Advisory Bicycle Lane Design Guide

This guide attempts to more completely address facility selection and design issues for Advisory Bike Lanes in the North American context.

I reference information from the 2016-2017 survey of twelve North American ABL facilities co-authored by me, the 2016 Dutch CROW bicycle design manual, and the 2016 FHWA Small Town and Rural Multimodal Networks guide (AKA the FHWA Small Town guide in this work).

This guide is organized as a series of questions one might ask themselves when considering an ABL as a potential design solution.

Disclaimer: I am not a licensed Professional Engineer. All information in this guide should be considered my personal opinion.

August 30, 2017 Michael Williams

WHAT TRAFFIC CHARACTERISTICS ARE APPROPRIATE FOR AN ABL?

The first decision one needs to make is whether the candidate street is appropriate for an ABL installation. For obvious reasons, a candidate street is assumed to be a two-lane street with vehicular travel in both directions.

In the Netherlands, ABLs are used in both rural and urban settings. After surveying the existing North American installations in 2017, all were in an urban or suburban setting. No rural installation is known to exist on this continent. Since the release of that survey paper, more facilities have arisen and some are in rural settings, e.g. Yarmouth, ME and Scarborough, ME.

Figure 1 Dutch ABL with Horse

Of more importance than setting are the traffic characteristics, primarily traffic volume and speed.

FHWA Small Town and Rural Multimodal Networks guide Recommendations

The FHWA Small Town and Rural Multimodal Networks guide provides recommendations for both traffic volume and speed for candidate ABL streets.

With respect to volume, it recommends a preferred ADT of less than 3,000 and a maximum ADT of 6,000. The MUTCD requires a centerline on streets over 6,000 ADT precluding use of ABLs on those streets.

This guide recommends a preferred speed of 25 MPH or less and a potential maximum speed of 35 MPH.

2016 CROW Recommendations

The 2016 CROW manual recommends a range of 2-3,000 ADT for rural roads. The manual recommends a range of 2-5,000 ADT for urban roads when the bike volumes are more than 500 bikes/day. Additionally, on urban roads, it encourages the exploration of other facilities when volume goes above 4,000 ADT.

With regards to speeds, the 2016 CROW differentiates between urban and rural facilities. Urban facilities are primarily installed on roads with 30 KPH/18 MPH speeds. They are also installed on 50 KPH/30 MPH urban roads but these higher speed roads should use a wider center travel lane than the slower roads and additional traffic calming should be considered. 50 KPH ABLs should not attempt to support too high a bicycle volume (less than 750 bikes/day is recommended).

Rural facilities are installed either on 30 or 60 KPH (18 or 35 MPH) roads. On rural roads only the narrow center lanes are allowed. This is due to the tendency to higher speeds in rural areas.

When viewed from a speed perspective, ABLs are only allowed at 35 MPH on rural roads with 2-3,000 ADT using a narrow center lane. At 30 MPH, ABLs are only allowed on urban roads with 2-4/5,000 ADT and less than 750 bikes/day using a wide center lane.

RECOMMENDATION

When I surveyed twelve sites in early 2017, seven (64%) had ADTs of 1,000 or less. The median value was 1,000 ADT, the average was 1,728 ADT and only three facilities had ADTs above 2,500 (one at 4,700 and two at 5,000).

Six of the installations were posted at 25 MPH, one used both 15 and 25 MPH and five were posted at 30 MPH.

My recommendations in this area are also informed by personal observations of Dutch ABLs at varying volume levels. During one such observation period, I was struck by the uncharacteristic hesitation that I observed from Dutch motorists and cyclists at the T-intersection of two ABL-equipped roads. Given that traffic flow in the Netherlands is normally free of such uncertainty, this indicated to me that the volumes were high enough to push the limits of the facility type. My estimate of volumes on those roads were approximately 2-3,000 ADT on one and 3-4,000 ADT on the other. Admittedly, the intersection was a worst-case scenario which combined those flows.

Until more drivers become acquainted with this facility, I consider 3,000 - 4,000 to be close to the maximum ADT for a street in the US and 30 MPH a maximum posted speed. This is purely a <u>personal</u> opinion based on information from both Dutch and American ABLs – no real data supports this position.

Street context, vehicle mix and other relevant conditions must also be weighed when making this decision but consideration of all possible factors isn't possible in this guide.

WHAT WIDTH OF ROAD IS APPROPRIATE FOR AN ABL?

Lack of available road width is often what leads an agency to consider installation of an ABL. In urban settings this is often due to an unwillingness to remove parking lanes. In rural settings, the available paved road width is often the chief constraint.

On streets with more than 30 to 32 feet of available width, standard bicycle lanes will normally be the preferred choice (two 10' travel lanes plus two bike lanes of 5+' width). Given the mixing of vehicles and bicycles that occurs on an ABL, sound reasoning should underpin the choice of ABLs over facilities with better protection.

Depending on the selection of lane widths, streets much narrower than 20 feet may have problems with higher traffic volumes, oncoming traffic being uncomfortable with passing maneuvers and center travel lane widths too narrow for driver acceptance.

RECOMMENDATION

As a rule of thumb, when available road width falls between twenty and thirty feet, an ABL can be a good alternative. Roads outside this range should be examined carefully for other options. Expansion of this range into narrower streets as drivers become more familiar with this type of facility should be explored.

FACILITY SELECTION: WHERE DOES AN ABL BEST FIT?

When considering an ABL, one may be considering other facility types as well. What criteria does one use to select between facilities suitable for low-volume, low-speed streets?

First, the desire or need for a centerline precludes an ABL. If the street will have a centerline, an ABL is not appropriate.

Figure 2 Dutch ABL on Narrow Roadway

Streets much below about 20 feet in available width will likely be better configured as a shared street. Once ABLs become familiar to American drivers, it may be possible to create ABLs with center travel lanes less than 9-10 feet which would allow them to be placed on streets narrower than 20 feet. European countries already create ABLs on streets narrower than 20 feet but this occurs where ABLs are already familiar to most, if not all, drivers. Whether this could be done successfully in North America without familiarity is open to debate.

On streets that have 20-30 feet of width available and do not need a centerline, it is possible to implement a bike boulevard as well as an ABL. The key to choosing between the two is the lateral separation between bicycles and cars. Bike boulevards are true mixed traffic facilities (cyclists and vehicles are sharing a lane) while an ABL provides separation due to its preferential channelization of the two road user types. ABLs can safely support operation with higher vehicular speeds and/or higher volumes than a bike boulevard. The key differences to be considered is the amount of car-bike passing "pressure" and the relative speeds.

One can argue that a vehicle-cyclist passing maneuver is safer on a bike boulevard because some Dutch studies have shown a small reduction in lateral separation during such maneuvers following installation of an ABL on an unmarked road. Whether this reduction (in the realm of single digits of centimeters) is meaningful is unclear.

RECOMMENDATION

This is a context-sensitive decision and guidance is non-existent on this issue. I recommend speed differential as the guiding concern here. Speeds above 25 MPH should strongly lean toward an ABL. Also of concern are resources available for traffic calming and the center lane width planned for the ABL.

WHAT ARE THE APPROPRIATE LANE DIMENSIONS FOR AN ABL?

FHWA Experimentation web page recommendations

The FHWA dashed bike lane experimentation web page suggests a center travel lane width of 16 feet or greater. Because this recommendation is significantly older, it is assumed to be superseded by the FHWA Small Town guide. Despite this suggestion being part of the experimentation webpage, the FHWA has approved ABLs with narrower center lanes. No recommendation is made on bicycle lane width.

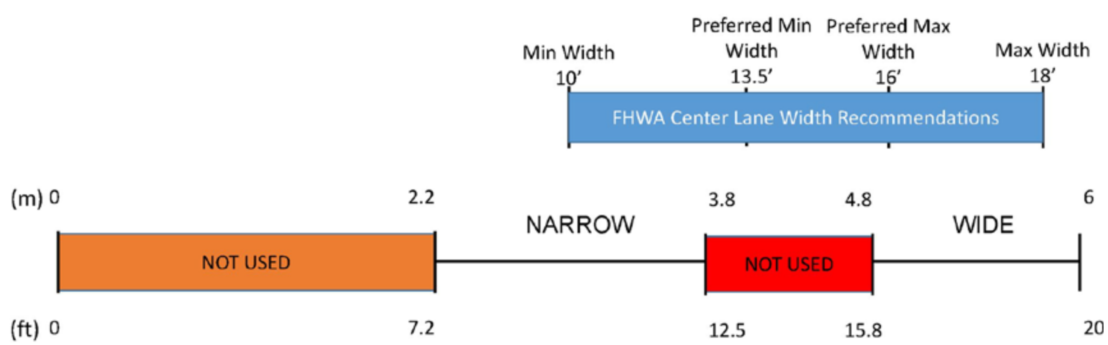
FHWA Small Town and Rural Multimodal Networks guide recommendations

The FHWA Small Town guide describes the bike lanes as having an absolute minimum width of 4 feet and a preferred width of 6 feet.

The guide gives four recommendations for center travel lane width. It recommends a minimum width of 10 feet, a preferred minimum width of 13.5 feet, a preferred maximum width of 16 feet, and an absolute maximum width of 18 feet.

2016 CROW Recommendations

The 2016 CROW manual contains more detailed guidance on this issue. It recommends against center lanes less than 2.2 m/7.2 ft though ABLs with much narrower center lanes are not uncommon. It also prohibits center lane widths between 3.8 m/12.5 ft and 4.8 m/15.8 ft. This width range is prohibited because it can produce uncertainty in the mind of the driver about whether opposing traffic can bypass without using the bike lanes. This may lead to a poor decision in the face of oncoming traffic, resulting in a conflict and possible collision. Their approach is to either make the center lane so narrow that a driver knows they will have to use the bike lanes when faced with oncoming traffic or so wide that they are sure they can bypass oncoming traffic without resorting to the bike lanes. Were this window to be applied to the American context, it may need to be increased to account for the larger vehicle sizes. A maximum center lane width is specified as 6 m/20 ft.



Advisory Bike Lane Center Lane Widths per 2016 CROW Manual

For bike lanes, the Dutch recommend widths which support side-by-side riding and bicycle-bicycle passing. As vehicular speed and volumes rise, a buffer space of .5 m/1.6 ft is added between the center lane and bike lane. The basic assumption is a bike lane of 1.7-2.25 m (5.6-7.4 ft) width with a preferred width of 2.0-2.25 m. These dimensions are for useable width only; they do not include pavement markings or areas of shy distance from fixed objects.

It is my opinion that Dutch widths for support of side-by-side riding are narrower than those needed in the American context. The geometry of Dutch bikes allow for riding closer to other cyclists because they are more stable. I once watched a mother ride next to her young daughter (7-10 years old) with her hand on her daughter's back for at least 1/8 mile. This was not an uncommon practice in the Netherlands. I do not believe this is possible for an average rider, much less a young child, on a commonly available bicycle in the US. My opinion is that bike lanes which support side-by-side riding in the U.S. need to be a minimum of 7' in width. This is wider than current published guidance recommends.

RECOMMENDATION

Whatever the dimensions chosen, it is **essential** to allocate width for the bike lanes first and use the remaining width for the center travel lane.

I recommend allocating 7 feet for each of the bike lanes and the remainder for the center travel lane to allow for a comfortable riding experience. If this results in a travel lane of unacceptably narrow width, the bike lanes may be reduced to 5 or 6 feet but it must be recognized that this change precludes comfortable side-by-side riding (such as a parent riding next to a child) and cyclist-cyclist passing maneuvers within the bike lane. The bike lane width may be adjusted depending on bicycle volume.

If insufficient bike volumes exist, a bike lane more than seven to eight feet in width could be mistaken for a travel lane. Bike lanes more than seven to eight feet wide supporting little volume may indicate the need to consider other facility types. For example, if one has 10' wide bike lanes and a 10' wide center lane, sufficient road width exists to support 2 travel lanes and 2 standard bike lanes.

If the center travel lane width exceeds 10 to 12 feet, consider widening the bike lanes to maintain the visual narrowness of the center travel lane. The center lane width may be adjusted depending on the traffic supported by the roadway.

The Dutch prohibition against center lane widths which produce uncertainty in the mind of the driver about whether two vehicles can fit without entering the bike lanes is sound. This width range likely needs to be up-sized for larger vehicles in the American context. The prohibited range of 12.5-15.8 ft might be adjusted to 14-17 ft.

If a wide center travel lane is desired, the addition of traffic calming measures should be strongly considered to keep speeds low.

The FHWA recommendations inhibit experimentation with narrower center travel lanes. Wider center lanes can engender higher vehicle speeds and higher speeds are not compatible with an ABL. ABLs with higher speeds may produce outcomes showing ABLs to be unsafe when the true root cause is a poorly designed ABL.

Two videos which show Dutch examples and a mix of vehicles are:

A video showing a Dutch ABL used by different vehicle combinations including a huge bus, 2:53
https://www.youtube.com/watch?v=L8nwEkBR7NI

A Dutch video showing an ABL on Hugo de Grootstraat with a 17.5' wide center travel lane within which two cars can pass without entering bike lanes and associated traffic calming; various vehicle combinations shown including a bus, 2:35
https://www.youtube.com/watch?v=DGMTFm_q8aI

WHAT HAPPENS AT INTERSECTIONS?

Current practice for treatment at intersections varies considerably. When surveying ABL installations across North America in 2016/2017, I found that ABL markings at intersections differed within facilities as well as between agencies.

When intersections are encountered, there are, broadly, two strategies which can be used. The first is to continue the ABL markings, both lines and contrasting pavement color/material, through the intersection. A broken edge line may have to be added if an edge line or parking lane line does not exist prior to the intersection. A variation of this treatment is to continue the ABL markings up to the stop line or crosswalk and leave the intersection area unmarked (see Figure 3). The East 14th Street ABL in Minneapolis, MN uses this strategy at signalized intersections and Valley Road in Hanover, NH uses this strategy at intersections with minor streets.

Figure 3 E. 14th St, Minneapolis ABL with no centerline

The second strategy is to convert to another treatment that allows for a centerline to be marked at the intersection. This is currently done by dropping the bike lane lines, adding a centerline and marking the travel lanes with shared lane markings (see Figure 4).

After installation of their ABNL, the City of Cambridge, MA received complaints of motorists stopped in the middle of the roadway which prevented others from turning onto the street as well as confusion about whether the street was one-way or two-way. They solved both problems by using the second strategy.

Figure 4 Cambridge ABL with centerline intersection treatment

It is interesting that few North American installations opted to install double yellow centerlines at intersections to inform drivers of the two-way nature of the street and to help vehicles position themselves appropriately. It isn't clear why this trend exists.

FHWA Small Town and Rural Multimodal Networks guide recommendations

The only domestic guidance for ABLs at intersections is the FHWA Small Town guide. As an underlying condition, the FHWA Small Town Guide recommends against installation of ABLs on streets with frequent intersections that require vehicles to stop on the roadway. This may be true in other countries, but doesn't appear to be the practice for current North American use.

The FHWA Small Town guide recommends that ABL markings and contrasting pavement be continued through all driveways and minor street crossings.

Where the ABL encounters a stop sign or traffic signal, it recommends discontinuing the treatment 50 feet in advance and providing an accessible paved shoulder or shared roadway treatment (sharrows). This type of intersection treatment is intended to provide a short stretch of yellow centerline but this isn't explicitly called out in the guide. I believe that 50 feet is the minimum distance for this transition. Depending on prevailing speeds, sight distances and/or conditions, this can sometimes be too short.

2016 CROW Recommendations

There appears to be no diagrammed guidance from the Dutch in this area. From personal observation, ABLs in the Netherlands are handled in the same way that E. 14th St is handled in Minneapolis, i.e. the striping is taken up to the crosswalk or intersection boundary.

Figure 5 Dutch ABL at intersection

RECOMMENDATION

Driveways should certainly use the first strategy: continue the ABL treatment through the driveway as is done with standard bike lanes and other street treatments. Unless conditions warrant otherwise, this is also the best strategy when ABL-equipped streets have no STOP/YIELD control at an intersection.

The choice of a treatment at an intersection where the ABL is subject to STOP or signalized control is influenced by a number of factors, the most significant of those being traffic volumes and proportion of drivers unfamiliar with the street. Other factors can be number of turning movements onto the ABL, presence of on-street parking, etc. The primary decision to be made is whether one desires a centerline at the intersection to indicate vehicle positioning or two-way use. Unfortunately, no data exists to support a specific selection algorithm.

If either higher traffic volumes or high proportions of unfamiliar drivers exist, it is wise to transition from an ABL to a treatment which provides for a short stretch of centerline.

This is most easily done by dropping the ABL markings, marking a centerline and adding shared lane markings to the travel lanes 50 – 200 feet before the intersection.

For more local, quieter intersections, bring the ABL up to the stop bar or crosswalk. If problems occur, a centerline and alternate treatment can be added.

Signage may also be of use, especially for motorists turning onto an ABL at an intersection. Signs that one may consider at intersections include the following:

- W6-3 Two-Way Traffic,
- W8-12 No Center Line,
- R8-1 No Parking on Pavement, and
- R3-17 Bike Lane.

WHAT HAPPENS AT ROUNDABOUTS?

At least one existing American ABL includes a roundabout as part of its route. This occurs at the intersection of Eastern Road and Whistler Landing in Scarborough, ME.

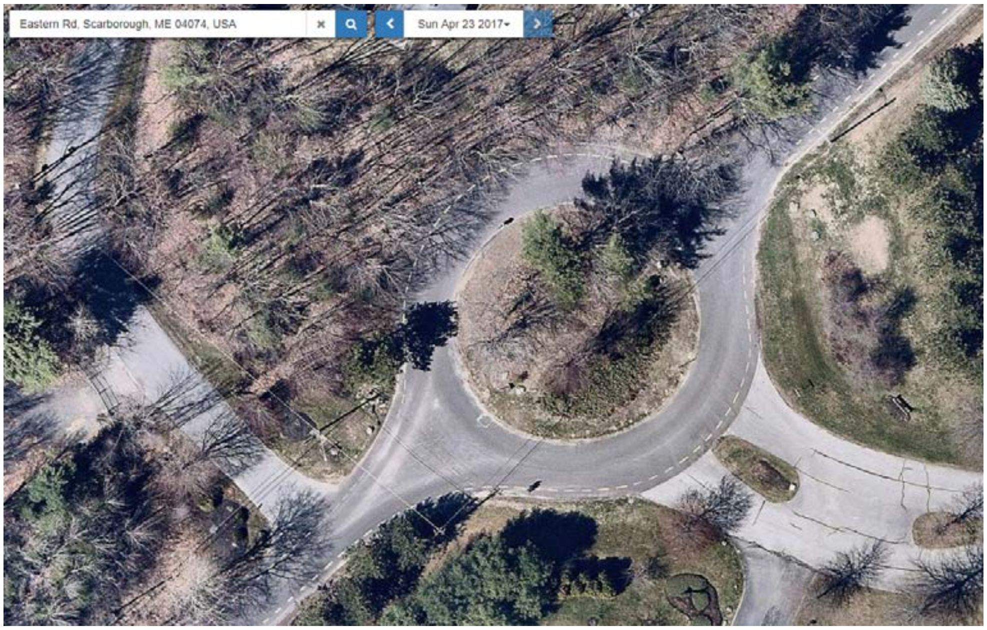


Figure 6 Roundabout on Eastern Road ABL, Scarborough, ME (Courtesy nearmap.com)

FHWA Small Town and Rural Multimodal Networks guide recommendations

The FHWA has no recommendations for ABLs at roundabouts.

2016 CROW Recommendations

There appears to be no diagrammed guidance from the Dutch in this area.

RECOMMENDATION

The bike lanes of an ABL should not be continued into the circulatory lane of the roundabout. This is contrary to MUTCD Section 9C.04 and findings of published studies of bike facilities on roundabouts.

A splitter island, whether curbed or marked should be installed to provide guidance to drivers entering and exiting the roundabout. Sufficient taper length for the splitter island should be provided as a warning to entering drivers. Signage may be necessary to inform drivers that they are on an ABL as they exit a roundabout (they may have entered the roundabout from a non-ABL-equipped street).

There are generally three options for an on-street bike lane, whether part of an ABL or not, at a roundabout. One option is to terminate the bike lane markings at least 100 feet prior to the roundabout entry and provide markings letting both cyclists and drivers know that cyclists belong in the travel lane. This is sometimes done at single lane roundabouts with low circulating speeds. Another option is to provide a connection to an off-street facility (either mixed use path or dedicated bike path) from the bike lane. Connections back to an on-street facility should be provided as well as crossings of the roundabout approaches. A third option is to combine the first two options to support various bicyclist preferences.

WHAT SIGHT DISTANCE IS NEEDED FOR AN ABL?

Sight distance requirements are critical on ABLs when vertical or horizontal curves are encountered.

FHWA Small Town and Rural Multimodal Networks guide recommendations

The only published domestic guidance is the FHWA Small Town guide. The FHWA guide adopts the use of passing sight distance as its recommendation. This distance is overly conservative and has no basis in an actual road situation. I have submitted a paper to the 2018 TRB on sight distance for ABLs and hope to have more input on my thoughts after then.

2016 CROW Recommendations

No Dutch guidance appears to exist on this subject.

RECOMMENDATION

My recommendation is to use twice the stopping sight distance (SSD) as a minimum sight distance requirement. This distance allows two vehicles to detect/recognize each other and stop before a collision occurs.

I believe the correct sight distance requirement for an ABL is a distance which allows a driver to detect and recognize oncoming traffic, check the bike lane for cyclists and respond appropriately by slowing or yielding into the bike lane. It appears that this sight distance has not yet been formulated though some alternatives may be comparable. See my paper titled “Sight Distance for Advisory Bicycle Lanes” on https://www.advisorybikelanes.com/more-info.html (if you’re reading this after 2018 TRB, it may be published).

WHAT DOES ONE DO WHEN SIGHT DISTANCES ARE NOT MET?

When the sight distance requirements are not met, something must be done to create a safe condition for all users.

RECOMMENDATION

The first step when faced with a sight distance problem is to evaluate whether the item causing the issue can be removed or relocated.

If removal or relocation is not feasible, the next step is to explore reduction of vehicular speed sufficient to eliminate the sight distance constraint. Traffic calming strategies are useful here.

Figure 7 Traffic calming on Dutch ABL

If it is not possible to eliminate the sight distance constraint, then a different treatment will be needed to reduce the possibility of a head-on collisions or vehicle-bicycle conflicts.

The most straightforward option for dealing with a sight-compromised area is to install a double yellow solid centerline complemented with bike lanes if room exists or sharrows if it does not. Widening of the roadway can be useful at these locations.

HOW DOES ONE TRANSITION INTO AND OUT OF AN ABL?

An ABL begins and ends at some point, it may need to transition to and from another treatment in sight-constrained situations, and it may need to change form at intersections. All of these situations require transitions into or out of an ABL.

Transitions between facility types are often dependent on context. Except for intersections, little guidance explicitly addresses transition design. Standard practices around transitions of other facilities such as those found in Chapter 9C of MUTCD can be useful references here.

RECOMMENDATION

Some standard principles should be observed:

- Provide sufficient warning or sight distance of the transition for all road users.
- Provide unambiguous direction and expectations for all road users.
- Signage can help, especially where markings may be obscured by snow.
- Consider context, e.g. grades, volumes, speeds when designing transitions.
- 50 – 200 feet is the range used for facility transitions at intersections in the MUTCD (see Figure 9C-6).

DOES ON-STREET PARKING WORK WITH AN ABL?

When surveying ABL installations in North America, I found ABLs were commonly chosen because removal of on-street parking was politically infeasible and insufficient room existed to install standard bike lanes.

The existence of parking lanes on an ABL-equipped street can produce the following problems:

- Unfamiliar drivers can find the street striping confusing, especially when the parking lanes are lightly used,
- High turnover in the parking lanes can produce vehicle/bicycle conflict and pedestrian/bicycle conflict as drivers access their vehicles, and
- Increased incidence of vehicle doors opening and conflicting with a cyclist (a problem known as dooring).

Figure 8 Ottawa ABL with hatched door zones

Despite these problems, ABLs with parking lanes do exist and appear to adequately work. One method of mitigating the dooring problem has been used by the City of Ottawa in their installation. They have added a 2-3 foot hatched buffer in the bike lane next to parking spaces. This provides awareness and guidance to the cyclist to ride outside the door zone. In order to implement this well, a wider bike lane will be required.

FHWA Small Town and Rural Multimodal Networks guide recommendations

The FHWA Small Town guide recommends against use of ABLs on streets with lightly-used on-street parking. This direction is to help eliminate possible driver confusion when faced with a wide street hosting a myriad of stripes and bike lanes which may look like travel lanes.

2016 CROW Recommendations

The Dutch prohibit the combination of ABLs and on-street parking on roads of 50 KPH/30 MPH or greater in urban areas. In situations where on-street parking lies next to bike lanes, a buffer space is recommended.

RECOMMENDATION

For parking lanes with high turnover rates, no guidance exists but common sense should cause one to look for better options, especially if higher vehicle volumes exist.

Per FHWA guidance, ABLs should not be implemented on streets with lightly-used parking lanes. Instead, remove the parking lanes and install dedicated or protected bike lanes.

When an ABL is installed next to a highly-utilized parking lane with moderate turnover, the use of a hatched buffer to visually communicate the door zone is intuitive and inexpensive. A wider bike lane should be created in these areas to preserve the useable width available to cyclists. Other forms of communicating the door zone area or separating the parking lane from the bike lane are possible.

WHAT PAVEMENT MARKINGS ARE USED ON AN ABL?

Because ABLs preclude the use of a centerline, design guidance for ABL pavement markings concentrates on the lines separating the center travel lane from the bike lane and the symbols inside the bike lanes. If the outer edge of the bike lanes are marked, edge lines or parking lane lines should follow MUTCD standards.

For pavement markings at intersections, see the intersection treatments section of this guide.

Color

MUTCD Section 3A.05 calls out white as the color to use when delineating traffic flows in the same direction and yellow for delineation of traffic flows in the opposite directions. Due to the bi-directional nature of the center travel lane, the bike lane lines separate both directions of traffic flows and technically qualify for both colors. Given the importance of the yielding behaviors on this facility, white is the appropriate color to use.

Line Width

Because this facility is unfamiliar to many drivers and because the default behavior is to channelize road users into their respective lanes when yielding behaviors are not required, the delineation should emphasize separation. Ideally, the delineation should be dissimilar to the delineation used to separate same-direction traffic flow lanes to avoid having the bike lane look like a travel lane and to highlight the special nature of this configuration. The Support provided in MUTCD Section 3A.06 links line width to emphasis. For these reasons, I believe a “wide line” which is defined in Section 3A.06 as “at least twice the width or a normal line” should be used. Specifically, a line width of at least 8” (or something of noticeably greater width than what is normally used for separation). This communicates that the facility is different from a normal road and emphasizes the separation.

Line Pattern

MUTCD Section 3A.06 provides guidance on the pattern of line to be used. A broken line is used to indicate a permissive condition which is exactly the intent of this delineation.

Broken lines are defined as consisting of "10-foot line segments and 30-foot gaps, or dimensions in a similar ratio of line segments to gaps as appropriate for traffic speeds and need for delineation".

The FHWA Small Town and Rural Multimodal Networks guide recommends 3 foot segments separated by 6 foot gaps. The basis for this recommendation is not clear.

I believe the FHWA Small Town recommendation is the better of the two. My personal favorite is a pattern I’ve seen used in Portland for bike lane delineation through intersections which consists of 8 inch line width with 3 foot segments interspersed with 4 foot gaps. This pattern emphasizes separation and visually differs from a normal lane line. There is no data to support my preference – it just looks “right” for a 25-30 MPH roadway.

Bike Lane Markings

The FHWA Small Town guide makes no explicit recommendation on bike symbol markings within the bike lane.

On its dashed bike lane experimentation web page, the FHWA requires use of bike lane markings in accordance "with Item C of Paragraph 6 in Section 3D.01 in the MUTCD" which refers to the use of the bicycle symbol or the words "Bike Lane".

In the 2016/2017 survey of existing installations, there was a variety of treatments used in the bike lane. Nine facilities used standard bike lane markings, two used shared lane markings and one facility had no markings on their bike lane.

RECOMMENDATION

ABL striping should emphasize separation and be dissimilar to normal vehicle lane delineation.

Given that many drivers may be unfamiliar with this facility, marking the bike lanes with bike lane symbols is important to communicate intended use.

The lines separating the center travel lane from the bike lane should be white, 8 inches wide, be composed of 3 foot stripes and 4 foot gaps.

In order to reduce confusion for unfamiliar users and to reaffirm the intended use of the lanes, use of standard bike lane markings within the bike lanes is recommended. It may be appropriate to adjust markings for a road's context. For example, low-volume roads, those dominated by local drivers, or those on which the bike lane also functions as a sidewalk may be fine without bike lane markings.

Use of standard bike lane markings versus the use of shared lane markings is a debate which is yet to occur. The shared lane markings make more sense since vehicles and bicycles share the space. It is likely that the choice between the two has little impact on most drivers. The nine surveyed facilities which used standard bike lane markings did not find these to preclude proper use of their ABLs.

WHAT SIGNAGE IS USED ON AN ABL?

Appropriate signage for an ABL is an interesting question with several answers at the moment. Of the twelve North American installations surveyed in early 2017, signage included the following:

- Some communities use no signage whatsoever.
- Some communities use Bike Lane (R3-17) signs.
- Some communities use Two Way Traffic (W6-3) signs.
- Some communities created their own signs which attempt to diagram use of the street for unfamiliar drivers.
- If on-street parking is prohibited, applicable No Parking (e.g. R7-1, R8-1, and R8.3a) or No Parking Bike Lane (R7-9, R7-9A) signs may be necessary.

Figure 9 Hanover Diagrammatic Sign

FHWA Small Town and Rural Multimodal Networks guide recommendations

The FHWA Small Town guide does not provide explicit direction on signage but lists three signs one should consider for an ABL:

W6-3 Two-Way Traffic

W8-12 No Center Line

R8-1 No Parking on Pavement


Figure 10 MUTCD W6-

Figure 11 MUTCD W8-

Figure 12 MUTCD R8-

The W6-3 sign is technically problematic because MUTCD Sections 2C.23 and 2C.44 describe its use as communicating an upcoming two-way, *two-lane* condition. However, most motorists are likely to interpret it as meaning only that two-way traffic exists.

At transitions into an ABL, one might consider use of the W5-1 Road Narrows or W20-4 One Lane Road signs.

Figure 13 MUTCD W5-1

With regard to the W5-1, MUTCD Section 2C.19 guidance states "…*a Road Narrows (W5-1) sign (see Figure 2C-5) should be used in advance of a transition on two-lane roads where the pavement width is reduced abruptly to a width such that vehicles traveling in opposite directions cannot simultaneously travel through the narrow portion of the roadway without reducing speed*". With the exception of the pavement width condition, this is highly descriptive of a transition into an ABL. The same section provides an option to omit the sign on low-volume local streets with speed limits of 30 MPH or less.

The MUTCD appears to target use of the W20-4 for temporary traffic control or for low-volume roads (< 400 ADT).

Recommendations from the FHWA Experimentation web page

On its dashed bike lane experimentation web page, the FHWA requires use of the bike lane sign, R3-17, but only six of the twelve facilities surveyed did so.

Figure 14 MUTCD R3-17

On its dashed bike lane experimentation web page, the FHWA recommends use of the two-way traffic sign, W6-3, but only two of the twelve facilities surveyed did so. Since most installations included well-used, on-street parking, the information provided by this sign could be considered redundant at those locations.

RECOMMENDATION

One of the important issues with ABLs is proper use by unfamiliar drivers. Signage can help solve this problem.

As a personal opinion, signs which attempt to educate drivers as they pass by are too complex to be easily comprehended in the time normally available. In a larger format, they can be useful during the familiarization period following installation. Large format signs provide more time for understanding and grab more attention.

I believe the use of large format, diagrammatic signs during the period following installation can speed the familiarization process for this new facility. If possible, these temporary signs should be placed where slowed or stopped cars have more time to view them. The best one I have seen is the Ottawa sign shown here.

Figure 15 Large format, instructional sign used by Ottawa

For permanent signage, a bike lane sign can be helpful, especially in areas where snowfall may obscure on-street bike lane markings.

As always, local conditions need to be considered, e.g. lack of on-street parking may necessitate use of a two way traffic sign.

HOW IS COLOR USED IN AN ABL?

Figure 16 ABL with contrasting color bike lanes

The Dutch use color successfully in their ABLs. The bike lanes are colored red and the travel lane is left uncolored (black). Red is associated with bicycle facilities throughout the Netherlands and its presence is a clear signal to drivers that the bike lanes are intended for bicycles. The dashed lines communicate a permeable barrier. This arrangement works well in their context and its use is intuitive for unfamiliar users.

The use of green for bicycle facilities is governed by the April 15, 2011 FHWA IA-14 interim approval as of this writing. This interim approval describes an allowable use as "Green colored pavement may be installed within bicycle lanes as a supplement to the other pavement markings that are required for the designation of a bicycle lane." This permits the use of green as a contrasting color on ABL bike lanes.

However, as of June, 2017, the guidance supplied by the FHWA dashed bike lane experimentation web page appears to oppose this use. It states the following:

> *"Green-colored pavement can be used, but should be limited to mixing/weaving locations and/or as a background conspicuity enhancement to the bicycle symbol, arrow, and/or pavement word markings used to mark the dashed bike lane."*

RECOMMENDATION

It is clear to me that the Dutch use of colored pavement does an excellent job communicating the purpose of the road. I believe the colorization of bike lanes in the United States works equally well. Green is the color selected for bike facilities in the United States and FHWA interim approval has been granted for marking bike lanes with that color.

I believe ABL bike lanes should be colored green whenever possible. Marking ABLs in this way provides additional information to road users and, via the experimentation process, will provide needed information on the performance of colored ABLs.

It should be noted that some ABL facilities which are not compliant with the experimental FHWA guidelines have been approved.

HOW IMPORTANT IS PUBLIC OUTREACH?

In the survey of North American ABL installations, I found that many of the successful installations included significant public outreach and education. Conversely, the only facility removed after installation did little public outreach.

An ABL trial installation in New Zealand which specifically avoided all forms of public education was terminated by the lead engineer less than 24 hours after it was begun due to public safety concerns that he felt were at least partially the results of the lack of public education.

RECOMMENDATION

This is a new facility type with a novel mode of operation. Some people will consider the concept unimaginable. Drivers can become confused or frustrated when faced with an unfamiliar street configuration. This can lead to poor reception of a new installation.

One of the lessons learned from the survey of existing ABLs was that the use of public education virtually eliminated negative reactions following installation.

Public outreach is important and should be part of the process.

WHAT OTHER DESIGN ELEMENTS ARE AVAILABLE FOR AN ABL?

Channelizing Islands

One design element used by the Dutch on their ABLs which has not yet been used in North America is the channelizing island. The usual purpose of these islands is to persuade drivers to return to the center lane. One can also envision these islands being used to notify drivers entering an ABL of their proper position.

These channelizing islands are centered on the broken delineation separating the center travel lane from the bike lane. These islands leave room for cyclists to pass unhindered on the right side. To maintain lane width for vehicles and cyclists, the road can be widened at these points although some installations narrow the center travel lane between islands for traffic calming purposes.

Figure 17 Photo of Staggered Soft Islands (Courtesy Peter Furth)

These islands come in two types. The first type can be driven over and are considered mountable (these are also called soft islands). The second type of island cannot be driven over and forces drivers to return to the center lane (these are known as hard islands). Both types can be used in a paired manner (directly across from each other), placed in a staggered fashion or used as a single element on one side only. Paired islands can be joined with a speed bump for additional traffic calming. It should be noted that the two types of islands lie on a spectrum; one could create an island with a 2-3" curb which could be driven over but provides more encouragement than the softer variety.


Figure 18 Photo of Paired Hard Islands (Courtesy Peter Furth)

More information on these islands can be found in the white paper and on a web page created by Dr. Peter Furth located at http://www.northeastern.edu/holland2016sustrans/systematic-safety-2/sustainable-safety-2-van-emmerik-and-nitka/.

On ABLs, vehicles should pass these islands on the left side. The MUTCD does not address pavement markings for islands which are intended to be passed only on the left side. In the face of unsuitable regulations, one could modify Figure 3B-15C with arrows to communicate passage on the left only. A modification of the MUTCD is required in this case.

Section 3B.10 provides a formula for calculating the taper length for pavement markings leading up to, and away from, the island. Unless islands and markings exceed 5 feet in width, the formula results always fall below the required minimums. The minimum taper lengths called out are 100 feet in urban areas and 200 feet in rural areas.

MUTCD Section 2C.64 prescribes object markers for channelizing islands. OM3-R object markers are appropriate object markers for placement on channelizing islands. Versions of the R4-8 sign may be applicable but could be confusing as well. Placement of a member of the R4-8 sign family should be considered on a case-by-case basis. An R4-8 sign may help with the lack of guidance on pavement markings.

Raised Bike Lanes

It is possible to create an ABL with raised bike lanes but I have not seen this design in practice nor have I heard this discussed anywhere.

One could envision a bike lane 2”-3” higher than the center lane with a transition which was easily mountable by vehicles, including motorcycles. This would create a sense of unease for drivers with right and left wheels at different heights and cause them to move back to the center lane sooner rather than later. This may reduce the need for channelizing islands and provide an additional sense of separation for all road users. Depending on the height difference and slope of the edge, this may not be appropriate on streets with higher speeds.

Half-ABLs

I define a half-ABL as a street with a permeable bike lane, delineated with a broken line, on one side of the street only. The other side can have a different facility type or no facility at all.

The examples of half-ABLs I have found, below, appear to achieve different goals.

Some examples of half-ABLs are listed below with a link to where they can be found on Google Maps.

1. Summer Street in Somerville, MA is a narrow street on a significant grade. The street has a bike lane delineated with broken lines on the uphill-bound side but sharrows marked in the travel lane on the downhill-bound side. A parking lane also exists on the downhill-bound side of the street.
   I assume this facility was installed because the City wanted bike facilities on Summer but was unwilling to remove the parking on the downhill side. The speed differentials on the uphill side required more protection than the downhill side. This resulted in a narrow bike lane (4 foot wide, positioned next to a concrete curb) which could be used by vehicles when necessary on the uphill side and a shared travel lane on the downhill side.

Figure 19 Half ABL in Somerville, MA (Courtesy of Phil Goff, Alta Planning+Design)

2. Shaw Road in Gibsons, B.C. in Canada was slated to receive an ABL but political concerns forced the installation of a half-ABL. This was installed in 2017. Google street view does not yet show the facility.

488 Shaw Rd
Gibsons, BC V0N 1V8, Canada

Figure 20 Half ABL in Gibsons, B.C. (Courtesy Gavin Davidson, Alta Planning+Design)

49.400764, -123.518642

https://goo.gl/maps/QzzmzLq6fEp

1. Oosterstraat in Utrecht, Netherlands has a short segment preceding an intersection with Zonstraat which appears to feature a half ABL. It is unclear exactly what one would call this facility since the street has a centerline. The line delineating the bike lane is broken which signifies permeability, the bike lane pavement is not contrasting and the other side of the street appears to have no bicycle facility at all. This could also be viewed as a short length of bike lane or long entry into the bike box at intersection.

Figure 21 Possible Half ABL in Utrecht (Courtesy Google)

   Oosterstraat 3
   3581 MK Utrecht, Netherlands
   52.085649, 5.130713

2. Zonstraat in Utrecht, Netherlands features a contraflow half ABL. The street is one-way for vehicles but two-way for bicycles. It has no centerline, broken line delineation for the bike lane, a parking lane on the other side of the bike lane, the cobble layout pattern in the parking and bike lanes are the same but different from travel lane. Bikes traveling in same direction as cars ride in travel lane and contraflow bikes ride in bike lane. The street is narrow, approximately 17' wide. My guess is 5.5' for parking lane (the cars don't really fit inside the parking lane), 8' for travel lane and 4' for bike lane.

Figure 22 Half ABL on Zonstraat in Utrecht (Courtesy Google)

   Zonstraat 41-43
   3581 MP Utrecht, Netherlands
   52.085337, 5.132565