Moving Together 24

Accessible bus stops in the presence of bike lanes

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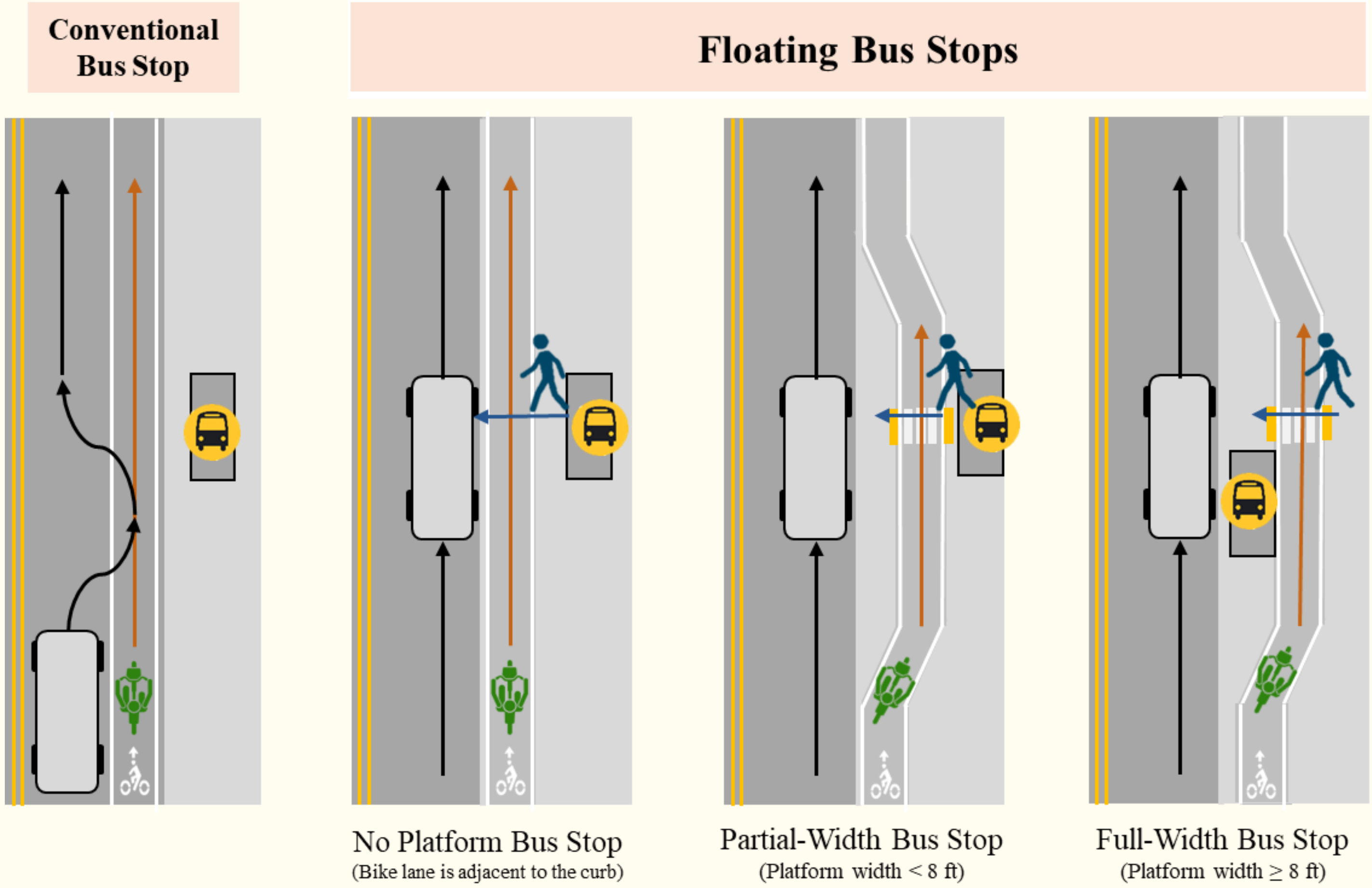
Objectives

- Despite increased dedicated infrastructure to both bikes and buses, a lack of understanding of their design **together**
- Two aims of this project:
  1. Investigate bus rider and bicyclist **behavior and interactions** at floating bus stops
  2. Propose **design improvements and guidance to enhance accessibility and mitigate conflicts** between bus riders of all abilities and bicyclists

Project tasks

1. Literature review
2. Input from practitioners and bus riders
    - Focus groups from SWA's contacts
    - City staff, state staff, consultants
3. Inventory of floating bus stops (56 stops)
    - Manual observations
4. Behavioral analysis (5 stops)
    - LiDAR scans
    - 3-12 hours of video footage

Stop definition



Stop selection

- Basic site selection based on:
  - Stop type
  - Bike infrastructure type
  - Average daily ridership
  - Average daily bike volume
  - Not in Cambridge
- Substantial differences in bike lane layout (e.g., sidewalk-level lanes vs. road-grade lanes)

Findings

I. Literature review

II. Outreach

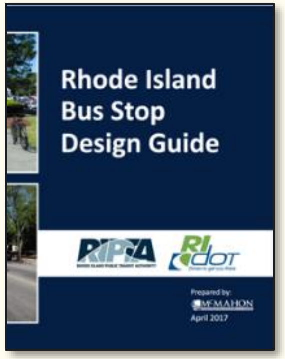
III. Inventory

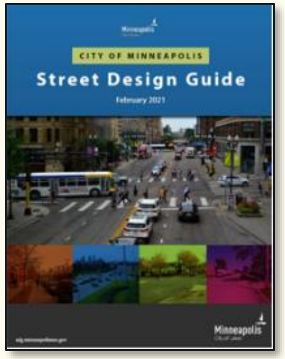
IV. Behavioral analysis

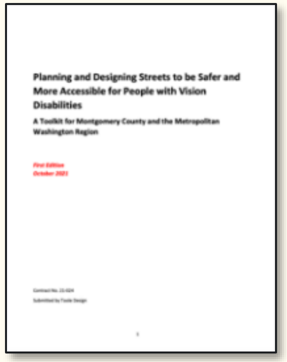
V. Recommendations

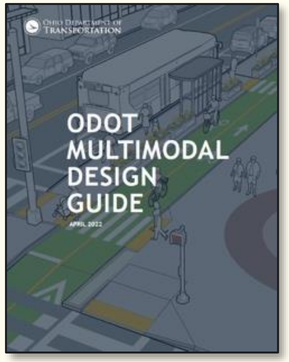
Findings: Literature review

- No available scholarship on bus stop/bike lane interactions focused on accessibility; this is new, emerging topic
- Project focused on guidebooks – no prevailing industry standard on joint design for bike lanes and accessible bus stops
- Common design elements:
    - Platform width: 8′-10′
    - Bike lane width: 4′-5′
    - Accessible boarding area: 4′ × 4′ - 5′ × 8′
    - Railings/Fences
    - Signage









Findings: Outreach (riders)

Bus Stop Type

- Strong **preference for full-width platform** bus stops; still in need of improvements
- Concerns about partial width platform bus stops: bus stop shelter location and bus stop sign location
- No-platform bus stops were considered unacceptable

Platform Width

- Important for wheelchair users (space for navigation, visibility to the driver, ramp implementation)

Fencing

- Helpful for crosswalk wayfinding and increased situational awareness

Additional concerns

- Protected bike lanes **communicate right of way to bicyclists**
- Lack of crosswalks
- Two-way bike lanes or **wrong-way bicycling** creates challenges for visually impaired individuals
- Buses not stopping next to the platform/curb
- E-bikes and scooters in bike lanes

Findings: Outreach (practitioners)

Targeting bikers

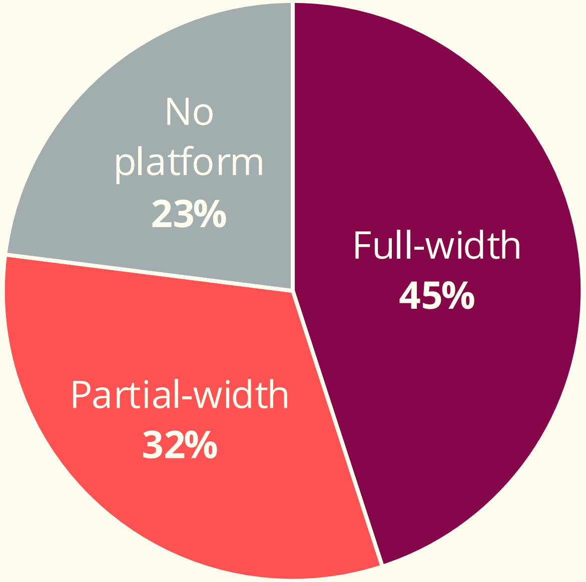
- Speed management
  - Raised bike lanes
  - Narrowed bike lanes
  - Curved bike lanes
  - Rumble strips
- Crosswalk awareness
  - Signage, markings, contrast pavement
  - Bollards at crosswalks
  - Regulations (e.g., in Toronto, bikes may not pass or approach bus closer than 6.5’ from rear or front doors)

Targeting bus riders

- Wayfinding
  - Additional bus stop sign pole (on sidewalk side, not platform side)
  - More tactile pavement, guidance strips, and detectable warning surfaces
  - Audible messages for bus riders
- Physical access
  - Signalization of crosswalks
  - Minimum platform width requirements ranging from 5 ft to 8 ft

Findings: Inventory

Municipality	Number of Floating Bus Stops
Boston	22
Cambridge	17
Somerville	10
Everett	3
Watertown	2
Brookline	2
Total	**56**



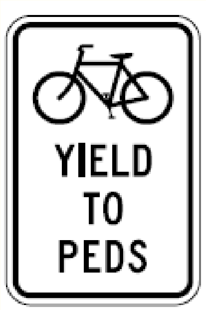
Findings: inventory

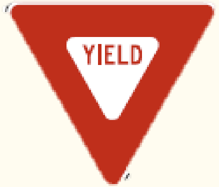
Bike lane design

- Very **few stops have horizontal and vertical deflection** in the bike lanes (5%); 39% have *any* combination of deflection
- 38% of all stops had yield signs *and* pavement markings in bike lane; 38% have one or the other; 24% of stops had **no signs or marking in the bike lane**

Bus stop design

- Most stops **do not have fencing** – full-width platforms are likeliest to have it (38%)
- **Tactile pavement found at most** full-width stops (80%), most partial-width stops (61%), and at no no-platform stops
- Fewer than half of stops had benches (45%)







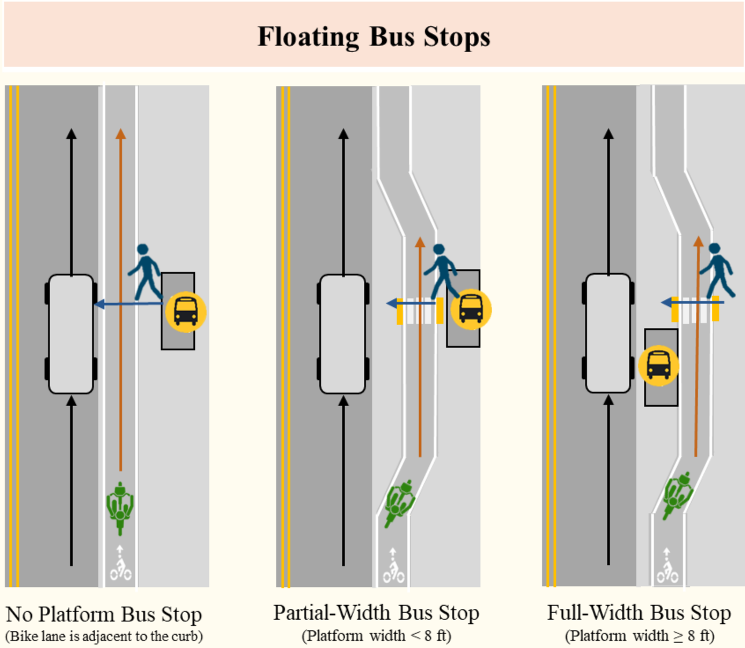
Findings: Behavioral analysis

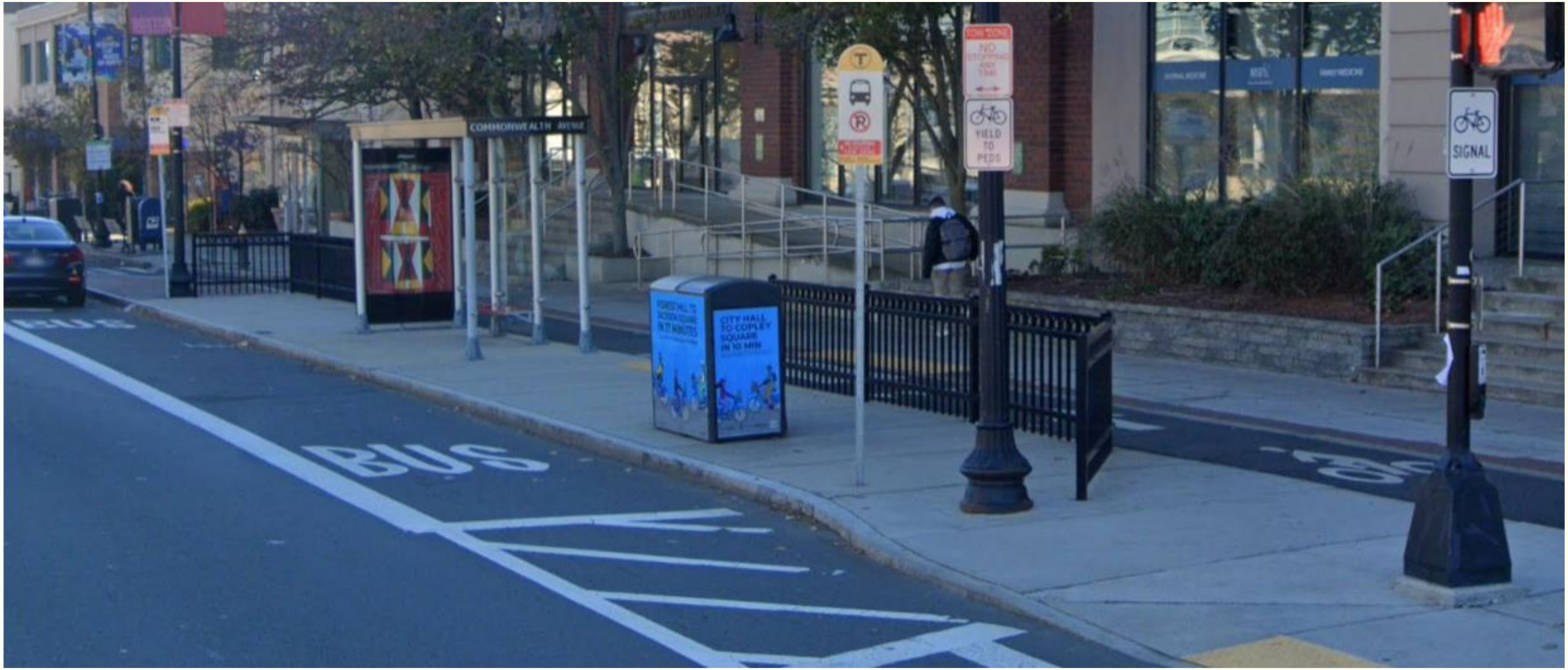
Fencing

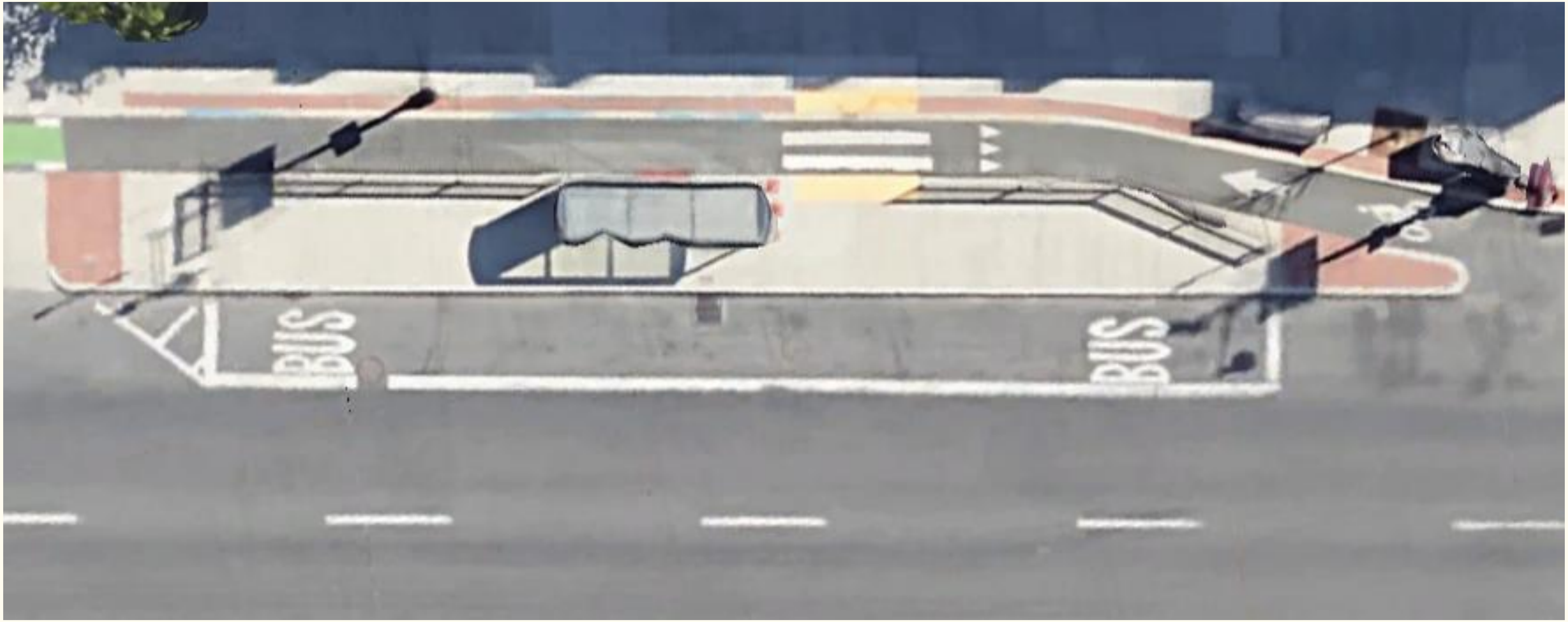
- **Does not reduce bicyclist speeds** at the bus stop area
- Encourages crosswalk use
- Restricts bicyclists from veering onto the sidewalk
- More pedestrians **walk along the bike lane at bus stops with fences** compared to those without, but the duration of walking is significantly lower than for stops without fencing, suggesting fences may remind pedestrians to step out

Crossings

- **Wide crosswalks encourage use** but can also result in longer crossing times
- Bus riders cross the bike lane multiple times at full- and partial-width platforms more than at no-platform bus stops
- Full-width stops saw more pedestrians standing in the bike lane than other designs; maybe due to site-specific characteristics
- High percentages of pedestrians traveling along the bike lane could be attributed to stop layouts and pedestrians' incentive to reduce their walking distance

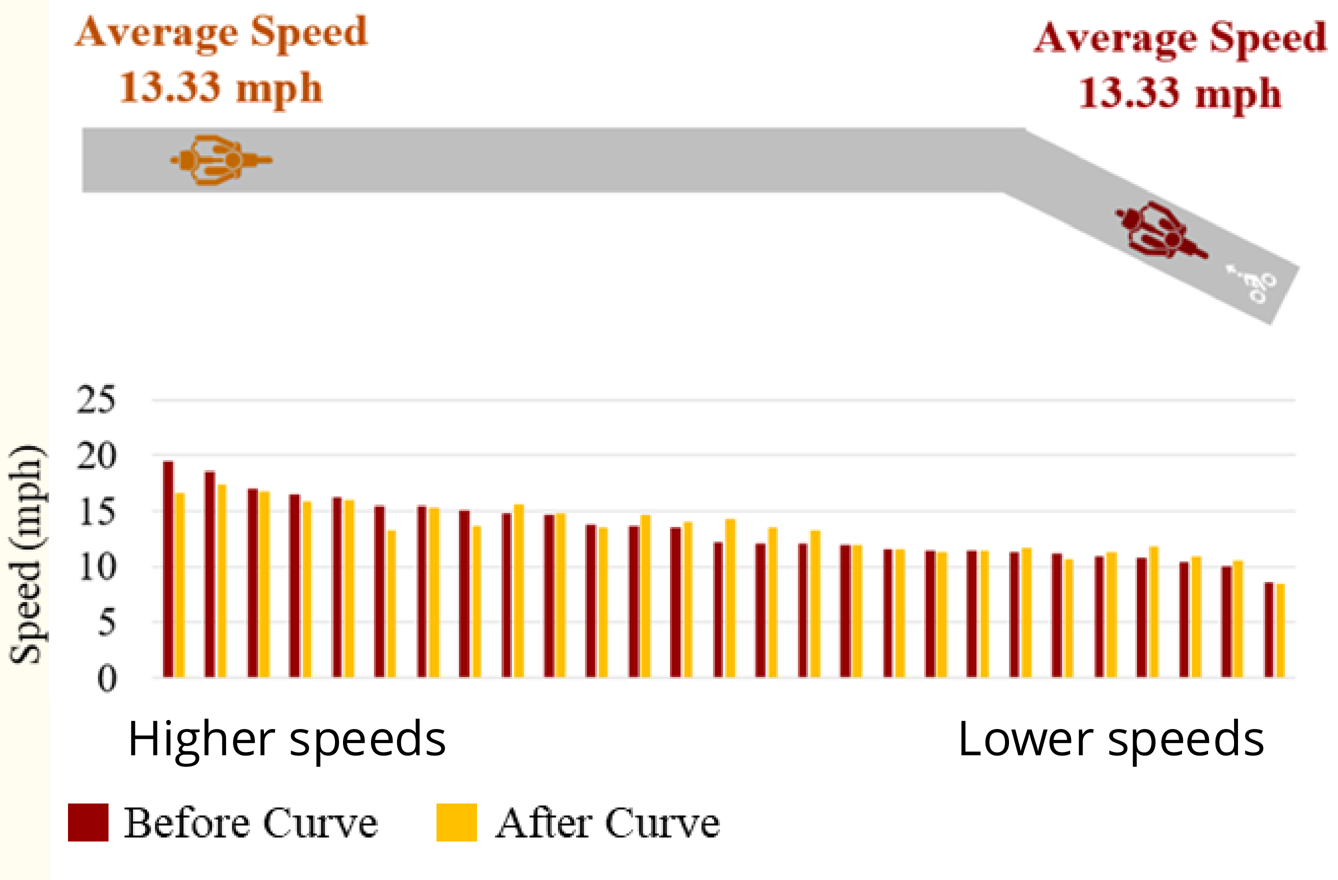



COMMONWEALTH AVENUE
NO STOPPING ANY TIME
YIELD TO PEDS
CITY HALL TO COPLEY SQUARE IN 10 MIN
SIGNAL
BUS


BUS
BUS

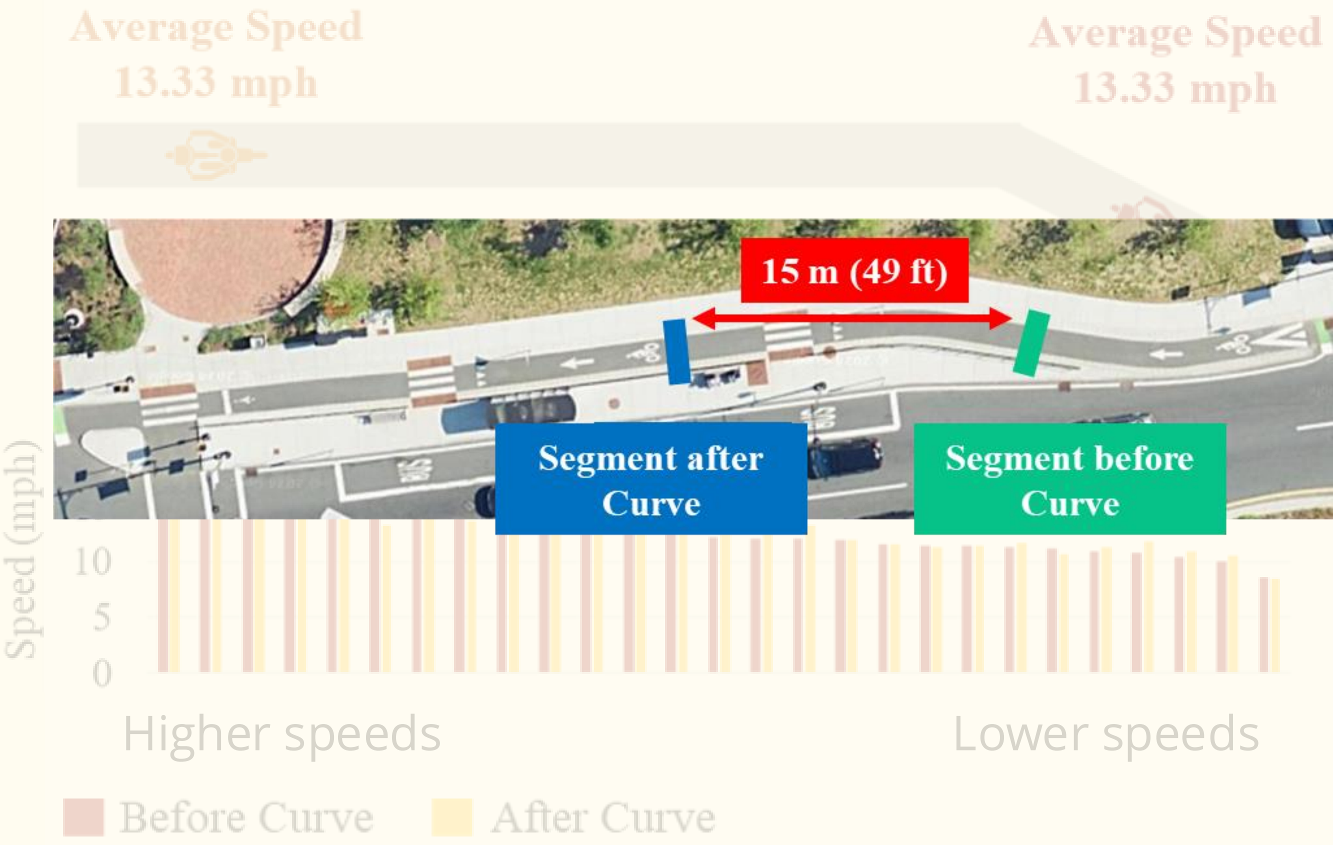
Findings: Behavioral analysis

- Horizontal deflection may not significantly reduce bicyclist speeds, **except for faster bikers** (15mph+) – but even then, only by about 1mph



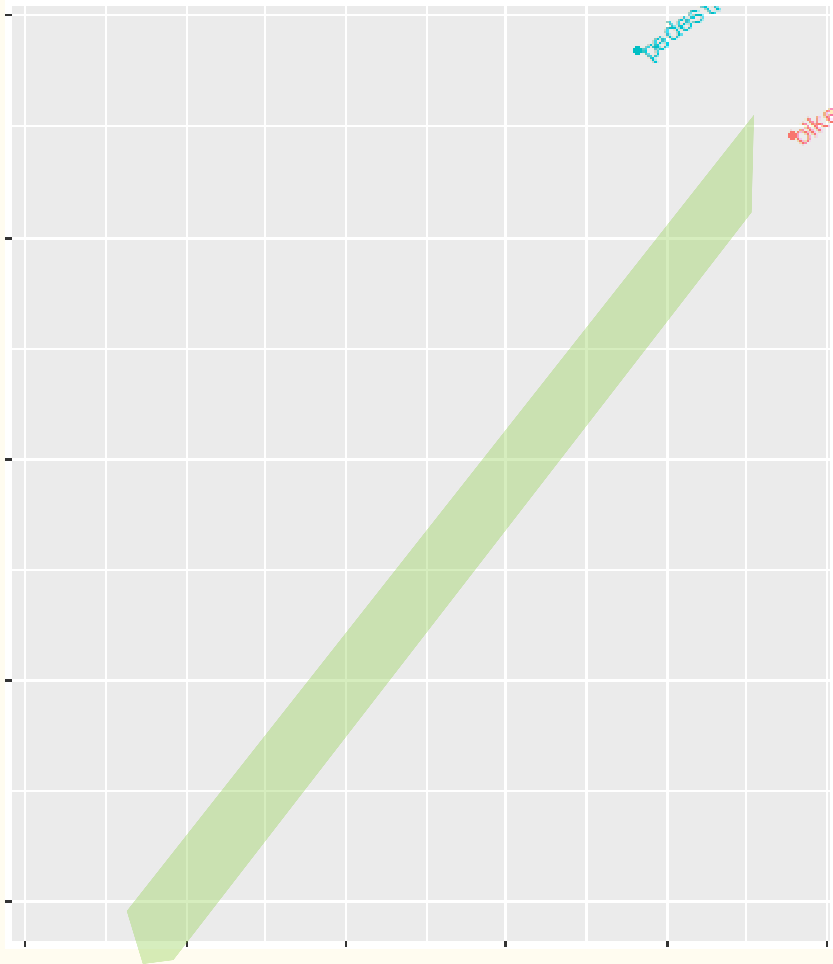
Findings: Behavioral analysis

- Horizontal deflection may not significantly reduce bicyclist speeds, **except for faster bikers** (15mph+) – but even then, only by about 1mph
- Caveat: Deflection measurement comes *after* first curve due to limitations in LiDAR distance



Findings: Behavioral analysis

Bikers generally do not reduce speeds, with pedestrians adjusting path of travel to wait, or bikers adjusting path of travel to circumvent pedestrians*

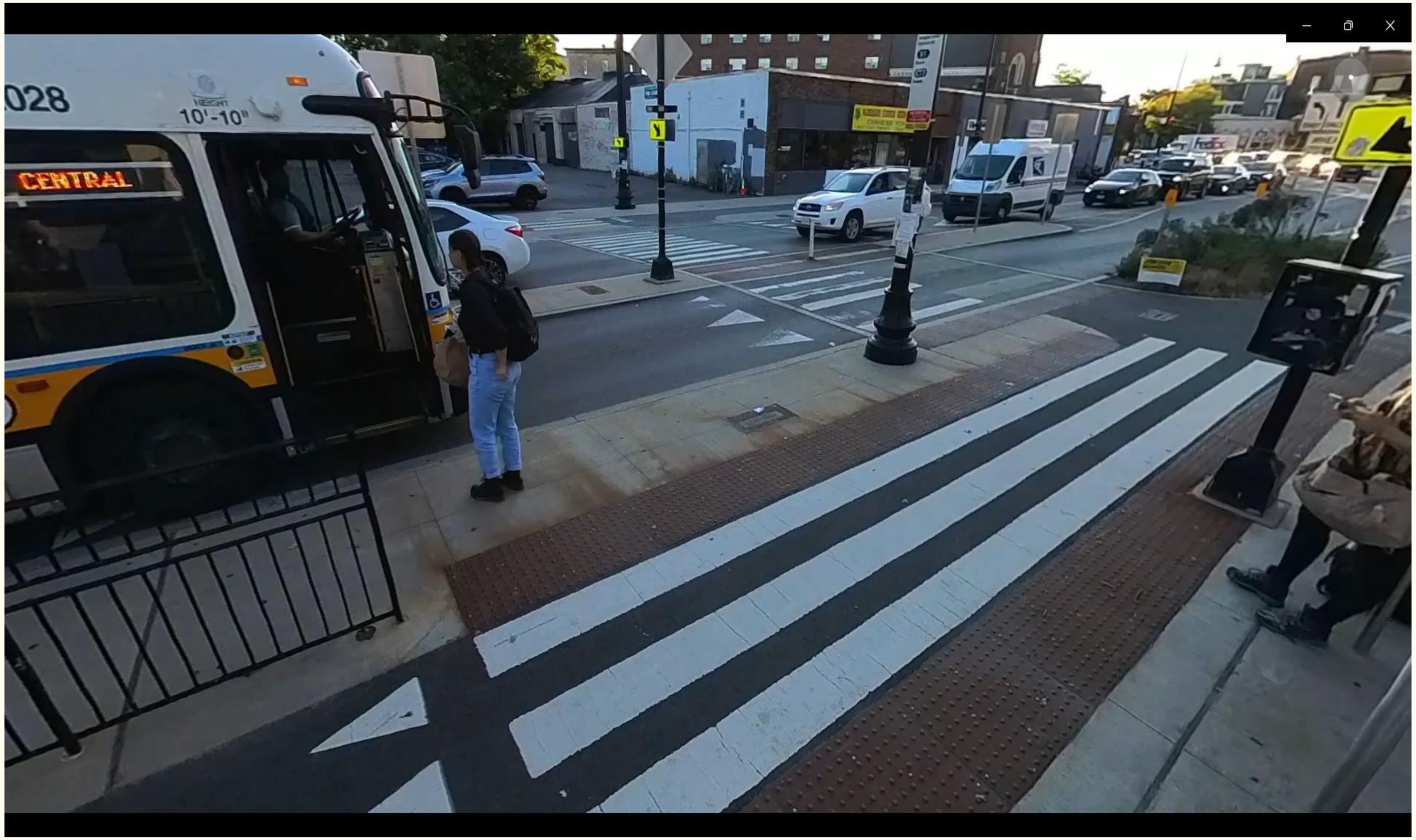


This animated plot is an interpretation of LiDAR data to identify pedestrian and biker paths.

It shows a pedestrian approaching the bike lane bike lane and slowing their travel to cross the bike lane *behind* the biker.

* *Limited number of potential-conflict observations*

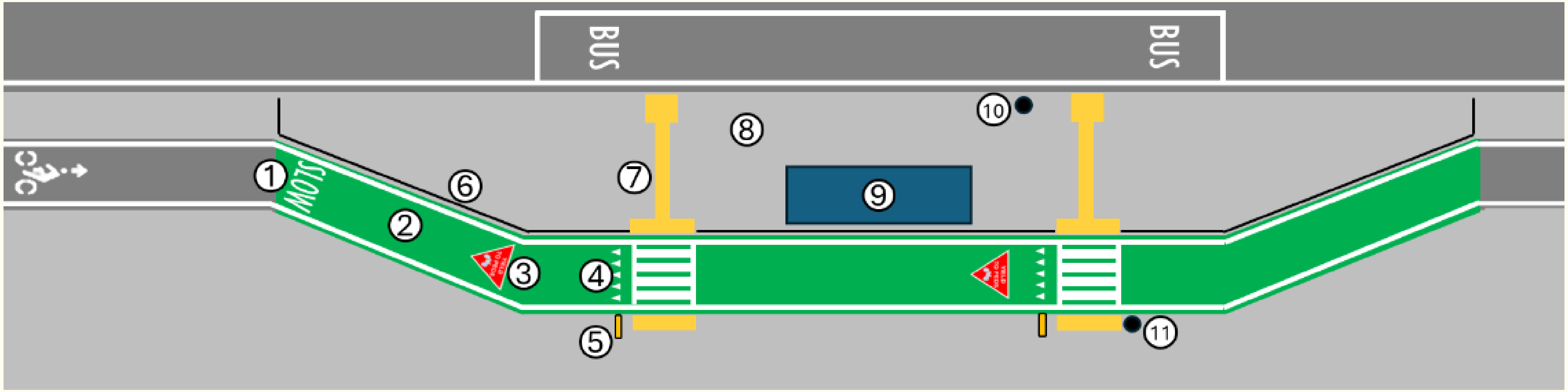
Findings: Behavioral analysis



This video shows two bus riders alighting at a partial-width platform. Both passengers walk most of the way down a wide crosswalk.

As a bike approaches in the bike lane, while a pedestrian remains in the crosswalk, the biker maintains speed but curves to the left to avoid a direct conflict with the pedestrian.

Recommendations: Design



1. “SLOW” stencil + colored pavement
2. Vertical + horizontal deflection
3. "YIELD TO PEDS" stencil
4. Shark teeth
5. "In Street Crossing" or "Bicycle Yield to Peds" sign
6. Fences with openings only at crosswalks
7. Crosswalks with tactile pavement aligned with boarding areas
8. Platforms at least 8 feet wide
9. Shelters/benches located on the platform
10. Bus stop sign pole near the shelter/bench and boarding area
11. Secondary bus stop sign pole at the sidewalk side of a crosswalk to indicate the crosswalk location and provide bus route information

Recommendation: Assessment

- Perform a **system-wide assessment** of the accessibility and safety of all floating bus stops using the developed step-by-step process.
  - Team developed a nine-step process for evaluating accessibility and quality of existing floating bus stops – see report for detailed questions and recommendations
- Future data collection
  - attention to the LiDAR **sensor selection and configuration** so that a desirable accuracy level can be achieved, and
  - overlapping of **multiple sensors** to cover a wider area and eliminate occlusion issues.

Recommendations: Further research

- Indication that high-speed bikers may behave (and react) differently to designs – **growth in e-bikes** may have particular influence on likelihood of conflict or impact of design
- Cambridge has most thorough bike lane + bus stop design, but were unable to study – potential for study expansion there
- Difficult to find stops with high ridership abutting high-volume bike lanes – this may become easier as more floating bus stops and bike lanes are installed

Questions?

Appendix

Stop designs: Full-width

Stop designs: Partial-width

Stop designs: No platform ("constrained")

Design recommendations

1. Separation
2. Bike speeds
3. Wayfinding

Design recommendations: Separation

- **Full-width** platform bus stops should be implemented when possible.
- **Fencing** is helpful for physically separating passengers from bicycles, managing platform access, and encouraging crosswalk use, in addition to improving situational awareness
- **Different pavement materials** can also increase situational awareness.
- Constructing **platforms with sufficient space** for ramp implementation and navigation of mobility-assisting devices
- **Narrowing or diverting bike lanes** to convert partial-width bus stops to full-width bus stops
- **Relocating shelters** from the sidewalk to the platform at partial-width platform bus stops by using narrower shelters

Bike lane adjacent to a full-width bus stop featuring colored pavement, vertical deflection, highly signed crosswalks, and bollards. (Montgomery County, MD)

Design recommendations: Bike speeds

- Bike **lane deflection and change in elevation** can help get bicyclists' attention, possibly resulting in lower speeds and greater likelihood of yielding to pedestrians, though more data is needed
- **Narrowing** bike lanes
- Creating **channelization** for bicyclists with flexposts and built-in ramps
- **Regulations** and signage/markings to standardize expectations for bikers
- Controlling crossings through **signals at the crossing** or by incorporating them in the main signal of a signalized intersection.

Pavement markings reminding cyclists of regulations requiring them to stop ahead of open bus doors. (Toronto, ON)

Design recommendations: Wayfinding

- **Alignment of the crosswalk and boarding area** marked by fencing openings and tactile paving
- **Detectable surfaces** to differentiate sidewalk, crosswalk entrance, bike lane, platform, and boarding area
- Bus stop **sign poles close to the shelter or bus door**
- An octagon-shaped flexpost or **secondary bus stop sign** pole can be set on the sidewalk to mark the crosswalk and provide bus route information to visually impaired passengers
- **Audible announcement** on buses to alert alighting passengers to an adjacent lane of active (bike) traffic

Tactile pavers lead to bus boarding zone at this no-platform stop. (Toronto, ON)