 24,758,678	$ 2,642,045	$ 5,007,445	$ 1,463,436	$ 178,629	$ 2,552,442	$ 2,569,729	$ 126,769	$ 2,252,806	$ 2,627,294	$ 6,228,925	$ 5,163,025
							Total ►	*$ 235,183,205*	**$ 8,371,581**	**$ 101,051,403**	**$ 10,783,385**	**$ 20,437,656**	**$ 5,972,948**	**$ 729,068**	**$ 10,417,675**	**$ 10,488,230**	**$ 517,403**	**$ 9,194,723**	**$ 10,723,178**	**$ 25,423,069**	**$ 21,072,650**

	Federal funding in today's dollars w/ 1.5% increase starting in 2021	GANs repayment	Funding less GANs repayments	Funding w/ non-federal match	Funding available for MPOs	Statewide Programs	Remaining Statewide Programs	Berkshire	Boston	Cape Cod	Central Mass	Franklin	Martha's Vineyard	Merrimack Valley	Montachusett	Nantucket	Northern Middlesex	Old Colony	Pioneer Valley	Southeast Mass
							MARPA formula ►	3.5596%	42.9671%	4.5851%	8.6901%	2.5397%	0.3100%	4.4296%	4.4596%	0.2200%	3.9096%	4.5595%	10.8099%	8.9601%
2016	$ 600,000,000	$ 44,440,000	$ 555,560,000	$ 694,450,000	$ 174,575,000	$ 519,875,000	$ 164,455,906	$ 5,853,972	$ 70,661,933	$ 7,540,468	$ 14,291,383	$ 4,176,687	$ 509,813	$ 7,284,739	$ 7,334,076	$ 361,803	$ 6,429,568	$ 7,498,367	$ 17,777,519	$ 14,735,414
2017	$ 600,000,000	$ 59,150,000	$ 540,850,000	$ 676,062,500	$ 206,575,000	$ 469,487,500	$ 176,981,944	$ 6,299,849	$ 76,044,009	$ 8,114,799	$ 15,379,908	$ 4,494,810	$ 548,644	$ 7,839,592	$ 7,892,687	$ 389,360	$ 6,919,286	$ 8,069,492	$ 19,131,571	$ 15,857,759
2018	$ 600,000,000	$ 68,463,700	$ 531,536,300	$ 664,420,375	$ 215,575,000	$ 448,845,375	$ 175,066,667	$ 6,231,673	$ 75,221,070	$ 8,026,982	$ 15,213,468	$ 4,446,168	$ 542,707	$ 7,754,753	$ 7,807,273	$ 385,147	$ 6,844,406	$ 7,982,165	$ 18,924,532	$ 15,686,148
2019	$ 600,000,000	$ 73,525,150	$ 526,474,850	$ 658,093,563	$ 215,575,000	$ 442,518,563	$ 184,870,619	$ 6,580,655	$ 79,433,544	$ 8,476,503	$ 16,065,442	$ 4,695,159	$ 573,099	$ 8,189,029	$ 8,244,490	$ 406,715	$ 7,227,702	$ 8,429,176	$ 19,984,329	$ 16,564,592
2020	$ 600,000,000	$ 77,951,600	$ 522,048,400	$ 652,560,500	$ 215,575,000	$ 436,985,500	$ 187,077,913	$ 6,659,225	$ 80,381,954	$ 8,577,709	$ 16,257,258	$ 4,751,218	$ 579,942	$ 8,286,803	$ 8,342,927	$ 411,571	$ 7,313,998	$ 8,529,817	$ 20,222,935	$ 16,762,368
					1st five years ►			$ 31,625,375	$ 381,742,510	$ 40,736,461	$ 77,207,458	$ 22,564,042	$ 2,754,204	$ 39,354,916	$ 39,621,452	$ 1,954,597	$ 34,734,960	$ 40,509,017	$ 96,040,886	$ 79,606,282
2021	$ 620,000,000	$ 82,588,050	$ 537,411,950	$ 671,764,938	$ 221,919,234	$ 449,845,703	$ 192,583,496	$ 6,855,202	$ 82,747,543	$ 8,830,146	$ 16,735,698	$ 4,891,043	$ 597,009	$ 8,530,679	$ 8,588,454	$ 423,684	$ 7,529,244	$ 8,780,844	$ 20,818,083	$ 17,255,674
2022	$ 629,300,000	$ 94,420,950	$ 534,879,050	$ 668,598,813	$ 220,873,297	$ 447,725,516	$ 191,675,822	$ 6,822,893	$ 82,357,542	$ 8,788,528	$ 16,656,821	$ 4,867,991	$ 594,195	$ 8,490,472	$ 8,547,975	$ 421,687	$ 7,493,758	$ 8,739,459	$ 20,719,965	$ 17,174,345
2023	$ 638,739,500	$ 114,931,804	$ 523,807,696	$ 654,759,620	$ 216,301,485	$ 438,458,135	$ 187,708,363	$ 6,681,667	$ 80,652,840	$ 8,606,616	$ 16,312,044	$ 4,767,229	$ 581,896	$ 8,314,730	$ 8,371,042	$ 412,958	$ 7,338,646	$ 8,558,563	$ 20,291,086	$ 16,818,857
2024	$ 648,320,593	$ 138,111,750	$ 510,208,843	$ 637,761,053	$ 210,685,966	$ 427,075,088	$ 182,835,165	$ 6,508,201	$ 78,558,968	$ 8,383,175	$ 15,888,559	$ 4,643,465	$ 566,789	$ 8,098,866	$ 8,153,717	$ 402,237	$ 7,148,124	$ 8,336,369	$ 19,764,298	$ 16,382,314
2025	$ 658,045,401	$ 144,321,750	$ 513,723,651	$ 642,154,564	$ 212,137,373	$ 430,017,191	$ 184,094,709	$ 6,553,035	$ 79,100,158	$ 8,440,927	$ 15,998,014	$ 4,675,453	$ 570,694	$ 8,154,659	$ 8,209,888	$ 405,008	$ 7,197,367	$ 8,393,798	$ 19,900,454	$ 16,495,070
					2nd five years ►			$ 33,420,997	$ 403,417,051	$ 43,049,392	$ 81,591,136	$ 23,845,181	$ 2,910,582	$ 41,589,406	$ 41,871,075	$ 2,065,575	$ 36,707,139	$ 42,809,034	$ 101,493,887	$ 84,126,160
2026	$ 667,916,082	$ 167,280,246	$ 500,635,836	$ 625,794,796	$ 206,732,882	$ 419,061,913	$ 179,404,644	$ 6,386,088	$ 77,084,973	$ 8,225,882	$ 15,590,443	$ 4,556,340	$ 556,154	$ 7,946,908	$ 8,000,730	$ 394,690	$ 7,014,004	$ 8,179,955	$ 19,393,463	$ 16,074,836
2027	$ 677,934,824	▲ GANs conclude	$ 677,934,824	$ 847,418,530	$ 279,946,839	$ 567,471,690	$ 242,940,371	$ 8,647,705	$ 104,384,432	$ 11,139,059	$ 21,111,761	$ 6,169,957	$ 753,115	$ 10,761,287	$ 10,834,169	$ 534,469	$ 9,497,997	$ 11,076,866	$ 26,261,611	$ 21,767,700
2028	$ 688,103,846		$ 688,103,846	$ 860,129,807	$ 284,146,042	$ 575,983,765	$ 246,584,476	$ 8,777,421	$ 105,950,198	$ 11,306,145	$ 21,428,438	$ 6,262,506	$ 764,412	$ 10,922,706	$ 10,996,681	$ 542,486	$ 9,640,467	$ 11,243,019	$ 26,655,535	$ 22,094,216
2029	$ 698,425,404		$ 698,425,404	$ 873,031,755	$ 288,408,233	$ 584,623,522	$ 250,283,243	$ 8,909,082	$ 107,539,451	$ 11,475,737	$ 21,749,864	$ 6,356,444	$ 775,878	$ 11,086,547	$ 11,161,632	$ 550,623	$ 9,785,074	$ 11,411,664	$ 27,055,368	$ 22,425,629
2030	$ 708,901,785		$ 708,901,785	$ 886,127,231	$ 292,734,356	$ 593,392,875	$ 254,037,492	$ 9,042,719	$ 109,152,543	$ 11,647,873	$ 22,076,112	$ 6,451,790	$ 787,516	$ 11,252,845	$ 11,329,056	$ 558,882	$ 9,931,850	$ 11,582,839	$ 27,461,199	$ 22,762,013
					3rd five years ►			$ 41,763,015	$ 504,111,598	$ 53,794,696	$ 101,956,618	$ 29,797,036	$ 3,637,076	$ 51,970,292	$ 52,322,267	$ 2,581,150	$ 45,869,391	$ 53,494,344	$ 126,827,176	$ 105,124,394
2031	$ 719,535,312		$ 719,535,312	$ 899,419,139	$ 297,125,371	$ 602,293,768	$ 257,848,054	$ 9,178,359	$ 110,789,831	$ 11,822,591	$ 22,407,254	$ 6,548,567	$ 799,329	$ 11,421,637	$ 11,498,992	$ 567,266	$ 10,080,828	$ 11,756,582	$ 27,873,117	$ 23,103,444
2032	$ 730,328,341		$ 730,328,341	$ 912,910,426	$ 301,582,252	$ 611,328,174	$ 261,715,775	$ 9,316,035	$ 112,451,679	$ 11,999,930	$ 22,743,363	$ 6,646,796	$ 811,319	$ 11,592,962	$ 11,671,477	$ 575,775	$ 10,232,040	$ 11,932,931	$ 28,291,214	$ 23,449,995
2033	$ 741,283,266		$ 741,283,266	$ 926,604,083	$ 306,105,986	$ 620,498,097	$ 265,641,512	$ 9,455,775	$ 114,138,454	$ 12,179,929	$ 23,084,513	$ 6,746,497	$ 823,489	$ 11,766,856	$ 11,846,549	$ 584,411	$ 10,385,521	$ 12,111,925	$ 28,715,582	$ 23,801,745
2034	$ 752,402,515		$ 752,402,515	$ 940,503,144	$ 310,697,576	$ 629,805,569	$ 269,626,134	$ 9,597,612	$ 115,850,531	$ 12,362,628	$ 23,430,781	$ 6,847,695	$ 835,841	$ 11,943,359	$ 12,024,247	$ 593,177	$ 10,541,303	$ 12,293,604	$ 29,146,316	$ 24,158,771
2035	$ 763,688,553		$ 763,688,553	$ 954,610,691	$ 315,358,039	$ 639,252,652	$ 273,670,526	$ 9,741,576	$ 117,588,289	$ 12,548,067	$ 23,782,242	$ 6,950,410	$ 848,379	$ 12,122,510	$ 12,204,611	$ 602,075	$ 10,699,423	$ 12,478,008	$ 29,583,510	$ 24,521,153
					4th five years ►			$ 47,289,357	$ 570,818,784	$ 60,913,145	$ 115,448,152	$ 33,739,965	$ 4,118,356	$ 58,847,325	$ 59,245,875	$ 2,922,704	$ 51,939,114	$ 60,573,049	$ 143,609,738	$ 119,035,108
2036	$ 775,143,881		$ 775,143,881	$ 968,929,852	$ 320,088,410	$ 648,841,442	$ 277,775,584	$ 9,887,700	$ 119,352,113	$ 12,736,288	$ 24,138,976	$ 7,054,667	$ 861,104	$ 12,304,347	$ 12,387,680	$ 611,106	$ 10,859,914	$ 12,665,178	$ 30,027,263	$ 24,888,970
2037	$ 786,771,040		$ 786,771,040	$ 983,463,799	$ 324,889,736	$ 658,574,063	$ 281,942,218	$ 10,036,015	$ 121,142,395	$ 12,927,333	$ 24,501,061	$ 7,160,487	$ 874,021	$ 12,488,912	$ 12,573,495	$ 620,273	$ 11,022,813	$ 12,855,155	$ 30,477,672	$ 25,262,305
2038	$ 798,572,605		$ 798,572,605	$ 998,215,756	$ 329,763,082	$ 668,452,674	$ 286,171,351	$ 10,186,555	$ 122,959,531	$ 13,121,243	$ 24,868,577	$ 7,267,894	$ 887,131	$ 12,676,246	$ 12,762,098	$ 629,577	$ 11,188,155	$ 13,047,983	$ 30,934,837	$ 25,641,239
2039	$ 810,551,194		$ 810,551,194	$ 1,013,188,993	$ 334,709,528	$ 678,479,465	$ 290,463,922	$ 10,339,354	$ 124,803,924	$ 13,318,061	$ 25,241,605	$ 7,376,912	$ 900,438	$ 12,866,390	$ 12,953,529	$ 639,021	$ 11,355,977	$ 13,243,703	$ 31,398,859	$ 26,025,858
2040	$ 822,709,462		$ 822,709,462	$ 1,028,386,828	$ 339,730,171	$ 688,656,656	$ 294,820,881	$ 10,494,444	$ 126,675,983	$ 13,517,832	$ 25,620,229	$ 7,487,566	$ 913,945	$ 13,059,386	$ 13,147,832	$ 648,606	$ 11,526,317	$ 13,442,358	$ 31,869,842	$ 26,416,246
					5th five years ►			$ 50,944,068	$ 614,933,945	$ 65,620,757	$ 124,370,448	$ 36,347,525	$ 4,436,639	$ 63,395,282	$ 63,824,634	$ 3,148,583	$ 55,953,177	$ 65,254,377	$ 154,708,473	$ 128,234,618
							Total ► $ 5,760,276,788	$ 205,042,813	$ 2,475,023,888	$ 264,114,451	$ 500,573,813	$ 146,293,750	$ 17,856,858	$ 255,157,221	$ 256,885,304	$ 12,672,609	$ 225,203,781	$ 262,639,820	$ 622,680,160	$ 516,126,560

Beginning in 2020, multiply the Percent of Total Statewide Programs for each program against the Statewide Programs amount in column G in each Statewide Program tab.

Statewide Programs	4-year average	Percent of Total Statewide Programs
Statewide Infrastructure	**$ 7,875,000.00**	**1.72%**
Statewide Interstate Maintenance Program	**$ 69,380,514.44**	**15.19%**
Statewide NHS Preservation Program	**$ 36,028,750.00**	**7.89%**
Statewide Bridges	**$ 147,997,142.41**	**32.39%**
Remaining Items	**$ 195,592,221.77**	**42.81%**
Statewide HSIP Program	$ 27,083,333.33	5.93%
Statewide Safe Routes to Schools	$ 6,578,930.75	1.44%
Statewide CMAQ	$ 46,136,896.88	10.10%
Statewide Transportation Enhancements	$ 1,452,485.50	0.32%
Statewide Recreational Trails	$ 1,000,000.00	0.22%
Statewide ITS	$ 17,750,000.00	3.89%
Statewide Design and Right of Way	$ -	0.00%
Statewide RR Grade Crossings	$ 7,312,500.00	1.60%
Statewide Transit	$ -	0.00%
Statewide Stormwater Retrofits	$ 5,148,475.00	1.13%
Statewide ADA	$ 3,000,000.00	0.66%
Award Adjustments, Change Orders, EWOs	$ 30,381,162.50	6.65%
Planning	$ 28,500,000.00	6.24%
DBEs, FAPO, Misc Programs	$ 1,000,000.00	0.22%
Regional Major Infrastructure Projects:	$ 20,248,437.81	4.43%
	$ 456,873,628.63	**100%**

	STATEWIDE	Berkshire	Boston	Cape Cod	Central Mass	Franklin	Martha's Vineyard	Merrimack Valley	Montachusett	Nantucket	Northern Middlesex	Old Colony	Pioneer Valley	Southeast Mass
I-90	689.9	95.92	205.84	0	196.45	0	0	0	0	0	0	0	191.38	0
Interstate Miles (no I-90)	2520.1	0	950.48	0	275.92	95.28	0	358	50.13	0	97.95	7.8	213.06	471.48
Interstate Percentage	**100.00%**	**0.00%**	**37.72%**	**0.00%**	**10.95%**	**3.78%**	**0.00%**	**14.21%**	**1.99%**	**0.00%**	**3.89%**	**0.31%**	**8.45%**	**18.71%**
NHS Miles	4637.71	338.41	1471.49	424.36	566.13	117.66	6.78	132.25	256.43	0	176.55	274.12	508.3	365.24
NHS Percentage	**100.00%**	**7.30%**	**31.73%**	**9.15%**	**12.21%**	**2.54%**	**0.15%**	**2.85%**	**5.53%**	**0.00%**	**3.81%**	**5.91%**	**10.96%**	**7.88%**
Bridges	7187	673	1896	126	1036	491	14	260	590	4	207	224	1033	633
All bridges	100%	9.36%	26.38%	1.75%	14.41%	6.83%	0.19%	3.62%	8.21%	0.06%	2.88%	3.12%	14.37%	8.81%

massDOT **Transit Financials**

Inflation factor	1.50%
	101.50%

SECTION 5307

Boston UZA	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
MBTA	$140,155,885	$142,258,223	$144,392,097	$146,557,978	$148,756,348	$150,987,693	$153,252,508	$155,551,296	$157,884,565	$160,252,834	$162,656,626	$165,096,476	$167,572,923	$170,086,517	$172,637,815	$175,227,382	$177,855,793	$180,523,629	$183,231,484	$185,979,956	$188,769,655	$191,601,200	$194,475,218	$197,392,347	$200,353,232	$203,358,530
BAT	$3,020,761	$3,066,072	$3,112,063	$3,158,744	$3,206,125	$3,254,217	$3,303,030	$3,352,576	$3,402,864	$3,453,907	$3,505,716	$3,558,302	$3,611,676	$3,665,851	$3,720,839	$3,776,652	$3,833,301	$3,890,801	$3,949,163	$4,008,400	$4,068,526	$4,129,554	$4,191,498	$4,254,370	$4,318,186	$4,382,958
MVRTA	$5,646,773	$5,731,474	$5,817,446	$5,904,708	$5,993,279	$6,083,178	$6,174,426	$6,267,042	$6,361,048	$6,456,463	$6,553,310	$6,651,610	$6,751,384	$6,852,655	$6,955,445	$7,059,776	$7,165,673	$7,273,158	$7,382,255	$7,492,989	$7,605,384	$7,719,465	$7,835,257	$7,952,786	$8,072,077	$8,193,159
LRTA	$3,739,138	$3,795,225	$3,852,154	$3,909,936	$3,968,585	$4,028,114	$4,088,535	$4,149,863	$4,212,111	$4,275,293	$4,339,422	$4,404,514	$4,470,582	$4,537,640	$4,605,705	$4,674,790	$4,744,912	$4,816,086	$4,888,327	$4,961,652	$5,036,077	$5,111,618	$5,188,292	$5,266,117	$5,345,109	$5,425,285
GATRA	$771,951	$783,530	$795,283	$807,213	$819,321	$831,611	$844,085	$856,746	$869,597	$882,641	$895,881	$909,319	$922,959	$936,803	$950,855	$965,118	$979,595	$994,289	$1,009,203	$1,024,341	$1,039,706	$1,055,302	$1,071,131	$1,087,198	$1,103,506	$1,120,059
CATA	$530,089	$538,041	$546,111	$554,303	$562,618	$571,057	$579,623	$588,317	$597,142	$606,099	$615,190	$624,418	$633,785	$643,291	$652,941	$662,735	$672,676	$682,766	$693,007	$703,403	$713,954	$724,663	$735,533	$746,566	$757,764	$769,131
MWRTA	$1,740,649	$1,766,759	$1,793,260	$1,820,159	$1,847,462	$1,875,173	$1,903,301	$1,931,851	$1,960,828	$1,990,241	$2,020,094	$2,050,396	$2,081,152	$2,112,369	$2,144,055	$2,176,215	$2,208,859	$2,241,991	$2,275,621	$2,309,756	$2,344,402	$2,379,568	$2,415,262	$2,451,490	$2,488,263	$2,525,587

Barnstable UZA	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
CCRTA	$ 6,911,030	$7,014,695	$7,119,916	$7,226,715	$7,335,115	$7,445,142	$7,556,819	$7,670,171	$7,785,224	$7,902,002	$8,020,532	$8,140,840	$8,262,953	$8,386,897	$8,512,701	$8,640,391	$8,769,997	$8,901,547	$9,035,070	$9,170,596	$9,308,155	$9,447,778	$9,589,494	$9,733,337	$9,879,337	$10,027,527
GATRA	$ 1,032,683	$1,048,173	$1,063,895	$1,079,854	$1,096,052	$1,112,492	$1,129,180	$1,146,118	$1,163,309	$1,180,759	$1,198,470	$1,216,447	$1,234,694	$1,253,215	$1,272,013	$1,291,093	$1,310,459	$1,330,116	$1,350,068	$1,370,319	$1,390,874	$1,411,737	$1,432,913	$1,454,407	$1,476,223	$1,498,366

Springfield UZA	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
PVTA	$ 11,954,100	$12,133,412	$12,315,413	$12,500,144	$12,687,646	$12,877,961	$13,071,131	$13,267,198	$13,466,206	$13,668,199	$13,873,222	$14,081,320	$14,292,540	$14,506,928	$14,724,532	$14,945,400	$15,169,581	$15,397,124	$15,628,081	$15,862,502	$16,100,440	$16,341,947	$16,587,076	$16,835,882	$17,088,420	$17,344,746

Worcester UZA	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
WRTA	$ 9,387,213	$9,528,021	$9,670,941	$9,816,005	$9,963,245	$10,112,694	$10,264,384	$10,418,350	$10,574,626	$10,733,245	$10,894,244	$11,057,657	$11,223,522	$11,391,875	$11,562,753	$11,736,194	$11,912,237	$12,090,921	$12,272,285	$12,456,369	$12,643,214	$12,832,863	$13,025,356	$13,220,736	$13,419,047	$13,620,333
MART	$ 44,225	$44,888	$45,562	$46,245	$46,939	$47,643	$48,357	$49,083	$49,819	$50,566	$51,325	$52,095	$52,876	$53,669	$54,474	$55,291	$56,121	$56,963	$57,817	$58,684	$59,564	$60,458	$61,365	$62,285	$63,220	$64,168

Massachusetts	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
MART	$ 2,992,457	$3,037,344	$3,082,904	$3,129,148	$3,176,085	$3,223,726	$3,272,082	$3,321,164	$3,370,981	$3,421,546	$3,472,869	$3,524,962	$3,577,836	$3,631,504	$3,685,976	$3,741,266	$3,797,385	$3,854,346	$3,912,161	$3,970,843	$4,030,406	$4,090,862	$4,152,225	$4,214,508	$4,277,726	$4,341,892
SRTA	$ 3,805,520	$3,862,603	$3,920,542	$3,979,350	$4,039,041	$4,099,626	$4,161,121	$4,223,537	$4,286,891	$4,351,194	$4,416,462	$4,482,709	$4,549,949	$4,618,199	$4,687,472	$4,757,784	$4,829,150	$4,901,588	$4,975,111	$5,049,738	$5,125,484	$5,202,366	$5,280,402	$5,359,608	$5,440,002	$5,521,602
BRTA	$ 1,711,046	$1,736,712	$1,762,762	$1,789,204	$1,816,042	$1,843,283	$1,870,932	$1,898,996	$1,927,481	$1,956,393	$1,985,739	$2,015,525	$2,045,758	$2,076,444	$2,107,591	$2,139,205	$2,171,293	$2,203,862	$2,236,920	$2,270,474	$2,304,531	$2,339,099	$2,374,185	$2,409,798	$2,445,945	$2,482,634

Out-Of-State UZAs	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
(RI) GATRA	$ 3,168,714	$3,216,245	$3,264,489	$3,313,456	$3,363,158	$3,413,605	$3,464,809	$3,516,782	$3,569,533	$3,623,076	$3,677,422	$3,732,584	$3,788,573	$3,845,401	$3,903,082	$3,961,628	$4,021,053	$4,081,369	$4,142,589	$4,204,728	$4,267,799	$4,331,816	$4,396,793	$4,462,745	$4,529,686	$4,597,631
(RI) SRTA	$ 2,976,566	$3,021,214	$3,066,533	$3,112,531	$3,159,219	$3,206,607	$3,254,706	$3,303,527	$3,353,079	$3,403,376	$3,454,426	$3,506,243	$3,558,836	$3,612,219	$3,666,402	$3,721,398	$3,777,219	$3,833,877	$3,891,386	$3,949,756	$4,009,003	$4,069,138	$4,130,175	$4,192,127	$4,255,009	$4,318,835
(NH) LRTA	$ 99,595	$101,089	$102,605	$104,144	$105,707	$107,292	$108,902	$110,535	$112,193	$113,876	$115,584	$117,318	$119,078	$120,864	$122,677	$124,517	$126,385	$128,281	$130,205	$132,158	$134,140	$136,152	$138,195	$140,267	$142,371	$144,507

Section 5307	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
MBTA	$140,155,885	$142,258,223	$144,392,097	$146,557,978	$148,756,348	$150,987,693	$153,252,508	$155,551,296	$157,884,565	$160,252,834	$162,656,626	$165,096,476	$167,572,923	$170,086,517	$172,637,815	$175,227,382	$177,855,793	$180,523,629	$183,231,484	$185,979,956	$188,769,655	$191,601,200	$194,475,218	$197,392,347	$200,353,232	$203,358,530
BAT	$3,020,761	$3,066,072	$3,112,063	$3,158,744	$3,206,125	$3,254,217	$3,303,030	$3,352,576	$3,402,864	$3,453,907	$3,505,716	$3,558,302	$3,611,676	$3,665,851	$3,720,839	$3,776,652	$3,833,301	$3,890,801	$3,949,163	$4,008,400	$4,068,526	$4,129,554	$4,191,498	$4,254,370	$4,318,186	$4,382,958
MVRTA	$5,646,773	$5,731,474	$5,817,446	$5,904,708	$5,993,279	$6,083,178	$6,174,426	$6,267,042	$6,361,048	$6,456,463	$6,553,310	$6,651,610	$6,751,384	$6,852,655	$6,955,445	$7,059,776	$7,165,673	$7,273,158	$7,382,255	$7,492,989	$7,605,384	$7,719,465	$7,835,257	$7,952,786	$8,072,077	$8,193,159
LRTA	$3,838,733	$3,896,314	$3,954,759	$4,014,080	$4,074,292	$4,135,406	$4,197,437	$4,260,399	$4,324,305	$4,389,169	$4,455,007	$4,521,832	$4,589,659	$4,658,504	$4,728,382	$4,799,307	$4,871,297	$4,944,366	$5,018,532	$5,093,810	$5,170,217	$5,247,770	$5,326,487	$5,406,384	$5,487,480	$5,569,792
CCRTA	$6,911,030	$7,014,695	$7,119,916	$7,226,715	$7,335,115	$7,445,142	$7,556,819	$7,670,171	$7,785,224	$7,902,002	$8,020,532	$8,140,840	$8,262,953	$8,386,897	$8,512,701	$8,640,391	$8,769,997	$8,901,547	$9,035,070	$9,170,596	$9,308,155	$9,447,778	$9,589,494	$9,733,337	$9,879,337	$10,027,527
GATRA	$4,973,348	$5,047,948	$5,123,668	$5,200,523	$5,278,530	$5,357,708	$5,438,074	$5,519,645	$5,602,440	$5,686,476	$5,771,774	$5,858,350	$5,946,225	$6,035,419	$6,125,950	$6,217,839	$6,311,107	$6,405,774	$6,501,860	$6,599,388	$6,698,379	$6,798,855	$6,900,837	$7,004,350	$7,109,415	$7,216,056
CATA	$530,089	$538,041	$546,111	$554,303	$562,618	$571,057	$579,623	$588,317	$597,142	$606,099	$615,190	$624,418	$633,785	$643,291	$652,941	$662,735	$672,676	$682,766	$693,007	$703,403	$713,954	$724,663	$735,533	$746,566	$757,764	$769,131
MWRTA	$1,740,649	$1,766,759	$1,793,260	$1,820,159	$1,847,462	$1,875,173	$1,903,301	$1,931,851	$1,960,828	$1,990,241	$2,020,094	$2,050,396	$2,081,152	$2,112,369	$2,144,055	$2,176,215	$2,208,859	$2,241,991	$2,275,621	$2,309,756	$2,344,402	$2,379,568	$2,415,262	$2,451,490	$2,488,263	$2,525,587
PVTA	$11,954,100	$12,133,412	$12,315,413	$12,500,144	$12,687,646	$12,877,961	$13,071,131	$13,267,198	$13,466,206	$13,668,199	$13,873,222	$14,081,320	$14,292,540	$14,506,928	$14,724,532	$14,945,400	$15,169,581	$15,397,124	$15,628,081	$15,862,502	$16,100,440	$16,341,947	$16,587,076	$16,835,882	$17,088,420	$17,344,746
WRTA	$9,387,213	$9,528,021	$9,670,941	$9,816,005	$9,963,245	$10,112,694	$10,264,384	$10,418,350	$10,574,626	$10,733,245	$10,894,244	$11,057,657	$11,223,522	$11,391,875	$11,562,753	$11,736,194	$11,912,237	$12,090,921	$12,272,285	$12,456,369	$12,643,214	$12,832,863	$13,025,356	$13,220,736	$13,419,047	$13,620,333
MART	$3,036,682	$3,082,232	$3,128,466	$3,175,393	$3,223,024	$3,271,369	$3,320,440	$3,370,246	$3,420,800	$3,472,112	$3,524,194	$3,577,057	$3,630,712	$3,685,173	$3,740,451	$3,796,557	$3,853,506	$3,911,308	$3,969,978	$4,029,528	$4,089,971	$4,151,320	$4,213,590	$4,276,794	$4,340,946	$4,406,060
SRTA	$6,782,086	$6,883,818	$6,987,075	$7,091,881	$7,198,259	$7,306,233	$7,415,827	$7,527,064	$7,639,970	$7,754,570	$7,870,888	$7,988,951	$8,108,786	$8,230,417	$8,353,874	$8,479,182	$8,606,370	$8,735,465	$8,866,497	$8,999,495	$9,134,487	$9,271,504	$9,410,577	$9,551,736	$9,695,012	$9,840,437
BRTA	$1,711,046	$1,736,712	$1,762,762	$1,789,204	$1,816,042	$1,843,283	$1,870,932	$1,898,996	$1,927,481	$1,956,393	$1,985,739	$2,015,525	$2,045,758	$2,076,444	$2,107,591	$2,139,205	$2,171,293	$2,203,862	$2,236,920	$2,270,474	$2,304,531	$2,339,099	$2,374,185	$2,409,798	$2,445,945	$2,482,634
Total	$199,688,396	$202,683,722	$205,723,978	$208,809,837	$211,941,985	$215,121,115	$218,347,931	$221,623,150	$224,947,498	$228,321,710	$231,746,536	$235,222,734	$238,751,075	$242,332,341	$245,967,326	$249,656,836	$253,401,688	$257,202,714	$261,060,754	$264,976,666	$268,951,316	$272,985,585	$277,080,369	$281,236,575	$285,455,123	$289,736,950

massDOT Transit Financials

SECTION 5311

	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
VTA	$ 853,978	$866,787	$879,789	$892,986	$906,381	$919,976	$933,776	$947,783	$961,999	$976,429	$991,076	$1,005,942	$1,021,031	$1,036,347	$1,051,892	$1,067,670	$1,083,685	$1,099,940	$1,116,440	$1,133,186	$1,150,184	$1,167,437	$1,184,948	$1,202,722	$1,220,763	$1,239,075
NRTA	$ 537,121	$545,177	$553,355	$561,655	$570,080	$578,631	$587,311	$596,121	$605,062	$614,138	$623,350	$632,701	$642,191	$651,824	$661,601	$671,525	$681,598	$691,822	$702,200	$712,733	$723,424	$734,275	$745,289	$756,468	$767,815	$779,333
BRTA	$ 263,744	$267,700	$271,715	$275,791	$279,928	$284,127	$288,389	$292,715	$297,105	$301,562	$306,085	$310,677	$315,337	$320,067	$324,868	$329,741	$334,687	$339,707	$344,803	$349,975	$355,224	$360,553	$365,961	$371,451	$377,022	$382,678
FRTA	$ 1,106,827	$1,123,430	$1,140,281	$1,157,385	$1,174,746	$1,192,367	$1,210,253	$1,228,407	$1,246,833	$1,265,535	$1,284,518	$1,303,786	$1,323,343	$1,343,193	$1,363,341	$1,383,791	$1,404,548	$1,425,616	$1,447,000	$1,468,705	$1,490,736	$1,513,097	$1,535,793	$1,558,830	$1,582,213	$1,605,946
Total	$ 2,761,669	$ 2,803,094	$ 2,845,141	$ 2,887,818	$ 2,931,135	$ 2,975,102	$ 3,019,729	$ 3,065,025	$ 3,111,000	$ 3,157,665	$ 3,205,030	$ 3,253,105	$ 3,301,902	$ 3,351,430	$ 3,401,702	$ 3,452,727	$ 3,504,518	$ 3,557,086	$ 3,610,442	$ 3,664,599	$ 3,719,568	$ 3,775,362	$ 3,831,992	$ 3,889,472	$ 3,947,814	$ 4,007,031

SECTION 5337

	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
Boston	$ 120,261,669	$122,065,594	$123,896,578	$125,755,026	$127,641,352	$129,555,972	$131,499,311	$133,471,801	$135,473,878	$137,505,986	$139,568,576	$141,662,105	$143,787,036	$145,943,842	$148,132,999	$150,354,994	$152,610,319	$154,899,474	$157,222,966	$159,581,311	$161,975,030	$164,404,656	$166,870,726	$169,373,787	$171,914,393	$174,493,109
Worcester	$ 2,435,582	$2,472,115	$2,509,197	$2,546,835	$2,585,038	$2,623,813	$2,663,170	$2,703,118	$2,743,665	$2,784,820	$2,826,592	$2,868,991	$2,912,026	$2,955,706	$3,000,042	$3,045,042	$3,090,718	$3,137,079	$3,184,135	$3,231,897	$3,280,375	$3,329,581	$3,379,525	$3,430,218	$3,481,671	$3,533,896
Providence (GATRA)	$ 813,514	$825,716	$838,102	$850,674	$863,434	$876,385	$889,531	$902,874	$916,417	$930,163	$944,116	$958,277	$972,652	$987,241	$1,002,050	$1,017,081	$1,032,337	$1,047,822	$1,063,539	$1,079,492	$1,095,685	$1,112,120	$1,128,802	$1,145,734	$1,162,920	$1,180,364
Total	$ 123,510,764	$ 125,363,425	$ 127,243,877	$ 129,152,535	$ 131,089,823	$ 133,056,170	$ 135,052,013	$ 137,077,793	$ 139,133,960	$ 141,220,969	$ 143,339,284	$ 145,489,373	$ 147,671,714	$ 149,886,789	$ 152,135,091	$ 154,417,118	$ 156,733,374	$ 159,084,375	$ 161,470,641	$ 163,892,700	$ 166,351,091	$ 168,846,357	$ 171,379,052	$ 173,949,738	$ 176,558,984	$ 179,207,369

SECTION 5339

Boston UZA	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
MBTA	$5,732,879	$5,818,872	$5,906,155	$5,994,748	$6,084,669	$6,175,939	$6,268,578	$6,362,607	$6,458,046	$6,554,916	$6,653,240	$6,753,039	$6,854,334	$6,957,149	$7,061,506	$7,167,429	$7,274,940	$7,384,065	$7,494,826	$7,607,248	$7,721,357	$7,837,177	$7,954,735	$8,074,056	$8,195,167	$8,318,094

Barnstable UZA	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
CCRTA	$ 603,050	$612,096	$621,277	$630,596	$640,055	$649,656	$659,401	$669,292	$679,331	$689,521	$699,864	$710,362	$721,018	$731,833	$742,810	$753,953	$765,262	$776,741	$788,392	$800,218	$812,221	$824,404	$836,770	$849,322	$862,062	$874,993
GATRA	$ 90,111	$91,463	$92,835	$94,227	$95,640	$97,075	$98,531	$100,009	$101,509	$103,032	$104,577	$106,146	$107,738	$109,354	$110,995	$112,660	$114,349	$116,065	$117,806	$119,573	$121,366	$123,187	$125,035	$126,910	$128,814	$130,746

Springfield UZA	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
PVTA	$ 812,780	$824,972	$837,347	$849,907	$862,655	$875,595	$888,729	$902,060	$915,591	$929,325	$943,265	$957,414	$971,775	$986,352	$1,001,147	$1,016,164	$1,031,406	$1,046,878	$1,062,581	$1,078,519	$1,094,697	$1,111,118	$1,127,784	$1,144,701	$1,161,872	$1,179,300

Worcester UZA	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
WRTA	$ 472,218	$479,301	$486,491	$493,788	$501,195	$508,713	$516,343	$524,088	$531,950	$539,929	$548,028	$556,248	$564,592	$573,061	$581,657	$590,382	$599,237	$608,226	$617,349	$626,610	$636,009	$645,549	$655,232	$665,061	$675,037	$685,162
MART	$ 2,225	$2,258	$2,292	$2,326	$2,361	$2,397	$2,433	$2,469	$2,506	$2,544	$2,582	$2,621	$2,660	$2,700	$2,740	$2,781	$2,823	$2,865	$2,908	$2,952	$2,996	$3,041	$3,087	$3,133	$3,180	$3,228

Out-Of-State UZAs	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
(RI) GATRA	$ 146,292	$148,487	$150,714	$152,975	$155,269	$157,599	$159,962	$162,362	$164,797	$167,269	$169,778	$172,325	$174,910	$177,534	$180,197	$182,899	$185,643	$188,428	$191,254	$194,123	$197,035	$199,990	$202,990	$206,035	$209,125	$212,262
(RI) SRTA	$ 137,421	$139,482	$141,574	$143,698	$145,853	$148,041	$150,262	$152,516	$154,803	$157,125	$159,482	$161,874	$164,303	$166,767	$169,269	$171,808	$174,385	$177,001	$179,656	$182,350	$185,086	$187,862	$190,680	$193,540	$196,443	$199,390

Section 5339	FFY 2015 Estimate	FFY 2016 Estimate	FFY 2017 Estimate	FFY 2018 Estimate	FFY 2019 Estimate	FFY 2020 Estimate	FFY 2021 Estimate	FFY 2022 Estimate	FFY 2023 Estimate	FFY 2024 Estimate	FFY 2025 Estimate	FFY 2026 Estimate	FFY 2027 Estimate	FFY 2028 Estimate	FFY 2029 Estimate	FFY 2030 Estimate	FFY 2031 Estimate	FFY 2032 Estimate	FFY 2033 Estimate	FFY 2034 Estimate	FFY 2035 Estimate	FFY 2036 Estimate	FFY 2037 Estimate	FFY 2038 Estimate	FFY 2039 Estimate	FFY 2040 Estimate
MBTA	$ 5,732,879	$ 5,818,872	$ 5,906,155	$ 5,994,748	$ 6,084,669	$ 6,175,939	$ 6,268,578	$ 6,362,607	$ 6,458,046	$ 6,554,916	$ 6,653,240	$ 6,753,039	$ 6,854,334	$ 6,957,149	$ 7,061,506	$ 7,167,429	$ 7,274,940	$ 7,384,065	$ 7,494,826	$ 7,607,248	$ 7,721,357	$ 7,837,177	$ 7,954,735	$ 8,074,056	$ 8,195,167	$ 8,318,094
CCRTA	$ 603,050	$ 612,096	$ 621,277	$ 630,596	$ 640,055	$ 649,656	$ 659,401	$ 669,292	$ 679,331	$ 689,521	$ 699,864	$ 710,362	$ 721,018	$ 731,833	$ 742,810	$ 753,953	$ 765,262	$ 776,741	$ 788,392	$ 800,218	$ 812,221	$ 824,404	$ 836,770	$ 849,322	$ 862,062	$ 874,993
GATRA	$ 236,403	$ 239,949	$ 243,549	$ 247,202	$ 250,910	$ 254,674	$ 258,494	$ 262,371	$ 266,307	$ 270,301	$ 274,356	$ 278,471	$ 282,648	$ 286,888	$ 291,191	$ 295,559	$ 299,992	$ 304,492	$ 309,060	$ 313,696	$ 318,401	$ 323,177	$ 328,025	$ 332,945	$ 337,939	$ 343,008
PVTA	$ 812,780	$ 824,972	$ 837,347	$ 849,907	$ 862,655	$ 875,595	$ 888,729	$ 902,060	$ 915,591	$ 929,325	$ 943,265	$ 957,414	$ 971,775	$ 986,352	$ 1,001,147	$ 1,016,164	$ 1,031,406	$ 1,046,878	$ 1,062,581	$ 1,078,519	$ 1,094,697	$ 1,111,118	$ 1,127,784	$ 1,144,701	$ 1,161,872	$ 1,179,300
WRTA	$ 472,218	$ 479,301	$ 486,491	$ 493,788	$ 501,195	$ 508,713	$ 516,343	$ 524,088	$ 531,950	$ 539,929	$ 548,028	$ 556,248	$ 564,592	$ 573,061	$ 581,657	$ 590,382	$ 599,237	$ 608,226	$ 617,349	$ 626,610	$ 636,009	$ 645,549	$ 655,232	$ 665,061	$ 675,037	$ 685,162
MART	$ 2,225	$ 2,258	$ 2,292	$ 2,326	$ 2,361	$ 2,397	$ 2,433	$ 2,469	$ 2,506	$ 2,544	$ 2,582	$ 2,621	$ 2,660	$ 2,700	$ 2,740	$ 2,781	$ 2,823	$ 2,865	$ 2,908	$ 2,952	$ 2,996	$ 3,041	$ 3,087	$ 3,133	$ 3,180	$ 3,228
SRTA	$ 137,421	$ 139,482	$ 141,574	$ 143,698	$ 145,853	$ 148,041	$ 150,262	$ 152,516	$ 154,803	$ 157,125	$ 159,482	$ 161,874	$ 164,303	$ 166,767	$ 169,269	$ 171,808	$ 174,385	$ 177,001	$ 179,656	$ 182,350	$ 185,086	$ 187,862	$ 190,680	$ 193,540	$ 196,443	$ 199,390
Total	*$7,996,976*	*$8,116,930*	*$8,238,684*	*$8,362,265*	*$8,487,699*	*$8,615,014*	*$8,744,239*	*$8,875,403*	*$9,008,534*	*$9,143,662*	*$9,280,817*	*$9,420,029*	*$9,561,329*	*$9,704,749*	*$9,850,321*	*$9,998,075*	*$10,148,047*	*$10,300,267*	*$10,454,771*	*$10,611,593*	*$10,770,767*	*$10,932,328*	*$11,096,313*	*$11,262,758*	*$11,431,699*	*$11,603,175*

BRIDGES RATINGS

In March 2015, MassDOT provided a bridge report for the conditions of state-owned and municipal bridges in the Commonwealth for 2011, 2012, and 2013. The bridge ratings for such bridges on Cape Cod are presented on the following pages.

Town	BDEPT	BIN	Item 8	Over	Under	Owner Code	Owner	Hist. Code	FC Code	Functional Class	Year Built	Year Rebuilt	AASHTO Rating	Deficiency	Fed. Aid. Eligib.
Barnstable	B01001	41F	B0100141FMUNNBI	HWY S MAIN ST	WATER BUMPS RIVER	03	Town Agency	5	16	Urban Minor Arterial	1957		47.7	FO	Y
Barnstable	B01002	AED	B01002AEDMUNNBI	HWY BEACH RD	WATER CENTERVILLE RIVER	03	Town Agency	4	16	Urban Minor Arterial	2002		85		
Barnstable	B01003	435	B01003435MUNNBI	HWY BRIDGE ST	WATER WEST-NORTH BAY	03	Town Agency	5	17	Urban Collector	1946		47.9	FO	Y
Barnstable	B01004	434	B01004434MUNNBI	HWY MILLWAY RD	WATER MARASPIN CREEK	03	Town Agency	4	19	Urban Local	1936	1996	78.4	FO	Y
Barnstable	B01005	433	B01005433MUNNBI	HWY KEVENEY LN	WATER MILL CREEK	03	Town Agency	4	19	Urban Local	1978		62.8	FO	Y
Barnstable	B01006	AEC	B01006AECMUNNBI	HWY SCHOOL ST	WATER SANTUIT RIVER	03	Town Agency	4	16	Urban Minor Arterial	2001		75.3	FO	
Barnstable	B01011	49T	B0101149TDOTNBI	ST149 MTNG HSE WAY	US 6 WB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		61	FO	Y
Barnstable	B01012	4AP	B010124APDOTNBI	HWY OAK ST	US 6 WB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		71.6	FO	Y
Barnstable	B01014	4AN	B010144ANDOTNBI	HWY OAK ST	US 6 EB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		60.8	FO	Y
Barnstable	B01015	46J	B0101546JDOTNBI	US 6 EB/MD CP HWY	HWY PHINNEY'S LN	01	State Highway Agency	5	12	Freeway/Expressway	1966		84.7		
Barnstable	B01015	46K	B0101546KDOTNBI	US 6 WB/MD CP HWY	HWY PHINNEY'S LN	01	State Highway Agency	5	12	Freeway/Expressway	1953		79.7		
Barnstable	B01016	49R	B0101649RDOTNBI	ST149 MTNG HSE WAY	US 6 EB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1953		56	FO	Y
Barnstable	B01018	46L	B0101846LDOTNBI	US 6 WB/MD CP HWY	HWY MARY DUNN RD	01	State Highway Agency	5	12	Freeway/Expressway	1953		80.2		
Barnstable	B01018	46M	B0101846MDOTNBI	US 6 EB/MD CP HWY	HWY MARY DUNN RD	01	State Highway Agency	5	12	Freeway/Expressway	1966		87.4		
Barnstable	B01019	46G	B0101946GDOTNBI	US 6 WB/MD CP HWY	ST132 IYANNOUGH RD	01	State Highway Agency	5	16	Urban Minor Arterial	1966		67	FO	Y
Barnstable	B01019	46H	B0101946HDOTNBI	US 6 EB/MD CP HWY	ST132 IYANNOUGH RD	01	State Highway Agency	5	12	Freeway/Expressway	1966		97		
Bourne	B17001	41H	B1700141HMUNNBI	HWY SHORE RD	WATER POCASSET RIVER	03	Town Agency	4	16	Urban Minor Arterial	1939		19.2	SD	Y
Bourne	B17002	41J	B1700241JMUNNBI	HWY SHORE RD	WATER BACK RIVER	03	Town Agency	5	16	Urban Minor Arterial	1931		69.3		
Bourne	B17006	4BJ	B170064BJDOT634	HWY SHORE RD	RR MASS COASTAL	01	State Highway Agency	4	16	Urban Minor Arterial	1923		58.4	FO	Y
Bourne	B17010	4BH	B170104BHDOT634	HWY PERRY AVE	RR BCRR	01	State Highway Agency	5	19	Urban Local	1993		93.4		
Bourne	B17017	45G	B1701745GDOTNBI	US 6 /ST28/CRNBRY	WATER COHASSET NARROWS	01	State Highway Agency	5	16	Urban Minor Arterial	1921	1935	52.3	FO	Y
Bourne	B17019	45L	B1701945LDOTNBI	ST 28 BOURNE BR RD	US 6	01	State Highway Agency	5	12	Freeway/Expressway	1985		64	FO	Y
Bourne	B17025	4AF	B170254AFDOTNBI	HWY BOURNEDAL RD	ST 25	01	State Highway Agency	5	17	Urban Collector	1987		96.7		
Bourne	B17026	457	B17026457DOTNBI	HWY BOURNE CR CN	ST 25	01	State Highway Agency	5	16	Urban Minor Arterial	1985		88.3		
Bourne	B17027	5YK	B170275YKDOTNBI	ST 3 NB	US 6	01	State Highway Agency	4	12	Freeway/Expressway	2006		79		
Bourne	B17027	B11	B17027B11DOTNBI	ST 3 SB	US 6	01	State Highway Agency	4	12	Freeway/Expressway	2006		97		
Brewster	B22002	4AQ	B220024AQDOTNBI	HWY FREEMANS WAY	US 6	01	State Highway Agency	5	16	Urban Minor Arterial	1955		89		
Chatham	C07001	437	C07001437MUNNBI	HWY BRIDGE ST	WATER MITCHELL RIVER	03	Town Agency	5	17	Urban Collector	1936	1980	45.5	SD	Y
Dennis	D07001	41N	D0700141NMUNNBI	HWY UPPER COUNTY	WATER SWAN POND RIVER	03	Town Agency	4	16	Urban Minor Arterial	1949		39.4	SD	Y
Dennis	D07002	41M	D0700241MMUNNBI	HWY LOWER COUNTY	WATER SWAN POND RIVER	03	Town Agency	5	16	Urban Minor Arterial	1955		52.5	FO	Y
Dennis	D07003	AV5	D07003AV5MUNNBI	HWY LORING AVE	WATER WEIR CREEK	03	Town Agency	4	17	Urban Collector	1999		77.8	FO	Y
Dennis	D07004	47T	D0700447TDOTNBI	ST 28 MAIN ST	WATER BASS RIVER	01	State Highway Agency	4	14	Urban Arterial	1935		75		
Dennis	D07005	41L	D0700541LMUNNBI	HWY HIGHBANK RD	WATER BASS RIVER	03	Town Agency	5	16	Urban Minor Arterial	1953		48.6		
Dennis	D07006	47M	D0700647MDOTNBI	ST 28 MAIN ST	WATER SWAN POND RIVER	01	State Highway Agency	4	14	Urban Arterial	1946		61.3	SD	Y
Dennis	D07009	49U	D0700949UDOTNBI	ST134	US 6 WB/MID CAPE HWY	01	State Highway Agency	5	14	Urban Arterial	1955	1970	71.9	FO	Y
Dennis	D07009	B1B	D07009B1BDOTNBI	ST134	US 6 EB/MID CAPE HWY	01	State Highway Agency	4	14	Urban Arterial	1969		74.2	FO	Y
Dennis	D07010	46P	D0701046PDOTNBI	US 6 WB/MD CP HWY	WATER BASS RIVER	01	State Highway Agency	5	12	Freeway/Expressway	1954		52.1		
Dennis	D07011	4AR	D070114ARDOTNBI	HWY OLD BSS R RD	US 6 MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1954	1970	64.6	FO	Y
Dennis	D07012	46N	D0701246NDOTNBI	US 6 EB/MD CP HWY	WATER BASS RIVER	01	State Highway Agency	5	12	Freeway/Expressway	1970		73		
Dennis	D07013	ACQ	D07013ACQMUNNBI	HWY LIGHTHSE RD	WATER WARE RIVER	03	Town Agency	4	17	Urban Collector	1995		78	FO	Y
Dennis	D07014	B76	D07014B76MUNNBI	HWY BRIDGE ST	WATER SESUIT CREEK	03	Town Agency	4	09	Rural Local	2008		76.7		
Eastham	E04001	ADR	E04001ADRMUNNBI	HWY BRIDGE RD	WATER BOAT MEADOW BROOK	03	Town Agency	4	16	Urban Minor Arterial	1999		93.4		
Falmouth	F03001	47N	F0300147NDOTNBI	ST 28 WAQUOIT HWY	WATER CHILDS RIVER	01	State Highway Agency	5	14	Urban Arterial	1928		70.5	FO	Y
Falmouth	F03002	41W	F0300241WMUNNBI	HWY MENAUHANT RD	WATER GREEN POND	03	Town Agency	5	16	Urban Minor Arterial	1995		79.5		
Falmouth	F03003	41V	F0300341VMUNNBI	HWY MENAUHANT RD	WATER GREAT POND RIVER	03	Town Agency	3	16	Urban Minor Arterial	1984		76.1		
Falmouth	F03004	45M	F0300445MDOTNBI	HWY CRANE ST	OTHER STEAMSHP AUTH PKG	01	State Highway Agency	5	19	Urban Local	1953		51.6	FO	Y
Falmouth	F03005	43E	F0300543EMUNNBI	HWY WATER ST	WATER EEL POND	03	Town Agency	5	17	Urban Collector	1940	2009	73.4		
Falmouth	F03006	41X	F0300641XMUNNBI	HWY MENAUHANT RD	WATER BOURNES POND	03	Town Agency	5	16	Urban Minor Arterial	1985		62.2	FO	Y
Falmouth	F03007	4BL	F030074BLDOT634	HWY PALMER AVE	RR BIKE PATH PREV RR	01	State Highway Agency	5	16	Urban Minor Arterial	1991		76.4	FO	Y
Falmouth	F03008	4BM	F030084BMDOT634	HWY PALMER AVE	OTHER BIKE PATH PREV RR	01	State Highway Agency	5	16	Urban Minor Arterial	1896		49.2	FO	Y
Falmouth	F03010	43G	F0301043GMUNNBI	HWY NASHAWENA ST	WATER W FALMOUTH HARBOR	03	Town Agency	5	17	Urban Collector	1992		89.6		
Falmouth	F03011	AEF	F03011AEFMUNNBI	HWY QUAKER RD	WATER HERRING BROOK	03	Town Agency	4	17	Urban Collector	2000		80.3		
Falmouth	F03012	4BN	F030124BNDOT634	HWY CURLEY BLVD	OTHER BIKE PATH PREV RR	01	State Highway Agency	3	19	Urban Local	1988		92.5		
Falmouth	F03014	AN8	F03014AN8MUNNBI	HWY CHURCH ST	COMB ACC RD & BIKEPATH	03	Town Agency	4	19	Urban Local	2002		73.6		
Falmouth	F03016	47P	F0301647PDOTNBI	ST 28 E FALMTH HWY	WATER COONAMESSET RIVER	01	State Highway Agency	5	14	Urban Arterial	1953		68.7		
Falmouth	F03019	AXU	F03019AXUMUNNBI	HWY MEADOWNCK RD	WATER MOONAKIS RIVER	03	Town Agency	4	19	Urban Local	2004		81		
Falmouth	F03025	49H	F0302549HDOTNBI	ST 28 A/FALMTH HWY	RR BCRR (OTIS SPURR)	01	State Highway Agency	4	16	Urban Minor Arterial	1941		90.7		
Falmouth	F03026	4BP	F030264BPDOT634	ST151 NATHAN ELLIS	RR BCRR (OTIS SPURR)	01	State Highway Agency	4	14	Urban Arterial	1941		61.8	FO	Y
Falmouth	F03029	45N	F0302945NDOTNBI	ST 28 NB	HWY BRICK KILN RD	01	State Highway Agency	5	12	Freeway/Expressway	1959		97.4		
Falmouth	F03029	45P	F0302945PDOTNBI	ST 28 SB	HWY BRICK KILN RD	01	State Highway Agency	5	12	Freeway/Expressway	1959		86.5		
Falmouth	F03030	45Q	F0303045QDOTNBI	ST 28 NB	HWY THOMAS LANDERS RD	01	State Highway Agency	5	12	Freeway/Expressway	1960		83.1		
Falmouth	F03030	45R	F0303045RDOTNBI	ST 28 SB	HWY THOMAS LANDERS RD	01	State Highway Agency	5	12	Freeway/Expressway	1960		77.1		
Falmouth	F03031	45T	F0303145TDOTNBI	ST 28 NB	RR BCRR	01	State Highway Agency	5	12	Freeway/Expressway	1960		92.5		
Falmouth	F03031	45U	F0303145UDOTNBI	ST 28 SB	RR BCRR	01	State Highway Agency	5	12	Freeway/Expressway	1960		61.1	FO	Y
Falmouth	F03032	45V	F0303245VDOTNBI	ST 28 NB	ST151 NATHAN ELLIS HWY	01	State Highway Agency	5	12	Freeway/Expressway	1960		84.8		

Town	BDEPT	BIN	Item 8	Over	Under	Owner Code	Owner	Hist. Code	FC Code	Functional Class	Year Built	Year Rebuilt	AASHTO Rating	Deficiency	Fed. Aid. Eligib.
Falmouth	F03032	45W	F0303245WDOTNBI	ST 28 SB	ST151 NATHAN ELLIS HWY	01	State Highway Agency	5	12	Freeway/Expressway	1960		82.8		
Harwich	H10001	423	H10001423MUNNBI	HWY LOWER COUNTY	WATER HERRING RIVER	03	Town Agency	5	16	Urban Minor Arterial	1930	2003	73.1		
Harwich	H10002	47Q	H1000247QDOTNBI	ST 28 MAIN ST	WATER HERRING RIVER	01	State Highway Agency	5	14	Urban Arterial	1953		81.9		
Harwich	H10003	424	H10003424MUNNBI	HWY LOWER COUNTY	WATER DOANES CREEK	03	Town Agency	5	16	Urban Minor Arterial	1955		61.2	FO	Y
Harwich	H10011	43Q	H1001143QMUNNBI	HWY BELLS NCK RD	WATER HERRING RIVER	03	Town Agency	5	19	Urban Local	1986		79.9	FO	
Harwich	H10013	49V	H1001349VDOTNBI	ST124 PLSNT LK AVE	US 6 MID CAPE HWY	01	State Highway Agency	5	14	Urban Arterial	1955		56.2	FO	Y
Harwich	H10014	4A9	H100144A9DOTNBI	ST137 LONG POND RD	US 6 MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1955		56	FO	Y
Harwich	H10016	46T	H1001646TDOTNBI	US 6 MID CAPE HWY	HWY DEPOT ST	01	State Highway Agency	5	12	Freeway/Expressway	1955	2003	82		
Harwich	H10019	43P	H1001943PMUNNBI	HWY AZALEA DR	WATER HERRING RIVER	03	Town Agency	5	09	Rural Local	1974		78.5		
Orleans	O04001	47R	O0400147RDOTNBI	ST 28 S ORLEANS RD	WATER SALT MARSH CREEK	01	State Highway Agency	5	14	Urban Arterial	1954		93.4		
Orleans	O04003	46V	O0400346VDOTNBI	US 6 MID CAPE HWY	ST 6 A/CRANBERRY HWY	01	State Highway Agency	3	12	Freeway/Expressway	1957	1987	72.4	FO	Y
Orleans	O04004	4B1	O040044B1DOTNBI	HWY WEST RD	US 6 MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1958	1986	84.2		
Orleans	O04005	49W	O0400549WDOTNBI	HWY ROCK HRBR RD	US 6 MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1958	1987	94.5		
Sandwich	S04001	4A4	S040014A4DOTNBI	ST 6 A/CRNBRY HWY	WATER SCORTON RIVER	01	State Highway Agency	5	16	Urban Minor Arterial	1926		57.5	SD	Y
Sandwich	S04002	4C2	S040024C2DOT634	HWY OLD CNTY RD	RR BCRR	01	State Highway Agency	2	16	Urban Minor Arterial	1890	1995	73.2	FO	Y
Sandwich	S04003	4A5	S040034A5DOTNBI	ST 6 A/CRNBRY HWY	WATER MILL CREEK	01	State Highway Agency	5	16	Urban Minor Arterial	1951		95.6		
Sandwich	S04006	470	S04006470DOTNBI	US 6 WB/MD CP HWY	ST130 SANDWICH RD	01	State Highway Agency	3	16	Urban Minor Arterial	1950		81		
Sandwich	S04007	4BB	S040074BBDOTNBI	HWY QUKR MTNG HS	US 6 WB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		64.6	FO	Y
Sandwich	S04008	4BA	S040084BADOTNBI	HWY CHASE RD	US 6 WB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		70.9	FO	Y
Sandwich	S04009	471	S04009471DOTNBI	US 6 EB/MD CP HWY	ST130 SANDWICH RD	01	State Highway Agency	3	12	Freeway/Expressway	1953		78	FO	Y
Sandwich	S04010	4BC	S040104BCDOTNBI	HWY QUKR MTNG HS	US 6 EB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1953		66	FO	Y
Sandwich	S04011	4B9	S040114B9DOTNBI	HWY CHASE RD	US 6 EB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1953		67.6	FO	Y
Truro	T08003	472	T08003472DOTNBI	US 6 MID CAPE HWY	HWY S PAMET RD	01	State Highway Agency	5	02	Rural Arterial	1951		84.5		
Truro	T08004	473	T08004473DOTNBI	US 6 MID CAPE HWY	HWY HIGHLAND RD	01	State Highway Agency	5	02	Rural Arterial	1953		77		
Wellfleet	W14006	44A	W1400644AMUNNBI	HWY LT ISLAND RD	WATER LOAGY BAY	03	Town Agency	4	09	Rural Local	1920		50.9	FO	Y
Wellfleet	W14007	44B	W1400744BMUNNBI	HWY CHEQUSST NCK	WATER HERRING RIVER	03	Town Agency	5	09	Rural Local	1973		80.1		
Wellfleet	W14008	4BE	W140084BEDOTNBI	HWY LNG PND RD	US 6 MID CAPE HWY	01	State Highway Agency	5	08	Minor Collector	1949		73.3		
Yarmouth	Y01005	474	Y01005474DOTNBI	US 6 WB/MD CP HWY	COMB WILLOW ST & BCRR	01	State Highway Agency	5	16	Urban Minor Arterial	1953	1997	63.1	FO	Y
Yarmouth	Y01005	475	Y01005475DOTNBI	US 6 EB/MD CP HWY	COMB WILLOW ST & BCRR	01	State Highway Agency	5	12	Freeway/Expressway	1966		87.5		
Yarmouth	Y01006	47A	Y0100647ADOTNBI	US 6 WB/MD CP HWY	HWY UNION ST	01	State Highway Agency	5	12	Freeway/Expressway	1954		57.4	FO	Y
Yarmouth	Y01007	4BF	Y010074BFDOTNBI	HWY GRT WSTRN RD	US 6 MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1954	1970	47.4	FO	Y
Yarmouth	Y01012	47B	Y0101247BDOTNBI	US 6 EB/MD CP HWY	HWY UNION ST	01	State Highway Agency	5	12	Freeway/Expressway	1970		58.4	FO	Y
Yarmouth	Y01013	478	Y01013478DOTNBI	US 6 EB/MD CP HWY	RR BCRR	01	State Highway Agency	5	12	Freeway/Expressway	1970		85.2		
Yarmouth	Y01014	479	Y01014479DOTNBI	US 6 WB/MD CP HWY	RR BCRR	01	State Highway Agency	5	12	Freeway/Expressway	1971		86		
Yarmouth	Y01015	477	Y01015477DOTNBI	HWY W YARMTH RD	US 6 EB/MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1969		94.6		
Yarmouth	Y01016	476	Y01016476DOTNBI	HWY W YARMTH RD	US 6 WB/MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1969		97		

Town	BDEPT	BIN	Item 8	Over	Under	Owner Code	Owner	Hist. Code	FC Code	Functional Class	Year Built	Year Rebuilt	AASHTO Rating	Deficiency	Fed. Aid. Eligib.
Barnstable	B01001	41F	B0100141FMUNNBI	HWY S MAIN ST	WATER BUMPS RIVER	03	Town Agency	5	16	Urban Minor Arterial	1957		47.7	FO	Y
Barnstable	B01002	AED	B01002AEDMUNNBI	HWY BEACH RD	WATER CENTERVILLE RIVER	03	Town Agency	4	16	Urban Minor Arterial	2002		85		
Barnstable	B01003	435	B01003435MUNNBI	HWY BRIDGE ST	WATER WEST-NORTH BAY	03	Town Agency	5	17	Urban Collector	1946		47.9	FO	Y
Barnstable	B01004	434	B01004434MUNNBI	HWY MILLWAY RD	WATER MARASPIN CREEK	03	Town Agency	4	19	Urban Local	1936	1996	78.4	FO	Y
Barnstable	B01005	433	B01005433MUNNBI	HWY KEVENEY LN	WATER MILL CREEK	03	Town Agency	4	19	Urban Local	1978		74.8	FO	Y
Barnstable	B01006	AEC	B01006AECMUNNBI	HWY SCHOOL ST	WATER SANTUIT RIVER	03	Town Agency	4	16	Urban Minor Arterial	2001		75.3	FO	Y
Barnstable	B01011	49T	B0101149TDOTNBI	ST149 MTNG HSE WAY	US 6 WB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		61	FO	Y
Barnstable	B01012	4AP	B010124APDOTNBI	HWY OAK ST	US 6 WB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		71.6	FO	Y
Barnstable	B01014	4AN	B010144ANDOTNBI	HWY OAK ST	US 6 EB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		60.8	FO	Y
Barnstable	B01015	46J	B0101546JDOTNBI	US 6 EB/MD CP HWY	HWY PHINNEY'S LN	01	State Highway Agency	5	12	Freeway/Expressway	1966		84.7		
Barnstable	B01015	46K	B0101546KDOTNBI	US 6 WB/MD CP HWY	HWY PHINNEY'S LN	01	State Highway Agency	5	12	Freeway/Expressway	1953		79.7		
Barnstable	B01016	49R	B0101649RDOTNBI	ST149 MTNG HSE WAY	US 6 EB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1953		56	FO	Y
Barnstable	B01018	46L	B0101846LDOTNBI	US 6 WB/MD CP HWY	HWY MARY DUNN RD	01	State Highway Agency	5	12	Freeway/Expressway	1953		80.2		
Barnstable	B01018	46M	B0101846MDOTNBI	US 6 EB/MD CP HWY	HWY MARY DUNN RD	01	State Highway Agency	5	12	Freeway/Expressway	1966		87.4		
Barnstable	B01019	46G	B0101946GDOTNBI	US 6 WB/MD CP HWY	ST132 IYANNOUGH RD	01	State Highway Agency	5	16	Urban Minor Arterial	1966		67	FO	Y
Barnstable	B01019	46H	B0101946HDOTNBI	US 6 EB/MD CP HWY	ST132 IYANNOUGH RD	01	State Highway Agency	5	12	Freeway/Expressway	1966		97		
Bourne	B17001	41H	B1700141HMUNNBI	HWY SHORE RD	WATER POCASSET RIVER	03	Town Agency	4	16	Urban Minor Arterial	1939		22.4	FO	Y
Bourne	B17002	41J	B1700241JMUNNBI	HWY SHORE RD	WATER BACK RIVER	03	Town Agency	5	16	Urban Minor Arterial	1931		69.3		
Bourne	B17006	4BJ	B170064BJDOT634	HWY SHORE RD	RR MASS COASTAL	01	State Highway Agency	4	16	Urban Minor Arterial	1923		46.9	FO	Y
Bourne	B17010	4BH	B170104BHDOT634	HWY PERRY AVE	RR BCRR	01	State Highway Agency	5	19	Urban Local	1993		93.4		
Bourne	B17017	45G	B1701745GDOTNBI	US 6 /ST28/CRNBRY	WATER COHASSET NARROWS	01	State Highway Agency	5	16	Urban Minor Arterial	1921	1935	52.3	FO	Y
Bourne	B17019	45L	B1701945LDOTNBI	ST 28 BOURNE BR RD	US 6	01	State Highway Agency	5	12	Freeway/Expressway	1985		64	FO	Y
Bourne	B17025	4AF	B170254AFDOTNBI	HWY BOURNEDAL RD	ST 25	01	State Highway Agency	5	17	Urban Collector	1987		96.7		
Bourne	B17026	457	B17026457DOTNBI	HWY BOURNE CR CN	ST 25	01	State Highway Agency	5	16	Urban Minor Arterial	1985		88.3		
Bourne	B17027	5YK	B170275YKDOTNBI	ST 3 NB	US 6	01	State Highway Agency	4	12	Freeway/Expressway	2006		79		
Bourne	B17027	B11	B17027B11DOTNBI	ST 3 SB	US 6	01	State Highway Agency	4	12	Freeway/Expressway	2006		97		
Brewster	B22002	4AQ	B220024AQDOTNBI	HWY FREEMANS WAY	US 6	01	State Highway Agency	5	16	Urban Minor Arterial	1955		89		
Chatham	C07001	437	C07001437MUNNBI	HWY BRIDGE ST	WATER MITCHELL RIVER	03	Town Agency	5	17	Urban Collector	1936	1980	45.5	SD	Y
Dennis	D07001	41N	D0700141NMUNNBI	HWY UPPER COUNTY	WATER SWAN POND RIVER	03	Town Agency	4	16	Urban Minor Arterial	1949		39.4	SD	Y
Dennis	D07002	41M	D0700241MMUNNBI	HWY LOWER COUNTY	WATER SWAN POND RIVER	03	Town Agency	5	16	Urban Minor Arterial	1955		52.5	FO	Y
Dennis	D07003	AV5	D07003AV5MUNNBI	HWY LORING AVE	WATER WEIR CREEK	03	Town Agency	4	17	Urban Collector	1999		77.8	FO	Y
Dennis	D07004	47T	D0700447TDOTNBI	ST 28 MAIN ST	WATER BASS RIVER	01	State Highway Agency	4	14	Urban Arterial	1935		75		
Dennis	D07005	41L	D0700541LMUNNBI	HWY HIGHBANK RD	WATER BASS RIVER	03	Town Agency	5	16	Urban Minor Arterial	1953		59.7		
Dennis	D07006	47M	D0700647MDOTNBI	ST 28 MAIN ST	WATER SWAN POND RIVER	01	State Highway Agency	4	14	Urban Arterial	1946		61.3	SD	Y
Dennis	D07009	49U	D0700949UDOTNBI	ST134	US 6 WB/MID CAPE HWY	01	State Highway Agency	5	14	Urban Arterial	1955	1970	71.9	FO	Y
Dennis	D07009	B1B	D07009B1BDOTNBI	ST134	US 6 EB/MID CAPE HWY	01	State Highway Agency	4	14	Urban Arterial	1969		73.8	FO	Y
Dennis	D07010	46P	D0701046PDOTNBI	US 6 WB/MD CP HWY	WATER BASS RIVER	01	State Highway Agency	5	12	Freeway/Expressway	1954		52.1		
Dennis	D07011	4AR	D070114ARDOTNBI	HWY OLD BSS R RD	US 6 MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1954	1970	64.6	FO	Y
Dennis	D07012	46N	D0701246NDOTNBI	US 6 EB/MD CP HWY	WATER BASS RIVER	01	State Highway Agency	5	12	Freeway/Expressway	1970		73		
Dennis	D07013	ACQ	D07013ACQMUNNBI	HWY LIGHTHSE RD	WATER WARE RIVER	03	Town Agency	4	17	Urban Collector	1995		78	FO	Y
Dennis	D07014	B76	D07014B76MUNNBI	HWY BRIDGE ST	WATER SESUIT CREEK	03	Town Agency	4	09	Rural Local	2008		77.1		
Eastham	E04001	ADR	E04001ADRMUNNBI	HWY BRIDGE RD	WATER BOAT MEADOW BROOK	03	Town Agency	4	16	Urban Minor Arterial	1999		93.1		
Falmouth	F03001	47N	F0300147NDOTNBI	ST 28 WAQUOIT HWY	WATER CHILDS RIVER	01	State Highway Agency	5	14	Urban Arterial	1928		70.5	FO	Y
Falmouth	F03002	41W	F0300241WMUNNBI	HWY MENAUHANT RD	WATER GREEN POND	03	Town Agency	5	16	Urban Minor Arterial	1995		79.5		
Falmouth	F03003	41V	F0300341VMUNNBI	HWY MENAUHANT RD	WATER GREAT POND RIVER	03	Town Agency	3	16	Urban Minor Arterial	1984		76.1		
Falmouth	F03004	45M	F0300445MDOTNBI	HWY CRANE ST	OTHER STEAMSHP AUTH PKG	01	State Highway Agency	5	19	Urban Local	1953		51.6	FO	Y
Falmouth	F03005	43E	F0300543EMUNNBI	HWY WATER ST	WATER EEL POND	03	Town Agency	5	17	Urban Collector	1940	2009	73.4		
Falmouth	F03006	41X	F0300641XMUNNBI	HWY MENAUHANT RD	WATER BOURNES POND	03	Town Agency	5	16	Urban Minor Arterial	1985		62.2	FO	Y
Falmouth	F03007	4BL	F030074BLDOT634	HWY PALMER AVE	RR BIKE PATH PREV RR	01	State Highway Agency	5	16	Urban Minor Arterial	1991		76.4	FO	Y
Falmouth	F03008	4BM	F030084BMDOT634	HWY PALMER AVE	OTHER BIKE PATH PREV RR	01	State Highway Agency	5	16	Urban Minor Arterial	1896		49.2	FO	Y
Falmouth	F03009	B1Y	F03009B1YMUNNBI	HWY CHAPOQUOIT	WATER W FALMOUTH HARBOR	03	Town Agency	4	09	Rural Local	2012		95.3		
Falmouth	F03010	43G	F0301043GMUNNBI	HWY NASHAWENA ST	WATER W FALMOUTH HARBOR	03	Town Agency	5	17	Urban Collector	1992		89.4		
Falmouth	F03011	AEF	F03011AEFMUNNBI	HWY QUAKER RD	WATER HERRING BROOK	03	Town Agency	4	17	Urban Collector	2000		80.3		
Falmouth	F03012	4BN	F030124BNDOT634	HWY CURLEY BLVD	OTHER BIKE PATH PREV RR	01	State Highway Agency	3	19	Urban Local	1988		92.5		
Falmouth	F03014	AN8	F03014AN8MUNNBI	HWY CHURCH ST	COMB ACC RD & BIKEPATH	03	Town Agency	4	19	Urban Local	2002		73.6	FO	
Falmouth	F03016	47P	F0301647PDOTNBI	ST 28 E FALMTH HWY	WATER COONAMESSET RIVER	01	State Highway Agency	5	14	Urban Arterial	1953		68.7		
Falmouth	F03019	AXU	F03019AXUMUNNBI	HWY MEADOWNCK RD	WATER MOONAKIS RIVER	03	Town Agency	4	19	Urban Local	2004		81		
Falmouth	F03025	49H	F0302549HDOTNBI	ST 28 A/FALMTH HWY	RR BCRR (OTIS SPURR)	01	State Highway Agency	4	16	Urban Minor Arterial	1941		90.7		
Falmouth	F03026	4BP	F030264BPDOT634	ST151 NATHAN ELLIS	RR BCRR (OTIS SPURR)	01	State Highway Agency	4	14	Urban Arterial	1941		61.8	FO	Y
Falmouth	F03029	45N	F0302945NDOTNBI	ST 28 NB	HWY BRICK KILN RD	01	State Highway Agency	5	12	Freeway/Expressway	1959		97.4		
Falmouth	F03029	45P	F0302945PDOTNBI	ST 28 SB	HWY BRICK KILN RD	01	State Highway Agency	5	12	Freeway/Expressway	1959		86.5		
Falmouth	F03030	45Q	F0303045QDOTNBI	ST 28 NB	HWY THOMAS LANDERS RD	01	State Highway Agency	5	12	Freeway/Expressway	1960		83.1		
Falmouth	F03030	45R	F0303045RDOTNBI	ST 28 SB	HWY THOMAS LANDERS RD	01	State Highway Agency	5	12	Freeway/Expressway	1960		77.1		
Falmouth	F03031	45T	F0303145TDOTNBI	ST 28 NB	RR BCRR	01	State Highway Agency	5	12	Freeway/Expressway	1960		92.5		
Falmouth	F03031	45U	F0303145UDOTNBI	ST 28 SB	RR BCRR	01	State Highway Agency	5	12	Freeway/Expressway	1960		60	FO	Y

Town	BDEPT	BIN	Item 8	Over	Under	Owner Code	Owner	Hist. Code	FC Code	Functional Class	Year Built	Year Rebuilt	AASHTO Rating	Deficiency	Fed. Aid. Eligib.
Falmouth	F03032	45V	F0303245VDOTNBI	ST 28 NB	ST151 NATHAN ELLIS HWY	01	State Highway Agency	5	12	Freeway/Expressway	1960		84.8		
Falmouth	F03032	45W	F0303245WDOTNBI	ST 28 SB	ST151 NATHAN ELLIS HWY	01	State Highway Agency	5	12	Freeway/Expressway	1960		82.8		
Harwich	H10001	423	H10001423MUNNBI	HWY LOWER COUNTY	WATER HERRING RIVER	03	Town Agency	5	16	Urban Minor Arterial	1930	2003	73.1		
Harwich	H10002	47Q	H10002470DOTNBI	ST 28 MAIN ST	WATER HERRING RIVER	01	State Highway Agency	5	14	Urban Arterial	1953		81.9		
Harwich	H10003	424	H10003424MUNNBI	HWY LOWER COUNTY	WATER DOANES CREEK	03	Town Agency	5	16	Urban Minor Arterial	1955		61.2	FO	Y
Harwich	H10011	43Q	H10011430MUNNBI	HWY BELLS NCK RD	WATER HERRING RIVER	03	Town Agency	5	19	Urban Local	1986		79.9	FO	Y
Harwich	H10013	49V	H10013490DOTNBI	ST124 PLSNT LK AVE	US 6 MID CAPE HWY	01	State Highway Agency	5	14	Urban Arterial	1955		56.2	FO	Y
Harwich	H10014	4A9	H100144A9DOTNBI	ST137 LONG POND RD	US 6 MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1955		54.2	FO	Y
Harwich	H10016	46T	H10016460DOTNBI	US 6 MID CAPE HWY	HWY DEPOT ST	01	State Highway Agency	5	12	Freeway/Expressway	1955	2003	82		
Harwich	H10019	43P	H10019430MUNNBI	HWY AZALEA DR	WATER HERRING RIVER	03	Town Agency	5	09	Rural Local	1974		78.5		
Orleans	O04001	47R	O0400147RDOTNBI	ST 28 S ORLEANS RD	WATER SALT MARSH CREEK	01	State Highway Agency	5	14	Urban Arterial	1954		94.3		
Orleans	O04003	46V	O0400346VDOTNBI	US 6 MID CAPE HWY	ST 6 A/CRANBERRY HWY	01	State Highway Agency	3	12	Freeway/Expressway	1957	1987	72.4	FO	Y
Orleans	O04004	4B1	O040044B1DOTNBI	HWY WEST RD	US 6 MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1958	1986	84.2		
Orleans	O04005	49W	O0400549WDOTNBI	HWY ROCK HRBR RD	US 6 MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1958	1987	94.5		
Sandwich	S04001	4A4	S040014A4DOTNBI	ST 6 A/CRNBRY HWY	WATER SCORTON RIVER	01	State Highway Agency	5	16	Urban Minor Arterial	1926		57.5	SD	Y
Sandwich	S04002	4C2	S040024C2DOT634	HWY OLD CNTY RD	RR BCRR	01	State Highway Agency	2	16	Urban Minor Arterial	1890	1995	73.2	FO	Y
Sandwich	S04003	4A5	S040034A5DOTNBI	ST 6 A/CRNBRY HWY	WATER MILL CREEK	01	State Highway Agency	5	16	Urban Minor Arterial	1951		95.6		
Sandwich	S04006	470	S04006470DOTNBI	US 6 WB/MD CP HWY	ST130 SANDWICH RD	01	State Highway Agency	3	16	Urban Minor Arterial	1950		81		
Sandwich	S04007	4BB	S040074BBDOTNBI	HWY QUKR MTNG HS	US 6 WB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		64.6	FO	Y
Sandwich	S04008	4BA	S040084BADOTNBI	HWY CHASE RD	US 6 WB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		70.9	FO	Y
Sandwich	S04009	471	S04009471DOTNBI	US 6 EB/MD CP HWY	ST130 SANDWICH RD	01	State Highway Agency	3	12	Freeway/Expressway	1953		78	FO	Y
Sandwich	S04010	4BC	S040104BCDOTNBI	HWY QUKR MTNG HS	US 6 EB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1953		66	FO	Y
Sandwich	S04011	4B9	S040114B9DOTNBI	HWY CHASE RD	US 6 EB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1953		67.6	FO	Y
Truro	T08003	472	T08003472DOTNBI	US 6 MID CAPE HWY	HWY S PAMET RD	01	State Highway Agency	5	02	Rural Arterial	1951		84.5		
Truro	T08004	473	T08004473DOTNBI	US 6 MID CAPE HWY	HWY HIGHLAND RD	01	State Highway Agency	5	02	Rural Arterial	1953		77		
Wellfleet	W14006	44A	W1400644AMUNNBI	HWY LT ISLAND RD	WATER LOAGY BAY	03	Town Agency	4	09	Rural Local	1920		50.9	FO	Y
Wellfleet	W14007	44B	W1400744BMUNNBI	HWY CHEQUSST NCK	WATER HERRING RIVER	03	Town Agency	5	09	Rural Local	1973		80.1		
Wellfleet	W14008	4BE	W140084BEDOTNBI	HWY LNG PND RD	US 6 MID CAPE HWY	01	State Highway Agency	5	08	Minor Collector	1949		72.3		
Yarmouth	Y01005	474	Y01005474DOTNBI	US 6 WB/MD CP HWY	COMB WILLOW ST & BCRR	01	State Highway Agency	5	16	Urban Minor Arterial	1953	1997	63.1	FO	Y
Yarmouth	Y01005	475	Y01005475DOTNBI	US 6 EB/MD CP HWY	COMB WILLOW ST & BCRR	01	State Highway Agency	5	12	Freeway/Expressway	1966		87.5		
Yarmouth	Y01006	47A	Y0100647ADOTNBI	US 6 WB/MD CP HWY	HWY UNION ST	01	State Highway Agency	5	12	Freeway/Expressway	1954		59.6	FO	Y
Yarmouth	Y01007	4BF	Y010074BFDOTNBI	HWY GRT WSTRN RD	US 6 MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1954	1970	47.4	FO	Y
Yarmouth	Y01012	47B	Y0101247BDOTNBI	US 6 EB/MD CP HWY	HWY UNION ST	01	State Highway Agency	5	12	Freeway/Expressway	1970		58.4	FO	Y
Yarmouth	Y01013	478	Y01013478DOTNBI	US 6 EB/MD CP HWY	RR BCRR	01	State Highway Agency	5	12	Freeway/Expressway	1970		79.2	FO	
Yarmouth	Y01014	479	Y01014479DOTNBI	US 6 WB/MD CP HWY	RR BCRR	01	State Highway Agency	5	12	Freeway/Expressway	1971		86		
Yarmouth	Y01015	477	Y01015477DOTNBI	HWY W YARMTH RD	US 6 EB/MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1969		94.6		
Yarmouth	Y01016	476	Y01016476DOTNBI	HWY W YARMTH RD	US 6 WB/MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1969		97		

Town	BDEPT	BIN	Item 8	Over	Under	Owner Code	Owner	Hist. Code	FC Code	Functional Class	Year Built	Year Rebuilt	AASHTO Rating	Deficiency
Barnstable	B01001	41F	B0100141FMUNNBI	HWY S MAIN ST	WATER BUMPS RIVER	03	Town Agency	5	16	Urban Minor Arterial	1957		48.2	FO
Barnstable	B01002	AED	B01002AEDMUNNBI	HWY BEACH RD	WATER CENTERVILLE RIVER	03	Town Agency	4	16	Urban Minor Arterial	2002		85	
Barnstable	B01003	435	B01003435MUNNBI	HWY BRIDGE ST	WATER WEST-NORTH BAY	03	Town Agency	5	17	Urban Collector	1946		47.9	FO
Barnstable	B01004	434	B01004434MUNNBI	HWY MILLWAY RD	WATER MARASPIN CREEK	03	Town Agency	4	19	Urban Local	1936	1996	78.4	FO
Barnstable	B01005	433	B01005433MUNNBI	HWY KEVENEY LN	WATER MILL CREEK	03	Town Agency	4	19	Urban Local	1978		74.8	FO
Barnstable	B01006	AEC	B01006AECMUNNBI	HWY SCHOOL ST	WATER SANTUIT RIVER	03	Town Agency	4	16	Urban Minor Arterial	2001		75.3	FO
Barnstable	B01011	49T	B0101149TDOTNBI	ST149 MTNG HSE WAY	US 6 WB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		82	
Barnstable	B01012	4AP	B010124APDOTNBI	HWY OAK ST	US 6 WB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		71.6	FO
Barnstable	B01014	4AN	B010144ANDOTNBI	HWY OAK ST	US 6 EB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		60.8	FO
Barnstable	B01015	46J	B0101546JDOTNBI	US 6 EB/MD CP HWY	HWY PHINNEY'S LN	01	State Highway Agency	5	12	Freeway/Expressway	1966		82	
Barnstable	B01015	46K	B0101546KDOTNBI	US 6 WB/MD CP HWY	HWY PHINNEY'S LN	01	State Highway Agency	5	12	Freeway/Expressway	1953		77.7	
Barnstable	B01016	49R	B0101649RDOTNBI	ST149 MTNG HSE WAY	US 6 EB/MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1953		76.3	FO
Barnstable	B01018	46L	B0101846LDOTNBI	US 6 WB/MD CP HWY	HWY MARY DUNN RD	01	State Highway Agency	5	12	Freeway/Expressway	1953		79.6	
Barnstable	B01018	46M	B0101846MDOTNBI	US 6 EB/MD CP HWY	HWY MARY DUNN RD	01	State Highway Agency	5	12	Freeway/Expressway	1966		87.4	
Barnstable	B01019	46G	B0101946GDOTNBI	US 6 WB/MD CP HWY	ST132 IYANNOUGH RD	01	State Highway Agency	5	16	Urban Minor Arterial	1966		77.4	FO
Barnstable	B01019	46H	B0101946HDOTNBI	US 6 EB/MD CP HWY	ST132 IYANNOUGH RD	01	State Highway Agency	5	12	Freeway/Expressway	1966		96.8	
Bourne	B17001	41H	B1700141HMUNNBI	HWY SHORE RD	WATER POCASSET RIVER	03	Town Agency	4	16	Urban Minor Arterial	1939		52.9	FO
Bourne	B17002	41J	B1700241JMUNNBI	HWY SHORE RD	WATER BACK RIVER	03	Town Agency	5	16	Urban Minor Arterial	1931		69.3	
Bourne	B17006	4BJ	B170064BJDOT634	HWY SHORE RD	RR MACRR	01	State Highway Agency	4	16	Urban Minor Arterial	1923		46.9	FO
Bourne	B17010	4BH	B170104BHDOT634	HWY PERRY AVE	RR MACRR	01	State Highway Agency	5	19	Urban Local	1993		93.4	
Bourne	B17017	45G	B1701745GDOTNBI	US 6 /ST28/CRNBRY	WATER COHASSET NARROWS	01	State Highway Agency	5	16	Urban Minor Arterial	1921	1935	52.3	FO
Bourne	B17019	45L	B1701945LDOTNBI	ST 28 BOURNE BR RD	US 6	01	State Highway Agency	5	12	Freeway/Expressway	1985		64	FO
Bourne	B17025	4AF	B170254AFDOTNBI	HWY BOURNEDAL RD	ST 25	01	State Highway Agency	5	17	Urban Collector	1987		96.7	
Bourne	B17026	457	B17026457DOTNBI	HWY BOURNE CR CN	ST 25	01	State Highway Agency	5	16	Urban Minor Arterial	1985		88.3	
Bourne	B17027	5YK	B170275YKDOTNBI	ST 3 NB	US 6	01	State Highway Agency	4	12	Freeway/Expressway	2006		79	
Bourne	B17027	B11	B17027B11DOTNBI	ST 3 SB	US 6	01	State Highway Agency	4	12	Freeway/Expressway	2006		97	
Brewster	B22002	4AQ	B220024AQDOTNBI	HWY FREEMANS WAY	US 6	01	State Highway Agency	5	16	Urban Minor Arterial	1955		89	
Chatham	C07001	437	C07001437MUNNBI	HWY BRIDGE ST	WATER MITCHELL RIVER	03	Town Agency	5	17	Urban Collector	1936	1980	45.5	SD
Dennis	D07001	41N	D0700141NMUNNBI	HWY UPPER COUNTY	WATER SWAN POND RIVER	03	Town Agency	4	16	Urban Minor Arterial	1949		39.4	SD
Dennis	D07002	41M	D0700241MMUNNBI	HWY LOWER COUNTY	WATER SWAN POND RIVER	03	Town Agency	5	16	Urban Minor Arterial	1955		52.5	FO
Dennis	D07003	AV5	D07003AV5MUNNBI	HWY LORING AVE	WATER WEIR CREEK	03	Town Agency	4	17	Urban Collector	1999		77.8	FO
Dennis	D07004	47T	D0700447TDOTNBI	ST 28 MAIN ST	WATER BASS RIVER	01	State Highway Agency	4	14	Urban Arterial	1935		75	
Dennis	D07005	41L	D0700541LMUNNBI	HWY HIGHBANK RD	WATER BASS RIVER	03	Town Agency	5	16	Urban Minor Arterial	1953		59.7	
Dennis	D07006	47M	D0700647MDOTNBI	ST 28 MAIN ST	WATER SWAN POND RIVER	01	State Highway Agency	4	14	Urban Arterial	1946		61.3	SD
Dennis	D07009	49U	D0700949UDOTNBI	ST134	US 6 WB/MID CAPE HWY	01	State Highway Agency	5	14	Urban Arterial	1955	1970	71.9	FO
Dennis	D07009	B1B	D07009B1BDOTNBI	ST134	US 6 EB/MID CAPE HWY	01	State Highway Agency	4	14	Urban Arterial	1969		73.8	FO
Dennis	D07010	46P	D0701046PDOTNBI	US 6 WB/MD CP HWY	WATER BASS RIVER	01	State Highway Agency	5	12	Freeway/Expressway	1954		52.1	
Dennis	D07011	4AR	D070114ARDOTNBI	HWY OLD BSS R RD	US 6 MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1954	1970	64.6	FO
Dennis	D07012	46N	D0701246NDOTNBI	US 6 EB/MD CP HWY	WATER BASS RIVER	01	State Highway Agency	5	12	Freeway/Expressway	1970		73	
Dennis	D07013	ACQ	D07013ACQMUNNBI	HWY LIGHTHSE RD	WATER WARE RIVER	03	Town Agency	4	17	Urban Collector	1995		78	FO
Dennis	D07014	B76	D07014B76MUNNBI	HWY BRIDGE ST	WATER SESUIT CREEK	03	Town Agency	4	09	Rural Local	2008		77.1	
Eastham	E04001	ADR	E04001ADRMUNNBI	HWY BRIDGE RD	WATER BOAT MEADOW BROOK	03	Town Agency	4	16	Urban Minor Arterial	1999		93.1	
Falmouth	F03001	47N	F0300147NDOTNBI	ST 28 WAQUOIT HWY	WATER CHILDS RIVER	01	State Highway Agency	5	14	Urban Arterial	1928		70.5	FO
Falmouth	F03002	41W	F0300241WMUNNBI	HWY MENAUHANT RD	WATER GREEN POND	03	Town Agency	5	16	Urban Minor Arterial	1995		78.9	
Falmouth	F03003	41V	F0300341VMUNNBI	HWY MENAUHANT RD	WATER GREAT POND RIVER	03	Town Agency	3	16	Urban Minor Arterial	1984		76.1	
Falmouth	F03004	45M	F0300445MDOTNBI	HWY CRANE ST	OTHER STEAMSHP AUTH PKG	01	State Highway Agency	5	19	Urban Local	1953		51.6	FO
Falmouth	F03005	43E	F0300543EMUNNBI	HWY WATER ST	WATER EEL POND	03	Town Agency	5	17	Urban Collector	1940	2009	73.4	
Falmouth	F03006	41X	F0300641XMUNNBI	HWY MENAUHANT RD	WATER BOURNES POND	03	Town Agency	5	16	Urban Minor Arterial	1985		62.2	FO
Falmouth	F03007	4BL	F030074BLDOT634	HWY PALMER AVE	RR BIKE PATH PREV RR	01	State Highway Agency	5	16	Urban Minor Arterial	1991		76.4	FO
Falmouth	F03008	4BM	F030084BMDOT634	HWY PALMER AVE	OTHER BIKE PATH PREV RR	01	State Highway Agency	5	16	Urban Minor Arterial	1896		49.1	FO
Falmouth	F03009	B1Y	F03009B1YMUNNBI	HWY CHAPOQUOIT	WATER W FALMOUTH HARBOR	03	Town Agency	4	09	Rural Local	2012		95.3	
Falmouth	F03010	43G	F0301043GMUNNBI	HWY NASHAWENA ST	WATER W FALMOUTH HARBOR	03	Town Agency	5	17	Urban Collector	1992		89.4	
Falmouth	F03011	AEF	F03011AEFMUNNBI	HWY QUAKER RD	WATER HERRING BROOK	03	Town Agency	4	17	Urban Collector	2000		80.3	
Falmouth	F03012	4BN	F030124BNDOT634	HWY CURLEY BLVD	OTHER BIKE PATH PREV RR	01	State Highway Agency	3	19	Urban Local	1988		92.5	
Falmouth	F03014	AN8	F03014AN8MUNNBI	HWY CHURCH ST	COMB ACC RD & BIKEPATH	03	Town Agency	4	19	Urban Local	2002		75.6	FO
Falmouth	F03016	47P	F0301647PDOTNBI	ST 28 E FALMTH HWY	WATER COONAMESSET RIVER	01	State Highway Agency	5	14	Urban Arterial	1953		68.7	
Falmouth	F03019	AXU	F03019AXUMUNNBI	HWY MEADOWNCK RD	WATER MOONAKIS RIVER	03	Town Agency	4	19	Urban Local	2004		80.3	
Falmouth	F03025	49H	F0302549HDOTNBI	ST 28 A/FALMTH HWY	RR MACRR (OTIS SPURR)	01	State Highway Agency	4	16	Urban Minor Arterial	1941		90.7	
Falmouth	F03026	4BP	F030264BPDOT634	ST151 NATHAN ELLIS	RR MACRR (OTIS SPURR)	01	State Highway Agency	4	14	Urban Arterial	1941		61.8	FO

Town	BDEPT	BIN	Item 8	Over	Under	Owner Code	Owner	Hist. Code	FC Code	Functional Class	Year Built	Year Rebuilt	AASHTO Rating	Deficiency
Falmouth	F03029	45N	F0302945NDOTNBI	ST 28 NB	HWY BRICK KILN RD	01	State Highway Agency	5	12	Freeway/Expressway	1959		97.4	
Falmouth	F03029	45P	F0302945PDOTNBI	ST 28 SB	HWY BRICK KILN RD	01	State Highway Agency	5	12	Freeway/Expressway	1959		83.3	
Falmouth	F03030	45Q	F0303045QDOTNBI	ST 28 NB	HWY THOMAS LANDERS RD	01	State Highway Agency	5	12	Freeway/Expressway	1960		83.1	
Falmouth	F03030	45R	F0303045RDOTNBI	ST 28 SB	HWY THOMAS LANDERS RD	01	State Highway Agency	5	12	Freeway/Expressway	1960		77.1	
Falmouth	F03031	45T	F0303145TDOTNBI	ST 28 NB	RR MACRR	01	State Highway Agency	5	12	Freeway/Expressway	1960		92.5	
Falmouth	F03031	45U	F0303145UDOTNBI	ST 28 SB	RR MACRR	01	State Highway Agency	5	12	Freeway/Expressway	1960		60	FO
Falmouth	F03032	45V	F0303245VDOTNBI	ST 28 NB	ST151 NATHAN ELLIS HWY	01	State Highway Agency	5	12	Freeway/Expressway	1960		74.8	
Falmouth	F03032	45W	F0303245WDOTNBI	ST 28 SB	ST151 NATHAN ELLIS HWY	01	State Highway Agency	5	12	Freeway/Expressway	1960		82.8	
Harwich	H10001	423	H10001423MUNNBI	HWY LOWER COUNTY	WATER HERRING RIVER	03	Town Agency	5	16	Urban Minor Arterial	1930	2003	73.1	FO
Harwich	H10002	47Q	H1000247QDOTNBI	ST 28 MAIN ST	WATER HERRING RIVER	01	State Highway Agency	5	14	Urban Arterial	1953		81.9	
Harwich	H10003	424	H10003424MUNNBI	HWY LOWER COUNTY	WATER DOANES CREEK	03	Town Agency	5	16	Urban Minor Arterial	1955		61.2	FO
Harwich	H10011	43Q	H1001143QMUNNBI	HWY BELLS NCK RD	WATER HERRING RIVER	03	Town Agency	5	19	Urban Local	1986		79.9	FO
Harwich	H10013	49V	H1001349VDOTNBI	ST124 PLSNT LK AVE	US 6 MID CAPE HWY	01	State Highway Agency	5	14	Urban Arterial	1955		56.2	FO
Harwich	H10014	4A9	H100144A9DOTNBI	ST137 LONG POND RD	US 6 MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1955		54.2	FO
Harwich	H10016	46T	H1001646TDOTNBI	US 6 MID CAPE HWY	HWY DEPOT ST	01	State Highway Agency	5	12	Freeway/Expressway	1955	2003	82	
Harwich	H10019	43P	H1001943PMUNNBI	HWY AZALEA DR	WATER HERRING RIVER	03	Town Agency	5	09	Rural Local	1974		78.9	
Orleans	O04001	47R	O0400147RDOTNBI	ST 28 S ORLEANS RD	WATER SALT MARSH CREEK	01	State Highway Agency	5	14	Urban Arterial	1954		94.3	
Orleans	O04003	46V	O0400346VDOTNBI	US 6 MID CAPE HWY	ST 6 A/CRANBERRY HWY	01	State Highway Agency	3	12	Freeway/Expressway	1957	1987	72.4	FO
Orleans	O04004	4B1	O040044B1DOTNBI	HWY WEST RD	US 6 MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1958	1986	84.2	
Orleans	O04005	49W	O0400549WDOTNBI	HWY ROCK HRBR RD	US 6 MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1958	1987	94.5	
Sandwich	S04001	4A4	S040014A4DOTNBI	ST 6 A/CRNBRY HWY	WATER SCORTON RIVER	01	State Highway Agency	5	16	Urban Minor Arterial	1926		57.5	SD
Sandwich	S04002	4C2	S040024C2DOT634	HWY OLD CNTY RD	RR MACRR	01	State Highway Agency	2	16	Urban Minor Arterial	1890	1995	73.2	FO
Sandwich	S04003	4A5	S040034A5DOTNBI	ST 6 A/CRNBRY HWY	WATER MILL CREEK	01	State Highway Agency	5	16	Urban Minor Arterial	1951		95.6	
Sandwich	S04006	470	S04006470DOTNBI	US 6 WB/MD CP HWY	ST130 SANDWICH RD	01	State Highway Agency	3	16	Urban Minor Arterial	1950		79	
Sandwich	S04007	4BB	S040074BBDOTNBI	HWY QUKR MTNG HS	US 6 WB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		64.6	FO
Sandwich	S04008	4BA	S040084BADOTNBI	HWY CHASE RD	US 6 WB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1950		70.9	FO
Sandwich	S04009	471	S04009471DOTNBI	US 6 EB/MD CP HWY	ST130 SANDWICH RD	01	State Highway Agency	3	12	Freeway/Expressway	1953		76	FO
Sandwich	S04010	4BC	S040104BCDOTNBI	HWY QUKR MTNG HS	US 6 EB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1953		66	FO
Sandwich	S04011	4B9	S040114B9DOTNBI	HWY CHASE RD	US 6 EB MID CAPE HWY	01	State Highway Agency	5	16	Urban Minor Arterial	1953		69.9	FO
Truro	T08003	472	T08003472DOTNBI	US 6 MID CAPE HWY	HWY S PAMET RD	01	State Highway Agency	5	02	Rural Arterial	1951		84.5	
Truro	T08004	473	T08004473DOTNBI	US 6 MID CAPE HWY	HWY HIGHLAND RD	01	State Highway Agency	5	02	Rural Arterial	1953		77	
Wellfleet	W14006	44A	W1400644AMUNNBI	HWY LT ISLAND RD	WATER LOAGY BAY	03	Town Agency	4	09	Rural Local	1920		50.9	FO
Wellfleet	W14007	44B	W1400744BMUNNBI	HWY CHEQUSST NCK	WATER HERRING RIVER	03	Town Agency	5	09	Rural Local	1973		80.1	
Wellfleet	W14008	4BE	W140084BEDOTNBI	HWY LNG PND RD	US 6 MID CAPE HWY	01	State Highway Agency	5	08	Minor Collector	1949		72.3	
Yarmouth	Y01005	474	Y01005474DOTNBI	US 6 WB/MD CP HWY	COMB WILLOW ST/MACRR	01	State Highway Agency	5	16	Urban Minor Arterial	1953	1997	63.1	FO
Yarmouth	Y01005	475	Y01005475DOTNBI	US 6 EB/MD CP HWY	COMB WILLOW ST/MACRR	01	State Highway Agency	5	12	Freeway/Expressway	1966		87.5	
Yarmouth	Y01006	47A	Y0100647ADOTNBI	US 6 WB/MD CP HWY	HWY UNION ST	01	State Highway Agency	5	12	Freeway/Expressway	1954		59.6	FO
Yarmouth	Y01007	4BF	Y010074BFDOTNBI	HWY NORTH DENNIS	US 6 MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1954	1970	47.4	FO
Yarmouth	Y01012	47B	Y0101247BDOTNBI	US 6 EB/MD CP HWY	HWY UNION ST	01	State Highway Agency	5	12	Freeway/Expressway	1970		58.4	FO
Yarmouth	Y01013	478	Y01013478DOTNBI	US 6 EB/MD CP HWY	RR MACRR	01	State Highway Agency	5	12	Freeway/Expressway	1970		79.2	FO
Yarmouth	Y01014	479	Y01014479DOTNBI	US 6 WB/MD CP HWY	RR MACRR	01	State Highway Agency	5	12	Freeway/Expressway	1971		86	
Yarmouth	Y01015	477	Y01015477DOTNBI	HWY W YARMTH RD	US 6 EB/MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1969		94.6	
Yarmouth	Y01016	476	Y01016476DOTNBI	HWY W YARMTH RD	US 6 WB/MID CAPE HWY	01	State Highway Agency	3	16	Urban Minor Arterial	1969		97	

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3225 MAIN STREET • P.O. BOX 226 • BARNSTABLE, MASSACHUSETTS 02630
(508) 362-3828 • Fax (508) 362-3136 • www.capecodcommission.org

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2016 REGIONAL TRANSPORTATION PLAN

Technical Appendix Q: Public Comments

Draft
June 15, 2015

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Public Comments 1

Technical Appendix Q: Public Comments

PUBLIC COMMENTS

To be added following the public comment period.

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