BALTIMORE CITY
SEPARATED BIKE LANE NETWORK
ADDENDUM TO 2015 BIKE MASTER PLAN UPDATE

MARCH 2017

Photo Credit: Elvert Barnes

Prepared for:

dot
DEPARTMENT OF TRANSPORTATION
BALTIMORE CITY

CITY OF BALTIMORE

Prepared by:

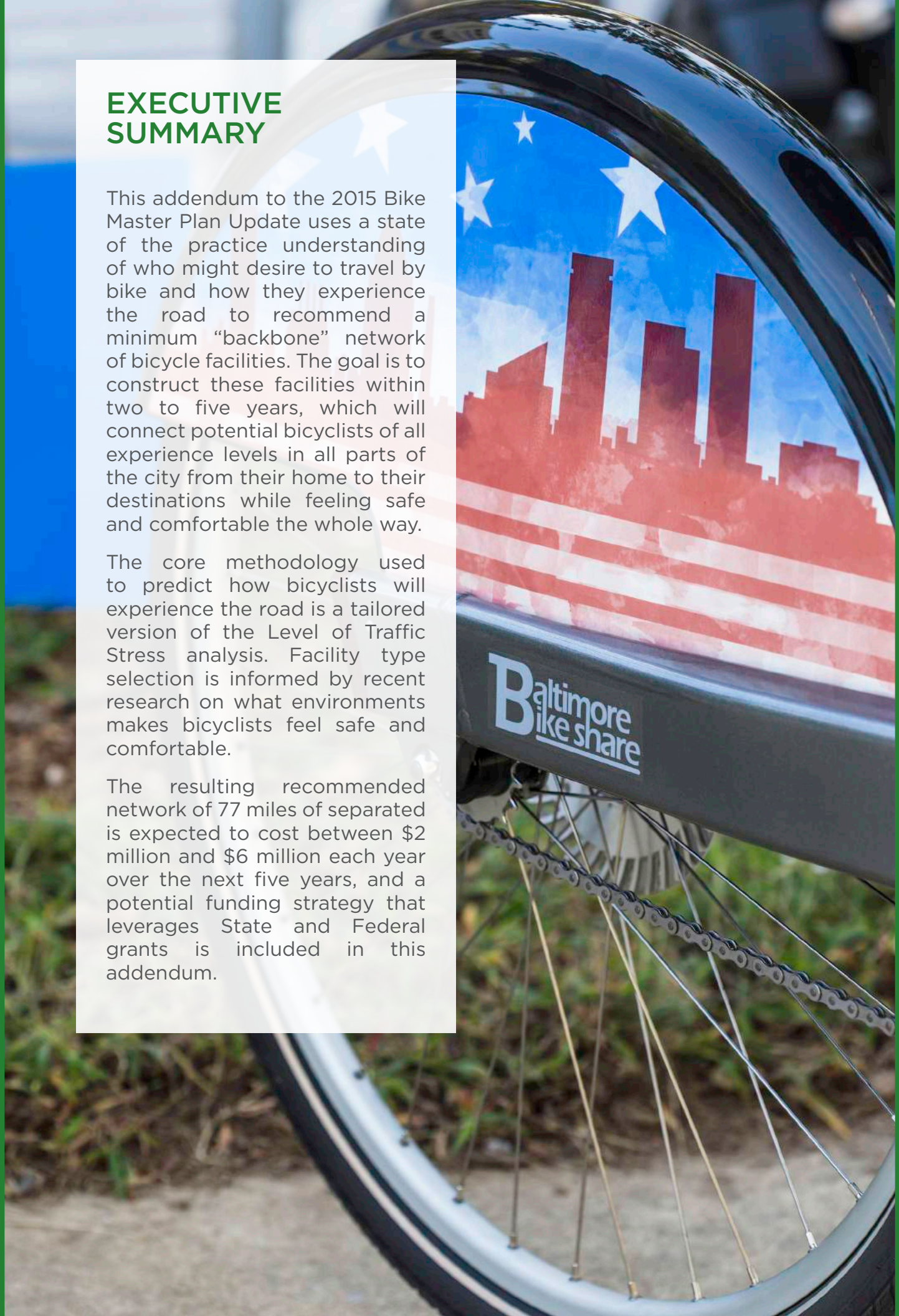
KITTELSON & ASSOCIATES

EXECUTIVE SUMMARY

This addendum to the 2015 Bike Master Plan Update uses a state of the practice understanding of who might desire to travel by bike and how they experience the road to recommend a minimum "backbone" network of bicycle facilities. The goal is to construct these facilities within two to five years, which will connect potential bicyclists of all experience levels in all parts of the city from their home to their destinations while feeling safe and comfortable the whole way.

The core methodology used to predict how bicyclists will experience the road is a tailored version of the Level of Traffic Stress analysis. Facility type selection is informed by recent research on what environments makes bicyclists feel safe and comfortable.

The resulting recommended network of 77 miles of separated is expected to cost between $2 million and $6 million each year over the next five years, and a potential funding strategy that leverages State and Federal grants is included in this addendum.



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Mayor Catherine E. Pugh
Jim Smith, Chief of Strategic Alliances, Mayor's Office
Matthew DeSantis, Special Assistant to the Chief of Strategic Alliances, Mayor's Office

Baltimore City Council
Bernard "Jack" Young, City Council President

Baltimore City Department of Transportation Officials
Frank Murphy, Interim Director
Lindsay Wines, Deputy Director
Connor Scott, Deputy Director
Veronica McBeth, Transit Bureau Chief
Graham Young, Deputy Chief of the Traffic Division
Caitlin Doolin, Bicycle and Pedestrian Coordinator
Jay Decker, Bike Share coordinator

Mayor's Bicycle Advisory Commission
Jon Laria, Chair
Robin Truiette-Theodorson, Mayor's Office Representative

Mayor's Bicycle Advisory Commission (cont'd)
Tony Savage, City Council President Representative
Graham Young, Traffic Division Representative
Caitlin Doolin, City Bicycle Planner Representative
Lt. Steve Olson, Baltimore City Police Department Representative
Dr. Keshia Pollock, Community Representative
Davin Hong, Architecture and Urban Design Representative
Greg Hinchliffe, Bicycle Advocacy Representative
Matthew Desantis, Planning Department Representative
Molly Gallant, Recreation and Parks Representative

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PART 1

A BETTER WAY TO PLAN FOR PEOPLE ON BIKES

ASSUME THEY HAVE THE SAME NEEDS AS EVERYONE ELSE

DEFINING AND RESPECTING BASIC TRAVEL NEEDS

Background

The 2015 Baltimore Bike Master Plan Update was a comprehensive document with good recommendations for every neighborhood in Baltimore. This Low Stress and Separated Facility Network addendum seeks to build on that work by identifying and prioritizing a set of projects that will dramatically increase the number of people in Baltimore City who can meet many of their basic travel needs by bike over the next two to five years. This section describes the general methodology used to plan a bike network that the general population will use. The application of this thinking to Baltimore's specific context is described in Part 2.

Fundamentally, people will only travel in a way that:

1. Gets them where they need to go
2. Feels safe to them

"I'm never quite sure if I'll arrive alive" is not a condition that anyone will willingly tolerate for their morning commute.

When we design streets for cars, we honor these basic travel needs by:

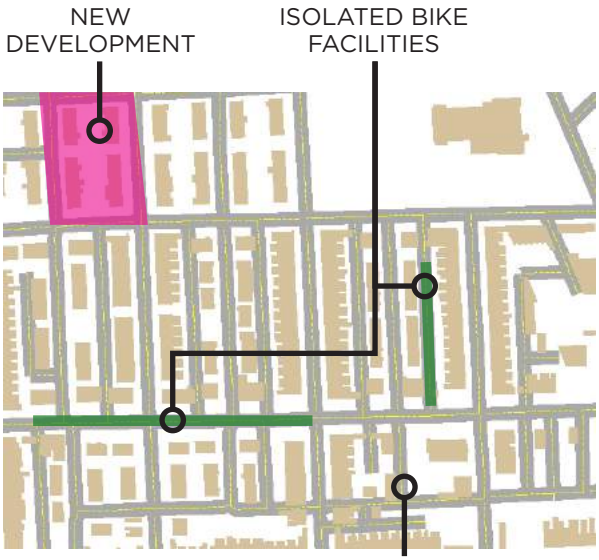
1. Connecting the new streets to the broader street network
2. Following engineering and design standards that ensure that the streets both are safe and feel safe to drivers

The Americans with Disabilities Act and other sidewalk standards also recognize these needs for pedestrians, even if implementation is imperfect.

NEW DEVELOPMENT CONNECTED SEAMLESSLY TO CITY STREET GRID

The way we traditionally plan bike facilities, however, often fails to meet one or both of these basic travel needs. Somewhere between the potential bike rider's home and the school, office, park, or grocery store that they're trying to reach, one of two things occurs:

1. A lack of bicycle facilities, or gaps between bicycle facilities requires people on bikes to ride in mixed traffic on streets where that feels dangerous
2. The bicycle facilities that do exist are designed in such a way that they don't feel safe, either because they're too close to traffic, they're frequently obstructed, or the doors of parked cars open into them



CITY STREET GRID, MOSTLY WITHOUT BIKE ACCOMMODATIONS

These shortcomings of traditional bike planning occurred for a variety of reasons, including perceptions that bicycling is primarily a recreational activity and not a valid transportation mode, misunderstandings about what street conditions make bicyclists feel unsafe, and bicycle planning methodologies that focus on single corridors, causing the facility gaps mentioned above.

The growing research into the attitudes, habits, and perception of safety of people who want to ride bikes for transportation suggests a relatively simple methodology for improving comprehensive bicycle planning so that it can better achieve the goal of allowing more people to travel by bike:

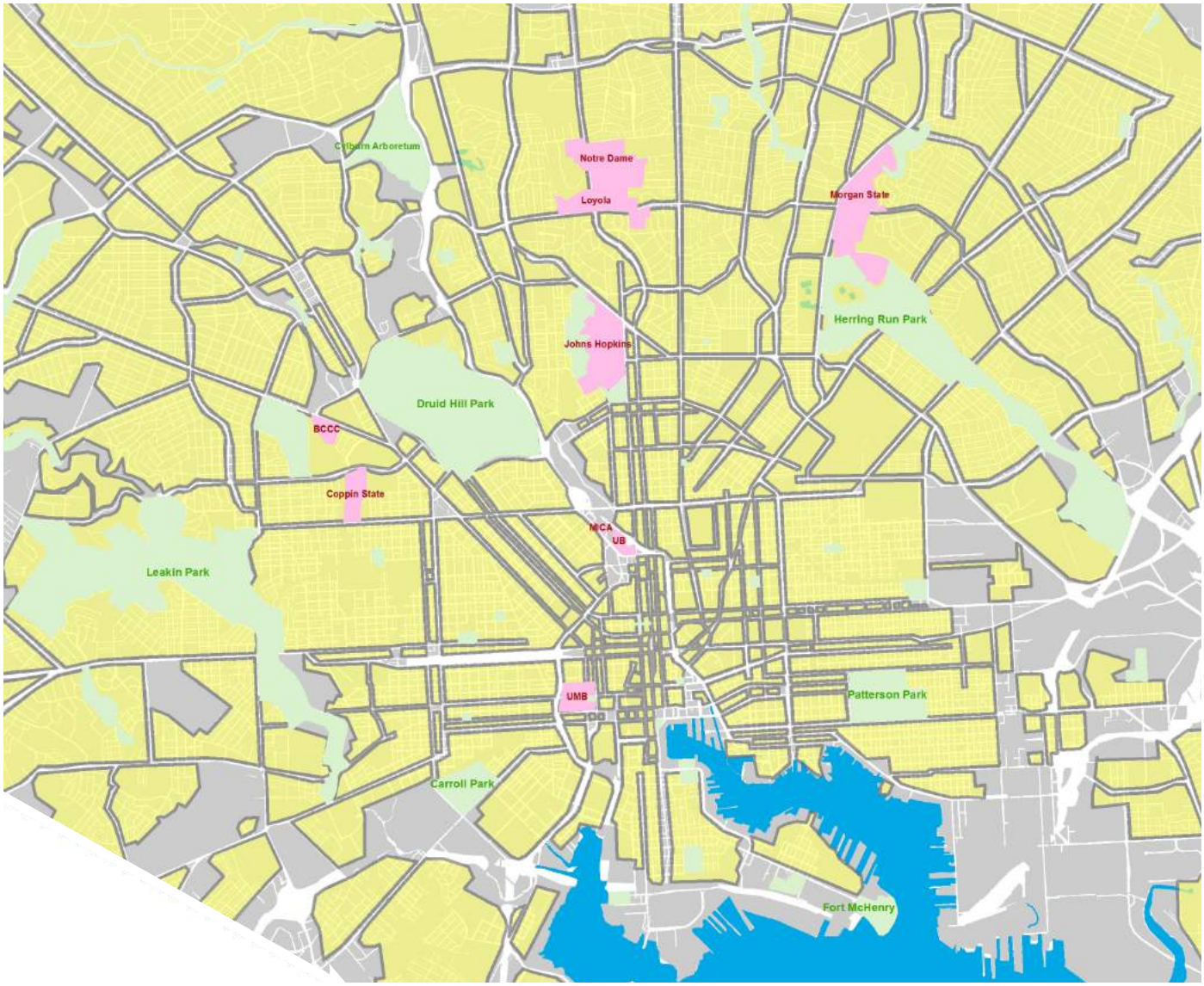
1. Identify the network of "low stress" streets where people already feel safe riding bikes
2. Identify strategic corridors that would connect places of interest most efficiently
3. Identify the correct facility type to allow people riding bikes to feel safe on strategic corridors
4. Prioritize construction of facilities on these strategic corridors based on how much of the existing low stress network they "unlock" to bike travel. Prioritize projects that connect other existing or planned facilities.

[1] Identify Existing Low Stress Streets

The effort to identify the existing low stress street network is simplified by the fact that people on bikes are vulnerable street users, and the presence of any one of several factors that make them feel unsafe is enough to render a street effectively off-limits to them. The factors that make bicyclists feel too unsafe to use a street or bike facility include:

- Interactions with fast moving traffic (greater than 30 mph, approximately)
- Frequent interactions with traffic of any speed (greater than 8,000 vehicles per day, approximately)
- Obstructions in a bike facility that force a bicyclist into traffic (debris, illegally parked vehicles, vehicles creeping forward from driveways in order to make turns, etc.)
- Dangerous pavement conditions (inadequate snow/ice removal, frequently broken asphalt, slippery gravel or maintenance plates, wheel-catching storm grates, etc.)

The most widely used methodology for determining the existing low stress network is the Level of Traffic Stress Methodology. This methodology was applied to the entire street network of Baltimore City, and then supplemented with volume data where available, to visualize all of the "islands" of connected low stress neighborhoods within the City. This visualization allows the strategic selection of corridors for low stress bike facilities based on how efficiently they connect these islands to one another and to the existing and planned Downtown Bike Network. The map below shows a section of Baltimore City's connectivity islands, in yellow, with the barriers between them shown in white.



[2] Identify Strategic Corridors for Interventions

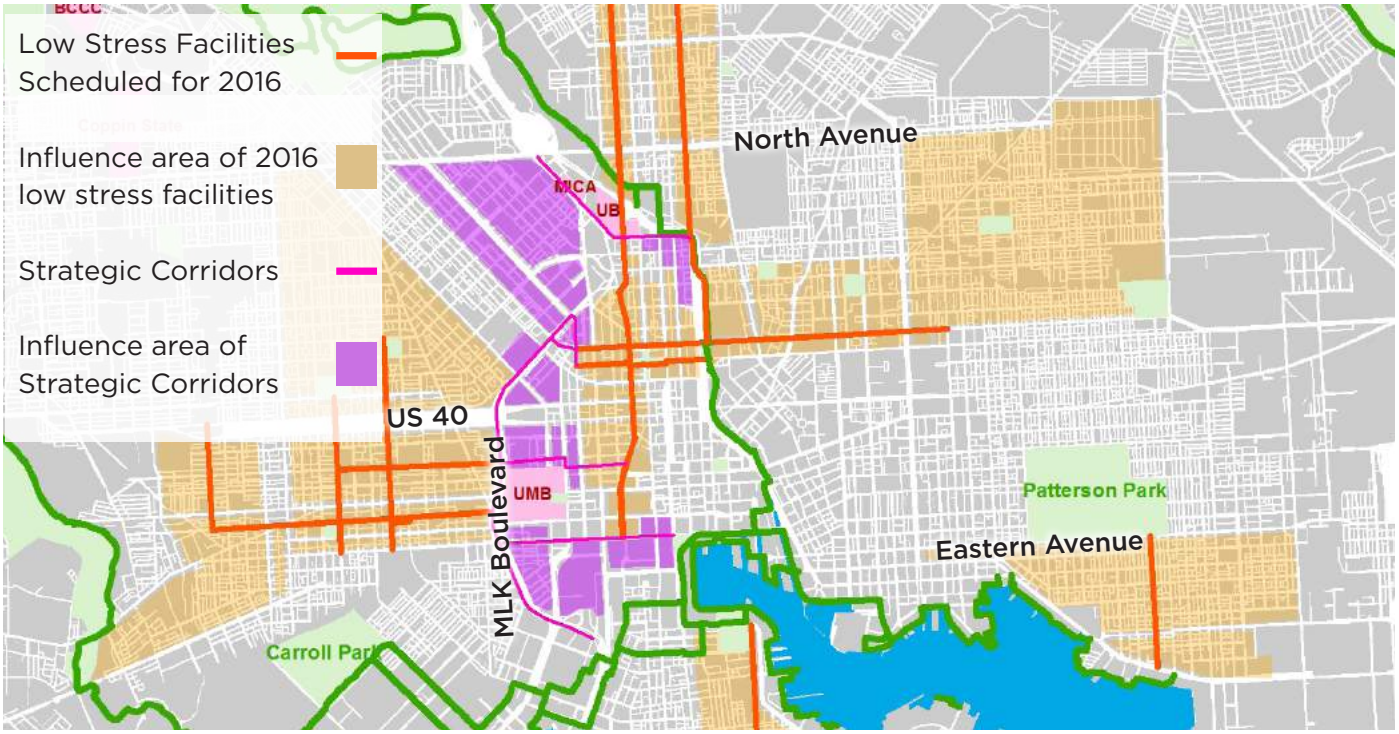
Knowing where people already feel safe riding bikes is crucial to strategic bike facility planning because it reflects the way people would actually use a bike for transportation. They will start at their home, which is likely to be on one of these low stress streets, wind through their neighborhood on streets they are familiar with and eventually hit a higher order roadway.

This higher order roadway can either serve as a barrier or a connection, depending on whether is has an appropriate and well-designed low stress bike facility.

The higher order roadways that most directly connect residential neighborhoods to job centers, downtown, and other important locations are usually in high demand as motor vehicle corridors, as well. For this reason, reclaiming some of the right of way from motor vehicle or parking usage is almost always a significant political battle. Thus, it is crucial to fight this battle on corridors that "unlock" the most network for the most potential riders. This necessity leads to a few important selection principles.

1. **Leverage existing low stress network when planning low stress bicycle facilities.**
2. **Carefully consider building low stress facilities that are not connected to the rest of the low stress network.** While taking advantage of opportunities to build facilities is important, it is also crucial to plan projects to connect these facilities to the wider low stress facility network so that they are accessible to more potential riders, and better connect to important destinations.
3. **Minimize out of direct travel in the low stress bicycle network**; people on bikes travel more slowly than people in cars, so detours are a more significant deterrent to bicycle travel.
4. **Provide comprehensive wayfinding and markings where detours are unavoidable.**
5. **Identify opportunities to create low stress off-street bicycle connections through land uses that are barriers to auto travel** (parks, schools, city-owned parcels).

HOW TO IDENTIFY STRATEGIC CORRIDORS

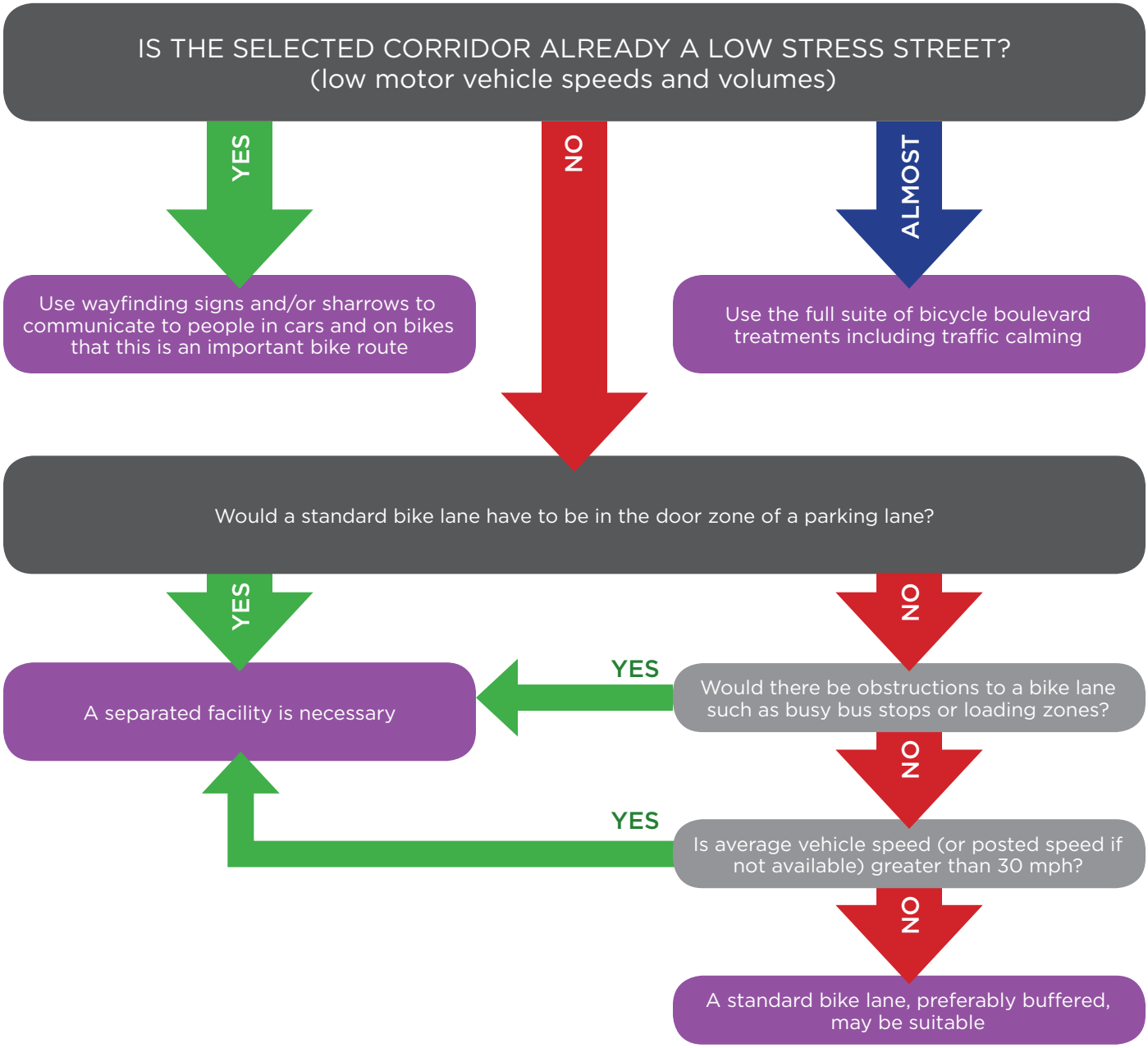


The map above shows the parts of Central Baltimore that can access a low stress bike facility (orange lines) via low stress streets. The magenta highlighted corridors are planned for low stress facilities. Strategic intervention on those corridors would enable bike travel from most of West Baltimore to Downtown and beyond.

[3] Identify Appropriate Facility Type

Once the most strategic corridors for intervention have been determined, a facility type that will yield a low stress condition must be selected for the corridor. This is simpler in a network focused approach than in traditional approaches. Succinctly put:

- If a street has high motor volumes, only a physically separated bicycle facility will make inexperienced bike riders feel safe and comfortable.
- If the motor vehicle traffic on a street is fast-moving, only a physically separated bicycle facility will make inexperienced bike riders feel safe and comfortable.
- Standard five-foot or six-foot bike lanes in the door zone of parked cars are never low stress facilities.
- Standard or buffered non-separated bike lanes are only low stress facilities when they are next to the curb and average traffic speeds are approximately 30 mph or less; if there is space for a buffered bike lane, it is best to add a vertical element to the buffer to create a separated facility.
- Bike lanes that buses must frequently pull through to reach their stop are not low stress facilities.



[4] Select Where to Build First

The Level of Traffic Stress methodology and resulting mapping are useful for determining strategic corridors, but each of the resulting projects must be designed, funded, and constructed. Selecting which projects to advance through this process should first be based on a combination of technical and community factors.

The technical factors for prioritizing construction are very similar to those used to select the most crucial corridors, just with added consideration for which other projects can be assumed to be built at the time the project is constructed. If a project earlier in the implementation time line is stalled or canceled, a previously viable project may no longer provide much additional network connectivity, or may become an "orphaned" facility. Connectivity to the wider low stress facility network is critically important in prioritizing projects..

The inclusion of community factors when prioritizing projects is meant to recognize that residents are invested in the physical environment in their neighborhood, and how its transportation infrastructure is used. These decisions affect their everyday lives, and their voices should be heard. However, street space is the public realm and must be managed according to the priorities of the City as a whole, as well. The below prioritization factors will be refined with public input in February 2017.

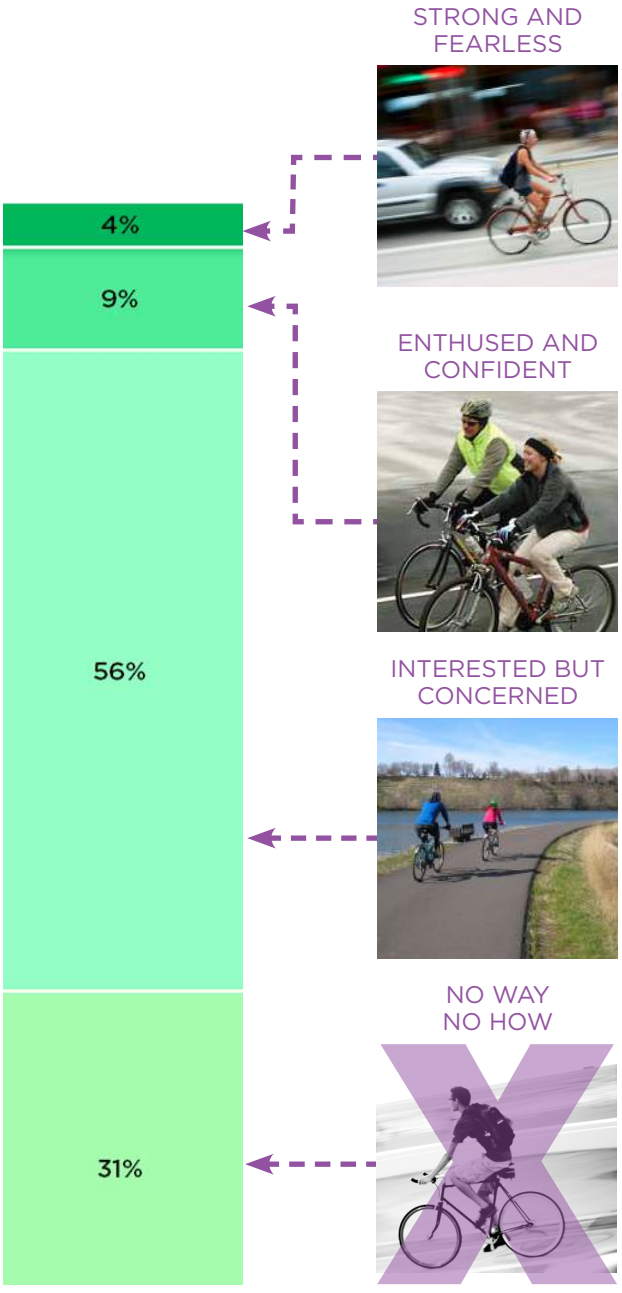
Technical Factors	Community Factors
Number of "low stress islands" that are connected to the broader low stress network	Provides low stress bicycle access to low car ownership neighborhoods
Connection to Downtown Bike Network	Provides low stress bicycle access to low-income neighborhoods
Connection to existing low stress facilities	Provides low stress bicycle access to job centers
Connection to transit facilities (bus and rail)	Provides low stress bicycle access to neighborhood-serving retail
Connection to Baltimore Bike Share stations	Supported by community residents and businesses

PART 2
RECOMMENDATIONS FOR BALTIMORE'S LOW STRESS AND SEPARATED BIKE FACILITY NETWORK

Project Background and Methodology

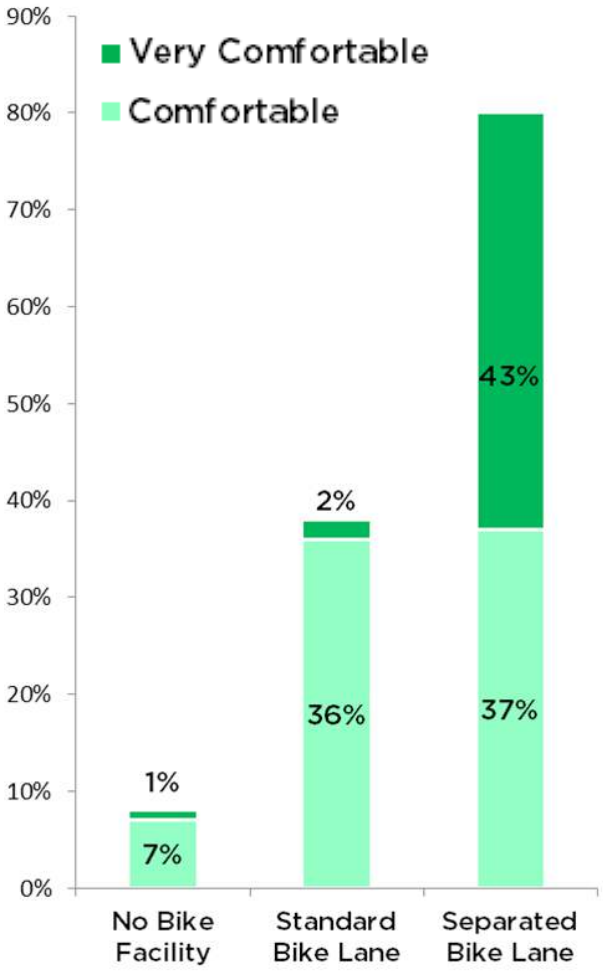
The 2015 Baltimore Bike Master Plan Update is a comprehensive document with recommendations for every neighborhood in Baltimore City. This Low Stress and Separated Facility Network addendum seeks to build on that work by identifying and prioritizing a set of projects that will dramatically increase the number of people in Baltimore City who can meet many of their basic travel needs by bike over the next two to five years.

As described in Part 1, these recommendations were made using a Level of Traffic Stress analysis of the entire street grid of Baltimore City supplemented with traffic volume data. The recommendations also relied on an emerging consensus among researchers, planners, and engineers as to what types of facilities provide sufficient comfort to be utilized by the general population, as opposed to only experienced bicyclists.



According to a 2012 study conducted in Oregon, nearly 70% of people report being interested in riding a bike for some of their travel. Under current conditions, only 13% feel safe and confident doing so. (Dill and McNeil, 2012)

COMFORT WITH DIFFERENT FACILITY TYPES AMONG "INTERESTED BUT CONCERNED" RIDERS.



Over half of the general population is interested in riding their bikes, but concerned about safety; standard bike lanes do not feel safe and comfortable, but separated facilities do for this group. (Dill and McNeil, 2012)

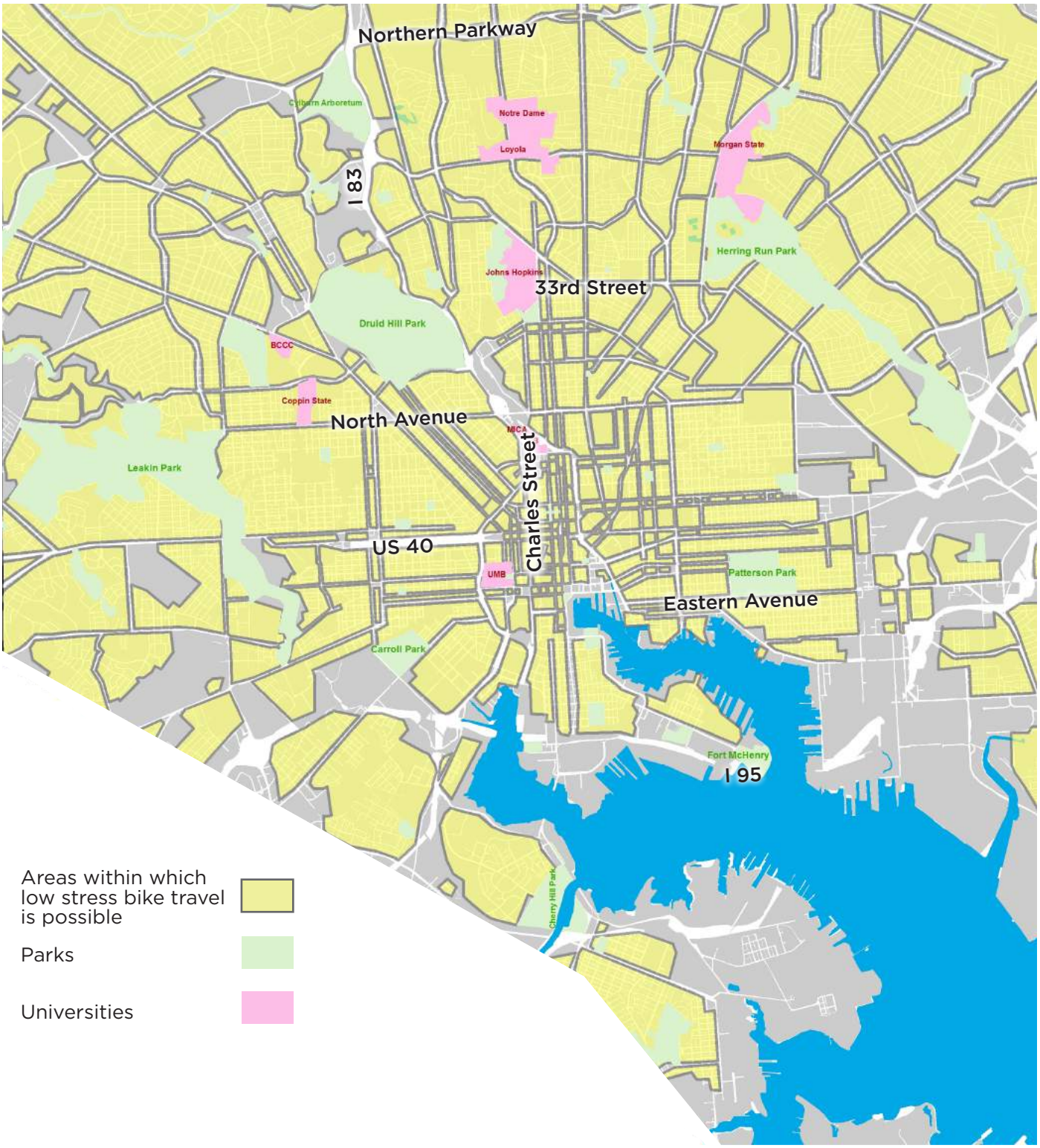
Level of Traffic Stress Analysis

The below map of Baltimore City shows every street rated using the Level of Traffic Stress Methodology. The green lines are the streets that an "interested but concerned" bicyclist would feel safe riding on, the blue lines are streets they would avoid and the red lines are streets that function as barriers to bicycle travel without a bike facility or intersection improvements to aid in crossing them.

CONNECTIVITY OF LOW STRESS STREETS

Existing Low Stress "Islands"

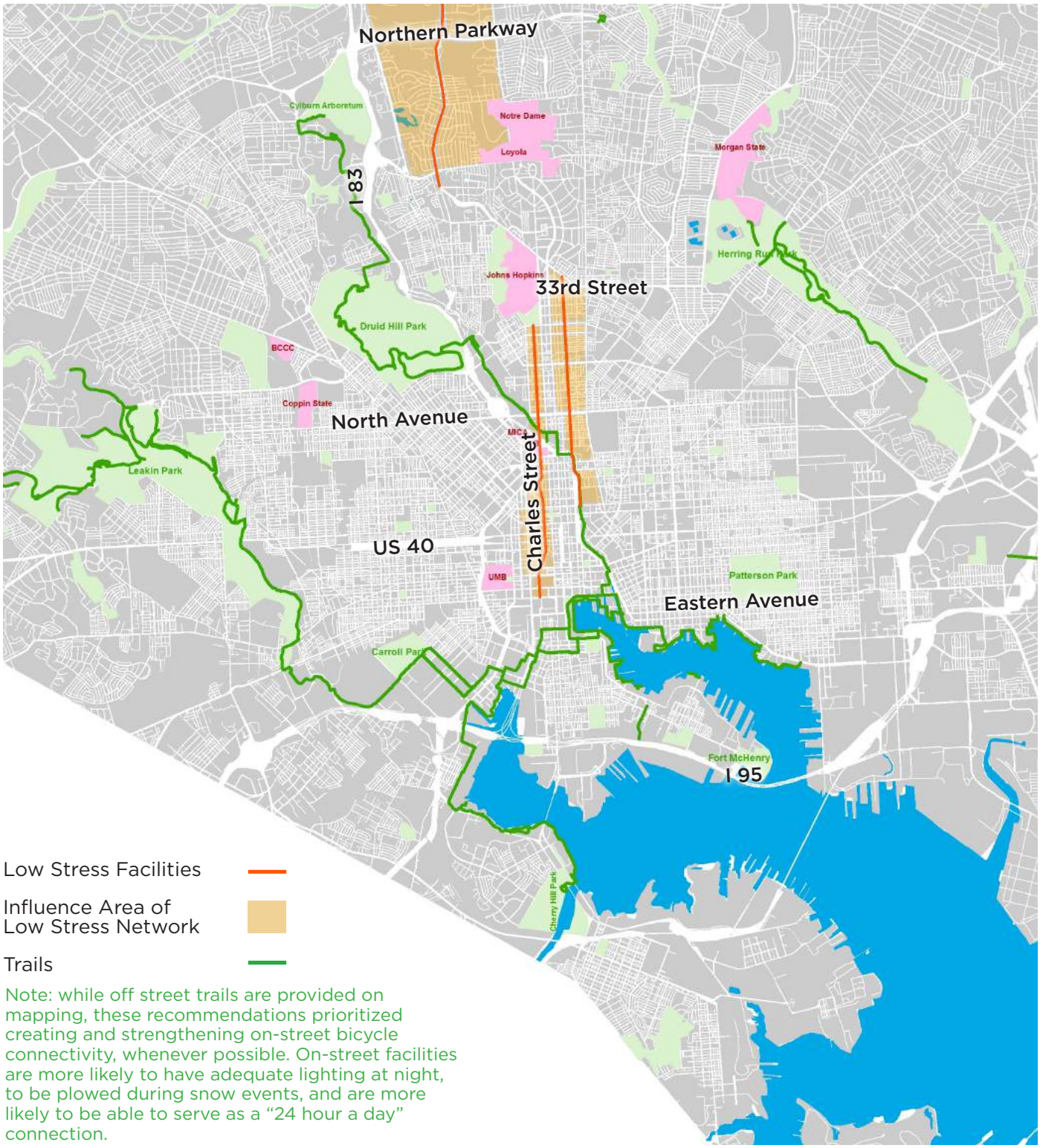
Based on the existing street network in Baltimore City, "interested but concerned" cyclists experience dozens of low-stress islands of connectivity. Outlined in yellow, these areas generally provide bicycle access within neighborhoods, but prevent travel across much of the City.



EXISTING LOW STRESS FACILITIES AND THE PLACES THEY CONNECT

Existing Low Stress Facilities

While many of Baltimore City's existing bike lanes are only suitable for experienced riders, there are existing low stress facilities that provide connectivity for interested but concerned riders across these connectivity islands. The map below highlights those facilities and the areas that they connect.



Low Stress Facilities

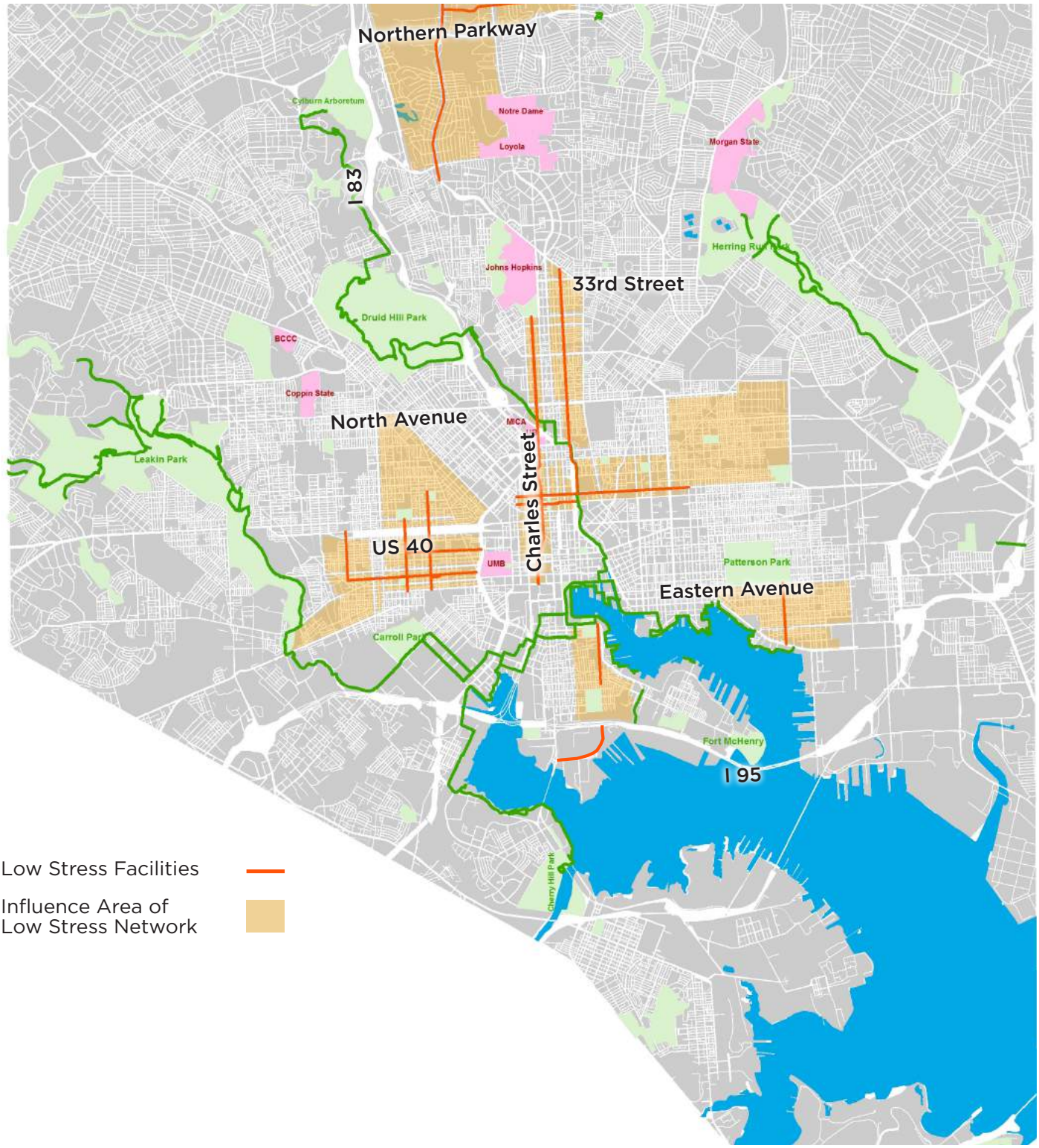
Influence Area of Low Stress Network

Trails

Note: while off street trails are provided on mapping, these recommendations prioritized creating and strengthening on-street bicycle connectivity, whenever possible. On-street facilities are more likely to have adequate lighting at night, to be plowed during snow events, and are more likely to be able to serve as a "24 hour a day" connection.

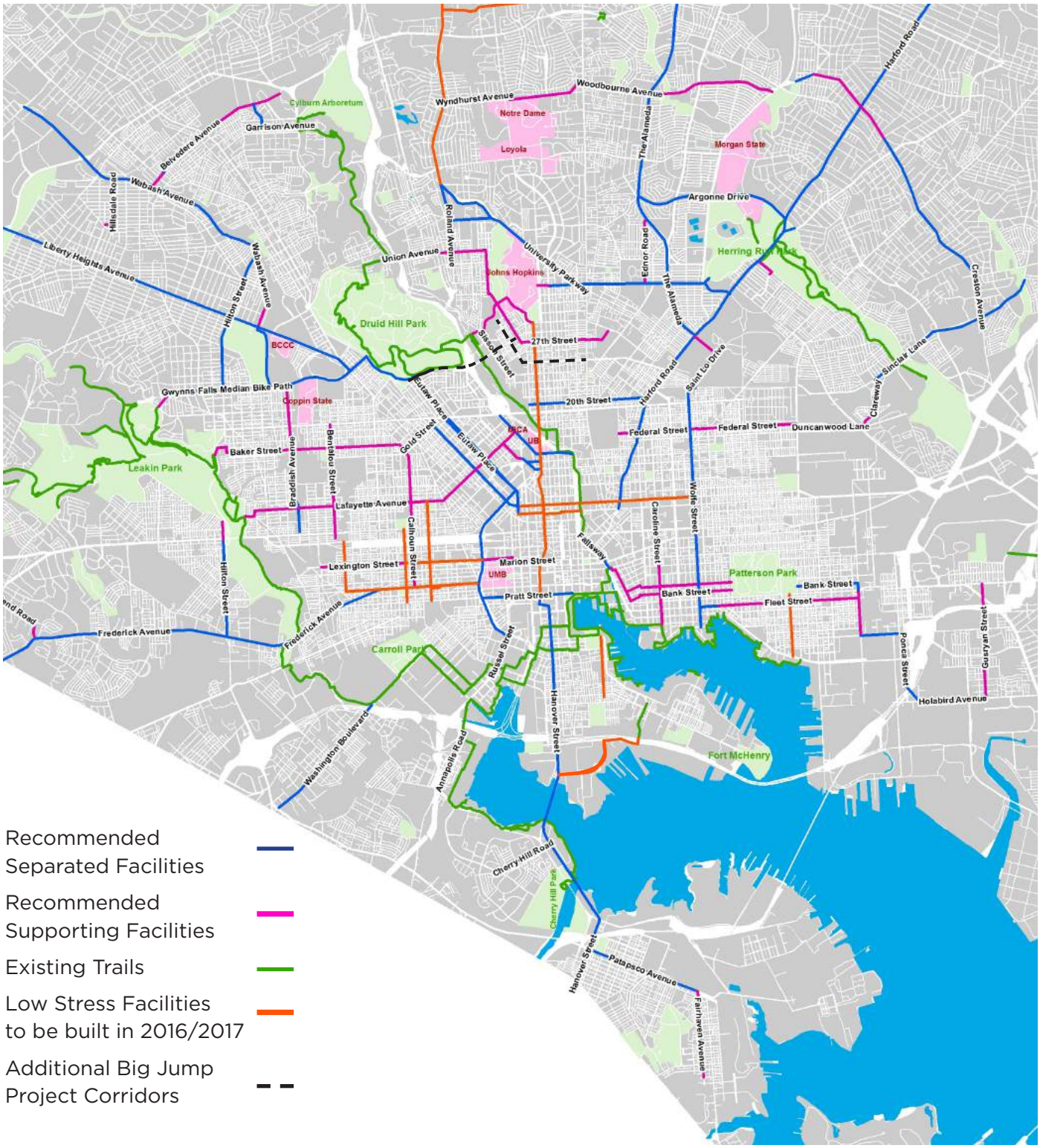
Planned Low Stress Facilities

Additional low stress facilities that are planned for construction in 2016 and 2017 will further expand the areas in that can be reached by bike by less experienced bicyclists, but there are still significant gaps, as shown in the map below.



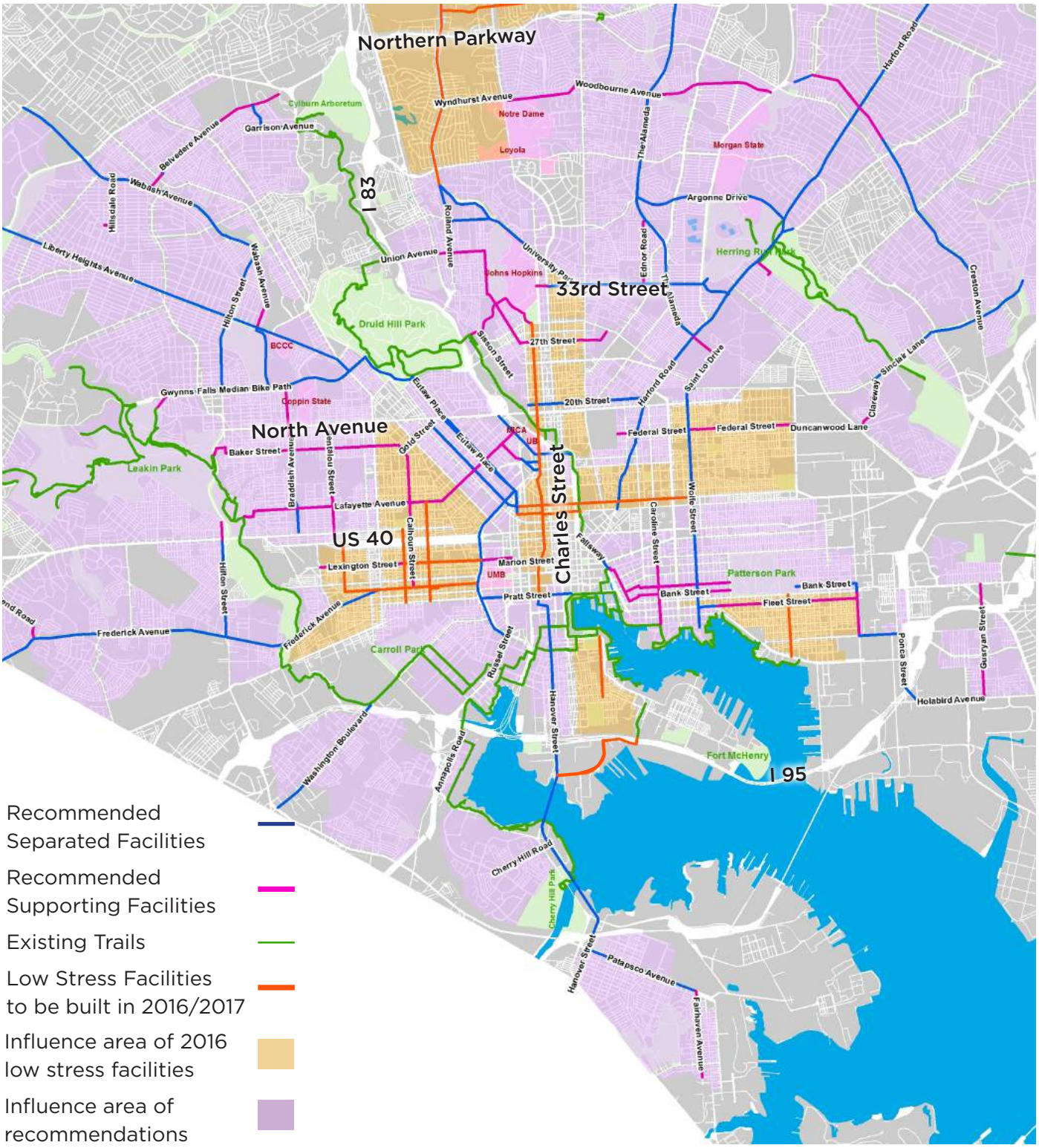
Map of Recommendations

The network of recommendations on the map below is a subset of the corridors in the 2015 Bike Master Plan Update. It also identifies corridors for their strategic importance in "unlocking" portions of Baltimore City to low stress bike travel. Corridors that require a separated facility to become low stress are shown in purple. Those where a non-separated facility is adequate are shown in pink. The goal is to complete construction of low stress facilities on these corridors within the next two to five years. The Bike Master Plan identifies additional facilities that are needed to reduce out-of-direction travel to the low stress network and reach remaining disconnected neighborhoods.



Influence of Recommendations

The purple shaded areas on the map below indicate the potential influence of implementing the recommendations on the previous page. If the recommended facility were constructed on every corridor, a person on a bike starting anywhere in the purple shaded zone could could reach any other place within that shaded zone without having to ride on a high stress roadway. Additional facilities to connect remaining disconnected neighborhoods to the low stress bike facility network will be planned for future years.



Choosing Low Stress Facilities

The recommended corridors mapped on previous pages are broken into the categories of Separated Facilities and Supporting Facilities. These designations were made with the best data available, but as each project moves forward, it is useful to use the facility selection flow chart on a more fine-grained level. At all times, facility selection should be guided by the following principals:

1. People on bikes are vulnerable road users and interactions with motor vehicle traffic must be extremely limited, either by physical separation (on a higher stress roadway) or by slowing and/or diverting traffic (on a lower stress roadway)
2. Beyond providing adequate protection details such as pavement quality, intermittent obstruction and encroachment by motor vehicles have the greatest impact on a rider's experience
3. If the above two requirements are met, facility design can be creative and context sensitive; it is not necessary to adhere to a limited number of highly standardized designs especially as the state of the practice evolves

Each project that is built as a result of these recommendations should be designed with community input and to reflect the state of the bicycle design profession.

EXAMPLE FACILITIES FOR HIGH STRESS STREETS

One way on-street cycle track separated by planters

Two way on street cycle track separated by curb and parking

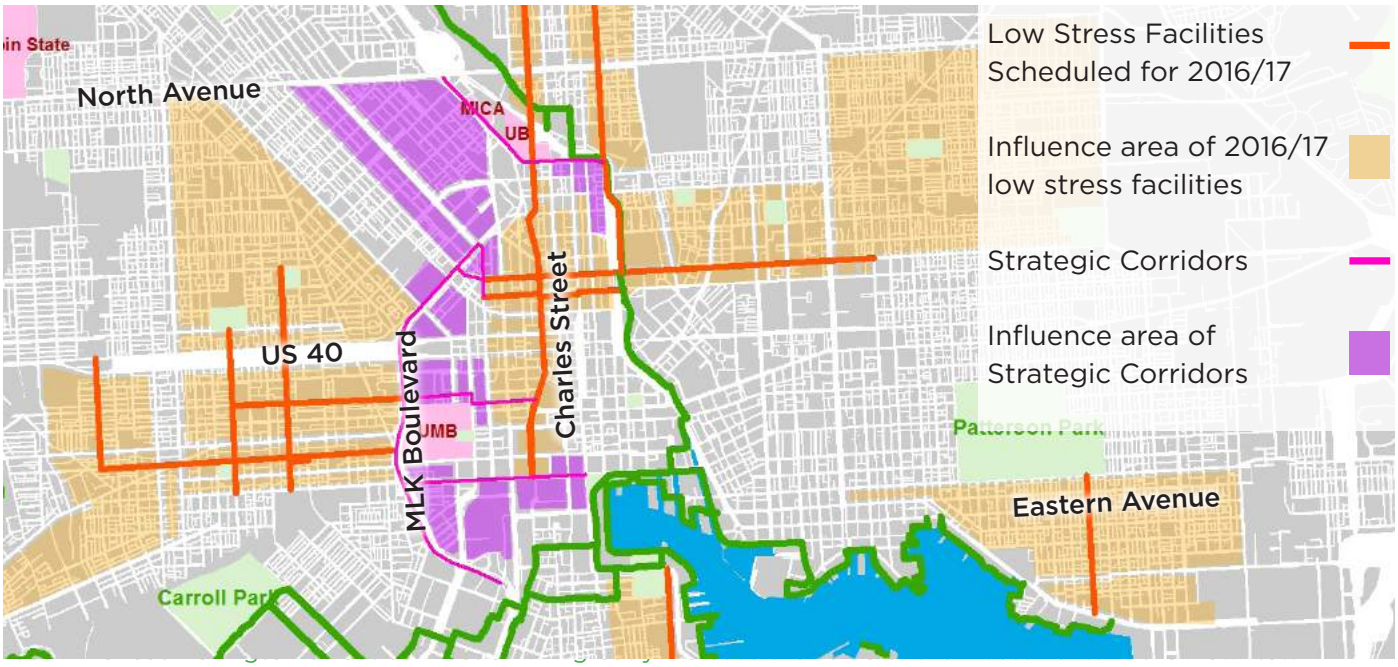
EXAMPLE FACILITIES FOR LOW STRESS STREETS

Sharrow on a local low stress street

Bicycle friendly speed hump to calm traffic on a bike boulevard

Connect Existing Low Stress Facilities

As shown previously, there are significant areas of the city that already or will soon have access to low stress bike facilities via low stress streets. However, these areas are not connected to one another, which limits the impact of these investments. An important first step to dramatically increase bike connectivity in Baltimore City is to construct low stress connections between these existing and planned facilities. Two notable examples of high value connections are shown below.

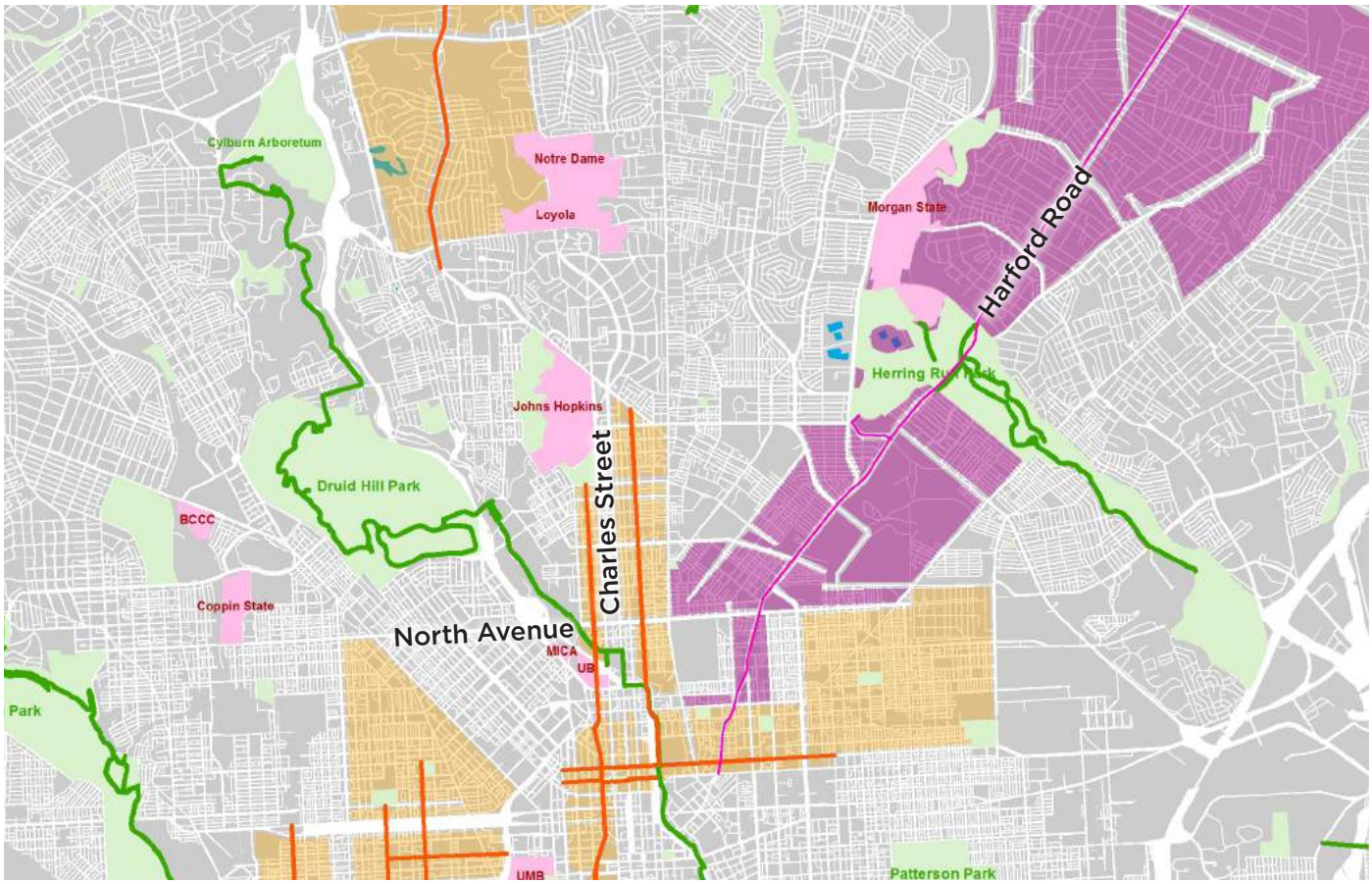


Bike Network and West Baltimore Bike Boulevard network by enabling travel to and across Downtown from large portions of East and West Baltimore.

Similarly, investing in facilities on the Fallsway, Albemarle Street, Gough Street, Bank Street, Wolfe and/or Washington Street (only one is necessary if a two-way facility is designed), and Fleet Street, would connect the vast majority of East Baltimore to Downtown. If the planned investments noted above are already made, these ares will also be connected to West Baltimore.

Choosing High Impact Connections

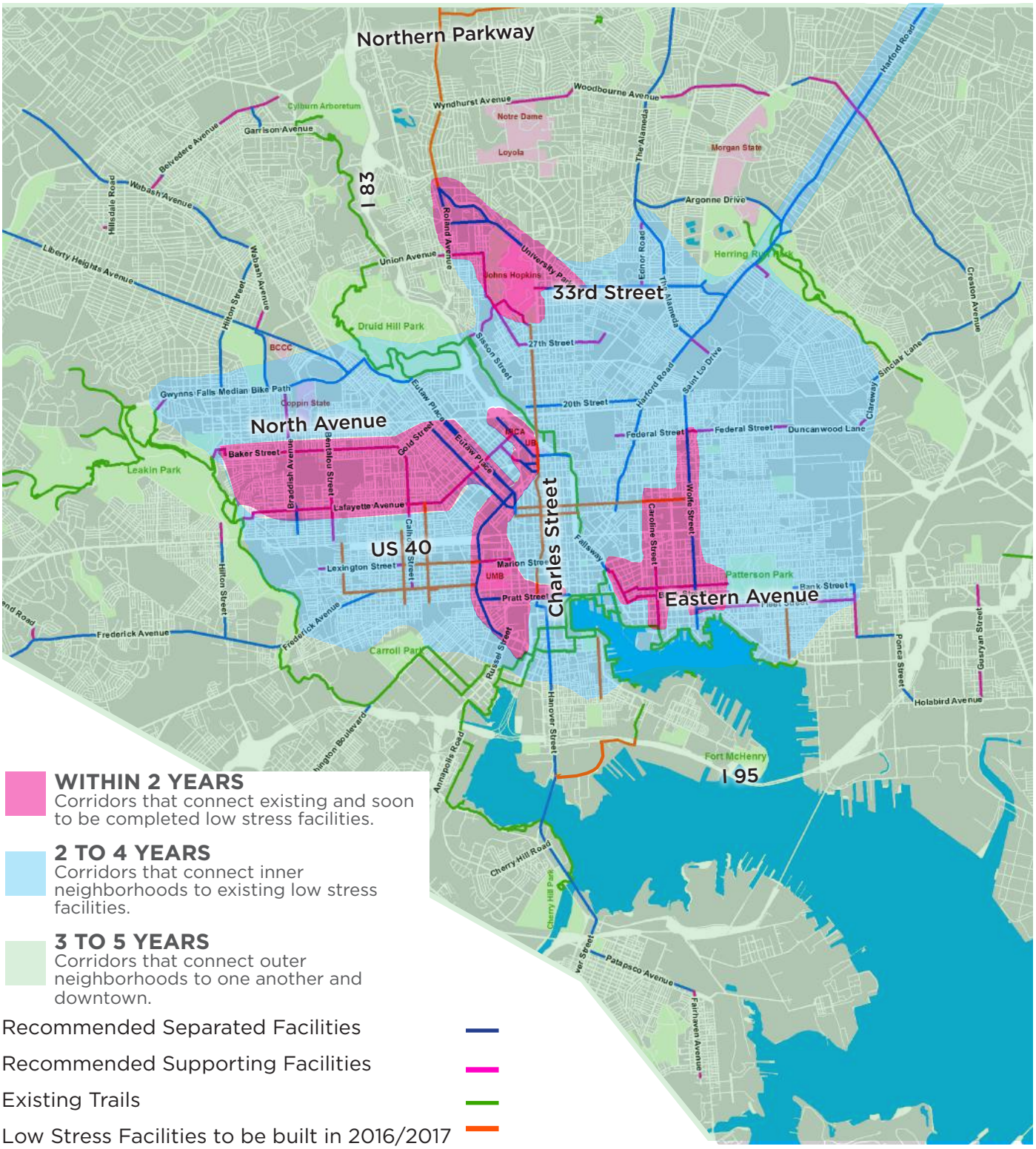
Technical and community factors (detailed in Part One) should be used to prioritize facilities to help expand the existing low stress network. They should connect to the existing low stress network, thus providing as much access as possible to the employment, transit, retail, and other destinations that are already connected to this network. However, community factors such as neighbors' support for the design must also be taken into account. Each project will have a thorough public input process to ensure that designs meet the needs of their neighborhoods.



Two notable high impact projects are a connection of Harford Road to the Downtown Bike Network, which would provide a connection to much of Northeast Baltimore. Baker Street, Mosher Street, Lafayette Avenue and the planned facility on Mount Royal Avenue will provide a connection from West Baltimore north of US 40 to Downtown and beyond.

Implementation

The map below shows three phases for project implementation. The first phase focuses on projects that directly connect existing and soon-to-be-built low stress facilities. The second phase connects inner-ring neighborhoods to downtown and to one another, and the final phase connects outer neighborhoods to one another and to downtown.



WITHIN 2 YEARS
Corridors that connect existing and soon to be completed low stress facilities.

2 TO 4 YEARS
Corridors that connect inner neighborhoods to existing low stress facilities.

3 TO 5 YEARS
Corridors that connect outer neighborhoods to one another and downtown.

Recommended Separated Facilities

Recommended Supporting Facilities

Existing Trails

Low Stress Facilities to be built in 2016/2017

Funding for Implementation

In order to achieve the Separated Bike Network Plan's vision to recommend Network that is implementable within 2-5 years. While there are many opportunities to leverage repaving and resurfacing projects, many of the recommended facilities will require separate funding sources. Assuming up to 10 percent of the mileage of recommendations will be completed through resurfacing and repaving projects, the below table provides a breakdown of funding per year necessary to build all of the recommendations. Note, the projects for 2017 are already funded, designed and ready to be constructed. **This plan recommends 77 miles of separated and supporting bike facilities be implemented at an estimated cost of $27 million between 2018 and 2022. This is an average of $5,400,000 in total investment (design and construction) per year.**

***Note: funding for 2017 design and construction is already secured.**

2017

Facility Type	Miles	Cost
Separated	6.27	$1,881,000
Supporting	6.6	$396,000
Total	12.87	$2,277,000

2018

Facility Type	Miles	Cost
Separated	9	$4,500,000
Supporting	6	$600,000
Total	15	$5,100,000

2019

Facility Type	Miles	Cost
Separated	9	$4,500,000
Supporting	6	$600,000
Total	15	$5,100,000

2020

Facility Type	Miles	Cost
Separated	12	$6,000,000
Supporting	5	$500,000
Total	17	$6,500,000

2021

Facility Type	Miles	Cost
Separated	10.5	$5,250,000
Supporting	5	$500,000
Total	15.5	$5,750,000

2022

Facility Type	Miles	Cost
Separated	12	$6,000,000
Supporting	6	$600,000
Total	18	$6,600,000

Funding Type	Funding Source	2018	2019	2020	2021	2022
Local Funding	General Fund and CIP Allocation	$1,000,000	$1,000,000	$1,000,000	$1,000,000	$1,000,000
State Funding	MDOT Bikeways Grant Funding	$836,000	$836,000	$1,160,000	$800,000	$1,196,000
Federal Funding	Transportation Alternatives Programs Grant	$3,264,000	$3,264,000	$4,240,000	$3,950,000	$4,404,000
Total		$5,100,000	$5,100,000	$6,500,000	$5,750,000	$6,600,000

Using this Guidance

The construction of low stress bike facilities on the corridors recommended in this document will dramatically expand the number of Baltimore City residents and visitors that can use a bike for some of their travel, or who can take advantage of the newly installed bike share system. However, the recommended corridors are neither an exhaustive list of streets that would benefit from low stress bike facilities nor the only streets that could be used to provide connectivity to certain neighborhoods.

The principles, facility selection chart, and decision making guidance provided in this document can be used to inform future bicycle planning in order to meet the goal of allowing more Baltimore City residents and visitors to travel by bike if they so choose. These will remain relevant well beyond the two to five year time frame intended for these recommendations. They can also be used to adjust recommendations, as long as the guiding goals of providing uninterrupted low stress on-street bicycle connections between origins and destinations is still met.

While it is important that the priority corridors that are indicated in this plan or suitable substitutes receive a low stress facility within two to five years, other bicycle connectivity projects should still be built as time and funding permits

Photo Credit: Elvert Barnes

Prepared for:

Prepared by:

KITTELSON & ASSOCIATES