CHAPTER 5: DESIGN OPPORTUNITIES AND CONSTRAINTS

Using the data collected in the previous chapters to understand the deficiencies of the existing transportation network, the Study Team identified multimodal options (for bicycles, pedestrians, transit, automobile, and freight) and potential improvements that address the transportation needs for a variety of users in the Hanover Street corridor, which has the potential to better support connectivity between all modes of travel. For this phase of the study, the public outreach effort included meetings with the Interagency Advisory Group (IAG) and the Community Advisory Panel (CAP) on April 26, 2017 and April 28, 2017 to present the design opportunities and constraints and obtain feedback, as well as a May 23, 2017 public meeting.

Roadway

The existing roadway conditions in the study area were previously discussed in Chapter 2 and Chapter 4. It should again be noted that no roadway as-built drawings or construction documents were available from BCDOT for the Hanover Street corridor and that assessments were made using aerial photography, GIS-based photogrammetry, and field observations. As mentioned in Chapter 4, the existing 12-foot travel lanes on Hanover Street, which match the width of the lanes on the Vietnam Veterans Memorial Bridge are appropriate for the major arterial roadway classification of the corridor.

To address the problematic pavement conditions that exist in the corridor, such as those due to significant truck traffic in the area causing pavement rutting, a potential option is to reconstruct the most-affected sections of Hanover Street with concrete pavement instead of asphalt. The enhanced structural strength of concrete is appropriate to mitigate the effects of truck traffic. Based on field reviews, it appears that the sections of Hanover Street most in need of this treatment are to the first intersection north and south of the Vietnam Veterans Memorial Bridge – namely, 375 feet to the north to Cromwell Street on Hanover Street and 800 feet to the south to Waterview Avenue on both Hanover Street and Potee Street.

Numerous blocked inlets were noted on the bridge and surrounding corridor during field observations and it is recommended that all existing inlets, pipes, and bridge scuppers should be cleaned to allow the existing drainage system to function properly. Additionally, the existing storm drain system should be visually inspected (inlets/manholes) or video inspected (pipe systems) to determine the extent of repair or replacement that would be necessary along with other corridor and bridge improvements.

As previously mentioned in this report, there does not appear to be any existing stormwater management in the area. The existing roads were likely constructed prior to water quality regulations and because the outfalls discharge to the Patapsco River, quantity control was likely not needed. Any future major reconstruction of the roadways will require quality control at a minimum and there are some median areas that may be useful for small bio retention type facilities. The Study Team acknowledges that there will be a need for stormwater management and available space is limited in the corridor.

Any proposed design will be in conformance with Baltimore City design standards for both drainage (inlet spacing and pipe sizes) and stormwater management for quality control (treat a minimum of one inch of rainfall for all reconstructed and new impervious areas).

Pedestrian and Bicycle

The existing pedestrian facilities in the corridor, shown on **Table 4-4**, generally provide for pedestrian mobility and safety to a significant degree. South of the bridge, sidewalks exist in the corridor on each side of the northbound and southbound lanes. North of the bridge, sidewalks exist on the east side of the northbound lane, since the I-95 northbound ramp to Hanover Street precludes sidewalks on the west side. The majority of pedestrian travel is east and west to/from neighborhoods. Current conditions include some recent upgrades, particularly for Americans with Disabilities Act (ADA) compliance related to curb ramps, to the north of the bridge.

There are no immediate gaps or barriers identified in the pedestrian network. The commercial businesses, MedStar Harbor Hospital, Vietnam Veterans Memorial, Middle Branch Park, Broening Park Boat Ramp, and other facilities are publicly accessible to pedestrians. There are some scattered non-compliant ADA features in the corridor that are related mostly to slope of driveways or ramps.

Pedestrian signals with push buttons are generally present at each intersection and only the intersection of McComas Street and Hanover Street northbound lacks a pedestrian signal. However, many pedestrian signals do not meet current design standards and may need to be upgraded.

Pedestrian lighting is not provided throughout most of the corridor, but needs to be in order to enhance pedestrian level of comfort and for safety.

One segment of protected bike lane is present on the northbound/east side of Hanover Street between Reedbird Avenue and ending just prior to Cherry Hill Road, as shown in **Photo 5-1**. There is no conflicting vehicular curbside parking in the corridor. Additionally, a bike path through Port Covington under the bridge is currently under construction (**Photo 5-2**).

PHOTO 5-1: SEGMENT OF PROTECTED BIKE LANE ON NORTHBOUND HANOVER STREET, ALONG WITH TYPICAL STREETLIGHT

PHOTO 5-2: A NEW BIKE PATH TO BE BUILT FROM PORT COVINGTON TO THE EAST AND WEST SIDES OF THE BRIDGE

BCDOT utilizes the National Association of City Transportation Officials (NACTO) guidelines for street design elements, including pedestrian and bicycle facilities, and are as follows:

Sidewalks:

Sidewalks should be six feet wide with an absolute minimum width of five feet. Where a sidewalk is directly adjacent to back of curb and moving traffic, the desired minimum is eight feet, providing a minimum two-foot buffer for street furniture and utilities. Each segment of sidewalk in the corridor will be adjusted as necessary to address existing right-of-way limits, utility poles and street lights that may remain.

Where right-of-way allows, and where appropriate, a street furniture zone may be established in the sidewalk segment. This zone will be located between the sidewalk and curb, or between the sidewalk and right-of-way. Street furniture and amenities, such as lighting, benches, newspaper kiosks, utility poles, tree pits, and bicycle parking may be located. This zone may also contain green infrastructure elements, such as rain gardens or flow-through planters, as shown in the photos below.

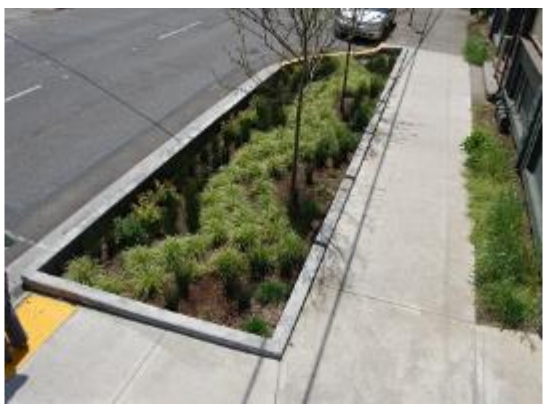

PHOTO 5-3: EXAMPLE FLOW-THROUGH PLANTER

PHOTO 5-4: EXAMPLE TREE WELL BY FILTERRA INCORPORATING WATER QUALITY FEATURES

Curb Ramps:

Sidewalk ramps will conform to City of Baltimore Standards and will also be ADA-compliant. Ramps will be designed for the specific location to provide a ramp that matches the width of the connecting sidewalk, and the ramp will not exceed a 12:1 slope (8.3 percent) in the direction of pedestrian travel, or 50:1 slope (2 percent) perpendicular to the direction of pedestrian travel. A detectable warning surface will be provided for ramps used to cross public streets.

Crosswalks:

Each of the signalized intersections currently has crossings to reinforce yielding of vehicles when pedestrians are crossing Hanover Street and intersecting streets. Crosswalks will be enhanced with stamped decorative asphalt, as shown in **Photo 5-5**. Other critical aspects of crosswalks will include the following:

- Crosswalk will be as wide as or wider than the walkway it connects to ensure that passing pedestrians can comfortably pass each other.
- Crosswalks will be aligned as closely as possible with the pedestrian through zone without inconvenient deviations.
- Where stamped asphalt is not used, an approved and high-visibility ladder, zebra, or continental crosswalk marking will be selected conforming to MUTCD (see **Figure 5-1**), and are highly visible to approaching motorists.
- Street lights should be provided at each intersection.
- Accessible curb ramps are required by ADA at all crosswalks and a detectable warning at each ramp crossing a public street would also be provided.
- An advanced stop bar will be located eight feet minimum in advance of the crosswalk to reinforce motorists yielding to pedestrians.

PHOTO 5-5: EXAMPLE TYPICAL STAMPED ASPHALT BRICK PATTERN CROSSWALK

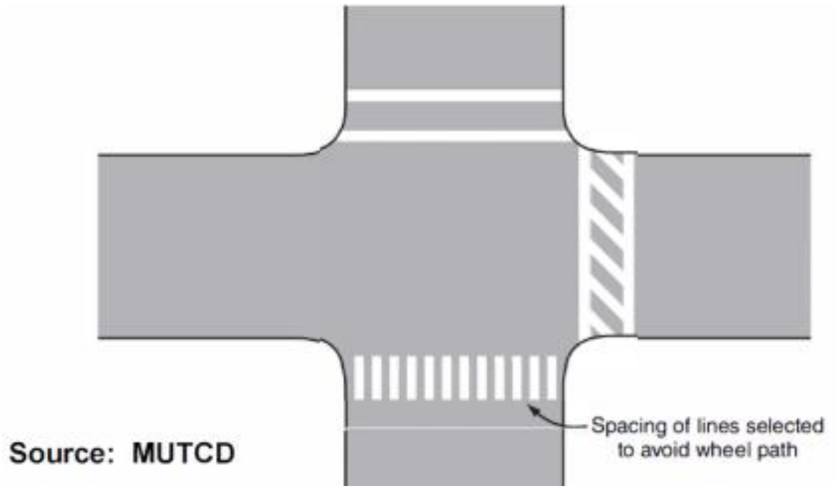

FIGURE 5-1: SAMPLE CROSSWALK MARKINGS

Midblock Crosswalk:
One midblock crosswalk is located at the Medstar Harbor Hospital and is primarily for access to the Harbor Hospital Life Resource Center, employee parking, and hospital employee and general public use. This location also includes a bus stop with shelter.

This location is identified as a dangerous crossing and will require designers to analyze the existing crossing and determine the appropriate upgrade needs to ensure the highest level of safety is provided. Improvements may include one or more of the following:

- A stop bar should be located 20–30 feet away to ensure pedestrians crossing the street are visible to the second driver when the first driver is stopped at the stop bar.
- Provide highly visible striping for the crosswalk, especially for motorist visibility at night.
- Traffic safety warning devices such as rapid flashing beacons.

Buffered Bike Lanes:
Baltimore City, in the Separated Bike Lane Network Addendum to the 2015 Bike Master Plan Update, dated March 2017, is developing a "Protected Bike Lanes Plan" to identify low-stress networks and plans to connect bike routes with minimal intervention. Hanover Street is recommended in the plan as needing bike facilities within the next five years. Bike facilities are recommended as separated facilities.

The various potential bridge options will direct to a large degree how bicycle and pedestrian facilities are connected at both ends of the bridge. Baltimore City is developing draft guidelines for improvements and items being considered in the bikeshed include: protected bike lanes, new bike lanes, cycle tracks, sharrows (shared lane markings), and other features.

Buffered bike lanes (**Figure 5-2**) provide numerous safety and level of comfort benefits by providing the following, per NACTO:

- Greater distance between bicyclists and motor vehicles.
- Space for bicyclists to pass another bicyclist without encroaching into the adjacent vehicular travel lane.
- Wider space for bicycling without making the bike lane appear so wide that it might be mistaken for a vehicular travel lane or a parking lane.
- Appeals to a wider cross-section of bicycle users.
- Encourages bicycling by contributing to the perception of safety among users of the bicycle network.

FIGURE 5-2: EXAMPLE BUFFERED BIKE LANES

Buffered bike lanes are installed with the following typical characteristics:

- Buffers should be at least 18 inches wide, but two feet is preferred.
- Bicycle lane word and/or symbol and arrow markings (per MUTCD)
- The bike lane buffer is marked with two solid white lines. White lines on both edges of the buffer space indicate lanes where crossing is discouraged, though not prohibited. Dashing the buffer boundary where cars are expected to cross at driveways is acceptable.
- Interior diagonal cross hatching or chevron markings if three feet in width or wider.
- Color should be used at the beginning of each block to discourage motorists from entering the buffered lane:

An existing buffered bike lane is present on northbound Hanover Street (south of bridge), depicted in **Figure 5-3**. For any bridge options that propose eliminating the reversible center lane and providing buffered bike lanes, additional considerations will be required. North of the Hanover Street/Waterview Avenue intersection, the eastern side of Hanover Street would require modification to offset curb and sidewalk 12 feet to accommodate the buffered bike lane between Waterview Avenue and the bridge.

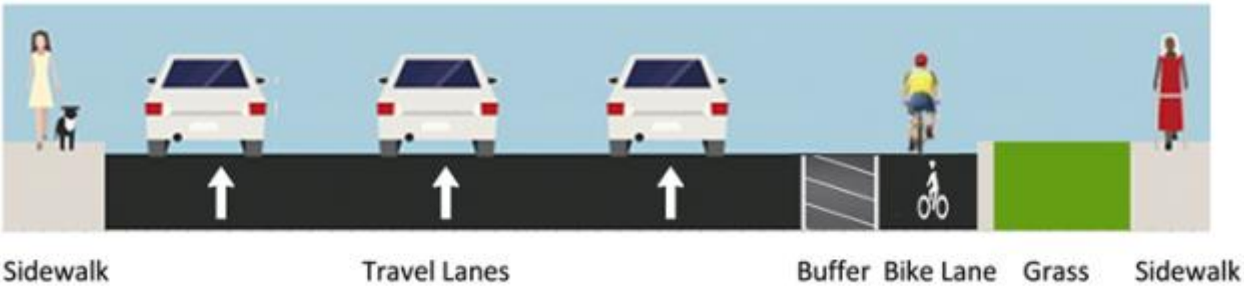

FIGURE 5-3: NORTHBOUND HANOVER STREET WITH BUFFERED BIKE LANE

Southbound Hanover Street does not have a buffered bike lane, as depicted in **Figure 5-4**:

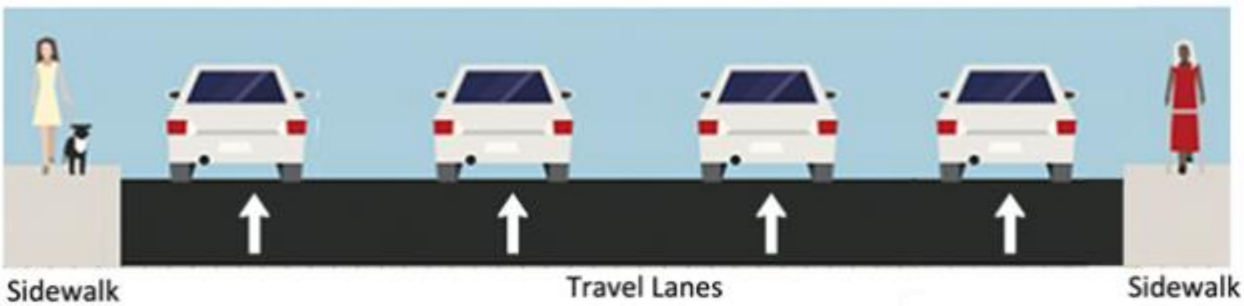

FIGURE 5-4: SOUTHBOUND HANOVER STREET – NO BUFFERED BIKE LANE

In order to add a buffered bike lane to southbound Hanover Street, the fourth lane would be removed from the bridge to Reedbird Avenue, with a buffered bike lane added in its place (see **Figure 5-5)**. There is little opportunity to add a grass buffer between the buffered bike lane and the sidewalk due to limited right-of-way and steep slopes in this portion of the corridor.

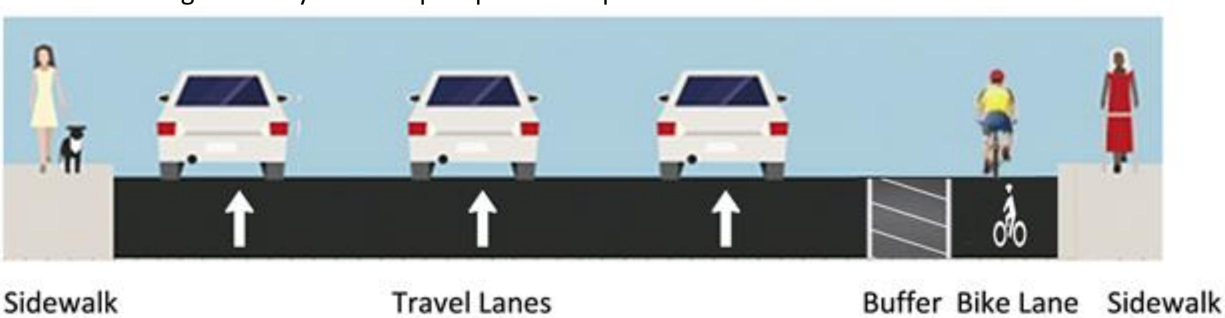

FIGURE 5-5: SOUTHBOUND HANOVER STREET WITH TRAVEL LANE REMOVED AND PROPOSED BUFFERED BIKE LANE

Bike Boxes:
A bike box (see **Photo 5-6**) is a designated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible way to get ahead of queuing traffic during the red signal phase. Bike boxes can:

- Increase visibility of bicyclists
- Reduce signal delay for bicyclists
- Provide priority for bicyclists at signalized bicycle crossings of major streets
- Group bicyclists together to clear an intersection quickly, minimizing impediment to transit or other traffic

PHOTO 5-6: EXAMPLE BIKE BOX AT INTERSECTION
SOURCE: NACTO

Clear Zones:
Hanover Street has a posted speed limit of 40 mph from Cherry Hill Road to Reedbird Avenue. According to NACTO, clear zones are applicable as a safety parameter for the Interstate and freeway system, but in this urban setting, delineation of a minimum setback from the curb is not a required element. To the greatest extent possible, the lateral distance between the travel way and the sidewalk should be minimized, providing ample space for sidewalks and other amenities.

Lighting:
As included in the Downtown Baltimore Streetscape Design Guidelines, **Figure 5-6** shows potential styles of pedestrian lighting that can be utilized in the Hanover Street corridor.

FIGURE 5-6: POTENTIAL PEDESTRIAN LIGHTING STYLES

Site Furniture:
Figure 5-7 shows potential styles of site furniture (City benches, trash receptacles, and bike rack) that can be utilized in the Hanover Street corridor.

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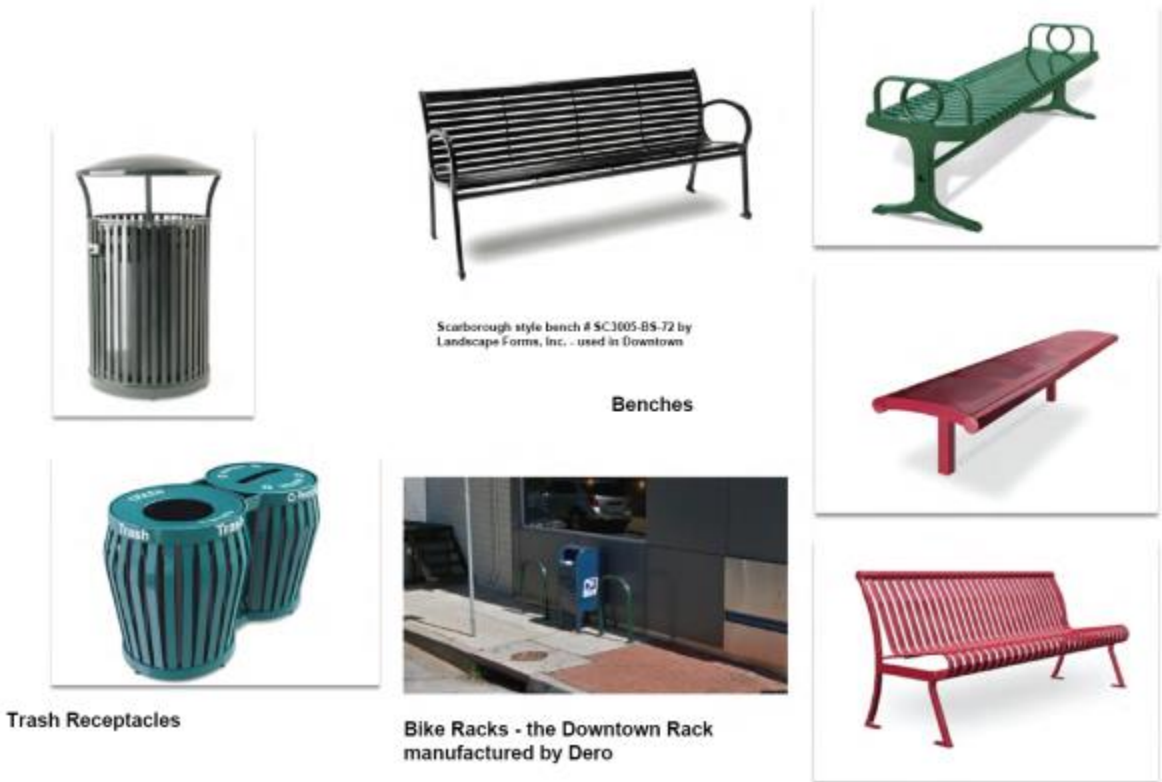

FIGURE 5-7: TYPICAL CITY BENCHES, TRASH RECEPTACLES, AND BIKE RACK

Street Trees:
Baltimore City's approved Street Tree Species List of May 3016 includes the following potential street trees for use in the corridor:

SCIENTIFIC NAME	COMMON NAME
Acer rubrum	Red Maple
Acer saccharium	Sugar Maple
Gleditsia triacanthos ver. inermis	Thornless Honeylocust
Platanus X acerifolia 'Bloodgood'	London Planetree
Platanus occidentalis	American Sycamore
Quercus bicolor	Swamp White Oak
Quercus coccinea	Scarlet Oak
Quercus imbricaria	Shingle Oak
Quercus muehlenbergii	Chinkapin Oak
Quercus shumardii	Shumard Oak

Quercus phellos	Willow Oak

UNDERSTORY TREE PLANTING

Acer campestre	Hedge Maple
Amelanchier canadensis	Shadblow Serviceberry
Betula nigra	River Birch
Cercis canadensis	Eastern Redbud
Celtis occidentalis	Common Hackberry
Magnolia Kobus var. stellata	Star Magnolia
Magnolia virginiana	Sweetbay Magnolia
Prunus cerasifera	Flowering Purple Plum
Viburnum prunifolium	Blackhaw Viburnum

Bicycle and Pedestrian Improvement Summary

The following list summarizes the bicycle and pedestrian elements and enhancements identified as improvements for the Hanover Street corridor:

- Enhanced crosswalks with stamped decorative asphalt to reinforce yielding of vehicles when pedestrians are crossing Hanover Street and intersecting streets
- Upgrade necessary pedestrian signals
- Further safety considerations for midblock crossing at MedStar Harbor Hospital (stop bar, highly visible crosswalk striping, traffic safety warning devices such as rapid flashing beacons, etc.)
- Pedestrian lighting improvements throughout the corridor
- Clear debris from all sidewalks and from stairwell connecting Hanover Street to the Gwynns Falls Trail
- Provide sidewalk bump-outs where not present to provide ADA clearance around utility poles, signs, etc.
- Existing bike facilities on Hanover Street can and should be converted to protected facilities, such as buffered bike lanes
- Support bicycle and pedestrian opportunities included in Port Covington improvements, such as the bike path through Port Covington under the bridge that is currently under construction, etc.

Transit

The Maryland Department of Transportation Maryland Transit Administration (MDOT MTA) made significant changes to its bus transit system operating throughout the Baltimore metropolitan area and implemented BaltimoreLink on July 17, 2017. With the implementation of BaltimoreLink, CityLink Silver, LocalLinks 26,67,69,70, and 71, and ExpressLink 164 now serve the study area. Former MDOT MTA bus routes 27, 64, 164, 14, 29, and 51 have been eliminated. The proposed MDOT MTA BaltimoreLink Plan, Draft 2 from late 2016 was previously described in Chapter 4 and was still subject to revision at that time. The BaltimoreLink Plan went through several rounds of revision before taking its current form and proposed routes serving the study area, hours of service, as well as the frequency of service has changed since the Draft 2 version. The newly implemented BaltimoreLink routes are discussed in detail below:

CityLink Silver – Johns Hopkins University to Curtis Bay: This is one of the high-frequency, 24-hour, color-coded routes. This route replicates the former Route 64 for the most part, but extends further north to University Parkway, whereas the Route 64 terminated at North Avenue. A branch route for CityLink Silver extends further north to serve Morgan State University and loops around at Cold Spring Lane. To the south, however, the route is shortened to terminate at Curtis Bay and LocalLink 67 picks up the branch to Marley Neck. The CityLink Silver operates every 12 minutes during weekday peaks, 15 minutes during weekday middays, 20 minutes during weekday evenings, and every hour at late night. On Saturdays and Sundays, the Silver line runs every 20-35 minutes. The service is expanded to operate 24 hours on weekdays, from 5:00 am to 3:40 am on Saturdays, and from 5:00 am to 2:40 am on Sundays.

LocalLink 26 – Mondawmin to South Baltimore Park & Ride: This route generally follows the former Route 27 through the study area. It originates at Mondawmin and instead of terminating at Port Covington like the former Route 27, LocalLink 26 terminates at the South Baltimore Park & Ride. This route is located in the southern section of the study area, serving the Cherry Hill neighborhood, and does not cross the bridge. Only a small portion of the route along Potee Street and Hanover Street is within the study area. LocalLink 26 operates every 15 minutes during weekday peaks and middays, every 30 minutes in early mornings, and every 20-40 minutes in the evenings. It runs every hour during late night. The operation spans from 4:00 am to 1:27 am on weekdays, 4:25 am to 12:38 am on Saturdays, and from 5:00 am to 1:05 am on Sundays.

LocalLink 67 – City Hall to Marley Neck: LocalLink 67 connects the areas southeast of the bridge, Curtis Bay and Marley Neck, to downtown and City Hall. This route inherits the former Route 64's Marley Neck branch. It operates from 4:57 am to 1:07 am on weekdays, from 5:19 am to 9:55 pm on Saturdays, and from 5:17 am to 9:44 pm on Sundays. Even though the service is seven days a week, it is important to note that there is no service after morning peak until afternoon. Weekday morning frequency ranges from 16 to 40 minutes while weekday afternoon and evening frequency ranges from 26 to 49 minutes. Service is very infrequent during late nights with time between two buses as high as 3 hours.

LocalLink 69 – Patapsco to Jumpers Hole: The LocalLink 69 connects Patapsco to Jumpers Hole. The main LocalLink 69 does not pass through the Hanover Street corridor study area. However, the branch route that extends further north to the University of Maryland Medical Center travels through the southern portion of the study area without crossing the Vietnam Veterans Memorial Bridge. The branch route operates only during late nights and Sunday morning and nights when the light rail is not in operation.

Local Link 70 – Patapsco to Annapolis: LocalLink 70 connects the Patapsco Light Rail stop to Annapolis. Just like the LocalLink 69, the main LocalLink 70 route does not travel through the Hanover Street corridor study area. However, the branch route that extends further north to the University of Maryland Medical Center travels through the southern portion of the study area without crossing the Vietnam Veterans Memorial Bridge. The branch route operates only during late nights and Sunday morning and nights when the light rail is not in operation.

LocalLink 71 – Lexington Market to Patapsco: The LocalLink 71 connects Lexington Market to Patapsco Light Rail station via downtown, Port Covington, and Cherry Hill neighborhoods. The Local Link 71 operates daily from 5:00 am to 2:20 am on weekdays, from 5:30 am to 2:31 am on Saturdays, and from 5:30 to 2:30 am on Sundays. The weekday frequency ranges from 30-60 minutes in the early morning, about 30 minutes throughout the day including the peak periods, and around 50 minutes later in the night. Saturdays and Sundays also have similar frequencies.

ExpressLink 164 – City Hall to Riviera Beach: The ExpressLink 164 mostly overlaps with LocalLink 67, but extends further south to Rivera Beach. It inherits and merges the former Route 164 with the former Route 64's Riviera Beach branch. This express link has two trips each way during the AM peak. The express route is in operation only on weekdays.

The former routes through the study area have been incorporated in the new routes in the following ways:

Route 14: The former Route 14: Patapsco/UM Transit Center to Marley Station or Annapolis is now a combination of LocalLinks. LocalLink 69: Patapsco or UM Transit Center to Marley Station inherited the former Route 14 route's Marley Station service. The Baymeadow Industrial Park service was discontinued, and LocalLink 70: Patapsco or UM Transit Center to Annapolis inherited the former Route 14 route's Annapolis service. The route between Jumpers Hole and the Patapsco Light Rail Station has been incorporated into the LocalLink 69 and the route between Annapolis and the Patapsco Light Rail Station has been incorporated into the LocalLink 70.

Route 27: The former Route 27: Reisterstown Plaza to Port Covington is now a combination of several LocalLinks. The LocalLink 94: Sinai Hospital to Fort McHenry inherited the central portion (Falls Road) of the former Route 27, LocalLink 31: Sinai Hospital to Social Security or Security Square inherited the Belvedere Avenue portion, LocalLink 82: Reisterstown Plaza to Monte Verde inherited the Seton Business Park portion, and LocalLink 71: Lexington Market to Patapsco via Port Covington maintains Cherry Hill's one -seat access to downtown and Lexington Market, but it does so via Port Covington rather than Russell Street as it previously did. The LocalLink 73: State Center to Patapsco via Greyhound inherited the Russell Street portion of the former Route 27 and LocalLink 26: Mondawmin to South Baltimore Park & Ride inherited the Cherry Hill portion of the former route. The route between Rogers Avenue and Sinai Hospital has been incorporated into LocalLink 31, the route between Waterview Avenue and Pratt Street has been incorporated into LocalLink 73, and the connection from Cherry Hill to downtown has been provided with LocalLink 71 via Locust Point. The route between Reisterstown Plaza Metro Station and Belvedere Avenue has been incorporated into LocalLink 82, including service to the Seton Business Park, the route between Belvedere Avenue and Martin Luther King, Jr. Blvd has been incorporated into LocalLink 94, and the route between Mondawin and South Baltimore Park & Ride has been incorporated into LocalLink 26. Among the LocalLinks discussed in this former Route 27 description, only LocalLinks 26 and 71 are in the study area.

Route 29: The former Route 29: Cherry Hill Light Rail Circulator is now LocalLink 26 and LocalLink 71. The LocalLInk 26: Mondawmin to South Baltimore Park & Ride and LocalLink 71: Patapsco to Lexington Market, both replace the entirety of the former Route 29 except the Waterview Avenue portion. Service to the Multi-Purpose Building has been discontinued due to its vacancy.

Route 51: The former Route 51: Rogers Avenue to Patapsco is now LocalLinks 26, 73, and 82. LocalLink 26: Mondawmin to South Baltimore Park & Ride inherited the central portion of the former Route 51 and LocalLink 73: State Center to Patapsco via Greyhound inherited the Baltimore Highlands portion. LocalLink 82: Reisterstown Plaza to Monte Verde inherited the northern portion of the former Route 51 and Cherry Hill branch between Hanover Street and Mondawmin Metro Station has been replaced by the LocalLink 26. The route between the Patapsco Light Rail Station and the Horseshoe Casino has been incorporated into LocalLink 73. The route between the Mondawmin Metro Station and the Rogers Avenue Metro Station has been incorporated into LocalLink 82.

Route 64: The former Route 64: Station North to Curtis Bay, Marley Neck, or Riviera Beach is now a combination of the CityLink Silver, LocalLink 67, and Express BusLink 164. CityLink Silver: Curtis Bay to Johns Hopkins University or Morgan State University inherits the trunk of the former Route 64 and extends it further north to Johns Hopkins and Morgan State Universities. It also upgrades the service level to frequent/24-hour. LocalLink 67: City Hall to Marley Neck and Brandon Woods inherits the former Route 64's Marley Neck branch. Express BusLink 164 City Hall to Riviera Beach inherits and merges the former Route 164 with the former Route 64's Riviera Beach branch. The route between Marley Neck/Energy Parkway and Curtis Bay has been replaced by the LocalLink 67, with service continuing to downtown. The connection between downtown and Riviera Beach has been incorporated into the Express BusLink 164. The Curtis Bay route between Curtis Bay and North Avenue has been incorporated into the CityLink Silver (with the exception of the deviation into Port Covington), with service extended to University Parkway and Morgan State.

Express Bus 164: The former Route 164: Station North to Curtis Bay, Marley Neck, or Riviera Beach is now Express BusLink 164. CityLink Silver: Curtis Bay to Johns Hopkins University or Morgan State University inherited the trunk of the former Route 64 and extended it further north to Johns Hopkins and Morgan State Universities. It also upgraded service levels to frequent/24 -hour. LocalLink 67: City Hall to Marley Neck and Brandon Woods inherited the former Route 64's Marley Neck branch. Express BusLink 164: City Hall to Riviera Beach inherited and merged the former Route 164 with the former Route 64's Riviera Beach branch.

Generally speaking, the new BaltimoreLink system adds more transit options across the Vietnam Veterans Memorial Bridge. It provides 24-hour frequent weekday service and extended frequent weekend service to the area. The new system improves headways on the main routes, especially during off-peak hours and weekends. The local routes do not see much improvement in terms of either frequency or service hours. However, efficiency and reliability of the network is expected to improve as former long routes have been replaced with several shorter routes. Additionally, the new network provides access to some areas previously unserved by MDOT MTA transit. The new LocalLink 71 links the study area with the Riverside and Locust Point areas, which did not have any direct transit access to the study area previously.

Table 5-1 shows the service span and frequency of MDOT MTA's BaltimoreLink routes:

HANOVER STREET CORRIDOR STUDY
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TABLE 5-1: SERVICE SPAN AND AVERAGE SCHEDULED HEADWAYS FOR MDOT MTA BALTIMORELINK BUS ROUTES SERVING THE STUDY AREA

Route	Service Span*	Average Scheduled Headways in Minutes
CityLink Silver	Weekday: 24 Hours Saturday: 5:00 AM – 3:30 AM Sunday: 5:00 AM – 3:30 AM	AM Peak: 12 Midday: 15 PM Peak: 12 Evening: 20 Late Night: 60 Saturday: 15-60 Sunday: 15-60
LocalLink 26	Weekday: 4:00 AM – 1:27 AM Saturday: 4:25 AM – 12:40 AM Sunday: 5:00 AM – 1:09 AM	AM Peak: 15 Midday: 15 PM Peak: 15 Evening: 20 Late Night: 60 Sunday: 35-60 Sunday: 35-60
LocalLink 67	Weekday: 4:57 AM – 1:07 AM Saturday: 5:19 AM – 9:55 PM Sunday: 5:17 AM – 9:44 PM	AM Peak: 18-40 Midday: 30 PM Peak: 20-30 Evening: 60-75 Late Night: one run Saturday: 30-90 Sunday: 30-90
LocalLink 69	Weekday: 5:20AM – 1:55 AM Saturday: 6:12 AM – 12:18 AM Sunday: 5:13 AM – 12:31 AM	AM Peak: 40 Midday: 50 PM Peak: 40 Evening:45 Late Night: 60 Saturday: 60 Sunday: 60
Local Link 70	Weekday: 4:16 AM – 2:24 AM Saturday: 4:35 AM – 1:53 AM Sunday: 5:08 AM – 1:07 AM	AM Peak: 17 Midday: 20 PM Peak: 15 Evening: 20 Late Night:48 Saturday: 41 Sunday: 35
LocalLink 71	Weekday: 4:29 AM – 2:20 AM Saturday: 5:01 AM – 2:29 AM Sunday: 5:02 AM – 2:26 AM	AM Peak: 17 Midday: 20 PM Peak: 15 Evening: 20 Late Night: 48 Saturday: 41 Sunday: 35
ExpressLink 164	Weekday: 5:55 AM – 8:41 AM	Two trips in each direction in AM peak on weekdays

Note: Time periods defined as AM Peak: 6am- 9am; Midday: 9am- 3pm; PM Peak: 3pm-6pm; Evening: 6pm – 10pm; Late Night: 10pm – 6am
**Span is from first departure to last arrival*

CATHERINE E. PUGH
MAYOR

DEPARTMENT OF TRANSPORTATION
BALTIMORE CITY

HANOVER STREET CORRIDOR STUDY
includes the Vietnam Veterans Memorial Bridge

Bus Stops – 2017 Update

An inventory of bus stops in the study area was prepared for Chapter 4 that included 22 bus stops inventoried at that time. With the implementation of BaltimoreLink, the following four underutilized bus stops have been eliminated:

1. W Wells St. at S Hanover St. (E),
2. E Cromwell St. bet. Insulator Dr. and Peninsula Dr.,
3. Hanover St. Ramp at W Cromwell St., and
4. Seamon Ave. at Larue Square N.

All eliminated bus stops lacked basic infrastructure and were represented by only a sign. The stop the on Hanover St. Ramp at W Cromwell St. lacked sidewalk to access the stop and had the bus stop sign placed on a grassy area.

Bus stop signs reflecting the new BaltimoreLink routes and related information have been installed at all bus stops in the study area (see **Photo 5-7**). No other improvements have occurred at any study area bus stops since discussed in Chapter 4.

PHOTO 5-7: NEW BALTIMORELINK BUS STOP SIGN

Ridership – 2017 Update

With implementation of BaltimoreLink, the general ridership trend has remained the same as 2015, but there is some shift in numbers for individual stops. The average daily ridership for 2017 was obtained from MDOT MTA for the bus stops in the study area and is summarized in **Table 5-2** on the following page. **Table 5-2** also includes historic data from Fall 2015 and the ridership change since then. The bus stops along Hanover Street, Potee Street, and Cherry Hill Road in the southern section of the study area still show significantly higher ridership than the bus stops in the northern section. The nine most utilized stops, based on 2017 Average Daily Weekday Ridership, are located in the southern section of the study area, indicating higher transit use in the south. The bus stop located on Potee Street at Cherry Hill Road has the highest ridership among the bus stops in the study area with 351 Average Daily Weekday Riders.

Figure 5-8 (see end of chapter) shows the implemented BaltimoreLink routes, bus stops, and 2017 Average Daily Ridership for each stop.

Table 5-3 provides an overview of the increased MDOT MTA BaltimoreLink bus service and passengers across the Vietnam Veterans Memorial Bridge from Fall 2017. There were a total of 317 buses traveling across the bridge (combined total for both directions) each weekday and 19 buses traveling across the bridge in the peak hour (combined total for both directions). As a comparison, prior to BaltimoreLink in Fall 2016, the number of buses traveling across the bridge each weekday was 185 and there were 14 buses traveling across the bridge in the peak hour for prior routes 27, 64, and 164.

TABLE 5-3: MDOT MTA BUS SERVICE ACROSS THE VIETNAM VETERANS MEMORIAL BRIDGE

Route	Fall 2017 Buses / Weekday Traveling Across the VVMB*	Fall 2017 Passengers / Day Traveling Across the VVMB*	Fall 2017 Peak Hour Buses Traveling Across the VVMB*	Fall 2017 Peak Hour Passengers Traveling Across the VVMB*
CityLink Silver	164	1,990	10	205
LocalLink 67	43	600	4	40
LocalLink 71	66	300	4	40
Express BusLink 164	44	15	1	5
Total	**317**	**2,905**	**19**	**290**

* Combined Total for Both Directions

Water Taxi – 2017 Update

Water Taxi added a few more stops in the Inner Harbor and Fells Point area north of I-95 in 2016. According to the Baltimore Business Journal (Oct. 12, 2016), the future plan is to add additional stops including two in/around the Hanover Street study area – one at Sagamore Spirit Whiskey Distillery in Port Covington and another at Nick's Fish House located adjacent to the Vietnam Veterans Memorial Bridge.

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TABLE 5-2: AVERAGE DAILY WEEKDAY RIDERSHIP (FALL 2017) FOR MDOT MTA BUS STOPS IN THE STUDY AREA

	Stop Location	Route(s)	Weekday	Saturday	Sunday	Rank	Weekday Ridership (Fall 2015)	Change in Ridership (2015 to 2017)
1	S Hanover St. @ E McComas St.	CityLink Silver, LocalLink 67, Express BusLink 164	8	5	18	13	5	3
2	S Hanover St. @ W Cromwell St. (S)	CityLink Silver, LocalLink 67, Express BusLink 164	26	18	11	10	1	25
3	Potee St. @ Waterview Ave.	*CityLink Silver, LocalLink 67, LocalLink 71, Express BusLink 164*	104	34	35	6	72	32
4	Potee St. @ Cherry Hill Rd.	CityLink Silver, LocalLink 26, LocalLink 67, LocalLink 69, LocalLink 70, LocalLink 71, Express BusLink 164	351	88	98	1	278	73
5	Potee St. @ Reedbird Ave.	CityLink Silver, LocalLink 26, LocalLink 67, LocalLink 69, LocalLink 70, LocalLink 71, Express BusLink 164	147	22	55	5	99	48
6	S Hanover St. @ Reedbird Ave.	LocalLink 70	0	0	0	16	43	-43
7	S Hanover St. bet. Reedbird Ave. & Cherry Hill Rd.	CityLink Silver, LocalLink 67, LocalLink 69, LocalLink 70, LocalLink 71, Express BusLink 164	192	49	98	2	111	81
8	S Hanover St. @ Waterview Ave.	CityLink Silver, LocalLink 67, LocalLink 69, LocalLink 70, LocalLink 71, Express BusLink 164	191	68	104	3	145	46
9	S Hanover St. @ Cromwell St. (N)	CityLink Silver, LocalLink 67, Express BusLink 164	5	4	32	15	2	3
10	W Wells St. @ S Hanover St. (E)	Eliminated	N/A	N/A	N/A	N/A	3	N/A
11	W Wells St. @ S Charles St. (E)	CityLink Silver, LocalLink 67, Express BusLink 164	20	7	6	11	30	- 10
12	W Wells St. @ S Charles St. (W)	LocalLink 71	10	4	4	12	12	-2
13	E Cromwell St. @ Insulator Dr. (W)	LocalLink 71	6	1	6	14	17	-11
14	E Cromwell St. @ Insulator Dr. (E)	LocalLink 71	10	4	4	12	7	3
15	E Cromwell St. bet. Insulator Dr. and Peninsula Dr.	Eliminated	N/A	N/A	N/A	N/A	8	N/A
16	Hanover St. Ramp @ W Cromwell St.	Eliminated	N/A	N/A	N/A	N/A	43	N/A
17	Waterview Ave. @ Potee St.	LocalLink 69, LocalLink 70	0	0	3	16	32	- 32
18	Cherry Hill Rd. @ Seamon Ave. (E)	LocalLink 26, LocalLink 71	63	25	34	7	238	- 175
19	Cherry Hill Rd @ Seamon Ave. (W)	LocalLink 26, LocalLink 71	154	51	48	4	130	24
20	Seamon Ave. @ Reedbird Ave.	LocalLink 26, LocalLink 71	61	11	18	8	44	17
21	Seamon Ave. @ Larue Square N	Eliminated	N/A	N/A	N/A	N/A	9	N/A
22	Reedbird Ave. bet. S Hanover St. & Potee St.	LocalLink 26	33	0	6	9	18	15

CATHERINE E. PUGH
MAYOR

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Transit Improvements

Based on the ridership information and inventory of bus stops previously presented in Chapter 4 (**Table 4-7**), improvement recommendations were made for the bus stops in the study area and are presented in **Table 5-4** below. All bus stops are recommended to have at least five-foot wide sidewalk access, a concrete pad connecting the sidewalk to the curb for boarding, clear signage, and adequate lighting at a minimum. Where space is available, benches and trash receptacles are recommended. Bus stops with an average daily weekday ridership of 50 or more are recommended for a shelter installation. Sidewalk widening, new sidewalk installation, and crosswalk improvements are identified in this section, but are covered in more detail within the Pedestrian and Bicycle section.

TABLE 5-4: RECOMMENDED IMPROVEMENTS FOR STUDY AREA MDOT MTA BUS STOPS

Location	Average Weekday Ridership	Rank	Recommendation
Potee St. @ Cherry Hill Rd.	351	1	Install a bus shelter, bench, and a trash receptacle
S Hanover St. bet. Reedbird Ave. & Cherry Hill Rd.	192	2	None
S Hanover St. @ Waterview Ave.	191	3	None
Cherry Hill Rd @ Seamon Ave. (W)	154	4	Install a trash receptacle
Potee St. @ Reedbird Ave.	147	5	Widen sidewalk; install a bus shelter, bench, and a trash receptacle
Potee St. @ Waterview Ave.	104	6	Widen sidewalk; install a bus shelter, bench, and a trash receptacle; install lighting
Cherry Hill Rd. @ Seamon Ave. (E)	63	7	Widen sidewalk; install concrete waiting area; install a bus shelter, bench, and a trash receptacle; install lighting
Seamon Ave. @ Reedbird Ave.	61	8	Widen sidewalk; install a bus shelter, bench, and a trash receptacle
Reedbird Ave. bet. S Hanover St. & Potee St.	33	9	Widen sidewalk; install a bench and a trash receptacle
S Hanover St. @ W Cromwell (S)	26	10	Install a trash receptacle; improve the crosswalks on east and south leading to the bus stop; install lighting
W Wells St. @ S Charles St. (E)	20	11	Widen sidewalk; install a bench and a trash receptacle
W Wells St. @ S Charles St. (W)	10	12	Widen sidewalk; install a bench and a trash receptacle; install lighting
E Cromwell St. @ Insulator Dr. (E)	10	12	Widen sidewalk; install a bench and a trash receptacle; install lighting
S Hanover St. @ E McComas St.	8	13	Install a trash receptacle; improve general upkeep and remove overgrown vegetation
E Cromwell St. @ Insulator Dr. (W)	6	14	Install a bench and a trash receptacle
S Hanover St. @ Cromwell St. (N)	5	15	Install clearly visible bus stop sign; widen sidewalk; install a trash receptacle
S Hanover St. @ Reedbird Ave.	0	16	install a trash receptacle
Waterview Ave. @ Potee St.	0	16	Install five-foot wide new sidewalk from the northwest corner of Waterview Ave. and Potee St. to the bus stop; install a bench and a trash receptacle

Freight

As discussed in Chapter 4, just south of the study area, the combination of constrained geometry at the intersection of Hanover Street at Frankfurst Avenue and lack of a direct connection from Frankfurst Avenue to Potee Street has a major impact on freight traffic in the area. Trucks traveling west on Frankfurst Avenue cannot turn left onto Potee Street to travel towards Anne Arundel County, so they instead travel north on Hanover Street to Waterview Avenue to access I-295 or I-95. Previous studies have also documented that truck drivers have difficulty turning to/from Frankfurst Street to Hanover Street. Although these intersections are south of the study area, it is recommended to further study the missing connections and constrained geometry for trucks at these locations since it has an impact on the Hanover Street corridor.

Additionally, the concrete pavement reconstruction that was identified in the roadway section will be beneficial to freight traffic as the pavement section will be better able to support these vehicles.

Urban Design

When first built, the Hanover Street Bridge conveyed pedestrian, vehicular, and streetcar traffic across the Middle Branch between residential communities and the employment opportunities at the port. Changes to the bridge over time favored car and truck traffic and today the Vietnam Veterans Memorial Bridge no longer meets the multimodal needs of South Baltimore.The following design ideas all point to a return the the bridge's original purpose, and contribute to the new economy emerging along the Middle Branch. The bridge has the opportunity to connect a vibrant community in Cherry Hill with an emerging employment center at Port Covington. In addition to improved function and experience along the entire Hanover Street corridor, multimodal enhancements across the bridge and along the water's edge also tie together existing and proposed destinations surrounding the entire Middle Branch basin.

Multimodal trips within the corridor will originate from the Cherry Hill neighborhood and eventually from new residential development in Westport and Port Covington. Current destinations within or adjacent to the corridor include parks along the Middle Branch, MedStar Harbor Hospital, the Port of Baltimore, light rail stations to the west, and commercial establishments in Cherry Hill. New destinations will emerge as well in Port Covington and the Under Armour complex. These local origins and destinations are further complicated by regional traffic accessing I-95 to the north and I-695 to the south. The following diagram illustrates the general multimodal desire lines between corridor origins and destinations.

FIGURE 5-9: MULTIMODAL DESIRE LINES AND KEY DESTINATIONS

These general desires for connectivity highlight an emerging loop surrounding the Middle Branch. This desire can be facilitated by the built environment through amenities that functionally connect neighborhoods and provide for an enhanced recreational attraction. The following diagram illustrates desire lines for each mode of transport.

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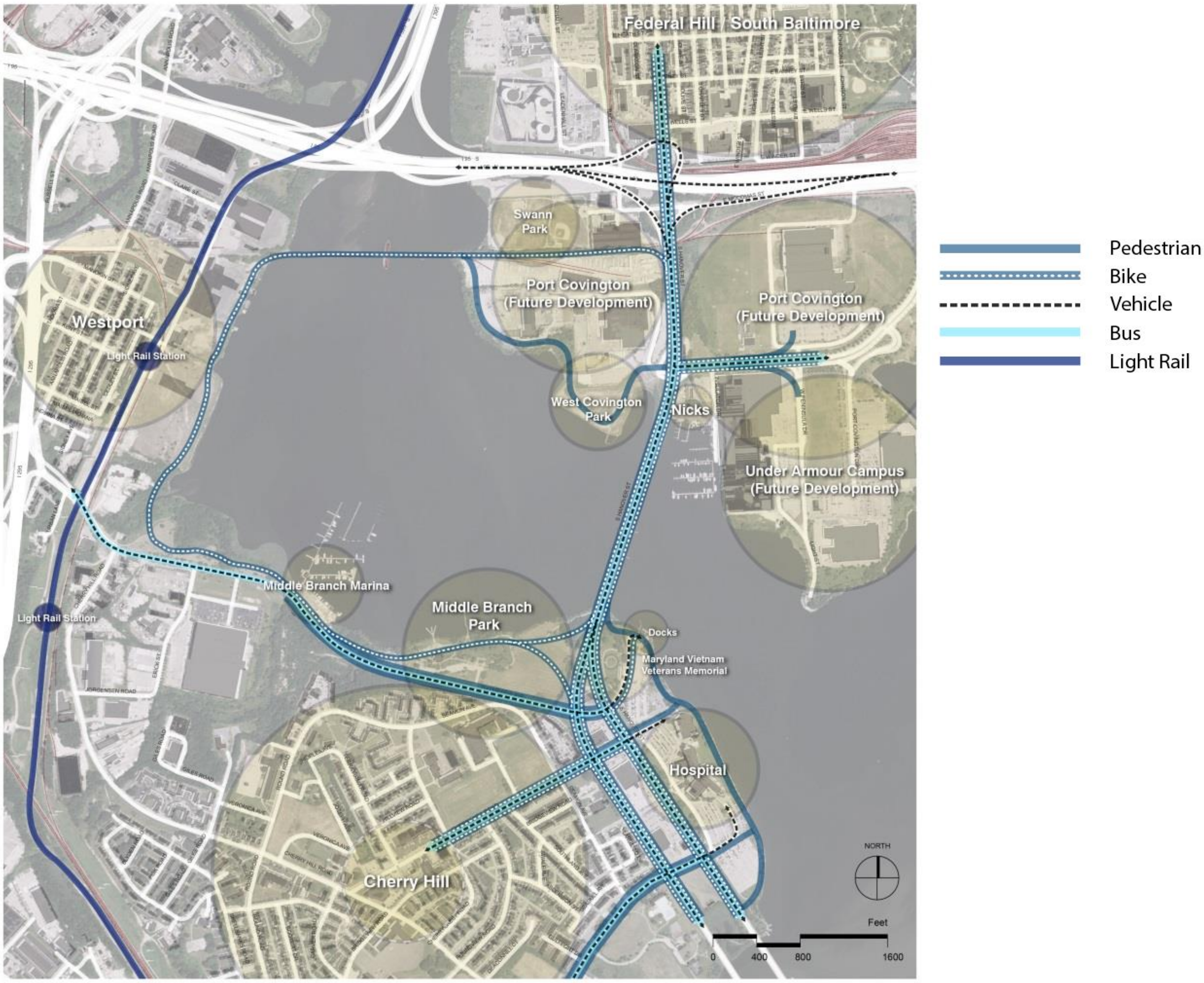

FIGURE 5-10: MODE-SPECIFIC DESIRE LINES AND KEY DESTINATIONS

Overcoming Barriers

The greatest barriers currently interrupting these desire lines and impeding multimodal connectivity are the lack of safe, accessible paths and the lack of wayfinding directions to attractive destinations that support pedestrian activity. The recommended corridor enhancements include numerous new or enhanced walkways that connect key destinations better. They also include new gathering points, overlooks, recreation facilities and cultural venues to encourage new activity. The character of these amenities matters a great deal, as well. They must provide human scale lighting, seating, and shade while preserving the visibility needed to encourage a sense of safety.

The solutions to public safety challenges can be informed by the Theory of Crime Prevention Through Environmental Design (CPTED). This theory is based on the goal of creating places with attributes that simultaneously reward and encourage legitimate behavior while making those who wish to engage in criminal activity feel less comfortable doing so. The theory can be used to diagnose barriers that hinder desired legitimate activity as well as to target interventions that can overcome those barriers based upon the following key principles:

- *Promoting natural surveillance* – designing public space and surrounding land use to maximize visibility of those inhabiting the space.
- *Enabling territorial reinforcement* – designing public spaces that can be easily occupied by legitimate activity and that instill community pride and a sense of stewardship.
- *Maintaining appropriate access control* – designing space that has the appropriate number and scale of access points.
- *Encouraging activity support* – designing public space to encourage and sustain legitimate gatherings and programmed activities.
- *Prioritize maintenance* – designing public spaces for ease of maintenance in order to avoid appearance of neglect.

Recommended Urban Design Enhancements

The recommended urban design enhancements address critical locations that have the greatest benefits to multimodal connectivity. These locations are focal points for multimodal transfers, conflict points between pedestrians and vehicles, and/or key pedestrian experiences that enable better connectivity throughout the corridor. These locations include key intersections, bus waiting areas, the waterfront spaces below each bridge landing, and the bridge itself. While not every intersection is shown in illustrative form, the recommended enhancements are corridor-wide for elements such as crosswalks, signals, etc.

FIGURE 5-11: ARTIST ILLUSTRATION OF PROPOSED INTERSECTION ENHANCEMENTS AT HANOVER STREET AND CROMWELL STREET

Proposed enhancements to the intersection of Cromwell Street and Hanover Street focus on improving pedestrian safety and convenience by reshaping the intersecting curbs to calm turning traffic, removing channelized/free right-turn movements to improve safety, and providing enhanced, high visibility crosswalks for all crossings. The urban design elements at this intersection will be developed in partnership with the Port Covington development.

The Port Covington development provides flexibility in creating opportunities at this intersection. Port Covington is constructing a bike path that connects destinations on the west side of Cromwell Street to the east side. The bike path is located underneath the Vietnam Veterans Memorial Bridge.

FIGURE 5-12: ARTIST ILLUSTRATION OF EXAMPLE ARCADE SECTION ENHANCEMENTS

Tying into the bike path currently under construction through Port Covington, the arcade bridge landing offers the opportunity to connect pedestrians along the waterfront from West Covington Park to Nick's Fish House without crossing Hanover Street at-grade. The unique bridge architecture creates the opportunity for a unique urban space, which was previously unused; an outdoor art gallery with interim recreation amenities that can be changed seasonally. The ground surface can be designed of resilient materials and become a permanent part of the art experience. Lighting can be designed to provide for public safety as well as accentuate the character of the space. In this way, the arcade can become a destination as well as a new animated pedestrian connection.

FIGURE 5-13: ARTIST DEPICTION OF EXAMPLE ENHANCEMENTS EAST OF THE ARCADE SECTION

The landing area east of the arcade offers the opportunity for an extension of the art and recreation experience in previously unused space. This area can be programmed for events that can be expanded to water by use of barges or docks. This location also can provide access to the bridge deck by means of a sculptural staircase designed in contemporary harmony with the historic bridge geometry. The staircase allows pedestrians access to the bridge roughly 1/3 of the way across from north to south, reducing walking distance from waterfront to waterfront.

FIGURE 5-14: ARTIST ILLUSTRATION DEPICTING THE POTENTIAL STAIRCASE DESIGN

The staircase previously shown in **Figure 5-13** can be designed as an independent structure on both the east and west side of the bridge. The metal work can reference the original metal work of the historic bridge in color and general curved form, but be detailed in a contemporary way that complements the existing bridge without replicating its elements. The stairway should be lit artistically for character and sufficiently to provide for public safety.

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FIGURE 5-15: ARTIST ILLUSTRATION DEPICTING THE EXISTING BRIDGE DECK CONFIGURATION

The existing bridge deck configuration provides minimal room for pedestrians and no dedicated space for bicycles. The lighting is oriented toward the roadway, putting pedestrians in uncomfortable situations and the balustrade has lost its original historic form in order to be reinforced for adjacent traffic.

FIGURE 5-16: ARTIST ILLUSTRATION DEPICTING POTENTIAL ENHANCEMENTS TO THE PEDESTRAIN CORRIDOR ON THE BRIDGE DECK

If the bridge deck returns to its original four-lane configuration, there will be enough space to create a shared use path for bicycles and pedestrians protected from vehicular traffic by a new barrier. This new barrier can support pedestrian-scaled lighting inspired by photographs of the historic bridge and the balustrade can be returned to its original open form. The improvements combine to dramatically improve the experience for pedestrian and bicycle traffic without impeding vehicles.

CATHERINE E. PUGH
MAYOR

DEPARTMENT OF TRANSPORTATION
BALTIMORE CITY

FIGURE 5-17: ARTIST ILLUSTRATION OF BRIDGE DECK ENHANCEMENTS AND WATER'S EDGE IMPROVEMENTS WEST OF THE ARCADE SECTION

The western edge of the arcade section can be enhanced with a living shoreline to complement the character of West Covington Park. Enhanced barrier-separated pedestrian and bicycle facilities along the bridge should be connected to the waterfront below with a second sculptural staircase. These pedestrian amenities combine to facilitate continuous access from waterfront to waterfront and eventually surrounding the Middle Branch basin.

FIGURE 5-18: POTENTIAL MULTIMODAL ENHANCEMENTS TO THE BRIDGE LANDINGS

The southern bridge landing offers a significant opportunity to improve public safety, enhance neighborhood amenity, and provide new multimodal connectivity. Today, the Hanover Street corridor disrupts the waterfront experience, segregating and separating the waterfront park from the boat launch and Vietnam Veterans Memorial and lacks intuitive access to surrounding neighborhoods to the southwest. The proposed public space concept promotes the idea of one park south of the Middle Branch. Improvements surrounding the bridge landing should tie together the waterfront with Cherry Hill and new amenities that access the bridge.

The existing woodland adjacent to the bridge should be removed to improve visibility of park visitors and the hillside could be converted into a terraced, amphitheater-like overlook that provides panoramic views of the Baltimore skyline and Middle Branch events. These stepped terraces can include new accessible paths that seamlessly connect pedestrians from the bridge deck to the waterfront. At the water's edge, a promenade deck can be created to connect visitors under the bridge and provide signature space unique to Baltimore. New tree plantings at the top of the amphitheater terraces can provide shade and be designed to maximize ground plain visibility and picnic amenities.

FIGURE 5-19: ARTIST DEPICTION OF EXAMPLE VAULT SECTION ENHANCEMENTS AT THE SOUTHERN BRIDGE LANDING

The southern bridge landing offers another opportunity for a signature waterfront experience that provides both new, safe connectivity and an animated destination. The vaulted space provides welcoming, but shaded space for activities, programmed events, relaxation on decorative benches, and fishing near the water's edge. The enhanced public recreation space includes pedestrian lighting and cleared vegetation to increase safety.

FIGURE 5-20: ARTIST DEPICTION OF POTENTIAL EVENING CHARACTER IN THE SOUTHERN VAULT SECTION

Artistic lighting can accentuate the signature bridge architecture and simultaneously provide for public safety and a new nighttime destination.

FIGURE 5-21: ARTIST DEPICTION OF POSSIBLE PUBLIC SPACE OPPORTUNITIES AND AMENITIES

The design of the space beneath the bridge must always support public safety. An example can be using reflective steel plating to create an artistic effect and to create visibility around corners of existing columns and piers.

FIGURE 5-22: ARTIST DEPICTION OF RECOMMENDED INTERSECTION ENHANCEMENTS AT WATERVIEW AVENUE AND POTEE STREET

Multimodal access improvements at intersections south of the bridge focus on improving conditions for pedestrians by enhancing pedestrian space at curb ramps, implementing wide, high visibility crosswalks, and pedestrian-scaled lighting.

FIGURE 5-23: ARTIST DEPICTION OF POTENTIAL MULTIMODAL ENHANCEMENTS TO HANOVER STREET SOUTH OF THE BRIDGE

Throughout the segment of Hanover Street south of the bridge, the right-hand lane could be converted into a dedicated two-way cycle track with adjoining sidewalk and planting space separating the flow of bicycles from the flow of cars. The narrower roadway width will have a traffic calming effect, improving the pedestrian experience as people connect to bus stops, the hospital, and other neighborhood amenities. The street trees and plantings contribute to the traffic calming effect, as well as provide shade for pedestrians of all ages. Portions of the right hand lane can be converted into enhanced bus stops, as well.

FIGURE 5-24: ARTIST DEPICTION OF POTENTIAL MULTIMODAL ENHANCEMENTS TO POTEE STREET SOUTH OF THE BRIDGE

Throughout the segment of Potee Street south of the bridge, the right hand lane could be converted into a dedicated two-way cycle track with adjoining sidewalk. Similar to the potential layout of Hanover Street in **Figure 5-23**, the bicycle and pedestrian flow can be separated by new street trees and planting space and pedestrian-scaled street lighting can improve visibility and perceived safety. Again, this will calm traffic that currently intimidates pedestrians. This allows the opportunity for enhanced bus stops and waiting areas that can dramatically improve the comfort, convenience, and safety of riding the bus along Hanover Street.

FIGURE 5-25: ARTIST DEPICTION OF RECOMMENDED BUS STOP WAITING AREA IMPROVEMENTS

As previously discussed in the Transit section, bus stops throughout the corridor should be enhanced to include new shelters, seating, waste and recycling receptacles, passenger information displays, wayfinding signage, and pedestrian level lighting, where applicable. These enhancements will improve the comfort, convenience, and safety of riding the bus throughout the corridor and improve multimodal access and amenity.

Bridge Structures

As previously mentioned in Chapters 2 and 4, the Vietnam Veterans Memorial Bridge – known locally as the Hanover Street Bridge – carries Hanover Street (Maryland State Route 2) over the Middle Branch of the Patapsco River and is the primary structural element of the corridor. Other minor structures within the corridor are immediately adjacent to Interstate Highway 95 (I-95) and include two crossings of Hanover Street over CSX Railroad and two interchange structures with I-95. Given that these minor structures will be reconfigured as a part of the Port Covington Development and I-95 Access Improvements projects, only the Vietnam Veterans Memorial Bridge will be discussed in the context of bridge improvements within the corridor.

The Vietnam Veterans Memorial Bridge is 2,290 feet in length. It is structurally configured of a two-leaf steel truss/girder Rall-type bascule span, eight concrete encased steel open spandrel arch-type spans on each side of the bascule, and 20 reinforced concrete arcade spans at the far north approach of the bridge. The bridge has a total width of 72 feet and accommodates five lanes of traffic (two northbound and two southbound, with a reversible direction center lane) in a 60-foot roadway, as well as two five-foot sidewalks. The bascule span also provides clearance for a 150-foot wide marine navigation channel.

Given the relative poor condition and age of this structure, both rehabilitation and replacement options are considered to accommodate the required needs of the corridor. The rehabilitation options are developed to consider a range of alternatives from minimal/short-term repairs (a new deck overlay) to continue service on the bridge until a major project can be developed and constructed to a comprehensive major rehabilitation which considers all major elements of the bridge. A new signature structure is also considered for the bridge replacement option.

Design Criteria

The design for either a rehabilitation or new bridge design will be in accordance with all applicable Federal, State, and Baltimore City criteria. These will include American Association of State Highway and Transportation Officials (AASHTO), Maryland Department of Transportation State Highway Administration (MDOT SHA), and Baltimore City Department of Transportation (BCDOT) guidelines. To meet the proposed corridor needs, in addition to vehicular traffic, the design is to consider pedestrian access and the existing marine navigation channel. The alternatives presented in this report – with the exception of one sub-option for Option 3 and Option 4 – all consider retaining a movable span since provision of the existing navigation channel is currently required by the United States Coast Guard. Options 1, 2 and one sub-option for Option 3 do not provide for rehabilitation of the movable span and would only provide for limited bridge openings as provided by the BCDOT's current maintenance program. The options where the movable span is transformed into a fixed span in the closed position are provided as exceptions to the Coast Guard requirement to maintain the existing navigation channel and will require approval from that agency to be implemented. It is relevant to understand the rehabilitation costs associated with these options since it will allow for a reduction of the recurring costs associated with operating and maintaining a bascule bridge, as well as the relatively high construction costs associated with rehabilitating the existing movable span electrical and mechanical operating systems. It is noted that if the movable span is permanently closed, the vertical clearance is approximately 38 feet at the center of the span and a minimum of 23 feet for the entire 150-channel width – a clearance suitable for the passage of a small tug boat and barge to accommodate channel dredging, as well as construction maintenance/access to existing bridge crossings maintained by MDOT MTA Light Rail and MDTA (I-95 and I-395).

With respect to pedestrian access and maintaining the existing channel – these two requirements are dependent upon one another. For ease of pedestrian access across the bridge, any new structure should also utilize the relatively flat grades present on the existing structure – level across the bascule span; approximately 0.5 percent on the arch approaches; and a transition through a vertical curve to a three percent grade on the far north approaches. To retain the navigation channel with a high-level structure (eliminating the movable span) to retain suitable navigation clearance, the approach grades would become excessive for comfortable pedestrian access or the bridge limits would likely extend prohibitively beyond the current approach limits.

Bridge Options

Cost estimates (in 2018 dollars) and potential bridge deck cross sections (where applicable) are developed for several rehabilitation options and for new "signature type" structures. The rehabilitation options are developed to indicate various levels of effort that vary from an immediate deck improvement project utilizing an overlay to a general rehabilitation that includes replacement of the electrical and mechanical operating systems of the bridge and lane reconfiguration on the structure.

These estimates include initial construction costs of primary constituent items based upon current prices for similar work performed in the State of Maryland. Quantities are derived based upon information developed from existing bridge plan sets. Also included are Maintenance of Traffic, Project Mobilization, and Project Soft Costs (construction management, inspection, and engineering fees). Based upon this level of study, a 40 percent Cost Contingency is added to cover unknown and miscellaneous items, as well as a one-year price escalation based upon an assumption of four percent inflation.

These estimates do not include life-cycle costs associated with general bridge maintenance and movable span operation, approach roadway work, aesthetic/architectural features not a part of the bridge structure, or specialized engineering work. In the event that one of the general rehabilitation options is developed, this specialized engineering work is required to demonstrate that a suitable additional service life (usually 75 years or more) can be obtained. This work may include:

- Detailed Structure and Underwater Condition Inspections to obtain detailed measurements and locations of required repairs
- Metallurgical Study of Existing Structural Steel
- Material Study of Existing Concrete Members
- Fatigue Life Evaluation of Existing Steel Elements
- In-situ Investigation and Geotechnical Analysis of Existing Pile Foundations

- Detailed Structural Analyses – including an assessment of movable span elements, existing riveted connections, and a non-linear analysis of the concrete encased steel trusses of the approach “arch” spans
- Cathodic Protection Study
- Vessel Collision Study of the Existing Piers
- Detailed Hydraulic Analyses
- Barrier Type Study
- Hazardous Material Evaluations
- Architectural Study – Period Lighting and Barrier Configurations

The specific Rehabilitation and Bridge Replacement Options include:

- Options 1 & 2: Short Term Maintenance Deck Rehabilitation (Roadway Only)
- Option 3 (with sub-options): Four-Lane Section
- Option 4: Separate Pedestrian / Bicycle Bridge and General Rehabilitation of the Existing Bridge to Accommodate Six Travel Lanes
- Option 5: New Six-Lane Bridge and Demolition of Existing Bridge
- Option 6: New Four-Lane Bridge and Demolition of Existing Bridge

The following figures illustrate the proposed bridge cross section for each option, as well as the proposed scope of the construction work and the total estimated project cost. Itemized cost developments for these options are presented in **Appendix D**. Note that costs shown below are rounded up for reporting to reflect this stage of planning.

Option 1 / 2: Full Deck Rehabilitation (Roadway Only)

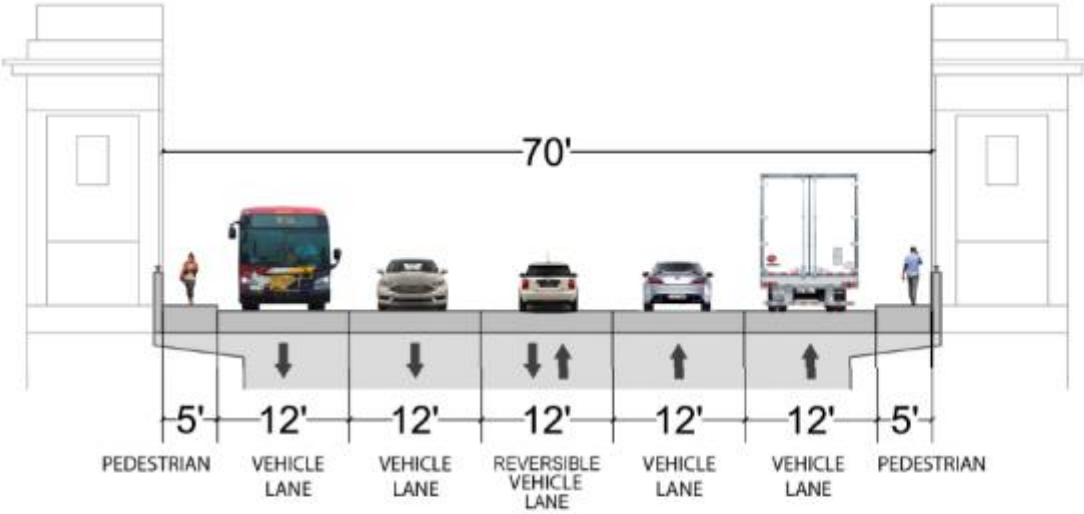

FIGURE 5-26: OPTION 1 / 2: FULL DECK REHABILITATION (ROADWAY ONLY)

- Short-term maintenance options
- Replacement of "Top Slab" of Deck above Precast Planks
  - Does not include movable span steel grid deck replacement
  - Does not include sidewalk replacement
- Hydrodemolition option would replace only the top surface of deck with concrete overlay and accounts for the lower end of the cost range
- Methodology
  - Used existing plan sets to derive quantities
  - Cost estimate based upon primary work items
- Cost Estimate
  - Used recent construction costs for similar work
  - Identified contingencies and project soft costs
  - **Total cost (2018 $): $8.0 million to $10.0 million**

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Option 3: Four-Lane Section

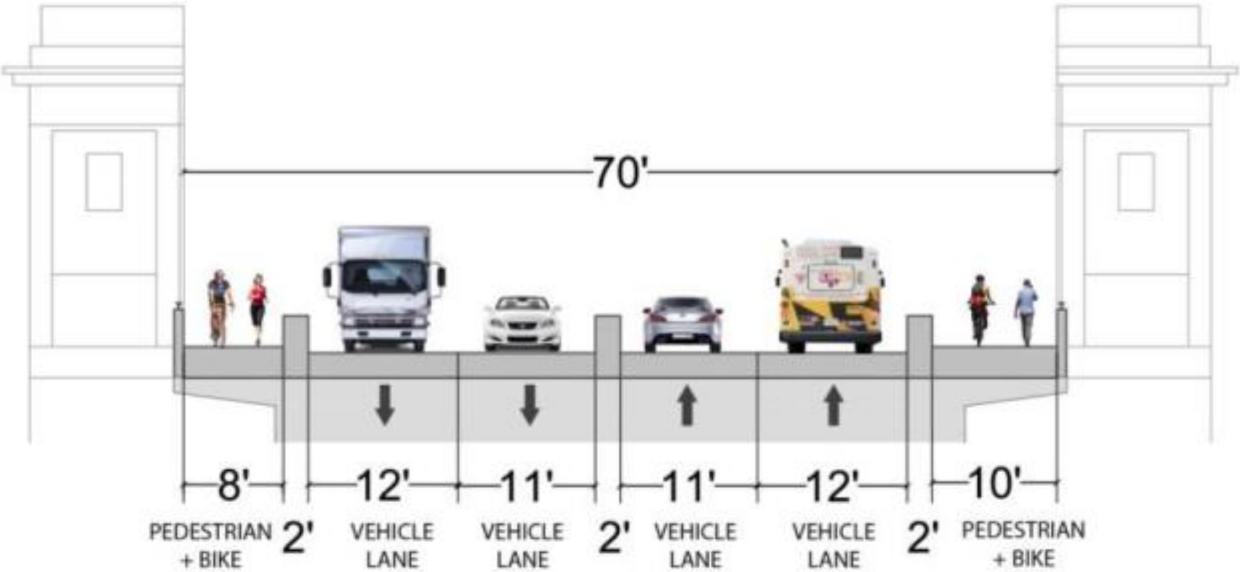

FIGURE 5-27: OPTION 3: FOUR-LANE SECTION

- Replacement of Bridge Deck – Full Depth including Precast Planks
    - Includes replacement of movable span steel grid deck
    - Includes bicycle and pedestrian paths, replacing outside barriers, installing new barriers between vehicular traffic and pedestrians and bicyclists, and installing new lighting
- Fixed Span in the Closed Position Sub-Option
    - Requires United States Coast Guard Approval to fix movable span of existing bridge
    - Includes structural modifications to fix existing movable span
    - Includes concrete filled steel grating of existing movable span
- Movable Span Rehabilitation Sub-Option
    - Includes structural repairs of movable span
    - Includes new movable span electrical operating system
    - Includes rehabilitation of movable span mechanical operating system
- Methodology
    - Used existing plan sets to derive quantities
    - Cost estimate based upon primary work items
- Cost Estimate
    - Used recent construction costs for similar work
    - Identified contingencies and project soft costs
    - **Total cost (2018 $): $30.0 million (no rehabilitation of the moveable span)**
    - **Total cost (2018 $): $50.0 million (fix the movable span in the closed position)**
    - **Total cost (2018 $): $70.0 million (full rehabilitation of the moveable span)**

CATHERINE E. PUGH
MAYOR

DEPARTMENT OF TRANSPORTATION
BALTIMORE CITY

Option 4: Separate Pedestrian / Bicycle Bridge and General Rehabilitation of the Existing Bridge to Accommodate Six Travel Lanes

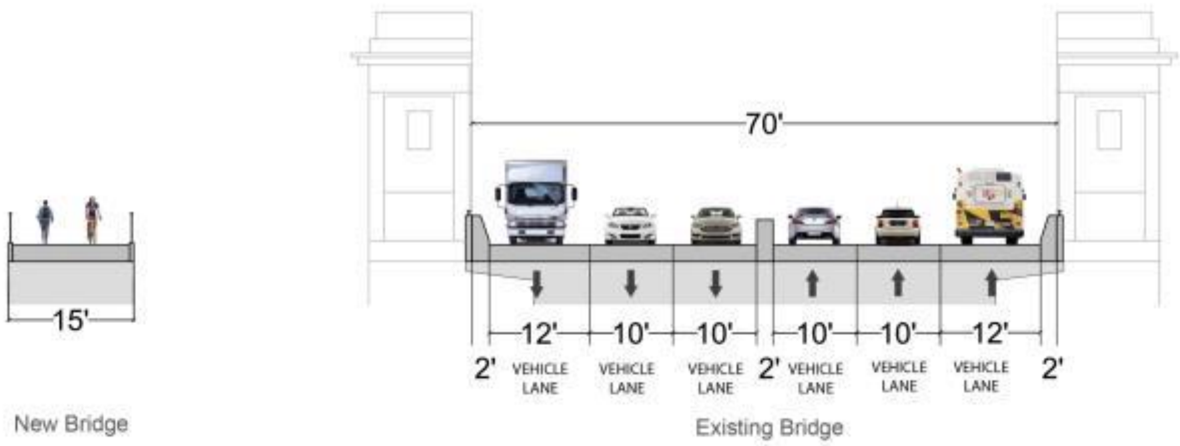

FIGURE 5-28: SEPARATE PEDESTRIAN / BICYCLE BRIDGE AND GENERAL REHABILITATION OF THE EXISTING BRIDGE TO ACCOMMODATE SIX TRAVEL LANES

- Requires United States Coast Guard Approval to Fix Movable Span of Existing Bridge
- Replacement of Bridge Deck – Full Depth including Precast Planks
    - Includes structural modifications to fix existing movable span
    - Includes concrete filled steel grating of existing movable span
    - Includes six travel lanes, replacing outside barriers, installing new barriers between opposing vehicular traffic, and installing new lighting
- Construction of New Parallel Pedestrian / Bicycle Bridge
    - Connecting Middle Branch Park to West Covington Park, west of the existing bridge
    - Assumes a fixed channel span
    - Serves bicyclists and pedestrians only
- Methodology
    - Used existing site information to derive bridge length
    - Cost estimate based upon industry recognized "square foot" costs for similar work
- Cost Estimate
    - Identified contingencies and project soft costs
    - **Pedestrian / bicycle bridge cost (2018 $): $20.0 million**
    - **Existing bridge rehabilitation cost (2018 $): $50.0 million**
    - **Total cost (2018 $): $70.0 million**

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Figure 5-29 below shows a potential Option 4 layout for reference purposes. Note that elevation of the new pedestrian / bicycle bridge is the same as the Vietnam Veterans Memorial Bridge in the closed position.

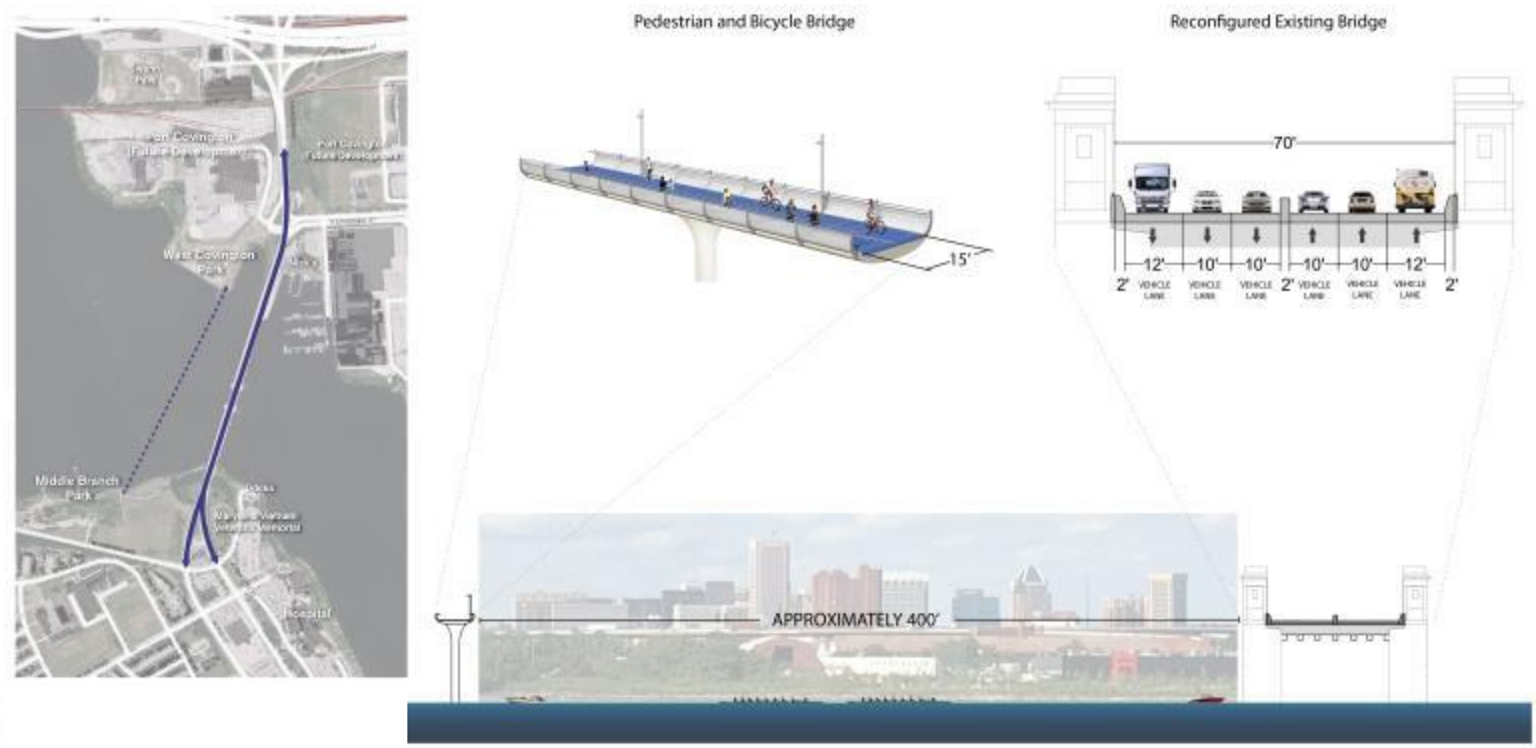

FIGURE 5-29: LAYOUT OF SEPARATE PEDESTRIAN / BICYCLE BRIDGE

CATHERINE E. PUGH
MAYOR

DEPARTMENT OF TRANSPORTATION
BALTIMORE CITY

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Option 5: New Six-Lane Bridge and Demolition of Existing Bridge

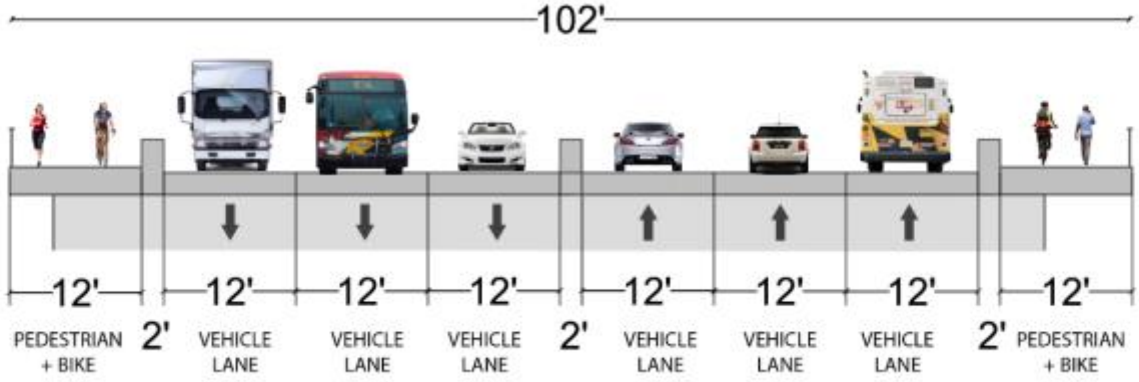

FIGURE 5-30: NEW SIX-LANE BRIDGE AND DEMOLITION OF EXISTING BRIDGE

- Construction of a New "Signature Crossing"
  - Assumes a movable channel span
  - Accommodates vehicular and pedestrian/bicycle traffic
  - Includes demolition of the existing bridge
- Methodology
  - Used existing site information to derive bridge length
  - Cost estimate based upon industry recognized "square foot" costs for similar work
  - Used relatively high unit costs for "signature" portion of bridge
- Cost Estimate
  - Used standard contingencies
  - Identified project soft costs
  - **New bridge cost (2018 $): $230.0 million**
  - **Demolition of existing bridge cost (2018 $): $15.0 million**
  - **Total cost (2018 $): $245.0 million**

CATHERINE E. PUGH
MAYOR

DEPARTMENT OF TRANSPORTATION
BALTIMORE CITY

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Option 6: New Four-Lane Bridge and Demolition of Existing Bridge

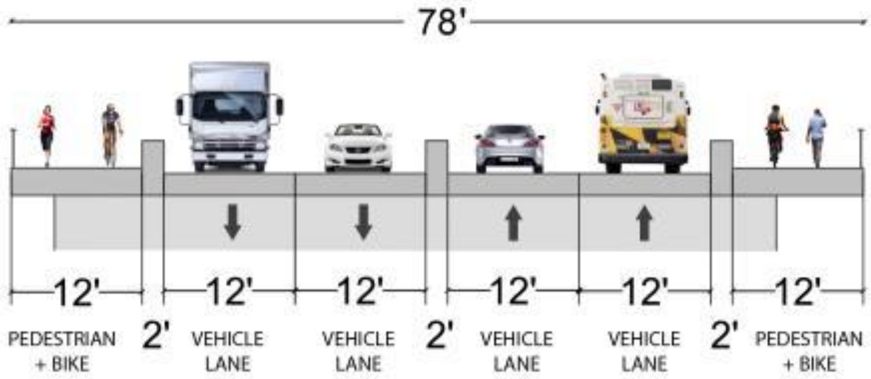

FIGURE 5-31: NEW FOUR-LANE BRIDGE AND DEMOLITION OF EXISTING BRIDGE

- Construction of a New "Signature Crossing"
  - Assumes a movable channel span
  - Accommodates vehicular and pedestrian/bicycle traffic
  - Includes demolition of the existing bridge
- Methodology
  - Used existing site information to derive bridge length
  - Cost estimate based upon industry recognized "square foot" costs for similar work
  - Used relatively high unit costs for "signature" portion of bridge
- Cost Estimate
  - Used standard contingencies
  - Identified project soft costs
  - **New bridge cost (2018 $): $180.0 million**
  - **Demolition of existing bridge cost (2018 $): $15.0 million**
  - **Total cost (2018 $): $195.0 million**

Maintenance of Traffic and Constructability

A primary constraint with respect to the feasibility of the major rehabilitation options is the need to remove the deck and portions of the floor system in a staged sequence to continue to accommodate vehicular traffic. This work will require longer term closures to perform demolition work and install new sections of deck. It is anticipated that no more than two lanes of the bridge could be closed at any one time. One sidewalk would also require closure during the closures of the respective adjacent exterior traffic lanes. For any options where substantial repairs are also required for the movable span, long term closures of the navigation channel will be required when components of the operating systems are replaced. Similar traffic closures for the movable span are required to allow for replacement of the grid deck and performing structural repairs, as well as sequential span rebalancing.

The short-term maintenance options are simpler because only a new deck overlay is applied to the approach spans. This work requires only short-term closures of lanes to accommodate construction.

In any case, traffic studies and stakeholder interaction will be required, along with preliminary construction schedule development to assess the effects of lane closures and determine the best and most acceptable sequencing for the work.

For the new bridge construction options, it is anticipated that the new structure will be built on an adjacent alignment to the existing Vietnam Veterans Memorial Bridge with only realignment of the approach roadways being required. Depending upon the projected needs of the corridor, the construction may take place on either the east or west side of the existing bridge. Minimal traffic interruptions are anticipated during this scenario. As another option, construction of the new bridge within the existing alignment will require complete closure of the existing bridge, at least until an appropriate width of the new structure is complete to accommodate traffic. Demolition of the existing bridge will also be required to begin construction on the existing alignment.

Summary of Potential Bridge Options

The following table summarizes the potential bridge options, including pedestrian and bicycle facilities. Additional summary notes on the options are provided, as well.

TABLE 5-5: SUMMARY OF POTENTIAL BRIDGE OPTIONS

Option	Description	Rehabilitation or Replacement	Total Cost (2018 $)
1 / 2	Full Deck Replacement (Roadway Only)	Short-Term Maintenance	$8.0 M to $10.0 M
3	Four-Lane Section with 8 to 10 Foot Barrier Separated Pedestrian / Bicycle Paths	Rehabilitation	$30.0 M to $70.0 M
4	Separate Pedestrian / Bicycle Bridge and General Rehabilitation of the Existing Bridge to Accommodate Six Travel Lanes with No Pedestrian or Bicycle Accommodations	Rehabilitation	$70.0 M
5	New Six-Lane Bridge with 12 Foot Barrier Separated Pedestrian / Bicycle Paths and Demolition of Existing Bridge	Replacement	$245.0 M
6	New Four-Lane Bridge with 12 Foot Barrier Separated Pedestrian / Bicycle Paths and Demolition of Existing Bridge	Replacement	$195.0 M

- For any of the deck replacement rehabilitation options, stakeholder and maintenance of traffic issues need to be considered from a multi-disciplinary approach.
- The short-term maintenance options (Options 1 / 2) are identified as temporary “stop gap” measures that will not meet the long-term needs of the corridor. The deck replacement option is slightly better than the hydrodemolition option in terms of useful life, but this does not consider the movable span at all.
- Any long term rehabilitation option will need to be proven feasible through further engineering studies that would be required to demonstrate that the rehabilitated structure has sufficient remaining service life of approximately 75 years
- Option 3 repairs the movable span steel grid deck and has three sub-options: no rehabilitation of the movable span system, permanently fix the movable span in the closed position, and full rehabilitation of the movable span system. The most thorough option would be the most expensive one that provides for unrestricted use of the movable span.
- Option 4 provides completely separate access for bicycles and pedestrians across the Middle Branch away from vehicles, but also forces users to travel away from Hanover Street to make this connection from Middle Branch Park to West Covington Park and then connect back to Hanover Street.
- Options 5 and 6 are the most expensive options and entail demolishing the historic structure, but provide full multimodal accommodations across the bridge.

Traffic – Future (2040) Conditions

This section covers the future 2040 No-Build and Build volume development and analysis. As mentioned previously in this report, the Hanover Street Corridor Study led by the City of Baltimore and the I-95 Access Improvements National Environmental Policy Act (NEPA)/Interstate Access Point Approval (IAPA) project led by the Maryland Transportation Authority (MDTA) are being conducted concurrently and have overlapping traffic study areas on the Hanover Street corridor. To ensure consistency between the two studies, the City of Baltimore and MDTA agreed to adopt a single set of peak hour traffic volumes to use for future conditions of both projects.

The traffic forecasts developed as part of the *Traffic Analysis Technical Report for the I-95 Access Improvements from Caton Avenue to Fort McHenry Tunnel – Environmental Assessment (EA)* were used for this study. The non-overlapping study intersections on Hanover Street and Potee Street south of Waterview Avenue (i.e. Hanover Street/Potee Street at Cherry Hill Road and Hanover Street/Potee Street at Reedbird Avenue) were balanced with the adopted volumes to the north.

A brief overview of the forecasting methodology from the *Traffic Analysis Technical Report* is presented below.

Traffic Forecasting / Demand Modeling Methodology

The Baltimore Metropolitan Council (BMC) regional travel demand model and the Institute of Transportation Engineers (ITE) trip generation methodology were both used, in a hybrid approach, to generate traffic forecasts for the AM and PM peak hours for the 2040 design year. These traffic forecasts were used to assess and compare travel conditions under the No Build Alternative and the Build Alternative.

BMC Model
The BMC regional travel demand model forecasts traffic volumes on major roadways in the Baltimore Region, using the transportation network and land use conditions in the region as inputs. The model was developed by BMC to provide a basis to predict travel trends based on planned development and transportation network changes at the regional level. The BMC model was used in this study as a starting point to develop traffic forecasts for the 2040 design year.

Trip Generation and Distribution
The BMC model does not explicitly include the development proposed for the Port Covington site. In order to account for this, the ITE methodology was used to generate site trips for the Port Covington development for the 2040 scenarios. The trip generation is summarized in **Table 5-6**.

TABLE 5-6: ITE TRIP GENERATION OF PORT COVINGTON

Land Use	ITE Code	Size	ITE Vehicle Trips					
			AM Peak			PM Peak		
			IN	OUT	TOTAL	IN	OUT	TOTAL
2040 Port Covington Development								
Office	710	4,300,000 SF	3,412	466	3,878	832	4,062	4,894
Retail	820	1,300,000 SF	462	283	745	1,604	1,737	3,341
Residential (Mid Rise)	223	5,300 DU	670	1,490	2,160	1,469	1,064	2,533
Hotel	310	200 Rooms	63	43	106	61	59	120
Manufacturing	140	303,000 SF	172	49	221	79	141	220
Park[1]	411	40.23 Acres	8	7	15	31	30	61
Internal Capture			(54)	(54)	(108)	(465)	(465)	(930)
Sum			**4,733**	**2,284**	**7,017**	**3,611**	**6,628**	**10,239**
Transit/Pedestrian/Bicycle Reduction		20%	(947)	(457)	(1,403)	(722)	(1,326)	(2,048)
Cumulative Total			**3,786**	**1,827**	**5,614**	**2,889**	**5,302**	**8,191**

1. The park space land use code provides a rate for a weekday, but does not provide rates for peak hours. It was assumed that all weekday trips occur during the peak hours (20% AM and 80% PM).

It should be noted that the trip generation assumes internal capture, i.e., that a portion of trips generated by the mixed-use development begin and end within the development.

Once the ITE trip generation analysis was completed, an adjustment factor was applied to the results, in order to account for transit, bicycle, and walking trips. (Such an adjustment is typically applied to urban study areas with significant transit service and opportunities for walking/bicycling.) For Port Covington, a reduction of 20 percent was felt to be reasonable. As shown in **Table 5-6**, following the adjustments for internal capture and transit/pedestrian/bicycle use, the Port Covington development is projected to generate 5,614 and 8,191 vehicle trips during the AM and PM peak hours, respectively.

The BMC model was then modified to explicitly account for these trips. The Port Covington-generated trips were distributed throughout the traffic analysis study area by the regional model. It should be noted that the trip generation and distribution were held constant for each of the future scenarios.

Post Processing

The modification of the BMC model to explicitly account for the Port Covington site trips in the 2040 forecasts resulted in some "double counting" of future trips. As a result, unrealistically high volumes were projected within the traffic analysis study area, particularly along the roadways directly accessing Port Covington. In order to address this, background annual growth rates were adjusted on Hanover Street and McComas Street to 0.25 percent, based on historical traffic count data.

The total number of vehicular trips estimated by the ITE method for the Port Covington development was held constant; however, due to the regional scale of the BMC travel demand model, it does not include all surface streets within the Port Covington peninsula. Merging ITE trip generation and the regional model was done to mitigate the limitations of both approaches, i.e. ITE does not capture the impact of proposed roadway projects, regional changes in demand, changes in destination choice, etc., while the regional model cannot generate peak hour trips at the parcel level. Therefore, engineering judgment based on capacity considerations and land use densities at various points within Port Covington were used to manually assign turning movements along Hanover Street and McComas Street at the proposed Port Covington development side streets.

It should be noted that the BMC regional model also forecasts significant growth on the northbound I-95 exit ramp to head north on Washington Boulevard unrelated to Port Covington, resulting in near grid lock conditions on Washington Boulevard which spilled back on the northbound off ramp and onto northbound I-95. For the purpose of this study, the projected volume on this northbound I-95 off ramp was distributed between north- and southbound Washington Boulevard in the Build scenarios in order to reduce spillback on the freeway to more accurately evaluate downstream freeway operations and to identify the most appropriate set of improvements.

2040 No Build Scenario

The 2040 No Build scenario for this study is consistent with the No Build scenario from the Traffic Analysis Technical Report for the I-95 Access Improvements from Caton Avenue to Fort McHenry Tunnel – Environmental Assessment (EA). Under this scenario, the existing I-95 entrance and exit ramps would remain as they exist today. However, the No Build scenario includes modifications to the surface street network to be made as part of the Port Covington development, and not as part of the Hanover Street Corridor Study. These surface street modifications will be in place even if no changes are made as part of the Hanover Street Corridor Study. These modifications include modifying the existing grade of Hanover Street, particularly south of McComas Street. It also includes widening Hanover Street to six lanes and constructing a median and turn lanes along the corridor north of the bridge. Additional surface street intersections will also be included along Hanover Street as part of the Port Covington development (i.e. Magenta Street, Blue Street, and Red Street).

The 2040 No Build volumes and lane configurations are shown in **Figure 5-32** (see end of chapter).

2040 No Build – Intersection Operations

Using the same methodology described in Chapter 3 (Existing Traffic Operations), a Synchro model was used to perform 2040 No Build capacity analyses using HCM 2000 methodology. **Table 5-7** summarizes the HCM analysis performed under 2040 No Build traffic conditions. **Figure 5-33** (see end of chapter) shows the existing LOS during the AM and PM peak hours for each study intersection.

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TABLE 5-7: 2040 NO BUILD INTERSECTION CAPACITY ANALYSIS RESULTS

Intersection	Future Year Condtions (2040 No-Build)					
	HCM					
	Delay (sec)		Level of Service		V/C Ratio	
	AM	PM	AM	PM	AM	PM
Hanover St & Wells St	80.4	109.2	F	F	1.17	1.35
Hanover St & McComas St	95.5	176.4	F	F	1.29	1.77
Hanover St & Magenta St	9.9	19.0	A	B	0.77	0.88
Hanover St & Blue St	264.8	180.0	F	F	2.13	1.84
Hanover St & Red St	37.1	69.5	D	E	1.06	1.17
Hanover St & Cromwell St	28.1	88.5	C	F	0.68	1.12
Potee St and Waterview Ave	11.6	12.5	B	B	0.32	0.53
Hanover St & Waterview Ave	10.9	29.3	B	C	0.59	0.55
Potee St & Cherry Hill Rd	19.7	31.8	B	C	0.40	0.61
Hanover St & Cherry Hill Rd	8.0	13.1	A	B	0.68	0.47
Potee St and Reedbird Ave	7.9	8.2	A	A	0.37	0.61
Hanover St & Reedbird Ave	39.6	19.6	D	B	0.70	0.53

The results of the 2040 No Build analysis show the following:

- 3 intersections operate with LOS F during the AM peak hour
  - Hanover Street at Wells Street
  - Hanover Street at McComas Street
  - Hanover Street at Blue Street

- 5 intersections operate with LOS E or LOS F during the PM peak hour
  - Hanover Street at Wells Street
  - Hanover Street at McComas Street
  - Hanover Street at Blue Street
  - Hanover Street at Red Street
  - Hanover Street at Cromwell Street

2040 Build Scenario

The 2040 Build scenario is consistent with Alternative 5 (Recommended Preferred Alternative) from the *Traffic Analysis Technical Report for the I-95 Access Improvements from Caton Avenue to Fort McHenry Tunnel – Environmental Assessment (EA).* Under this scenario, the existing Hanover Street northbound off ramp (Exit 54) would be removed. A new northbound off ramp spur from Russell Street (Exit 52) to McComas Street (West of Hanover Street) and a new ramp spur from I-395 SB to McComas Street (West of Hanover Street) would be constructed. These new spur ramps would merge and connect to McComas Street at an at-grade intersection west of Hanover Street. No changes are proposed to the existing Hanover Street southbound on ramp.

Hanover Street between Wells Street and McComas Street would not be reconstructed as part of the I-95 Access Improvements project. South of McComas Street, Hanover Street would be reconstructed as part of the Port Covington development to lower the grade and widen to a six lane section with a median and turn lanes.

The 2040 Build scenario also includes some additional left-turn turn restrictions along Hanover Street (i.e. Red Street and Magenta Street) and some additional side street left-turn lanes. The 2040 Build volumes and lane configurations are shown in **Figure 5-34** (see end of chapter).

2040 Build - Intersection Operations

Using the same methodology described in Chapter 3 (Existing Traffic Operations), a Synchro model was used to perform 2040 Build capacity analyses using HCM 2000 methodology. **Table 5-8** summarizes the HCM analysis performed under 2040 Build traffic conditions. **Figure 5-35** (see end of chapter) shows the existing LOS during the AM and PM peak hours for each study intersection.

It should be noted for consistency with the *Traffic Analysis Technical Report* analysis that all overlapping intersections (Waterview Avenue to Wells Street) were assumed to be Actuated-Coordinated signals. As part of this analysis, pedestrian "Flashing Don't Walk" times were updated and pedestrian calls were assumed 50 percent of the time.

TABLE 5-8: 2040 Build Intersection Capacity Analysis Results

Intersection	Future Year Condtions (2040 Build)					
	HCM					
	Delay (sec)		Level of Service		V/C Ratio	
	AM	PM	AM	PM	AM	PM
Hanover St & Wells St	56.0	91.7	E	F	1.13	1.29
Hanover St & McComas St	31.4	69.0	C	E	0.93	1.09
Hanover St & Magenta St	7.7	16.0	A	B	0.62	0.85
Hanover St & Blue St	27.6	42.5	C	D	0.93	1.00
Hanover St & Red St	11.4	19.2	B	B	0.68	0.81
Hanover St & Cromwell St	25.6	30.9	C	C	0.84	0.90
Potee St and Waterview Ave	13.5	15.4	B	B	0.32	0.53
Hanover St & Waterview Ave	3.8	8.7	A	A	0.59	0.55
Potee St & Cherry Hill Rd	15.5	8.8	B	A	0.40	0.61
Hanover St & Cherry Hill Rd	6.6	7.8	A	A	0.68	0.47
Potee St and Reedbird Ave	6.9	7.1	A	A	0.37	0.61
Hanover St & Reedbird Ave	39.3	14.3	D	B	0.70	0.53

The results of the 2040 Build analysis show the following:

- 1 intersection operates with LOS E during the AM peak hour
    - Hanover Street at Wells Street

- 2 intersections operate with LOS E or LOS F during the PM peak hour
    - Hanover Street at Wells Street
    - Hanover Street at McComas Street

Intersection results improve in 2040 Build compared to 2040 No-Build because of a combination of roadway improvements (e.g. I-95 NB ramp to Hanover Street realignment, side street left-turn lanes), turn restrictions, and signal timing improvements north of the bridge.

Alternative Bridge Cross Sections

Several alternative cross sections for the Vietnam Veterans Memorial Bridge were evaluated. These options included the following:

- 2 northbound/2 southbound/1 reversible lane (existing bridge width and operations)
- 2 northbound/2 southbound lanes (existing bridge width; one lane reconfigured for pedestrians/bicycles)
- 3 northbound/2 southbound lanes (existing bridge width; permanent imbalance with three northbound lanes; no reversible lane)
- 2 northbound/3 southbound (existing bridge width; permanent imbalance with three southbound lanes; no reversible lane)
- 3 northbound/3 southbound (new six-lane bridge)

Typical sections are shown below in **Figures 5-36, 5-37, 5-39, 5-39, and 5-40**, respectively.

FIGURE 5-36: 2/2/1 (REVERSIBLE LANE – EXISTING OPERATIONS)

FIGURE 5-37: 2/2 (ONE LANE RECONFIGURED FOR PEDS/BIKES)

FIGURE 5-38: 3/2 (PERMANENT IMBALANCE NORTHBOUND)

FIGURE 5-39: 3/2 (PERMANENT IMBALANCE SOUTHBOUND)

FIGURE 5-40: 3/3 (NEW SIX-LANE BRIDGE)

Alternative Bridge Cross Sections – Bicycle Level of Service

The cross section of the bridge would have an effect on a bicyclist's level of comfort while crossing the bridge. The Bicycle Level of Service (BLOS) Model uses measurable data to quantify and rate the comfort and ease of cycling along a roadway and is based on research in *Transportation Research Record 1578* published by the Transportation Research Board of the National Academy of Sciences. BLOS takes into account the following factors:

- Volume of traffic, per travel lane;
- Percent trucks;
- Outside lane and shoulder width;
- Availability and utilization rate of curbside parking;
- Parking width, if available;
- Posted Speed limit;
- Quality of roadway surface;
- And roadway configuration (undivided versus divided).

The BLOS uses the criteria to develop a score, to which a level of service is assigned (as shown in **Table 5-9** below). As an example, a low speed road with low traffic volume, few trucks, and a wide shoulder would be considered to have a BLOS score of an A.

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TABLE 5-9: BICYCLE LEVEL OF SERVICE CATEGORIES

LEVEL-OF-SERVICE	BLOS SCORE
A	≤ 1.5
B	> 1.5 and ≤ 2.5
C	> 2.5 and ≤ 3.5
D	> 3.5 and ≤ 4.5
E	> 4.5 and ≤ 5.5
F	> 5.5

Using a spreadsheet, the BLOS for each bridge cross section was evaluated. The results are shown in **Table 5-10**. The results show that the existing bridge cross section operates with a BLOS F and would continue to do so in 2040 if no changes are made. The 2040 Build Option 1 & 2 improves the BLOS to an E due to the improvement of roadway surface condition. The remaining options all operate with a BLOS A because the bicycle facility is fully protected by a barrier or on a separate detached bridge.

TABLE 5-10: BRIDGE CROSS SECTION BICYCLE LEVEL OF SERVICE RESULTS

Scenario	Level of Comfort
Existing (shared travel lane)	F
2040 No Build (shared travel lane)	F
2040 Build – Option 1, 2 (shared travel lane)	E
2040 Build – Option 3, 3A, 3B (barrier separated ped/bike paths)	A
2040 Build – Option 4 (separate ped/bike bridge)	A
2040 Build – Option 5 (new bridge with barrier separated ped/bike paths)	A

Alternative Bridge Cross Sections - Network Analysis

For corridor analyses, two different sets of metrics (intersection and network) are typically used. Intersection metrics (i.e. LOS, delay, v/c) for future conditions, shown above, look at each intersection to determine if they are operating adequately on their own. Network or corridor results typically use performance measures from SimTraffic (i.e. travel time, delay, speeds, queues). The network results

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show effects of downstream bottlenecks, turn bay spillover, etc. that are not accounted for in intersection analysis.

Although the cross section of the bridge does not directly affect the intersection performance measures, it could have an effect on network performance measures. Therefore, SimTraffic, a microscopic simulation and animation software program defined in Synchro, was used to report 95th percentile queues and corridor travel times. Five 60-minute simulations were run for each peak hour of each scenario.

Performance measures for each scenario, including queue lengths in the northbound direction at Cromwell Street, travel times by segments, and denied entry vehicles, were evaluated and are shown in **Table 5-11**. **Table 5-12** references the back of queue to the nearest study intersection. Queues and travel times are also shown graphically in **Figure 5-41** and **Figure 5-42** (see end of chapter). **Figure 5-42** also includes pedestrian and bicycle travel times for comparison purposes.

TABLE 5-11: 2040 BUILD RESULTS – NETWORK ANALYSISs

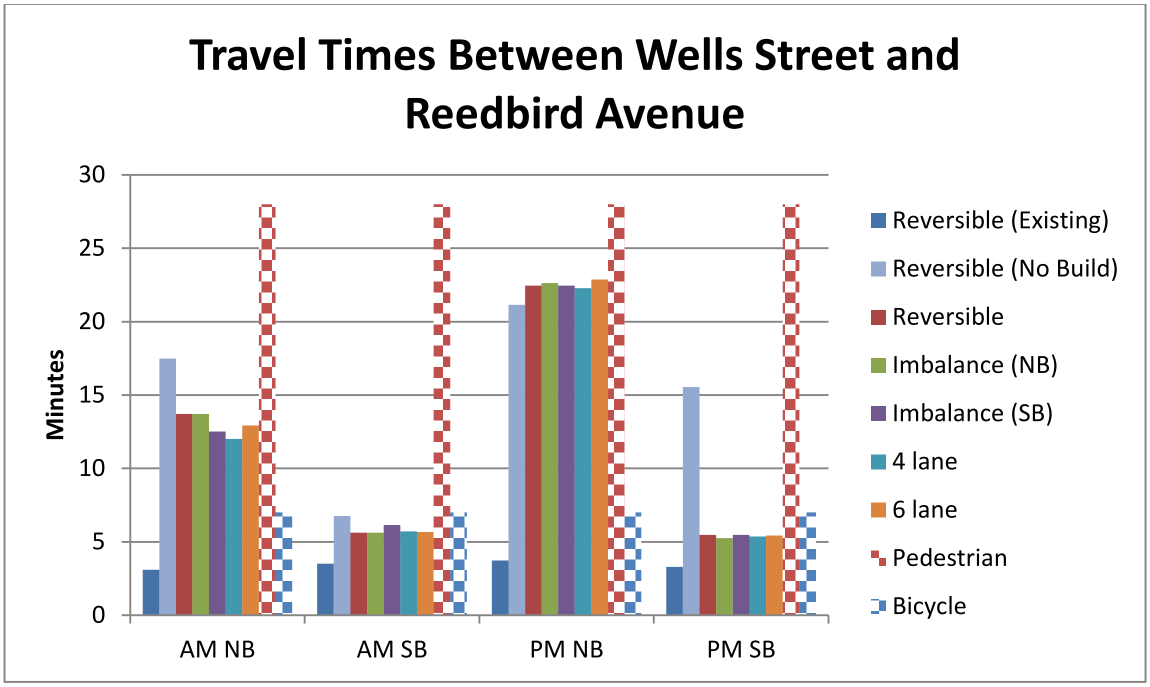
Performance Measure - AM (PM)	Alternative											
	No Build		Build									
	Reversible		*Reversible*		*Permanent Imbalance (NB)* [1]		*Permanent Imbalance (SB)* [2]		*4 lane*		*6 lane*	
Queue Length (feet)												
NB at Cromwell Street	>5660 (>5660)		3870 (5360)		- (4380)		4410 (-)		3890 (5280)		3290 (4350)	
Travel Time (minutes)	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
Wells Street to Cromwell Street	5.8 (4.8)	4.7 (13.3)	5.0 (6.5)	3.6 (3.5)	- (6.6)	- (3.2)	4.7 (-)	4.1 (-)	4.8 (6.5)	3.6 (3.3)	4.8 (6.6)	3.6 (3.5)
Cromwell Street to Reedbird Avenue	11.7 (16.3)	2.1 (2.2)	8.7 (15.9)	2.1 (2.0)	- (16.1)	- (2.0)	7.8 (-)	2.0 (-)	7.2 (15.7)	2.1 (2.0)	8.1 (16.2)	2.0 (2.0)
Total (Wells Street to Reedbird Avenue)	17.5 (21.1)	6.8 (15.5)	13.7 (22.5)	5.6 (5.5)	- (22.6)	- (5.3)	12.5 (-)	6.2 (-)	12.0 (22.3)	5.7 (5.4)	12.9 (22.9)	5.7 (5.4)
Denied Entry [3] (vehicles)	2927 (5570)		1232 (2916)		- (2872)		1382 (-)		1220 (2920)		1276 (2913)	

1 - Permanent Imbalance (NB) indicates 3 NB lanes and 2 SB lanes throughout the day. The AM results have a "-" because they are identical to the "Reversible" measures.
2 - Permanent Imbalance (SB) indicates 3 SB lanes and 2 NB lanes throughout the day. The PM results have a "(-)" because they are identical to the "Reversible" measures.
3 - Denied Entry vehicles are vehicles that are unable to enter the network due to congestion.

TABLE 5-12: 2040 BUILD RESULTS – BACK OF QUEUE REFERENCED TO NEAREST INTERSECTION (FEET)

Queues (feet)		
Alternative	**AM**	**PM**
No Build		
Reversible	>1130' beyond Reedbird	>1130' beyond Reedbird
Build		
Reversible	560' beyond Cherry Hill	840' beyond Reedbird
Permanent Imbalance (NB)	Same as AM Reversible	1,060' beyond Cherry Hill
Permanent Imbalance (SB)	1,090' beyond Cherry Hill	Same as PM Reversible
4 lane	580' beyond Cherry Hill	760' beyond Reedbird
6 lane	270' beyond Waterview	1,040' beyond Cherry Hill

FIGURE 5-41: 2040 BUILD RESULTS – TRAVEL TIMES



The following is a summary of the results:

AM Peak Hour

- The northbound queue from Cromwell Street would extend 560' (3,870' total) beyond Cherry Hill Road with existing bridge configuration (i.e. Reversible)
- The northbound queue from Cromwell Street would extend 270' (3,290' total) beyond Wateview Avenue with a 6 lane cross section (i.e. new bridge)
- With a permanent southbound imbalance (i.e. 2 northbound lanes/3 southbound lanes), queues would extend 1,090' (4,410' total) beyond Cherry Hill Road.
- Travel times from Wells Street to Reedbird Avenue range between 3-4 minutes in the northbound and southbound directions under existing conditions. Under all of the bridge build alternatives, northbound travel times are approximately 12-14 minutes and southbound travel times are approximately 5-6 minutes.

PM Peak Hour

- The northbound queue from Cromwell Street would extend 840' (5,360') beyond Reedbird Avenue with existing bridge configuration (i.e. Reversible)
- The northbound queue at Cromwell Street reduced by approximately 1,000 feet for bridge configurations with a 3rd NB lane (i.e. 6 lane and Permanent Northbound Imbalance)
- Travel times from Wells Street to Reedbird Avenue range between 3-4 minutes in the northbound and southbound directions under existing conditions. Under all of the bridge build alternatives, northbound travel times are approximately 22-23 minutes and southbound travel times are approximately 5-6 minutes.

The results show that although the bridge cross section affects storage space and can affect the queue lengths by up to 1,000 feet, the travel times are very consistent regardless of the cross section.

Travel times don't vary because the bridge is not the constraint of the corridor, and intersections north of the bridge can only process a certain amount of vehicles per hour. Although the overall intersection LOS may appear acceptable at intersections north of the bridge, individual approaches including the northbound approach at McComas Street may operate over capacity. Northbound queuing is significant during both peak hours due to the combination of lane utilization at the intersection of McComas Street at Hanover Street because of the I-95 SB on-ramp just beyond the signal and close intersection spacing. Static analysis does not account for things such as turn bay spillovers, queueing through adjacent intersections, and side street turning movements with no space to turn onto Hanover Street, which are all evident in the SimTraffic simulation. This combination of interactions creates significant congestion north of the bridge. Based upon the congestion north of Cromwell Street, the selected cross section of the bridge will have very little effect on operations.

It should also be noted that extensive queuing on side streets is anticipated under all scenarios. The network did not include intersections within South Baltimore/Port Covington on Wells Street, Red Street, Blue Street, and Cromwell Street. The network also did not include intersections north of Wells Street on Hanover Street. Most of these queues would be significant and queue out of the network, which contributes to the denied entry vehicles. The denied entry vehicles indicate that peak spreading would occur (i.e. a peak period longer than one hour).

Potential Geometric Improvements

A potential safety improvement at the intersection of Hanover Street at Cromwell Street was evaluated that would improve pedestrian safety/walkability at the intersection. The improvement would remove the channelized northbound right turn and the channelized westbound right turn. Removing the channelized right turns would have no impact on the HCM intersection capacity analysis as the control type (i.e. yield for northbound right and signalized for westbound right) would not change. This scenario was also simulated using SimTraffic, and the results showed very little no change in queues and travel times.

Public Outreach

For this phase of work, the Study Team met with the Interagency Advisory Group (IAG) and the Community Advisory Panel (CAP) to present the analysis of the existing transportation network and obtain feedback. The team met with the IAG April 26, 2017 and the CAP on April 28, 2017 to review information from this chapter. Design opportunities and constraints information was presented at a Public Meeting held on May 23, 2017 at MedStar Harbor Hospital. The Study Team reviewed the findings to date, summarized the corridor conditions, provided an overview of design opportunities and potential bridge typical sections, and discussed next steps.

Following the stakeholder and public meetings, the team received the following general feedback on what was important for the bridge typical section. This information will be used directly by the Study Team to refine the options and make study recommendations.

- Additional space needed for pedestrians and bicycles to increase comfort and enhance recreation
- Add barrier separation between pedestrians / bicycles and vehicles for safety
- Add barrier separation between opposing vehicle travel directions for safety
- Overall support for removing center reversible lane due to safety concerns
- Stronger support for pedestrian / bicycle accommodations rather than a dedicated transit lane

Summary

Using the data collected in the previous chapters to understand the deficiencies of the existing transportation network, the Study Team identified multimodal options (for bicycles, pedestrians, transit, automobile, and freight) and potential improvements that address the transportation needs for a variety of users in the Hanover Street corridor, which has the potential to better support connectivity between all modes of travel.

Design opportunities discussed in this chapter are briefly summarized below:

Roadway

- To address the problematic pavement conditions, reconstruct the most-affected sections of Hanover Street with concrete pavement instead of asphalt – to Cromwell Street north of the bridge and to Waterview Avenue south of the bridge.
- All existing inlets, pipes, and bridge scuppers should be cleaned to allow the existing drainage system to function properly and the existing storm drain system should be visually inspected (inlets/manholes) or video inspected (pipe systems) to determine the extent of repair or replacement that would be necessary along with other corridor and bridge improvements.
- There will be a need for stormwater management and available space is limited in the corridor.

Pedestrian and Bicycle

- There are some scattered non-compliant Americans with Disabilities Act (ADA) features in the corridor that are related mostly to slope of driveways or ramps.
- Many pedestrian signals do not meet current design standards and may need to be upgraded.
- Pedestrian lighting is provided by street lights located throughout most of the corridor, but needs to be supplemented with additional lighting for pedestrian level of comfort and for safety.
- Crosswalks should be enhanced with stamped decorative asphalt to reinforce yielding of vehicles when pedestrians are crossing Hanover Street and intersecting streets.

- Further safety considerations for midblock crossing at MedStar Harbor Hospital (stop bar, highly visible crosswalk striping, etc.)
- Debris should be cleared from all sidewalks
- Reconstruct the stairwell connecting Hanover Street to the Gwynns Falls Trail
- Provide sidewalk bump-outs where not present to provide ADA clearance around utility poles, signs, etc.
- Existing bike facilities on Hanover Street can and should be converted to protected facilities, such as buffered bike lanes
- Support bicycle and pedestrian opportunities included in Port Covington improvements, such as the bike path through Port Covington under the bridge that is currently under construction, etc.

Transit

- All bus stops are recommended to have at least five-foot wide sidewalk access, a concrete pad connecting the sidewalk to the curb for boarding, clear signage, and adequate lighting at a minimum.
- Where space is available, benches and trash receptacles are recommended.
- Bus stops with an average daily weekday ridership of 50 or more are recommended for a shelter installation.

Freight

- The combination of constrained geometry at the intersection of Hanover Street at Frankfurst Avenue and lack of a direct connection from Frankfurst Avenue to Potee Street has a major impact on freight traffic in the area. Although these intersections are south of the study area, it is recommended to further study the missing connections and constrained geometry for trucks at these locations since it has an impact on the Hanover Street corridor.
- The suggested concrete pavement reconstruction will be beneficial to freight traffic as the pavement section will be better able to support these vehicles.

Urban Design

- When first built, the Hanover Street Bridge conveyed pedestrian, vehicular, and streetcar traffic across the Middle Branch between residential communities and the employment opportunities at the port. Changes to the bridge over time favored car and truck traffic and today the Vietnam Veterans Memorial Bridge no longer meets the multimodal needs of South Baltimore. Suggested urban design ideas all point to a return to the bridge's original purpose. In addition to improved function and experience along the entire Hanover Street corridor, multimodal enhancements across the bridge and along the water's edge also tie together existing and proposed destinations surrounding the entire Middle Branch basin.

- Proposed intersection enhancements focus on improving pedestrian safety and convenience by reshaping the intersecting curbs to calm turning traffic, removing channelized/free right-turn movements to improve safety, providing enhanced, high visibility crosswalks for all crossings, and implementing pedestrian-scaled lighting.
- The arcade bridge landing offers the opportunity to connect pedestrians along the waterfront from West Covington Park to Nick's Fish House without crossing Hanover Street. The unique bridge architecture creates the opportunity for a unique urban space, which was previously unused, including an outdoor art gallery with interim recreation amenities.
- The landing area east of the arcade, closest to Nick's Fish House, offers the opportunity for an extension of the art and recreation experience in previously unused space. This location also can provide access to the bridge deck by means of a sculptural staircase designed in contemporary harmony with the historic bridge geometry.
- If the bridge deck returns to its original four-lane configuration, there will be enough space to create a shared use path for bicycles and pedestrians protected from vehicular traffic by a new barrier. This new barrier can support pedestrian-scaled lighting inspired by photographs of the historic bridge and the balustrade can be returned to its original open form.
- The western edge of the arcade section can be enhanced with a living shoreline to complement the character of West Covington Park.
- The southern bridge landing offers a significant opportunity to improve public safety, enhance neighborhood amenity, and provide new multimodal connectivity. The vaulted space provides welcoming, but shaded space for activities. The proposed public space concept promotes the idea of one park south of the Middle Branch, including a terraced, amphitheater-like overlook that provides panoramic views of the Baltimore skyline and Middle Branch events and new, acccessible paths that connect pedestrians from the bridge deck to the waterfront.
- Throughout the segments of Potee Street and Hanover Street south of the bridge, the right-hand lane could be converted into a dedicated two-way cycle track with adjoining sidewalk and planting space separating the flow of bicycles from the flow of cars. The narrower roadway width will have a traffic calming effect, improving the pedestrian experience.

Bridge Structures

- Cost estimates (in 2018 dollars) and potential bridge deck cross sections were developed for several rehabilitation options and for new “signature type” structures. The rehabilitation options were developed to indicate various levels of effort that vary from an immediate deck improvement project utilizing an overlay to a general rehabilitation that includes replacement of the electrical and mechanical operating systems of the bridge and lane reconfiguration on the structure.
- Bridge options and cost estimates do not include specialized engineering work. In the event that one of the general rehabilitation options is developed, specialized engineering work is required to demonstrate that a suitable additional service life (of approximately 75 years) can be obtained.
- Options 1 & 2 – Short Term Maintenance Deck Rehabilitation (Roadway Only): $8.0 M to $10.0 M
- Option 3 – Four-Lane Section with 8 to 10 Foot Barrier Separated Pedestrian / Bicycle Paths: rehabilitation, $30.0 M to $70.0 M
- Option 4 – Separate Pedestrian / Bicycle Bridge and General Rehabilitation of the Existing Bridge to Accommodate Six Travel Lanes with No Pedestrian or Bicycle Accommodations: rehabilitation, $70.0 M
- Option 5 – New Six-Lane Bridge with 12 Foot Barrier Separated Pedestrian / Bicycle Paths and Demolition of Existing Bridge: replacement, $245.0 M
- Option 6 – New Four-Lane Bridge with 12 Foot Barrier Separated Pedestrian / Bicycle Paths and Demolition of Existing Bridge: replacement, $195.0 M
- For any of the deck replacement rehabilitation options, stakeholder and maintenance of traffic issues need to be considered from a multi-disciplinary approach.
- The short-term maintenance options (Options 1 & 2) are identified as temporary “stop gap” measures that will not meet the long-term needs of the corridor. The deck replacement option is slightly better than the hydrodemolition option in terms of useful life, but this does not consider the movable span at all.
- Option 3 repairs the movable span steel grid deck and has three sub-options: no rehabilitation of the movable span system, permanently fix the movable span in the closed position, and full rehabilitation of the movable span system. The most thorough option would be the most expensive one that provides for unrestricted use of the movable span.
- Option 4 provides completely separate access for bicycles and pedestrians across the Middle Branch away from vehicles, but also forces users to travel away from Hanover Street to make

this connection from Middle Branch Park to West Covington Park and then connect back to Hanover Street.

- Options 4 and 5 are the most expensive options and entail demolishing the historic structure, but provide full multimodal accommodations across the bridge.

<u>2040 Traffic</u>

- The results of the 2040 No Build analysis show that three intersections operate with Level of Service (LOS) F during the AM peak hour and five intersections operate with LOS E or LOS F during the PM peak hour.
- The results of the 2040 Build analysis show that one intersection operates with LOS E during the AM peak hour and two intersections operate with LOS E or LOS F during the PM peak hour. Intersection results improve in the 2040 Build compared to the 2040 No-Build because of a combination of roadway improvements (e.g. I-95 NB ramp to Hanover Street realignment, side street left-turn lanes), turn restrictions, and signal timing improvements north of the bridge.
- The various cross sections for the Vietnam Veterans Memorial Bridge were evaluated for Bicycle Level of Service (BLOS). The results show that the existing bridge cross section operates with a BLOS F and would continue to do so in 2040 if no changes are made. The other bridge options range from BLOS E (due to only improving the roadway surface condition) to BLOS A (because the bicycle facility is fully protected by a barrier or on a separate detached bridge).
- Future 2040 analysis shows that the proposed signalized intersections north of the bridge are the constraints in the corridor, not the bridge itself – intersections north of the bridge can only process a certain amount of vehicles per hour. The results show that although the bridge cross section affects storage space and can affect the queue lengths by up to 1,000 feet due to the availability of storage lanes, the travel times are very consistent regardless of the cross section (i.e. a four-lane bridge would basically have the same impact on traffic as a six-lane bridge).
- In the AM peak hour, travel times from Wells Street to Reedbird Avenue range between 3-4 minutes in the northbound and southbound directions under existing conditions. Under all of the bridge build alternatives, northbound travel times are approximately 12-14 minutes and southbound travel times are approximately 5-6 minutes.
- In the PM peak hour, travel times from Wells Street to Reedbird Avenue range between 3-4 minutes in the northbound and southbound directions under existing conditions. Under all of the bridge build alternatives, northbound travel times are approximately 22-23 minutes and southbound travel times are approximately 5-6 minutes.
- Removing the channelized right turns throughout the corridor is a safety improvement that has very little change in queues and travel times along the corridor.

HANOVER STREET CORRIDOR STUDY
Includes the Vietnam Veterans Memorial Bridge

Hanover Street Corridor Study
Figure 5-8: MTA Baltimore Link Routes Facilities and Ridership
December 2017

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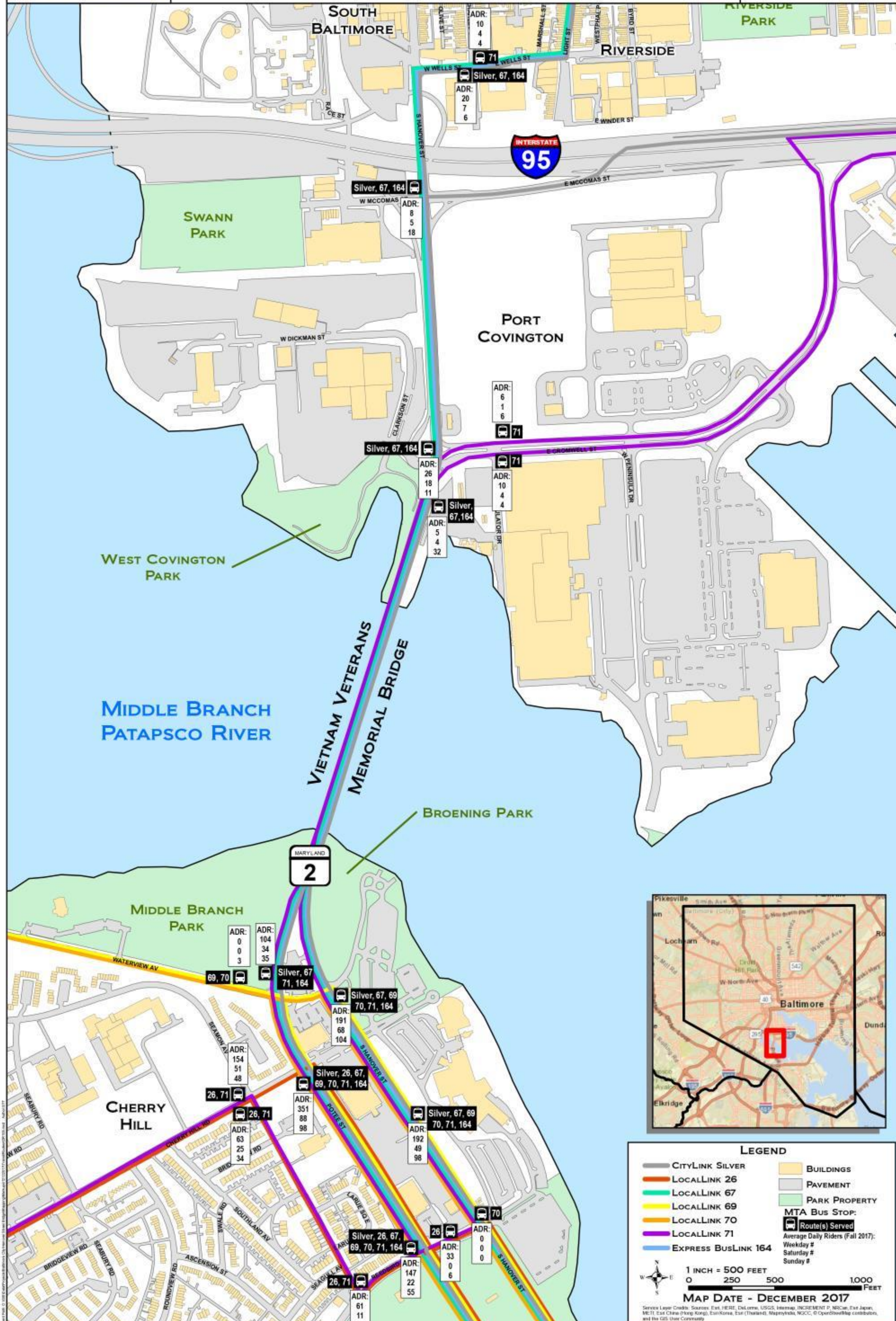
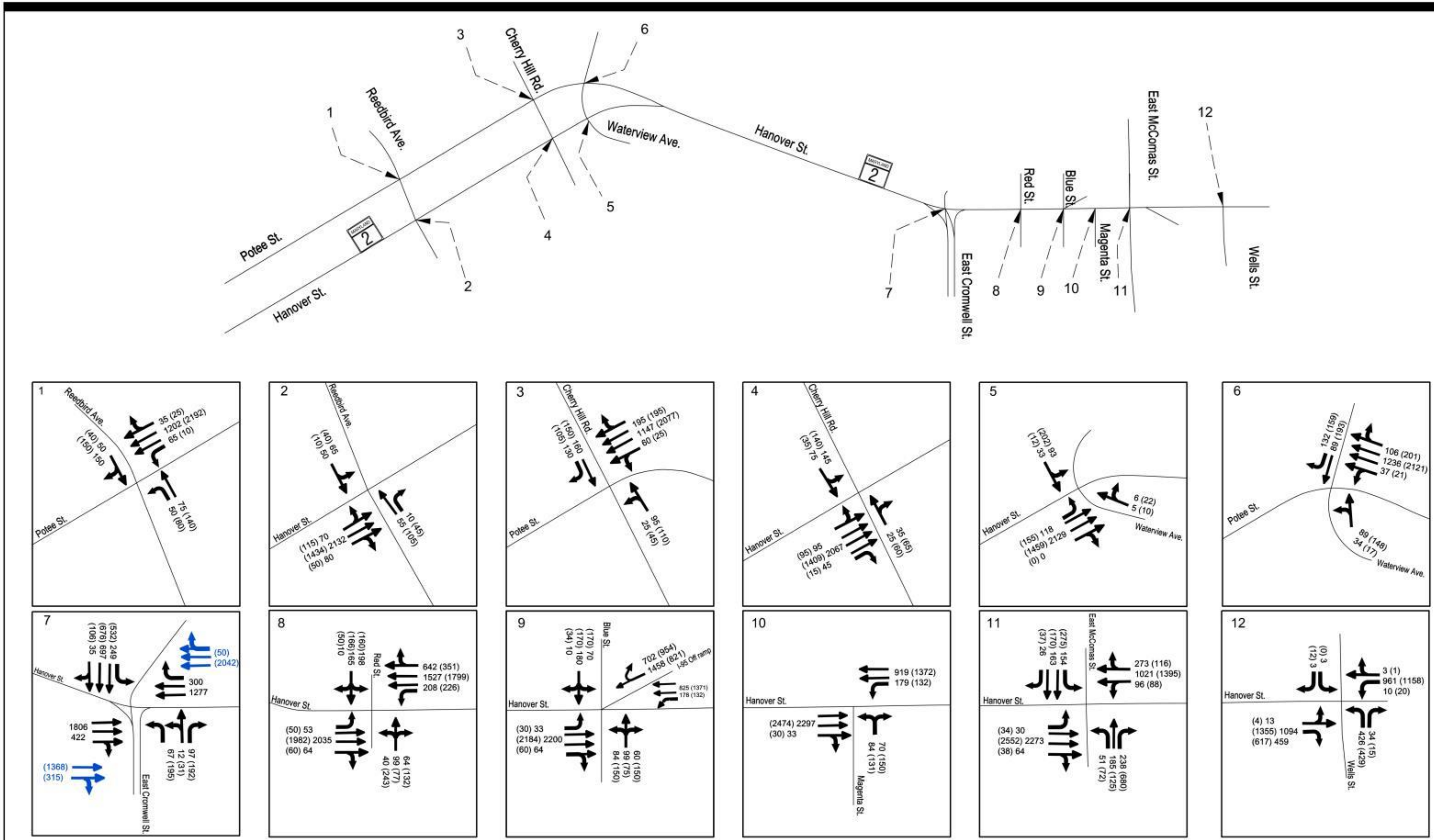
CATHERINE E. PUGH, MAYOR
dot DEPARTMENT OF TRANSPORTATION BALTIMORE CITY





HANOVER STREET CORRIDOR STUDY

Hanover Street Corridor Study
Figure 5-32: 2040 No-Build - Balanced Volumes

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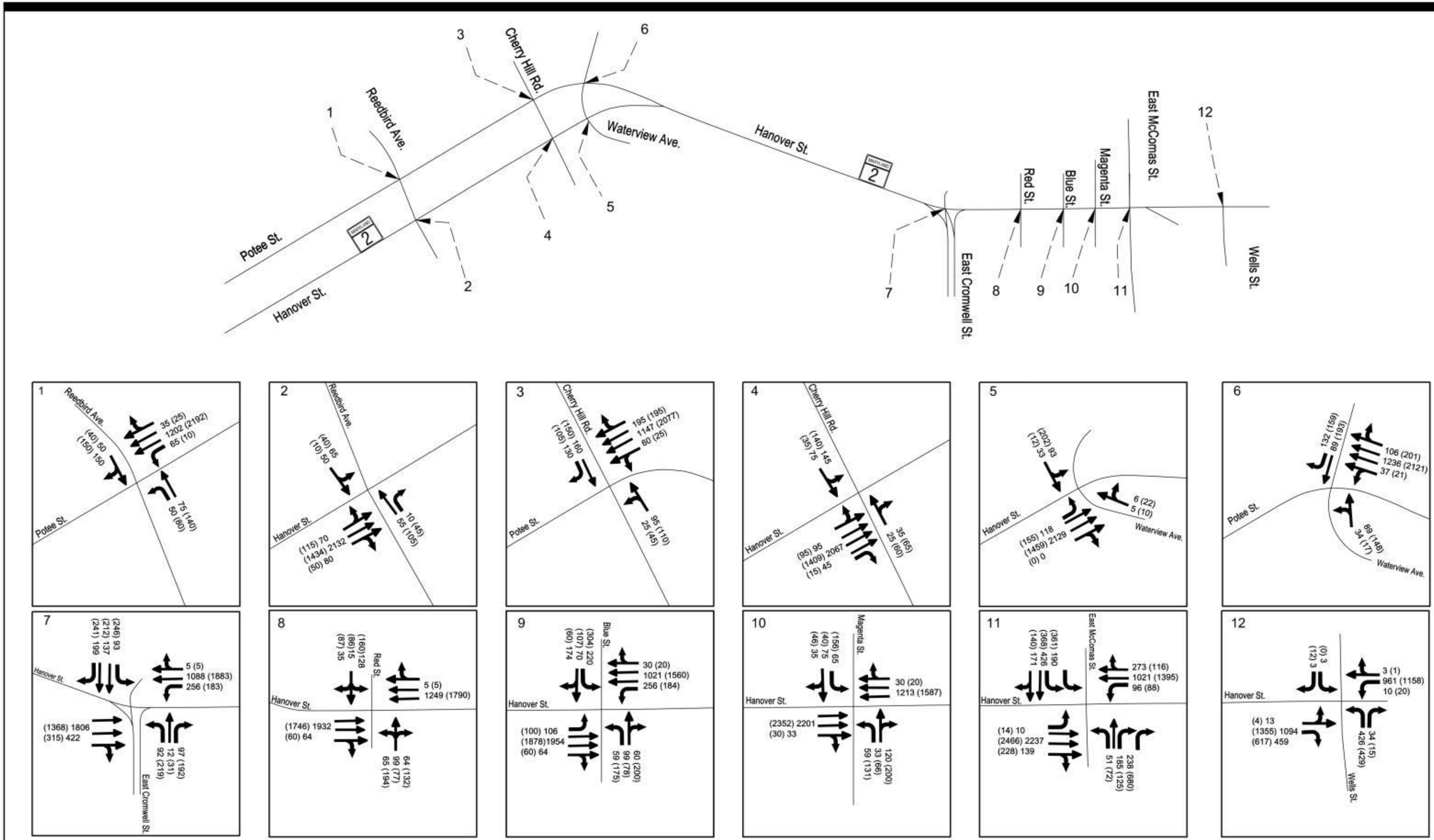
Legend
Lane Configurations
XX (XX) - AM (PM) Volumes

Hanover Street Corridor Study
Figure 5-33: Level of Service 2040 No-Build



HANOVER STREET CORRIDOR STUDY
Includes the Vietnam Veterans Memorial Bridge

Hanover Street Corridor Study
Figure 5-34: 2040 Build - Balanced Volumes

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Legend
Lane Configurations
XX (XX) - AM (PM) Volumes

Hanover Street Corridor Study
Figure 5-35: Level of Service 2040 Build

Hanover Street Corridor Study
Figure 5-42: Northbound Queue on Hanover St at Cromwell St
AM & PM 95th Percentile Queue Lengths