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To: Sandy Fry, City of Hartford

From: Francisco Gomes, Fitzgerald & Halliday Inc.

Date: 12/18/19

Re: Bike Boulevard Design Investigation Findings

Contraflow Travel on One-Way Streets

Contraflow operation on one-way bike boulevards is allowed by State statute and is supported by existing guidelines and standards. Design and application standards are provided by FHWA and NACTO for all contra-flow facilities. A striped contraflow lane can be used on Bike Boulevards and should be provided where contraflow traffic is desirable and feasible. The FHWA and NACTO guidance recommends careful consideration along corridors with frequent driveways and curb cuts.

Design of the contraflow lane should be consistent with the following guidance:

- Install on right side of the street facing one-way traffic (left side in the direction of one-way traffic). The contraflow lane should be separated from the motor vehicle lane with a double-yellow line.
- Provide contraflow lane width of 5 to 6 feet, 6 feet is preferred.
- Post signage indicating bicyclists may enter the one-way street. Place signage on all streets intersecting the contraflow lane so that drivers expect two-way bicycle traffic.

Chicanes (Offset Bumpouts)

Research[1] indicates that chicanes can produce speed reductions that average 12 mph. In general, path angles of 15 to 20 degrees result in 85th percentile speeds of between 20 and 25 mph, whereas path angles of about 10 degrees allow 85th percentile speeds of over 30 mph. Given this information, a path angle of 15 degrees (approximately 1:4 taper) is recommended for use.

While chicanes are effective in reducing travel speed, they require the prohibition of parking from segments of the roadway in proximity of the chicane and can potentially result in the loss of several spaces of parking capacity. Chicanes also need to be located where they will not conflict with driveways. Chicanes should be offset from the curb by five feet to prevent the interruption of drainage and allow bicyclists to bypass the chicane.

There is a lack of clear guidance regarding the design of chicanes from FHWA or ITE. States and municipalities have long led the way in experimenting with various prototypes. A strict interpretation of MUTCD taper requirements for traffic lanes suggests that many, if not most, chicanes that have been built for traffic calming purposes are not compliant with those taper requirements. The taper requirements established within the MUTCD, however, are generally more relevant to higher volume and higher speed arterial and collector roadways with delineating traffic lanes versus a low speed, low volume local roadway that lacks traffic lane striping. As such, the MUTCD guidance should not be considered relevant to the purpose of traffic calming devises such as chicanes that seek to reduce traffic speeds and require yielding when opposing traffic is present. Best practices from built examples in other communities and engineering judgement have been employed in the conceptual designs presented in these recommendations.

1. Transport Research Library, Traffic calming — an assessment of selected on-road chicane schemes, 1998

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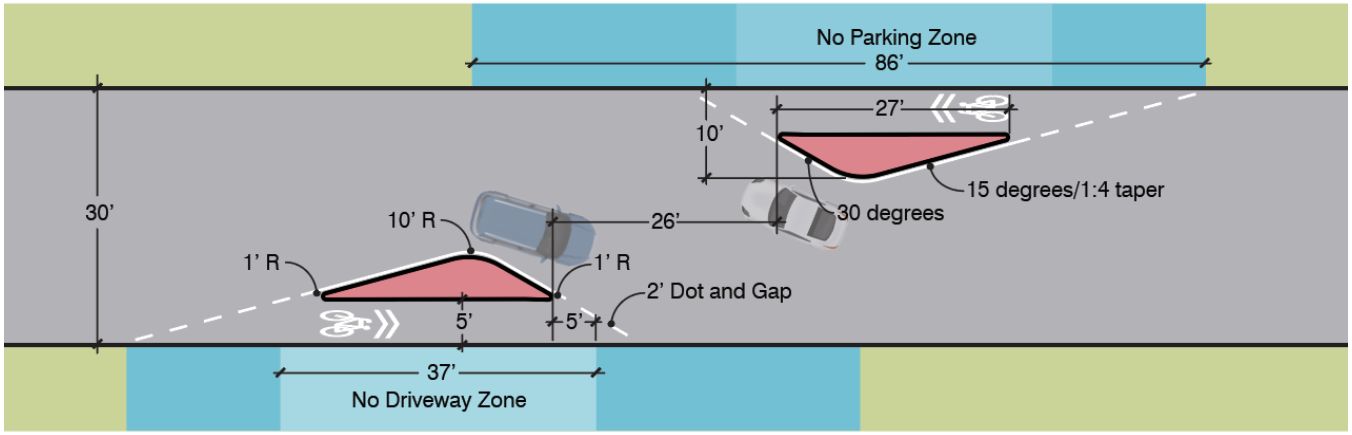

Figure 1: Chicane application on a 30' wide roadway

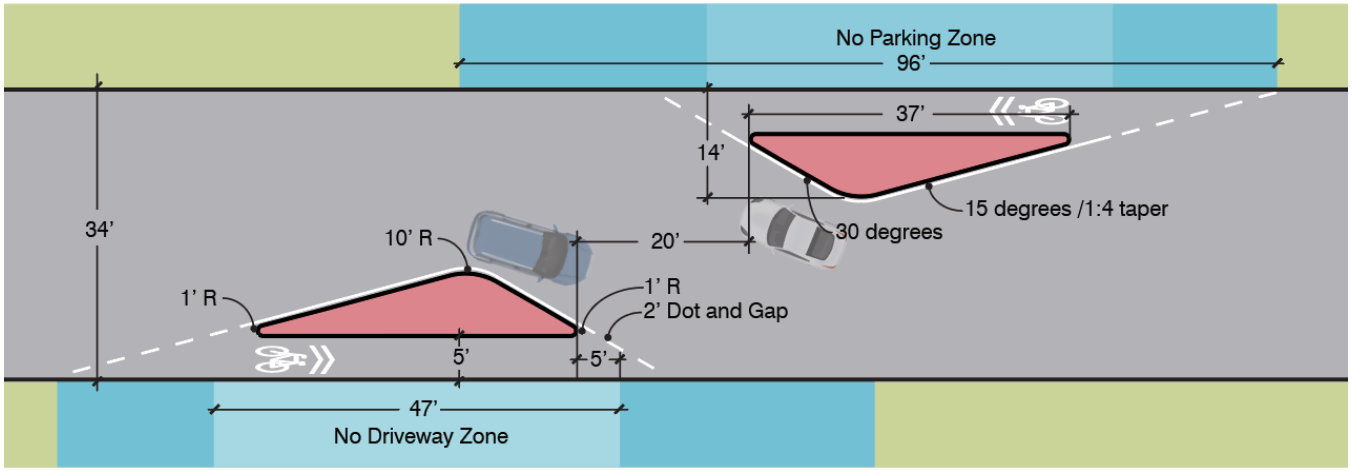

Figure 2: Chicane application on a 34' wide roadway

*Chicane Cost Estimate**

Roadway Size	Interim: Traffic delineator post construction. Acrylic pavement markings.	Permanent: Granite curb with paver or stamped asphalt surface. Epoxy pavement markings.
30 feet	$2,000 per pair	$30,000 per pair
34 feet	$2,500 per pair	$40,000 per pair

*These cost estimates are planning level estimates and are not inclusive of potential impacts to drainage, drainage structures, or other utility structures. The conceptual designs were prepared to avoid or minimize these impacts, but a full survey and engineering is required to assess the probable construction cost.

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Chicanes vs. Speed Humps

The City of Seattle has experimented with both chicanes and speed humps (as well as traffic circles). The City reached the following conclusions following analysis of the effectiveness of these devices (excerpt from Marek & Walgren, City of Seattle Transportation Department):

Both chicanes and speed humps are used in Seattle as mid-block speed control. Although one is not necessarily better than the other, there are advantages and disadvantages to each. Based on our experience with chicanes we have found they have been very effective at reducing high-end speeders and bringing mid-block speeds closer to the non-arterial limit of 25 mph. Chicanes have also lowered cut-through traffic and encouraged motorists to use nearby arterial routes. Another important characteristic of chicanes is that they visually change the appearance and character of a street, thus changing driver's perception. Some of the disadvantages of chicanes are that they are relatively expensive devices to install. The cost for installing chicanes is approximately $14,000 for one set of 3 concrete bulbs and $8,000 for 3 bulbs constructed with precast traffic curb and asphalt. Chicanes can also be problematic to design, especially with regards to curb bulb location and driveways. Other disadvantages include increasing emergency response time and reducing available on-street parking. Seattle's experience with speed humps has shown that the Watts style hump is also an effective tool for reducing speeds on local streets. Speed humps may also reduce volumes if an easy alternative arterial route is available. Speed humps are easier to locate and less likely to conflict with driveway locations. The relative low cost of speed humps also make them more feasible to install. One disadvantage with speed humps that Seattle has experienced is that, when compared with chicanes, speed humps are not as effective at reducing high end speeders. Also, speed humps do not change the appearance of the street to the same extent as chicanes. Similar to chicanes, speed humps could also increase emergency response time. Seattle has learned that, as with any traffic control devices, it is important to identify and understand what problems you are attempting to solve and to educate the community on the various trade-offs involved when making the choice installing chicanes or speed humps.

Median Island

The effectiveness of median island diverters varies, with typical traffic speed reduction ranging from 1 to 6 mph as documented by FHWA[2]. The presence of on-street parking reinforces the effectiveness of median islands in reducing speeds due to the chicane effect caused by the on-street parking. Therefore, median islands are most effectively used on corridors with regular on-street parking, particularly those that allow on-street parking on both sides of the roadway. Median islands are less effective on corridors that prohibit parking from one side of the roadway as there is little deflection of traffic on that side of the roadway.

Similar to chicanes, there is a lack of clear guidance regarding the design of median island devices as a traffic calming element from FHWA or ITE. States and municipalities have long led the way in experimenting with various prototypes. A strict interpretation of MUTCD taper requirements for traffic lanes suggests that the use of a median island would require substantial taper distances that would be highly impactful to on-street parking and would negate any traffic calming impact. The taper requirements established within the MUTCD, however, are generally more relevant to higher volume and higher speed arterial and collector roadways with delineating traffic lanes versus a low speed, low volume local roadway that lacks traffic lane striping. As such, the MUTCD guidance should not be considered relevant to the purpose of traffic calming devises such as median island traffic calming devices that seek to reduce traffic speeds and require yielding when opposing traffic is present. Best practices from built examples in other communities and engineering judgement have been employed in the conceptual designs presented in these recommendations.

An additional consideration is the clear width that is required or preferred by Fire Departments. This requirement is typically 14 feet of clear width, which allows sufficient space for response vehicle operation when parked and responding to a fire. It is not clear that this requirement would be necessary for limited distances. A traffic island may also be considered an acceptable obstruction within that clear zone as the island may be mountable. Discussion with the Hartford Fire Department is recommended for this, and all other traffic calming concepts.

2. FHWA Engineering Speed Management Countermeasures: A Desktop Reference of Potential Effectiveness in Reducing Speed July 2014

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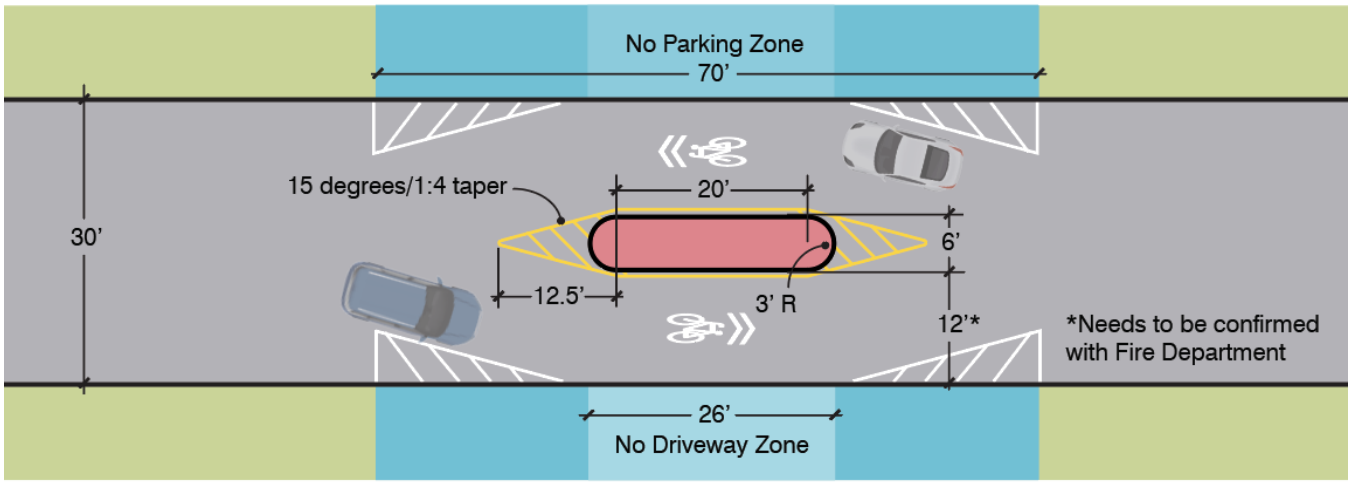

Figure 3: Median island deflection on a 30' wide roadway

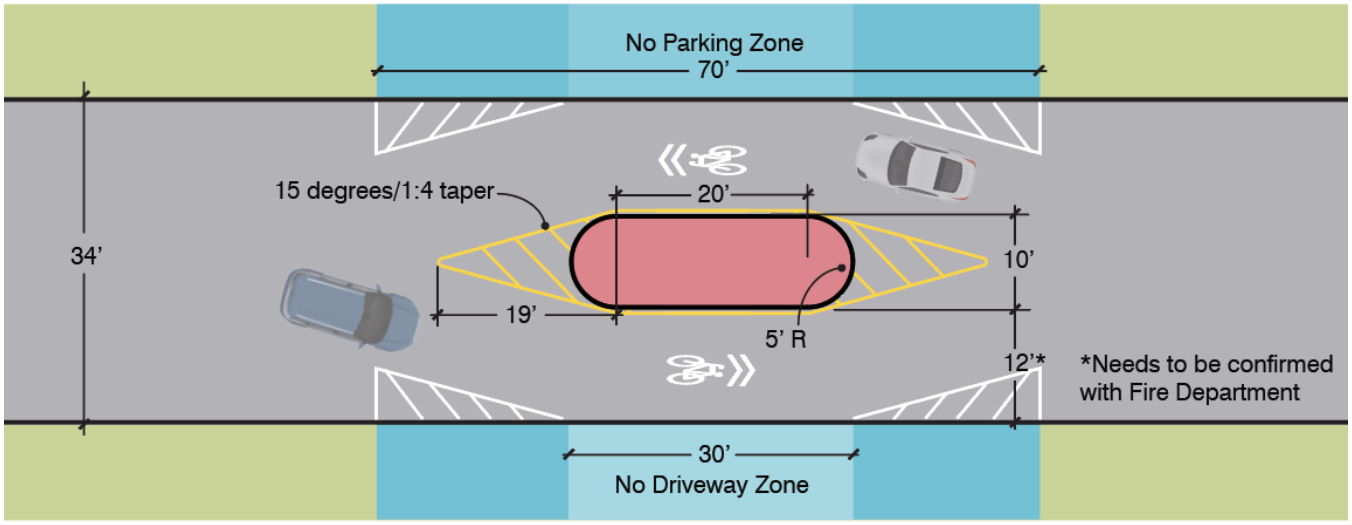

Figure 4: Median island deflection on a 34' wide roadway

*Median Island Cost Estimate**

Roadway Size	Interim: Rubber curb. Acrylic pavement markings.	Permanent: Granite curb with paver or stamped asphalt surface or landscaped surface. Epoxy pavement markings.
30 feet	$2,500 per median	$15,000 per median
34 feet	$3,000 per median	$20,000 per median

*These cost estimates are planning level estimates and are not inclusive of potential impacts to drainage, drainage structures, or other utility structures. The conceptual designs were prepared to avoid or minimize these impacts, but a full survey and engineering is required to assess the probable construction cost.

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Traffic Circles

The feasibility of implementing traffic circles was reviewed for several locations. The turning movements of passenger and BUS (School or City) vehicles was checked for each intersection. Turning movements are feasible at all locations, with left turning passenger vehicles circling the traffic circle and BUS vehicles turning left in front of the traffic circle, as is customary for this intersection treatment.

The primary constraint to implementing traffic circles at the proposed locations is the existence and location of marked crosswalks. Intersections with marked crosswalks are subject to encroachment of through vehicles into crosswalk under the traffic circle scenarios. This movement is not desirable.

We propose the following approach as a means of addressing the crosswalk encroachment issue:

1. Use a small traffic circle as an interim measure coupled with curb bumpouts where warranted to ensure adequate traffic deflection and speed reduction.

2. In permanent installations, crosswalks and curb ramps should be offset from existing locations to remove them from the path of through vehicles. This will allow for a larger traffic circle and greater speed reduction.

The intersection specific recommendations, per location, are as follows:

Intersection	Interim Recommendation	Permanent Recommendation
Hampton and Kensington	15' circle, curb bumpouts at each approach	24' circle, curb bumpouts at each approach
Affleck and Lincoln	10' circle, bumpouts on west side of roadway	10' circle, bumpouts on west side of roadway, relocated curb ramps and new crosswalk
Affleck and Madison	10' circle, bumpouts on west side of roadway	10' circle, bumpouts on west side of roadway, relocated curb ramps and new crosswalk
Affleck and Jefferson	10' circle, bumpouts on west side of roadway	10' circle, bumpouts on west side of roadway, relocated curb ramps and new crosswalk
Babcock and Russ	10' circle, bumpout at southwest corner, modify crosswalk markings	12' circle, bumpout at southwest corner, restripe/relocate crosswalks
Beacon and Warrenton	12' circle, reduce curb radius at southwest corner	12' circle, reduce curb radius at southwest corner
North Beacon and Cone	10' circle	10' circle

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The conceptual level cost estimates are as follows*:

Intersection	Interim Measures	Cost of Interim Measures	Permanent Measures	Cost of Permanent Measures
Hampton and Kensington	Rubber curb traffic circle. Traffic delineator post bumpouts. Acrylic pavement markings.	$6,000	Granite curbed landscaped traffic circle. Granite curbed bumpouts with paver or stamped asphalt surface. Epoxy pavement markings.	$60,000
Affleck and Lincoln	Rubber curb traffic circle. Traffic delineator post bumpouts. Acrylic pavement markings.	$3,000	Granite curbed traffic circle with paver or stamped asphalt surface. Granite curbed bumpouts with landscaped surface. Relocated curb ramps. Epoxy pavement markings.	$20,000
Affleck and Madison	Rubber curb traffic circle. Traffic delineator post bumpouts. Acrylic pavement markings.	$3,000	Granite curbed traffic circle with paver or stamped asphalt surface. Granite curbed bumpouts with landscaped surface. Relocated curb ramps. Epoxy pavement markings.	$20,000
Affleck and Jefferson	Rubber curb traffic circle. Traffic delineator post bumpouts. Acrylic pavement markings.	$3,000	Granite curbed traffic circle with paver or stamped asphalt surface. Granite curbed bumpouts with landscaped surface. Relocated curb ramps. Epoxy pavement markings.	$20,000
Babcock and Russ	Rubber curb traffic circle. Traffic delineator post bumpouts. Acrylic pavement markings.	$4,000	Granite curbed traffic circle with paver or stamped asphalt surface. Granite curbed bumpout with landscaped surface. Relocated curb ramps. Epoxy pavement markings.	$30,000
Beacon and Warrenton	Rubber curb traffic circle. Traffic delineator post realignment of southwest corner. Acrylic pavement markings.	$4,000	Granite curbed traffic circle with paver or stamped asphalt surface. Granite curbed bumpout with landscaped surface. Relocated curb ramp and new sidewalk. Epoxy pavement markings.	$30,000
North Beacon and Cone	Rubber curb traffic circle. Acrylic pavement markings.	$2,000	Granite curbed traffic circle with paver or stamped asphalt surface. Granite curbing at southwest corner realignment with new curb ramp and sidewalk. Epoxy pavement markings.	$10,000

*These cost estimates are planning level estimates and are not inclusive of potential impacts to drainage, drainage structures, or other utility structures. The conceptual designs were prepared to avoid or minimize these impacts, but a full survey and engineering is required to assess the probable construction cost.