2.7 CANAL AREA TRANSPORTATION

Almost everyone who has driven to Cape Cod has used one of the two highway bridges spanning the Cape Cod Canal. In addition to the highway bridges, the Cape Cod Canal Railway Bridge presents the potential to transport people onto Cape Cod by rail. These three bridges are each owned and maintained by the U.S. Army Corps of Engineers. Given that the canal effectively makes Cape Cod an island, the three canal bridges serve as the only means, excluding ferries, to transport vehicles to and from the Cape. Moreover, most people traveling to Martha's Vineyard and Nantucket rely on the canal bridges to reach their respective seaports by roadway. The history, use, maintenance, and future of these bridges are of vital importance to the residents, businesses, and visitors of Cape Cod and the Islands.

2.7.1 CANAL HIGHWAY BRIDGES' HISTORY

In 1928, Congress directed the Army Corps of Engineers to make improvements to the narrow Cape Cod Canal (as configured by 1915). These improvements resulted in the canal we have today – and result in highway bridges that provide a vertical clearance of 135 feet above mean high water and a horizontal clearance of 480 feet. The bridges were built from 1933 to1935 in land areas that were naturally elevated.

THE SAGAMORE BRIDGE, UNDER CONSTRUCTION, IN 1934. SOURCE: U.S. ARMY CORPS OF ENGINEERS

2.7.2 CANAL BRIDGE CONDITIONS

Currently, the Canal Bridges are owned and maintained by the Army Corps of Engineers (ACOE). As the bridges age and the average daily traffic volumes continue to rise, the ACOE maintenance efforts are nearly continuous. Based on recent bridge inspection reports, the Cape Cod Canal Highway bridges qualify for replacement under federal guidelines. The ACOE inspects and maintains both highway bridges over the Cape Cod Canal in safe condition; however, discussions about bridge replacement or another Canal crossing have begun informally.

In addition to the strategies for maintenance recommended by the Metropolitan Planning Organization (MPO) in this Regional Transportation Plan (RTP), there is a need to consider the future Canal crossing. The Bourne and Sagamore bridges are increasingly undergoing maintenance efforts that constrain mobility between Cape Cod and the mainland. While the cost and frequency of repairs increase, so does the inconvenience and economic detriment for residents, businesses, and visitors.

This RTP therefore recommends a study by the Cape Cod Commission and its consultant(s) with the Army Corps of Engineers, stakeholders, and the public to focus on the future Canal crossing. The study will include:

- Options for a new crossing, e.g., bridge, tunnel, ferry...
- Traffic flow capacity (vehicles per hour)
- Bicycle and pedestrian facilities included or as a separate crossing
- Consistency with emergency management plans

The result of this proposed study would be a recommendation for the future Canal crossing concept, along with assignment of the design proponent(s). It is desirable to have the stakeholders group and public process continue through the design process.

During certain maintenance activities (roadbed resurfacing or reconstruction) and structural repairs, lane closures may be required during parts of the day or continuously until completion. The effects of maintenance-related lane closures are discussed later in this document.

FIGURE 1 - BOURNE BRIDGE

FIGURE 2 - SAGAMORE BRIDGE

FIGURE 3 - ROADWAY OVER SAGAMORE BRIDGE

FIGURE 4 - SAGAMORE BRIDGE STRUCTURE

2.7.3 HIGHWAY BRIDGE CAPACITY

According to MassDOT's *Canal Area Traffic Study* (August 2006), each bridge has a theoretical directional peak capacity of approximately 3,400 vehicles per hour. Due to the narrow lanes and the absence of a median, the capacity of the two bridge lanes opposing the peak direction is estimated to be approximately 30% less than the peak flow, or 2,400 vehicles per hour. This results in a two-way capacity of approximately 5,800 vehicles per hour on each of the canal bridges.

2.7.4 TRAFFIC VOLUMES

Traffic over the bridges has continued to increase over the last 35 years (see following figure). However, traffic has decreased slightly since 2002. In 2009, the average daily traffic (ADT) of both directions of travel on both highway bridges was over 95,000, with a summer ADT of over 127,000. Of the two bridges, the Sagamore Bridge is more heavily traveled. The difference in average year-round bridge traffic volumes in 2009 is 5,000, as compared to the year 2000 when there were approximately 12,000 more vehicles crossing the Sagamore Bridge than the Bourne Bridge.

Comparing annual volumes to summer volumes, it is clear that the difference between the two has remained similar over the last decade (see following figure). Therefore, any traffic growth must be a result of year-round traffic, and not seasonal traffic. When compared to thirty years prior, bridge traffic volumes show significant change (see following figure). Eight months of the year now exceed the peak volumes from 1975. Moreover, the peak volumes from 1975 are now similar to current off-peak volumes.

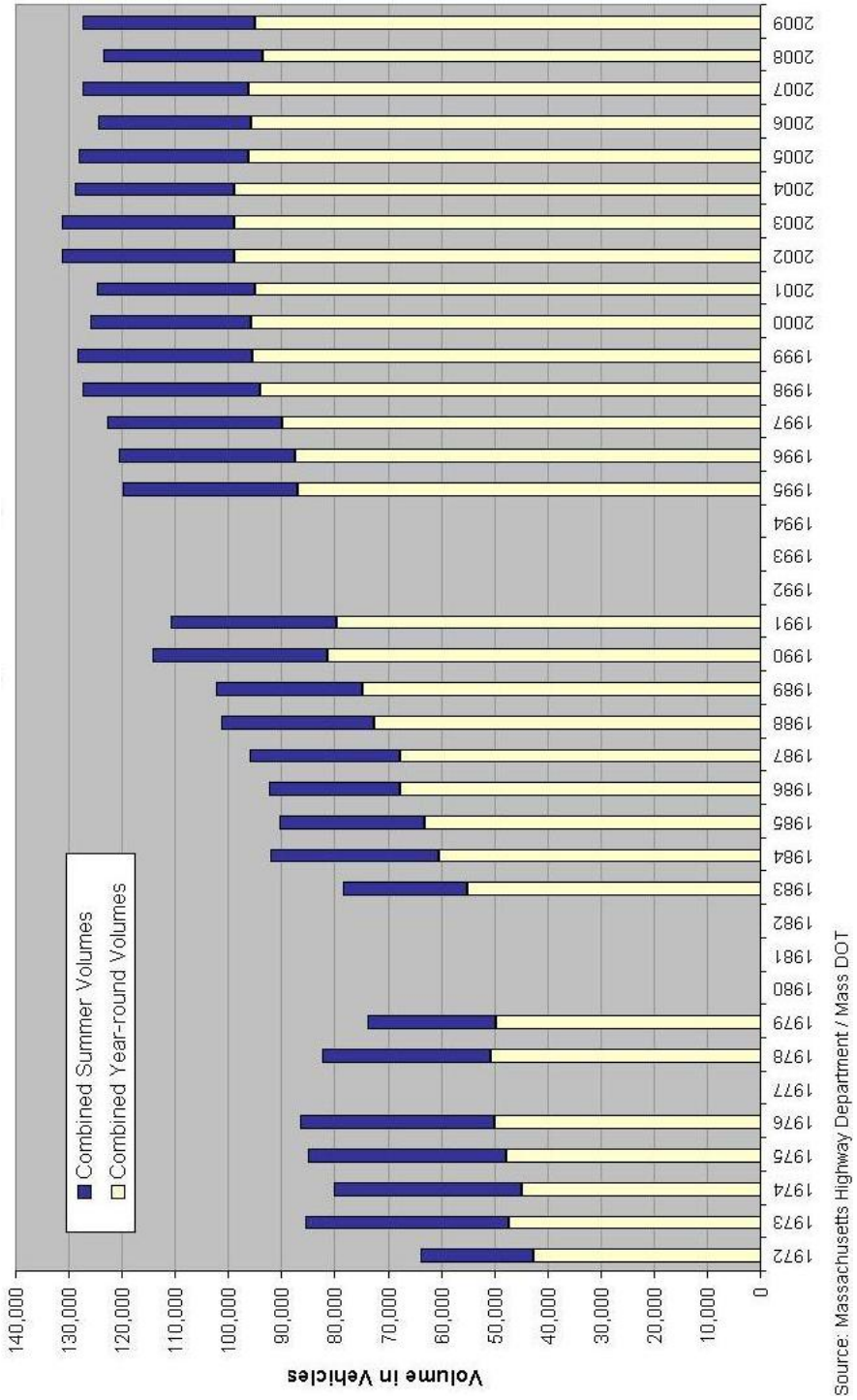

FIGURE 5 - COMBINED AVERAGE DAILY TRAFFIC OVER BOURNE AND SAGAMORE BRIDGES
(Source: MassDOT)

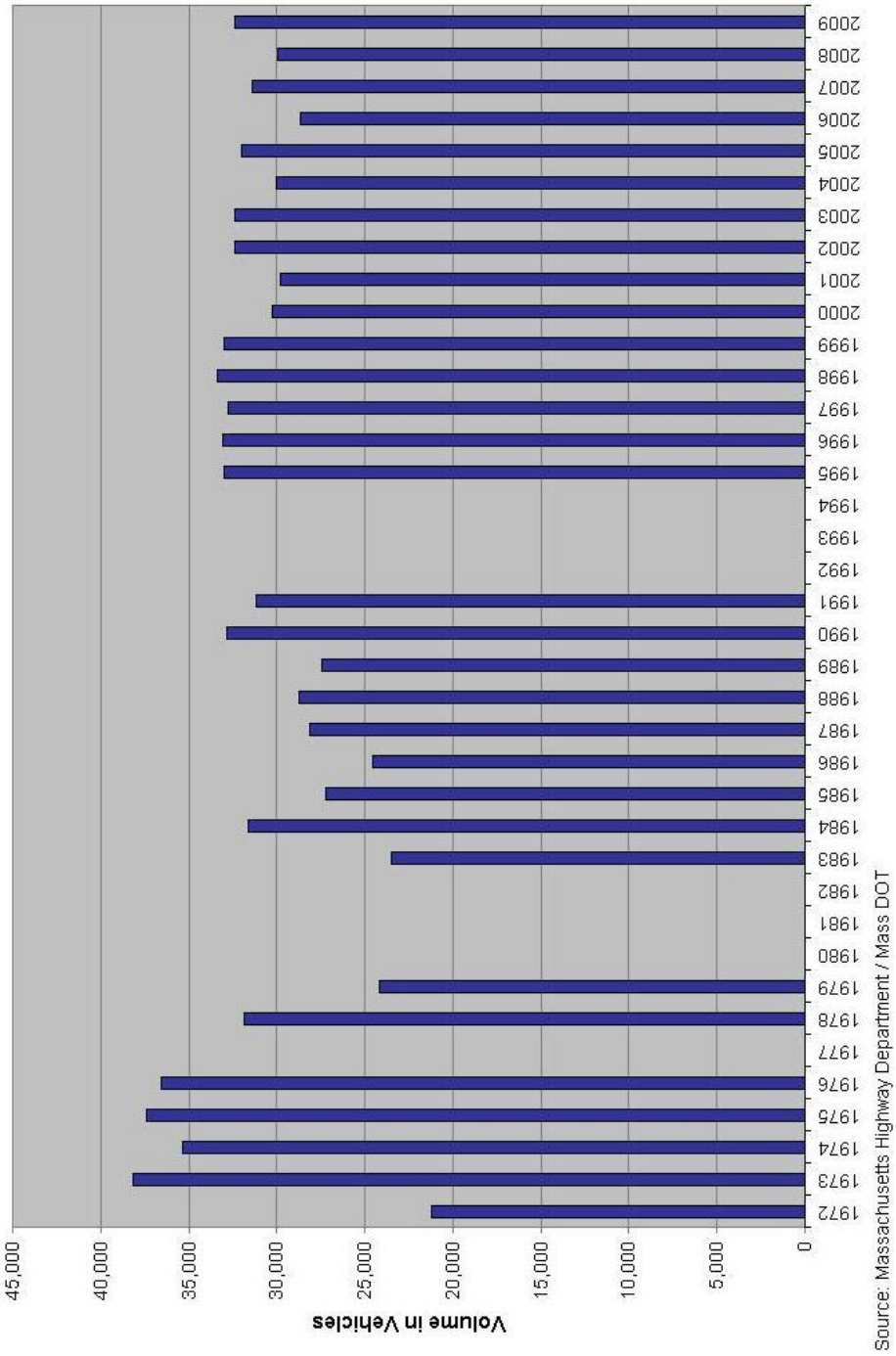

FIGURE 6 - DIFFERENCE BETWEEN SUMMER AND ANNUAL AVERAGE DAILY TRAFFIC OVER BOTH THE BOURNE AND SAGAMORE BRIDGES
(Source: MassDOT)

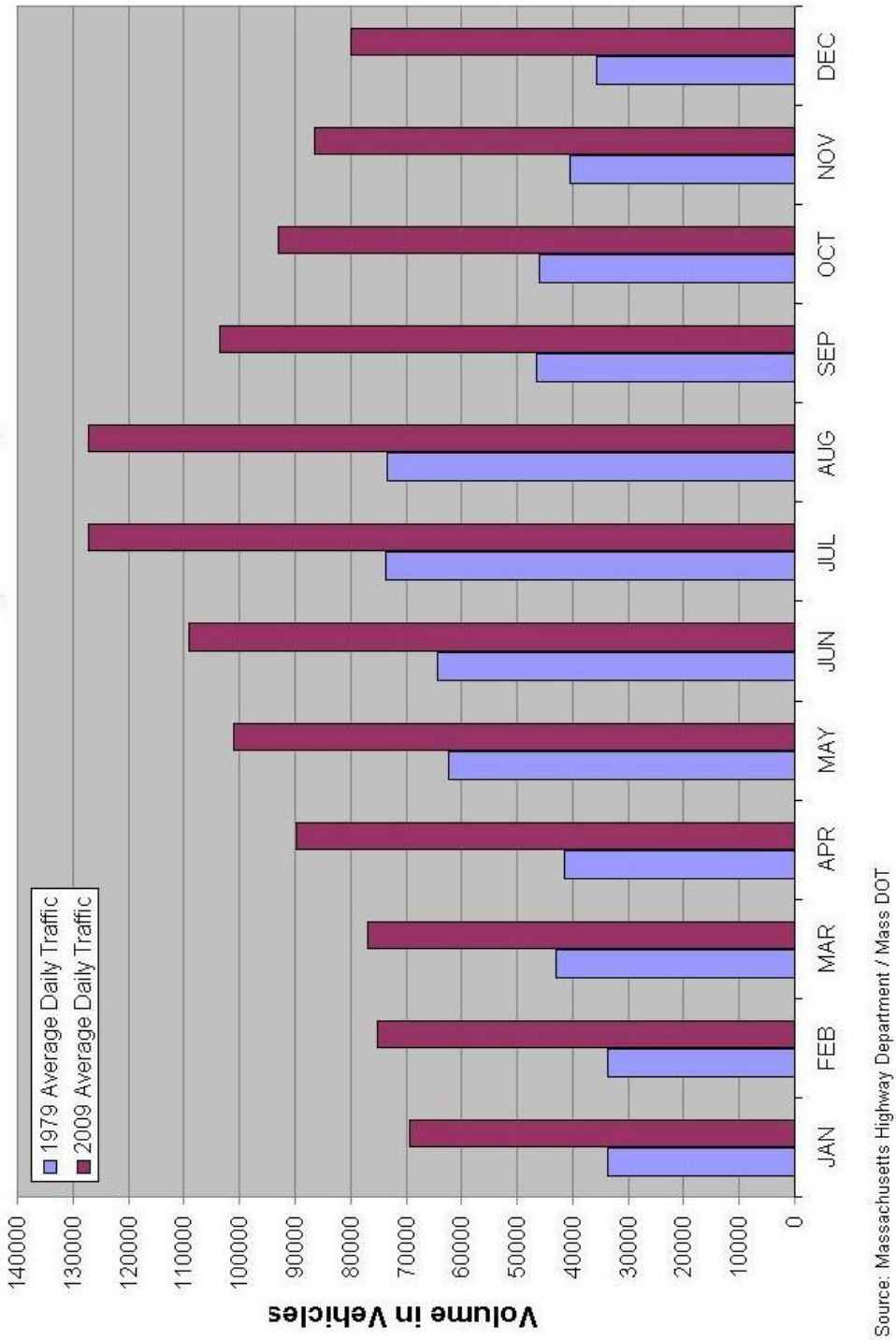

FIGURE 7 - THIRTY-YEAR COMPARISON OF COMBINED AVERAGE DAILY TRAFFIC OVER THE BOURNE AND SAGAMORE BRIDGES

TABLE 1 - CAPE COD CANAL BRIDGES TRAFFIC VOLUMES 1971-2009
(Source: MassDOT)

	#707 Bourne Bridge		#708 Sagamore Br.		Combined (both bridges)	
	Yr.Round/Summer		Yr.Round/Summer		Yr.Round/Summer	
2009	44,839	58,031	50,052	69,256	94,890	127,287
2008	42,396	55,492	51,019	67,854	93,415	123,346
2007	43,506	57,042	52,559	70,407	96,065	127,449
2006	43,909	57,411	51,916	67,020	95,824	124,431
2005	43,873	58,858	52,282	69,279	96,155	128,137
2004	44,688	59,615	54,143	69,274	98,832	128,889
2003	44,635	60,430	54,114	70,716	98,749	131,146
2002	43,981	60,059	54,905	71,207	98,886	131,266
2001	40,561	54,639	54,309	70,025	94,869	124,664
2000	41,805	56,892	53,832	68,997	95,637	125,889
1999	43,013	59,595	52,434	68,833	95,447	128,428
1998	42,427	58,063	51,490	69,195	93,918	127,258
1997	40,216	56,204	49,716	66,513	89,932	122,717
1996	39,304	54,195	48,071	66,277	87,375	120,472
1995	38,885	52,503	47,994	67,385	86,879	119,888
1994	36,406	52,078				
1993	35,413	49,753				
1992	34,899	49,120				
1991	33,926	48,194	45,667	62,564	79,593	110,758
1990	34,818	49,010	46,571	65,240	81,388	114,250
1989	33,936	49,137	40,814	53,024	74,751	102,161
1988	32,735	46,709	39,822	54,556	72,557	101,265
1987	29,675	39,300	38,078	56,575	67,753	95,875
1986	26,858	35,035	40,870	57,224	67,728	92,259
1985	26,136	36,800	36,877	53,441	63,014	90,241
1984	26,179	41,571	34,244	50,441	60,423	92,012
1983	23,276	29,685	31,695	48,788	54,971	78,473
1982						
1981	15,223	25,427				
1980						
1979	19,480	29,930	30,090	43,792	49,570	73,722
1978	22,256	31,823	28,310	50,557	50,566	82,380
1977	23,113	41,307				
1976	23,173	41,130	26,693	45,260	49,866	86,390
1975	23,484	41,900	24,140	43,095	47,623	84,995
1974	20,971	41,087	23,728	38,979	44,699	80,066
1973	21,635	40,682	25,691	44,824	47,327	85,506
1972	19,479	30,964	23,034	32,742	42,513	63,706
1971	19,280		22,050		41,330	

2.7.5 CAPE COD CANAL HIGHWAY BRIDGE MAINTENANCE

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. Please see the introduction for a discussion on the bridges regarding long-range planning issues.

Estimates for delay at the Sagamore and Bourne Bridges

This section is intended to help identify critical "windows of opportunity" for scheduling maintenance activities that require lane closures. Daytime during the July 4th holiday weekend would be a bad time for such activity, whereas midnight in February would have minimal impact. This analysis should help identify other time periods that may also be acceptable.

Bridge volumes observed during recent work on the Sagamore and Bourne Bridges were compared to volumes observed in April and October 1999. Volumes observed on the Sagamore and Bourne Bridges during recent closures led to an identification of the one-lane capacity of the bridges. A review of the hourly MassDOT traffic counts during the lane closures indicates that a sustained flow of about 1,250 vehicles per hour can cross the bridge in each direction. It is logical that some vehicles in the theoretical backup would divert to the other bridge (for analysis purposes, assume 20%) and some trips observed in 1999 would not be made (again, for analysis, assume 10%).

In calculating the backups and delays, the cumulative number of cars that could not be accommodated was divided by the bridge capacity to get the maximum theoretical delay for an average weekday (this is the amount of time required for the peak demand to dissipate). The results are shown in the following table:

TABLE 2 - THEORETICAL DAILY VEHICULAR DELAYS DURING BRIDGE LANE CLOSURES

		April	October
Sagamore Bridge	Northbound	1.7 hours	4.4 hours
	Southbound	2.4 hours	2.3 hours
Bourne Bridge	Northbound	0.3 hours	0.4 hours
	Southbound	0.3 hours	1.8 hours

Impacts to traffic will be most severe in the Fall during maintenance on the Sagamore Bridge. Encouraging the use of the alternate bridge would be an important element of any mitigation strategy. Impacts to the areas on bypass routes, (e.g., diversion from Route 6 westbound at Exit 2 through Sandwich), will be significant and some planning to minimize these impacts must also be done.

Strategies related to Bridge Maintenance

Several strategies are suggested for addressing the impacts of maintenance-related lane closures. In all cases, adequate public notification is recommended. In 2009, the Army Corps of Engineers established a website and email notification system for major maintenance efforts on the bridges. The Cape Cod Commission is committed to providing access to updates through the internet traveler information system (www.gocapecod.org). 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. The ACOE seems to now include this aspect in consideration of the estimated maintenance schedule, and that has provided for improved public expectations.

• *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 staff has included announcements of upcoming maintenance activities and links to transportation providers on the Cape Cod Commission Transportation Information Center (www.gocapecod.org). Included is a link to the ACOE website to provide travelers with the latest information on lane closures. Working together, the MassDOT and Cape Cod Commission (CCC) staff outlined ITS improvements for the Cape Cod Canal bridge area. MassDOT then hired a consultant to design ITS improvements, and the project was bid for construction in September 2010.

• *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.

2.7.6 CANAL AREA TRAFFIC MOVEMENTS

Using the Cape Cod Transportation Demand Model, an analysis of cross-canal traffic patterns can be made. Cape Cod was separated into four quadrants, based on the location's primary approach to the Canal. For example, Route 6 is the primary point of access to the Canal of people from Hyannis and easterly points in the region. The primary point of access to the canal for people in Boston is Route 3. Using the model, the levels of traffic between the 4 quadrants can be determined. These traffic flows are illustrated in the following figure.

This analysis does not give specific traffic volumes over the bridges or supporting roadways. What it shows is that 56,000 vehicles per day have a choice of what bridge to take. Therefore, if traffic needed to be diverted to avoid congestion, 56,000 vehicles could be potentially diverted based on a modeled average summer day.

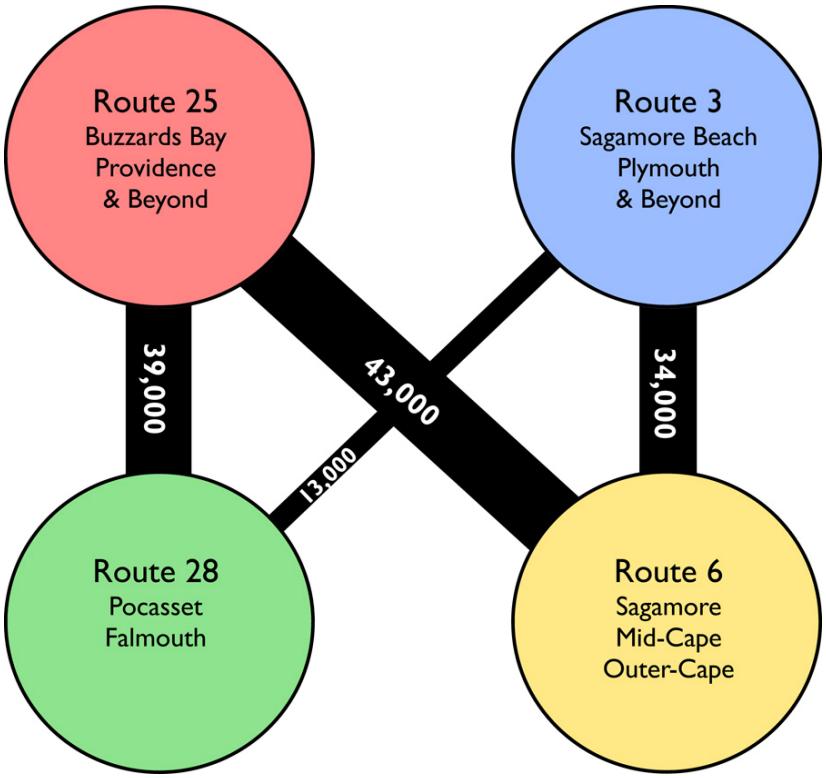

FIGURE 8 - CROSS-CANAL TRAFFIC, ESTIMATED 2004 SUMMER ADT

2.7.7 SUPPORTING ROAD NETWORK

In addition to the two highway bridges, there are several roadways that support movement over the Canal. These include the Scenic Highway, Sandwich Road, Belmont Circle, and the Sagamore Interchange. The Sagamore Interchange replaced the Sagamore Rotary and area connections, beginning with the project advertising in 2004. The before-and-after diagrams are shown in the figures below.

FIGURE 9 - SAGAMORE CROSSING
(note: Sagamore Rotary has been eliminated – see following figure)

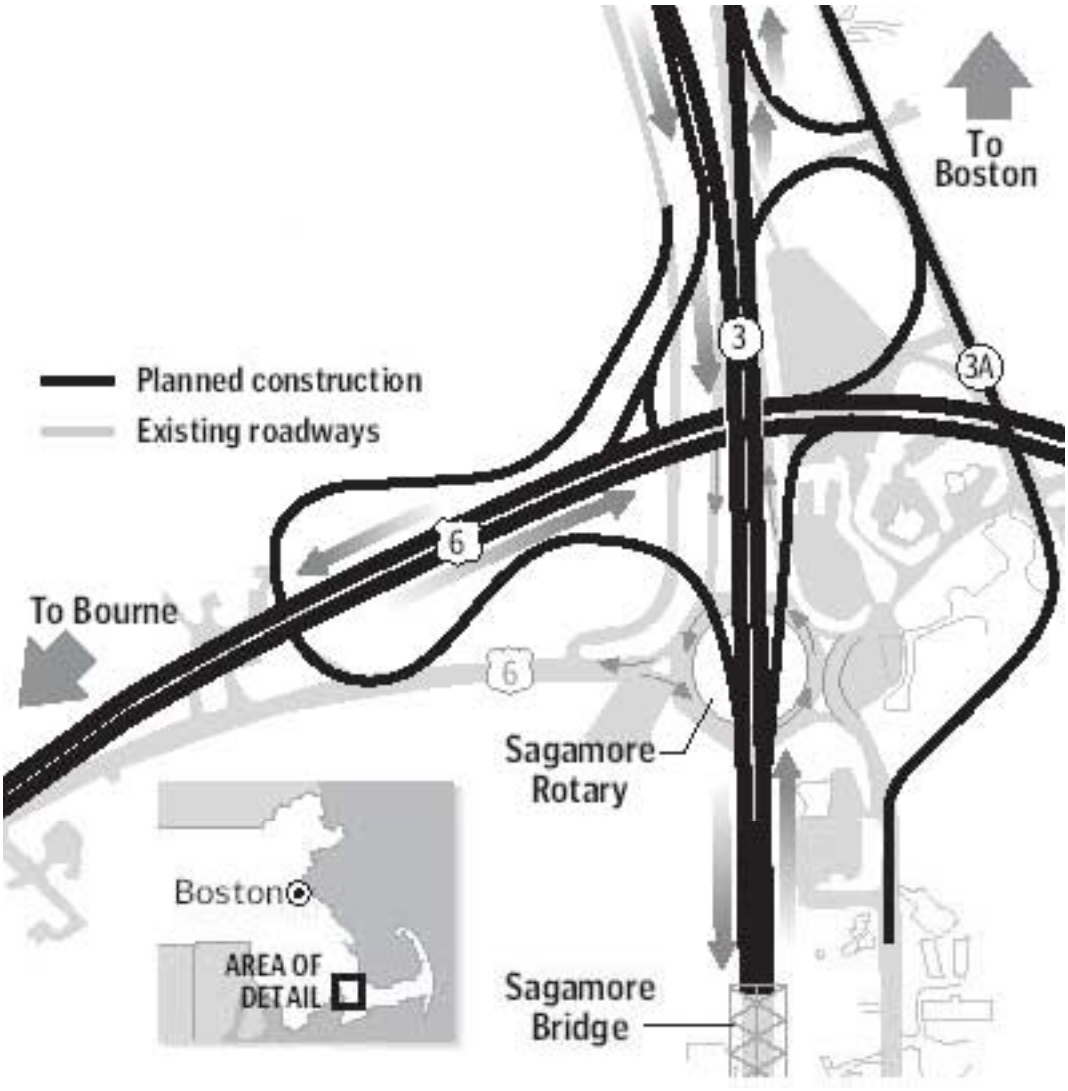

FIGURE 10 - SAGAMORE INTERCHANGE DIAGRAM

FIGURE 11 - BOURNE CROSSING

2.7.7.1 Scenic Highway

Scenic Highway (U.S. Route 6) stretches approximately 3 miles from the Belmont Circle to the Sagamore Interchange on the mainland side of the Cape Cod Canal. The roadway is generally undivided four lanes, two in either direction, with a posted speed limit of 50 MPH. As sections of this roadway have been improved, there have been median installations. The improvements at the Sagamore Interchange have extended a raised median from the traffic signal at Bournedale Road to the Route 3 interchange near the Sagamore Bridge. Another section of raised median is included with the new traffic signal at Edgehill Road.

In addition to being an important connection between the Bourne and Sagamore Bridges, The Scenic Highway also provides access to Buzzards Bay, Bournedale and Sagamore. Most of the land along Scenic Highway is undeveloped but there are several local businesses, a shopping plaza and a camping area along the roadway.

FIGURE 12 - SCENIC HIGHWAY (U.S. ROUTE 6), FACING EAST

FIGURE 13 - SCENIC HIGHWAY, FACING EAST

FIGURE 14 - SCENIC HIGHWAY AT THE BOURNEDALE ROAD INTERSECTION

2.7.7.2 Sandwich Road

Sandwich Road connects the Bourne and Sagamore Bridge on the Cape Cod side of the canal. The roadway stretches approximately three miles from the Bourne Rotary to Interchange 1 of Route 6. The roadway has two undivided lanes, one in either direction, and a posted speed limit of 45 MPH. Sandwich Road also provides access to Route 28, Route 6A and Sagamore Village. The Upper Cape Cod Regional Technical School, John Gallo Ice Arena, several residences, and a recreation area are located on Sandwich Road.

FIGURE 15 - SANDWICH ROAD FACING EAST

2.7.7.3 Belmont Circle

The Belmont Circle is a rotary named after August Belmont who was the developer of the original Cape Cod Canal. The circle is located at the intersection of Route 25 Interchange 2, Scenic Highway (U.S. 6), Buzzards Bay Bypass (U.S. 6), Head of the Bay Road, and Main Street (Route 28) in Buzzards Bay. The rotary is shaped roughly like a trapezoid about 1,990 feet in circumference. The longest side (from Main Street to Scenic Highway) is approximately 650 feet long; the shortest side (from the Route 6 Bypass to Main Street) is approximately 265 feet long. It was configured during the creation of the Route 25 extension to the Bourne Bridge in 1987. The roadway has three lanes, traveling counter-clockwise, and a posted speed limit of 45 MPH. Rotary traffic has the right-of-way. Several businesses also have access points within the rotary.

FIGURE 16 - THE BELMONT CIRCLE, FACING EAST TOWARDS THE SCENIC HIGHWAY

FIGURE 17 - SIGNS DIRECTING MOTORISTS THROUGH THE BELMONT CIRCLE

2.7.7.4 Sagamore Interchange (formerly Sagamore Rotary)

The Sagamore Interchange is located at the base of the Sagamore Bridge on the mainland side. It is located at the intersection of Route 3 Interchange 1, Scenic Highway, Route 6 and Route 3A. The intersection was previously the Sagamore Rotary. On September 10, 2006, the rotary was officially removed, and replaced by an interchange. The interchange includes a series of ramps for direct service to Route 3. Route 6 Scenic Highway passes beneath newly constructed Route 3 bridges. The project includes signalization at three intersections and will include a replacement Park-and-Ride lot adjacent to the interchange.

FIGURE 18 - THE FORMER SAGAMORE ROTARY AND CONGESTION

FIGURE 19 - ROUTE 3 CONGESTION AT THE FORMER SAGAMORE ROTARY, FROM SCENIC HIGHWAY

FIGURE 20 - THE SAGAMORE INTERCHANGE OVERPASS, DURING CONSTRUCTION

2.7.7.5 Route 6 Interchange 1

Route 6 Interchange 1 is located at the base of the Sagamore Bridge on the Cape side. It allows access to Route 6 from Route 6A and Sandwich Village. Westbound access ramps have direct access from Route 6A. The westbound on-ramp is within close proximity to the upgrade of the Sagamore Bridge and is a source of significant queuing during heavy off-Cape traffic. Service to and from Route 6 eastbound is via the "Mid-Cape Connector" road from Sandwich Road. The Mid-Cape Connector is a two-way ramp system that includes local unsignalized intersection access to a factory outlet center and the U.S. military's PAVE PAWS radar installation.

FIGURE 21 - THE MID-CAPE CONNECTOR (INTERCHANGE 1) NORTH OF THE OUTLET STORE ENTRANCE

2.7.7.6 Bourne Rotary

The Bourne Rotary connects Route 28 and Cape Cod to the Bourne Bridge. It is located at the intersection of Route 28 (MacArthur Boulevard), Trowbridge Road, Sandwich Road, and the Bourne Bridge. The rotary is approximately 400 feet in diameter, and approximately 1,250 feet in circumference. The roadway has two unmarked lanes, traveling counter clockwise, and a posted speed limit of 25 MPH. Rotary traffic has the right of way.

2.7.8 RAILROAD BRIDGE

The third bridge over the Cape Cod Canal is also an United States Army Corps of Engineers (ACOE) owned bridge, and is the vertical lift railroad bridge.

This bridge was substantially upgraded in 2001-2003 through a two-phase effort that was coordinated by the Army Corps of Engineers with the Commonwealth of Massachusetts Executive Office of Transportation (EOT), and cost approximately $27,000,000. Please note that EOT is now the Massachusetts Department of Transportation (MassDOT).

Rail information is contained in sub-chapter 2.4 of this Plan.

2.7.9 CONCLUSION

The Cape Cod Canal area highway system provides transportation infrastructure for thousands of motorists and many truckers each day. The heavily-traveled and aging highway bridges are becoming a continuing source of concern due to their narrow lanes and frequent need for maintenance. Historic traffic growth now results in increases throughout the year, resulting in off-season traffic of current years exceeding that of peak summer conditions of a couple of decades ago. The railroad bridge serves an important function in the transport of regional solid waste, and may have opportunities for other uses such as passenger rail.

Because of the close relationship of the two highway bridges in the center of the Town of Bourne with the connecting roadways for both local and intraregional traffic, the Canal Area needs to be studied as a sub-system both in the region and connecting Cape Cod with the rest of the world. This sub-system data collection and analysis approach will allow for proposed transportation and access improvements to be analyzed in relation to each other and overall, and will provide the most coherent effort to date. This is a critical planning need and area for the region.