

# Concept Comparison and Metric Summary

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May 2023

[alexandriava.gov/DukeInMotion](https://alexandriava.gov/DukeInMotion)

# Corridor Concepts

Busway Concept A & B and Curb Concept Y & Z

# Busway Corridor Concept A: *Mostly Center-running & Mixed Traffic*



## •Segment 1:

- Center bus lanes in both directions

## •Segment 2A:

- Mixed traffic bus operations
- Avoids residential service roads for busway improvements

## •Segment 2B:

- Eastbound center bus lane, westbound mixed traffic
- Requires widening

## •Segment 3:

- Eastbound mixed traffic through Telegraph Road to balance traffic and bus operations
- Westbound center bus lane

# Corridor Concept B

## *Mostly Curb-running & Mixed Traffic*



### •Segment 1:

- Curb bus lanes
- Available roadway for busway

### •Segment 2A:

- Mixed traffic bus operations

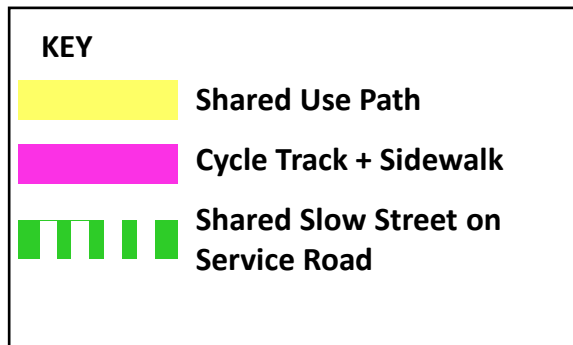
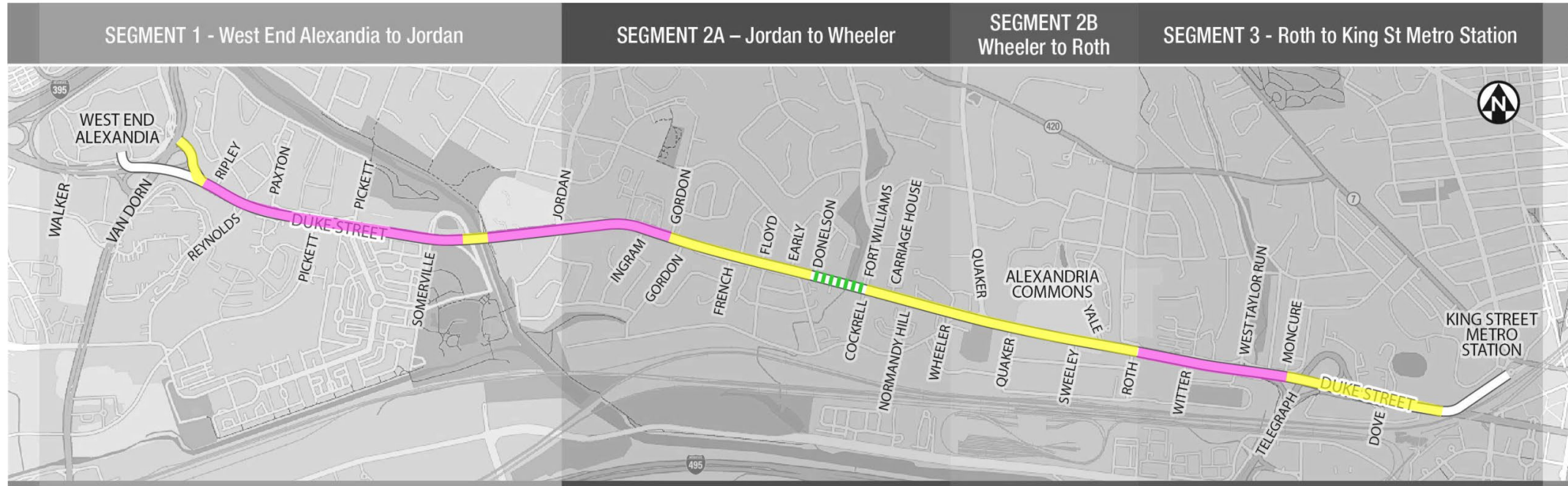
### •Segment 2B:

- Mixed traffic bus operations
- Avoid significant impacts at Alexandria Commons

### •Segment 3:

- Eastbound mixed traffic
- Westbound curb lane through Telegraph interchange
- Center bus lanes east of Telegraph to Diagonal

# Proposed Curb Concept Y (North Side of Duke Street)



Shared Use Path

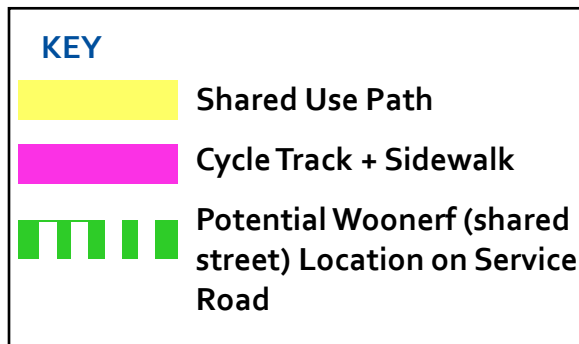
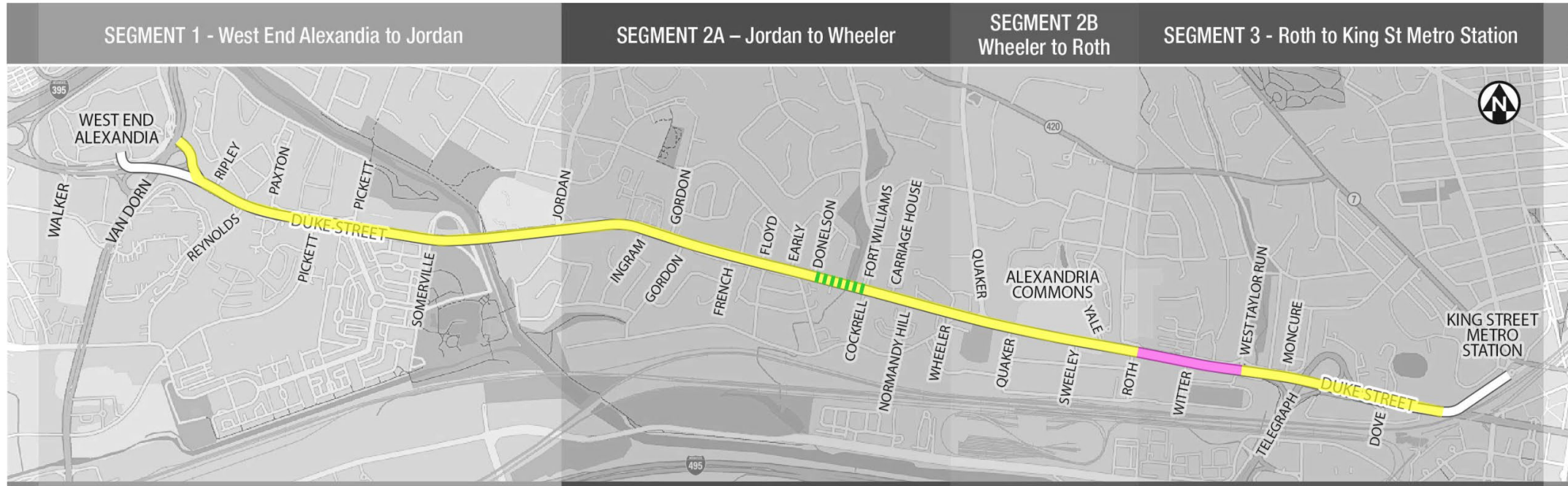


Two-Way Cycle Track



Cycle track locations reduce conflicts between pedestrians and cyclists

# Proposed Curb Concept Z (North Side of Duke Street)



Shared Use Path



Two-Way Cycle Track



Woonerf



More shared use path provides a greater opportunity to add green space

# Metric Comparison

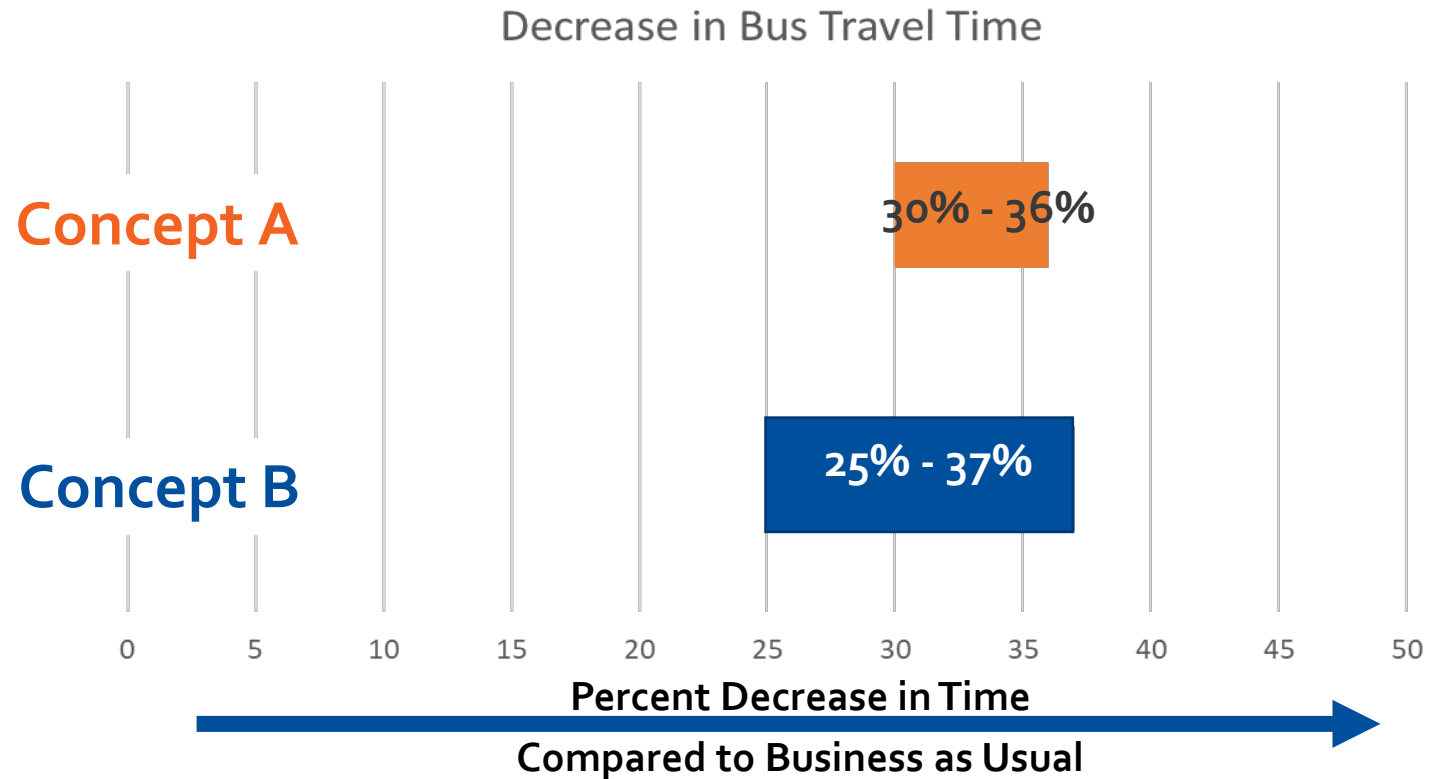
Busway Concept A-Curb Concept Y



# Efficient



## Travel Time (Bus - PM)



- Both concepts significantly improve bus travel times in the afternoon/evening rush hour
  - Afternoon/evening rush hour was determined to be the most challenging hour of the day based on initial traffic and bus data
  - Concept A improves a little more than Concept B, on average

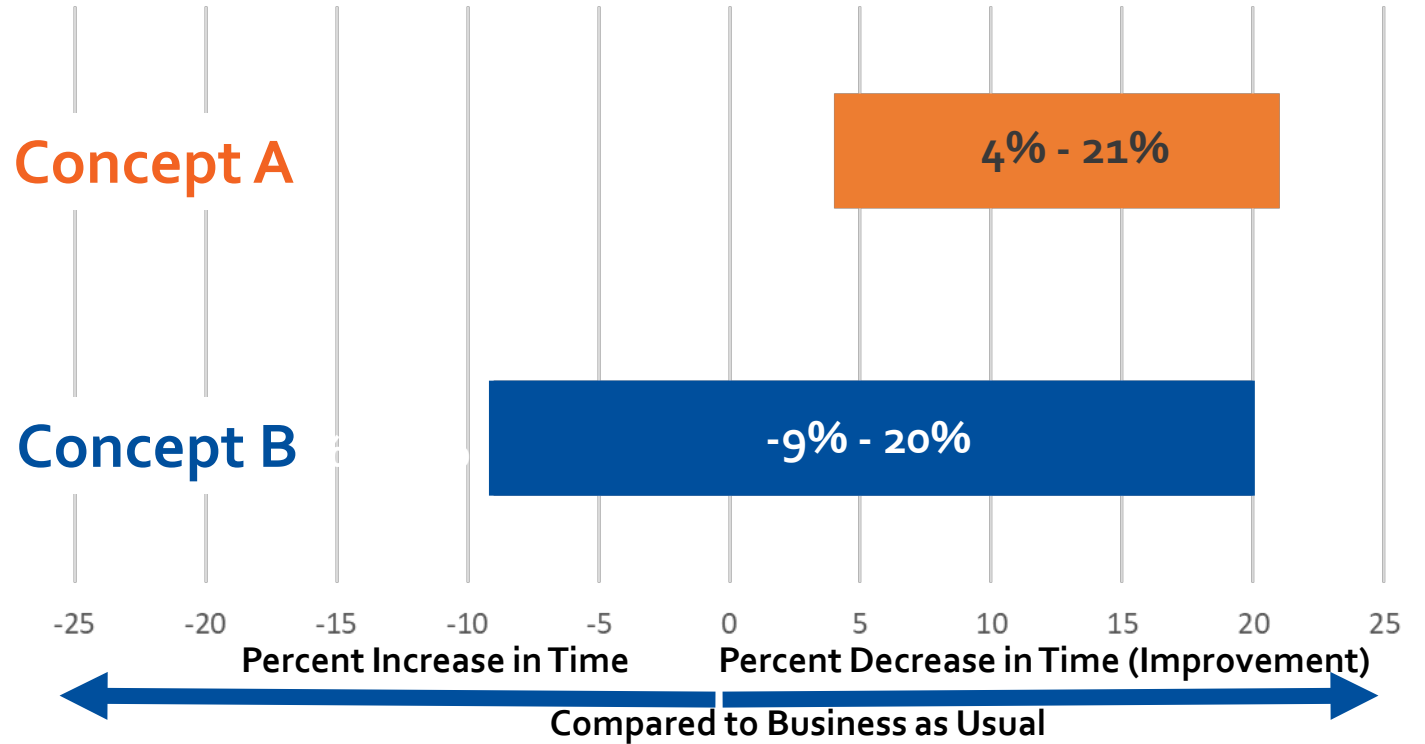


**Efficient**

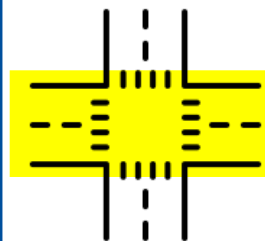


## Travel Time (Vehicular - PM)

Change in General Traffic Travel Time

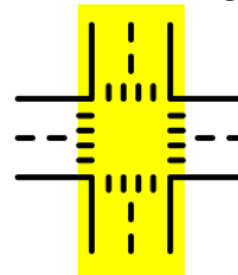


### Duke Street Delay



Delay decreases  
with increased  
green time

### Side Street Delay



Delay  
increases with  
bus and Duke  
Street priority



# Convenient



## Transit Reliability (Bus travel time variability)

### Concept A

Less than 1 minute variability

### Concept B

Less than 2 1/2 minute variability

- Both concepts are highly reliable & provide improvement
- Concept A is less variable (locations with center bus lanes)
- Concept B is more variable (locations with curb bus lanes/mixed)
- Modeling limitations may underestimate variability in Concept B



# Sustainable



## Alternative Modes / Travel Options (Ridership)

### Concept A

5,940 riders/day (210% increase)

### Concept B

5,770 riders/day (205% increase)

- Both concepts increase ridership significantly
  - Increase is primarily driven by faster, more reliable bus service
  - Other scenarios show similar percentage increase in ridership
- Zero-car household ridership more than doubles for both concepts
- Bus trips for households with cars increase, suggesting that some trips by car could be eliminated from Duke Street in the future



# Safe

Existing:

20 vehicle-pedestrian  
crashes from 2016 -2020



## Pedestrian Safety

### Concept A

29 refuge islands  
26 Protected Lefts

### Concept B

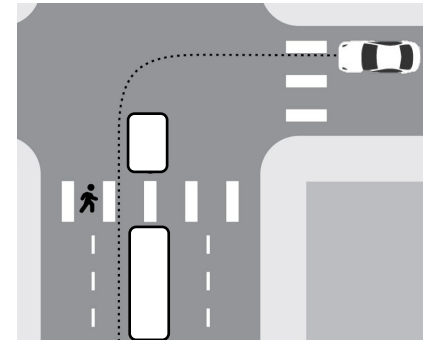
10 refuge islands  
6 Protected Lefts



#### Pedestrian Refuges

46%-56% reduction in  
pedestrian crashes

*FHWA*



#### Protected Lefts and Calming

Up to 18% reduction in  
pedestrian crashes

*VDOT*



# Safe

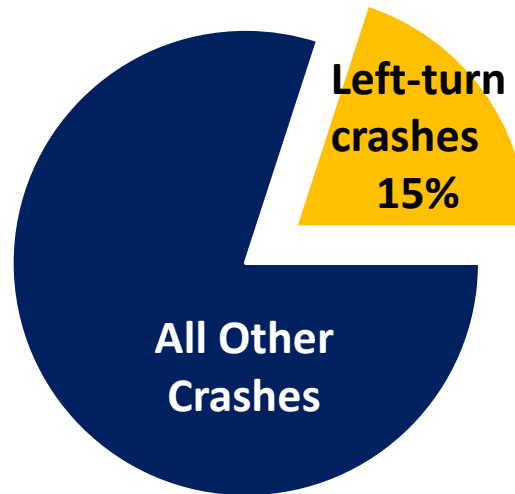
## Existing:

74 left-turn angle crashes  
at signalized intersections  
from 2016 -2020

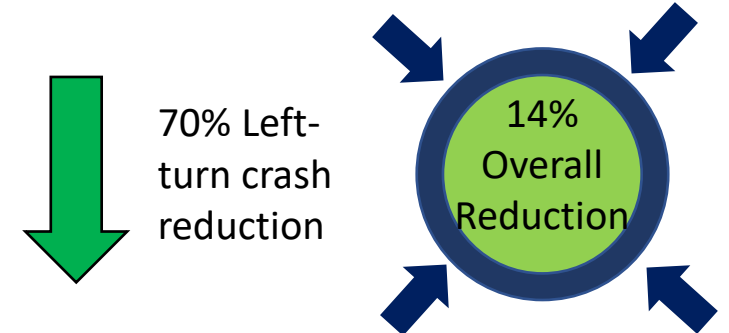


## Intersection Safety

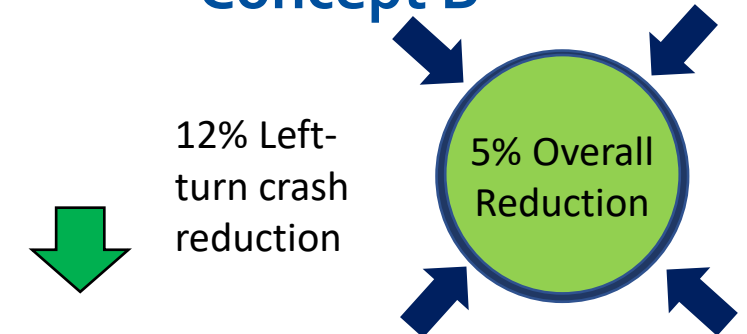
Duke Street Crashes



### Concept A



### Concept B



Protected left turns (which require a green arrow)  
reduce left-turn or angle crashes by 99%

*NCHRP Report 617*

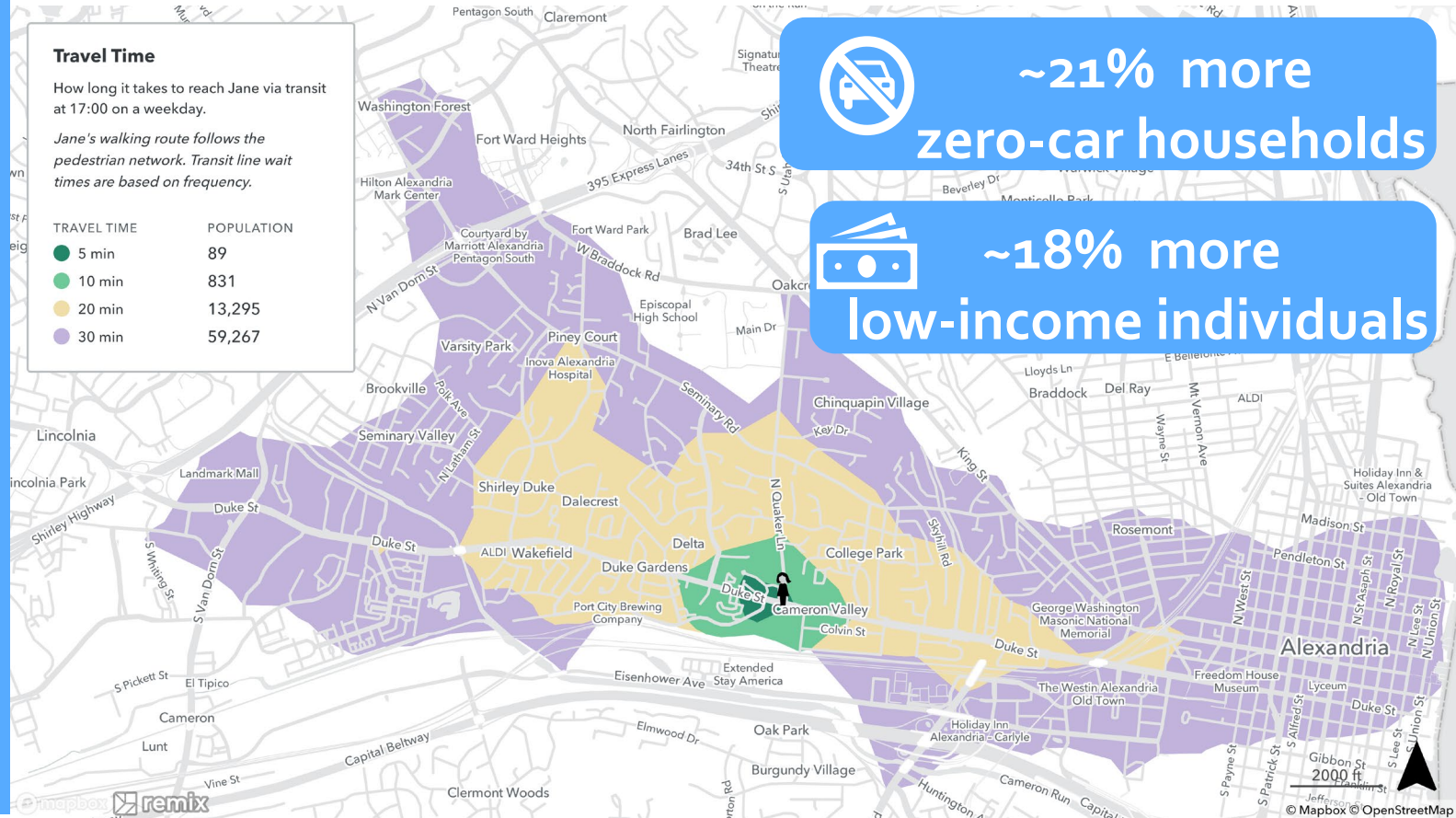


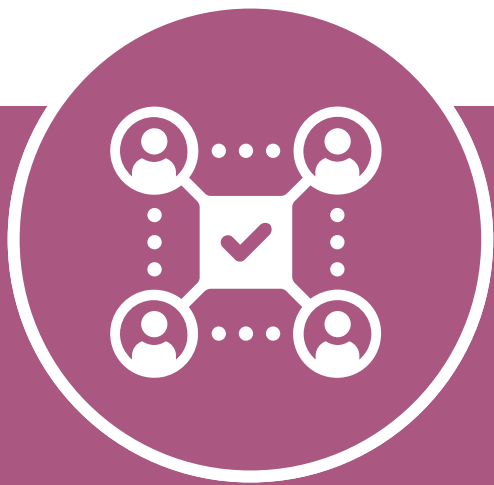
# Equitable



## Serving Low-Income and Zero-Car Households

Increased access to jobs within 30 minutes by transit from Alexandria Commons:





# Vibrant



## Improved Access (Access to Activity Centers)

- Access to activity centers within 30 minutes by transit, driven by faster bus service



~13% more residents within 30 minutes of **Alexandria Commons** by transit

# Travel Time Comparison

Busway Concept A-Curb Concept Y

# Transportation Modeling Overview

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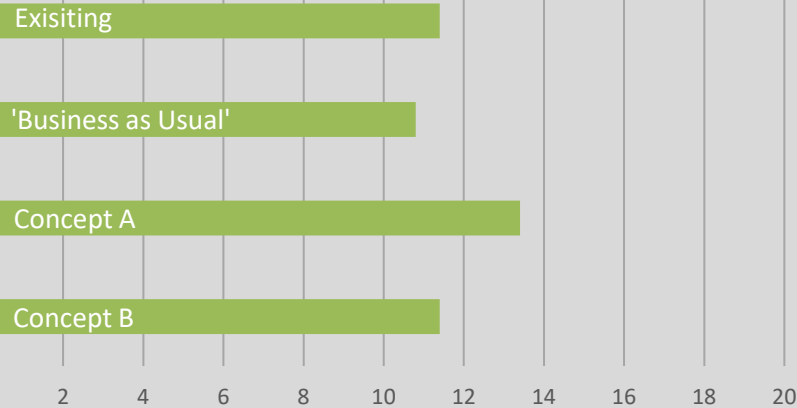
- The **PM peak period has more congestion** than the AM, which is why the project team focus on that metric.
- The findings from the analysis are informative to compare the concepts, but there are many factors that are not fully captured, such as:
  - **Change in vehicle route choice** given changing volumes on Duke Street and the surrounding region.
  - **Change in Duke Street volumes** that could be attributed to some trips being taken using the BRT instead of cars.
  - **Further improvements** that may be possible as we finalize the design
  - **Enforcement of bus lanes**
- Concept A and B are compared to a **2030 “business as usual” scenario**, which is what would happen if this project were not built, but **includes population growth and other funded projects**.
- Business as Usual is showing a 10% increase increase in volumes resulting in a 20-30% increase in travel times.
- More information on the model is available on p 22.

# Passenger Car Travel Times

AM

ENTIRE CORRIDOR TRAVEL TIME

WESTBOUND

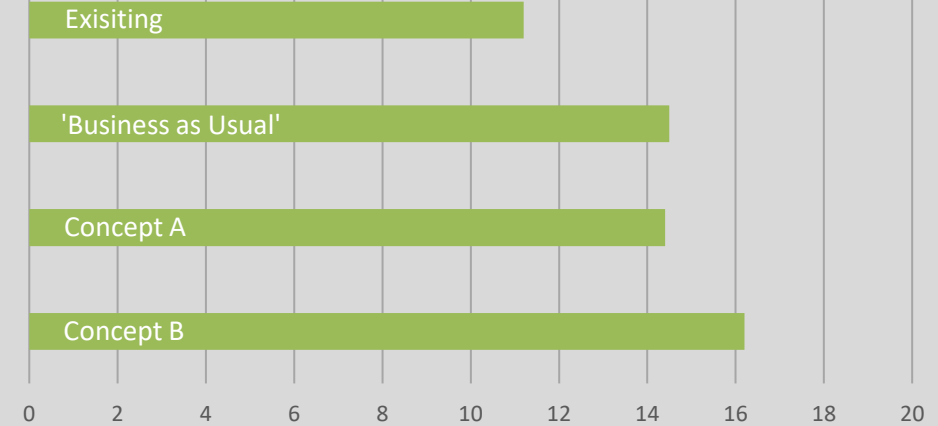


WESTBOUND



PM

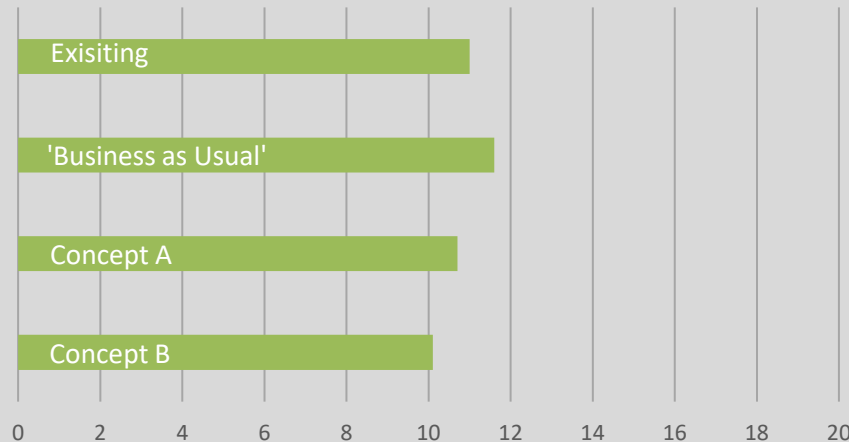
ENTIRE CORRIDOR TRAVEL TIME



AM

ENTIRE CORRIDOR TRAVEL TIME

EASTBOUND

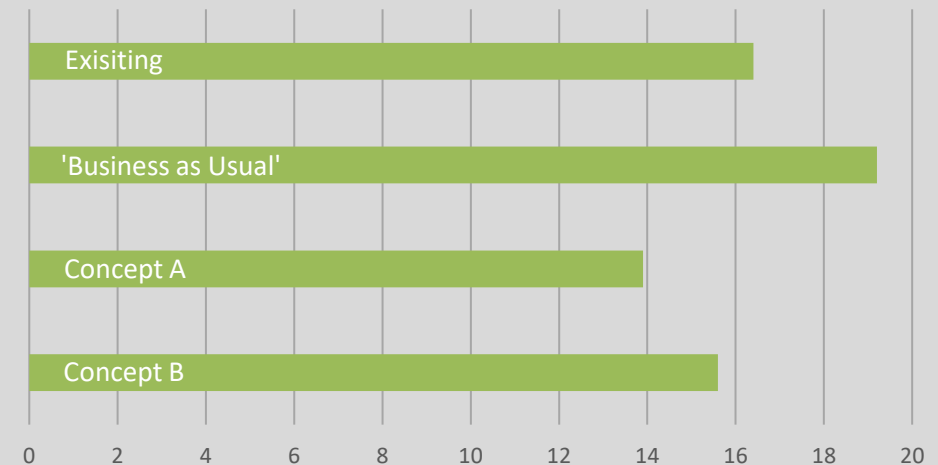


EASTBOUND



PM

ENTIRE CORRIDOR TRAVEL TIME



EASTBOUND

# Bus Travel Times

AM

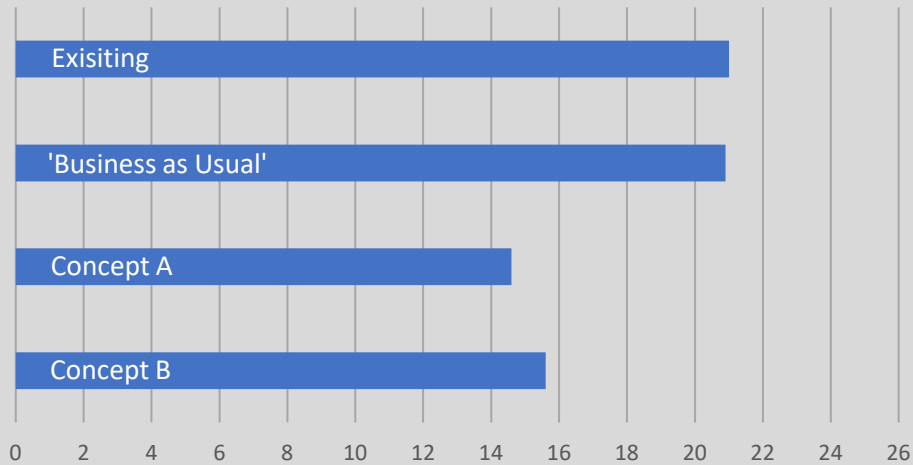
WESTBOUND



BUSES

TRAVEL TIME (MINS)

ENTIRE CORRIDOR



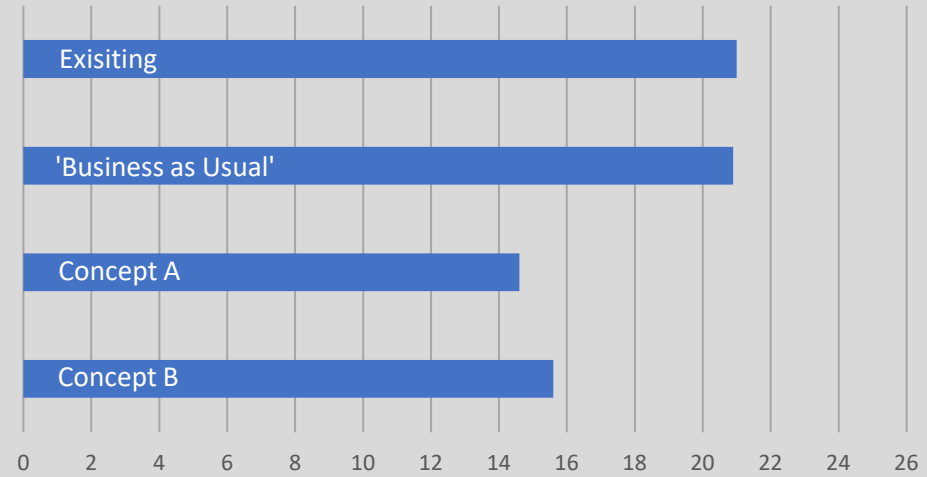
WESTBOUND



BUSES

TRAVEL TIME (MINS)

ENTIRE CORRIDOR TRAVEL TIME



PM

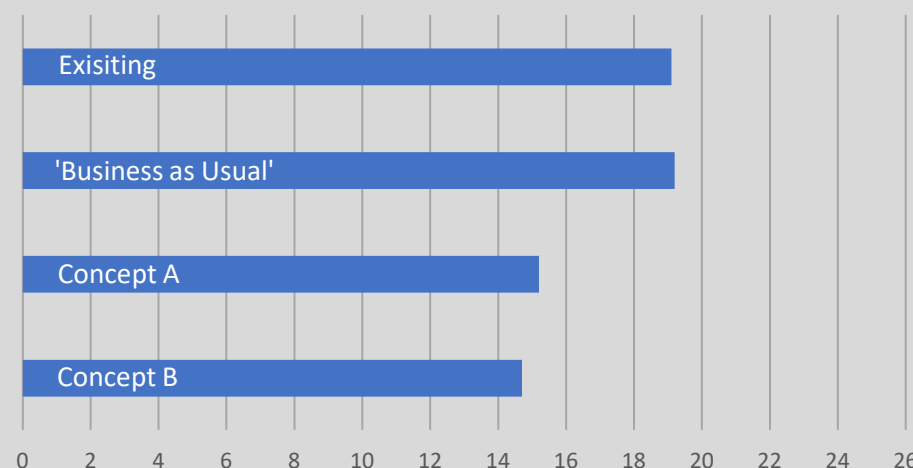
AM



BUSES

TRAVEL TIME (MINS)

ENTIRE CORRIDOR



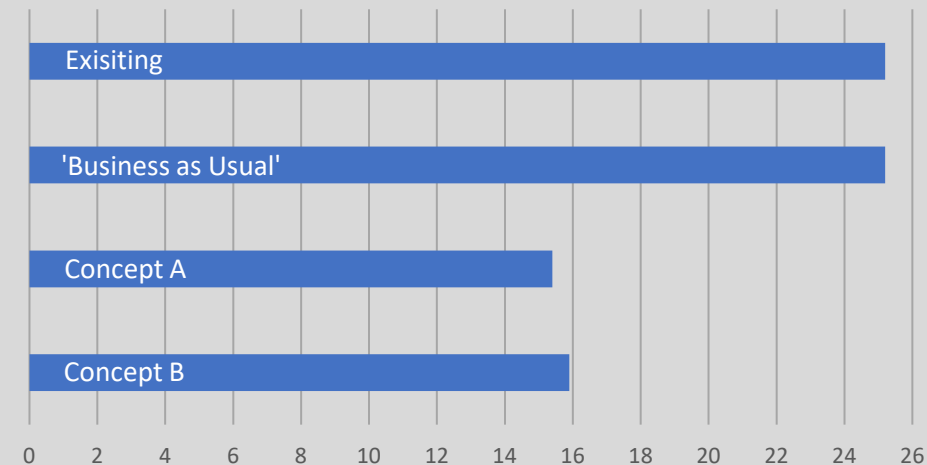
EASTBOUND



BUSES

TRAVEL TIME (MINS)

ENTIRE CORRIDOR TRAVEL TIME



PM

EASTBOUND

# Eastbound PM Peak Period Comparison

## Travel Time Model Results by Timepoint

| BUS TRAVEL TIMES       | Length (mi) | 2030 Business as Usual (min) | 2030 Concept A Travel Time Change (min) |   | 2030 Concept B Travel Time Change (min) |   |
|------------------------|-------------|------------------------------|-----------------------------------------|---|-----------------------------------------|---|
| Van Dorn to Jordan     | 1.1         | 13                           | - 7                                     | ● | - 7                                     | ● |
| Jordan to Quaker       | 1.1         | 5                            | - ½                                     | ● | - ½                                     | ● |
| Quaker to Callahan     | 1.3         | 7                            | - 1 ½                                   | ● | - 1 ½                                   | ● |
| <b>Eastbound TOTAL</b> | <b>3.6</b>  | <b>25</b>                    | <b>- 9 ½</b>                            | ● | <b>- 9</b>                              | ● |



**Travel Time Improvement\***  
**Compared to Business as Usual**



**Travel Time Deterioration\***  
**Compared to Business as Usual**

\*Totals and segment times rounded to the nearest ½ minute. Icon next to 0 change indicates directionality prior to rounding.

| PASSENGER CAR TRAVEL TIMES | Length (mi) | 2030 Business as Usual (min) | 2030 Concept A Travel Time Change (min) |   | 2030 Concept B Travel Time Change (min) |   |
|----------------------------|-------------|------------------------------|-----------------------------------------|---|-----------------------------------------|---|
| Van Dorn to Jordan         | 1.2         | 12                           | - 6                                     | ● | - 5                                     | ● |
| Jordan to Quaker           | 1.1         | 2 ½                          | ½                                       | ■ | 1                                       | ■ |
| Quaker to Callahan         | 0.5         | 4 ½                          | ½                                       | ■ | 1/2                                     | ■ |
| <b>Eastbound TOTAL</b>     | <b>3.6</b>  | <b>19 ½</b>                  | <b>- 5</b>                              | ● | <b>- 3 ½</b>                            | ● |

- Bus travel times improve by almost 40% for both.
- Vehicle travel times improve by almost 20%

# Westbound PM Peak Period Comparison

## Travel Time Model Results by Timepoint

| BUS TRAVEL TIMES       | Length (mi) | 2030 Business as Usual (min) | 2030 Concept A Travel Time Change (min) |                                                                                     | 2030 Concept B Travel Time Change (min) |                                                                                     |
|------------------------|-------------|------------------------------|-----------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------|-------------------------------------------------------------------------------------|
| Callahan to Quaker     | 1.3         | 10 ½                         | - 4                                     |  | - 3 ½                                   |  |
| Quaker to Jordan       | 1.1         | 6 ½                          | - 2                                     |  | - ½                                     |  |
| Jordan to Van Dorn     | .9          | 5 ½                          | 0                                       |  | -1 ½                                    |  |
| <b>Westbound TOTAL</b> | <b>3.6</b>  | <b>22 ½</b>                  | <b>- 6</b>                              |  | <b>- 5 ½</b>                            |  |



**Travel Time Improvement\***  
**Compared to Business as Usual**



**Travel Time Deterioration\***  
**Compared to Business as Usual**

\*Totals and segments rounded to the nearest ½ minute. Icon next to 0 change indicates directionality prior to rounding.

| PASSENGER CAR TRAVEL TIMES | Length (mi) | 2030 Business as Usual (min) | 2030 Concept A Travel Time Change (min) |                                                                                       | 2030 Concept B Travel Time Change (min) |                                                                                       |
|----------------------------|-------------|------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------|
| Callahan to Quaker         | 1.2         | 8                            | - 2 ½                                   |    | - 2 ½                                   |    |
| Quaker to Jordan           | 1.1         | 3                            | ½                                       |  | 2                                       |  |
| Jordan to Van Dorn         | 0.9         | 3 ½                          | 2                                       |  | 2                                       |  |
| <b>Westbound TOTAL</b>     | <b>3.6</b>  | <b>14 ½</b>                  | <b>0</b>                                |  | <b>1 ½</b>                              |  |

- Bus travel time improvement is about 1.5 min greater in Concept A.
- Vehicle travel times improve slightly in concept A and get about 10% worse in Concept B.

# Eastbound AM Peak Period Comparison

## Travel Time Model Results by Timepoint

| BUS TRAVEL TIMES       | Length (mi) | 2030 Business as Usual (min) | 2030 Concept A Travel Time Change (min) |   | 2030 Concept B Travel Time Change (min) |   |
|------------------------|-------------|------------------------------|-----------------------------------------|---|-----------------------------------------|---|
| Van Dorn to Jordan     | 1.2         | 7                            | -1 ½                                    | ● | -2                                      | ● |
| Jordan to Wheeler      | 1.1         | 6                            | -2                                      | ● | -2                                      | ● |
| Wheeler to Roth        | 0.5         | 3 ½                          | -½                                      | ● | - ½                                     | ● |
| Roth to Callahan       | 0.8         | 3                            | 0                                       | ● | 0                                       | ● |
| <b>Eastbound TOTAL</b> | <b>3.6</b>  | <b>19 ½</b>                  | <b>- 4</b>                              | ● | <b>- 4 ½</b>                            | ● |



**Travel Time Improvement\***  
**Compared to Business as Usual**



**Travel Time Deterioration\***  
**Compared to Business as Usual**

\*Totals and segments rounded to the nearest ½ minute. Icon next to 0 change indicates directionality prior to rounding.

| PASSENGER CAR TRAVEL TIMES | Length (mi) | 2030 Business as Usual (min) | 2030 Concept A Travel Time Change (min) |   | 2030 Concept B Travel Time Change (min) |   |
|----------------------------|-------------|------------------------------|-----------------------------------------|---|-----------------------------------------|---|
| Van Dorn to Jordan         | 1.2         | 4 ½                          | -½                                      | ● | -1 ½                                    | ● |
| Jordan to Wheeler          | 1.1         | 2 ½                          | 0                                       | ■ | 0                                       | ■ |
| Wheeler to Roth            | 0.5         | 2                            | -½                                      | ● | 0                                       | ● |
| Roth to Callahan           | 0.8         | 2 ½                          | ½                                       | ■ | 0                                       | ● |
| <b>Eastbound TOTAL</b>     | <b>3.6</b>  | <b>11 ½</b>                  | <b>-1 ½</b>                             | ● | <b>-1 ½</b>                             | ● |

- Bus travel time improvement is about 30 sec better in Concept B – more than 20% better for both.
- Vehicle travel times improve slightly more in Concept B, but improve in both.

# Westbound AM Peak Period Comparison

## Travel Time Model Results by Timepoint

| BUS TRAVEL TIMES       | Length (mi) | 2030 Business as Usual (min) | 2030 Concept A Travel Time Change (min) |                                                                                     | 2030 Concept B Travel Time Change (min) |                                                                                     |
|------------------------|-------------|------------------------------|-----------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------|-------------------------------------------------------------------------------------|
| Callahan to Roth       | 0.8         | 5                            | - 2                                     |  | -1                                      |  |
| Roth to Wheeler        | 0.5         | 4                            | - ½                                     |  | - ½                                     |  |
| Wheeler to Jordan      | 1.1         | 6                            | - 2 ½                                   |  | - 2                                     |  |
| Jordan to Van Dorn     | 1.2         | 5.5                          | -1 ½                                    |  | - 1 ½                                   |  |
| <b>Westbound TOTAL</b> | <b>3.6</b>  | <b>21</b>                    | <b>- 6 ½</b>                            |  | <b>- 5</b>                              |  |



**Travel Time Improvement\***  
Compared to Business as Usual



**Travel Time Deterioration\***  
Compared to Business as Usual

\*Totals and segments rounded to the nearest ½ minute. Icon next to 0 change indicates directionality prior to rounding.

| PASSENGER CAR TRAVEL TIMES | Length (mi) | 2030 Business as Usual (min) | 2030 Concept A Travel Time Change (min) |                                                                                       | 2030 Concept B Travel Time Change (min) |                                                                                       |
|----------------------------|-------------|------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------|
| Callahan to Roth           | 1.2         | 4                            | 1 ½                                     |    | - ½                                     |    |
| Roth to Wheeler            | 1.1         | 2                            | ½                                       |  | 0                                       |  |
| Wheeler to Jordan          | 0.5         | 3                            | 0                                       |  | ½                                       |  |
| Jordan to Van Dorn         | 0.8         | 2                            | ½                                       |  | ½                                       |  |
| <b>Westbound TOTAL</b>     | <b>3.6</b>  | <b>11</b>                    | <b>2 ½</b>                              |  | <b>½</b>                                |  |

- Bus travel time improvement is about 1 min. better in Concept A.
- Vehicle travel times get worse in both, but are worse in Concept A.
- Overall travel times are still several minutes better than PM.

# Round Trip Travel Time Examples

If you commute during the **AM peak** and **return during the PM peak**, you save...

## West End to Old Town



2 min (Concept A)  
0 min (Concept B)



11 min (Concept A)  
10 min (Concept B)

## Old Town to West End



1.5 min (Concept A)  
3.5 min (Concept B)



16 min (Concept A)  
15 min (Concept B)

## Jordan/Fox Chase to Old Town



2.5 min (Concept A)  
0.5 min (Concept B)



9 min (Concept A)  
6 min (Concept B)

## Old Town to Jordan/Fox Chase



- 3.5 min (Concept A)  
1.5 min (Concept B)



8 min (Concept A)  
6.5 min (Concept B)

## **MODEL ASSUMPTIONS**

### **Volumes**

- Turning movement counts from 2018
- Supplemented by more recent data
- '2018' volumes converted to '2030' volumes by:
  - Adding traffic from developments (e.g. Landmark Mall)
  - Adding general traffic from regional growth based on historical data points
- If anything, the 2030 volumes are conservative since the base year of 2018 assumes pre-pandemic traffic volume and patterns, and because the model does not consider whether drivers would change their route decision making in the future.

### **Transit Stops**

- Dwell times based on historic data, varied by major, minor, and BRT stops
- Bus stops along Duke Street consolidated (from about 20 per direction to 8)

### **Geometry changes (in all models, including No Build)**

- West Taylor Run area proposed changes
  - Southbound vehicles on West Taylor Run Parkway prevented from accessing eastbound ramp to Telegraph Road (matches current pilot project conditions)
  - Added WB slip lane from Duke Street onto service road
  - Reconfiguration of ramp connections between eastbound Duke Street and Telegraph Road
- Landmark Mall redevelopment proposed changes
  - 2 new intersections along Duke Street
  - New traffic signal at I-395 northbound off-ramp
  - Reconfiguration of ramp connections between Duke Street and Van Dorn Street

### **Signal Operations (general)**

- While the 'Business as Usual' (i.e., the No Build) model shows signal timing improvements from today, the models for the two concepts have more refined signal timing plans. The concepts reflect how a corridor with BRT would be operated differently than without BRT, with priority given to the bus lanes/through traffic at the expense of the side streets. Hence, some of the travel time gains from the Concept models are due to this operational difference, and not inherently due to the infrastructure changes themselves.

## **GENERAL TALKING POINTS**

### **Traffic Patterns**

- The Duke Street corridor doesn't have traditional traffic volume patterns – there are many intersections with heavy turning volumes for some movements but minimal turning volume for other movements. This is due to a lack of options for drivers, with some roads leading nowhere, and a few roads being the only connections to certain destinations. For example, there are only two ways along the corridor to go south, Telegraph Road and Van Dorn Street, and these types of restrictions lead to funneling of traffic to certain points/junctions. The high amount of turns at several intersections in the corridor dictates overall congestion more than the number of vehicles travelling straight through the corridor.
  - Importantly, this is why we are able to reduce the number of travel lanes without major negative impacts to travel time on Duke Street.
  - This is also why the difference in the model results comes down to how turns are handled at intersections

### **Center Running Operations**

- The center running bus lanes have different types of signal operations:
  - For most intersections, left turns are only permitted under a 'green arrow', and not a combination of 'green arrow' and 'green ball' (or flashing yellow arrow) left turns like they are today. This means that some more time needs to be dedicated to left turns compared to through traffic, which increases travel time for cars and buses in the corridor.
  - The center running lanes allow for two-staged pedestrian crossings (where peds would get a walk signal to get to the median, then wait a little bit to get another walk signal to finish crossing the street). This allows for some more efficient signal timings at certain intersections.
  - The center running lanes can require special accommodations where they start and stop to help get buses in and out of them. The intersections that have these accommodations need to dedicate some traffic signal time to them, thus reducing overall efficiency handling traffic in general.

### **Curb Running Operations**

- The Curb running lanes can handle large volumes of right turns better, since those right turns can use the curb bus-only lanes.
- Generally, curb running lanes handle intersections with larger turns from Duke Street better (since right turns can use the bus lane, and they can use both 'green arrow' and 'green ball' types of left turns). While center running can handle intersections where side streets have large amounts of turning traffic better since they can use two-stage ped crossings.



**GOROVE SLADE**  
Transportation Planners and Engineers



## **Duke Street in Motion – Model Assumptions & Talking Points**

### **DETAILED MODELING TALKING POINTS**

#### **West end of transitway (Reynolds Street/Ripley Street):**

- VISSIM modeling was helpful in determining the optimal placement of the start and end points of the bus lanes in the vicinity of Van Dorn Street
- Modeling team went through multiple design iterations which balanced ease of movement for buses with limited delay for passenger vehicles.

#### **Cambridge Road:**

- Build concepts include improvements to the Cambridge Road intersection which reduce conflict between movements and improve operations.
- This is a complicated area with interactions between Duke Street, Cambridge Road, and the service road and differing volume patterns throughout the day (i.e., school traffic in AM peak)

#### **W Taylor Run Parkway:**

- Currently proposed background improvements near the W Taylor Run Parkway intersection would integrate well with the transitway.
- Improvements foster better multimodal connections, reduce potential conflicts, and improve traffic flow for the bus lanes if implemented.

### **MODEL LIMITATIONS**

- The model is unable to factor in poor driver behavior like blocking of the bus lane or double-parking
- The model does not consider how drivers may choose to alter their routes in the future. For example, drivers may seek an alternate path for their commute in the future based on traffic congestion or reliability of travel time on the Duke Street corridor.
- The model does not consider any shifts in travel modes with the transitway improvements.



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Transportation Planners and Engineers



## **Duke Street in Motion – Model Assumptions & Talking Points**