CAPE COD
COMMISSION

Town Centers Bicycle and Pedestrian Level of Service Report

November 2012

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Introduction

Bicycle and pedestrian level of service (LOS) determination is a measurement of bicyclist and pedestrian perceived comfort and safety with respect to motor vehicle traffic while travelling in a road corridor. It is considered a performance grade of how well a roadway accommodates the bicycle and pedestrian modes of travel. Town center streets typically are "shared" streets whose rights of way necessitate that motorists and bicyclists operate in close proximity to each other, sometimes even sharing the same portion of the cross section (e.g., a vehicular traffic lane). Sidewalks, where available, provide space for pedestrians.

This study provides a Level of Service (LOS) analysis for bicyclists and pedestrians within each of the 15 Cape Cod "town centers."[1] The report represents the Cape Cod Commission's (CCC) first bicycles and pedestrian LOS analysis and serves as a "pilot" study both in terms of the data collected and results as well as understanding the value of LOS determination and selected methodology. Transportation policies and highway design historically have focused on accommodating motor vehicles, with little consideration for bicycles or pedestrians. To improve roadways for shared-use by bicycles, motor vehicles, and pedestrians, it is important to move beyond the traditional auto-centric planning perspective and evaluate roadway conditions for what is considered user-friendly from the perspective of the bicyclists and pedestrians.

PURPOSE

The purpose of this study is to examine bicycle and pedestrian issues related to LOS in each of the towns' centers and/or economic activity areas. These "hub" locations generally contain a mix of residential, commercial and civic uses and attract people for shopping, dining, and other services as well as jobs/work. Making these areas convenient for bicycles and pedestrians is important for increasing transportation options and encouraging people to bicycle or walk, rather than drive – especially for short trips. Improving bicyclist and pedestrian conditions in downtowns is beneficial for traffic congestion, for the environment, for public health, and for personal convenience. In addition, for the aged and under-aged populations, low-income families, and others who may not drive or own a car, having access to downtown services by bicycle or on foot is essential.

This study is part of the Cape Cod Commission's initiative to develop a regional bicycle and pedestrian plan and improve connections between destinations such as downtowns/activity centers and bicycle and pedestrian facilities/routes. This report evaluates existing conditions related to bicyclist and pedestrian LOS in town centers and represents an initial step in providing safe connections between these areas and bicycle and pedestrian facilities (both existing and planned). Future studies will examine level of service issues on the "connectors" outside the town centers.

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[1] For towns without a designated town center, the project team reviewed Local Comprehensive Plans and land use maps to identify activity /economic activity areas with a mix of uses. Availability of traffic counts also influenced study area selection. See Methodology.

As noted above, the study also represents a "pilot" project for conducting LOS analysis for bicycles and pedestrians and serves as a test for understanding the value of the HCM BLOS methodology for use in future studies. The methodology appears to be biased somewhat towards separate facilities for bicycles and motor vehicles over "shared road" conditions, which are the prevalent form of bicycle accommodations in downtowns/town centers due to existing land use and development patterns. The primary value in conducting the LOS analysis is identification and understanding of factors that affect a bicyclist's/pedestrian's perception of safety, as well as collection of useful data about roadway features. The actual scores resulting from this study may be less important, given qualitative factors related to setting, motorist behavior, and potential biases in scoring methodology. The Analysis section of this report discusses both the value of conducting LOS analysis and the benefits/limitations of the selected methodology.

DEFINITIONS

Bicycle lane - A bicycle lane is a portion of the roadway that has been designated by striping, signing, and pavement markings for the preferential and exclusive use of bicyclists. Bike lanes are striped at the outer edge of vehicle travel lanes, on the shoulder or between a vehicle travel lane and parking or turn lanes. The width of the bike lane will vary depending upon the roadway geometrics and operations (such as on-street parking, presence of curb or shoulder, etc.). Minimum width is four feet (five feet with a curb or gutter).

Level of service – A qualitative measure that characterizes operational conditions within a traffic stream and their perception by motorists and passengers.

> *Bicycle Level of Service* – a model used to estimate bicyclists' perception of how well a roadway accommodates bicycles.
>
> *Pedestrian Level of Service* – a model uses to estimate pedestrians' perception of how well a roadway accommodates pedestrians.

Shoulder – The portion of a roadway contiguous with vehicle travel lanes, for accommodation of stopped vehicles and emergency use, often used by cyclists where paved.

"Share the road" program – a public education initiative directed at cyclists and motorists to encourage safe roadway behavior and promote safe travel spaces for all road users. State and local transportation departments throughout the country promote such programs through signage workshops, brochures, and other informational materials.

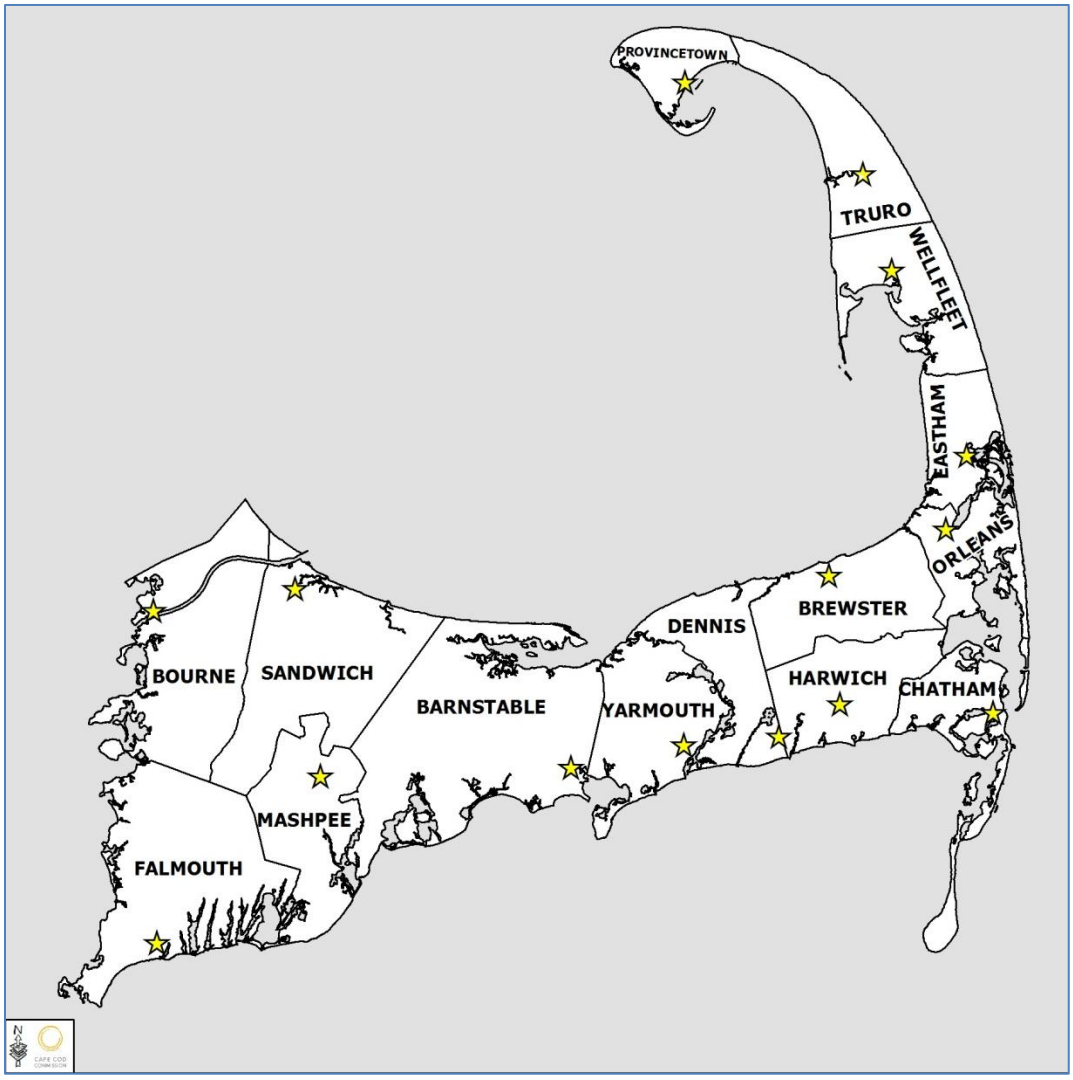
Sharrow - A "shared-lane" marking (share + arrow) used to indicate that bicycles and cars operate in the same lane. Sharrow placement – depending on the width of the travel lane – guides bicyclist position in the roadway. Sharrows are appropriate on roadways with speed limits up to 35 mph.

METHODOLOGY

TOWN CENTER LOCATIONS

The project team identified a town center in each of the 15 towns. For towns without a designated town center, the project team reviewed Local Comprehensive Plans and land use maps to identify areas that functioned as "activity centers." For the purpose of this study, the project team chose one "center" location for each town. In towns with multiple town centers and/or activity centers, the project team selected one location to study based on the availability of traffic counts and surrounding land uses.

STUDY AREA MAP. THE STARS IDENTIFY APPROXIMATE LOCATIONS FOR DATA COLLECTION AND ANALYSIS.



The bicycle level of service (BLOS) analysis requires that measurements be taken at a specific point along a roadway segment. The project team chose the selected points to roughly represent common characteristics along the roadway. The specific location for

data measurement also represented points for which the CCC had conducted traffic counts previously. (See individual town maps in Bicycle Level of Service by Town section.)

BICYCLE LEVEL OF SERVICE (BLOS) METHODOLOGY

The 2010 Highway Capacity Manual (HCM), published by the Transportation Research Board, Washington, D.C. provides methodologies for calculating bicycle Level of Service for a variety of facility types. The project team selected the HCM methodology for this study because it is nationally recognized and provides quantifiable analyses using measurable roadway characteristics and traffic conditions that are important to bicyclists' and pedestrians' perceptions of accommodation. These include roadway links, signalized intersections, and separate shared-use paths. HCM Chapter 17 provides a methodology to evaluate street segments. The full application of this method blends an analysis of a "link" and a downstream intersection into LOS for a "segment."

The procedures the project team used in adopting the HCM methodology included a preparation phase and an implementation phase. For preparation, the project team developed an analytical spreadsheet containing the HCM LOS equations. The team made site visits to each designated location/site to collect geometric and roadway characteristic data (lane widths, presence of curb, pavement condition, etc.). Following the site visits, the team entered the data into the spreadsheets to calculate the BLOS link score and corresponding letter grade (A-F) for each site's BLOS.

The HCM recognizes that the "link"-based analysis can be used as a stand-alone procedure for evaluation of bicycle service, rather than conducting an analysis of a more extensive roadway segment. Local, regional, and state transportation agencies regularly use the link-based approach. If offers the advantage of being less data-intensive than the full "segment" methodology and produces results that are generally reflective of bicycle perception of service along the roadway. It can be especially attractive when agencies are performing a network-wide evaluation for a large number of roadway links.

The resulting "link" LOS does not consider some aspects of bicycle travel along a segment (e.g., intersection service). For this reason, the LOS score for the link should not be aggregated for the purpose of characterizing facility performance. Also, the link approach precludes an integrated multimodal evaluation because it does not fully reflect segment performance.

LOS Values

The project team prepared an Excel spreadsheet from the HCM analysis for automating the calculation process. Using a series of inputs including variables, equations, and values from the HCM, staff calculated a BLOS score for a given link ($I_{b,link}$), which correlates to letter grade of LOS. A higher LOS score reflects a poorer LOS. Conversely, a lower LOS score reflects a better LOS.

LOS VALUES

LOS	LOS Score ($I_{b,link}$)
A	**≤2.00**
B	>2.00-2.75
C	>2.75-3.50
D	>3.50-4.25
E	>4.25-5.00
F	>5.00

LOS Variables

The link based bicycle LOS score is based on variables listed below in bullet points.

A "[+]" symbol indicates that an *increase* in the variable generally results in a *lower* LOS Score (i.e. an increase in the variable *improves* LOS) . A "[-]" symbol indicates that an increase in the variable results in a *higher* LOS Score (i.e. an increase in the variable *worsens* LOS). For example, an increase in the width of the paved outside shoulder results in lower –better- LOS score. An increase in the proportion of on-street parking results in higher – worse – LOS score.

- Number of Lanes **[+]**
- Pavement Condition Rating **[+]**
- Width of Outside Through Lane **[+]**
- Width of Paved Outside Shoulder **[+]**
- Width of Bicycle Lane **[+]**
- Proportion of On-Street Parking **[-]**
- Mid-Segment Demand Flow Rate **[-]**
- Percent Heavy Vehicles in the Mid-Segment Demand Flow Rate **[-]**
- Motorized Vehicle Running Speed [-]
- Presence of Curb **[*]**
- Roadway is Divided **[**]**

* Curbing reduces effective width of paved outside shoulder by 1.5' and therefore worsens LOS.

** If street is divided for some lower volume roadways, it may reduce effective total width of outside through lane, bicycle lane, and shoulder as a function of traffic volume – thereby worsening LOS.

Example Spreadsheet

The Excel spreadsheet produced the table on the next page using the following hypothetical data as inputs:

- 2 lane roadway
- Pavement condition: 2

- 12’ wide outside through lane
- 9.5’ wide paved outside shoulder
- 5’ wide bicycle lane
- 0.20 on-street parking
- 940 vehicles per hour midsegment demand flow rate
- 8 percent heavy vehicles in the midsegment demand flow rate
- 33 mph motorized vehicle running speed
- Curb is present, street is not divided

The calculated link-based LOS score for these assumptions is **4.02** which results in bicycle LOS **D**.

Variable	Title	Equation	Value
LOS	**Level of Service**	**Lookup Values from HCM Exhibit 17-4**	**D**
$I_{b,link}$	Bicycle LOS Score for Link	=0.76+Fw+Fv+Fs+Fp	4.02
F_w	Cross-section adjustment factor	=-0.005 We^2	-3.38
F_v	Motorized vehicle volume adjustment factor	=0.507 ln(vma/4Nth)	2.42
F_s	Motorized vehicle speed adjustment factor	=0.199 [1.1199 ln(Sra-20)+0.8103](1+0.1038PHVa)^2	2.46
F_p	pavement condition adjustment factor	=7.066/Pc^2	1.77
W_e	effective width of outside through lane (ft)	if(Wbl+Wos*<4.0 ft,Wv-10Ppk>=0,Wv+Wbl+Wos*-20Ppk>=0)	26
v_{ma}	adjusted midsegment demand flow rate (veh/hr)	if (Vm>4Nth, Vm, 4Nth)	940
N_{th}	number of through lanes on the segment in the subject direction of trave (# of lanes)	number of lanes > 0	2
S_{Ra}	adjusted motorized vehicle running speed (mi/hr)	If (SR<21 mi/hr, 21, SR)	33
P_{Hva}	adjusted percent heavy vehicles in midsegment demand flow rate (%)	If (AND([vm(1-0.01PHV)<200 veh/hr,],[PHV>50%]),50%,PHV)	8
P_c	Pavement condition rating	range: >0 (failure) - 5 (excellent)	2
W_t	total width of the outside through lane, bicycle lane, and paved shoulder	if(PPk=0.0.Wt=Wol+Wbl+Wos*,Wt=Wol+Wbl)	17
W_{ol}	width of outside through lane (ft)		12
W_{os*}	adjusted width of paved outside shoulder; if curb is present Wos*=Wos-1.5>=0.0, otherwise Wos*=Wos (ft)	if(curb="yes",Wos-1.5>=0.0,Wos)	8
W_{os}	width of paved outside shoulder (ft)		9.5
W_{bl}	width of bicycle lane = 0.0 if bicycle lane not provided (ft)		5
W_v	effective total width of outside through lane, bicycle lane, and shoulder as a function of traffic volume (ft)	if(OR(Vm>160 veh/hr, street is divided),Wt,Wt*(2-0.005Vm)	17
P_{pk}	proportion of on street parking (decimal)		0.20
v_m	midsegment demand flow rate (veh/hr)		940
P_{HV}	percent heavy vehicles in the midsegment demand flow rate (%)		8
S_R	motorized vehicle running speed (mi/hr)		33
Curbed?	Presence of Curb	yes or no	yes
Divided?	Street is divided	yes or no	no

Data Sources

The project team conducted site visits during spring/summer of 2012 to each of the town center locations to collect geometric information, including the following:

- Number of through lanes
- Pavement condition rating
- Width of outside through lane
- Width of paved outside shoulder
- Proportion of on street parking
- Presence of curb
- Whether street is divided or not

The team also identified speed limits in the field or in some cases by consultation with MassDOT's Roadway Inventory files. *Source:* *http://services.massdot.state.ma.us/maptemplate/RoadInventory*

Traffic flow and percentage of heavy vehicle data were derived from Automatic Traffic Recorder (ATR) counts taken by the Cape Cod Commission within the years 2010-2012. Due to the significant seasonal and monthly traffic fluctuations on Cape Cod, counts were modified using MassDOT's monthly adjustment factors, available in the Cape Cod Traffic Counting Report. June counts were not adjusted, as they roughly correlate with Cape Cod's "30th Highest Hour" or "Design Hour". The design hour represents a typical weekday evening peak hour in June is commonly used in Cape Cod traffic volume calculations]

Source: *http://www.capecodcommission.org/resources/transportation/counts/pdf_count/CapeCod2011TrafficCountingReport.pdf*

PEDESTRIAN LEVEL OF SERVICE (PLOS) METHODOLOGY

While collecting data for BLOS, the project team noted the presence of sidewalks. If sidewalks were present, the team did not conduct a LOS analysis. The team conducted PLOS calculation only in locations that lacked sidewalks (e.g. Truro). PLOS is calculated using variables also input for BLOS:

- Width of paved outside shoulder
- Midsegment demand flow rate in direction of travel
- Number of through lanes on the segment in the subject direction of travel
- Motorized vehicle running speed
- Presence of curb?
- Street is divided?

One additional variable is included for PLOS:

- Parking is striped?

BICYCLE LEVEL OF SERVICE BY TOWN

The *LOS Summary Sheet* below shows the locations of data collection and the LOS scores.

TABLE 4 – BLOS SUMMARY SHEET

Town	Street		Location	Direction	BLOS Score for Link	BLOS	Side walk?
Bourne	Route 6 & Route 28 (Main St Buzzards Bay)		West of St. Margaret Street	EB	6.49	F	Yes
				WB	6.45	F	Yes
Sandwich	Main Street		East of Route 130	EB	3.20	C	Yes
				WB	3.71	D	Yes
Falmouth	Route 28 (Main St)		East of King Street	EB	5.07	F	Yes
				WB	4.27	E	Yes
Mashpee	Great Neck Road North		South of Route 130	NB	4.69	E	No
				SB	5.35	F	Yes
Barnstable	Main Street (Hyannis)		West of Winter Street	WB	4.82	E	Yes
Yarmouth	Route 28 (Main St)		East of Wood Road	EB	5.29	F	Yes
				WB	4.61	E	Yes
Dennis	Route 28 (Main St)		East of Telegraph Road	EB	5.85	F	Yes
				WB	5.52	F	Yes
Harwich	Route 39 (Main St)		East of Route 124 (Pleasant Lake Av)	EB	5.19	F	Yes
				WB	5.12	F	Yes
Chatham	Main Street		West of Chatham Bars Av	EB	5.63	F	Yes
				WB	5.55	F	Yes
Brewster	Route 6A (Main St)		East of Route 124	EB	4.80	E	No
				WB	5.03	F	Yes

Town	Street		Location	Direction	BLOS Score for Link	BLOS	Side walk?
Orleans	Main Street		East of Route 6A	EB	5.92	F	Yes
				WB	6.11	F	Yes
Eastham	Route 6		South of Samoset Road	NB	6.28	F	No
				SB	6.29	F	Yes
Wellfleet	Main Street		At Methodist Church	EB	4.26	E	Yes
				WB	4.19	D	Yes
Truro	Truro Center Road (Old Route 6A)		North of Castle Road	NB	2.64	B	No
				SB	2.95	C	No
Provincetown	Bradford Street (Route 6A)		Between Winslow St & Prince St	EB	5.51	F	Yes
				WB	10.45	F	No

ANALYSIS

All of the town center study area locations are "shared" facilities, meaning that bicycles and motor vehicles occupy the roadway space without a separate facility for bicycles (e.g. a designated bicycle lane). All locations have sidewalks except for Truro), and while they could accommodate bicycles, they are not considered bicycle "facilities" for the purposes of this report. (A pedestrian LOS field summary sheet for Truro is provided in the Town LOS Summaries section.) Paved shoulders exist in some town centers but generally are of insufficient width to be considered a bicycle facility.

High traffic volumes, lack of separation between motor vehicles and bicycles, and on-street parking (characteristics typical of downtown settings), are the general reasons for the poor-fair BLOS scores in most locations. In some cases, motor vehicle speed limit also affected BLOS. (Most of the town centers have a posted speed limit between 25 and 35 mph, with a few at 40 mph.) The scoring methodology also counts the presence of curbs (which are commonplace elements of a downtown street) as a "negative" on BLOS The percentage of heavy vehicles on the roadway was generally about 4-6% but was 12% in Bourne. None of the locations studied was a divided roadway.

The HCM BLOS methodology appears to be biased somewhat towards separate facilities for bicycles and motor vehicles over "shared road" conditions, which are the prevalent form of bicycle accommodations in downtowns/town centers due to existing land use and development patterns. The LOS scoring methodology also does not consider the potential safety benefits resulting from a high proportion of bicyclists using a roadway.

In busy downtowns, with a high volume of bicyclists in the street, motor vehicles tend to slow down to accommodate the bikes, and bicyclists' perception of safety may be enhanced.

The methodology could be adjusted or customized for shared road conditions. The variables used in the HCM methodology are appropriate for LOS analysis, but an adjusted scoring system (e.g. "grading on a curve") or an adjusted LOS letter system to create a customized "Cape Cod" bicycle/pedestrian LOS score that reflects Cape users' perceptions and conditions may be useful for future LOS analyses given that the bicycle and pedestrian LOS score is based on cyclists' and walkers' perception of their travel.

The primary value in conducting the LOS analysis is identification and understanding of factors that affect a bicyclist's/pedestrian's perception of safety, as well as collection of useful data about roadway features. The actual scores resulting from this study may be less important, given qualitative factors related to setting and motorist behavior and potential biases in scoring methodology. Additional inputs both quantitative and qualitative might produce a BLOS analysis that is more applicable to downtown/town center conditions and could be considered for future BLOS studies.

POTENTIAL IMPROVEMENTS/RECOMMENDATIONS

The potential improvements/recommendations section following each town's LOS summary sheet and analysis focuses on safety improvements that could be provided within the existing road footprint (i.e. without additional pavement/widening). While additional facilities such as bicycle lanes and wider shoulders outside the existing footprint may be viable options in some town centers, understanding their feasibility requires additional data and analyses beyond the scope of this report. Exploring such options could be considered as a "next step" to this study.

A "share the road" program with signage, sharrows, and other pavement markings is a relatively low-cost, easy to implement safety improvement in town center locations without separate bicycle facilities where bicycles and motorists must share limited space. A road or lane "diet" that reduces and reconfigures existing vehicle travel lane width to create shoulder space for bicycles may also be a viable option in some locations. Providing additional space for cyclists, even if it is less than the generally recommended four foot minimum shoulder width, is beneficial. Lowering vehicle speeds in the town center may be an option in some town centers as well.

TOWN LEVEL OF SERVICE SUMMARIES

This section of the report provides BLOS and PLOS field sheet summaries and analyses for each town location. Included with each sheet is a brief analysis of the primary factors impacting the BLOS score plus potential safety improvements/recommendations. All recommendations provide options for improvements that could occur within the existing roadway footprint. No recommendations involve road widening or improvements

outside the footprint. While additional facilities such as bicycle lanes and wider shoulders outside the existing footprint may be viable options in some locations, their feasibility requires additional data and analyses beyond the scope of this report.

As discussed in the Methodology section, pedestrian LOS was calculated only for sites that lack sidewalks (e.g. Truro). Sidewalk presence is indicated for each town following the data sheet.

Note about the maps:

The maps in this report are produced by the GIS Department of the Cape Cod Commission, a division of Barnstable County. The information depicted on these maps is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel level analysis. It should not substitute for actual on-site survey, or supersede deed research."

BARNSTABLE

Location of data collection: Main Street, west of Winter Street (Hyannis)

LOS score: E (4.82)

BARNSTABLE (HYANNIS) - MAIN STREET. LOOKING EAST (L) AND LOOKING WEST (R). THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.

LOS FIELD SHEET SUMMARY DATA – BARNSTABLE (HYANNIS)

Variable	Feature	Value	Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	2	2 westbound lanes
P_c	Pavement condition rating	3	Fair - good
W_{ol}	Width of outside through lane (ft)	10.8	
W_{os}	Width of paved outside shoulder (ft)	8	parking
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	
P_{pk}	Proportion of on street parking (decimal)	0.90	
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	384	
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	3	
S_R	Motorized vehicle running speed (mi/hr)	35	
Curbed?	Presence of Curb	yes	Both sides of road
Divided?	Street is divided	no	

PEDESTRIAN LOS

Sidewalk?	Yes.

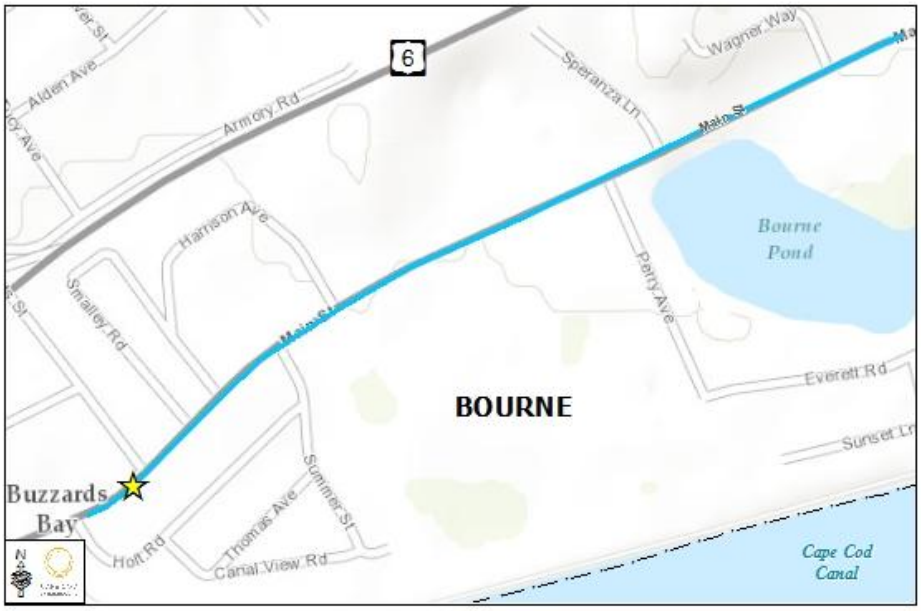
Potential Improvements/Recommendations For busy downtowns such as Hyannis, a "share the road" signage program with sharrows or other pavement markings may help reduce potential conflicts between bicycles and motor vehicles (however, the BLOS scoring methodology does not account for these). Reduced vehicle speed also would improve BLOS score. A more complex but potential safety improvement would be a road or lane "diet" that reduces and reconfigures the roadway cross-section to create space for a bicycle lane.

BOURNE

Location of analysis: Main Street, west of St. Margaret Street, Buzzards Bay*
*Note: The Town of Bourne recently (October 2012) completed a significant streetscape improvement project for Main Street that includes new sidewalks, crosswalks, other pedestrian amenities, and traffic calming elements

LOS score: F (6.45) Eastbound/F (6.45) Westbound

BOURNE (BUZZARDS BAY) - MAIN STREET. LOOKING WEST (L) AND LOOKING EAST (RIGHT). *(SEE NOTE BELOW) THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.



LOS FIELD SHEET SUMMARY DATA - BOURNE

Variable	Feature	Value		Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB	
P_c	Pavement condition rating	3	3	Fair -good
W_{ol}	Width of outside through lane (ft)	14.4	13.2	
W_{os}	Width of paved outside shoulder (ft)	8	8	Parking lane/spaces
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0	
P_{pk}	Proportion of on street parking (decimal)	0.10	.10	
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	616	364	
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	12	12	
S_R	Motorized vehicle running speed (mi/hr)	40	40	
Curbed?	Presence of Curb	yes	yes	
Divided?	Street is divided	no	no	

PEDESTRIAN LOS

Sidewalk?	Yes.

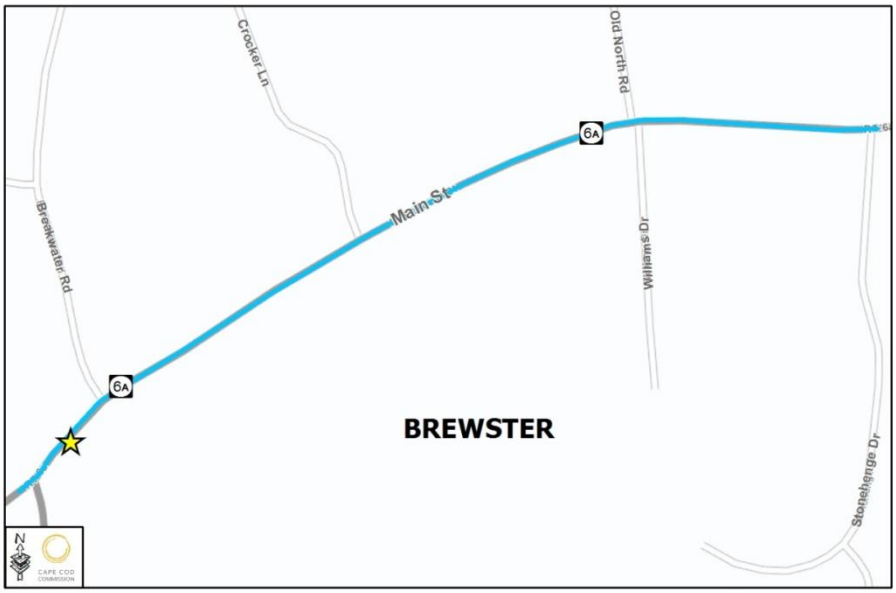
Potential Improvements/Recommendations: Creating a separate space in the road for bicycles would increase BLOS, and with fairly wide existing vehicle lanes, a "lane diet" and restriping plan that reduces vehicle lane width (and/or eliminates on-street parking areas) to create a bicycle lane or shoulder on each side of the road may be possible. Lowering speed limit below the current 40 mph would improve BLOS. A "share the road" signage program that includes pavement markings such as sharrows provides a relatively low-cost safety improvement but should only be implemented where the speed limit is 35 mph or lower.

BREWSTER

Location of data collection: Route 6A, east of Route 124

LOS score: E (4.80) Eastbound/F (5.03) Westbound.

BREWSTER - ROUTE 6A/MAIN STREET EAST OF ROUTE 124. LOOKING EAST (L) AND LOOKING WEST (R). THE YELLOW STAR ON THE MAP BELOW MARKS APPROXIMATE LOCATION OF DATA COLLECTION.



LOS FIELD SHEET SUMMARY DATA - BREWSTER

Variable	Feature	Value	Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB
P_c	Pavement condition rating	5	4 New/very good
W_{ol}	Width of outside through lane (ft)	12	12
W_{os}	Width of paved outside shoulder (ft)	1	1
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0
P_{pk}	Proportion of on street parking (decimal)	0	0
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	470	545
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	6	6
S_R	Motorized vehicle running speed (mi/hr)	40	40
Curbed?	Presence of Curb	no	no
Divided?	Street is divided	no	no

PEDESTRIAN LOS

Sidewalk?	Yes.

Potential Improvements/Recommendations: A lane "diet" and restriping plan that reduces the vehicle lanes to 11 feet each could provide room for an additional foot of paved shoulder on each side without road widening. While a two-foot shoulder is not ideal, it would create additional room for bicycles. (In some areas of Route 6A the existing paved shoulder is greater than one foot.) Reduced travel speeds would also improve BLOS. Given the proximity of the Cape Cod Rail Trail to Route 6A in Brewster, a signage and education program that guides cyclists to alternate routes, including "connectors" between Route 6A and the rail trail, could help provide safer options than Route 6A for bicycles.

CHATHAM

Location of analysis: Main Street, west of Chatham Bars Road.

LOS score: F (5.63) Eastbound /F (5.55) Westbound

CHATHAM - MAIN STREET. LOOKING EAST (L) AND LOOKING WEST (R). THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.

LOS FIELD SHEET SUMMARY DATA - CHATHAM

Variable	Feature	Value	Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB
P_c	Pavement condition rating	2	2 fair
W_{ol}	Width of outside through lane (ft)	9.2	9.8
W_{os}	Width of paved outside shoulder (ft)	8	8
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0
P_{pk}	Proportion of on street parking (decimal)	.95	0
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	232	201
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	4	4
S_R	Motorized vehicle running speed (mi/hr)	25	25
Curbed?	Presence of Curb	yes	yes
Divided?	Street is divided	no	no

PEDESTRIAN LOS

Sidewalk?	Yes.

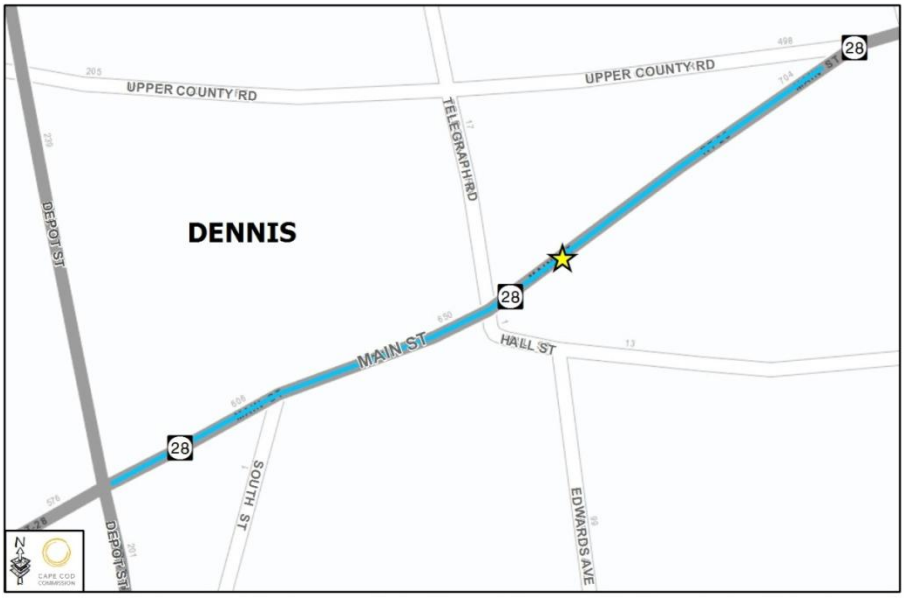
Potential Improvements/Recommendations: For busy downtowns such as Chatham's, a "share the road" signage program with sharrows or other pavement markings may help reduce potential conflicts between bicycles and motor vehicles (however, the BLOS scoring methodology does not account for these). With narrow vehicle lanes, heavily used on-street parking, and sidewalks located on both sides of the road, reconfiguring the existing roadway cross-section to provide a separate bicycle facility is a less viable option. As Main Street continues beyond the downtown, providing separate bicycle facilities (paved shoulder or bike lane) within the right of way may become more viable.

DENNIS

Location of analysis: Route 28, east of Telegraph Road

LOS score: F (5.85) Eastbound/F (5.52) Westbound

DENNIS (DENNISPORT) - ROUTE 28. LOOKING EAST (L) AND LOOKING WEST (R). THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.



LOS FIELD SHEET SUMMARY DATA -DENNIS

Variable	Feature	Value	Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB
P_c	Pavement condition rating	2	2 fair
W_{ol}	Width of outside through lane (ft)	11.2	10.7
W_{os}	Width of paved outside shoulder (ft)	8	.75 parking
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0
P_{pk}	Proportion of on street parking (decimal)	.50	0
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	335	302
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	6	6
S_R	Motorized vehicle running speed (mi/hr)	25	25
Curbed?	Presence of Curb	yes	yes
Divided?	Street is divided	no	no

PEDESTRIAN LOS

Sidewalk?	Yes.

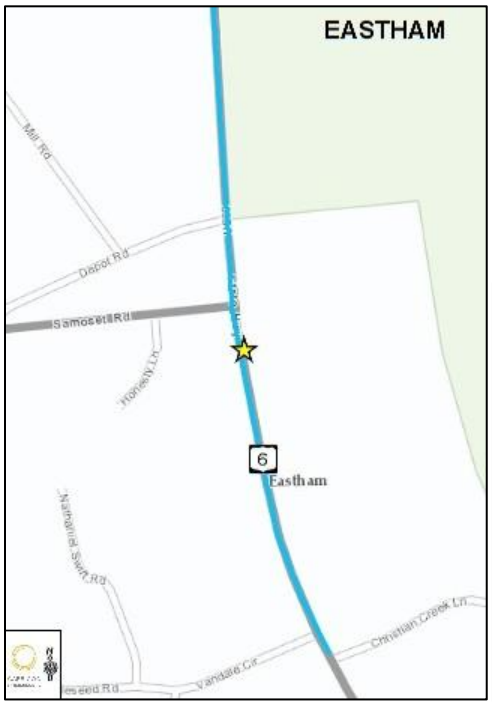
Potential Improvements/Recommendations: A "share the road" signage program that includes pavement markings such as sharrows could provide relatively low-cost and easy to implement strategy to improve safety on roads where motorists and bicycles must share road space. Providing separate bicycle facilities such as a paved shoulder could enhance BLOS on Route 28/Main Street.

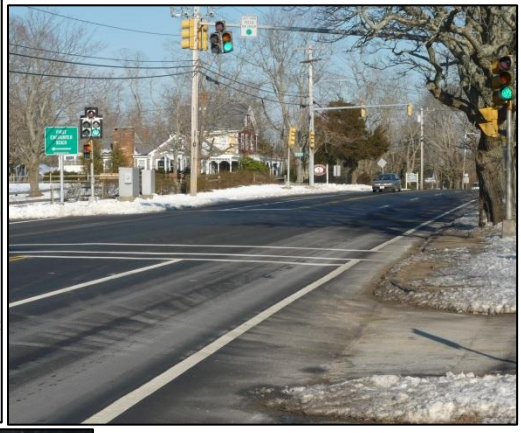
EASTHAM

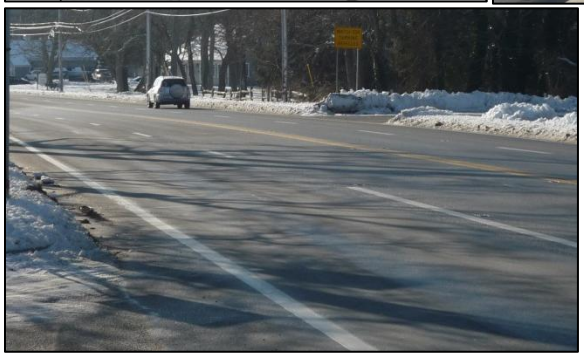
Location of analysis*:* Route 6, south of Samoset Road

LOS score: F (6.28) Northbound/F (6.29) Southbound

EASTHAM - ROUTE 6. LOOKING NORTH (TOP PHOTO) AND LOOKING SOUTH (BOTTOM PHOTO). THE YELLOW STAR ON MAP MARKS APPROXIMATE DATA COLLECTION LOCATION.







LOS FIELD SHEET SUMMARY DATA - EASTHAM

Variable	Feature	Value	Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 NB	1 SB
P_c	Pavement condition rating	2	2 fair
W_{ol}	Width of outside through lane (ft)	11.8	11.9
W_{os}	Width of paved outside shoulder (ft)	2.8	2.8
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0
P_{pk}	Proportion of on street parking (decimal)	0	0
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	703	738
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	6	6
S_R	Motorized vehicle running speed (mi/hr)	40	40
Curbed?	Presence of Curb	yes	yes
Divided?	Street is divided	no	no

PEDESTRIAN LOS

Sidewalk?	Yes.

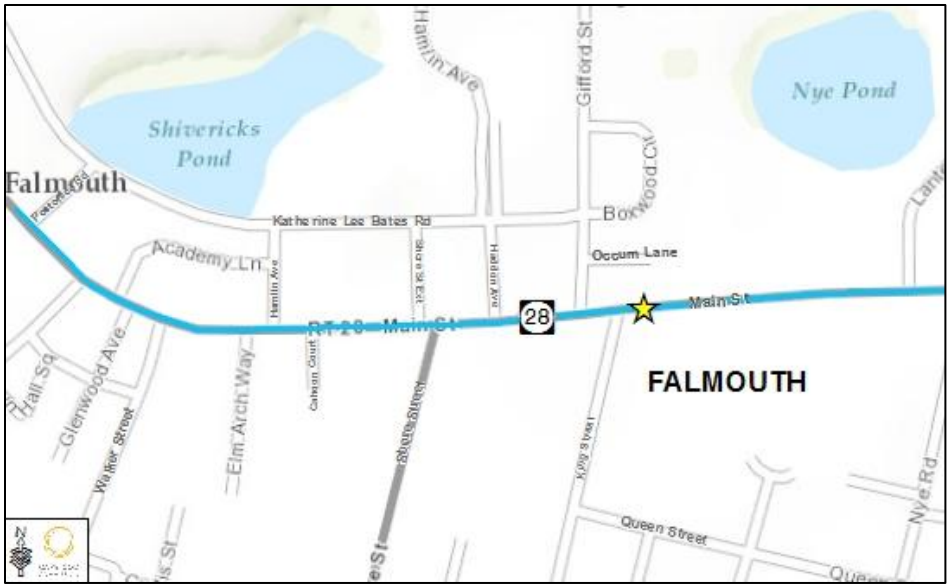
Potential improvements/Recommendations: A "share the road" approach in this location is not safe due to the vehicle speeds. While additional shoulder area may provide more room for bicyclists; the existing roadway footprint could accommodate wider shoulders only by a "diet" that either reduces existing lane width or eliminates a lane. With travel lanes of about 10.5 feet, lane width reduction is not feasible, and eliminating a travel lane on Route 6 would require substantial analysis and traffic studies (and is unlikely to gain support).Given the difficulty of either implementing a share the road approach or providing separate bicycle facilities at this location, using alternate routes such as the Cape Cod Rail Trail and local connector roads to access the town center is recommended. A signage program to direct bicyclists to both the rail trail and interconnecting bicycle routes could help guide them to safer alternatives to access the town center area. For destinations on Route 6 (such as the post office and adjacent residential neighborhoods) that lack connections to alternate routes, improving the existing sidewalk on the east side to accommodate cyclists, as well as adding a sidewalk to the west side, may be an option.

FALMOUTH

Location of analysis: Route 28 (Main Street), east of King Street.

LOS score: F (5.07) Eastbound/E (4.27) Westbound

FALMOUTH - ROUTE 28 MAIN STREET. LOOKING EAST (L) AND LOOKING WEST (R). THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.



FALMOUTH LOS FIELD SHEET SUMMARY DATA

Variable	Feature	Value		Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB	
P_c	Pavement condition rating	3	3	good
W_{ol}	Width of outside through lane (ft)	15	14.3	
W_{os}	Width of paved outside shoulder (ft)	0	8	Parking lane in some locations varies from both sides, to one side, to none.
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0	
P_{pk}	Proportion of on street parking (decimal)	0	0	On street parking varies.
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	722	516	
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	6	6	
S_R	Motorized vehicle running speed (mi/hr)	35*	35*	*Speed limit not posted in study area.
Curbed?	Presence of Curb	yes	no	
Divided?	Street is divided	no	no	

PEDESTRIAN LOS

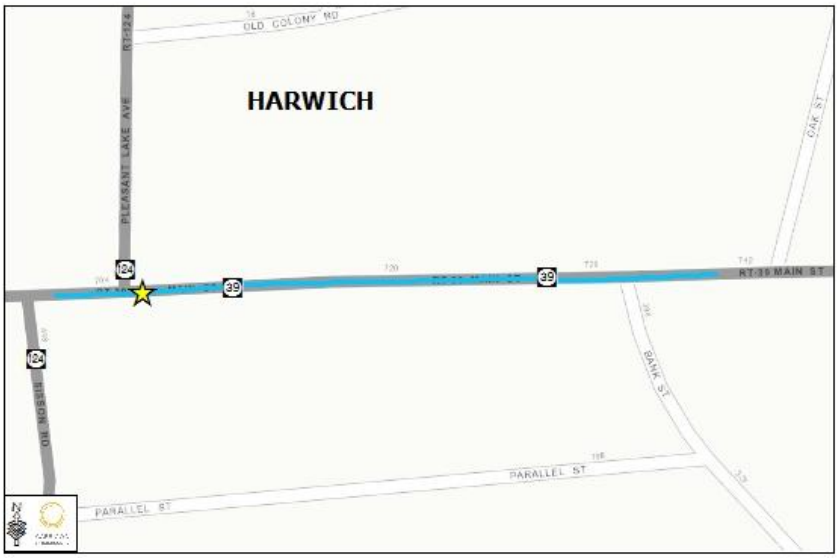
Sidewalk?	Yes.

Potential improvements/Recommendations: A "share the road" signage program that provides pavement markings such as sharrows is a relatively low-cost strategy to improve safety on roads where motorists and bicycles must share road space. The 15 foot eastbound lane could be reduced to accommodate a separate four foot shoulder space for bicycles. Paved shoulder space less than four feet adjacent to curbs generally is not recommended for bicycling; however, providing more separation between motor vehicles and bicycles would improve BLOS.

Location of data collection: Route 39 (Main Street), east of Route 124 (Pleasant Lake Avenue)

LOS score: F (5.19) Eastbound/ F (5.12) Westbound

HARWICH - ROUTE 39 (MAIN STREET). LOOKING WEST (L) AND LOOKING EAST (R). THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.



LOS FIELD SHEET SUMMARY DATA HARWICH

Variable	Feature	Value	Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB
P_c	Pavement condition rating	3	3 good
W_{ol}	Width of outside through lane (ft)	9	10
W_{os}	Width of paved outside shoulder (ft)	8	8 parking
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0
P_{pk}	Proportion of on street parking (decimal)	.50	0
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	478	472
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	6	6
S_R	Motorized vehicle running speed (mi/hr)	25	25
Curbed?	Presence of Curb	yes	yes
Divided?	Street is divided	no	no

PEDESTRIAN LOS

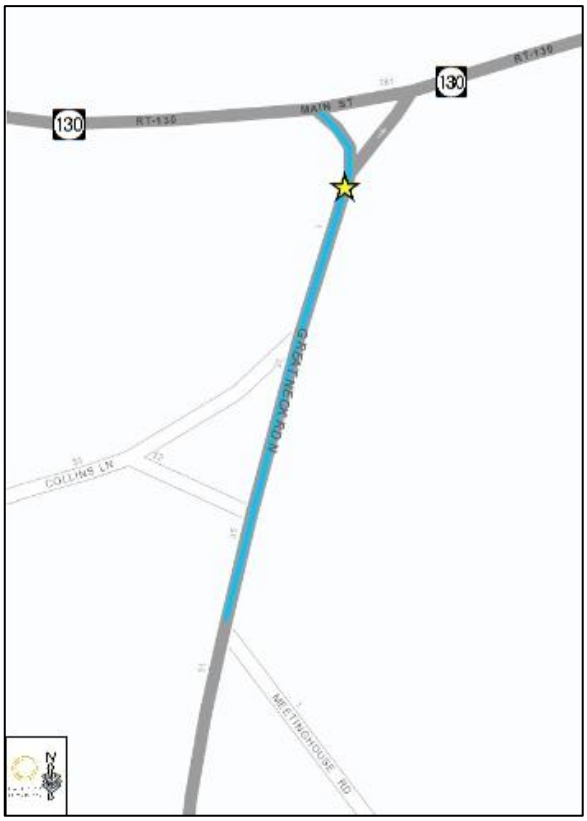
Sidewalk?	Yes.

Potential improvements/Recommendations: A "share the road" signage program that includes pavement markings such as sharrows could provide relatively low-cost and easy to implement improvements for bicyclists headed for town center/Main Street destinations. Directional signage to guide bicyclists to the rail trail and connecting roads as an alternative to Route 39 could help direct thru-bicyclists to a safer route. Elimination of the parking areas could create additional space for bicycles (i.e. a shoulder or bike lane) but may not be a desired option in this location.

MASHPEE

Location of data collection: Great Neck Road North, south of Route 130

LOS score: E (4.69) Northbound/F (5.35) Southbound



MASHPEE - GREAT NECK ROAD NORTH. LOOKING NORTH (TOP) AND LOOKING SOUTH (BOTTOM). THE YELLOW STAR ON THE MAP ABOVE MARKS DATA COLLECTION LOCATION.

LOS FIELD SHEET SUMMARY DATA - MASHPEE

Variable	Feature	Value		Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 NB	1 SB	
P_c	Pavement condition rating	3	3	good
W_{ol}	Width of outside through lane (ft)	14.9	10.8	
W_{os}	Width of paved outside shoulder (ft)	1.2	1.1	
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0	
P_{pk}	Proportion of on street parking (decimal)	0	.2	
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	820	730	
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	5	5	
S_R	Motorized vehicle running speed (mi/hr)	30	30	Speed limit higher away from Town Hall, towards rotary.
Curbed?	Presence of Curb	yes	yes	No curb on much of EB side.
Divided?	Street is divided	no	no	

PEDESTRIAN LOS

Sidewalk?	Yes.

Potential improvements/recommendations: A "share the road" signage program that provides pavement markings such as sharrows is a relatively low-cost strategy to improve safety on roads where motorists and bicyclists must share space. A lane "diet" for the 15-foot northbound lane could provide additional shoulder space for bicyclists on both sides. Paved shoulders adjacent to curbs (e.g. the southbound lane) generally are not recommended for bicycling, but providing more room for bicycles would improve BLOS.

ORLEANS

LOS Analysis Location: Main Street, east of Route 6A

LOS score: F (5.95) Eastbound/F (6.11) Westbound

ORLEANS - MAIN STREET, LOOKING EAST. THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.

LOS FIELD SHEET SUMMARY DATA - ORLEANS

Variable	Feature	Value		Observations/Notes
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB	
P_c	Pavement condition rating	4	4	very good
W_{ol}	Width of outside through lane (ft)	12	12	
W_{os}	Width of paved outside shoulder (ft)	7	7	parking
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0	
P_{pk}	Proportion of on street parking (decimal)	.6	.7	
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	346	502	
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	2	6	
S_R	Motorized vehicle running speed (mi/hr)	33*	33*	Speed limit not posted in this area
Curbed?	Presence of Curb	yes	yes	
Divided?	Street is divided	no	no	

PEDESTRIAN LOS

Sidewalk?	Yes.

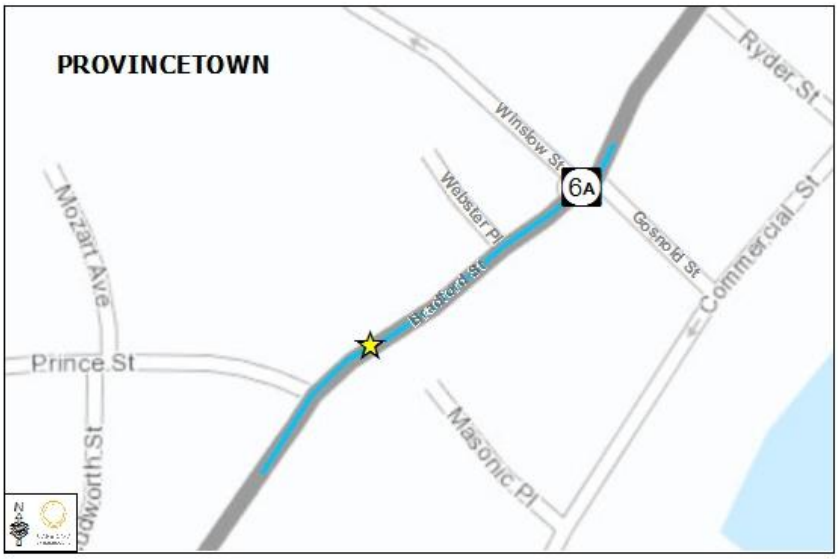
Potential improvements/Recommendations: For busy downtowns such as Orleans, a "share the road" signage program that provides pavement markings such as sharrows may help reduce potential conflicts between bicycles and motor vehicles in the shared roadway space (however, the BLOS scoring methodology does not account for these). With 12 foot vehicle lanes, heavily used on-street parking, and sidewalks located on both sides of the road, reconfiguring the existing roadway cross-section to provide separate bicycle facilities on each side of the road is a less viable (and more complex) option. As Main Street continues outside the downtown, providing separate bicycle facilities (paved shoulder or bike lane) within the right of way may be more viable in some areas.

PROVINCETOWN

Location of analysis: Bradford Street, between Winslow Street and Prince Street

LOS score: F (5.51) Eastbound/F (10.45) westbound

PROVINCETOWN - BRADFORD STREET. LOOKING EAST (L) AND LOOKING WEST (R). THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.



LOS FIELD SHEET SUMMARY DATA - PROVINCETOWN

Variable	Feature	Value		Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB	
P_c	Pavement condition rating	2	1	Fair/Poor –due to construction
W_{ol}	Width of outside through lane (ft)	11.7	13.8	
W_{os}	Width of paved outside shoulder (ft)	0	0	
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0	
P_{pk}	Proportion of on street parking (decimal)	0	0	
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	259	214	
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	7	7	
S_R	Motorized vehicle running speed (mi/hr)	25	25	
Curbed?	Presence of Curb	no	no	Yes (curb) in some places
Divided?	Street is divided	no	no	

PEDESTRIAN LOS

Sidewalk?	Yes.

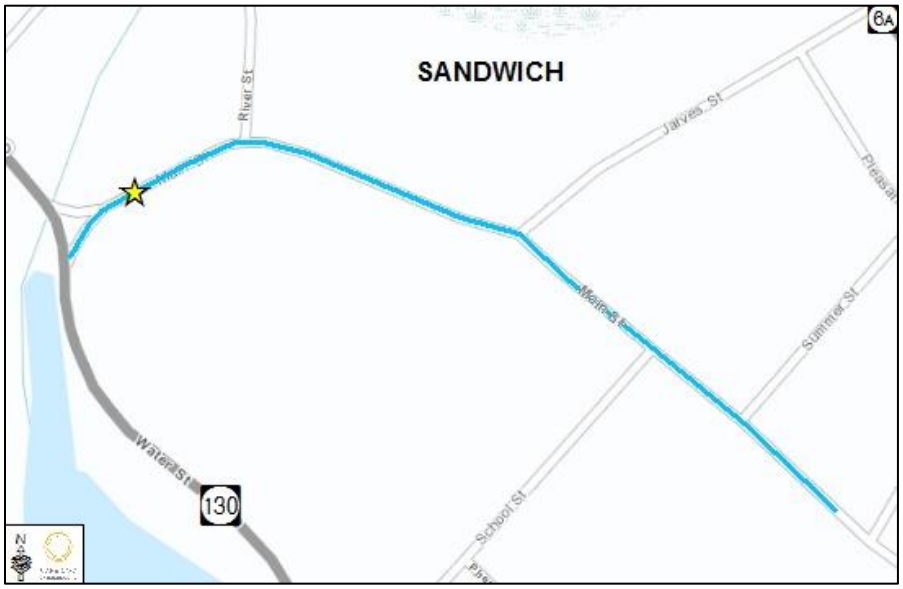
Potential improvements/Recommendations: For busy downtowns like Provincetown's, a "share the road" signage program that includes pavement markings such as sharrows may help reduce potential conflicts between bicycles and motor vehicles (however, the LOS scoring methodology does not account for these). It may be possible to provide a narrow shoulder on each side by reducing each vehicle lane to 10 feet. A narrow paved shoulder adjacent to a curb generally is not recommended for a bicycle facility, but providing more separation between motor vehicles and bicycles would improve BLOS. Providing separate bicycle facilities (e.g. paved shoulder or bike lane) within the right of way may be more viable as Bradford Street continues beyond the downtown. Improving pavement condition would also increase BLOS performance.

SANDWICH

Location of analysis: Main Street, east of Route 130

LOS score: C (3.20) Eastbound/ D (3.71) Westbound

SANDWICH MAIN STREET: LOOKING EAST (L) AND LOOKING WEST (R). THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.



SANDWICH LOS FIELD SHEET SUMMARY DATA

Variable	Feature	Value		Observations & Notes
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB	
P_c	Pavement condition rating	3	3	good
W_{ol}	Width of outside through lane (ft)	13	12.2	
W_{os}	Width of paved outside shoulder (ft)	.8	0	
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0	
P_{pk}	Proportion of on street parking (decimal)	.25	.5	On street parking varies-both sides in some areas, on one side only and none in others.
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	106	103	
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	6	6	
S_R	Motorized vehicle running speed (mi/hr)	25	25	Speed limit not posted.
Curbed?	Presence of Curb	yes	yes	
Divided?	Street is divided	no	no	

PEDESTRIAN LOS

Sidewalk?	Yes.

Potential improvements/Recommendations: A "share the road" program that includes pavement markings such as sharrows signage may help reduce potential conflicts between bicycles and motor vehicles in the shared roadway space (however, the BLOS scoring methodology does not account for these). Reducing vehicle lane width could create (minimal) additional shoulder space for bicyclists.

TRURO

Location of analysis: Truro Center Road/Old Route 6A north of Castle Road

LOS score: B (2.64) Northbound/C (2.95) Southbound

TRURO - TRURO CENTER ROAD. LOOKING NORTH (L) AND LOOKING SOUTH (R). THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.

LOS FIELD SHEET SUMMARY DATA - TRURO

Variable	Feature	Value	Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB
P_c	Pavement condition rating	3	3 good
W_{ol}	Width of outside through lane (ft)	11.4	12
W_{os}	Width of paved outside shoulder (ft)	0	0
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0
P_{pk}	Proportion of on street parking (decimal)	0	0
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	41	65
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	7	7
S_R	Motorized vehicle running speed (mi/hr)	30	30
Curbed?	Presence of Curb	no	no
Divided?	Street is divided	no	no

PEDESTRIAN LOS

Sidewalk?	Yes.

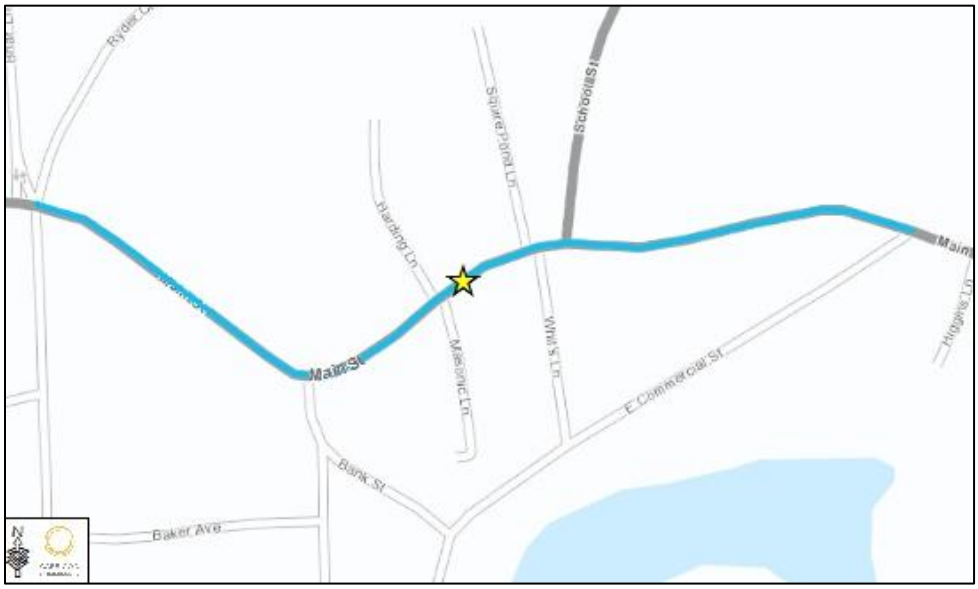
Potential improvements/Recommendations: Low traffic volumes, low speed limit, good pavement condition, and lack of curbing all contribute to Truro Center's fair – good BLOS performance. A "share the road" signage program that includes pavement markings such as sharrows may help reduce potential conflicts between bicycles and motor vehicles in the shared roadway space (however, the BLOS scoring methodology does not account for these). In addition, it may be possible to create a narrow shoulder on each side by reducing each vehicle lane to 10 -10.5 feet and striping shoulder space for bicycles.

WELLFLEET

Location of analysis: Main Street, at the Methodist Church

LOS score: E (4.26) Eastbound/D (4.19) Westbound

WELLFLEET - MAIN STREET: LOOKING WEST (L) AND LOOKING EAST (R). THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.



LOS FIELD SHEET SUMMARY DATA - WELLFLEET

Variable	Feature	Value		Notes
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB	
P_c	Pavement condition rating	5	5	New
W_{ol}	Width of outside through lane (ft)	10.2	11.1	
W_{os}	Width of paved outside shoulder (ft)	0	0	
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0	
P_{pk}	Proportion of on street parking (decimal)	0	0	On street parking is provided on Main Street eastbound side between Bank Street and Holbrook Street.
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	203	216	
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	8	8	
S_R	Motorized vehicle running speed (mi/hr)	25	25	
Curbed?	Presence of Curb	yes	yes	
Divided?	Street is divided	no	no	

PEDESTRIAN LOS

Sidewalk?	Yes.

Recommendations: A share the road signage program that includes pavement markings such as sharrows is a relatively low-cost strategy to reduce conflicts between motorists and bicycles in the shared roadway space. (However, the BLOS scoring methodology does not account for these improvements.) With narrow vehicle lanes and sidewalks located on both sides of the road, reconfiguring the existing cross-section to provide separate bicycle facilities on each side of the road is a less viable (and more complex) option.

YARMOUTH

Location of data collection: Route 28 (Main Street), east of Wood Road

LOS score: F (5.29) Eastbound)/E (4.61) Westbound

YARMOUTH ROUTE 28: LOOKING EAST (L) AND LOOKING WEST (R). THE YELLOW STAR ON THE MAP BELOW MARKS DATA COLLECTION APPROXIMATE LOCATION.

LOS FIELD SHEET SUMMARY DATA - YARMOUTH

Variable	Feature	Value		Comments
N_{th}	Number of through lanes on the segment in the subject direction of travel (# of lanes)	1 EB	1 WB	
P_c	Pavement condition rating	3	3	good
W_{ol}	Width of outside through lane (ft)	14.4	18.8	Width where data collected on WB side reflects turn-area & isn't characteristic of lane elsewhere.
W_{os}	Width of paved outside shoulder (ft)	1	0	
W_{bl}	Width of bicycle lane = 0.0 if bicycle lane not provided (ft)	0	0	
P_{pk}	Proportion of on street parking (decimal)	0	0	
v_m	Midsegment demand flow rate in direction of travel (veh/hr)	563	624	
P_{HV}	Percent heavy vehicles in the midsegment demand flow rate (%)	7	7	
S_R	Motorized vehicle running speed (mi/hr)	35	35	
Curbed?	Presence of Curb	yes	yes	
Divided?	Street is divided	no	no	

PEDESTRIAN LOS

Sidewalk?	Yes.

Recommendations: A lane "diet" that reduces each vehicle lane to 11 feet could provide additional space to create a shoulder on each side within the existing road footprint. A fog line should be provided as well to delineate the shoulder area. A paved shoulder adjacent to a curb generally is not recommended as a bicycle facility, but providing more separation between motor vehicles and bicycles would improve BLOS in this location. Share the road signage to alert drivers to bicyclists' presence may enhance safety as well. (Lane sharing between bicyclists and motorists is not recommended in this location due to motor vehicle speeds and traffic volumes.)

CAPE COD COMMISSION

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