CYCLE TRACKS: A TECHNICAL REVIEW OF SAFETY, DESIGN, AND RESEARCH

City of Cambridge
June, 2014

Toole Design Group

This paper has been prepared by Toole Design Group for the City of Cambridge.

Photographs have been provided by the City of Cambridge, Toole Design Group, New York City Department of Transportation, and Alice Brown.

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Introduction

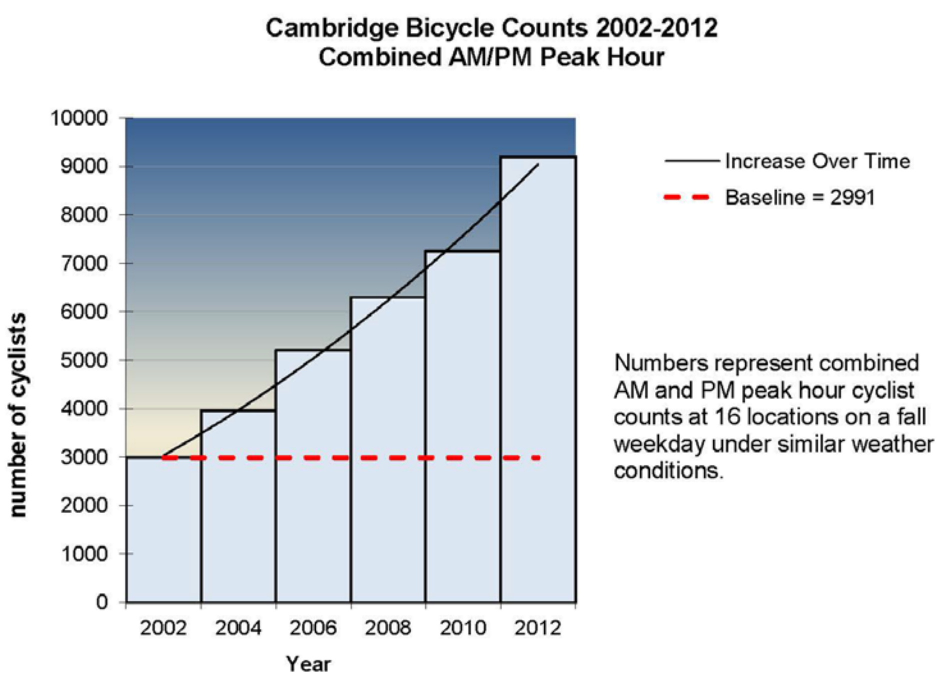
What are Cycle Tracks?

Cycle tracks are exclusive bicycle facilities that are physically separated from motor vehicle lanes and sidewalks. Separation is achieved through a variety of treatments, such as vertical grade changes; parking lanes and pavement markings; curbs; or landscaping, all of which can enhance the comfort and safety of bicycling on urban streets. Cycle tracks can create a more low-stress, path-like bicycling experience and are sometimes referred to as protected or separated bicycle lanes.

Why Provide Cycle Tracks?

Cycle tracks are an integral piece of infrastructure proven to increase ridership. Increasing bicycling can improve the overall quality of life in a city: it can enhance the city's economy; increase transportation choices; reduce parking and roadway congestion; and improve personal health. Bicycling is not only the most efficient and cost effective mode of transportation in a city, it is also often the fastest. Replacing vehicle trips with bicycle trips can reduce the number of single-occupancy vehicles, vehicle miles traveled, traffic and associated air pollution, and fuel consumption, all of which help achieve the City of Cambridge's climate goal of 80% reduction in greenhouse gas emissions by 2050.

To achieve these benefits, there is a growing need to provide bicycle facilities that are safe and accessible for people of all ages and abilities. Cambridge already possesses the basic conditions to support high bicycle use, including relatively flat topography, a high density of destinations within close proximity to one another, and a large student population, which together have increased the current bicycling mode share to about 7%.[1] While the City of Cambridge has already achieved high bicycling levels relative to most cities in the US, it has not reached its full potential. Cycle tracks are a proven strategy to attract a larger percentage of the population, and have been linked to increasing overall bicycle mode share. Safe and protected facilities create a more comfortable, low-stress environment for bicycling for people who have an interest in bicycling more regularly but may be in the majority of the population that is "interested but concerned,"[2] about bicycling on city streets. Providing infrastructure such as cycle tracks and secure bicycle parking can help increase bicycling mode share and improve livability.



Source: City of Cambridge, Bicycle Trends in Cambridge Report. (2013)

[1] U.S. Census Bureau. (2008-2010). Cambridge, MA, S0801 Commuting Characteristics by Sex [Data]. *2010 American Community Survey 5-Year Estimates*. Retrieved from http://factfinder2.census.gov/.
[2] Dill, J., & McNeil, N. (2012). Four types of Cyclists? Examining a typology to better understand bicycling behavior and potential. *Transportation Research Board*, 92nd Annual Meeting.

Cycle Tracks in Cambridge and North American Cities

The City of Cambridge was one of the first cities in the United States to design and construct cycle tracks. In 2004, a raised cycle track was installed on Vassar Street from Main Street to Massachusetts Avenue, with full construction to Audrey Street completed in 2009. A second cycle track was more recently installed on Concord Avenue from Alewife Brook Parkway to Blanchard Road. Cycle tracks are also included in the Western Avenue Reconstruction Project (in construction); Binney Street/Galileo Galilei Way (Second Street – Broadway); Ames Street (Broadway – Main Street); Main Street (Longfellow Bridge – 3rd Street) and Fern Street.

The following North American communities have also installed or are in the process of installing cycle tracks (as of June, 2014)[3]:

- Alameda, CA
- Arlington, VA
- Atlanta, GA
- Austin, TX
- Beaverton, OR
- Bend, OR
- Birmingham, AL
- Boston, MA
- Boulder, CO
- Cambridge, MA
- Champaign, IL
- Charlotte, NC
- Chicago, IL
- Cincinnati, OH
- Decatur, GA
- Denton, TX
- Denver, CO
- Doraville, GA
- Eugene, OR
- Evanston, IL
- Fairbanks, AK
- Herndon, VA
- Hillsboro, OR
- Hoboken, NJ
- Indianapolis, IN
- Kansas City, MO
- Lincoln, NE
- Long Beach, CA
- Madison, WI
- McDonough, GA
- Memphis, TN
- Milwaukee, WI
- Minneapolis, MN
- Missoula, MT
- Montreal, QC
- Munhall, PA
- Nashville, TN
- New York, NY
- Newark, NJ
- Palms Springs, CA
- Philadelphia, PA
- Portland, OR
- Russellville, AR
- Salt Lake City, UR
- San Francisco, CA
- San Jose, CA
- Santa Monica, CA
- Seattle, WA
- Somerville, MA
- Springdale, AR
- St Petersburg, FL
- St. Georges, DE
- Syracuse, NY
- Temple City, CA
- Tigard, OR
- Vancouver, BC
- Washington, DC
- Wichita, KS
- Woodburn, OR


New York City, NY


Chicago, IL

[3] People for Bikes (2013). *Green Lane Project: Inventory of protected bike lanes*. Retrieved from http://www.peopleforbikes.org/green-lane-project/pages/inventory-of-protected-bike-lanes.

Accessible for All: Cycle Tracks Increase Ridership and are Preferred by More People

A review of research, preference surveys, and bicycle data around the world has shown a clear trend: cycle tracks increase overall ridership, and are preferred by more types of potential bicyclists. Below are some of the key findings:

- In Washington, DC, more bicyclists began riding on 15th Street after the one-way cycle track was installed. After the two-way cycle track was installed, there was a 205% increase in bicycle volumes between P Street and Church Street during the p.m. peak hour, and there was a 272% increase in bicyclist volumes between T Street and Swann Street during the p.m. peak hour.[4]
- An evaluation of six cycle tracks in Montreal compared the facilities to parallel streets without bicycle facilities, and found on average that 2.5 times as many riders use the cycle track over the parallel streets[5].
- A study of nine large North American cities show a clear trend in safety in numbers, and "as the levels of cycling increase, injury and fatality rates per trip and per km traveled fall dramatically. Thus, if we can increase cycling, it will almost inevitably be safer."[6]
- A study of 14 large cities shows a clear trend that a higher percentage of female cyclists is correlated with a higher overall bicycle mode share.[7]
- More and better bicycling facilities have dramatically increased bicycle share trips in cities without any tradition of cycling for daily travel.[8]
- The City of Vancouver, BC, conducted counts before and after the installation of a cycle track on Hornby Street. Ridership increased from 10,000 bicyclists per month prior to construction to 55,000 bicyclists per month two years after construction. Bicycling on the sidewalk declined 80% post-installation (for a total of about 1% observed sidewalk riding). The ridership share by women increased by 4%, and children increased from 0.14% to 0.41% one year after construction.[9]
- Before and after counts on the Prospect Park West cycle track in NYC showed a 190% increase and a 125% increase in weekday and weekend ridership respectively.[10]
- The Institute of Transportation Engineers (ITE) states that "research and surveys conducted… suggest there is demand from current and potential bicyclists for separation from motor vehicle traffic." [11]
- A Vancouver preference survey found that "regular" and "frequent" bicycle commuters (who bicycle at least once per month) were more likely to be male (57.6%), while "potential" cyclists (had not biked within the last year) were more likely to be female (54.9%). Respondents reported highest preference for off-street paved paths (85%), and 71% reported they were likely to use cycle tracks, expressing even greater preference for cycle

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[4] Parks J., Ryus P., Tanaka A., Monsere C., McNeil M., Dill J., Schultheiss W. (2012). *District Department of Transportation Bicycle Facility Evaluation*. Project No. 11404. Retrieved from http://dc.gov/DC/DDOT/Publication Files/On Your Street/Bicycles and Pedestrians/Bicycles/Bike Lanes/DDOT_BicycleFacilityEvaluation_ExecSummary.pdf

[5] Lusk, A. C., Furth, P. G., Morency, P., Miranda-Moreno, L. F., Willett, W. C., & Dennerlein, J. T. (2011). Risk of injury for bicycling on cycle tracks versus in the street. *Injury prevention*, 17(2), 131-135.

[6] Pucher, J., & Buehler, R. (2012). Promoting Safe Walking and Cycling: Lessons from Europe and North America. (Presentation to Harvard Graduate School of Design, 17 Oct 2012). Retrieved from http://policy.rutgers.edu/faculty/pucher/HarvardTalk_Pucher_17October2012.pdf. Also Pucher, J., & Buehler, R. (2012). *City Cycling*. Cambridge, MA: MIT Press.

[7] Garrard, J., Handy, S., & Dill, J. (2012) Women and Cycling, in Pucher, J., & Buehler, R. (eds.), *City Cycling*. Cambridge MA: MIT Press.

[8] Pucher, J., Dill, J., & Handy, S. Infrastructure, Programs, and Policies to Increase Bicycling, *Preventive Medicine*, Jan 2010, Vol. 50, S.1 pp. S106-S125.

[9] ITE Pedestrian and Bicycle Council. (2013). *Separated Bikeways*. Institute of Transportation Engineers.

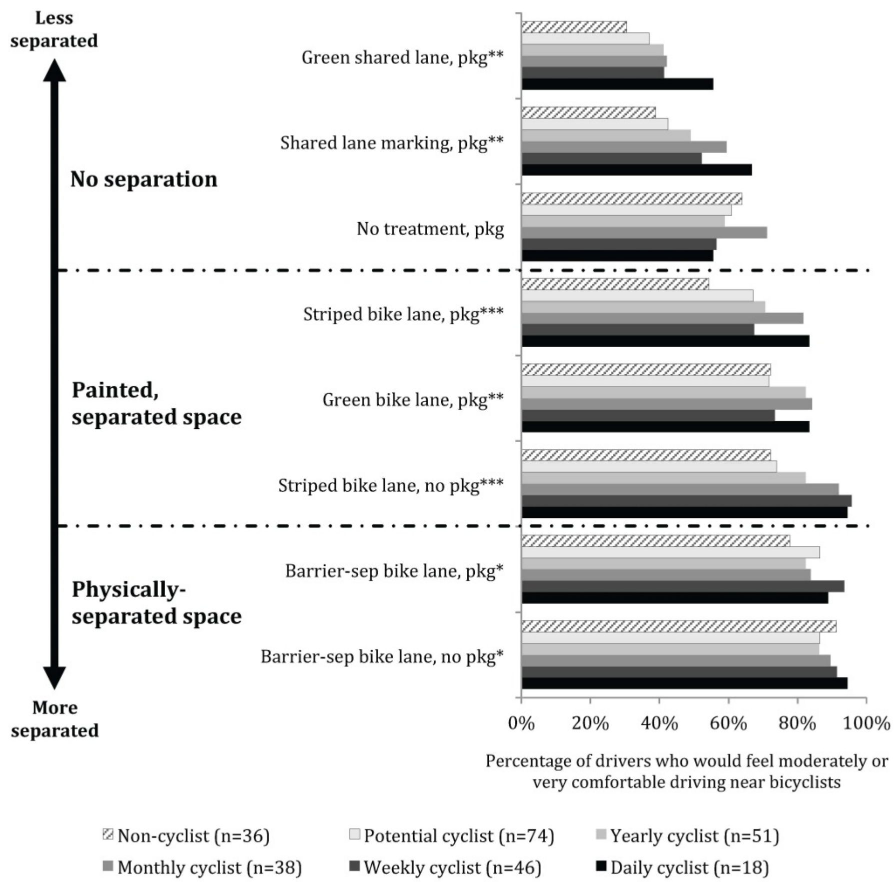
[10] NYCDOT (2011). Prospect Park West: Bicycle Path and Traffic Calming Update. (Presentation, 20 Jan 2011). Retrieved from *http://www.nyc.gov/html/dot/downloads/pdf/2012_ppw_trb2012.pdf*

[11] ITE Pedestrian and Bicycle Council. (2013). *Separated Bikeways*. Institute of Transportation Engineers.

tracks than quiet residential streets (48-65%, depending on street characteristics). Women reported higher preference for separated bike paths and lanes than men.[12]

- A survey of 463 people, roughly half drivers and half cyclists (including drivers who are non-cyclists), found that both drivers and cyclists feel significantly more comfortable with separation between motor vehicles and bicycles. Streets with barrier-separation between moving non-motorized and motorized traffic were unanimously found to be the most comfortable for both cyclists and drivers alike. Potential cyclists in particular are averse to shared space: only 10% would feel comfortable on facilities with shared lane markings, and 3% on a commercial street with no markings. The survey also indicates that the risk of being hit by a car door is a consistent worry for weekly and daily cyclists, many of whom have been hit or almost hit in this situation. [13]
- Copenhagen observed an increase in bicycle ridership of 18 to 20% after construction of cycle tracks compared with a 5 to 7% increase in ridership from bicycle lanes. The research also showed that cycle tracks saw an increase in accidents and injuries of 9 to 10%, while bicycle lanes showed an increase of 5 to 15%. It was noted that additional intersection treatments such as colored pavement, advanced stop lines, and leading bicycle intervals had not been widely used when the study was conducted, and additional safety measures would most likely have improved road safety. Also, cyclists reported feeling most secure on cycle tracks and least secure in mixed traffic.[14]

Survey Respondents who Drive Feel More Comfortable with Greater Separation from Bicyclists



Sanders, R. (2013). Examining the Cycle: How Perceived and Actual Bicycling Risk Influence Cycling Frequency, Roadway Design Preferences, and Support for Cycling Among Bay Area Residents, University of California, Berkeley, Berkeley, CA, 218 pp.

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[12] Winters, M., & Teschke, K. (2010). Route preferences among adults in the near market for bicycling: Findings of the cycling in cities study. *American Journal of Health Promotion*, 25(1), 40-47.

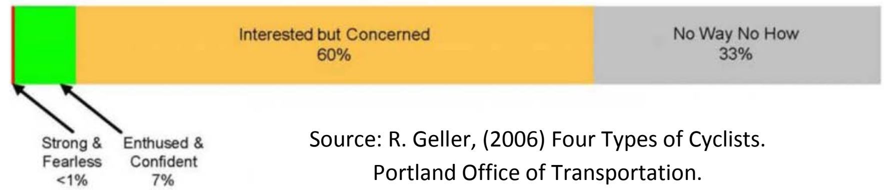
[13] Sanders, R. (2013). Examining the Cycle: How Perceived and Actual Bicycling Risk Influence Cycling Frequency, Roadway Design Preferences, and Support for Cycling Among Bay Area Residents, University of California, Berkeley, Berkeley, CA, 218 pp.

[14] Jensen, S. U., Rosenkilde, C., & Jensen, N. (2007). *Road safety and perceived risk of cycle facilities in Copenhagen.* (Presentation to AGM of European Cyclists Federation).

- In 2006, the City of Portland's Office of Transportation proposed a typology describing different kinds of bicyclists: "Strong and Fearless, Enthused and Confident, Interested but Concerned, and No Way No How".

Four Types of Transportation Cyclists in Portland

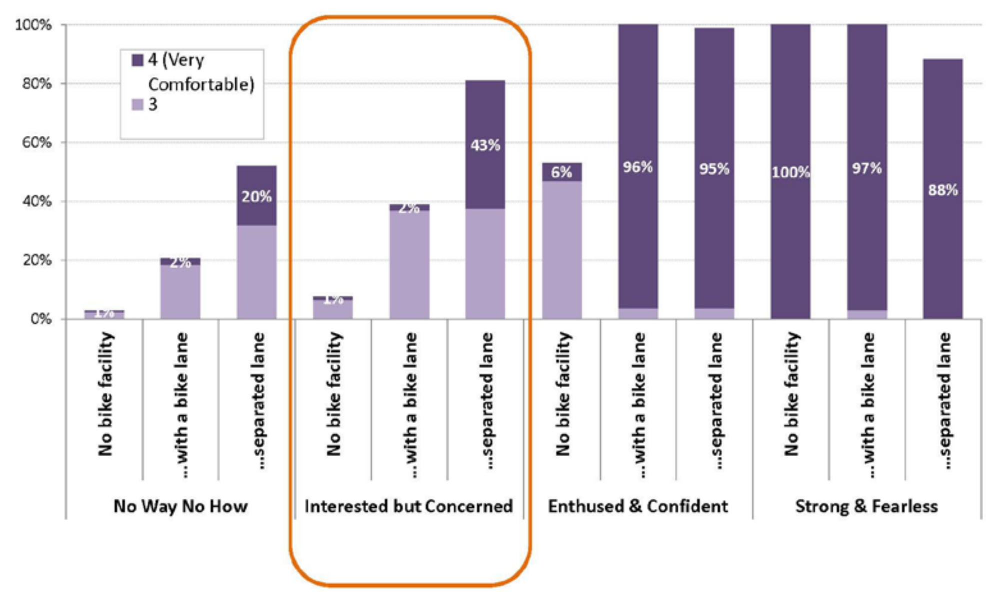
By Proportion of Population



Source: R. Geller, (2006) Four Types of Cyclists. Portland Office of Transportation.

- Research conducted by Portland State University in 2012 indicated that nearly all of the sampled population (908 adults) studied in Portland, OR fit into one of the four categories in a similar proportion. The research found that 56% of the region's population was categorized as "Interested but Concerned," which is considered to be the target market for increasing bicycling for transportation; this population reported the highest level of comfort on separated paths and quiet residential streets, closely followed by riding in cycle tracks on busy streets (30 to 40 mph), a dramatic improvement over the comfort level reported in striped bicycle lanes or riding in mixed traffic without a facility. The analysis indicated that reducing traffic speeds and increasing separation between bicycles and motor vehicles, such as through cycle tracks, increase levels of comfort and bicycling rates.
- In the same study, women and the elderly were underrepresented among the more confident adults and those who currently cycle for transportation. Additionally, the survey respondents categorized as the "no way no how" typology reported they would feel "comfortable or very comfortable" with a separate bicycle facility.[15] Perhaps an additional typology, "maybe if the conditions are right," should be considered.

Effects of Different Facilities on Comfort



Source: Dill, J. (2012). *Categorizing Cyclists: What Do We Know? Insights from Portland, OR.* Presentation at VeloCity, 2012.

[15] Dill, J., & McNeil, N. (2012). Four types of Cyclists? Examining a typology to better understand bicycling behavior and potential. *Transportation Research Board*, 92nd Annual Meeting.

Beyond Bicycle Lanes: The Benefits of Cycle Tracks

While bicycle lanes are an important component of the bicycle network and can serve some users well, especially on lower volume and lower speed routes, they are not comfortable for riders of all ages and abilities on streets with higher traffic volumes and speeds. Providing facilities that separate bicyclists from moving vehicles on routes with faster moving traffic that serve popular destinations, residential areas, schools, parks and employment centers will help encourage more bicycling for transportation.

Standard bicycle lanes on busier streets may limit bicycling levels, as bicycle lanes do not serve all types of riders equally. Many people are not comfortable merging and riding with motor vehicle traffic, especially large trucks and buses, which have been involved in some of the most severe recent crashes in the Boston region, and there is a desire to separate bicyclists from large vehicles where possible. Bicycle lanes often require riders to merge into traffic to avoid hazards like motorists driving or parking in bicycle lanes. Where on-street parking is present, bicyclists often do not feel comfortable riding outside of the door zone on busy streets closer to moving motor vehicle traffic, and may not have quick enough reaction times to avoid an opening car door when riding in the door zone. Although less common, passenger side "doorings" in bicycle lanes remain a risk, especially with passengers exiting or boarding taxis. Even the most extensive educational and outreach efforts are not as effective as infrastructure design that eliminates the conflict altogether. Crash data in the City of Cambridge from 2004 to 2009 shows that 20% of all crashes involve bicyclists being "doored" by motorists, 87% of which are from the driver side door opening.

Cycle Track Benefits Summary

The list below summarizes the benefits of cycle tracks in a variety of contexts:

- Cycle tracks provide increased comfort and safety for bicyclists through separation from motor vehicles to create a more path-like experience.
- Cycle tracks are more comfortable and accessible for people of all ages and abilities, children and the elderly alike. They attract new riders at all levels who otherwise may not bicycle, and therefore increase ridership more so than bicycle lanes.
- Cycle tracks reduce crashes, overall injury risk, and fear of collisions with over-taking vehicles at mid-block.
- Cycle tracks remove bicyclists from the door zone, eliminating the risk of "dooring" and potentially being struck by a motor vehicle.
- Cycle tracks can reduce or eliminate potential obstructions that occur commonly in bicycle lanes, such as motorists parking or driving in the lane.
- Providing a dedicated space for bicyclists improves clarity about expected behavior for all modes of travel.
- Cycle tracks can enhance the pedestrian environment by creating a buffer between pedestrians and vehicle traffic adjacent to the sidewalk.
- Narrowing the roadway width, either physically or visually, through the installation of cycle tracks can have a traffic calming benefit and help to create a more human-scale environment.
- Intersection designs can reduce or separate conflicts with motorists.
- Cycle tracks provide a better air quality environment for users than riding in the roadway.
- Cycle tracks provide economic benefits—they attract more bicyclists than standard bike lanes which results in more productive workers and more spending at local businesses.

Safety

An underlying principle of roadway design is maximizing safety for people using all modes of transportation. Cycle tracks have the potential to drastically improve safety for all modes by reducing or eliminating exposure to and conflicts with motor vehicles and pedestrians. Due to concerns generated by earlier bicycle facility safety research, prevailing design guidance and public opinion has developed a misplaced bias in the United States that cycle tracks are unsafe. A reexamination of this research found limitations in these studies, as they did not account for all crash types, the impact of additional safety treatments at intersections, and the increase in ridership associated with cycle tracks. Furthermore in earlier studies, sidewalk riding was evaluated for safety where no real bicycle facility existed, and that data was then falsely associated with cycle track and sidepath safety.

New studies have shown an overall increase in safety associated with well-designed cycle tracks, and a decrease in injury risk as more cyclists are riding. Studies from numerous cities throughout the world show there is safety in numbers: as ridership increases, crashes typically remain at the same level or decrease overall. Literature review has shown that intersection treatment crash modification factors for cycle tracks can decrease crash risk ranging from 10% to as much as 51%.[16]

As more research develops, and cycle track and bicycle facility designs evolve, it is clear that intersection treatments are the key for creating safer facilities for all; intersections are critical no matter what the bicycle facility type as the majority of crashes occur at intersections with and without bicycle facilities. Current intersection conditions do not accommodate bicyclists of all ages and abilities, and overall improvements at all intersections are needed to enhance safety for bicyclists. There are design elements and criteria related specifically to cycle tracks that need to be addressed to improve the overall safety of intersections for all modes. There is considerable guidance and global experience on how to design intersections with cycle tracks, which can provide safer and more comfortable conditions by clearly defining space and expected behaviors for all. For more information on cycle tracks designs at intersections, see Intersection Design Considerations later in this paper.

[16] Thomas, B., & DeRobertis, M. (2013). The safety of urban cycle tracks: A review of the literature. *Accident Analysis & Prevention,* 52, 219-227.

Cycle Track Research: Safety and Health

Evolutions in cycle track design have created safer facilities by separating conflicts at intersections, improving sight lines, and slowing bicycle and vehicle speeds to create a safer environment for all modes. Below is a high level summary of some of the safety research for cycle tracks:

- An evaluation of six cycle tracks in Montreal compared the streets with cycle tracks to parallel streets without bicycle facilities, and found that the streets with cycle tracks have a 28% lower injury rate over the parallel streets without bicycle facilities.[17]
- Researchers examined crash rates on 19 US cycle tracks physically separated from vehicle traffic by a buffer and distinct from the walking paths compared to reference streets without cycle tracks. The overall crash rate for cycle tracks was 2.3 (95% CI = 1.7, 3.0) crashes per million bicycle kilometers. For vehicle-bicycle crashes on roadways, the overall published crash rates per million bicycle kilometers ranged from 3.75 to 54, and from 46 to 67 in the US and Canada respectively. These "results suggest that, in the United States, bicycling on cycle tracks is safer than bicycling on roads."[18]
- A study of 690 bicycling injuries in Canada across all types of bicycle facilities showed that cycle tracks had the lowest risks, about one-ninth the risk of the reference street: a major street with parked cars and no bicycle infrastructure. Bicycle lanes were found to have about one-half the risk as the reference. Busy streets are associated with higher risks than quiet streets, and bicycle-specific facilities are associated with lower risks.[19]
- The Prospect Park West New York City cycle track case study found that all crashes decreased by 16%, injuries decreased by 63%, and injury risk decreased by 50% post-installation. The study also reported there were no reported injuries between bicyclists and pedestrians.[20]
- Researchers surveyed cyclists in two buffered bicycle lanes and one cycle track in Portland about their perceived safety and route choice (cycle track and buffered lane vs. on-street, all other). About 45% of cyclists agreed that they chose to ride on the cycle track more often. Additionally, women significantly felt safer on the cycle track than men (94% [of women] vs. 64% [of men]).[21]
- Researchers in Portland measured air quality on the driver side and passenger side of a parked car to compare particulate matter found in a typical location of bicycle lane vs. the typical location of a cycle track. Air quality was found to be 8% to 38% better in the cycle track location than the bicycle lane, and researchers also found that the highest differences between the two facilities corresponded with higher traffic volumes, supporting the conclusion that the distance created by a physical barrier between a bicycle facility and moving traffic affects air quality and bicyclists' exposure to ultrafine pollutant particles.[22]

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[17] Lusk, A. C., Furth, P. G., Morency, P., Miranda-Moreno, L. F., Willett, W. C., & Dennerlein, J. T. (2011). Risk of injury for bicycling on cycle tracks versus in the street. *Injury prevention*, 17(2), 131-135.

[18] Lusk, A. C., Morency, P., Miranda-Moreno, L. F., Willett, W. C., & Dennerlein, J. T. (2013). Bicycle Guidelines and Crash Rates on Cycle Tracks in the United States. *American journal of public health*, 103(7), 1240-1248.

[19] Teschke, K., Harris, M.A., Reynolds, C.C., Winters, M., Babul, S., Chipman, M., Cusimano, M.D., Brubacher, J.R., Hunte, G., Friedman, S.M., Monro, M., Shen, H., Vernich, L., & Cripton, P.A. (2012). Route infrastructure and the risk of injuries to bicyclists: A case-crossover study. *American journal of public health*, 102(12), 2336-2343.

[20] NYCDOT (2011). Prospect Park West: Bicycle Path and Traffic Calming Update. (Presentation, 20 Jan 2011). Retrieved from *http://www.nyc.gov/html/dot/downloads/pdf/2012_ppw_trb2012.pdf*.

[21] Monsere, C. M., McNeil, N., & Dill, J. (2012). Multiuser perspectives on separated, on-street bicycle infrastructure. *Transportation Research Record: Journal of the Transportation Research Board*, 2314(1), 22-30.

[22] Kendrick, C.M., Moore, A., Haire, A., Bigazzi, A., Figliozzi, M., Monsere, C.M., George, L. (2010). The impact of bicycle lane characteristics on bicyclists' exposure to traffic-related particulate matter. *90th Annual Meeting of the Transportation Research Board*.

Planning

Bicycle Facility and Cycle Track Implementation in Dense Urban Environments

In urban environments such as Cambridge, streets should provide safe accommodations for all modes and people of all ages and abilities. The City's policy objectives aim to protect and improve the urban fabric; promote cultural advancements and historic preservation; increase environmental, economic, and social sustainability; and improve the quality of life for its residents. All bicycle facility designs require creative and pragmatic solutions to often complex and historic land use characteristics and roadway configurations.

When determining what type of facility is most appropriate and feasible for each location, and how to create a network of connected, protected facilities, general planning level considerations include:

- Balancing the accommodation of all modes
- Density, connectivity, and latent demand
- Context of land uses and street type
- Available right-of-way
- Proximity to or on the desired route to special uses: schools, parks, youth centers, etc.
- Traffic volumes and speeds
- Presence of transit stops
- Driveways and intersections
- Type of project - retrofit vs. reconstruction
- Major routes that serve popular destinations, residential areas, schools, parks and employment centers that are:
    - High volume, high speed roadways
    - Major arterials and connectors
    - Commercial corridors with high parking turnover

It is important to note that cycle tracks may not be appropriate for every street. Other bicycle facilities such as bike lanes are also important components of a bicycle network and can serve some users well, especially on lower volume and lower speed routes. Bicycle boulevards or neighborways, shared streets, or local residential streets may not be appropriate routes for cycle tracks. All facility types should be selected based on engineering judgment and receive feedback from the local community

Copenhagen, Denmark

New York City, NY

Types of Bicycle Facilities

Below is a comparison table of the benefits and challenges associated with each type of typical urban bicycle facility:

Shared Travel Lanes: *Shared bicycle and motor vehicle travel lanes denoted by pavement markings and signs.*	
Benefits	**Challenges**
• Directs bicyclists to the safest place to ride • Alerts motorists of shared space	• Bicyclists must operate as a vehicle in mixed traffic • Narrow right-of-way may not provide enough space to direct bicyclists out of the "door zone" and requires bicyclists to "take the lane" • Not appropriate for roadways with speeds greater than 30 mph • High exposure to motor vehicle pollution
Bicycle Lanes: *On-road facilities designated for exclusive use by bicyclists through pavement markings and signs.*	
Benefits	**Challenges**
• Designated space for bicyclists • Visually narrows the street to calm traffic	• May require bicyclists to operate as a vehicle in mixed traffic to avoid obstructions • Motor vehicles often drive or park in the bicycle lane • Narrow right-of-way may not provide enough space to direct bicyclists out of the "door zone" • High exposure to motor vehicle pollution
Buffered Bicycle Lanes: *A bicycle lane with pavement marking buffers to provide separation from parked motor vehicles.*	
Benefits	**Challenges**
• Designated space for bicyclists • Additional buffer space for separation from motor vehicles to avoid "dooring" • Space for passing other bicyclists • Visually narrows the street to calm traffic	• May require bicyclists to operate as a vehicle in mixed traffic to avoid obstructions • Motor vehicles often drive or park in the bicycle lane; this is exacerbated with wider bicycle lanes • High exposure to pollution
Shared-Use Paths: *Off-road path physically separated from traffic and designated for shared use by bicyclists and pedestrians.*	
Benefits	**Challenges**
• Off-street space physically separated from motor vehicles • Provides regional and inter-city off-street connections • Lower exposure to pollution	• Typically requires more right-of-way space and is generally installed along or in open green spaces, parkland, etc. • Shared with walkers, joggers, roller skaters, skateboards, dog walkers, etc.
Cycle Tracks: *Exclusive bicycle facilities physically separated from motor vehicle travel lanes and sidewalks.*	
Benefits	**Challenges**
• Exclusive, protected space for bicyclists physically separate from motor vehicles and pedestrians • Prevents driving and parking in facility • Eliminates "dooring" • Helps reduce exposure to pollution • Visually narrows the street to calm traffic	• Typically requires more right-of-way space • Maintaining pedestrian accessibility at intersections and transit stops • Drainage considerations, especially for the type of drainage infrastructure required for raised cycle tracks • Accommodating existing street sweeping and snow clearing equipment • Developing a year-round maintenance plan

Types of Cycle Tracks

Raised vs. Street-level Cycle Tracks

Raised cycle tracks are vertically separated from motor vehicle traffic by installing the facilities at a different grade, whether at the same level of the sidewalk separate from pedestrian travel, or in between the roadway grade and sidewalk grade (e.g., sidewalks are typically six inches above the roadway, so the cycle track could be installed three inches above the roadway and three inches below the sidewalk). Street-level cycle tracks are installed on the roadway but physically separated from motor vehicles through various methods such as on-street parking or plantings. Below is a comparison table of raised and street-level cycle tracks

Raised Cycle Track *Bicycle facilities constructed above the roadway physically separated from motor vehicle and pedestrian traffic through a variety of methods including curbs, furnishings, plantings, etc.*		
Benefits	**Challenges**	**Maintenance Considerations**
• Provides vertical separation and more protection from motor vehicle traffic; increased separation can be more attractive to a wider range of bicyclists • Prevents motorists from easily entering or obstructing the cycle track • Potentially more visually attractive • Allows for driveway and side street designs that are similar to sidewalks and improves yielding as well as reduces turning motor vehicle speeds	• Potential for conflicts with pedestrians in cycle track accessing transit stops, at intersections, or to access the sidewalk from parked vehicles • Typically more expensive if designs require reconstruction and adjustments to stormwater management unless implemented as part of a planned street reconstruction project	• May require special maintenance equipment or operations • Sweeping and snow plowing may be done with adjacent sidewalk • If wide enough, standard street equipment can be used • Snow storage and de-icing strategies need to be considered
Street Level Cycle Track, also known as a Protected Bike Lane *[23] *Bicycle facilities at street level physically separated from motor vehicle traffic through a variety of methods including parked vehicles, pavement markings, flexposts, bollards, curbs, plantings, etc.*		
Benefits	**Challenges**	**Maintenance Considerations**
• Lower cost of implementation when installed on existing roadway • Typically have minimal effect on storm water management and drainage infrastructure • Typically have minimal impact on pedestrian crossings at intersections	• May be less attractive to inexperienced cyclists depending on type of separation • If used, flexible posts can pose maintenance challenges and may be less visually attractive within streetscape • Without physical separation, enforcement may be needed to restrict motor vehicle access	• Sweeping and snow plowing may need to be done separate from roadway • Locations with flexible posts should consider minimum clearances required for street sweeping and snow plowing equipment • Special equipment, operations, or maintenance agreements may be needed for cycle tracks • Planters require regular maintenance

[23] For greater clarity the term "Protected Bike Lane" is used in Cambridge to describe a street level cycle track.

One-way vs. Two-way Cycle Tracks

Cycle tracks can either be one-directional or two-directional, and can be provided on both sides of two-way streets or on one side of one-way streets. Below is a comparison table of one-way and two-way cycle tracks and the contexts for which they may or may not be more appropriate:

One-Way Cycle Track – Each side of two-way roadway *Context: Corridors with more frequent intersections, active edges on both sides of street*	
Benefits	**Challenges**
• Provides access to both sides of roadway • Cyclists ride in the same direction as vehicles in adjacent roadway • Simpler treatments at intersections • Can transition to bicycle lanes to match a connecting facility • Generally conforms to standard roadway operating expectations	• Requires more roadway space to accommodate a buffer on two sides of the roadway than a two-way cycle track • Need more width overall to allow for passing, especially where volumes are higher and on hills and longer stretches • Potentially more total parking restrictions for sight lines due to presence on both sides of roadway (depends on number of side streets/driveways) • May make wrong way bicycle riding more appealing • May require changes to signal operations, especially at locations with high volumes of turning traffic
Two-Way Cycle Track – One side of one-way roadway *Context: Corridors with few intersecting streets, barrier or edge on one side, trail connections*	
Benefits	**Challenges**
• Has a "bike path" feel that is more attractive to less experienced cyclists • Requires less space than two one-way cycle tracks on each side of the roadway • Cyclists may pass in opposing cycle track lane • May improve connectivity for bicyclists when used on one-way streets	• Contrary to standard roadway operating expectations, as cyclists approach motorists from potentially unexpected direction • Pedestrians may not expect contra-flow bicyclists • Can limit access to land uses and activities on non-cycle track side of street • The contra-flow movement will likely be less efficient due to signal progression operation resulting in frustration by the user or violations of traffic controls • Will require changes to signal operations to manage turning conflicts, especially left turning vehicles and contra-flow bicyclists

When choosing which side of the street to install a two-way cycle track, consideration should be given to:

- Available right-of-way
- Number of intersections and driveways
- Width of adjacent sidewalk
- Adjacent land uses
- Transit stops
- Access management
- Presence and type of parking
- Desired turning movements
- Commercial loading and delivery
- Taxi, valet, or temporary loading areas
- Emergency vehicle needs
- Stormwater management

Retrofits vs. Reconstruction

When the curb location is fixed, street-level cycle tracks can often be retrofitted by reallocating existing street space. Cycle tracks can be installed using strategies such as minimizing lane widths or removing travel or parking lanes. A physical buffer between a curbside bicycle lane and adjacent parking and/or travel lanes can be created with pavement markings and flexposts, curbs, planters, and other design elements as space permits. Retrofit projects are usually lower in cost and quicker to implement than reconstruction projects, and can be the first phase of an incremental installation of protected facilities.

Reconstruction projects are excellent opportunities to install raised cycle tracks. During reconstruction projects, all aspects of the available right-of-way should be considered to achieve the best facility possible.

Design

General Design Considerations

Cycle tracks have been designed and built around the world for decades; the most thorough and substantial design guidance widely available comes from the Netherlands and Denmark. The NACTO Urban Bikeway Design Guide provides a summary of design considerations and treatments for cycle tracks based upon European and North American guidance and experience. FWHA (the Federal Highway Administration) officially supports use of the NACTO guide. For this paper, the City of Cambridge has developed cycle track design considerations using best practices from around the world, and lessons learned from local experience with the installation of the Vassar Street and Concord Avenue cycle tracks as well as the designs for Western Avenue, Binney Street, and Main Street.

The planning level considerations for cycle tracks discussed previously help determine what type of facility is best for the project site. This section of the paper will discuss general cycle track design considerations including:

- Determination of cross-section widths
- Separation methods
- Pavement markings and signage
- How to discourage pedestrian use of cycle tracks
- Transit stop accommodations
- Drainage
- Maintenance

Intersection and driveway treatments are discussed later in the Intersection Design Considerations section of this paper.

Cycle Track Cross Section Recommendations

Below is a chart with minimum and preferred cycle track widths, whether raised or at street-level, for one-way and two-way cycle tracks:

Facility Dimensions	One-Way Cycle Track		Two-Way Cycle Track	
	Minimum[1]	**Preferred[2]**	**Minimum[1]**	**Preferred[2]**
Cycle Track Width	5’	7’	8’	12’
Separation[3]	1’ to 3’	3’+	1’ to 3’	3’+

1. The minimum total clear width needed to accommodate existing street sweeping and snow clearing equipment in the City of Cambridge is 10’. Sidewalk plowing equipment can handle narrower widths. Maintenance equipment or maintenance agreements may be required on a case-by-case basis for narrower cycle tracks.

2. Designs should meet or exceed the preferred widths to the maximum extent feasible to allow for passing.

3. Separation can be achieved through a variety of methods including vertical grade changes. Separation widths from motor vehicle lanes and sidewalks will vary depending on the context and constraints of each site and require engineering judgment.

Each project should be evaluated using engineering judgment to develop context-sensitive solutions. Cycle track and roadway design guidance is ever evolving, and designs should be piloted and tested to continuously improve conditions for people using all modes of transportation. As more cycle tracks are installed throughout the U.S. and Cambridge, more specific design guidance will be developed for cross section widths. At this time, for the most extensive recommendations on cross section widths please refer to the Dutch “Design Manual for Bicycle Traffic” (CROW) for additional information.

Cambridge, MA

Chicago, IL

Separation Methods

There are a variety of separation methods for cycle track designs. The overall goal is to provide a physical barrier to reinforce separation between the cycle track and the adjacent parking or travel lane and the pedestrian realm. Generally, pavement marking is an acceptable method for buffering parked vehicles from the cycle track. However, depending on the context and constraints within a project site, and whether a cycle track is raised or at street-level, separation can be achieved through any of the following:

- Parking with pavement marking buffers and/or flexible bollards or flexposts
- Curbs
- Concrete barriers
- Planters, trees, stormwater management features
- Differentiating materials
- Street furniture

For raised cycle tracks without curbside parking, separation methods should consider ways to mitigate larger vehicles mounting the curb and parking partially on the cycle track. The furnishing zone between a raised cycle track and the sidewalk can include street furniture, plantings, trees, and other furnishings to define and separate the pedestrian realm from the raised cycle track.


New York City, NY


Vancouver, BC


Galapagos Islands, Ecuador


Boston, MA

Pavement Markings and Signage

Pavement markings should be determined by consulting the NACTO Urban Bikeway Design Guide, the latest edition of the MUTCD, and the AASHTO Guide for the Development of Bicycle Facilities. Bicycle lane symbols can be placed to promote the correct direction of travel and discourage wrong-way riding, while indicating to pedestrians the intended use of the facility.

Regulatory, warning, and wayfinding signage specific to cycle tracks can be developed to improve overall safety and expectations for all roadway users. Signs can be placed within the buffer or adjacent to the curb where practical and visible for the intended user. For cycle tracks with parking protection, signs and markings can alert all users to be aware and where to look for potential conflicts, including pedestrians loading and unloading from parked vehicles and at intersection mixing zones. Pavement markings and signage at intersections are discussed in further details in Intersection Design Considerations.

Pedestrians and Cycle Tracks

Because cycle tracks are still relatively new in North America, many people are not yet accustomed to their place and function in the streetscape environment. As in the Netherlands and other countries with an abundance of cycle tracks, people will become accustomed to behaviors; however, at the introductory stage it is valuable to include design elements that will reduce conflicts, educate users, and encourage appropriate behaviors. In particular, people should not walk or jog in cycle tracks, and designs should be intuitive and encourage separation of pedestrian and bicycle traffic. Minimal treatments include differentiating materials and providing signage and pavement markings restricting pedestrian use of the cycle track. More effective treatments include providing a vertical element separating the pedestrian and bicycle space such as a change in grade or the installation of street furniture and/ or street trees. Where adjacent to on-street parking, regular access from the sidewalk to the parking lane should be provided. Pedestrian and bicycle interactions at intersections are discussed later in Intersection Design Considerations section of this report.


New York City, NY


Copenhagen, Denmark

Transit Stops

Depending on the configuration of the cycle track, the presence of curbside parking, and the location of the transit stop, a variety of treatments can be used to facilitate accessible pedestrian transit stops. Strategies can include:

- Removing separation at the stop to allow curbside access
- Providing transit stop islands in the buffer space at nearside and farside bus stops
- Raising the cycle track to allow pedestrians access across the cycle track from the sidewalk to the curb; this treatment can include bus stop platform islands in the buffer space or allow buses to access the curb directly adjacent to the cycle track
- Routing the cycle track behind the transit stop where space permits

Stops should include accessible pedestrian landing zones for each bus stop door. Tactile warning strips, pavement markings, colored pavement, and signage can be used to alert bicyclists to yield to pedestrians loading and unloading.

Cycle track designs often involve relocating transit stops to the far-side of the intersection to reduce conflicts. Far-side bus stops can help improve sight lines, reduce transit delay as buses do not have to wait for a green indication after loading passengers, and reduce conflicts between buses and right turning bicyclists and vehicles. Far-side bus stops also encourage pedestrians to cross behind the bus to access the intersection.

Drainage

Cycle tracks can be designed to allow water to drain freely from the street and eliminate standing water whether at the sidewalk or street level. Depending on the type of project, simple changes to drainage infrastructure or complex overhauls during full depth reconstruction projects can accommodate cycle tracks through a variety of methods Drainage and utility structures should be placed along the curb may to maintain a smooth riding surface free from hazardous drainage grates. Catch basin grates must be City standard “cascade” type that have cross bars so as not to catch bike tires.

For raised cycle tracks, the cycle track can be pitched toward the road like typical sidewalks to allow water to drain into existing infrastructure or into the buffer zone (where present) which can contain planters, rain gardens, and other stormwater management features. This area can also be used to store snow in winter. Another option is to install a central drain or stormwater management features between the cycle track and sidewalk to drain and filter stormwater. Permeable pavement can also be used to allow water to drain directly through the pavement, helping to eliminate freezing surface water which can be a safety problem for cyclists. A permeable asphalt cycle track is being constructed on Western Ave. (in construction, 2014).

Maintenance

Street Sweeping and Snow Clearing

To ensure success, cycle tracks must be designed and constructed to facilitate year-round maintenance. Where feasible, cycle track widths 10’ or more are most compatible with the City’s existing street sweeping and snow clearing equipment so they can be included with normal maintenance operations. Cycle tracks designed with flexposts or bollards should be removable to facilitate snow and ice clearance in the winter.

To accommodate a narrower cycle track, it may be necessary to either purchase specialized maintenance equipment such as tractors with brooms, snow blowers, or pickup trucks, or identify maintenance partners and establish maintenance agreements to clean and plow cycle tracks prior to implementation. Specialized equipment can serve both as snow clearance equipment during the winter and street sweepers throughout the rest of the year.

For winter maintenance it is especially important to have proper drainage to prevent ice formation during freeze/thaw conditions and after plowing. De-icing strategies will depend on the configuration of the cycle track and the type of pavement used. De-icers can be applied prior to snow fall and again while clearing to help prevent ice formation. Salt and deicers are not recommended for permeable pavements to prevent clogging in the void spaces of the pavement. Alternatively, beet juice/brine has been used in some cities as a deicer on streets and bicycle facilities to reduce environmental impacts associated with salt. Stormwater management features can be used in the buffer zones between the street and/or the sidewalk to store, filter, and allow snowmelt to re-enter into the water table.

In the City of Cambridge, sidewalk snow clearance is the responsibility of the abutter. For raised cycle tracks, maintenance agreements with public and private partners will be part of the strategy; for example, MIT clears the cycle tracks along Vassar Street as part of an agreement.

Intersection Design Considerations

Intersections are where most motor vehicle-bicycle crashes occur in urban areas with and without bicycle facilities. Unfortunately there is not enough research or guidance on how to mitigate or redesign standard intersections for all types of bicycle facilities. Existing laws define bicycles as vehicles, and assume that bicyclists operate similarly as motorists do, with some notable exceptions (e.g., being allowed to pass on the right and to ride on sidewalks under certain conditions). However, bicycles and motor vehicles have drastically different operating characteristics, including top speeds and acceleration and deceleration rates. Prevailing laws and design practices do not accommodate bicyclists of all ages and abilities. As motor vehicles, transit vehicles, and pedestrians have specific accommodations at intersections including pavement markings, signage, and signalization, bicyclists likewise need explicit accommodations to reduce conflicts and improve safety and comfort for all. The good news is that there is considerable guidance and global experience on how to design intersections with cycle tracks, which can provide safer and more comfortable conditions by clearly defining space and expected behaviors for all.

Cycle track designs at intersections can manage conflicts with turning vehicles and pedestrians through a variety of treatments. The overall goals of intersection design are to reduce conflicts, speeds, and delay, as well as improve safety and comfort for all modes. This section will cover the following intersection design considerations:

- Sight/stopping distances including parking setbacks
- Geometry, including raised crossings, chicanes, and curb radii
- Intersection pavement markings and signage
- Corner designs for bicycle and pedestrians crossings
- Providing bicyclists opportunities for desired turning movements
- Signalization
- Access into and out of two-way cycle tracks
- Driveways

Sight/Stopping Distances

When designing all types of bicycle facilities, stopping sight distances at intersections and driveways should be reviewed to maximize visibility of bicyclists and reduce conflicts between modes. Sight and stopping distance calculations will vary based on the characteristics and constraints of each project and will be influenced by the configuration of facility types. For street level, parking protected cycle tracks, parking restrictions between 20’ to 40’ minimum may be generally sufficient at the near and far-side of intersections and driveways to allow for proper sight distances, however additional restrictions may be needed based on site specific geometric or operational characteristics, which would result in greater sight distance requirements. Sight distance calculations can be developed for all modes at intersections. Sight and stopping distance calculations for bicycles are found below:

Table 5-4. Minimum Stopping Sight Distance

U.S. Customary		
$S = \frac{V^2}{30(f \pm G)} + 3.67V$		
where:		
S	=	stopping sight distance (ft)
V	=	velocity (mph)
f	=	coefficient of friction (use 0.16 for a typical bike)
G	=	grade (ft/ft) (rise/run)

Metric		
$S = \frac{V^2}{254(f \pm G)} + \frac{V}{1.4}$		
where:		
S	=	stopping sight distance (m)
V	=	velocity (km/h)
f	=	coefficient of friction (use 0.16 for a typical bike)
G	=	grade (m/m) (rise/run)

Source: AASHTO Guide for the Development of Bicycle Facilities Table 5-4

Intersection Approach Geometry

Based on available sight distance, intersection operations, and physical constraints, there are several ways to design cycle track intersection approach geometry to improve safety and maximize visibility for all users. Solutions may include:

- Continuing the cycle track all the way to intersection and:
  - Restricting parking to provide adequate sight distances and/or space for turn lanes or other desired operational features.
  - Designing chicanes to slow bicyclists speeds to meet sight distance requirements.
- Creating a cycle track and motor vehicle mixing zone where vehicles yield to bicyclists in the cycle track and merge to accommodate turning movements
- Maintaining a raised cycle track across intersections, especially appropriate across driveways and minor side streets.
- Terminating the cycle track and removing separation to provide a standard bicycle lane with bicycle boxes, where appropriate, to improve visibility and raise awareness of the shared space between all users of the intersection.

Chicanes

For parking protected street level cycle tracks where sight distance requirements cannot be achieved by only restricting parking, the geometry of the approach can be altered to slow bicycle traffic to speeds which are compatible with sight distance requirements at potential conflict points. A chicane is a design feature that creates an “S” curve that bicyclists will weave through, effectively reducing speeds, and places bicyclists at a more visible location on the roadway. For a typical roadway, parking should be restricted 20’ from the crosswalk; however, further restrictions based on specific speeds and stopping sight distances can improve the visibility of bicyclists at intersections. Chicanes can be designed to help improve visibility as well as maintain bicycle approach speeds between eight and 11 miles per hour. To keep bicycle speeds within this range, a chicane is designed with a reverse curve and an approximate centerline radius of 22’ followed by 13’. This combination of radii can result in bicycle speeds of 8 to 11 miles per hour on the approach to the intersection. This will correspond to a bicycle stopping distance of 35’ to 65’. For parking protected cycle tracks, presuming motor vehicle turns will be made no faster than 15 mph, motorists will have approximately 80’ to 100’ of available sight distance to see the bicyclists once they appear, and will require approximately 50’ to 80’ to stop once they see the bicyclist. This is sufficient for a bicyclist to react prior to the intersection if a vehicle is likely to turn in front of the bicyclist and for a motorist to yield to the straight-traveling bicyclist as legally required.


Washington, D.C.


Washington, D.C.

Cycle Track and Motor Vehicle Mixing Zones

In some situations, cycle tracks can be designed with mixing zones at intersections to accommodate vehicle turning movements. Mixing zones can be used where there are space constraints or as an alternative to bicycle signals. In this design treatment, the cycle track transitions to a shared curb-side bicycle and motor vehicle lane. Cars are angled into the mixing zone, reducing speeds and maximizing visibility of on-coming bicyclists. Yield markings at the approach to the mixing zone accompanied by "Turning vehicles yield to bicycles" R10-15 signs help denote bicycle prioritization and reinforce that motor vehicles must yield to oncoming bicyclists. Mixing zones may not be appropriate at intersections with high volumes of right turning vehicles or higher speeds, and further studies are needed to determine their effectiveness in reducing crashes compared to alternative treatments such as signalization.

Modified R10-15 Sign
Source: Toole Design Group

Standard Bicycle Lanes

Separation should only be removed in limited circumstances based on engineering judgment. Where there are constraints and separation cannot be accommodated, separation should be removed prior to intersections to provide a standard bicycle lane with bicycle boxes or turn queue boxes where appropriate. Additional treatments such as green colored pavement, warning signs, and/ or separated signal phases should be provided to improve visibility and raise awareness of the shared space between all users of the intersection. Also, removing separation may reduce comfort for some users.

Cycle Track Intersection Pavement Markings and Signage

Cycle track pavement markings through intersections can reduce conflicts by alerting motorists and pedestrians to expect and be aware of bicyclists, and encourage proper tracking by bicyclists through intersections. To alert bicyclists that they are approaching an intersection and to control approach speeds, visual and tactile cues can be incorporated into the design of the cycle track. The application of color to the cycle track can be used to effectively communicate to all modes of upcoming intersections where reduced speeds and increased awareness are required. Colored pavement can be used to increase awareness of bicyclists at:

- Curbside locations where there are conflicts at driveways
- The beginning of the block for a short distance to highlight the cycle track
- Intersections to increase awareness of conflicts areas and increase visibility

Variations of symbols including shared lane marking symbols, standard bicycle symbols, or oversized shared lane marking or bicycle symbols can be used to define intersection space. It is generally recommended to choose a standard symbol for intersection crossings to maintain continuity and clarity throughout the bicycling network. Symbols and/or colored pavement should be supplemented with dashed lines. Many communities have also used temporary educational signage to help users understand where to predict movements by different modes and reduce potential conflicts.

Corner Designs: Bicycle and Pedestrian Crossings at Intersections

Treatments at intersections can help reduce conflicts between pedestrians and bicyclists to improve safety and comfort. Designs can incorporate accessible pedestrian features including high-visibility crosswalks across the cycle track and tactile warning strips on the sidewalk and at medians where applicable. Pavement markings such as yield symbols and transverse stop lines, along with geometric features such as chicanes and signage, can slow and help alert bicyclists to yield to pedestrians. Raised cycle tracks can transition to a shared pedestrian and bicycle area at corners. These treatments all require slow speeds similar to those found on shared streets. Another option is to design intersection crossings to provide bicycle specific pavement markings, signage, and signalization in addition to traditional pedestrian crosswalks.

New York City, NY

Providing Opportunities for Turning Movements: Jug Handles and Two-Stage Turn Queue Boxes

Bicyclists turning movements can be accommodated at intersections and major destinations along the cycle track through a variety of treatments, including narrowing the buffer width to provide bicycle turn lanes where space is available, and facilitating “jug handle” or two-stage left turn movements. Jug handle movements are where bicyclists bear right onto a ramp or side street to then continue to turn left. Two-stage left turn movements are common practice in the Netherlands and other European countries, and are typically easier for most bicyclists to execute, and may be more comfortable because it does not require waiting for gaps to merge laterally across multiple lanes of traffic.
Jug handles can be created through geometric changes to sidewalks or by creating queuing areas on adjacent side streets called two-stage turn queue boxes. Two-stage turn queue boxes help bicyclists safely make left or right turns at intersections, driveways, and midblock crossing locations where there is demand. Queue boxes can be placed in multiple locations depending on the configuration and constraints of each site. Two-stage turn queue boxes prevent conflicts by separating turn movements. Bicycle signals can also help facilitate turning movements for bicyclists and reduce conflicts between other modes.

Toronto, ON

Bicycle Signals and Detection

Providing dedicated signalization for all modes can be used to manage conflicts and improve safety. Bicycle specific traffic signals are a common and effective way of moving bicycles through signalized intersections in conjunction with cycle tracks. Signal timing can allow for bicycles minimum green and clearance times and is often provided concurrently with pedestrian phasing. The MUTCD allows standard traffic signals to be designated for bicyclist use with the application of a regulatory sign. Interim Approval for the optional use of bicycle signal faces was issued by FHWA in December, 2013. The National Committee on Uniform Traffic Control Devices has established a Task Force to develop a proposal to incorporate bicycle signals with a bicycle symbol into the next edition of the MUTCD.

Bicycle signals can be accompanied by bicycle detection to reduce delay. Typically push-buttons for crossing signal activation present a challenge for bicyclists and are not recommended. New advancements in bicycle detection can include in-pavement loop detectors, video detection, or micro-wave detection. Technologies are continuously being developed and will continue to improve the efficiency of cycle track designs.

Access into and out of Two-Way Cycle Tracks

Access into and out of two-way cycle tracks can be achieved through a variety of treatments depending on the roadway configurations, adjacent facilities, and trip generators. Treatments can include pavement markings, colorized pavement, signage, geometric features such as median islands, and signalization. Bicycle boxes and two-stage turn queue boxes can be used at intersections to direct contra-flow bicyclists to the most conspicuous location on the roadway to execute turning movements and to be the most visible for all users; these spaces can also serve as waiting areas to find the best time to enter the normal stream of traffic onto an adjacent facility or roadway. Bicycle signals can also be used to separate conflicts. Jughandles and corner designs can help facilitate desired turning movements onto adjacent facilities.

At midblock locations, access into and out of cycle tracks can be achieved through several methods. Where parking is not present, breaks in the buffer between motor vehicles and the cycle track can allow bicyclists to enter the normal flow of traffic to access popular destinations or connections at midblock locations (note: if raised, these locations can include mountable curbs). Turn lanes, jug-handles, or queuing areas in the buffer space can also be used where appropriate and feasible depending on site characteristics and desired routes.

Cycle Tracks at Driveways

Reducing conflicts at driveways is another key consideration to improving the safety of cycle track designs. Driveways have similar design characteristics to intersections and require improved sight lines, reduced speeds, and prioritization of bicycle movements. The City of Cambridge standards calls for raised cycle tracks and sidewalks to remain level across driveways, so that any crossing vehicle must travel vertically over the cycle track and sidewalk. In this way, bicyclists are more visible and motor vehicle speeds are kept to a minimum. Requiring setback and restricting parking near driveways improves visibility between bicyclists and drivers. Additional treatments to reduce conflicts and improve safety at driveways include pavement markings, signage, and other traffic calming treatments to slow speeds and alert drivers to look for oncoming bicyclists.