



massDOT
Massachusetts Department of Transportation





DRAFT FOR REVIEW - SUMMER 2019

CAPE COD CANAL
TRANSPORTATION STUDY



Prepared by:
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Future No-Build Transportation Conditions

3.1 INTRODUCTION

This chapter analyzes future (2040) no-build traffic conditions in the study area. Highway system improvements are typically designed to satisfy traffic demands forecast for 25 years in the future. As the traffic analysis for this study began in 2015, the year 2040 was selected as the design year. This analysis assumes that no substantial transportation improvements will be made in the study area between now and 2040, such as the construction of additional travel lanes, as well as new or reconstructed interchanges, intersections, or multimodal facilities. This 'no-build' alternative serves as the baseline for the comparison of future transportation improvements.

This transportation analysis includes:

- Average daily and peak-period traffic volumes to provide a better understanding of the locations that experience the most vehicular activity. Traffic volumes are provided for different times of day, on both weekends and weekdays, and during the summer and non-summer periods.

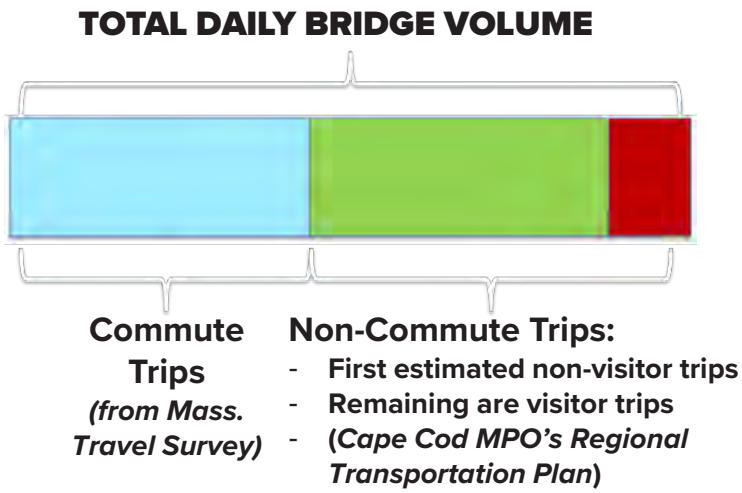
- Turning movement counts to quantify the movement of vehicles traveling through intersections.
- Measurements of efficiency (levels of service), including an analysis of traffic operations for a range factors, as described in Section 2.5.5.
- Detailed analysis of traffic operations of the Bourne Rotary and Belmont Circle.

3.2 FACTORS AFFECTING FUTURE TRANSPORTATION CONDITIONS

Projecting future travel demand requires an understanding of the socio-economic factors that lead to changes in traffic volumes. The primary contributors to traffic volumes in most locations are the daily commuting trips to work and school combined with non-commuting trips related to daily shopping, recreation, and other local destinations. As a major tourist destination, visitor travel to Cape Cod can contribute approximately 35% more vehicles on the Canal bridges during the summer compared to the non-summer. Therefore, as demonstrated in Exhibit 3-1, overall traffic volumes have two main components, daily local (commuting/non-commuting) trips and visitor trips.

The forecast 2040 commuter/non-commuter trips used for this study are based on socio-economic data provided by the Central Transportation Planning Staff (CTPS)[1] of the Boston Metropolitan Planning Organization (MPO). This socio-economic data is based

Exhibit 3-1 ***Visitors as a Percent of Traffic on Cape Cod Canal Bridges CTPS Method***



1 Destination 2040, Long-Range Transportation Plan, Boston MPO, Central Transportation Planning Staff

on forecast changes in population, employment, and housing. Known future developments, which would increase population and employment, are also included in this forecast. Increases (or decreases) in population and employment lead directly to similar changes in traffic volumes as more (or less) people are commuting to work or school or other daily trips.

The socio-economic data indicated only modest changes in the forecast population and employment levels in Barnstable County. The population of Barnstable County decreased by 2.8% between 2000 and 2010 but is forecast to increase very modestly (less than 1.0%) in this decade. Total employment in Barnstable County is also not projected to substantially increase in the coming decade.

Unlike commuter and non-commuter trips, there is no direct method to count visitor trips to Cape Cod. To estimate the changes in the volume in visitor trips, a non-direct method was used based on an economic analysis of trends in the hotel and restaurant industry as well as other factors. Based on this economic analysis, annual visitor trips to Cape Cod were forecast to increase within a range of 0.26% to 0.69% annually. To provide a conservative estimate, the higher 0.69% annual growth in visitors was used to forecast the growth in traffic volumes attributable to visitors. Based on multiple coordination sessions with the Cape Cod Commission, it was agreed that this was a reasonable forecast of visitor growth.

Overall, the combined forecast increase for all trips results in a 0.11% annual increase in vehicle trips during the non-summer weekday period and a 0.50% annual increase during the summer weekend (Friday - Sunday) period. This would result in an overall growth in traffic volumes of 30% in the summer period and 26% in the non-summer period between 2014 and 2040. These growth factors were applied to the existing (2014) traffic volumes to calculate future (2040) traffic volumes. A travel demand model (described below) was used to evaluate future no-build and build conditions.

By 2040, traffic volumes in the study area are forecast to increase 30% in the summer period and 26% in the non-summer period.

3.3 TRANSPORTATION

3.3.1 Regional Travel Demand Modeling

Future (2040) no-build traffic conditions in the study area were forecast using a regional travel demand model. To develop a transportation model of the study area, the Cape Cod Commission's (CCC) regional traffic model and portions of the CTPS regional traffic model were obtained. The network links for highways and transit, as well the existing traffic analysis zone

(TAZ) geographies, were reviewed and the model was updated as necessary within the study area. As described in Chapter 4, the travel demand model was also used to test the effectiveness of proposed transportation improvements.

A crucial step in the process of creating a regional travel-demand model is calibrating the model to replicate travel times on key routes crossing the Canal and existing traffic volumes on study area highways. The model-calibration not only replicates existing traffic counts but also attempts to match travel time data collected during the peak season by the BlueTOAD™ units (as described in Section 2.5.4.)

The model-calibration process gives the model the ability to assign traffic to specific routes through the study area during a wide variety of time ranges during summer and non summer periods. The model was calibrated to within 5% of the existing total two-way volumes on the two bridge crossings, in accordance with Federal Highway Administration (FHWA) and MassDOT guidelines.

3.3.2 Planned Transportation Improvements

To further refine the analysis of study area's transportation system, known planned transportation improvements were identified. The following projects within the study area are anticipated to be constructed as they are listed on the Cape Cod Commission's 2017 – 2021 Transportation Improvement Program (TIP).

- Sandwich (MassDOT Project No. 608422) Service Road Shared-Use Bike Path from Route 130 to Chase Road
- Bourne (MassDOT Project No. 606900) Belmont Circle Multimodal Improvements
- Wareham (MassDOT Project No. 608554) Resurfacing on Route 6 & 28 Bypass Road

3.3.3 Cape Cod Commission Regional Transportation Plan

The Cape Cod Commission serves as the Metropolitan Planning Organization (MPO) for Barnstable County. The MPO's Regional Transportation Plan (2016 – 2040) was reviewed to gain an understanding of the regional future priorities for all modes of transportation on Cape Cod. The following projects within the study area are listed in the MPO's long range plan.

Highway/Roadway Improvements:

- Belmont Circle to Route 25 Westbound Ramp
- Route 6 Exit 1C Reconfiguration
- Buzzards Bay Commuter Rail Infrastructure

Multimodal Improvements:

- Cape Cod Rail Trail Extension: Barnstable to Cape Cod Canal
- Shining Sea Bike Path Extension to Cape Cod Canal

The AM weekday peak period is 7:00 - 9:00AM; the PM weekday peak period is 4:00 - 6:00PM; and the Saturday peak period is 10:00AM - 12:00PM.

3.3.4 Future (2040) No-Build Average Daily Traffic Volumes and Peak-Period Traffic Volumes

This section presents the future (2040) no-build average daily traffic (ADT) volumes and the peak hour traffic volumes in the study area. Table 3-1 provides future ADT and peak-hour traffic volumes for the AM, PM, and Saturday periods for both summer and non-summer traffic. Exhibits 3-2 and 3-3 present future

Table 3-1 Future (2040) No-Build Average Daily Traffic and Peak Hour Traffic Volumes

ATR COUNTING STATIONS	FUTURE (2040) NO-BUILD SUMMER				FUTURE (2040) NO-BUILD NON-SUMMER			
	AM	PM	SAT	ADJUSTED ADT[1]	AM	PM	SAT	ADJUSTED ADT[1]
Bourne Bridge	4,215	5,945	4,930	61,600	3,780	4,045	4,480	45,200
Sagamore Bridge	6,305	7,635	8,175	93,300	4,870	5,660	5,470	59,600
Route 3 between Exits 1A and 2	4,895	6,430	5,530	72,400	3,910	4,890	4,840	51,800
Route 6 between Exits 1 and 2	6,115	7,705	7,565	90,600	4,665	5,370	5,535	51,800
Route 25 West of Exit 2	5,735	8,455	7,845	78,900	4,580	5,340	5,900	56,800
Route 25 East of Exit 2	4,595	6,940	5,240	26,200	3,940	3,960	4,235	19,700
Route 6 (Scenic Hwy) East of Nightingale Rd	2,895	3,695	2,810	36,200	2,435	2,735	2,590	25,400
Sandwich Rd East of Bourne Rotary Connector	2,435	2,935	2,400	33,400	2,105	2,185	2,680	28,100
Adams St South of Sandwich Rd	400	350	275	11,800	345	380	420	13,900
Buzzards Bay Bypass	570	760	810	8,800	505	845	830	6,000
Main St West of Perry Ave	2,065	2,395	2,680	28,500	1,080	1,375	1,155	11,600
Trowbridge Rd West of Veterans Way	885	1,465	895	12,000	890	1,035	1,175	9,900
Route 28 South of Bourne Rotary	3,820	3,715	4,685	49,000	3,330	2,580	3,685	40,100
Route 130 North of Route 6	845	980	1,170	12,500	610	770	1,875	13,200
Route 6 between Exit 2 and 3	5,005	6,150	6,645	67,000	4,520	4,115	5,205	56,000
Mid-Cape Connector South of Sandwich Rd	1,380	1,855	1,800	28,500	1,380	1,600	1,825	18,100
Route 6 East of Exit 3	4,995	6,395	7,330	70,900	3,905	4,405	5,375	53,400
State Rd North of Ramp to Route 3 NB	450	710	785	8,200	445	610	745	6,200
Route 6A East of Cranberry Hwy	765	1,500	1,760	15,100	655	790	1,240	8,300
Route 3 between Exits 2 and 3	4,895	6,435	5,525	60,000	3,905	4,885	4,835	50,300
Route 28 South of Exit 2 (Route 151)	1,100	2,070	1,115	12,800	1,440	1,650	1,465	16,800

[1] *Average Daily Traffic (ADT)*

Table 3-1 continues on the next page.

Table 3-1 Future (2040) No-Build Average Daily Traffic and Peak Hour Traffic Volumes

ATR COUNTING STATIONS	FUTURE (2040) NO-BUILD SUMMER				FUTURE (2040) NO-BUILD NON-SUMMER			
	AM	PM	SAT	ADJUSTED ADT[1]	AM	PM	SAT	ADJUSTED ADT[1]
Route 3 NB Off Ramp to Herring Pond Rd	230	425	225	3,100	190	335	310	2,500
Route 3 SB Off Ramp to Herring Pond Rd	385	645	945	7,900	465	605	925	3,400
Route 3 SB Off Ramp to Scenic Highway	375	730	430	5,000	535	685	700	6,200
Route 6 EB Off Ramp to Mid-Cape Connector	710	815	800	8,600	655	730	515	5,900
Route 6 EB Off Ramp to Quaker Meeting House Rd	415	295	275	1,700	170	230	225	2,100
Route 6 EB Off Ramp to Route 130	695	995	735	15,700	685	935	670	7,200
Route 6 WB Off Ramp to Cranberry Hwy	410	660	220	3,800	405	510	535	2,400
Route 6 WB Off Ramp to Meetinghouse Lane EB	340	510	340	4,500	275	375	340	3,500
Route 6 WB Off Ramp to Quaker Meetinghouse Rd	125	345	655	2,300	240	400	265	2,500
Route 6 WB Off Ramp to Route 130	175	215	225	2,000	195	245	810	4,200
Route 6 WB Off Ramp to Scenic Hwy WB	830	990	1,350	13,400	720	765	615	6,800
Route 25 EB Off Ramp to Belmont Circle	665	1,280	1,025	11,200	590	835	565	5,500
Route 25 EB Off Ramp to Maple Springs Rd	695	1,055	1,745	14,800	510	770	920	8,000
Route 28 NB Off Ramp to Route 151	25	285	80	600	105	230	130	1,500
Route 28 SB Off Ramp to Route 151	385	900	550	5,500	455	685	475	5,500
Route 130 On Ramp to Route 6 EB	165	135	145	1,800	185	160	155	1,400
Route 130 On Ramp to Route 6 WB	755	910	550	12,300	815	725	625	6,800
Route 130 South of Route 6	2,045	2,555	2,025	28,600	1,970	2,235	2,345	21,100
Route 151 On Ramp to Route 28 NB	535	660	385	5,500	620	540	620	6,500
Route 151 On Ramp to Route 28 SB	155	225	100	1,600	260	230	240	2,600
Belmont Circle On Ramp to Bourne Bridge	800	785	1,115	11,800	825	785	1,175	9,800
Belmont Circle On Ramp to Route 25 WB	1,110	1,335	940	12,200	925	1000	1,070	9,600
Bourne Bridge Off Ramp to Belmont Circle	595	835	540	7,100	530	730	705	6,700
Scenic Hwy EB On Ramp to Sagamore Bridge	705	815	955	11,100	670	590	485	5,200
Scenic Hwy WB On Ramp to Sagamore Bridge	305	310	740	6,700	295	255	345	3,500
Sandwich Rd West of Jillian Drive	2,255	2,840	2,395	34,600	2,055	2,225	2,610	29,800
Sandwich Rd East of Adams St	1,095	1,505	1,365	14,900	1,030	1,255	1,275	9,200
Cranberry Hwy On Ramp to Route 6 WB	685	790	1030	11,100	585	780	1,020	8,500
Mid Cape Connector On Ramp to Route 6 EB	795	1,015	1,000	12,500	630	710	1,065	9,400
Herring Pond Rd On Ramp to Route 3 NB	425	455	445	5,500	735	460	575	6,300
Herring Pond Rd On Ramp to Route 3 SB	495	615	720	7,800	385	605	330	7,200
Quaker Meeting House Rd On Ramp to 6 EB	410	345	410	4,400	490	260	305	3,500
Quaker Meeting House Rd On Ramp to Route 6 WB	130	150	85	1,100	200	145	175	1,600
Glen Charlie Rd On Ramp to Route 25 EB	155	255	195	2,000	360	150	95	1,400
Maple Springs Rd On Ramp to Route 25 WB	820	1,050	1,275	11,000	780	610	990	8,700

[1] *Average Daily Traffic (ADT)*

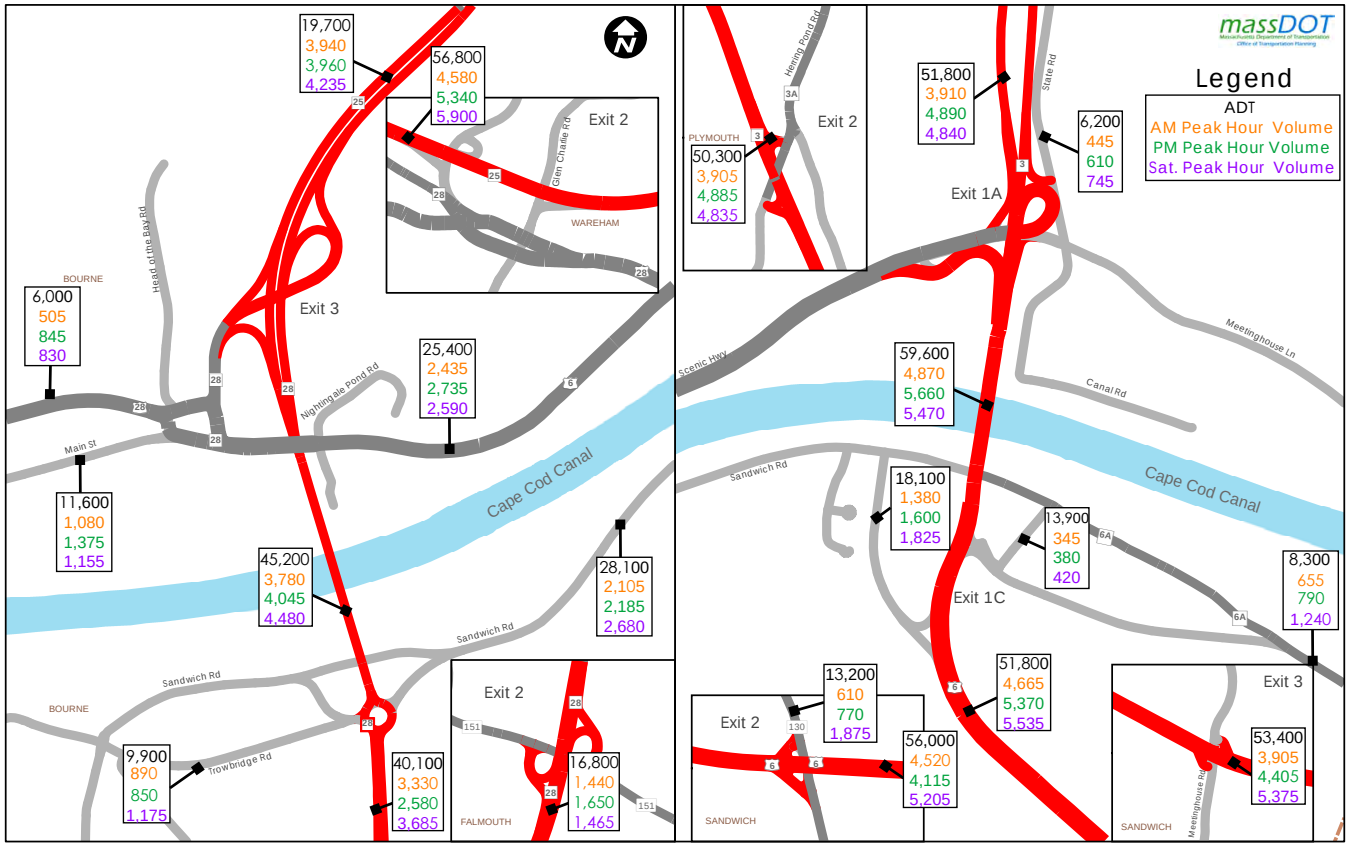
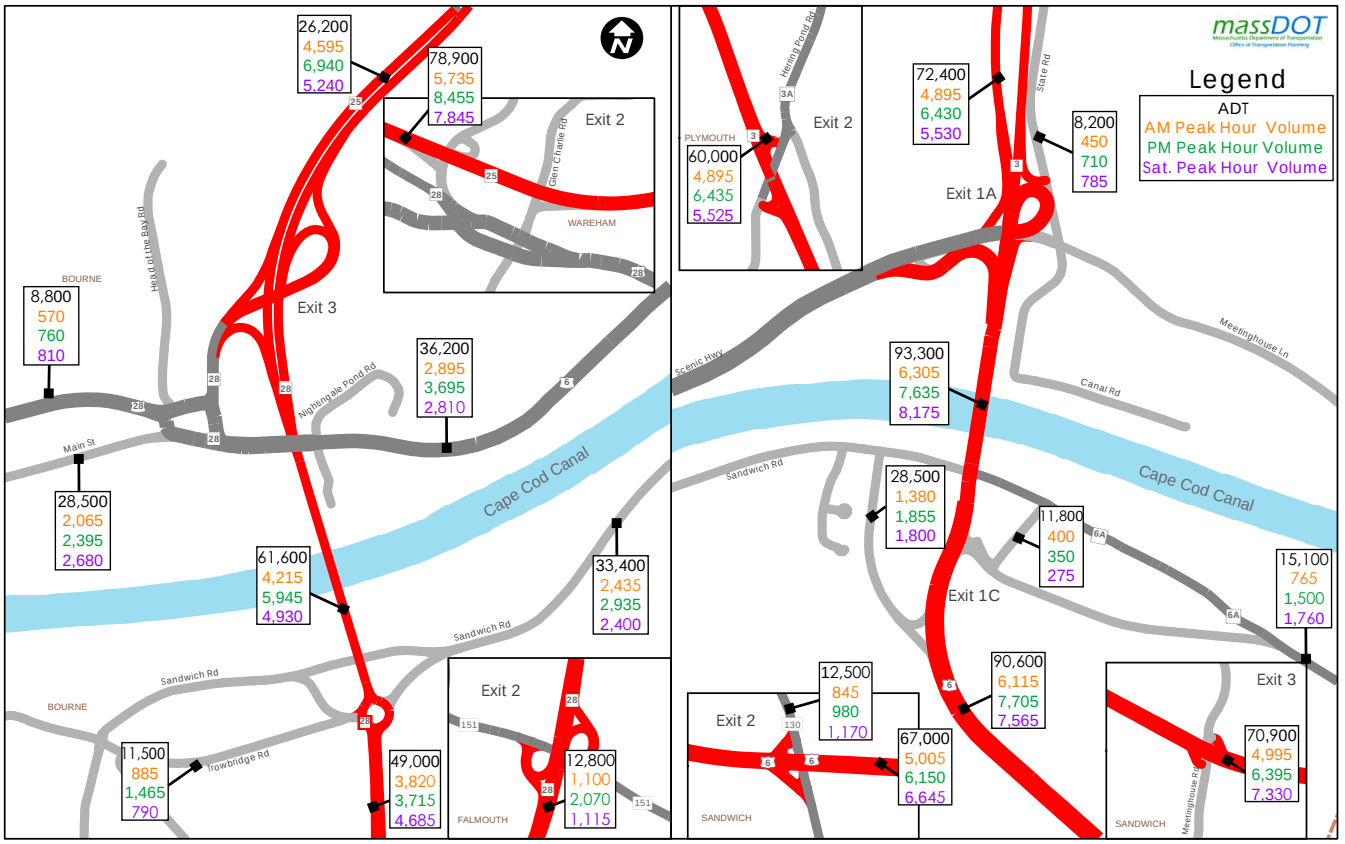


Exhibit 3-2 Future (2040) Non-Summer Average Daily and Peak Period Traffic Volumes (AM/PM/Saturday)

Exhibit 3-3 Future (2040) Summer Average Daily and Peak Period Traffic Volumes (AM/PM/Saturday)



summer and non-summer ADT and the AM, PM, and summer peak-hour traffic volumes at select locations in the study area. The ADT and peak-period traffic volumes for the existing condition are discussed in Chapter 2.5.6.

These exhibits show that, similar to the existing condition, the highest daily and peak-hour traffic volumes in the study area occur at the following locations:

- Major bridges (Sagamore and Bourne Bridges)
- Major highways (Routes 3, 6, 25, 28, and 130)
- Arterial roadways (Scenic Highway, Sandwich Road, and Main Street in Bourne).

Summary of Future ADT

As noted in Section 3.2, traffic volumes in the study area are forecast to increase approximately 30% in the summer period and 26% in the non-summer period between 2014 and 2040. This growth in traffic volumes will not be uniform throughout the study area; some locations will experience greater rates of growth than others.

Locations forecast to experience the greatest increase in traffic volumes include the Sagamore Bridge and other roadways in the immediate area of the bridge such as Route 3 (between Exits 1A & 2), Route 6 (between Exits 1 & 2), the Mid-Cape Connector, and State Road. Other areas of notable forecast traffic increases include Trowbridge Road, Route 28 (south of the Bourne Rotary), and Route 6 (between Exits 2 and 3). Table 3-2 also shows that traffic volumes are generally forecast to increase more in the non-summer period than in the summer period.

3.3.5 Turning Movement Counts

Turning movement counts (TMC) quantify the movement of vehicles traveling through intersections, including signalized intersections, stop-controlled intersections, and rotaries. The methodology for determining TMCs is provided in Section 2.5.3 and Exhibit 2-19 shows the location of the intersections for which TMCs are provided. Exhibits 3-4 through 3-9 display future (2040) TMCs for the AM, PM, and Saturday peak hours during the summer and non summer periods.

Turning Movement Counts are important to traffic analysis because they provide the data necessary to analyze delay and queuing at an intersection. These data allow a LOS to be assigned for that location. The future (2040) TMCs are used to assign a LOS at signalized and unsignalized intersections in the study area (as presented in Section 3.3.6).

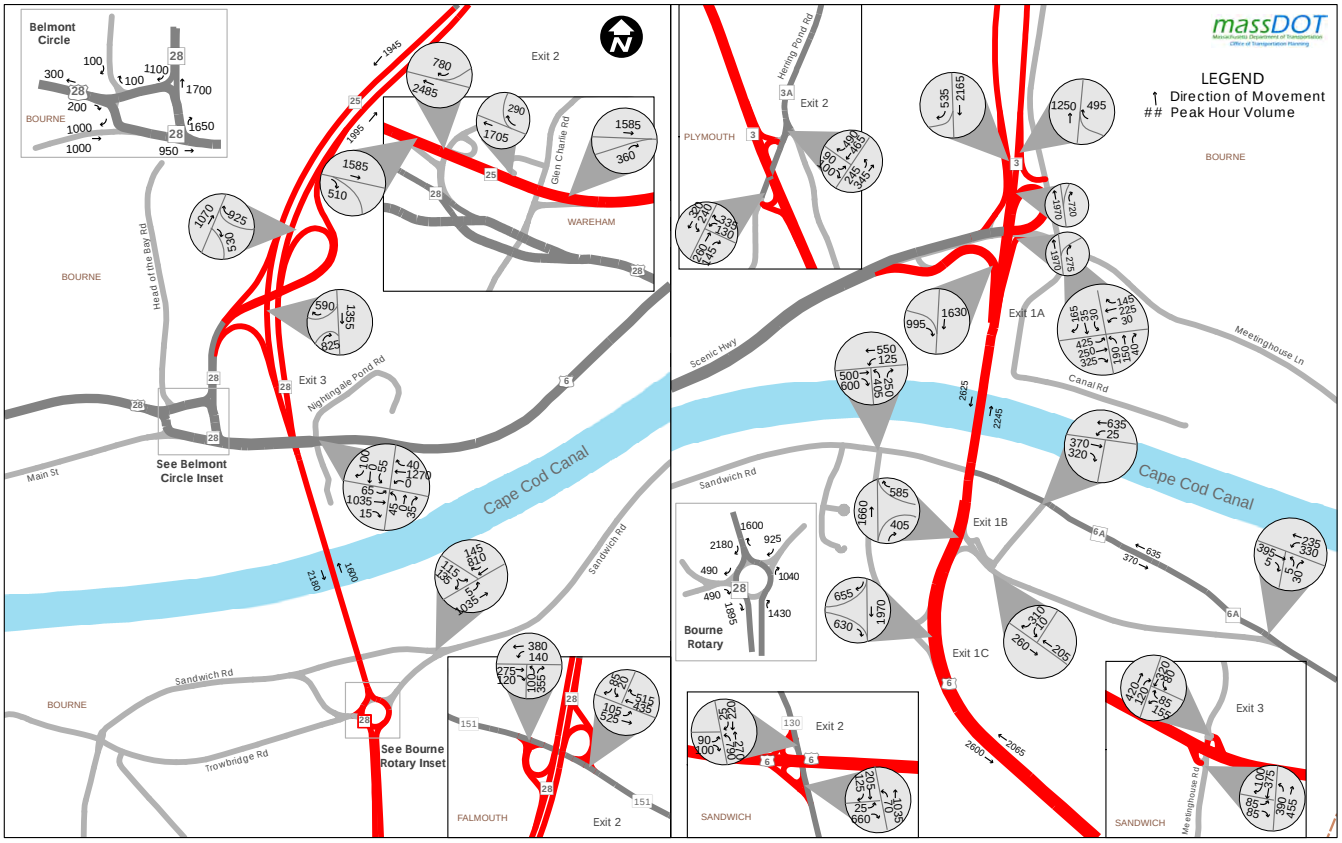
Text continues on page 3-12.

Table 3-2 Growth in Average Daily Traffic (ADT) at Key Locations 2014 - 2040

ATR COUNTING STATIONS	EXISTING (2014)		FUTURE (2040)		PROJECTED GROWTH	
	SUMMER ADT[1]	NON-SUMMER ADT[1]	SUMMER ADT[1]	NON-SUMMER ADT[1]	SUMMER ADT[1]	NON-SUMMER ADT[1]
Bourne Bridge	56,500	38,000	61,600	45,200	9%	19%
Sagamore Bridge	65,900	41,400	93,300	59,600	42%	44%
Route 3 between Exits 1A and 2	51,600	29,900	72,400	51,800	40%	73%
Route 6 between Exits 1 and 2	72,300	39,600	90,600	51,800	25%	31%
Route 25 West of Exit 2	62,900	42,900	78,900	56,800	25%	32%
Route 25 East of Exit 2	24,500	16,900	26,200	19,700	7%	17%
Route 6 (Scenic Hwy) East of Nightingale Rd	33,600	21,000	36,200	25,400	8%	21%
Sandwich Rd East of Bourne Rotary Connector	30,800	22,600	33,400	28,100	8%	24%
Adams St South of Sandwich Rd	7,600	7,600	11,800	13,900	55%	83%
Buzzards Bay Bypass	7,900	6,000	8,800	6,000	11%	0%
Main St West of Perry Ave	25,600	11,900	28,500	12,120	11%	2%
Trowbridge Rd West of Veterans Way	7300	6,300	11,500	9,900	58%	57%
Route 28 South of Bourne Rotary	42,500	34,800	49,000	40,100	15%	15%
Route 130 North of Route 6	12,200	9,300	12,500	13,200	2%	42%
Route 6 between Exit 2 and 3	56,400	41,600	67,000	56,000	19%	35%
Mid-Cape Connector South of Sandwich Rd	19,100	15,300	28,500	18,100	49%	18%
Route 6 East of Exit 3	57,000	44,900	70,900	53,400	24%	19%
State Rd North of Ramp to Route 3 NB	5,700	4,700	8,200	6,200	44%	32%
Route 6A East of Cranberry Hwy	12,400	7,500	15,100	8,300	22%	11%
Route 3 between Exits 2 and 3	44,600	37,400	60,000	50,300	35%	35%

[1]*Average Daily Traffic (ADT)*

Exhibit 3-4 Future (2040) Non-Summer Weekday AM Turning Movements



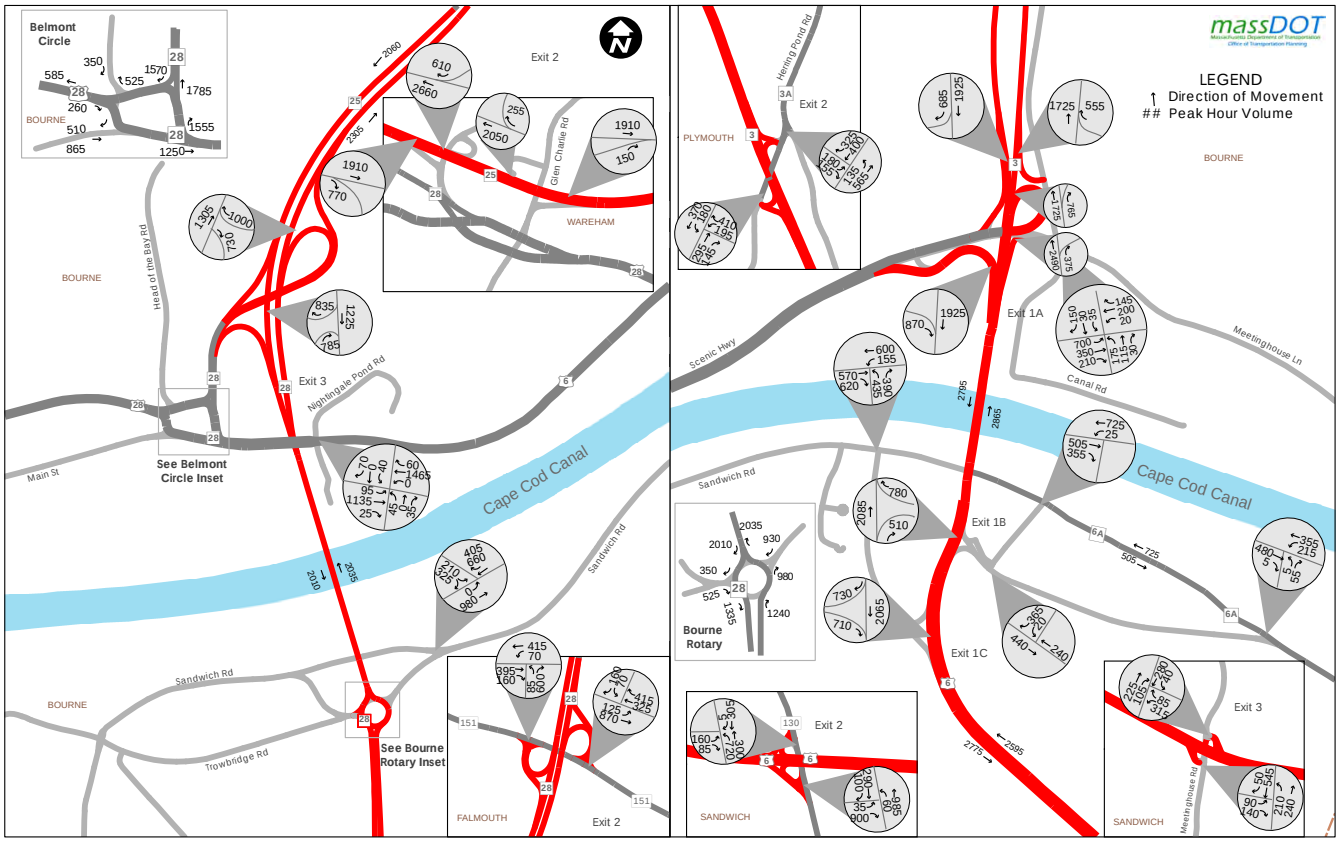
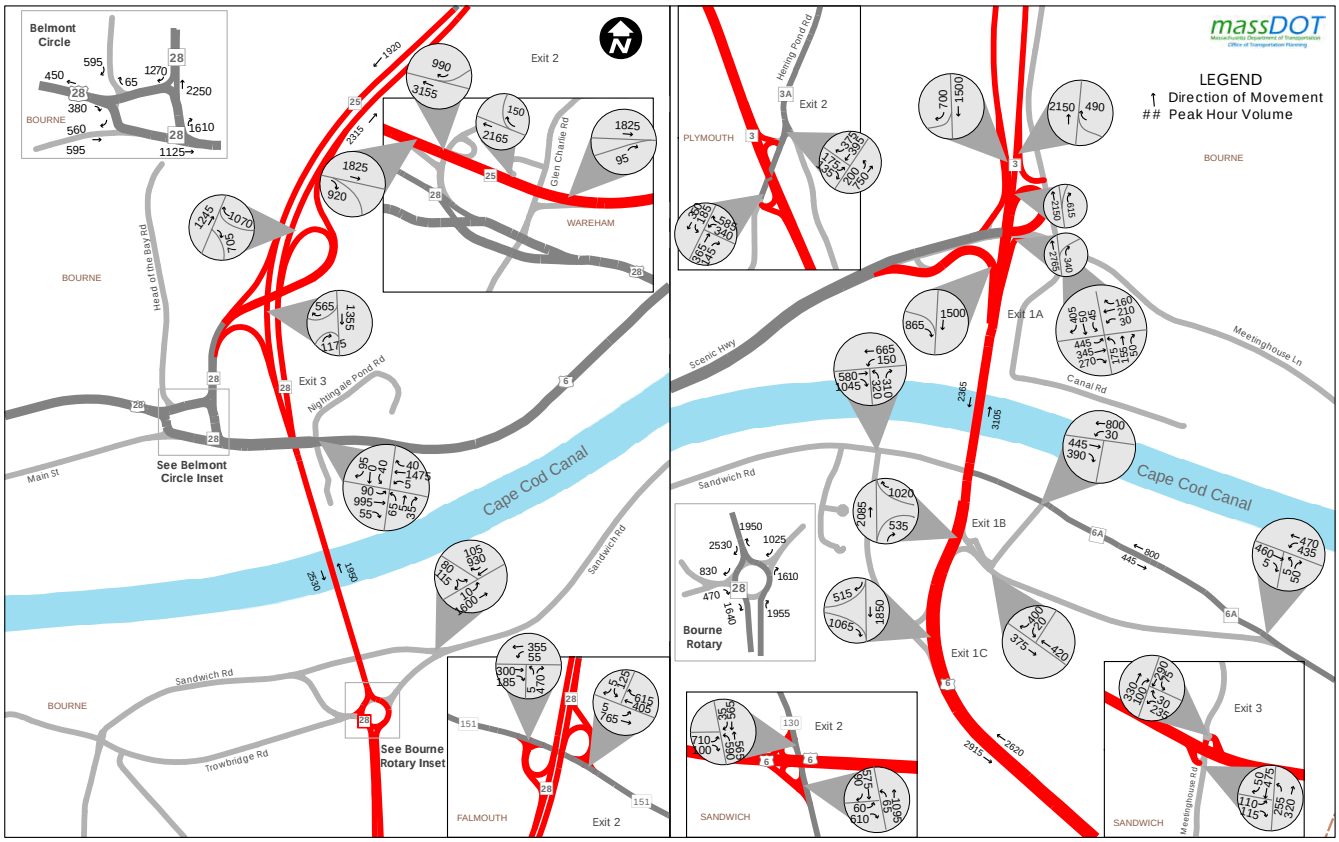


Exhibit 3-5 *Future (2040) Non-Summer Weekday PM Turning Movements*

Exhibit 3-6 *Future (2040) Non-Summer Saturday Turning Movements*



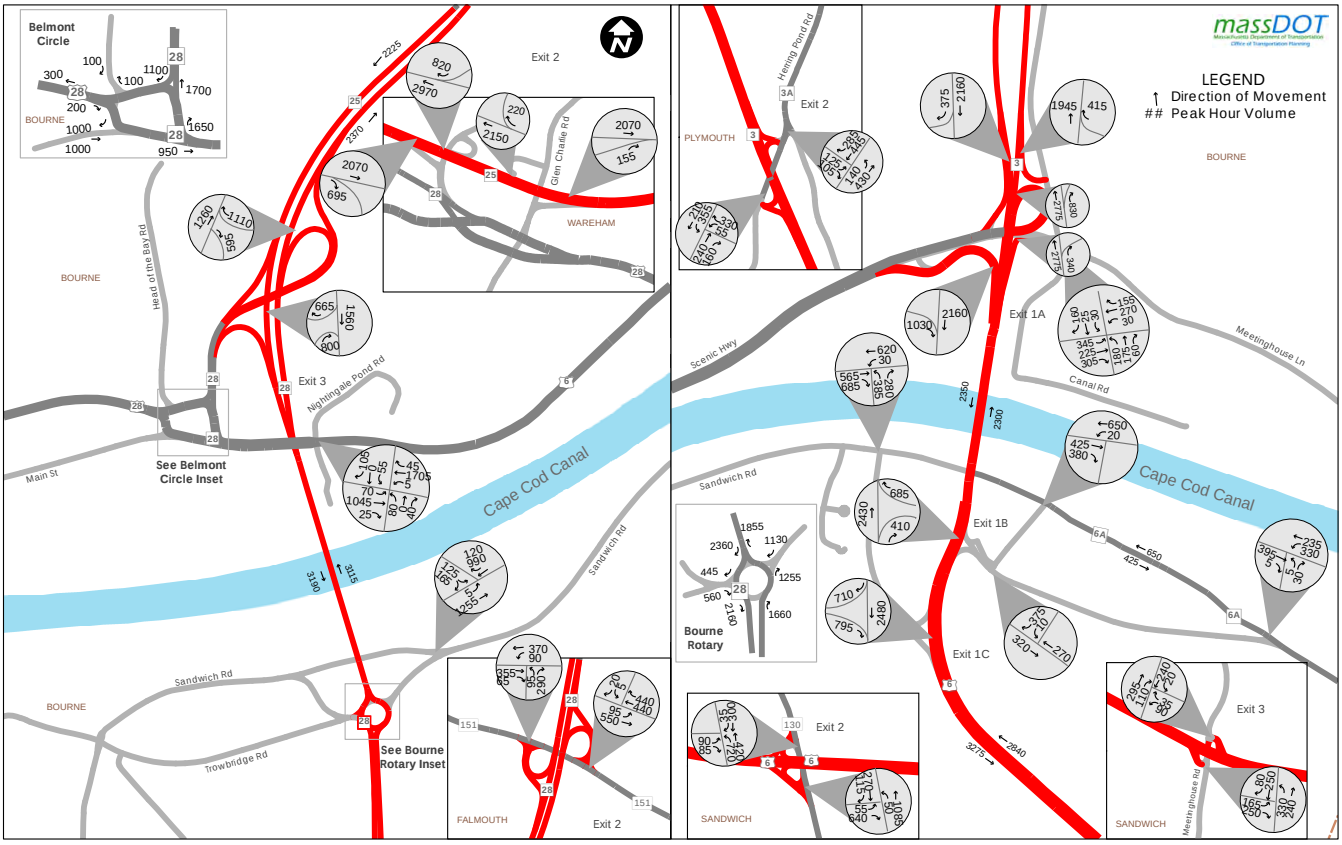


Exhibit 3-7 *Future (2040) Summer Weekday AM Turning Movements*

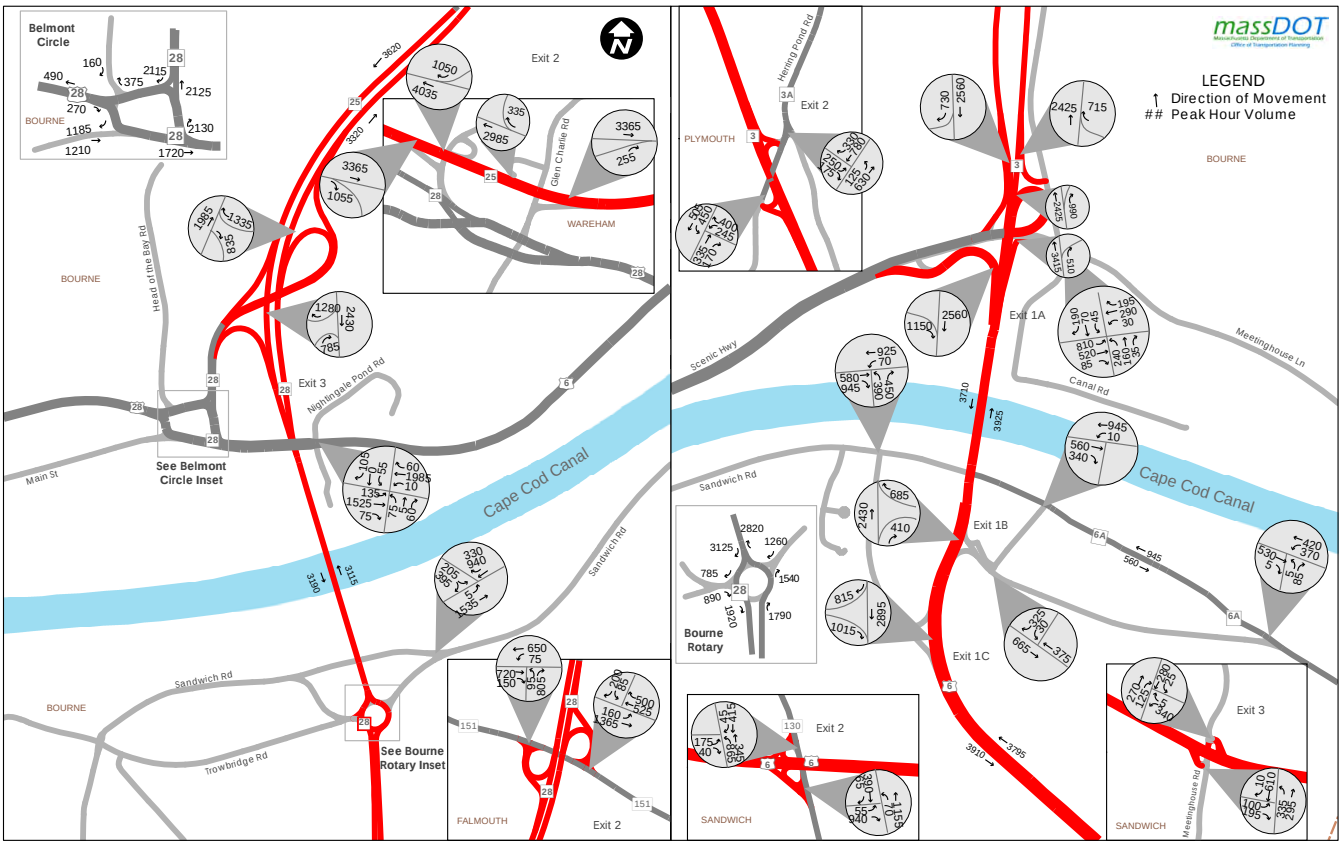


Exhibit 3-8 *Future (2040) Summer Weekday PM Turning Movements*

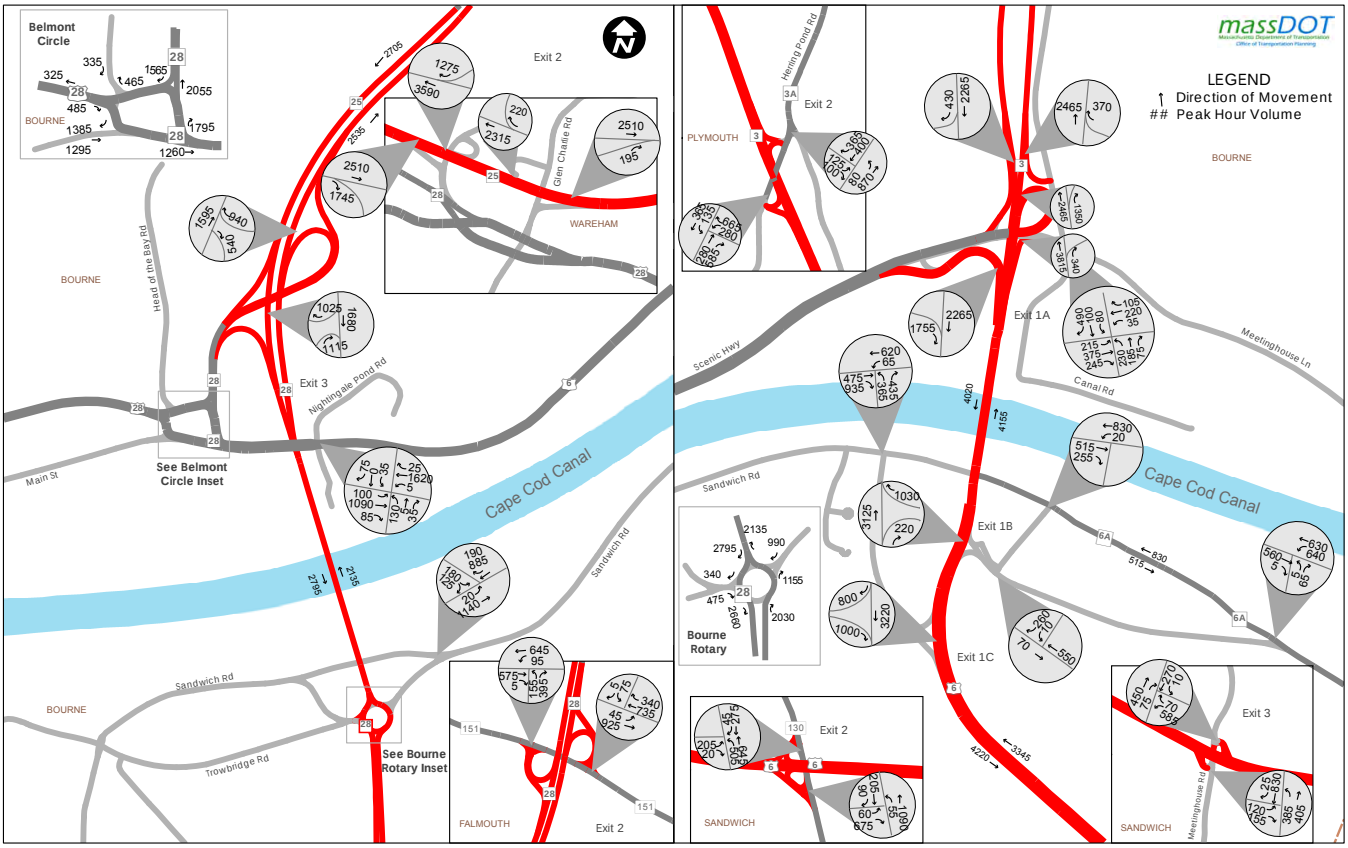


Exhibit 3-9 ***Future (2040) Summer Saturday Turning Movements***

3.3.6 Future (2040) No-Build Levels of Service

Based on the future (2040) forecast traffic volumes, LOS were analyzed at 60 locations throughout the study area, including signalized and unsignalized intersections, highway links, and highway ramps. As with other data, LOS was calculated for the AM and PM weekday peak-periods and Saturday mid-day peak periods. The time periods examined were:

- AM summer weekday (7:00 AM – 9:00 AM)
- PM summer weekday (4:00 PM – 6:00 PM)
- Saturday summer (10:00 AM -12:00 PM)
- AM non-summer weekday (7:00 AM – 9:00 AM)
- PM non-summer weekday (4:00 PM – 6:00 PM)
- Saturday non-summer (10:00 AM -12:00 PM)

The methodology for determining LOS is provided in Section 2.5.8. This same methodology is used to forecast future LOS. The LOS for the existing conditions is also provided in Section 2.5.8. The results of the future no-build analysis for LOS appear in Tables 3-3 and 3-4. Exhibits 3-10 and 3-11 (freeways) and Exhibits 3-12 through 3-17 (intersections) present the results graphically.

Text continues on page 3-19.

Table 3-3 Future (2040) No-Build Levels of Service for Freeway Sections

	SUMMER AM	NON-SUMMER AM	SUMMER PM	NON-SUMMER PM	SUMMER SATURDAY	NON-SUMMER SATURDAY
HIGHWAY LINKS						
Bourne Bridge (NB)	C	B	D	C	C	C
Bourne Bridge (SB)	C	C	D	C	D	C
Route 25 East of Exit 2 (EB)	B	A	C	A	B	A
Route 25 East of Exit 2 (WB)	B	A	B	B	B	B
Route 25 West of Exit 2 (EB)	B	A	C	B	C	B
Route 25 West of Exit 2 (WB)	B	B	C	B	C	B
Route 3 Between Exits 1A and 2 (NB)	C	B	D	C	C	C
Route 3 Between Exits 1A and 2 (SB)	C	C	D	C	C	C
Route 6 EB Between Exits 1 and 2 (EB)	D	C	**E**	C	**E**	D
Route 6 WB Between Exits 1 and 2 (WB)	D	C	**E**	C	D	C
Sagamore Bridge (NB)	D	C	**E**	D	**E**	D
Sagamore Bridge (SB)	D	C	D	D	**E**	C
HIGHWAY ON-RAMPS						
Belmont Circle to Route 25 WB	B	B	B	B	B	B
Cranberry Highway to Route 6 WB (Exit 1C)	D	C	**E**	D	**E**	D
Route 130 to Route 6 EB	C	C	D	B	**E**	C
Glen Charlie to Route 25 EB	B	B	C	B	B	B
Route 130 to Route 6 WB	D	C	**E**	C	D	C
Quaker Meeting House Rd to Route 6 EB	C	C	D	C	**E**	C
Herring Pond Road to Route 3 NB	C	C	D	C	D	C
Herring Pond Road to Route 3 SB	C	C	D	B	C	C
Mid Cape Connector to Route 6 EB	D	C	**E**	C	**E**	D
Quaker Meeting House Road to Route 6 WB	C	B	D	C	D	C
Scenic Hwy to Route 6 EB/Bridge	D	C	**E**	D	**E**	C
Belmont Circle to Route 25 EB (Bourne Bridge)	C	C	D	B	D	C
HIGHWAY OFF-RAMPS						
Route 25 EB to Maple Springs Rd	B	B	C	B	C	B
Route 6 EB to Route 130	**E**	C	**E**	D	**E**	D
Route 6 WB to Route 130	C	B	D	C	D	D
Route 6 EB to Mid-Cape Connector	D	D	**E**	D	**E**	C
Route 6 EB to Quaker Meeting House Rd	D	C	D	C	**E**	C
Route 6 WB to Quaker Meetinghouse Rd	C	B	D	C	**E**	D
Route 6 WB (Exit 1) to Cranberry Hwy	D	C	**E**	D	**E**	D
Route 25 EB to Belmont Circle	B	B	C	B	B	B
Route 3 NB to Herring Pond Rd	C	B	D	C	D	C
Route 3 SB to Herring Pond Rd	C	C	D	D	D	D

LOS E or LOS F locations are **bold**

Table 3-3 continues on the next page.

Table 3-3 Future (2040) No-Build Levels of Service for Freeway Sections

	SUMMER AM	NON-SUMMER AM	SUMMER PM	NON-SUMMER PM	SUMMER SATURDAY	NON-SUMMER SATURDAY
Bourne Bridge to Belmont Circle	B	A	B	B	B	B
Route 3 SB to Scenic Hwy	C	C	**E**	D	D	C
Route 6 WB (Sagamore Bridge NB) to 6 WB/Scenic Hwy	D	C	**E**	C	**E**	D
Route 6 WB (Sagamore Bridge NB) to Meeting House Rd	D	C	**E**	D	**E**	D

LOS E or LOS F locations are **bold**

Table 3-4 Future (2040) No-Build Levels of Service at Select Intersections

	SUMMER AM	NON-SUMMER AM	SUMMER PM	NON-SUMMER PM	SUMMER SATURDAY	NON-SUMMER SATURDAY
SIGNALIZED INTERSECTIONS						
Route 130 (Main St) at Tupper Rd	B	B	D	B	D	C
Scenic Hwy at Church Lane	C	C	C	B	D	C
Meetinghouse Lane, State Rd and Canal Rd	D	D	**F**	**F**	C	D
Scenic Highway at Nightingale Pond Rd/Andy Olivia Drive	B	A	**F**	B	D	B
Route 6 EB Off Ramp (Exit 2) at Route 130	C	C	**F**	**F**	C	**F**
UNSIGNALIZED INTERSECTIONS (FOR MINOR ROAD APPROACH)						
Sandwich Rd at Bourne Rotary Connector	**F**	**F**	**F**	**F**	**F**	**F**
Sandwich Rd at High School Drive	**F**	**F**	**F**	**F**	**F**	**F**
Sandwich Rd at Harbor Lights Rd	**F**	**F**	**F**	**F**	**F**	**F**
Sandwich Rd at Jarvis Drive	D	**F**	A	**F**	A	**E**
County Road, Sandwich Road, & Trowbridge Road	**E**	D	**F**	**F**	C	**E**
Route 28 NB Off-ramp at Route 151	C	D	**F**	**F**	**F**	D
Route 28 SB Off-ramp at Route 151	D	D	**F**	**F**	**F**	C
Sandwich Rd, Cranberry Hwy, and Regency Drive	**F**	D	**E**	**E**	**F**	C
Old Kings Hwy at Main Street	B	B	C	C	**F**	D
Route 6A at Route 130 (Main Street) / Tupper Road	**F**	D	C	F	**F**	**F**
Maple Springs Rd at Route 25 EB	C	B	**F**	D	**F**	**F**
Route 130 at Cotuit Rd	**F**	**F**	**F**	**F**	**F**	**F**
Herring Pond Rd at State Road	**E**	**F**	**F**	**F**	**F**	**F**
Belmont Circle	**F**	**F**	**F**	**F**	**F**	**F**
Bourne Rotary	**F**	**F**	**F**	**F**	**F**	**F**
Route 6 EB Off Ramp (Exit 3) Quaker Meeting House Rd	**F**	**F**	**F**	**F**	**F**	**F**
Route 3 SB Off Ramp at Exit 2/Herring Pond Rd	**E**	**F**	**F**	**F**	**F**	**F**

LOS E or LOS F locations are **bold**

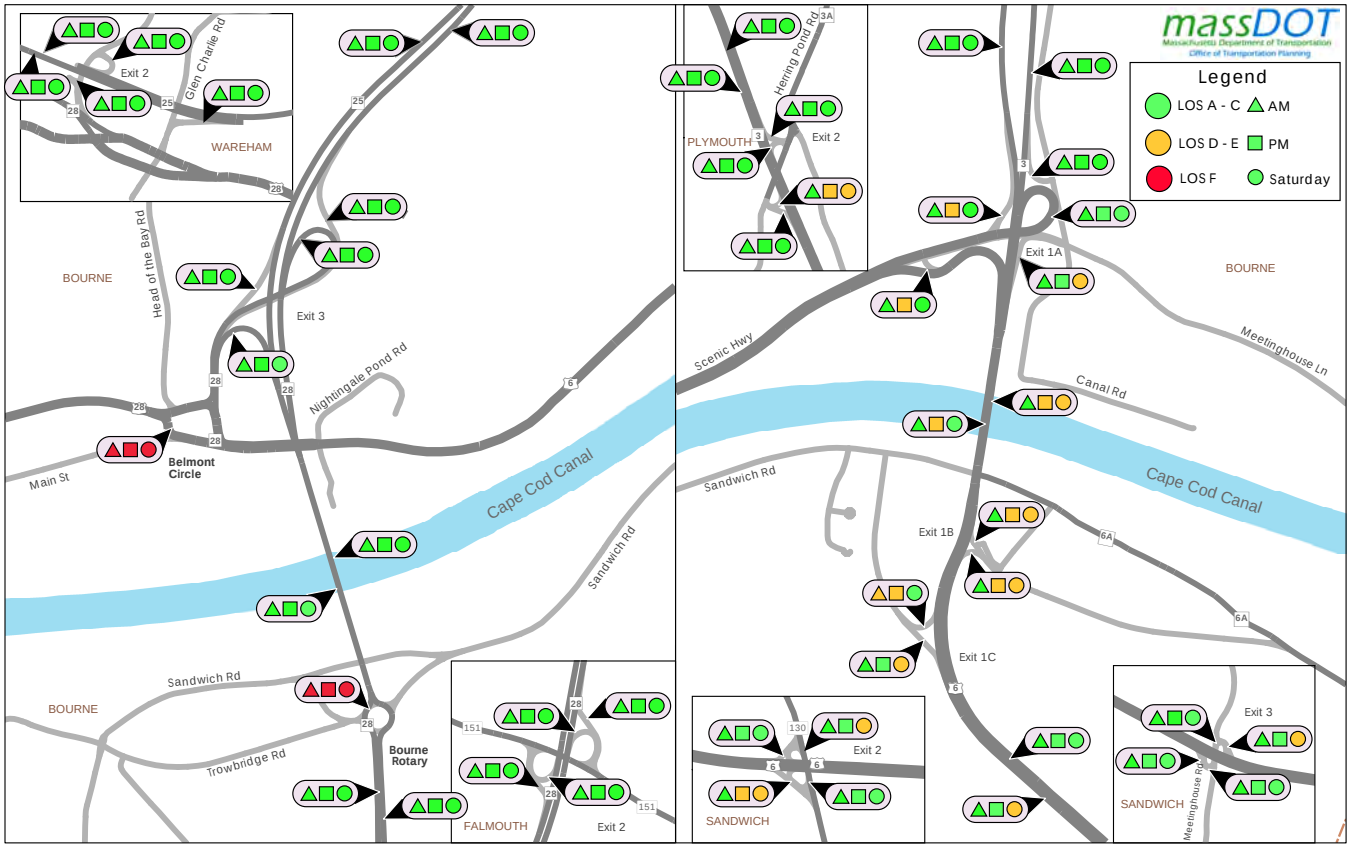
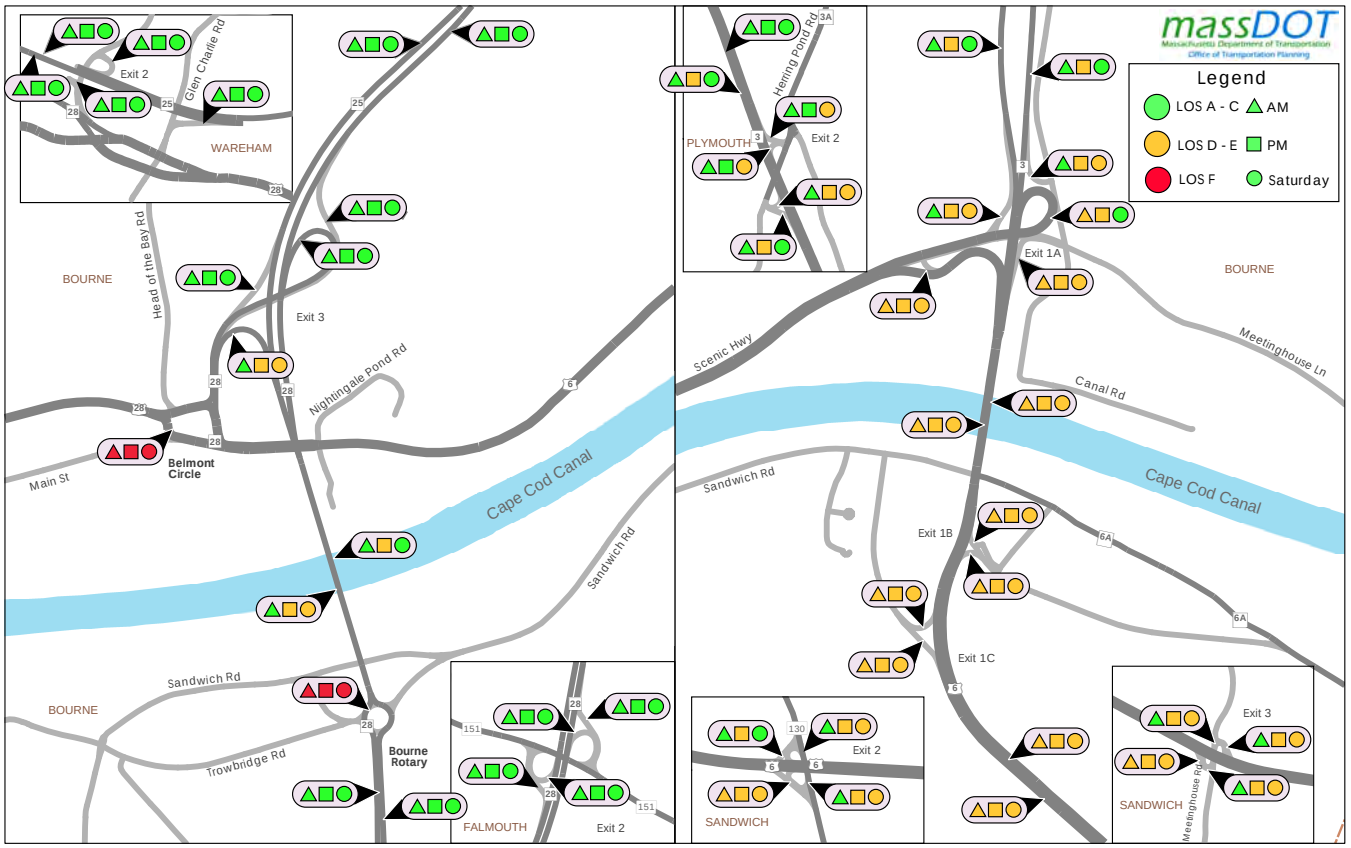


Exhibit 3-10 Future (2040) No-Build Non-Summer Levels of Service - AM/PM/Saturday (Freeway)

Exhibit 3-11 Future (2040) No-Build Summer Levels of Service - AM/PM/Saturday (Freeway)



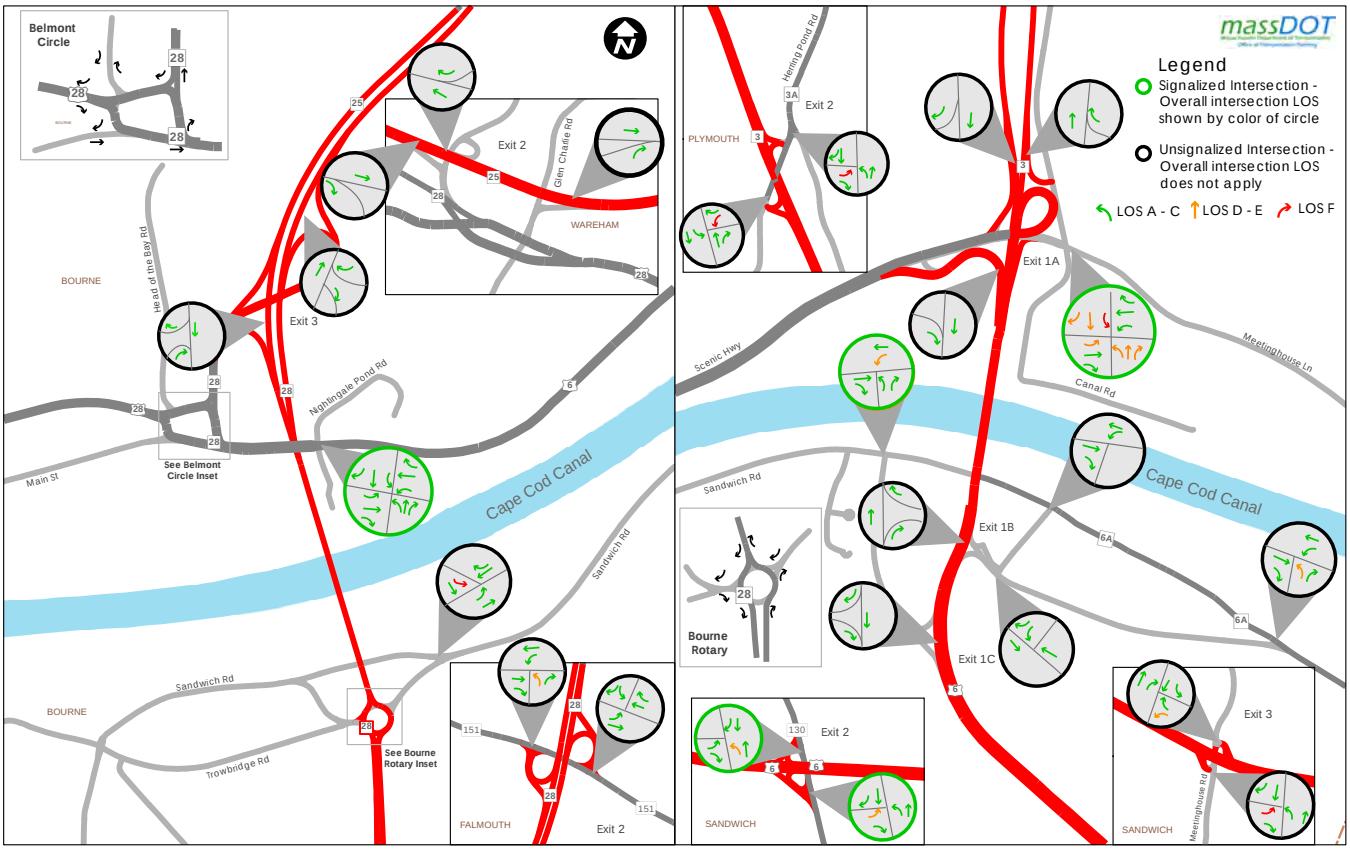
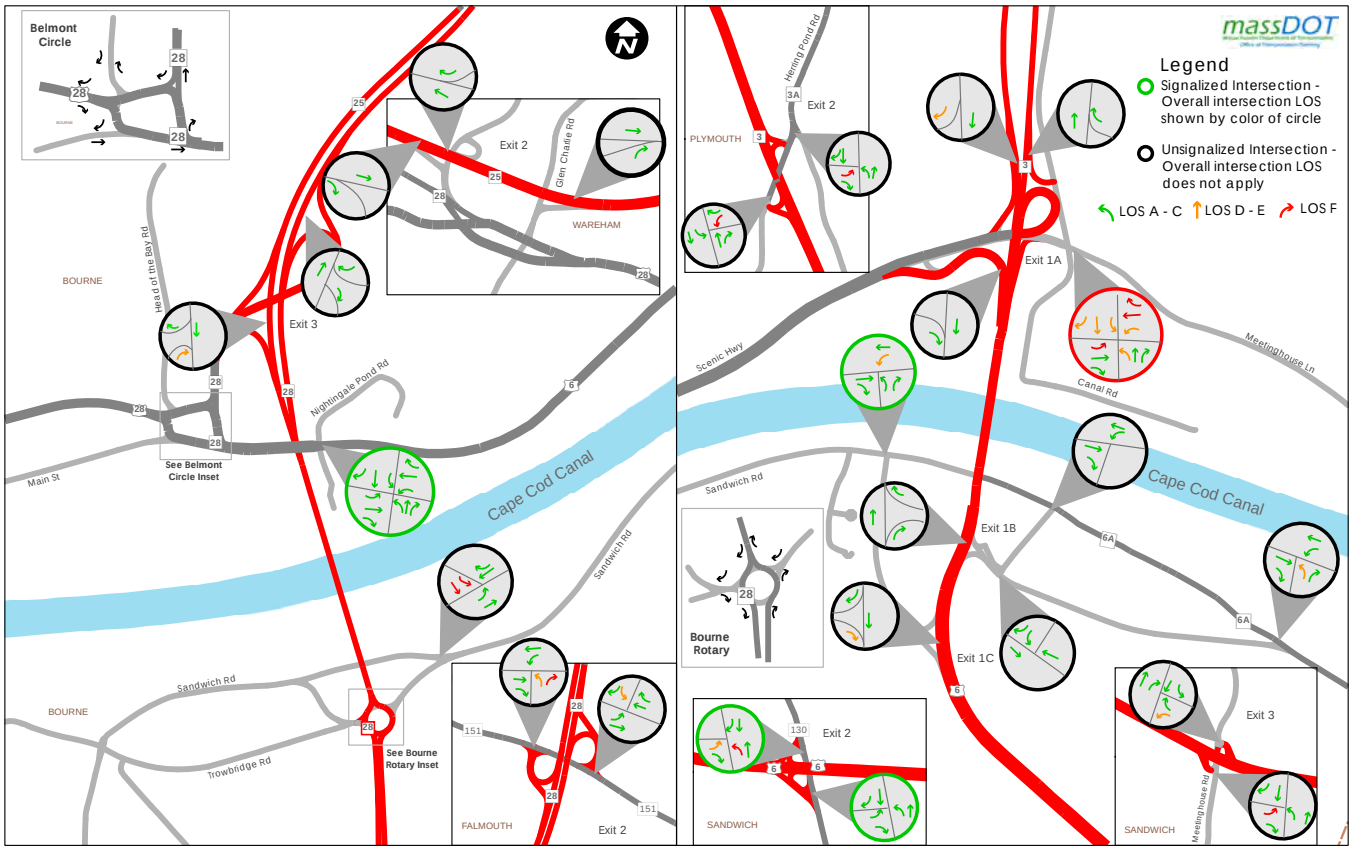


Exhibit 3-12 *Future (2040) No-Build Non-Summer Weekday AM Levels of Service (Intersections)*

Exhibit 3-13 *Future (2040) Non-Build Non-Summer Weekday PM Levels of Service (Intersections)*



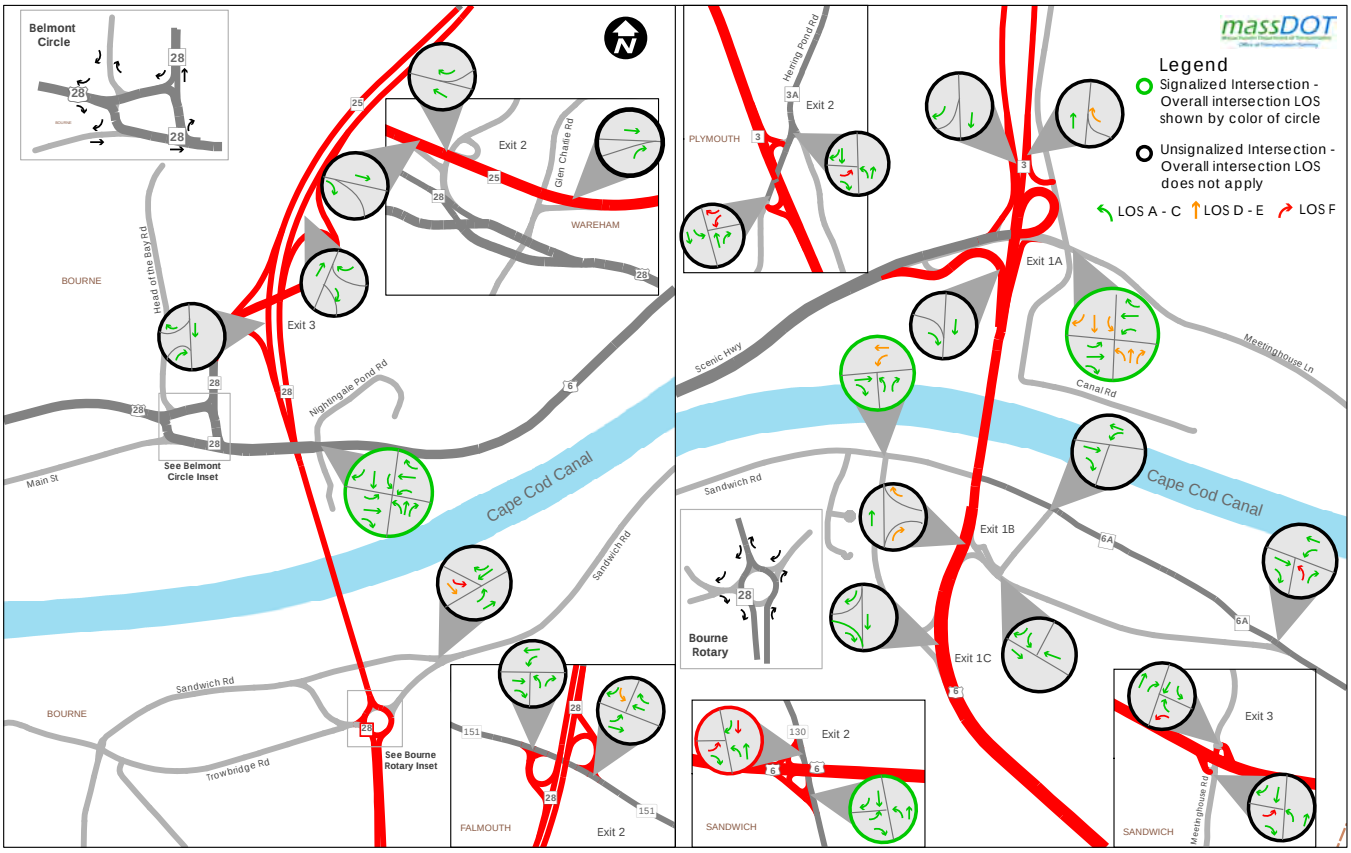
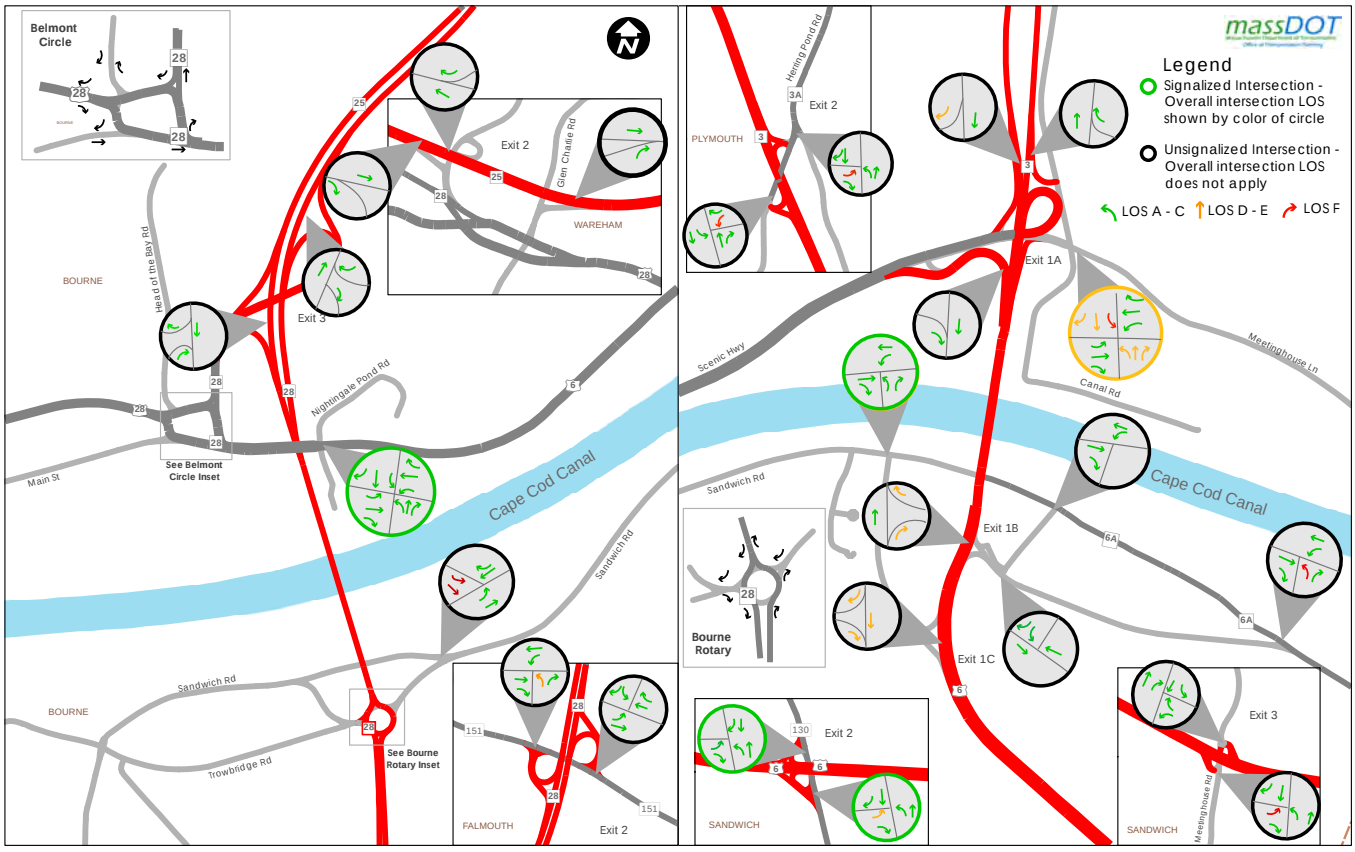


Exhibit 3-15 Future (2040) No-Build Non-Summer Saturday Levels of Service (Intersections)

Exhibit 3-14 Future (2040) No-Build Summer Weekday AM Levels of Service (Intersections)



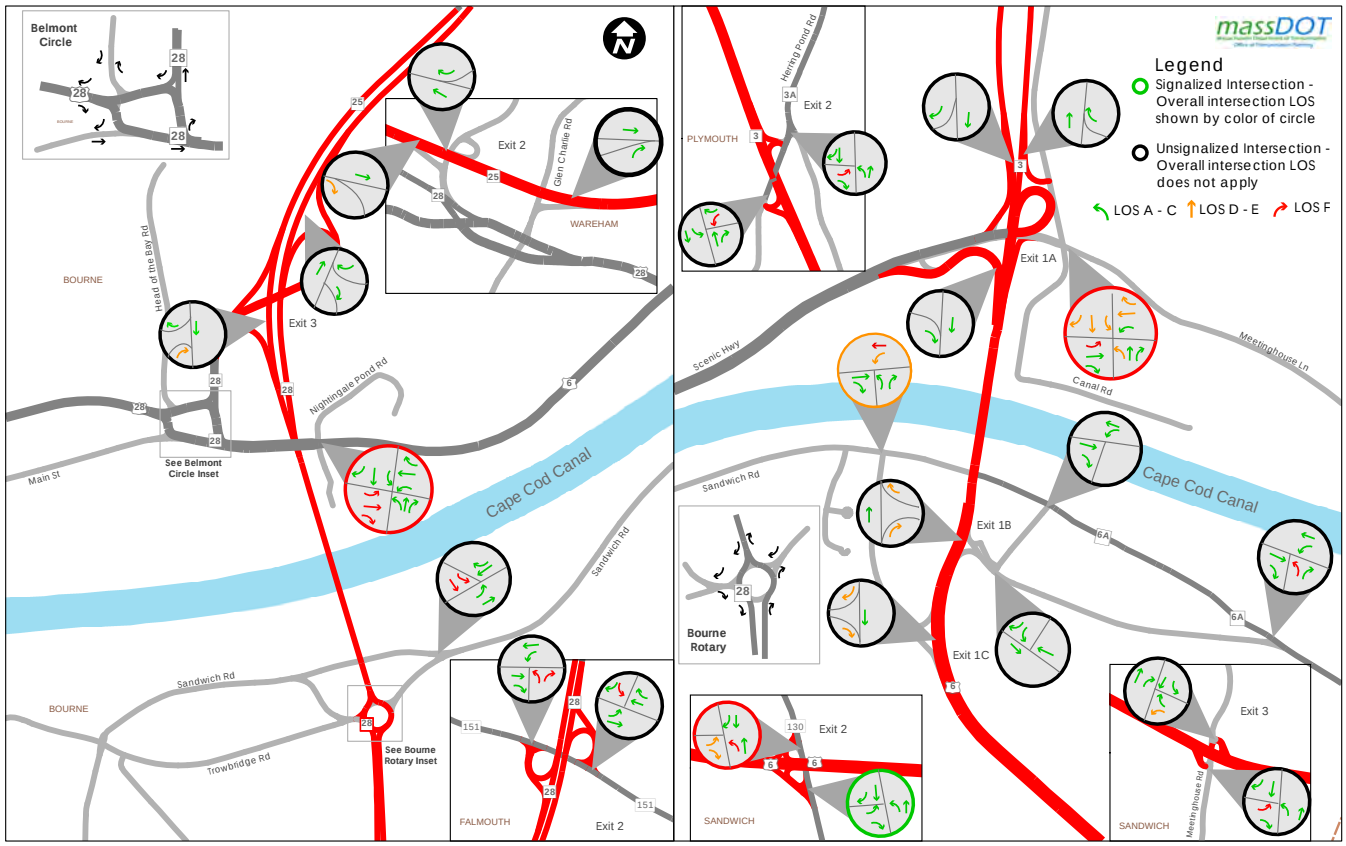
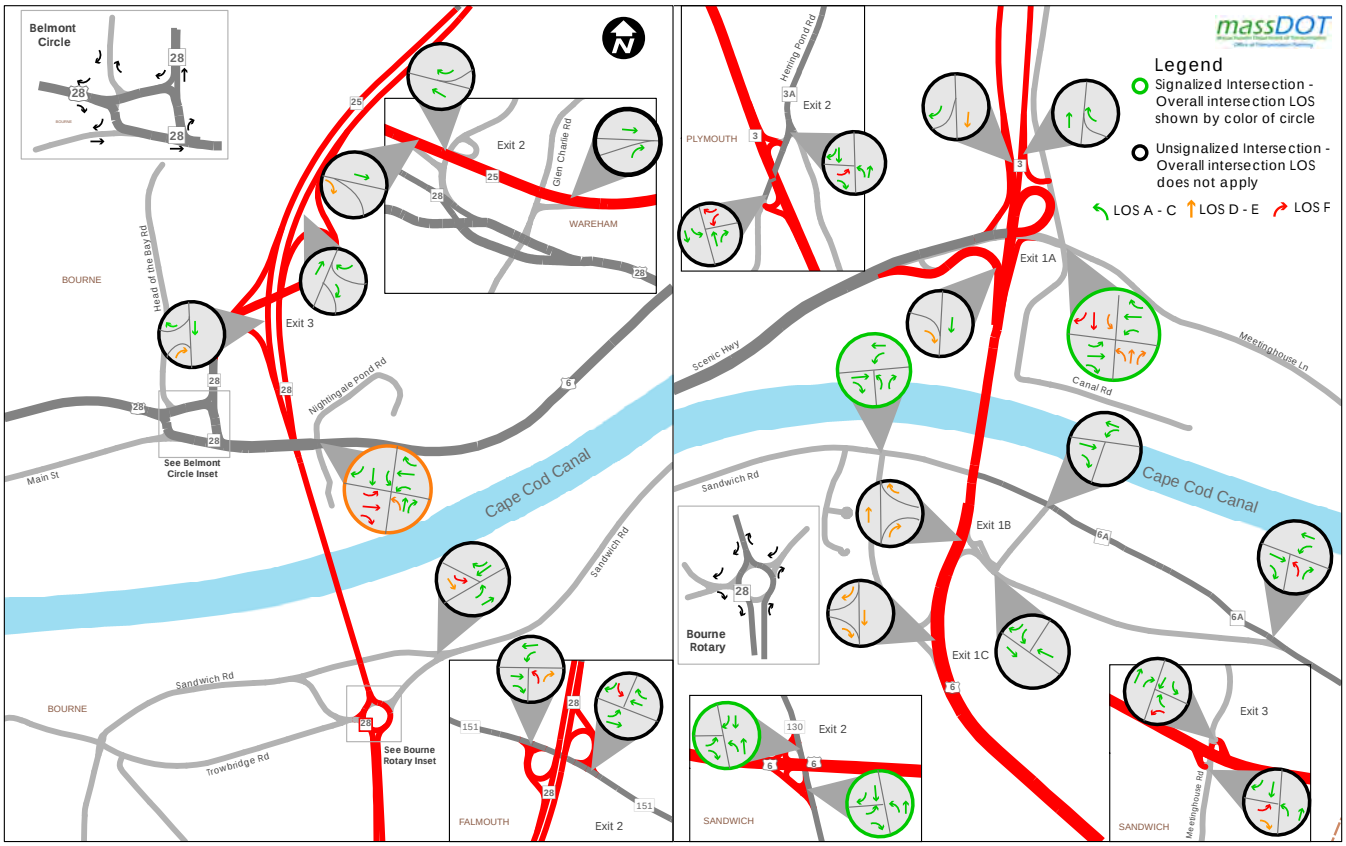


Exhibit 3-16 *Future (2040) No-Build Summer Weekday PM Levels of Service (Intersections)*

Exhibit 3-17 *Future (2040) No-Build Summer Saturday Levels of Service (Intersections)*



The following presents a summary of traffic operations (in terms of LOS) for both the existing and future no-build conditions.

Summary of Freeway Traffic Operations

Existing (2014) Conditions

- Generally acceptable traffic operations (LOS A – C) during most non-summer and summer periods along the mainline and interchanges of Route 3, Route 6, and Route 25.
- Less acceptable traffic operations (LOS D) on the Sagamore Bridge and the Route 6 approach to the Sagamore Bridge during summer periods.
- Less acceptable traffic operations (LOS D) during the summer periods at several Route 6 interchanges, including Exit 1C (Cranberry Highway), Exit 2 (Route 130), and Exit 3 (Quaker Meetinghouse Road).

Future (2040) No-Build Conditions

- Generally acceptable traffic operations (LOS A – C) during all non-summer periods along the mainline and interchanges of Route 3, Route 6, and Route 25.
- Substantially more freeway and interchange locations operating at less acceptable levels (LOS D/E) during the summer periods (compared to the existing condition), particularly at the Bourne and Sagamore Bridges, and adjacent interchanges.

Summary of Intersection Traffic Operations

Existing (2014) Conditions

- Numerous intersections with poor traffic operations (LOS E/F), especially during summer periods.
- Worst performing intersections (LOS E/F during all time periods) include:
- Belmont Circle
- Bourne Rotary
- Sandwich Road at Bourne Rotary Connector
- Sandwich Road at High School Drive
- Sandwich Road at Harbor Lights Drive
- Route 130 at Cotuit Road

Future (2040) No-Build Conditions

- Numerous intersections with poor traffic operations (LOS E/F), especially during summer periods. Compared to the

existing conditions, degraded traffic conditions occur at intersections throughout the study area.

- The most congested intersections (LOS E/F during all time periods) include those identified for the existing conditions plus three additional locations:
- Belmont Circle
- Bourne Rotary
- Sandwich Road at Bourne Rotary Connector
- Sandwich Road at High School Drive
- Sandwich Road at Harbor Lights Drive
- Route 130 at Cotuit Road
- Herring Pond Road at State Road
- Route 3 SB Off-Ramp at Exit 2/Herring Pond Road
- Route 6 EB Off-Ramp (Exit 3) at Quaker Meeting House Lane

3.3.7 Traffic Operations at Belmont Circle and Bourne Rotary

As noted in Section 2.5.10, Belmont Circle and the Bourne Rotary have a considerable impact on regional travel patterns and traffic operations. The high frequency of cross-corridor travel often results in traffic volumes that exceed the capacity of Belmont Circle and Bourne Rotary. This results in significant queues and delays at their approaches. Further, the proximity of these rotaries to each other can result in queues at one location negatively affecting traffic operations at the other. Both locations currently experience LOS F conditions during all peak periods in the summer and non summer.

Tables 3-5 and 3-6 and Exhibit 3-18 provide a comparison of vehicle delay and queue lengths for approaches to Belmont Circle and Bourne Rotary, respectively, for the existing (2014) and future (2040) non-summer weekday PM and summer Saturday peak periods.

Belmont Circle

The VISSIM™ analysis quantified vehicle delays and the queue length for the five approaches to Belmont Circle including Scenic Highway, Main Street, Buzzards Bay Bypass, Head of the Bay Road, and the Route 25 ramps. As shown in Table 3-6 and Exhibit 3-18, the approaches with the greatest delay and queue lengths include those from Scenic Highway and Main Street to Belmont Circle.

The queues of note for the future no-build condition include the Scenic Highway (westbound) and the Main Street (eastbound)

Table 3-5 *Belmont Circle – Comparison of Existing (2014) and Future (2040) No-Build Queue Lengths and Average Delay*

Street Name/ Approach	2014 EXISTING				2040 FUTURE NO BUILD			
	Ave. Vehicle Delay (sec./min.)		95% Max. Queue Lengths (feet/miles)		Ave. Vehicle Delay (sec./min.)		95% Max. Queue Lengths (feet/miles	
	Non-Summer PM	Summer Saturday	Non-Summer PM	Summer Saturday	Non-Summer PM	Summer Saturday	Non-Summer PM	Summer Saturday
Route 25 Exit 3 Off-Ramps (WB)	5	**4**	515	510	2	3	645	**1,025**
Head of Bay Road (SB)	15	**83 (1.4)**	270	570	317 (5.3)	656 (10.9)	1,780	2,700 (0.5)
Buzzards Bay Bypass (EB)	3	19	100	335	3	11	110	305
Main Street (EB)	13	**82 (1.4)**	530	**5,755 (1.1)**	29	**126 (2.1)**	**1,245**	**6,140 (1.2)**
Scenic Highway (WB)	7	**125 (2.1)**	380	**10,605 (2.0)**	14	**161 (2.7)**	**840**	**11,610 (2.2)**

Notes:
Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles
Locations of excessive delay are **bold**

Table 3-6 *Bourne Rotary – Comparison of Existing (2014) and Future (2040) No-Build Queue Lengths and Average Delay*

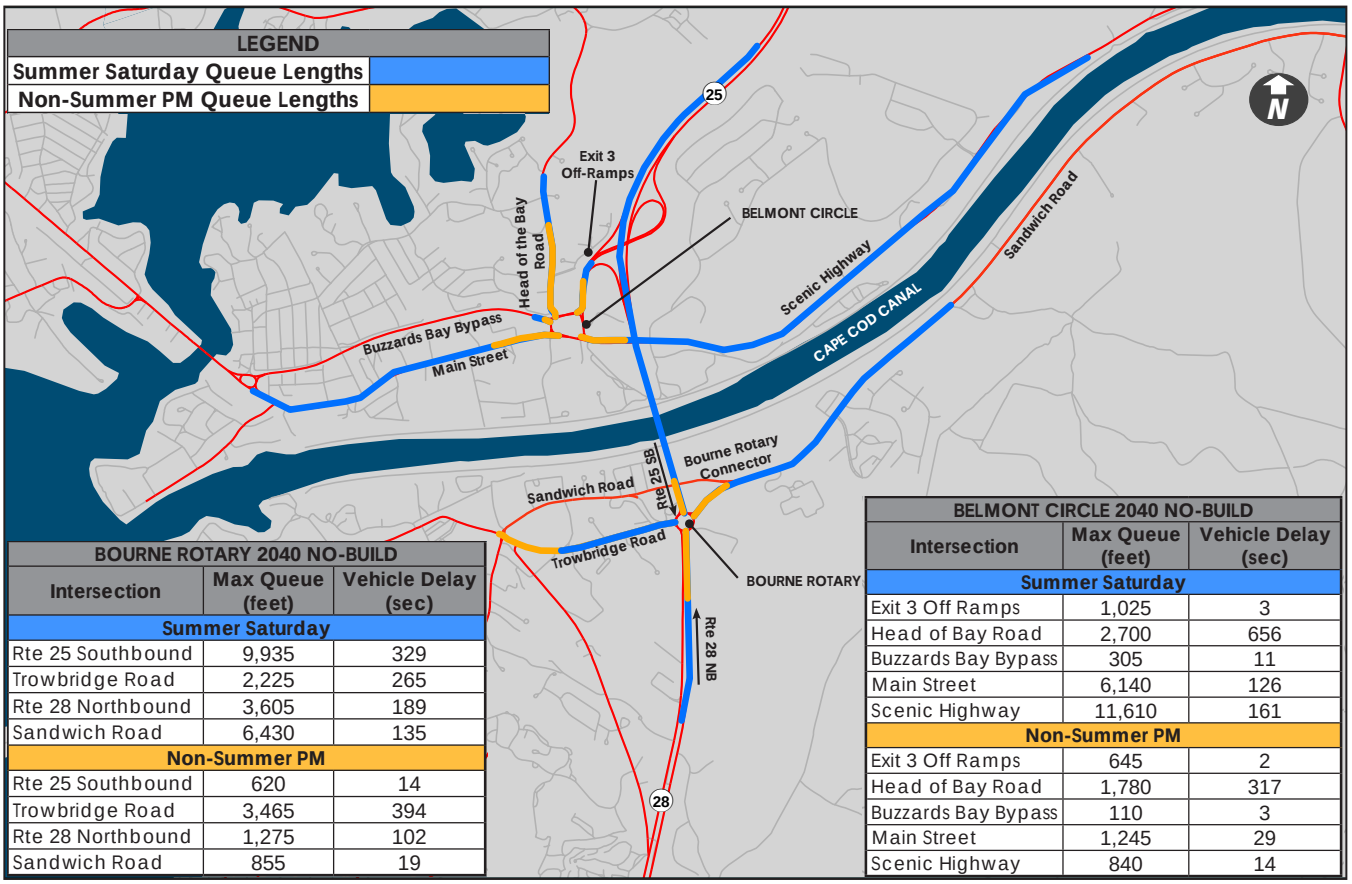
STREET NAME/ APPROACH	2014 EXISTING				2040 FUTURE NO BUILD			
	Ave. Vehicle Delay (sec./min.)		95% Max. Queue Lengths (feet/miles)		Ave. Vehicle Delay (sec./min.)		95% Max. Queue Lengths (feet/miles	
	Non-Summer PM	Summer Saturday	Non-Summer PM	Summer Saturday	Non-Summer PM	Summer Saturday	Non-Summer PM	Summer Saturday
Route 25 (SB)	19	**280 (4.7)**	650	**8,885 (1.7)**	14	329 (5.5)	620	**9,935 (1.9)**
Trowbridge Road (EB)	75 (1.3)	30	840	335	**394 (6.6)**	**265 (4.4)**	**3,465 (0.7)**	**2,225**
Route 28 (NB)	14	**301 (5.0)**	340	**4,135 (0.8)**	**102 (1.7)**	**189 (3.2)**	**1,275**	**3,605 (0.7)**
Bourne Rotary Connector (WB)	20	27	1,530	1,475	19	135 (2.3)	855	**6,430 (1.2)**

Notes:
Delay over 60 seconds also provided in minutes. Queues over 2,500 feet also provided in miles
Locations of excessive delay are **bold**

approach to Belmont Circle which can extend 6,140 to 11,610 feet (1.2 to 2.2 miles) during the summer Saturday peak periods, respectively. The queues on the Main Street (eastbound) approach to Belmont Circle can extend 1,245 feet during the non-summer weekday peak period.

Bourne Rotary

The VISSIM™ analysis quantified vehicle delays and the queue length for the four approaches to Belmont Circle, including Route 28 (north and south approaches), Trowbridge Road, and Sandwich Road. As shown on Table 3-6 and Exhibit 3-18, the approaches with the greatest delay and queue lengths include those from Route 25 southbound and the Bourne Rotary Connector.



BOURNE ROTARY 2040 NO-BUILD

Intersection	Max Queue (feet)	Vehicle Delay (sec)
Summer Saturday		
Rte 25 Southbound	9,935	329
Trowbridge Road	2,225	265
Rte 28 Northbound	3,605	189
Sandwich Road	6,430	135
Non-Summer PM		
Rte 25 Southbound	620	14
Trowbridge Road	3,465	394
Rte 28 Northbound	1,275	102
Sandwich Road	855	19

BELMONT CIRCLE 2040 NO-BUILD

Intersection	Max Queue (feet)	Vehicle Delay (sec)
Summer Saturday		
Exit 3 Off Ramps	1,025	3
Head of Bay Road	2,700	656
Buzzards Bay Bypass	305	11
Main Street	6,140	126
Scenic Highway	11,610	161
Non-Summer PM		
Exit 3 Off Ramps	645	2
Head of Bay Road	1,780	317
Buzzards Bay Bypass	110	3
Main Street	1,245	29
Scenic Highway	840	14

Exhibit 3-18 Belmont Circle and Bourne Rotary - Future (2040) No-Build Queue Lengths

The queues of note for the future no-build condition include the Route 25 (southbound) and the Bourne Rotary Connector approach to the Bourne Rotary which can extend 9,935 and 6,430 feet (1.9 and 1.2 miles), respectively during the summer Saturday peak period. The queues on the Route 28 (northbound) approach to Bourne Rotary can extend 1,275 to 3,605 feet during the non-summer PM and summer Saturday peak periods, respectively.

3.4 PROBLEM INTERSECTIONS

The following section provides information on the 12 year-round problem intersections in the study area (Table 3-7). Problem intersections are defined as those that operated (or are forecast to operate) as an LOS E or F during at least one summer and non-summer peak period in 2014 or 2040. Problem intersections also include those intersections designated as high-crash locations under the Highway Safety Improvement Program (HSIP -described in greater detail in Section 2.5.11).

Roadway improvement alternatives will focus on these intersections. Particular attention was paid to problem intersections in the study area that experience the highest

Table 3-7 Growth in Average Daily Traffic (ADT) at Key Locations 2014 - 2040

LOCATION NUMBER (EXHIBITS 3-21)	NAME OF LOCATION	TOWN	HSIP LOCATION (Y/N)	NON-SUMMER PM LOS 2040 FUTURE NO-BUILD	SUMMER SATURDAY LOS 2040 FUTURE NO-BUILD
1	Herring Pond Road at State Road	Plymouth	N	F	F
2	Belmont Circle	Bourne	Y	F	F
3	Scenic Highway at Nightingale Pond Road	Bourne	N	B	D
4	Bourne Rotary	Bourne	Y	F	F
5	Sandwich Road at Bourne Rotary Connector	Bourne	N	F	F
6	Sandwich Road at High School Drive	Bourne	Y	F	F
7	Sandwich Road at Harbor Lights Road	Bourne	N	F	F
8	Sandwich Road at Cranberry Highway/Regency Drive	Bourne	N	E	F
9	Route 6A at Route 130 (Main Street)/Tupper Road	Sandwich	Y	F	F
10	Scenic Highway/Meetinghouse Lane at State Road	Bourne	N	F	C
11	Route 130 at Cotuit Road	Sandwich	N	F	F
12	Route 28 Northbound Off/On Ramps at Route 151 (outside of study area)	Falmouth	N	E/F	F

Exhibit 3-19 Problem Intersections in the Study Area



Exhibit 3-20 Photos of Problem Intersections



Intersection #	1
Roadways	Herring Pond Rd at State Rd
Town	Plymouth
Traffic Control	Yield
HSIP	No



Intersection #	2
Roadways	Belmont Circle
Town	Bourne
Traffic Control	Yield/Rotary
HSIP	Yes



Intersection #	3
Roadways	Scenic Hwy at Nightingale Pond Rd
Town	Bourne
Traffic Control	Signalized
HSIP	No



Intersection #	4
Roadways	Bourne Rotary
Town	Bourne
Traffic Control	Yield/Rotary
HSIP	Yes



Intersection #	5
Roadways	Sandwich Rd at Bourne Rotary Conn.
Town	Plymouth
Traffic Control	Yield
HSIP	No



Intersection #	6
Roadways	Sandwich Rd at High School Dr
Town	Bourne
Traffic Control	Flashing Yellow
HSIP	Yes



Intersection #	7
Roadways	Sandwich Rd at Harbor Lights Rd
Town	Bourne
Traffic Control	Unsignalized
HSIP	No



Intersection #	8
Roadways	Sandwich Rd at Cranberry Hwy
Town	Bourne
Traffic Control	Stop-Controlled
HSIP	No



Intersection #	9
Roadways	Route 6A at Route 130
Town	Sandwich
Traffic Control	Stop-Controlled
HSIP	Yes

Figure 3-20 (continued) Photos of Problem Intersections



Intersection #	10
Roadways	Scenic Hwy at Meetinghouse Ln
Town	Bourne
Traffic Control	Signalized
HSIP	No



Intersection #	11
Roadways	Route 130 at Cotuit Road
Town	Sandwich
Traffic Control	Stop-Controlled
HSIP	No



Intersection #	12
Roadways	Route 28 at Route 151 On/Off Ramps
Town	Falmouth
Traffic Control	Yield-Control
HSIP	No

travel volumes and associated congestion and delays. While not meeting the definition of a 'problem intersection', the Scenic Highway at Nightingale Pond Road intersection will be evaluated because of its proximity to, and effect on, Belmont Circle. The Route 6 Exit 1C interchange has also been evaluated because its location and substandard design contribute to congestion on Route 6 westbound, particularly during summer Sundays. The existing problem intersections are shown in Exhibits 3-19 and 3-20.

3.5 SUMMARY OF FUTURE NO-BUILD TRAFFIC CONDITIONS

As described in Chapters 2 and 3, traffic conditions along highways and at intersections in the study area, particularly in the immediate area of the Canal bridges, often suffer from severe congestion and delay. Several intersections have a history of high crash rates. While historically known to occur during the summer tourist season, this roadway congestion now often occurs during the spring and fall shoulder seasons.

The highest daily- and peak-period traffic volumes in the study area occur along the major highway corridors in the study area, including the Route 3/Sagamore Bridge/Route 6 corridor and the Route 25/Bourne Bridge/Route 28 corridor. Under existing conditions, average daily traffic (ADT) on the bridges is 30% to 40% higher in the summer compared to the non-summer peak period. Daily traffic volumes range from 56,000 to 65,000 vehicles in the summer and 38,000 to 41,000 in the non-summer periods, with the Sagamore Bridge generally having the higher traffic volumes. In the future, daily traffic crossing the Canal

bridges is forecast to increase by 30% in the summer and 22% in the non-summer period.

Currently, the levels of service (LOS) along the highways in the study area were generally found to be within the acceptable LOS A - C range. In the future, traffic operations are forecast to degrade, with substantially more freeway and interchange locations operating at less acceptable levels (LOS D/E) during the summer periods (compared to the existing condition), particularly at the Bourne and Sagamore Bridges, and adjacent interchanges.

The roads connecting the bridge approaches - Scenic Highway north of the Canal and Sandwich Road south of the Canal - also experience high traffic volumes and congestion. This is the result of high traffic volumes within the focus area (not just travel through the focus area) and vehicles traveling between the Route 25/Route 28 corridor and the Route 3/Route 6 corridor. This congestion is exacerbated by the inadequate capacity and substandard design at the intersections at the bridge approaches, especially Belmont Circle and Bourne Rotary (north and south of the Bourne Bridge) and Route 6 Exit 1C south of the Sagamore Bridge. The former Sagamore Rotary, north of the Bourne Bridge, was reconstructed as a highway interchange in 2006. These intersections and several others along Sandwich Road and Scenic Highway experience severe congestion (LOS E / F) during both the summer and non-summer periods.