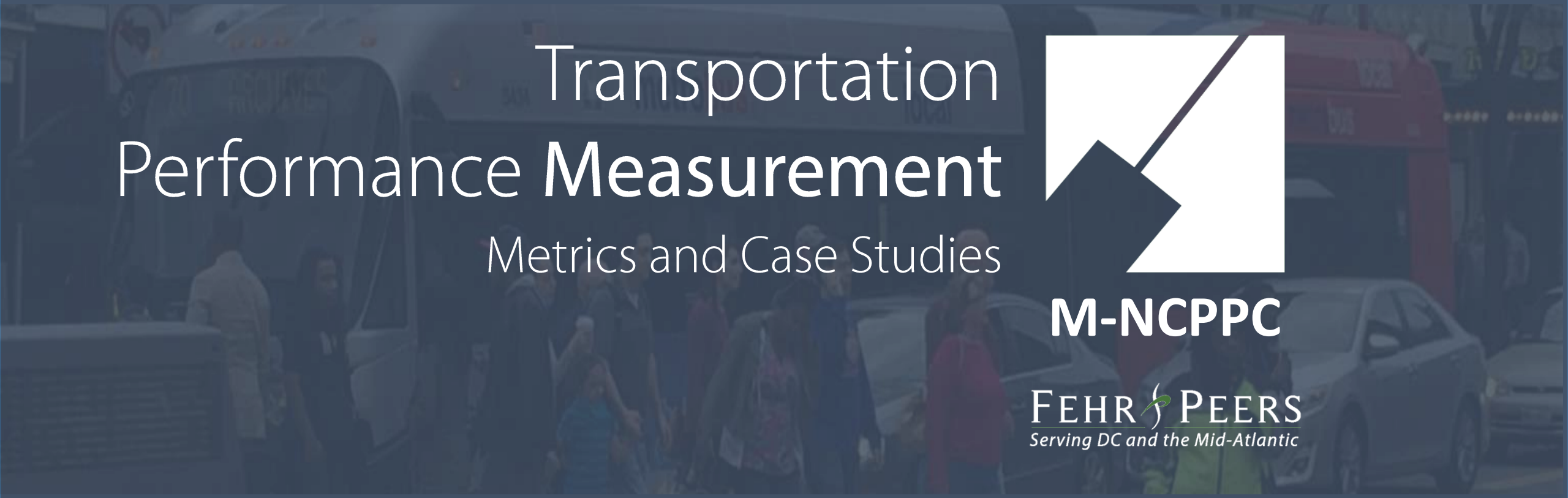


Transportation Performance **Measurement**

Metrics and Case Studies

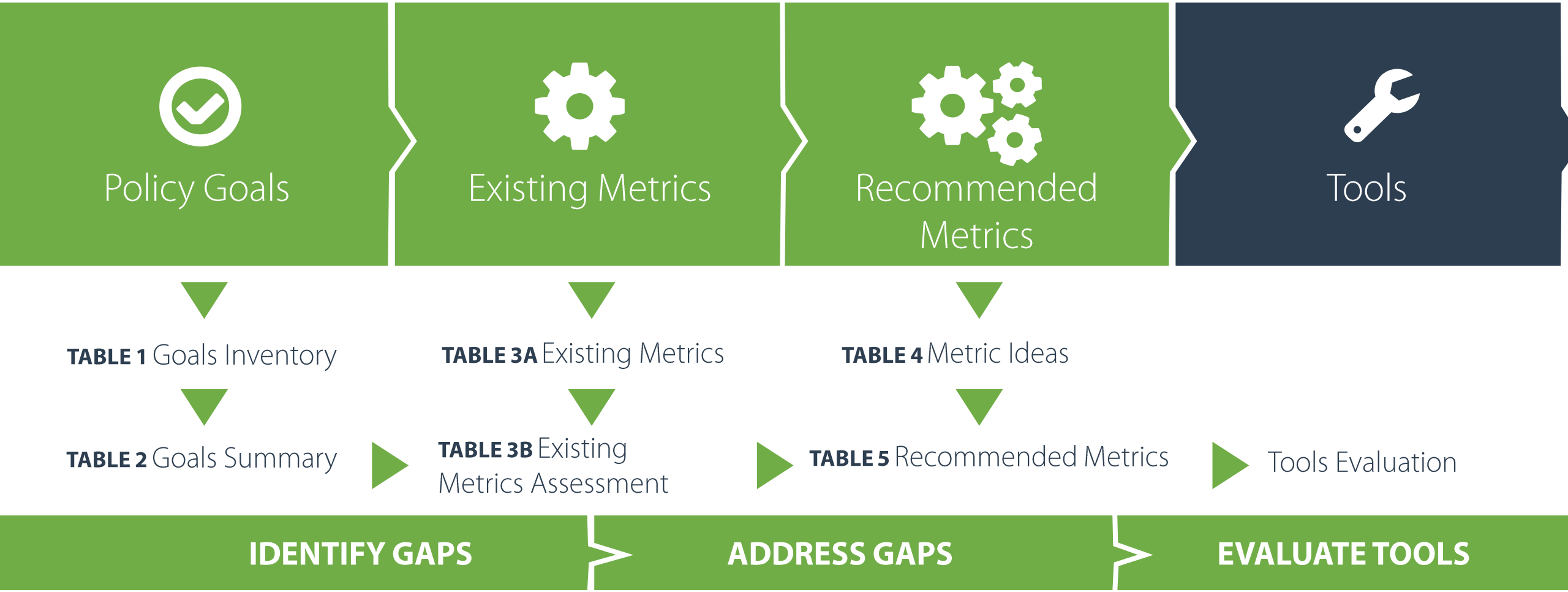
M-NCPPC

FEHR & PEERS
Serving DC and the Mid-Atlantic

Agenda

- STUDY PROCESS
- POLICY GOALS
- EXISTING METRICS
- RECOMMENDED METRICS
- CASE STUDIES
- NEXT STEPS
- QUESTIONS

Study Process

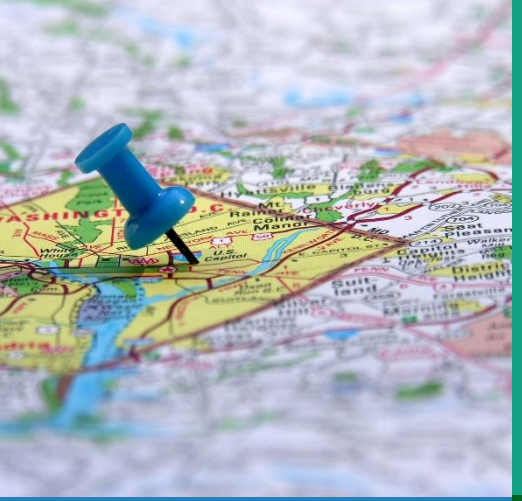


Overarching Transportation Policy Statement

To enhance mobility while providing a safe and efficient transportation system offering a wide range of alternatives.

To serve the needs of the County, which are environmental, economic, social, and land use.

To provide a framework for development.



NETWORK

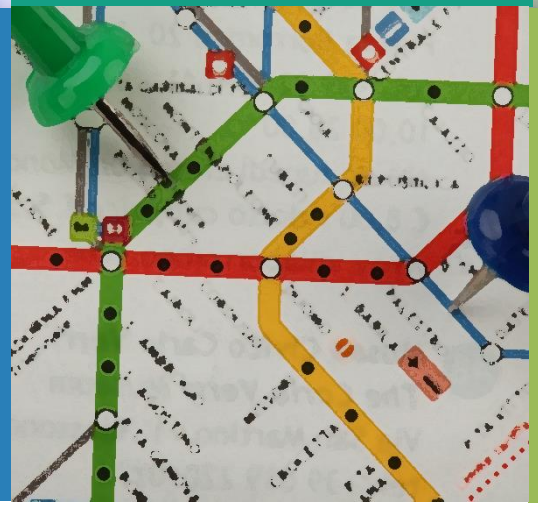
"provides choices in mode and routes of travel"

USAGE

"Encourage non-auto travel"

LAND USE

Mix of uses and densities consistent with "Wedges and Corridors"



FUNCTION/QUALITY

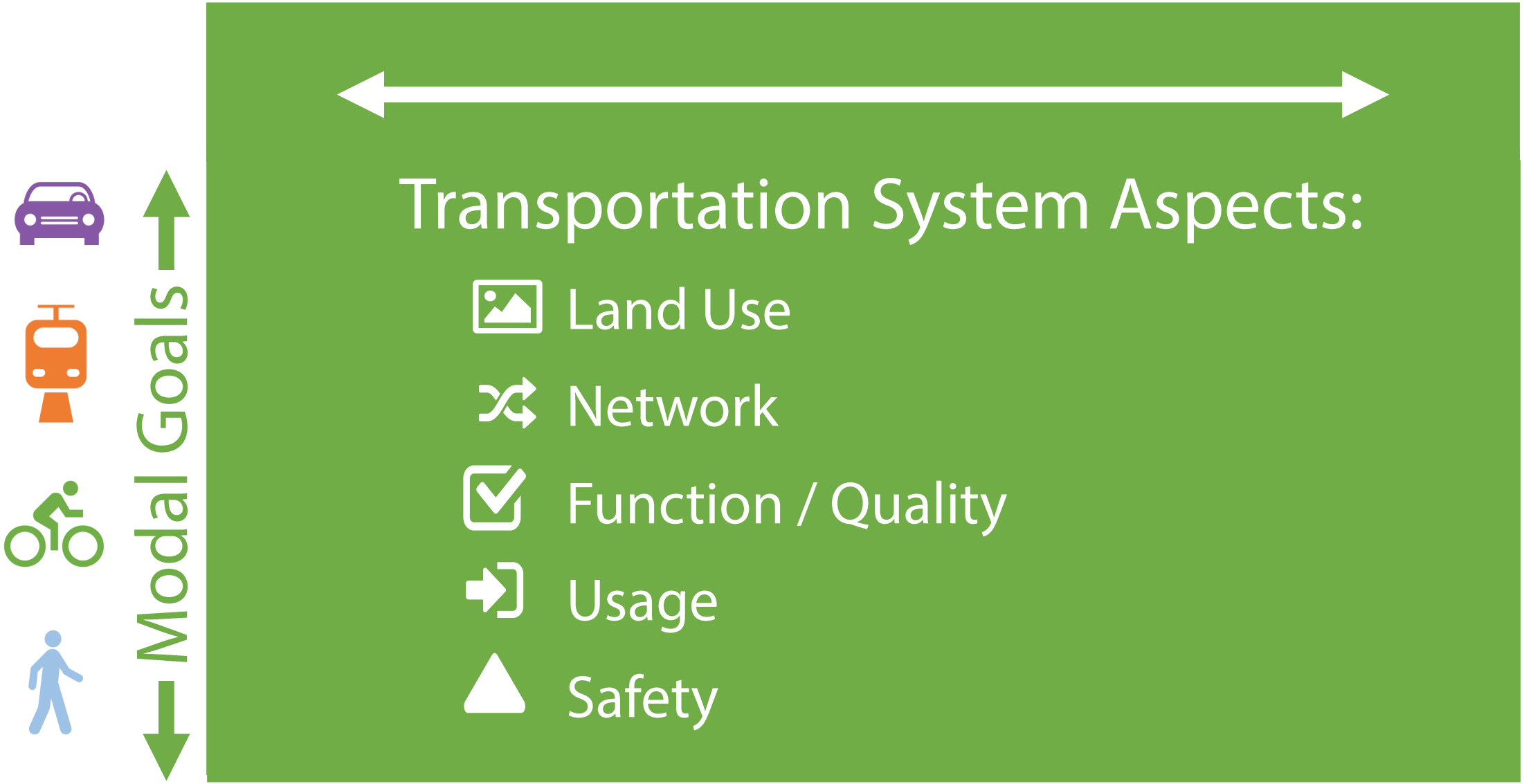
Reduce delays without "eroding quality of life"

SAFETY

"Maximize safety"

TABLE 2

Summary of Montgomery County Transportation Goals



Modal Goals

	Land Use	Network	Function/Quality	Usage	Safety
	Concentrate Development Encourage Transit-Oriented Development Opportunities Provide Mixed Uses	Expand Street Network	Improve Efficiency/Capacity	Increase Carpool	Improve Safety
		Viable Alternative to Driving Alone Improve Connectivity and Access Implement Bus Rapid Transit	Maximize Person Throughput	Increase Transit Use Increase Non-Auto Mode Share	
		Safe, Direct, and Convenient Improve Connectivity	Comfortable Facilities	Increase Non-Auto Mode Share	
		Variety of Skill Levels	Comfortable Facilities Improve Access for People with Disabilities	Increase Non-Auto Mode Share	

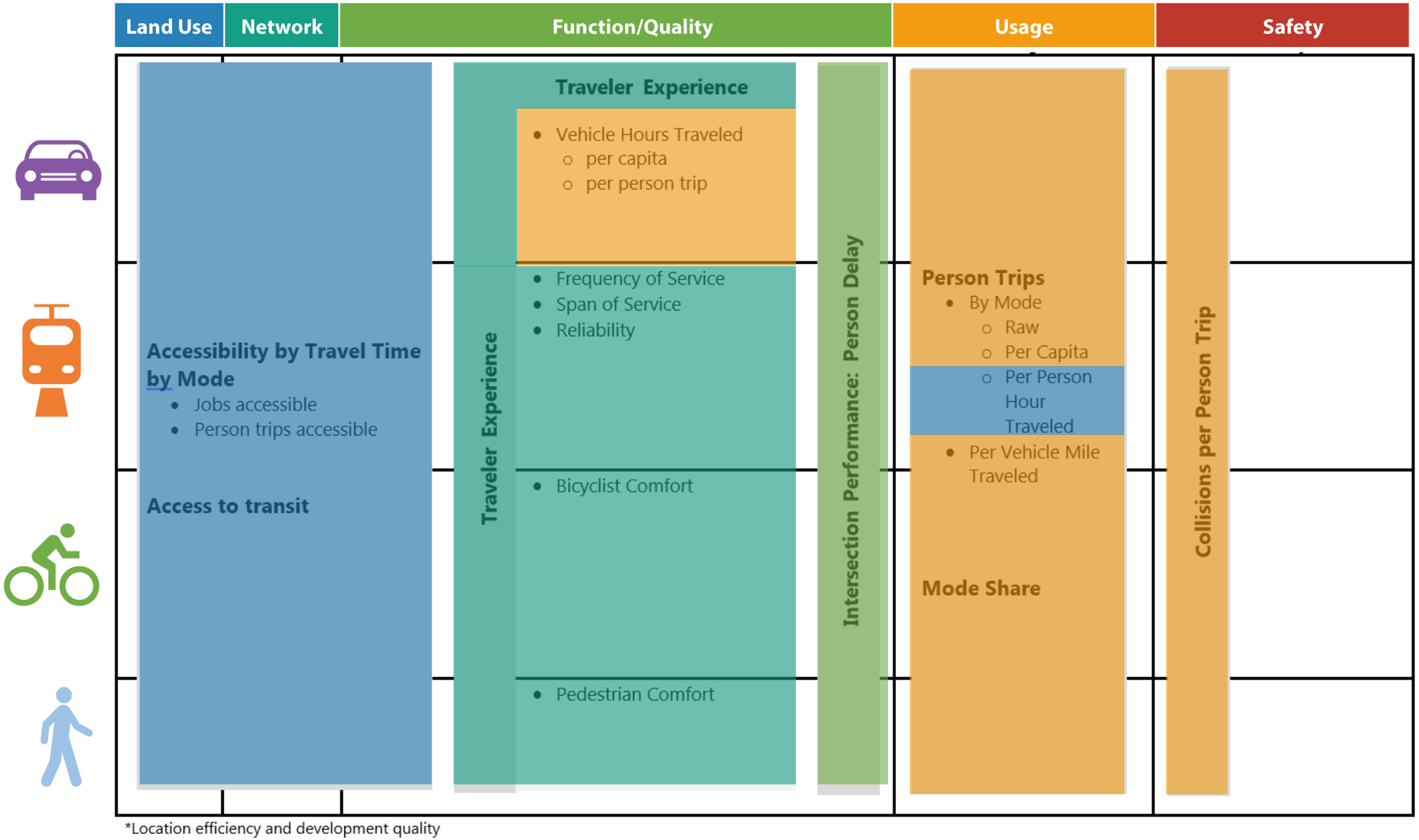
Existing Metrics Assessment

Applicability to Goals: **Good** **Fair** **Poor**

	Land Use	Network	Function/Quality	Usage	Safety
	Varied Auto Performance Standards by Area	None	Congested Speeds Travel Time Index Highway Capacity Manual Level of Service Critical Lane Volume	Counts Non-Auto Driver Mode Share Vehicle Miles Traveled	None
	None	Coverage	Peak Headway All-Day Headways Span of Service	Ridership Non-Auto Driver Mode Share	
		Facility Inventory		Counts Non-Auto Driver Mode Share	
					

TABLE 5

Transportation Metric Recommendations



*Location efficiency and development quality

Summary of Recommended Metrics

01 ACCESSIBILITY

- Jobs Accessible within 45 minutes by Mode
- Person Trips Accessible within 45 minutes by Mode
- Jobs Accessible by Travel Time by Mode
- Person Trips Accessible by Travel Time by Mode
- Person Trip Duration by Mode
- Access to Transit by Mode

02 TRAVELER EXPERIENCE

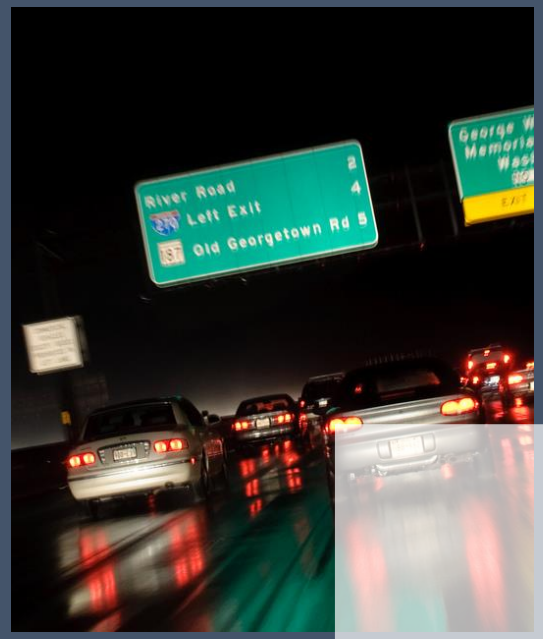
- Frequency of Service
- Span of Service
- Reliability
- Bicyclist Comfort
- Pedestrian Comfort

03 INTERSECTION PERFORMANCE

- Person Delay

04 ACTIVITY

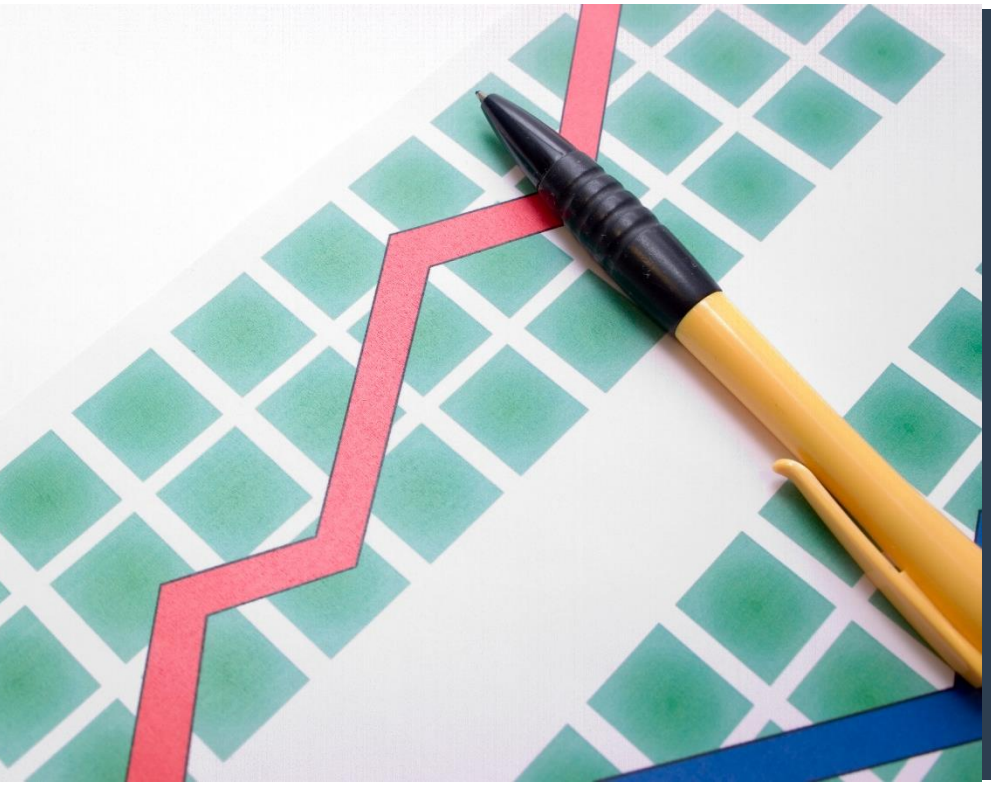
- Raw Person Trips by Mode
- Person Trips Per Capita by Mode
- Vehicle Miles of Travel per Person Trip
- Vehicle Hours of Travel per Person Trip
- Person Trips per Collision


River Road
Left Exit
Old Georgetown Rd S


9:30 TO 3:00


PUSH
BUTTON
FOR
R62DL5

Case Study Objectives

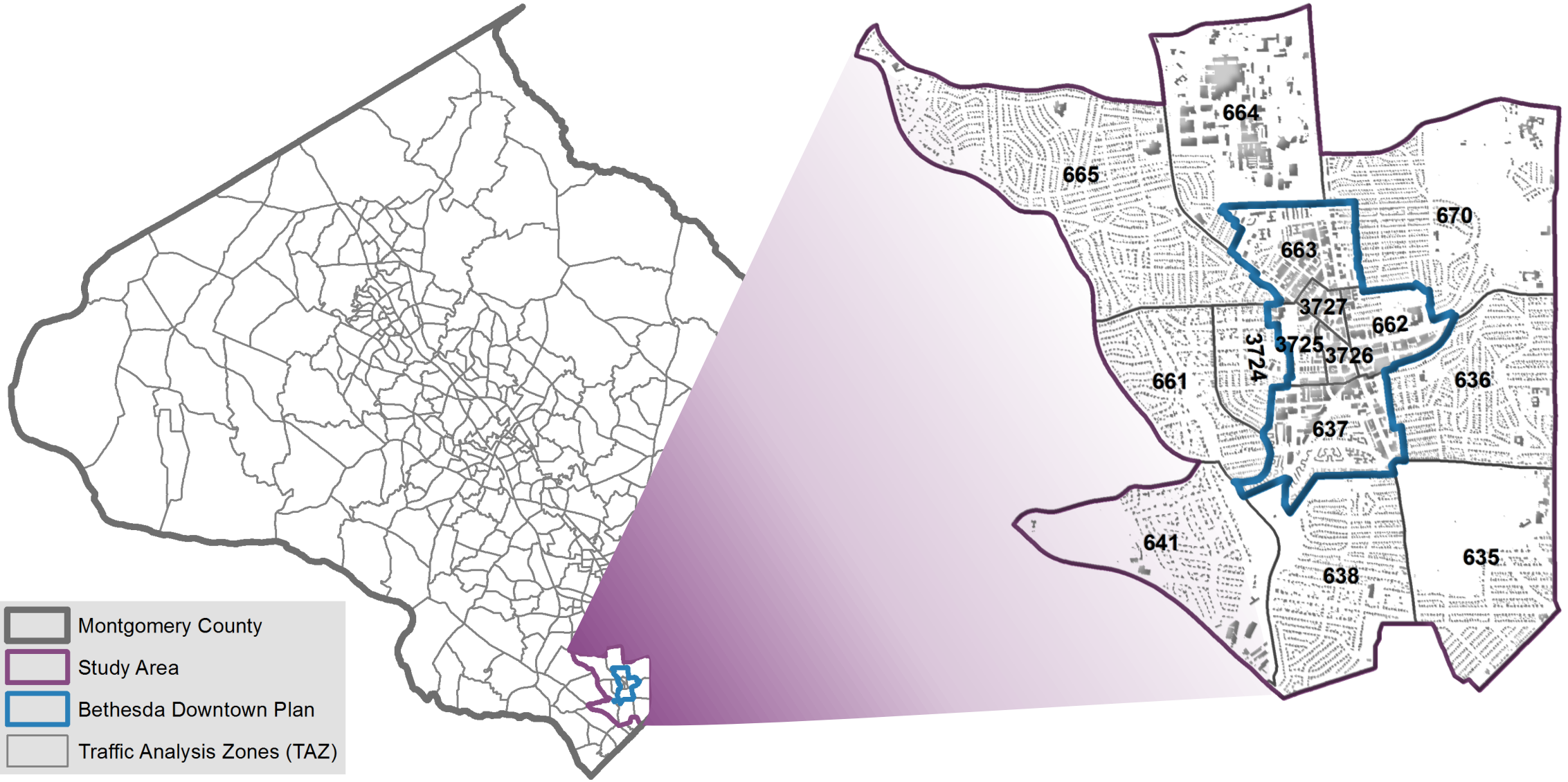


Test the metrics in a specific sector plan setting to ensure applicability and identify gaps in data and tools

Provide a "recipe" in a form that's digestible for the Board and Staff:

- What is the metric?
- Why are we interested?
- What data and tools are needed?
- How is it calculated?
- What is the output?

Study Area


Montgomery County
Study Area
Bethesda Downtown Plan
Traffic Analysis Zones (TAZ)
664
665
670
663
3727
662
3725
3726
3724
661
636
637
641
635
638

Base and Project Scenarios

2040 BASE

2040 Land Use

Existing Transportation Infrastructure

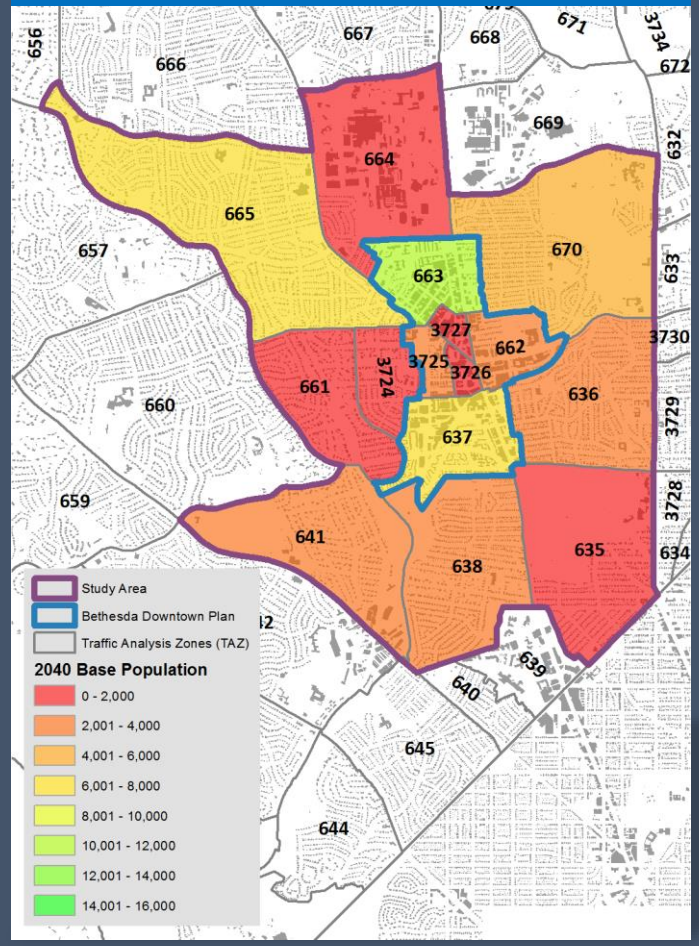
2040 PROJECT

2040 Land Use
(EXCEPT in Downtown Bethesda)

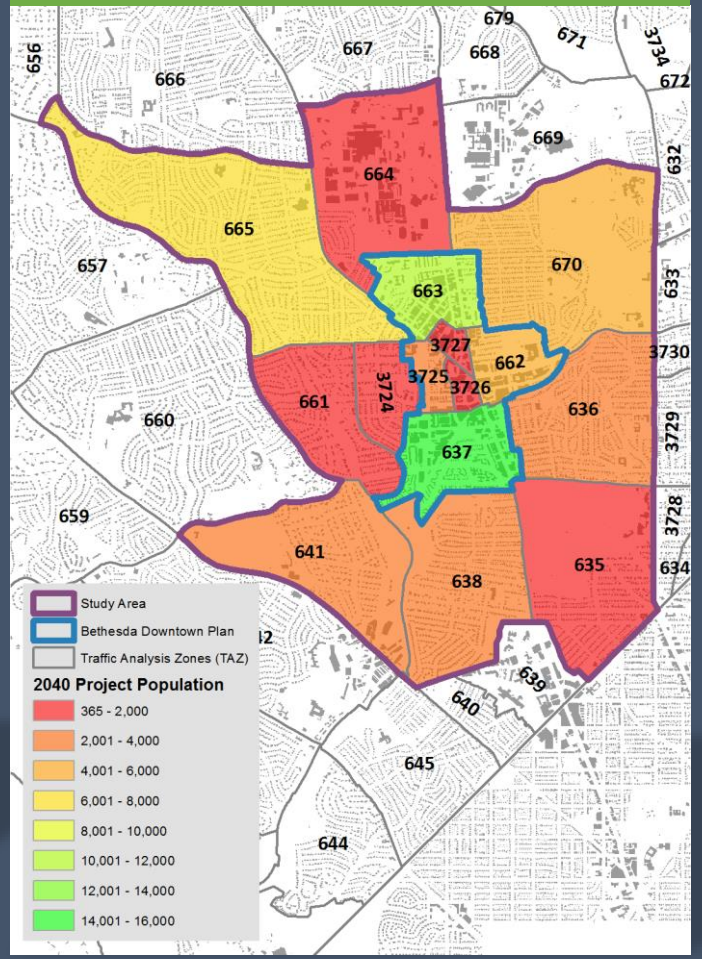
Existing Transportation Infrastructure

Study Area Population

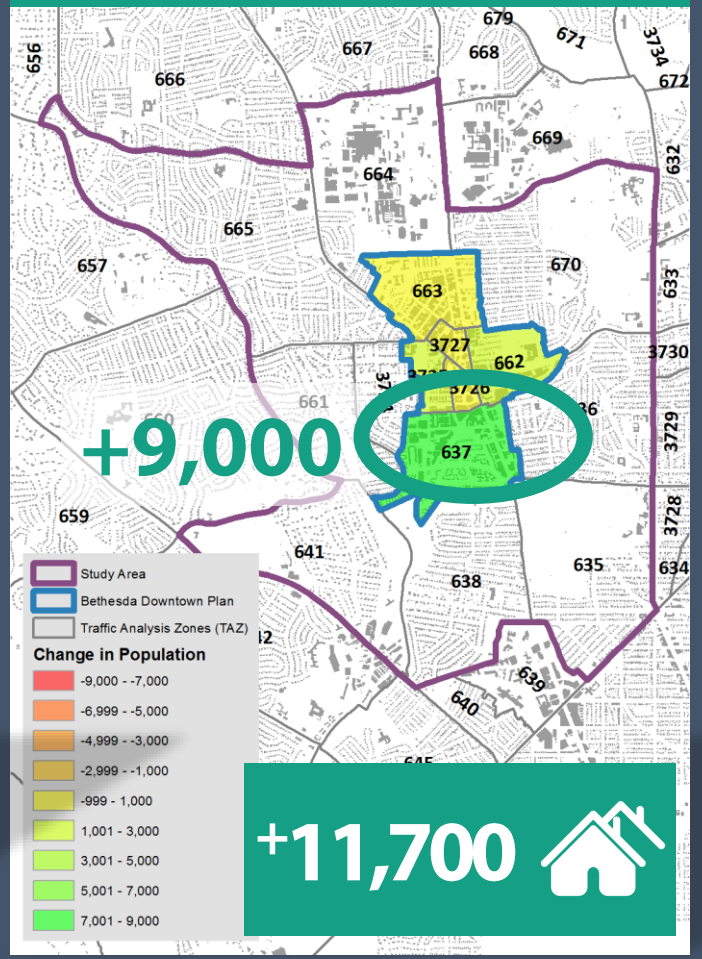
2040 BASE



2040 PROJECT

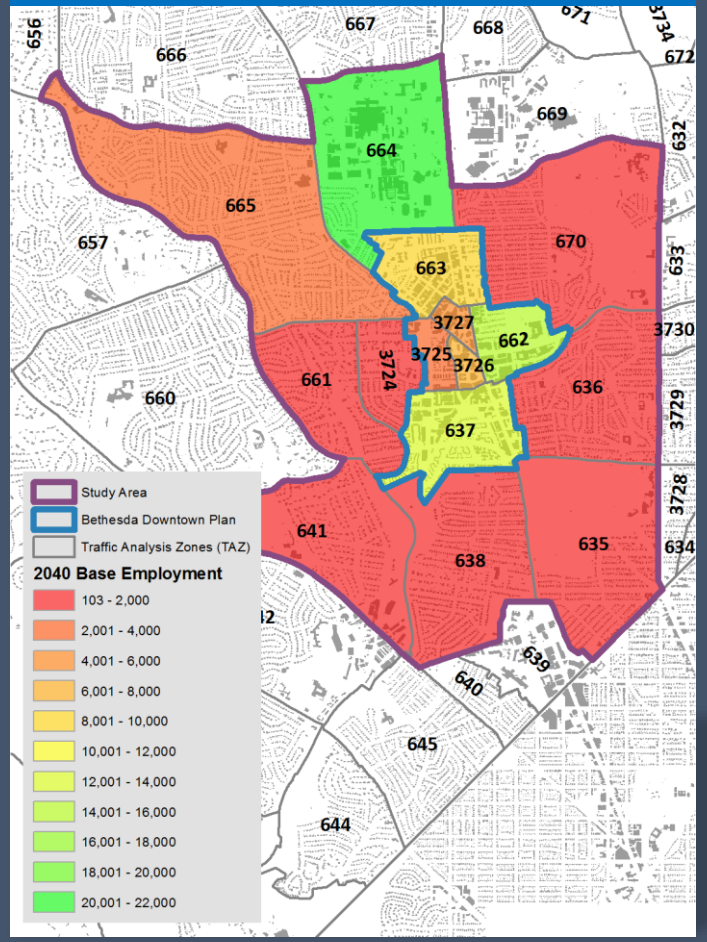


CHANGE

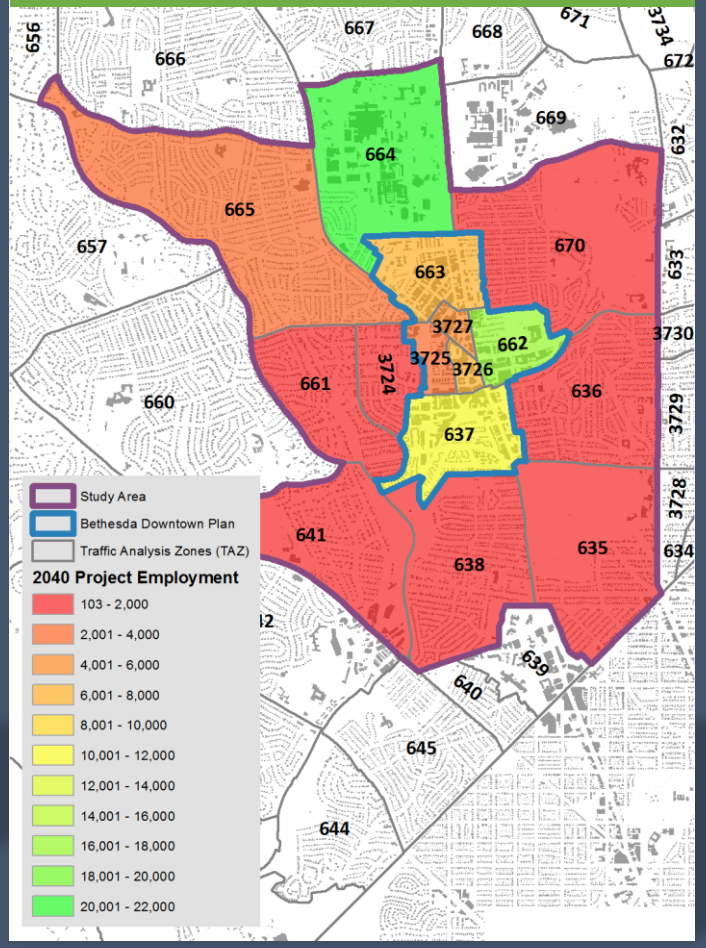


Study Area Employment

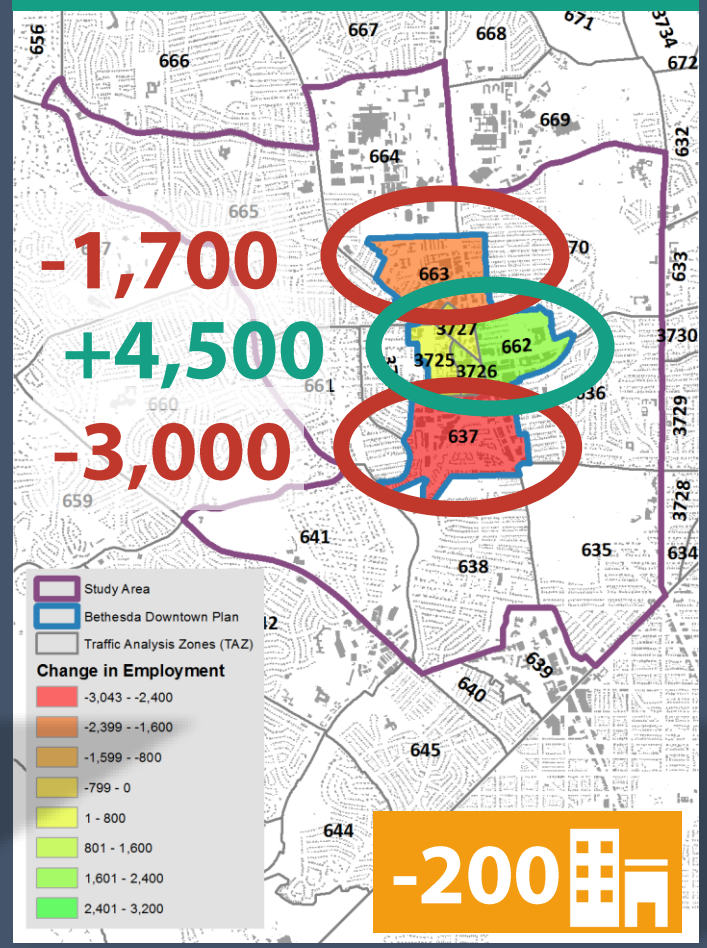
2040 BASE



2040 PROJECT

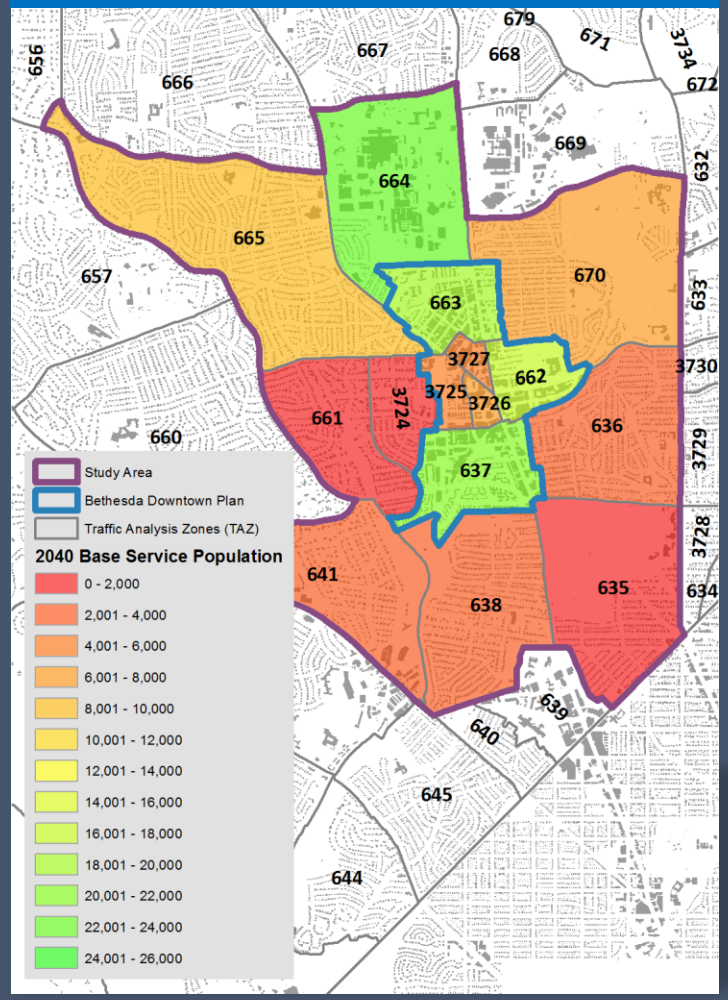


CHANGE

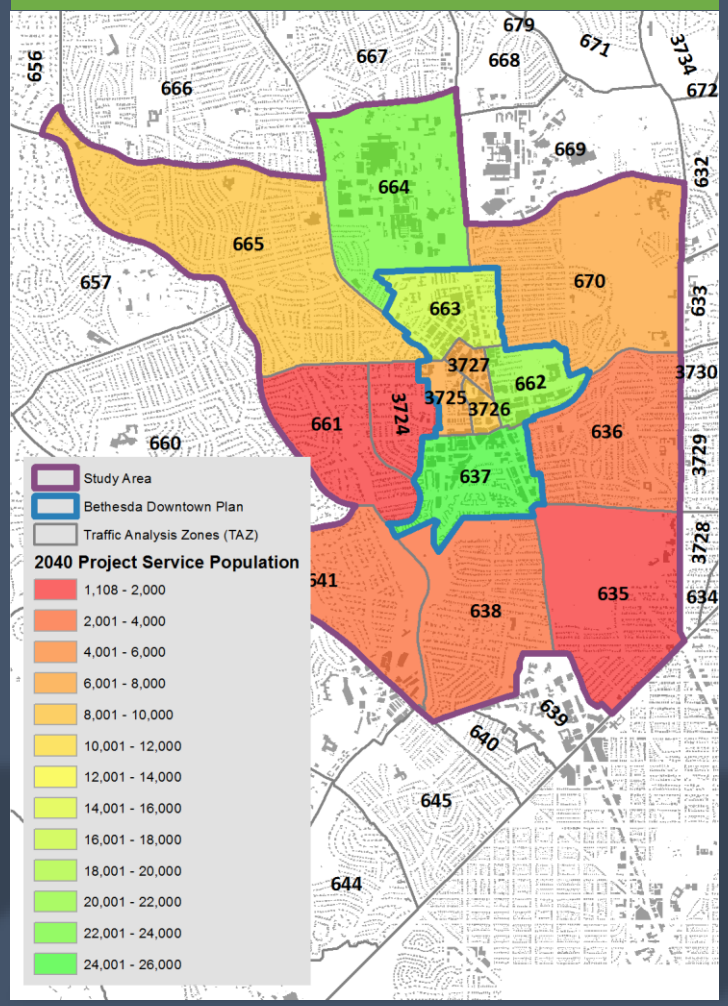


Study Area Service Population

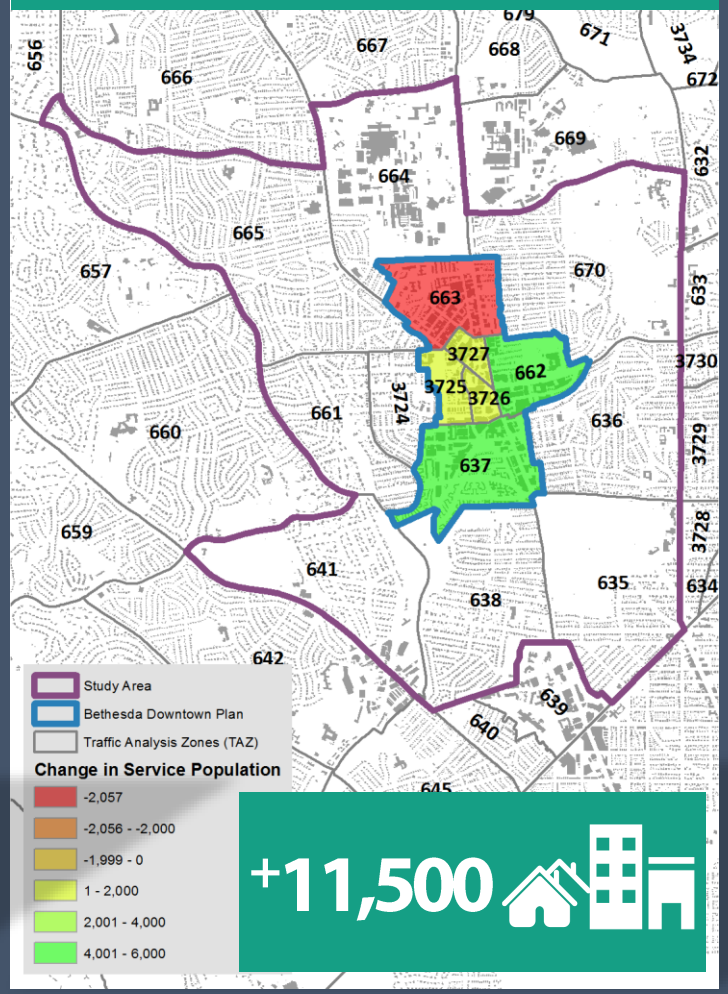
2040 BASE



2040 PROJECT



CHANGE



+11,500

01

ACCESSIBILITY

Congestion vs. Accessibility

D.C. tops list of nation's worst traffic gridlock

By Dick Uliano
August 26, 2015 2:17 am

300 Shares

wtop | WASHINGTON'S TOP NEWS

Traffic crawls along the Capital Beltway during rush hour, in Greenbelt, Md., Tuesday, Aug. 25, 2015. Traffic congestion nationally reached a new peak last year and is greater than ever before, according to a report by the Texas A&M Transportation Institute and INRIX Inc. (AP...

The Washington Post

Washington rated the worst for traffic congestion — again

Texas A&M Transportation Institute

Travel Time Index (TTI):

Ratio of congested auto travel time to free-flow auto travel time

Congestion vs. Accessibility

Travel Time Index: 1.35

Travel Time Index: 1.43

Source: Texas Transportation Institute via Smart Growth America

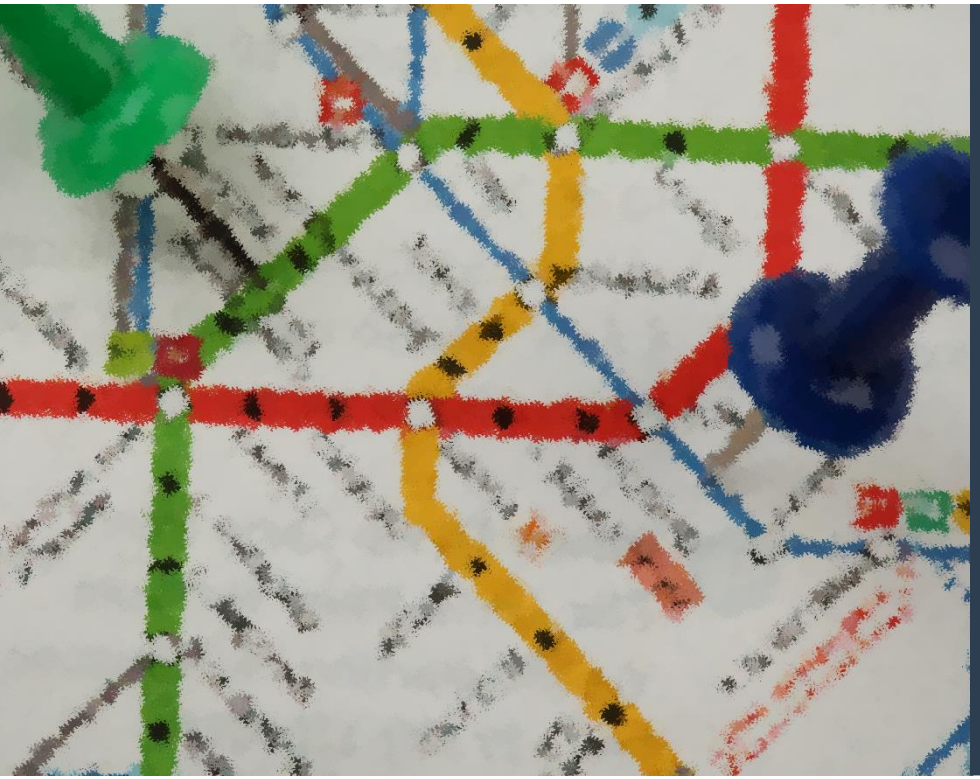
Congestion vs. Accessibility

Denver 1982		Denver 2007
1.09	Travel Time Index	1.31
50.6 minutes	Average travel time	49.6 minutes
46.4 mins	Travel time without traffic	37.9 minutes
4.2 mins	Extra rush hour delay	11.7 minutes

Source: Texas Transportation Institute via Smart Growth America

1a/b. Jobs and Person Trip Accessibility by Mode

Evolved from: Congested Speeds, Travel Time Index, Highway Capacity Manual Level of Service, Critical Lane Volume, Transit Coverage, Pedestrian and Bike Facility Inventory



Emphasizes tripmaking possibilities over speed of travel

Jobs Accessibility: Number of jobs that can be reached within a fixed amount of time from each zone

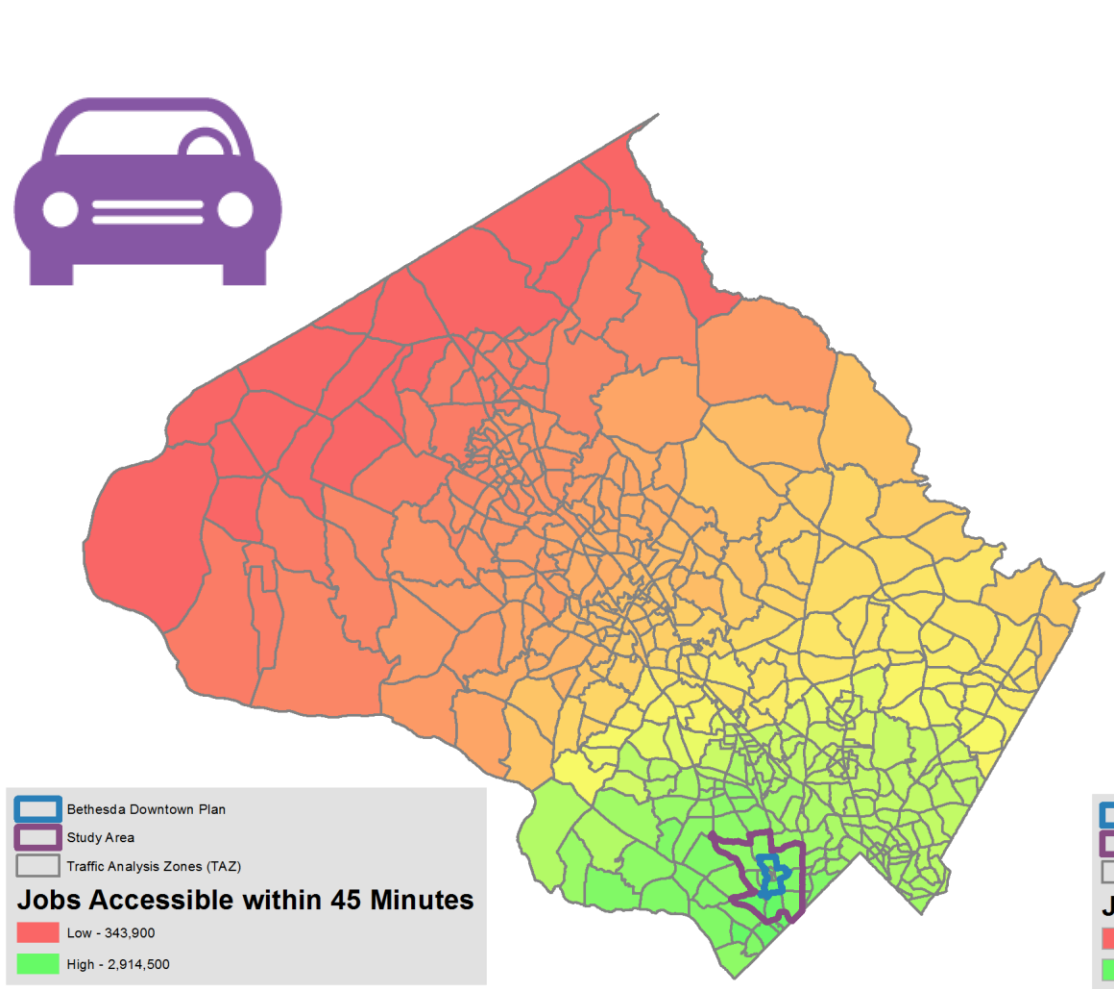
Person Trip Accessibility: Total desired destinations (per travel demand model) that can be reached within a fixed amount of time

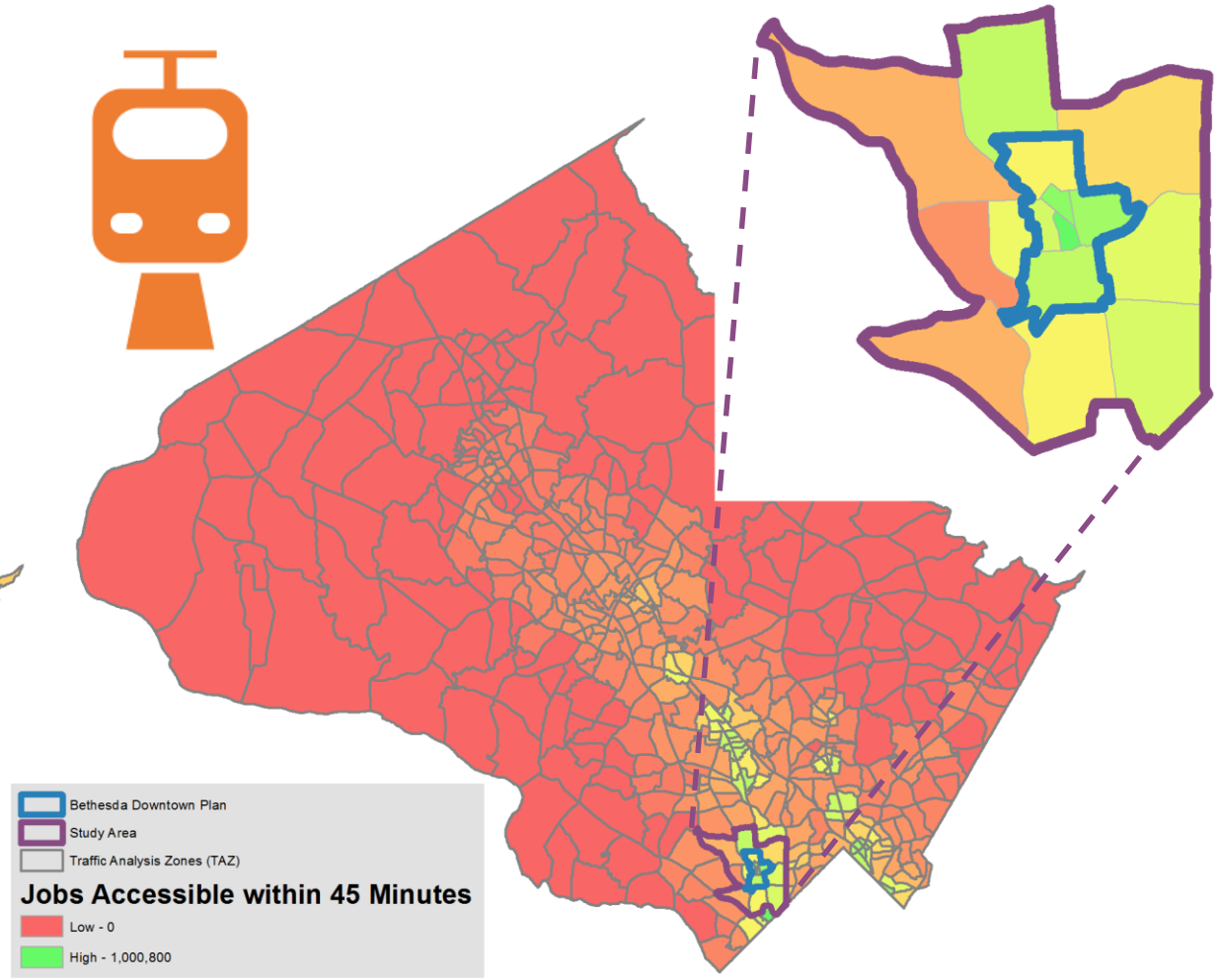
Calculation approaches:

- TRAVEL/4 Model (all modes)
- GIS-based analysis (transit, walk, and bike; for jobs)

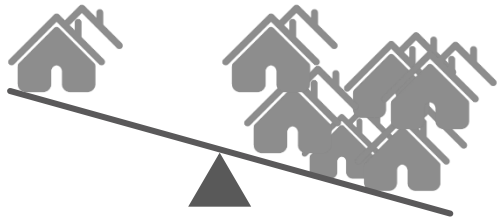
1a/b. Jobs Accessible within 45 minutes

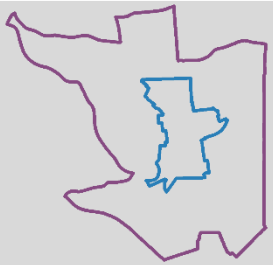
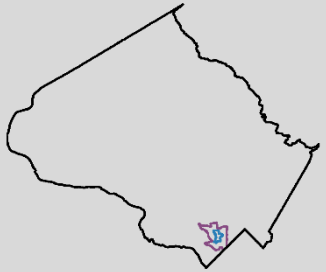
2040 Base





Jobs Accessible within 45 minutes to an Average Resident of:

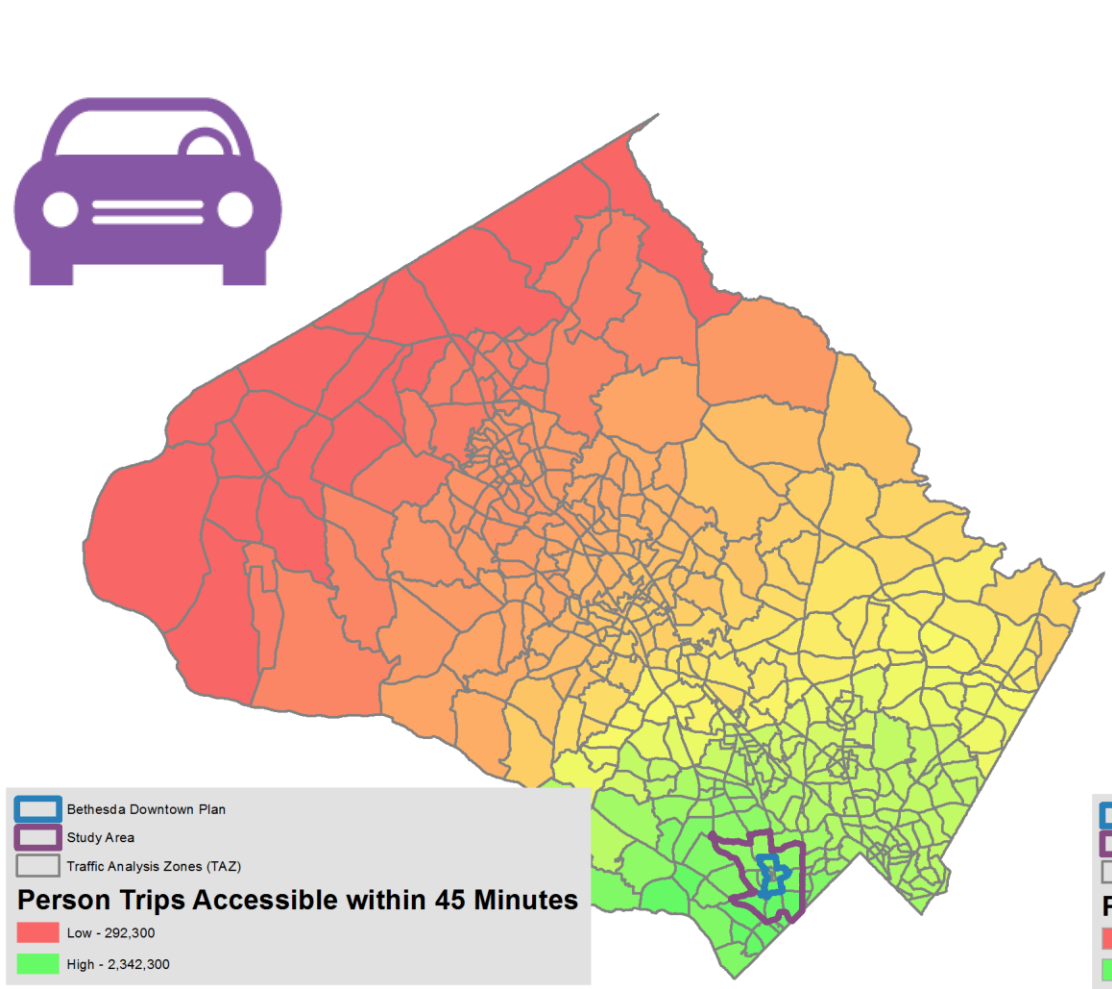


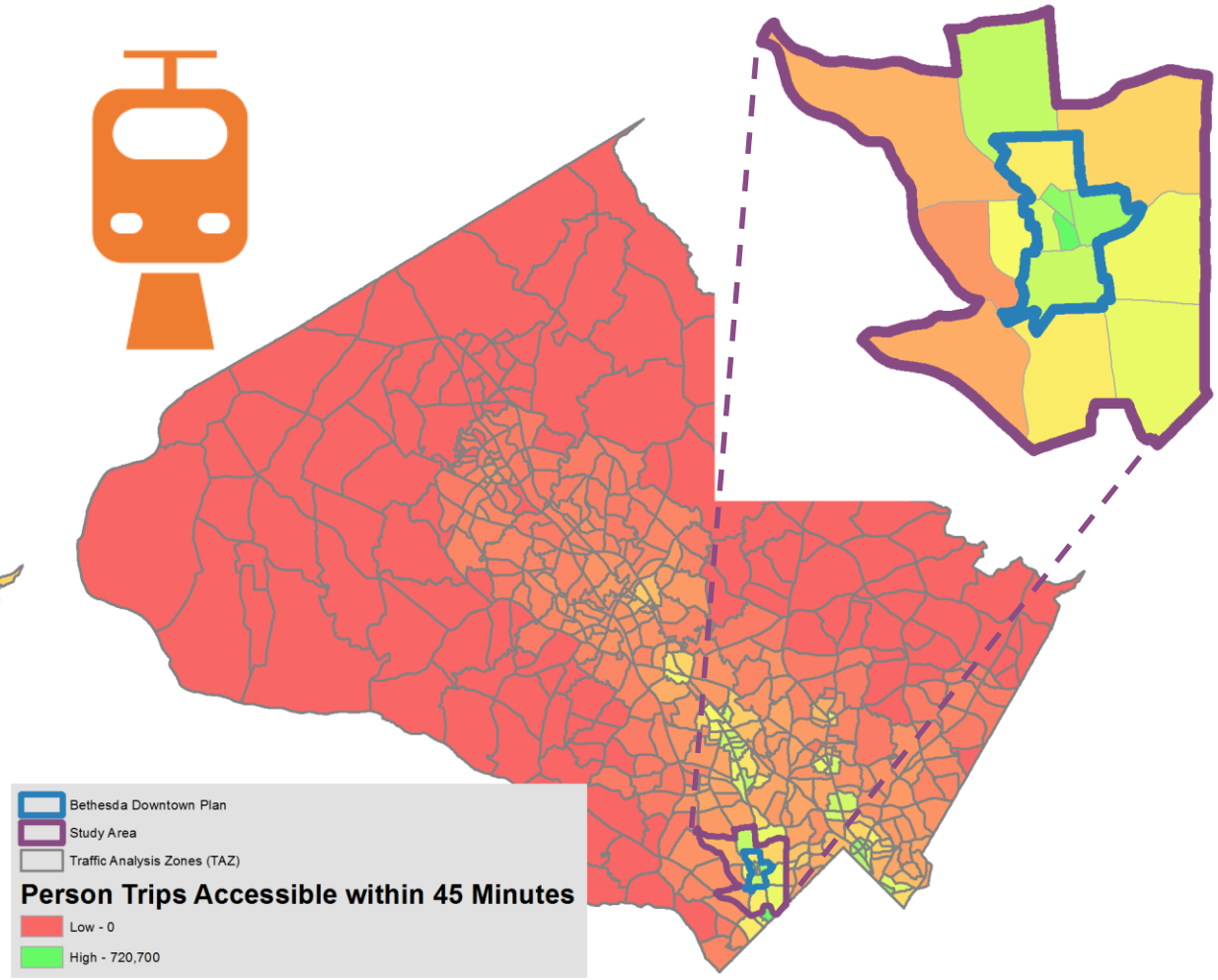
	Mode	2040 Base	Change	2040 Project	% Change
 Downtown Bethesda		2,807,500	-12,100	2,795,500	-0.43%
		657,700	+40,900	698,600	+6.22%
 Study Area		2,787,400	-9,100	2,778,400	-0.33%
		517,700	+50,600	568,300	+9.77%
 Montgomery County		1,587,500	+9,200	1,596,700	+0.58%
		157,800	+6,200	163,900	+3.93%

Includes all jobs, based on AM peak period (6-9am) accessibility.

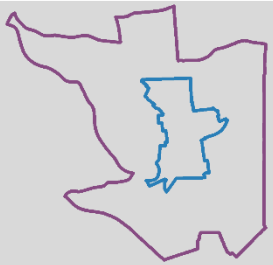
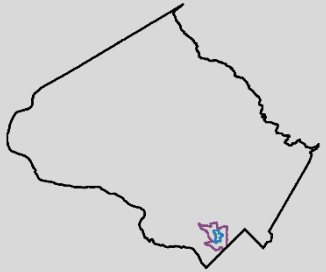
Person Trips Accessible within 45 minutes

2040 Base





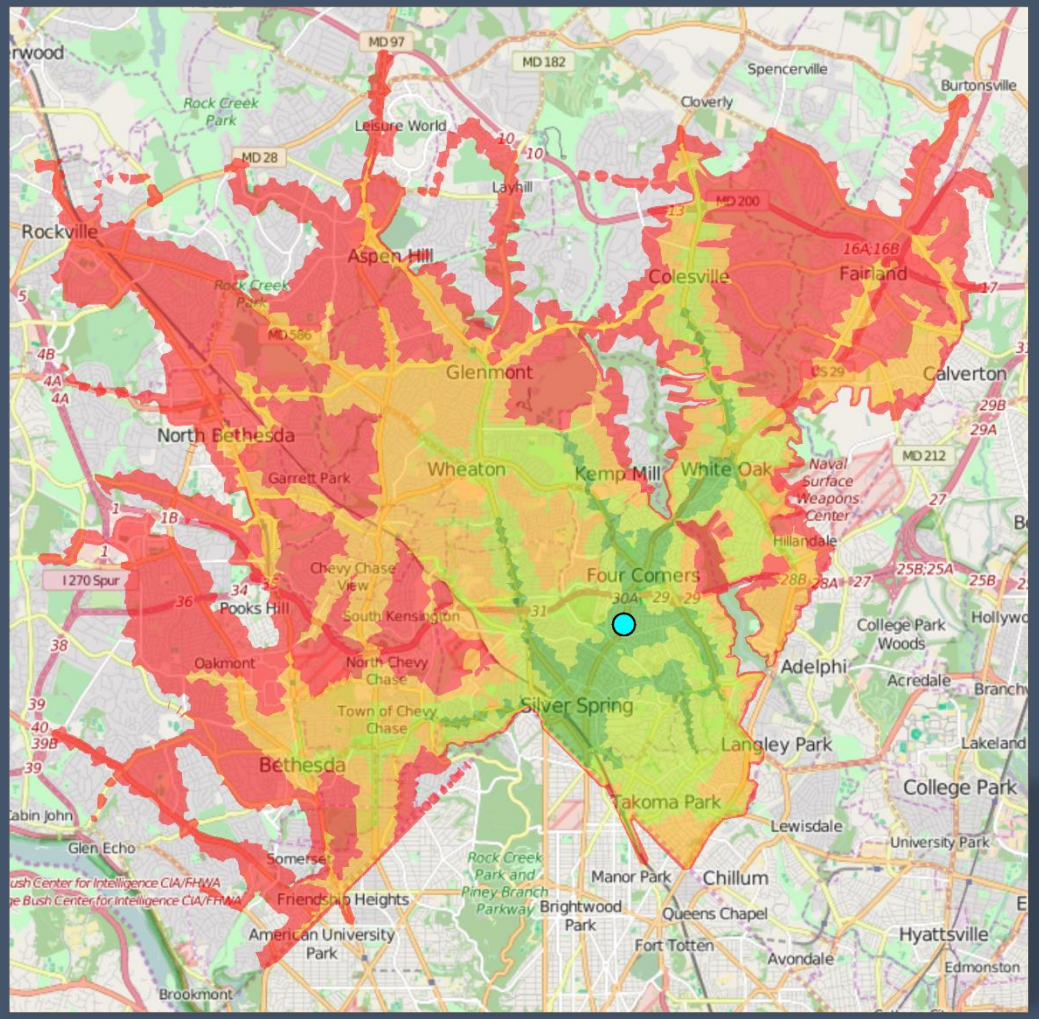
Person Trips Accomplishable within 45 minutes for an Average Resident of:

	Mode	2040 Base	Change	2040 Project	% Change
 Downtown Bethesda		2,253,500	-6,100	2,247,400	-0.27%
		460,000	+28,700	488,700	+6.24%
 Study Area		2,234,900	-2,700	2,232,200	-0.12%
		359,700	+36,100	395,800	+10.04%
 Montgomery County		1,304,400	+10,400	1,314,900	+0.80%
		116,800	+5,000	121,800	+4.28%

Includes all trip ends based on AM peak period (6-9am) accessibility.

Jobs (or Person Trips) Accessible by Transit

GIS / GTFS Approach | Existing Conditions

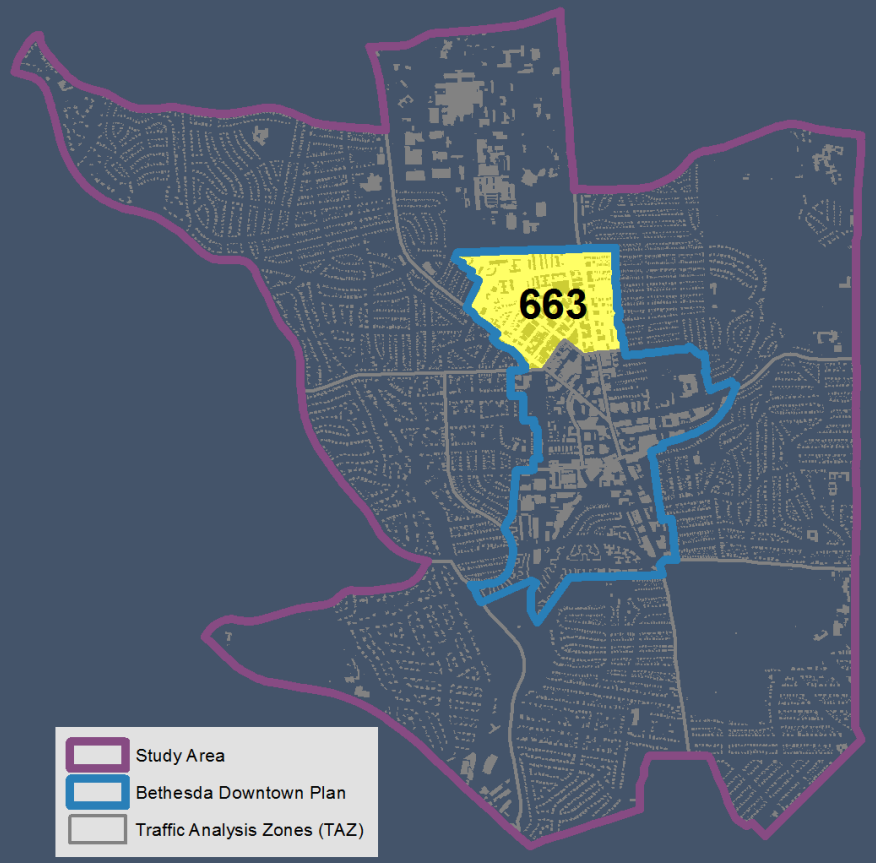


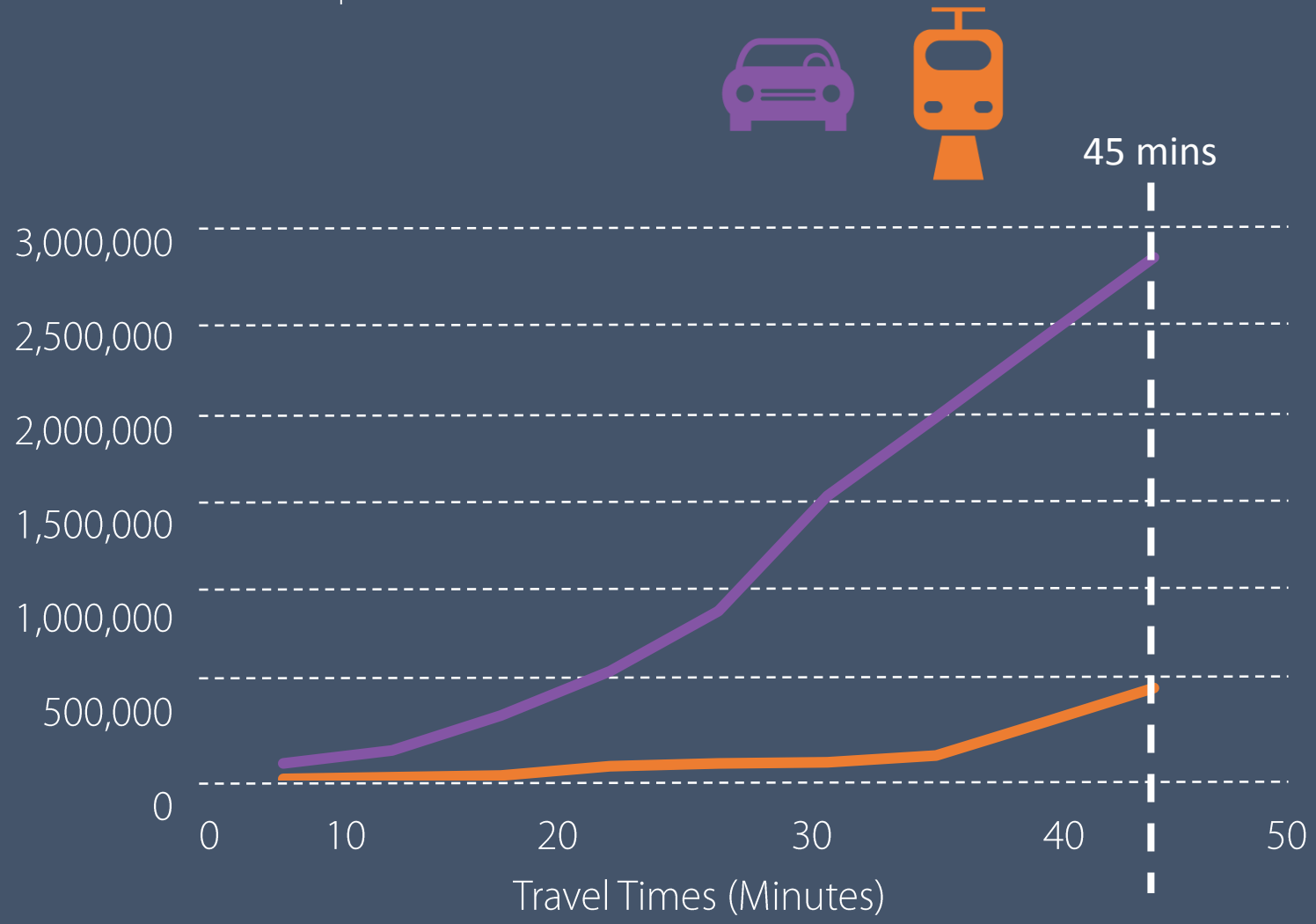
Places you can get to by transit:

- Within 30 min
- Within 45 min
- Within 60 min
- Within 75 min

1c/d. Jobs (or Person Trips) Accessible by Travel Time by Mode – TAZ 663

2040 Downtown Specific Plan





1e. Trip Duration

Evolved from: Congested Speeds, Travel Time Index,
Highway Capacity Manual Level of Service, Critical Lane Volume

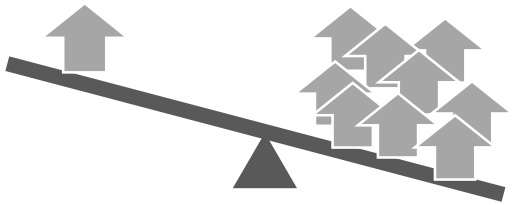
Accounts for both how fast and how far people travel

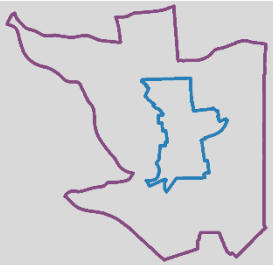
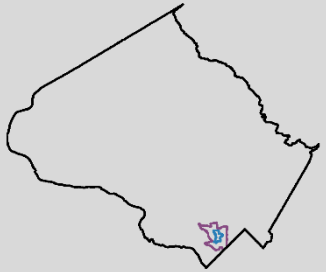
Reflects total amount of time people need to travel to accomplish their trip purposes

Calculation approaches:

- Travel Demand Model
- Household Travel Survey (tracking only)

1e. Average Trip Duration (minutes) for an Average Resident of:



	Mode	2040 Base	Change	2040 Project	% Change
 Downtown Bethesda		41.5	-3.1	38.4	-7.4%
		51.4	-2.3	49.0	-4.6%
 Study Area		35.2	-0.7	34.4	-2.1%
		53.6	-1.9	51.7	-3.5%
 Montgomery County		22.3	+0.1	22.4	+0.2%
		69.4	-0.3	69.1	-0.4%

Includes all trips in the AM peak period (6-9am) departing from TAZs in the indicated geography.

1f. Access to Transit

Evolved from: Transit Coverage

Minutes to access transit stations by mode

- Walk, Bike, Auto

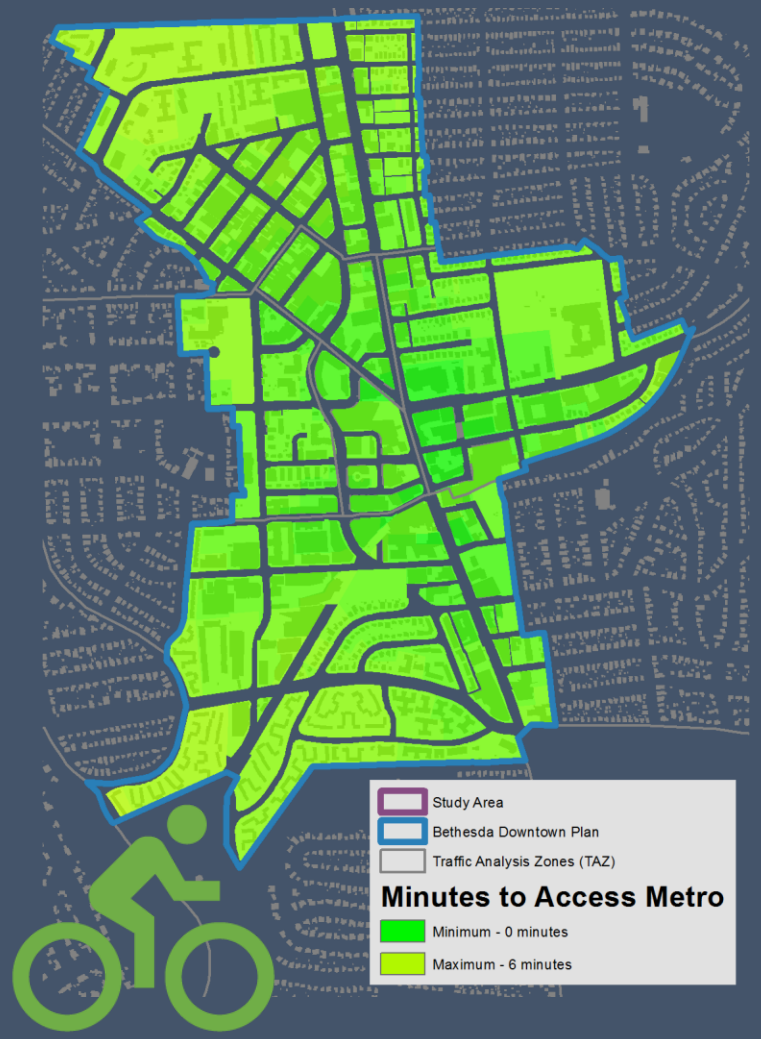
Can be differentiated by levels of transit service

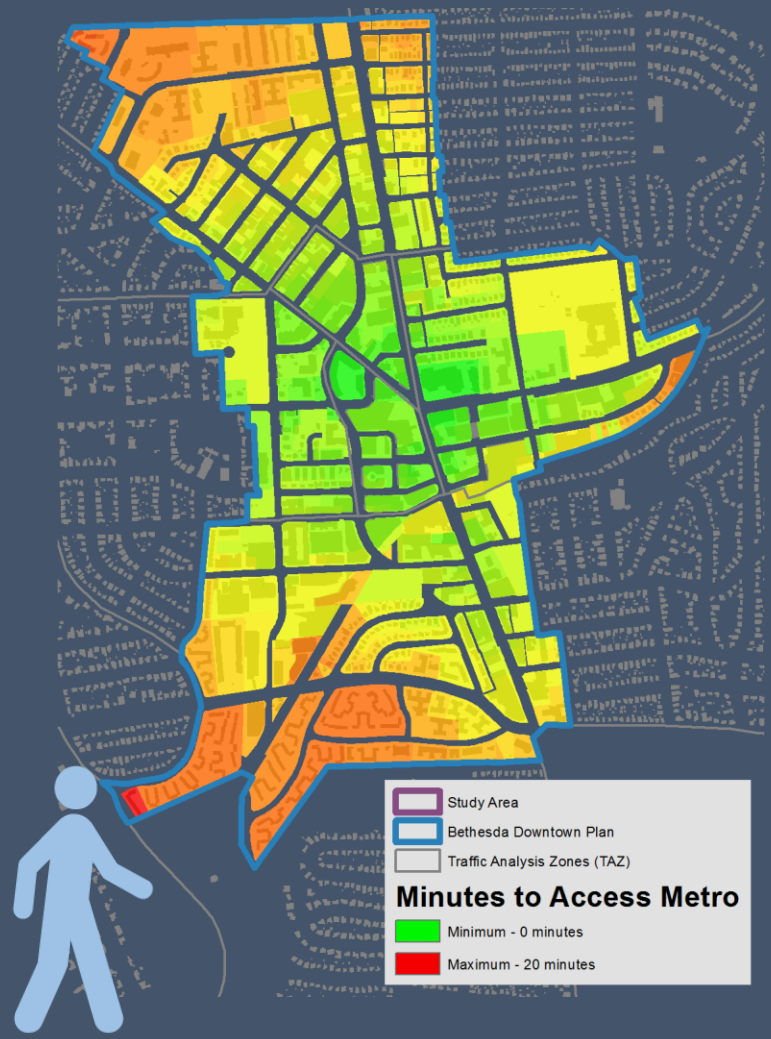
- Rail vs Bus
- Frequency of Service

Informs statements like "70% of residents live within a 10-minute walk of Metrorail"

- GIS-based analysis

1f. Access to Transit under Sector Plan





02

TRAVELER EXPERIENCE

Transit – Peak Headways and Span of Service – Current Practice

Route-by-Route Average Adequacy: Bethesda/Chevy Chase (BCC) in 2012

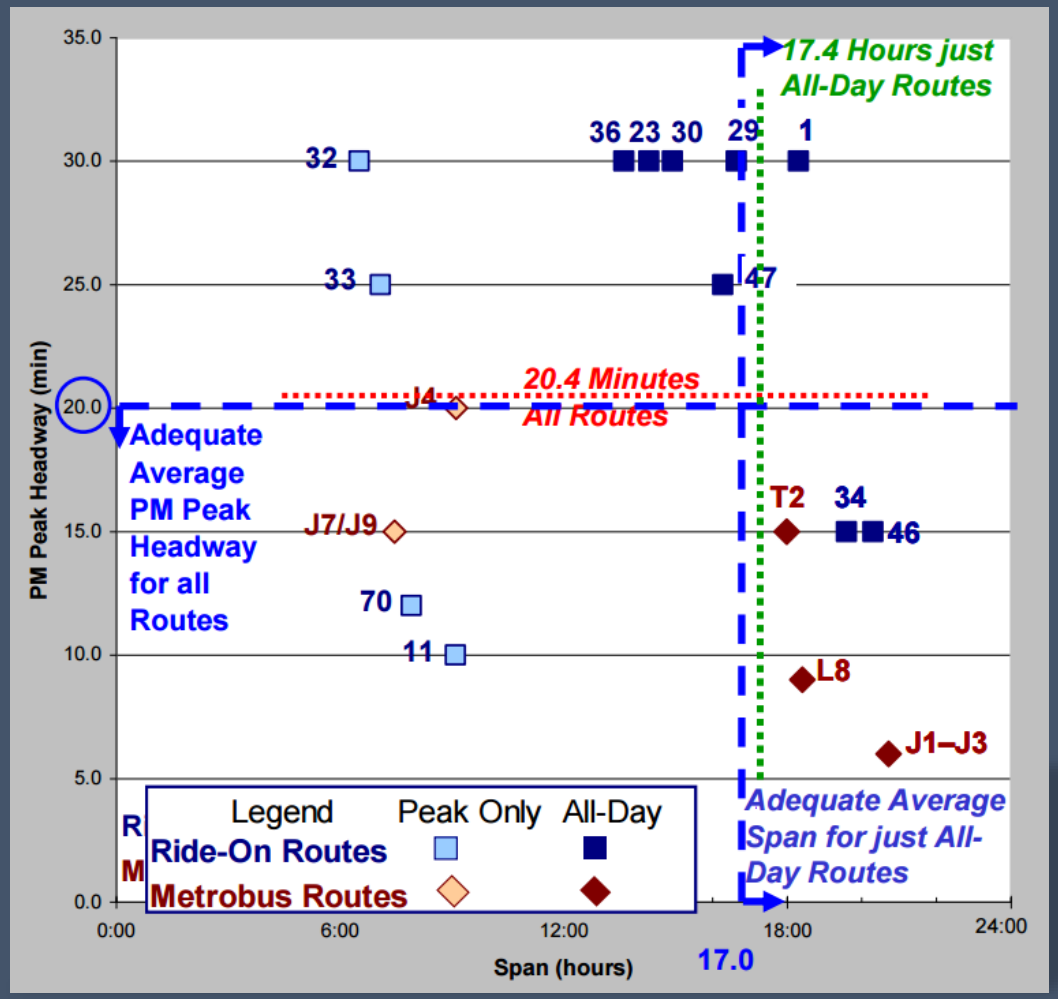


Image: *TPAR Report (2012)*

TPAR Report (2012)

Simple average of route-level frequency and span of service

Insensitive to land use context differences within policy area

Penalizes adding low-frequency service

Current Practice is Insensitive to Land Use Context (1)

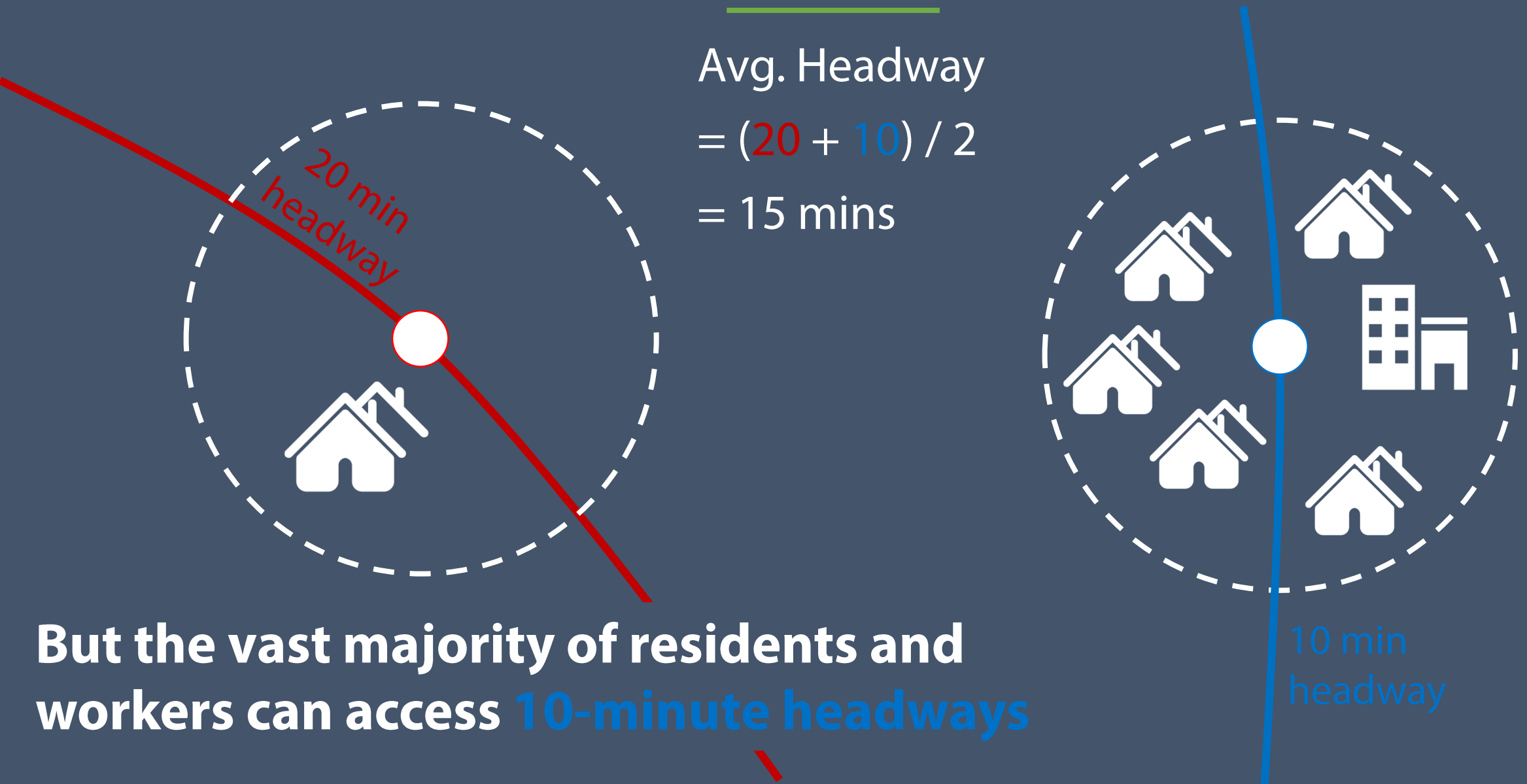
Avg. Headway

= (20 + 10) / 2

= 15 mins

Current Practice is Insensitive to Land Use Context (2)

Avg. Headway
= (20 + 10) / 2
= 15 mins



But the vast majority of residents and workers can access 10-minute headways

Current Practice Penalizes Adding Low-Frequency Service (1)

Avg. Headway

= (20 + 10) / 2

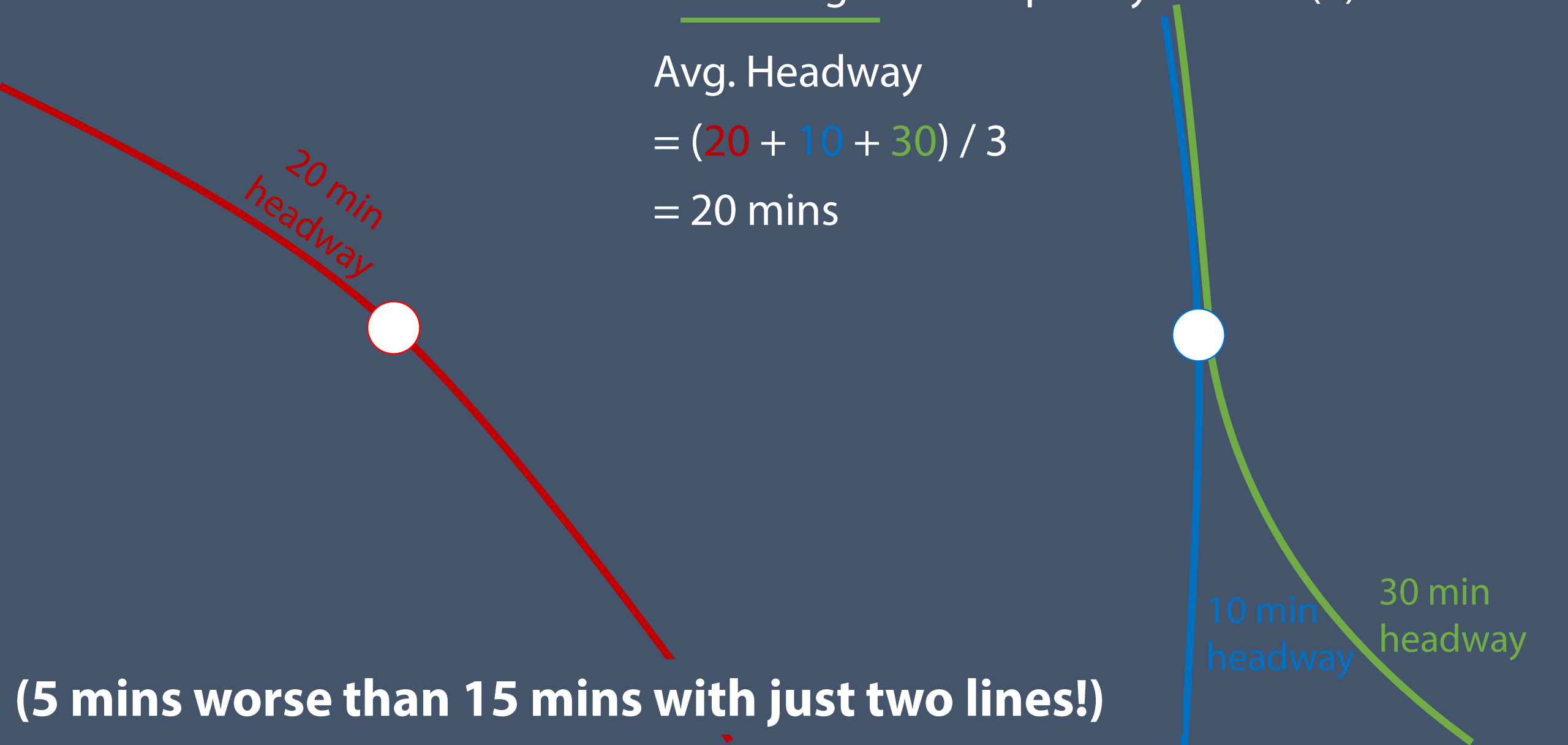
= 15 mins

Current Practice Penalizes Adding Low-Frequency Service (2)

Avg. Headway

= (20 + 10 + 30) / 3

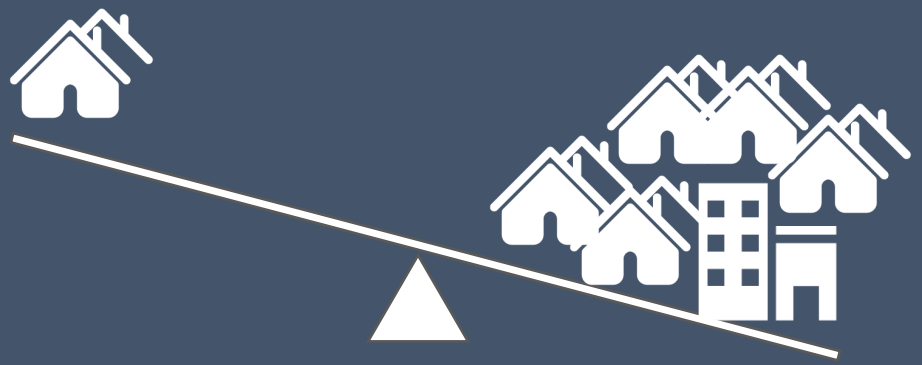
= 20 mins

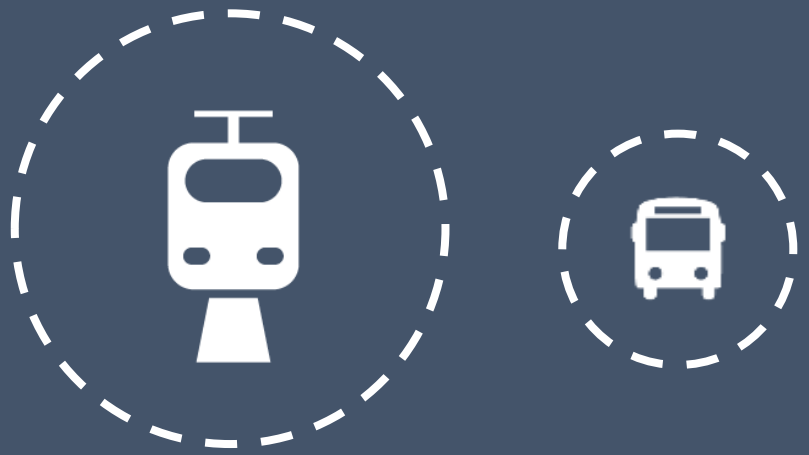


(5 mins worse than 15 mins with just two lines!)

2a. Transit – Frequency of Service

Evolved from: Peak Headways





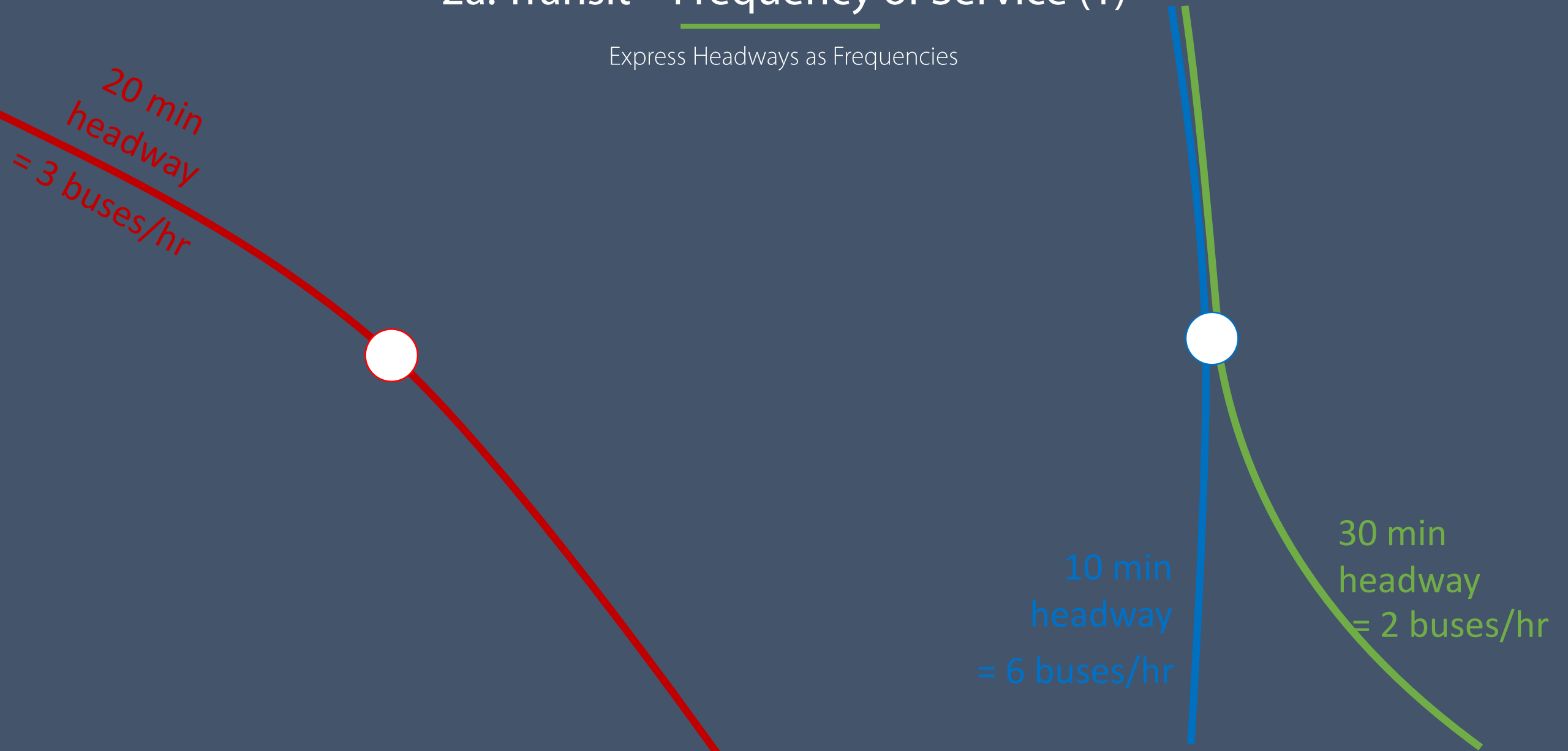
Average of service frequency, weighted by service population

Within ½ mile of rail transit; ¼ mile of bus stop (as in TPAR)

Service population = residents + workers

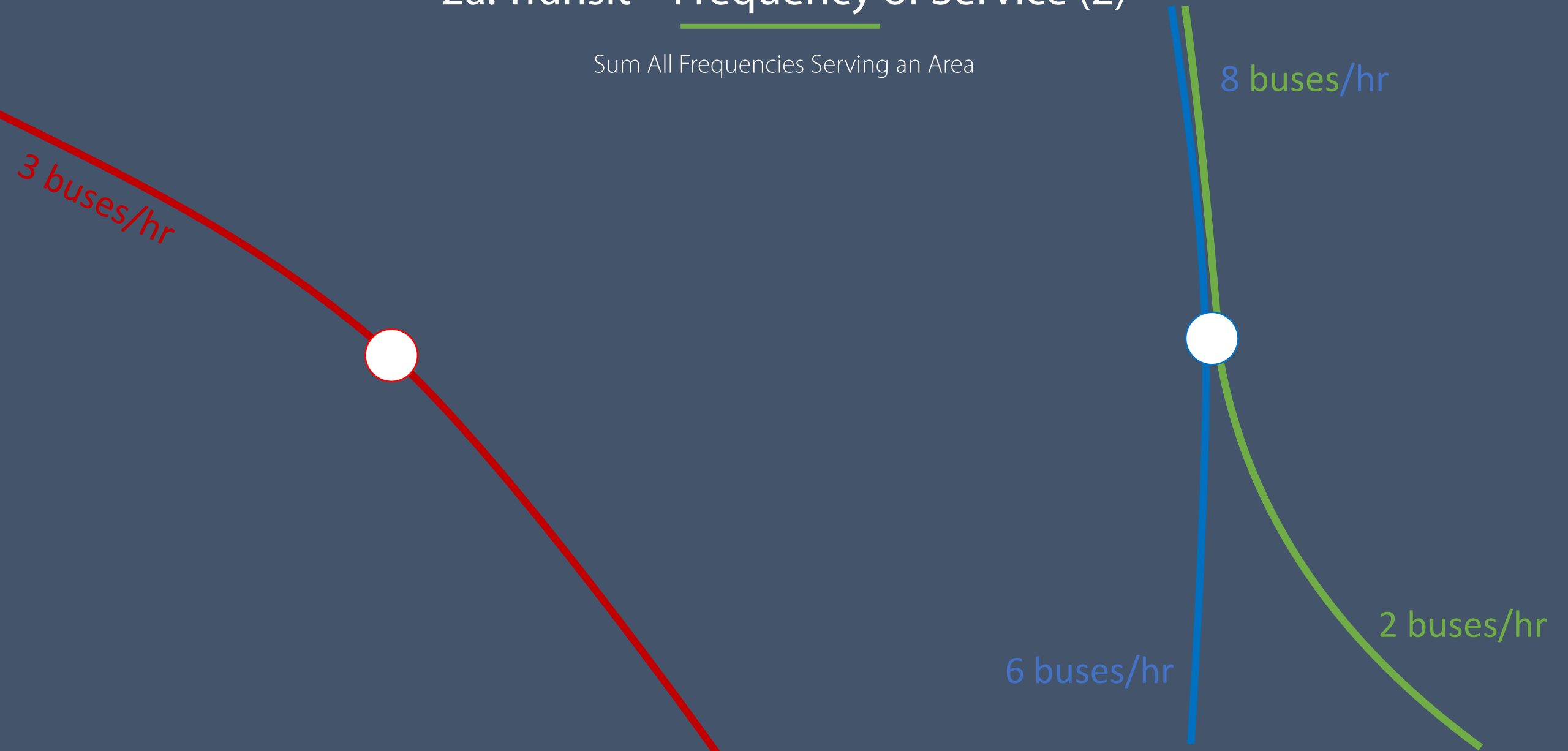
2a. Transit – Frequency of Service (1)

Express Headways as Frequencies



2a. Transit – Frequency of Service (2)

Sum All Frequencies Serving an Area



2a. Transit – Frequency of Service (3)

Consider Population and Employment

2a. Transit – Frequency of Service (4)

Service Population = Residents + Workers

2a. Transit – Frequency of Service (5)

Weighted Avg. Frequency

(**3***100) + (**8***1,000)/1,100

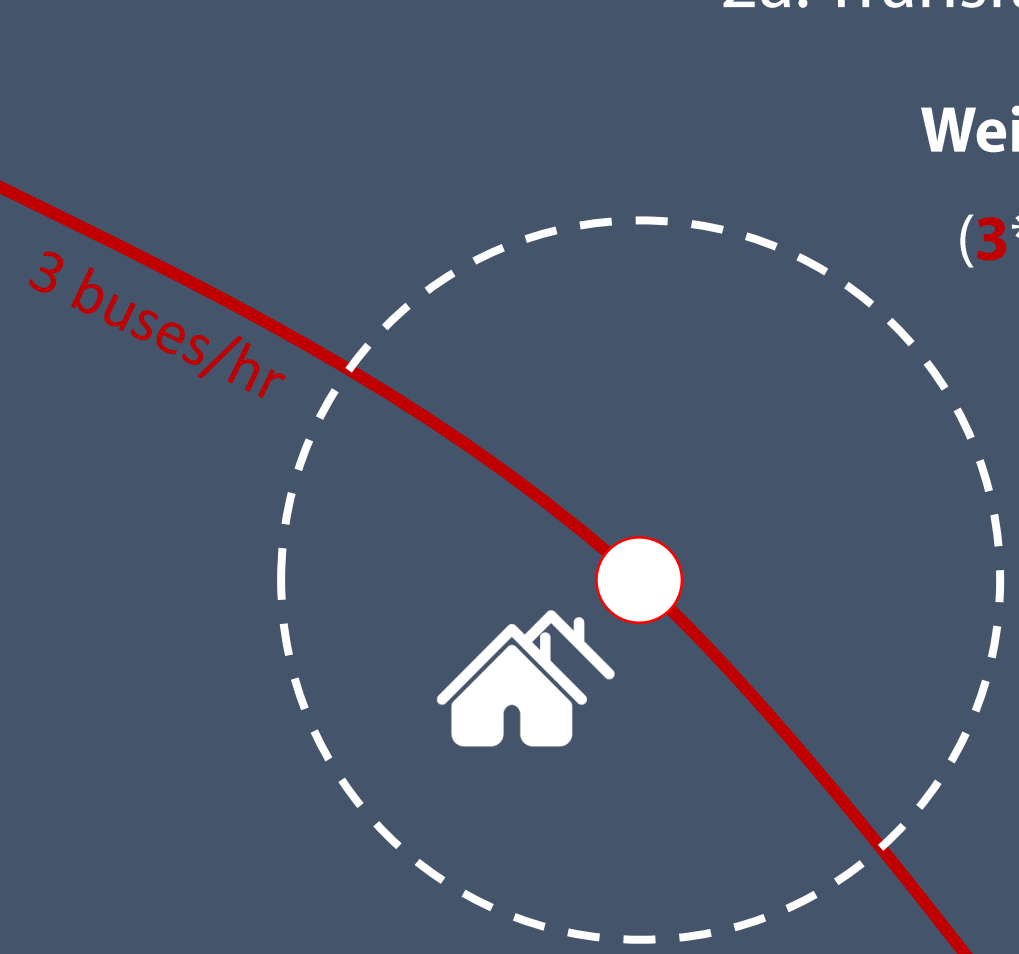
= **7.5 buses/hr**

vs.

Existing Approach

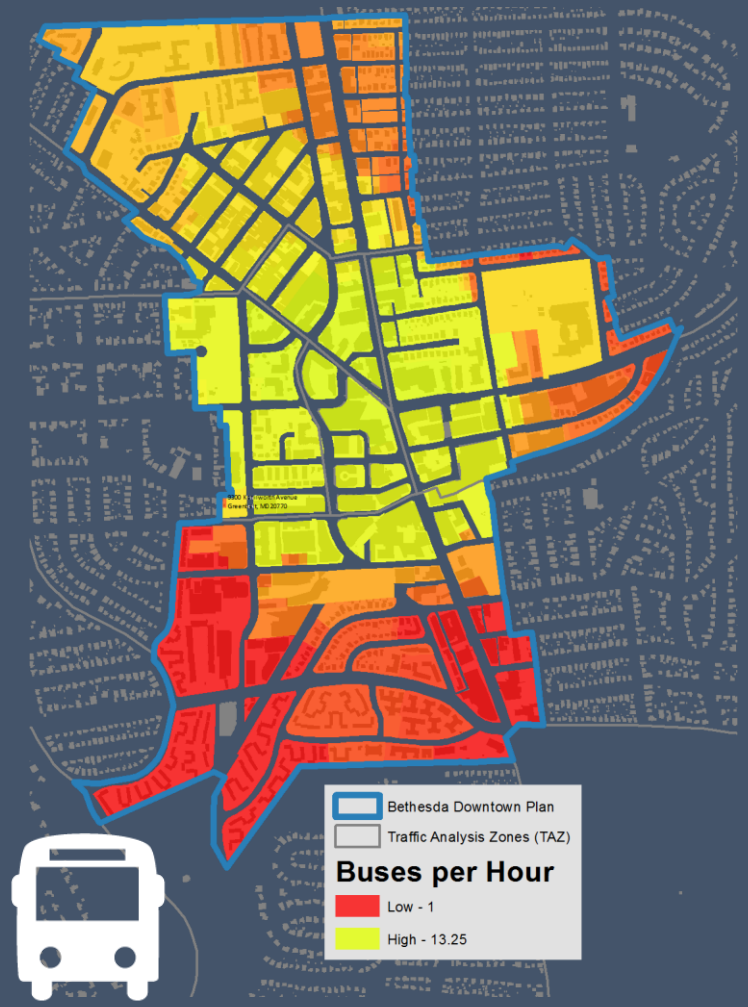
20 min headway

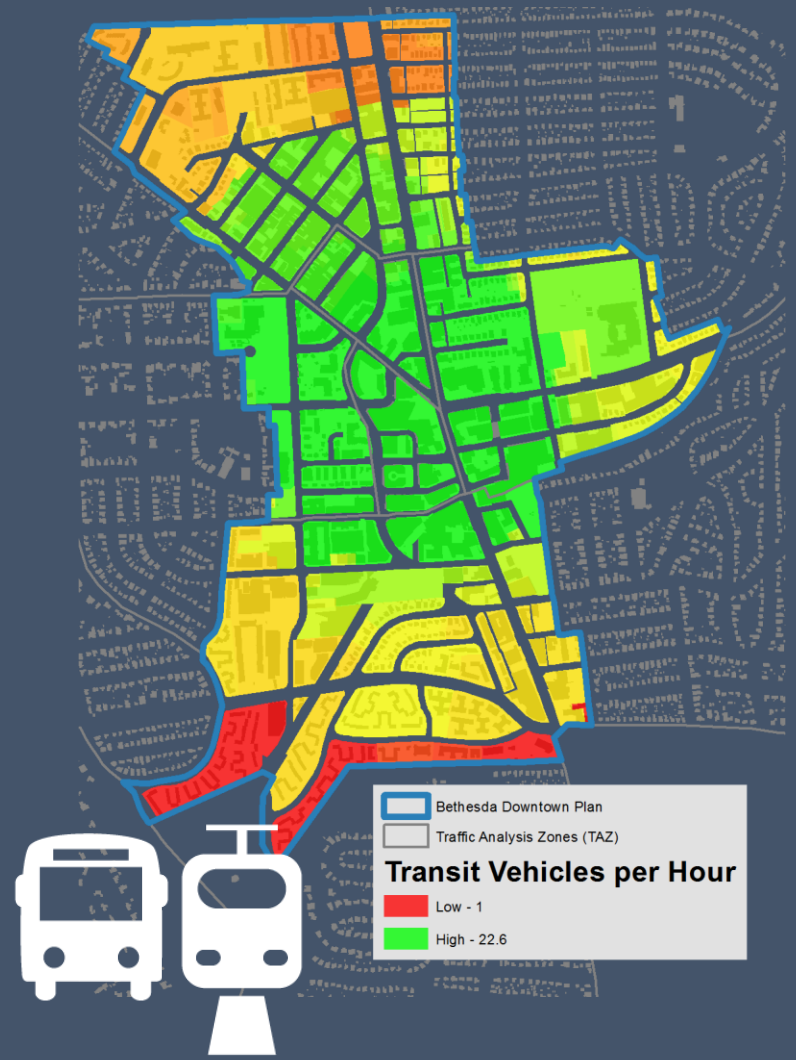
or **3 buses/hr**



2a. Transit Frequency – PM Peak

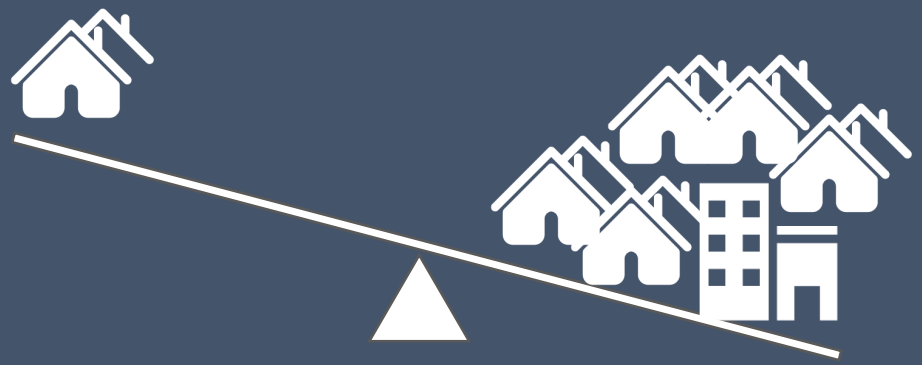
Existing Transportation Infrastructure





2b. Transit – Span of Service

Evolved from: Span of Service



Similar weighting to Frequency of Service

Average of service spans by population and workers served

2c. Transit – Reliability

Evolved from: Transit Adequacy

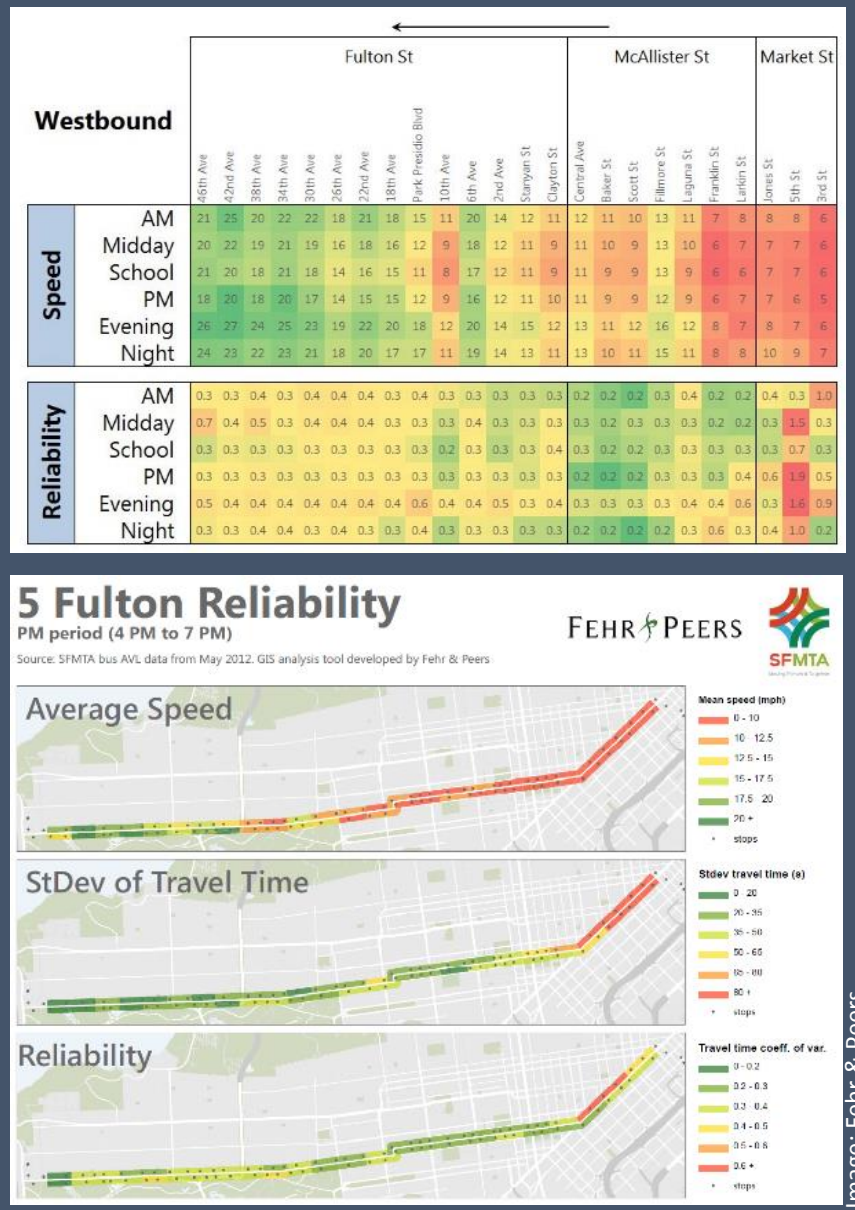
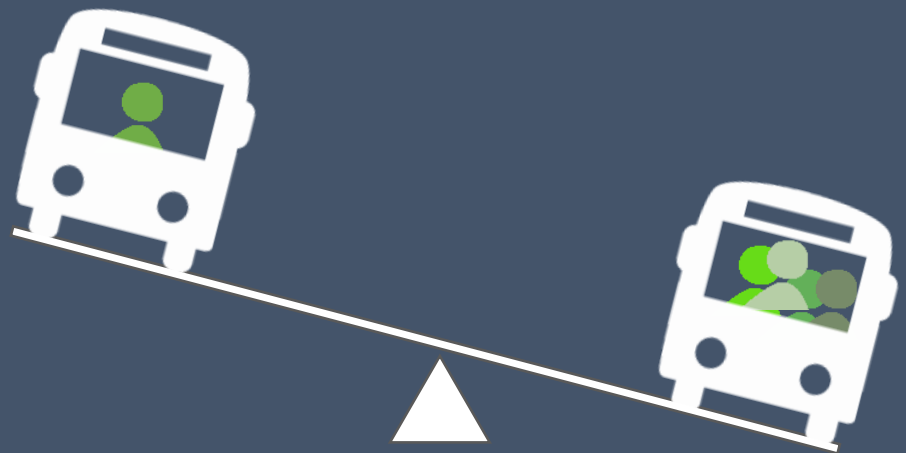


Image: Fehr & Peers

Measure of variability of travel time relative to average speed

Expressed at the segment level

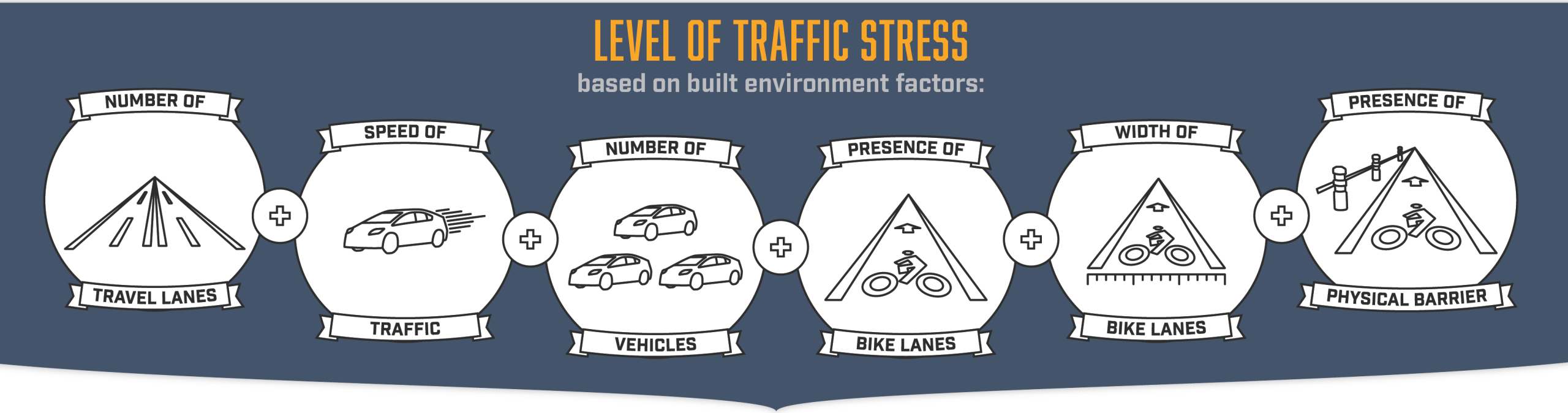
Weight segments by passenger load to calculate a line-level or area-wide average



2d. Bicyclist Comfort

Evolved from: Bike Facility Inventory

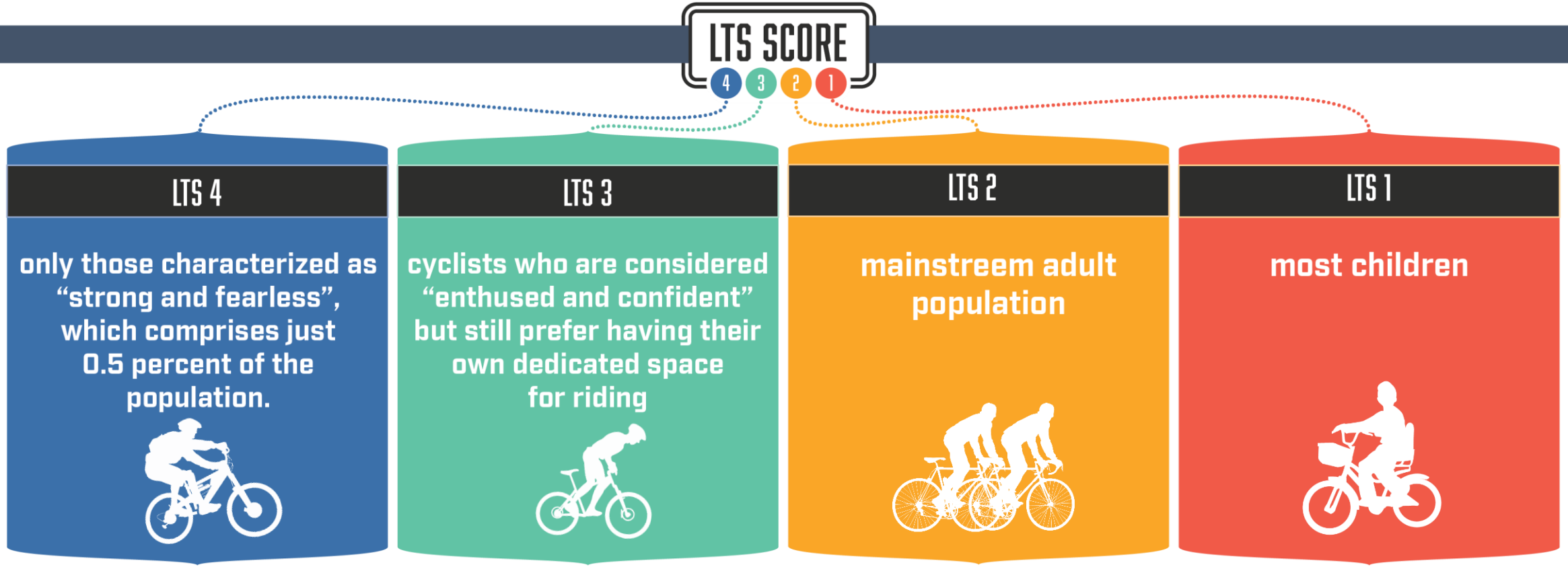
Rather than listing bicycle facilities in a study area, evaluate them based on how stressful they are to navigate by bike



Ease of intersection crossings is also considered

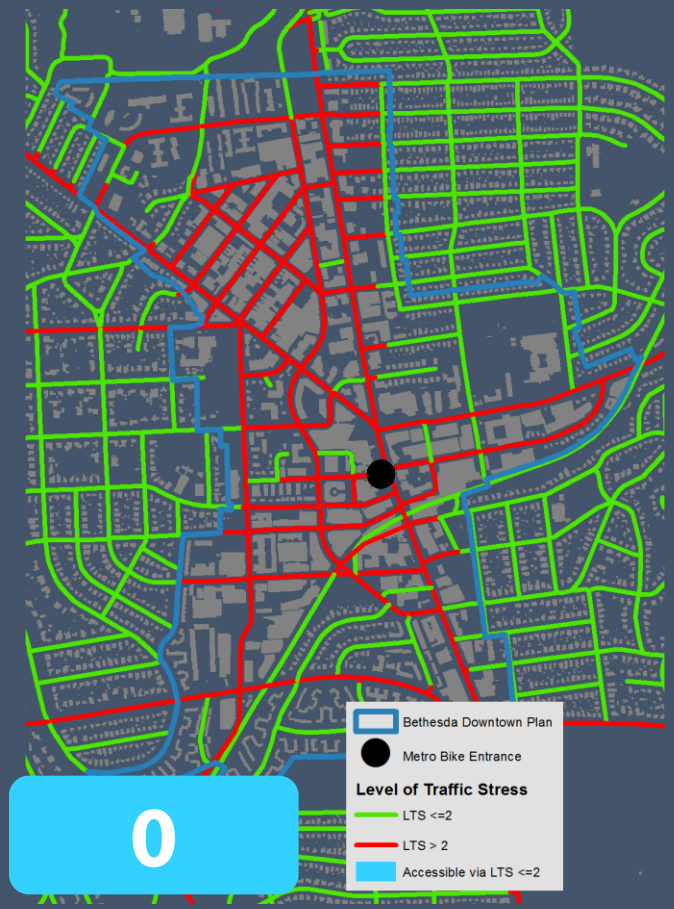
2d. Bicyclist Comfort

Different bicyclist groups will feel safe while bicycling:

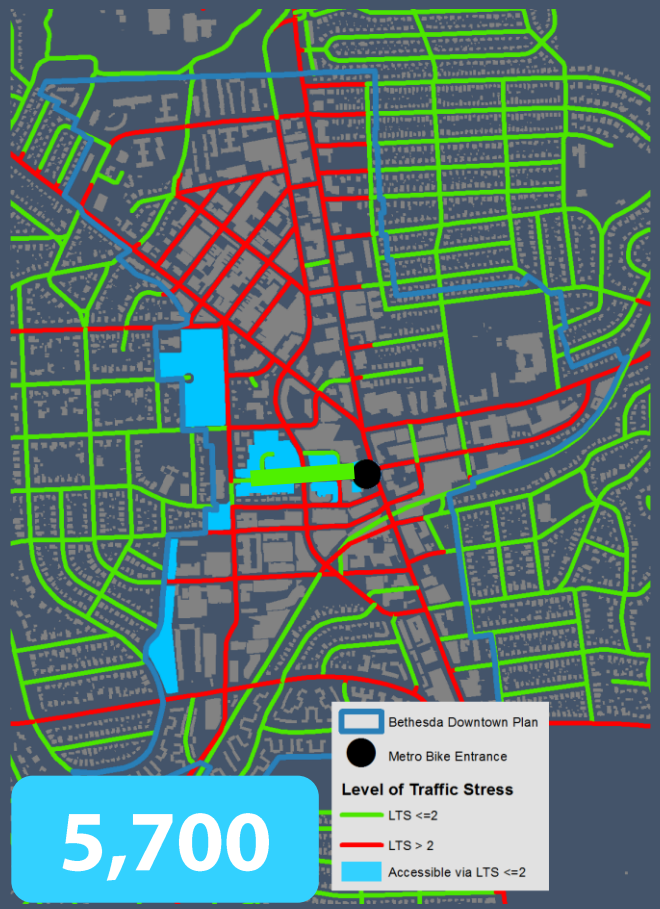


2d. Bicyclist Comfort

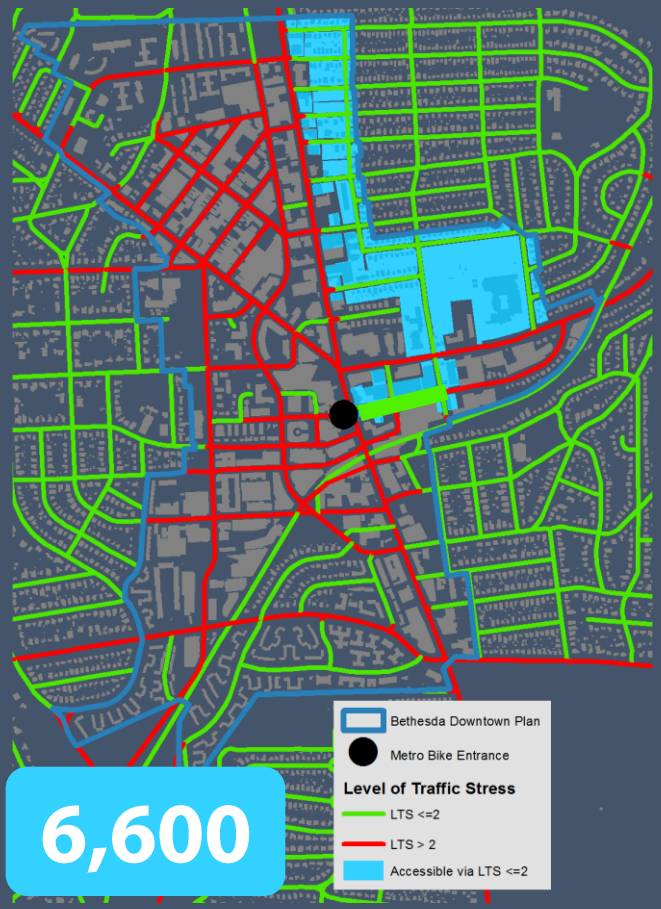
Low-Stress Access to Transit Example



0



5,700



6,600

2d. Bicyclist Comfort

Evolved from: Bicycle Facility Inventory

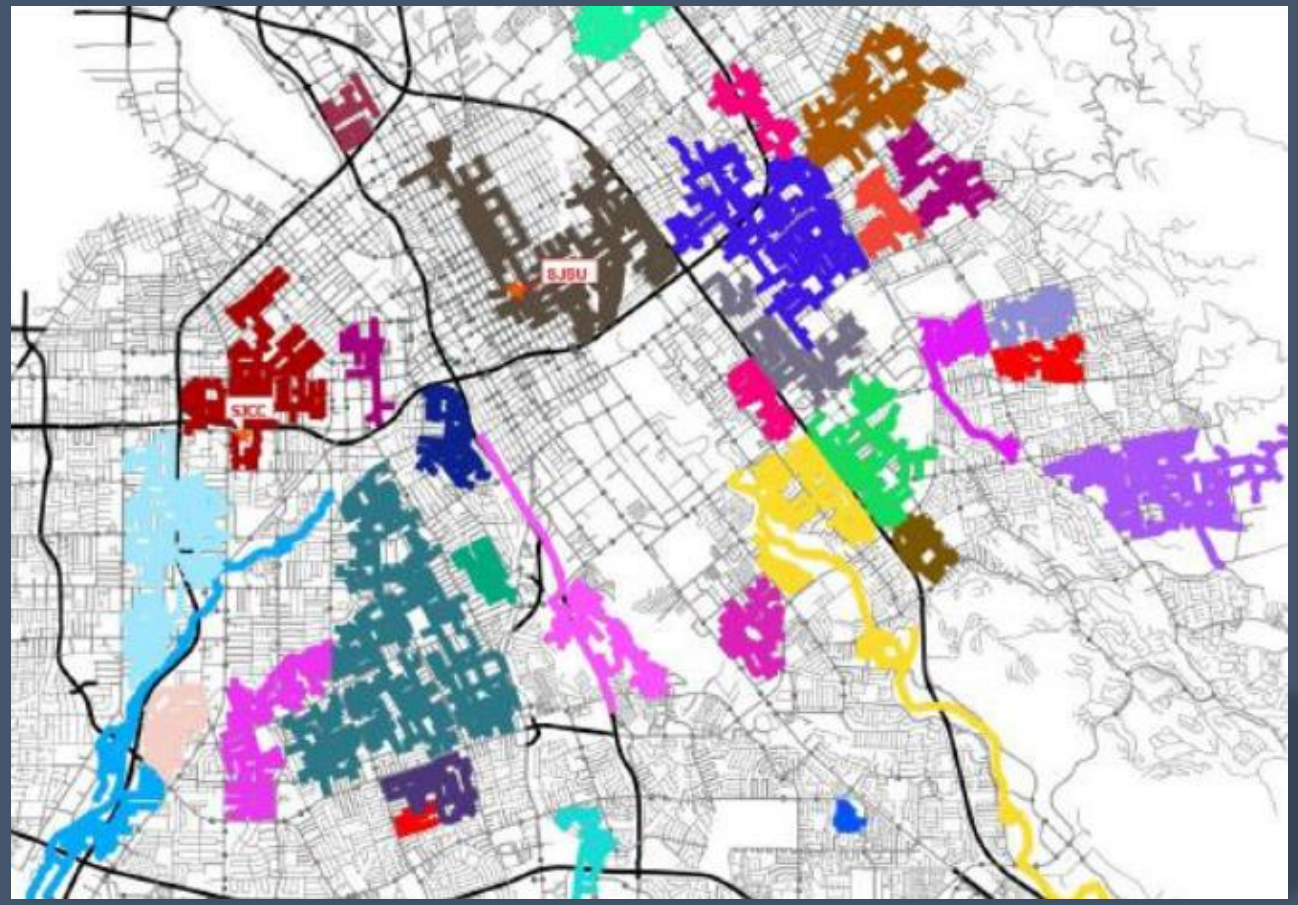


Image: Mekuria, Furth & Nixon

Expands access-to-transit concept to include access to jobs and access to total person trips

Calculates accessibility clusters

Allows targeted bicycle facility improvements to connect the most potential trips

2e. Pedestrian Comfort

Evolved from: Pedestrian Facility Inventory

Establishes levels based on built environment factors from:

- Pedestrian Environmental Quality Index (PEQI) and
- Pedestrian Level of Service (PLOS) method from 2010 Highway Capacity Manual

Sought simpler measure without onerous data needs

Sought overlap with data collection for bicycle Level of Traffic Stress measure

Can be applied to develop accessibility networks like bicycle Level of Traffic Stress (LTS)

2e. Pedestrian Comfort

Evolved from: Pedestrian Facility Inventory

Segments defined by changes in corridor characteristics, e.g. Speed, # of lanes

Unsignalized crossings are assessed and included as a component of segment characteristics

Signalized intersections scored separately

03

INTERSECTION PERFORMANCE

3a. Person Delay

Evolved from: Highway Capacity Manual Level of Service, Critical Lane Volume

Highway Capacity Manual Level of Service (LOS) and Critical Lane Volume (CLV) measure delay for automobiles

Person Delay adds similar measures for transit passengers, people walking, and people riding bikes

Modest additional effort

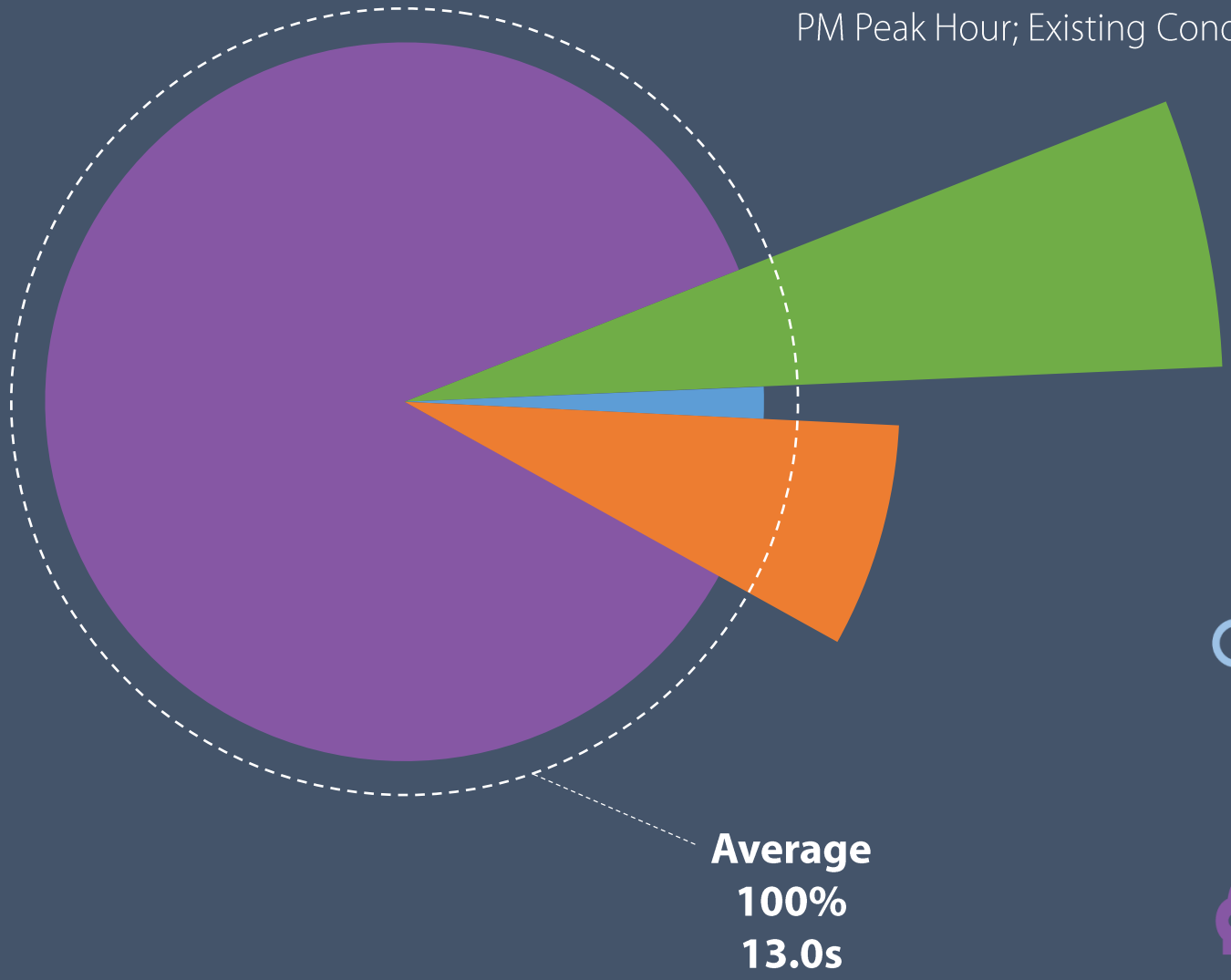
Allows:

- Comparisons of delay across modes
- Aggregations of delay for all modes

Policies can be set specific to each mode and/or in aggregate

3a. Person Delay

Wisconsin Ave at Cheltenham Rd
PM Peak Hour; Existing Conditions



Walk	seconds of delay/trip	26.9s
	% of person trips	5.3%
Bike	seconds of delay/trip	11.9s
	% of person trips	1.3%
Transit	seconds of delay/trip	16.4s
	% of person trips	7.4%
Auto	seconds of delay/trip	11.9s
	% of person trips	86%

04

ACTIVITY

Person Trips by Mode

Evolved from: Counts

4a. Raw

4b. Per Capita

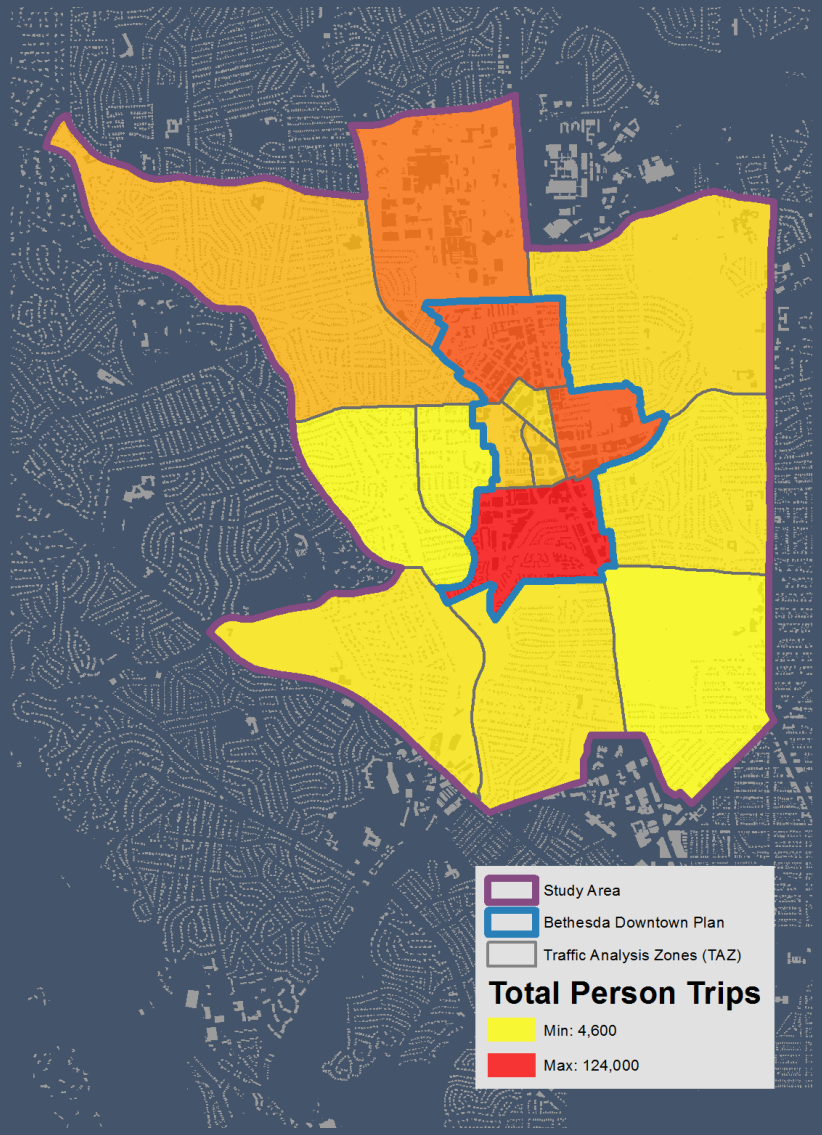
4c. Per Vehicle Mile of Travel

4d. Per Vehicle Hour of Travel

4e. Per Collision

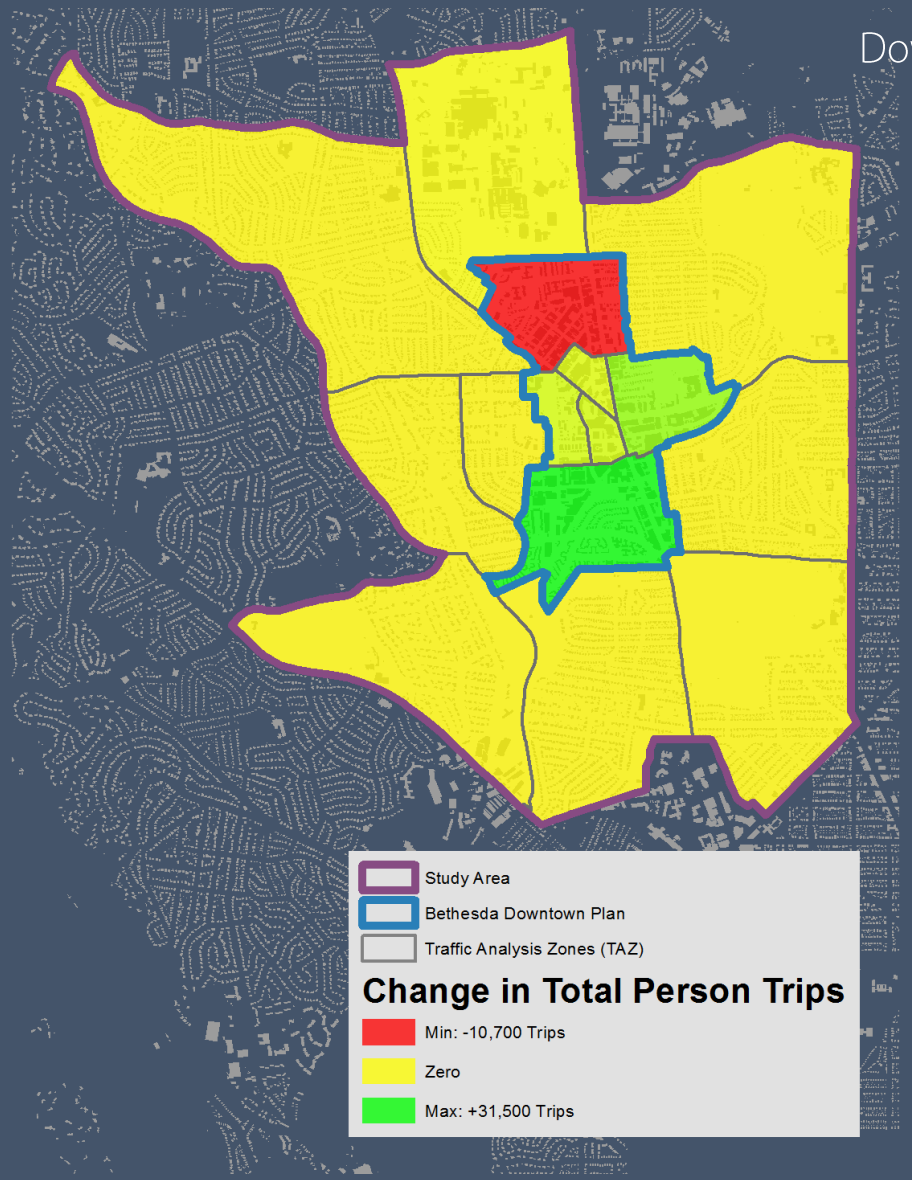
4a. Daily Raw Person Trips by Mode

2040 Base; Downtown Bethesda



	108,600
	25,000
	28,300
Total	**161,800**

4a. Change in Daily Raw Person Trips by Mode



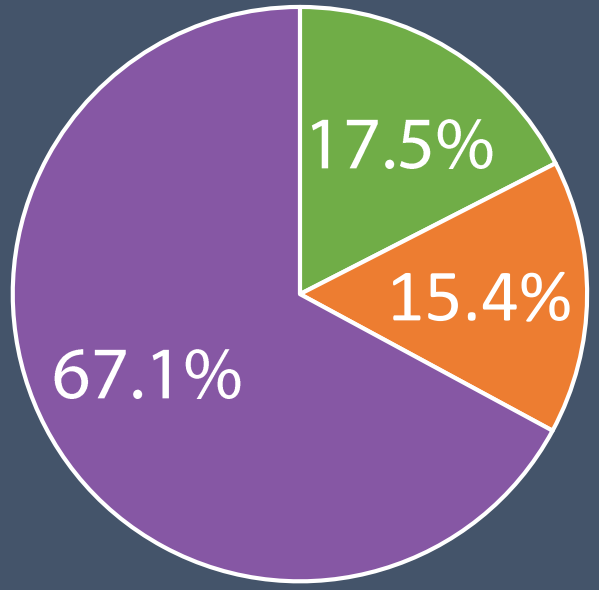
Downtown Bethesda Plan vs. 2040 Base

	+17,700	+16%
	+2,900	+12%
	+8,400	+30%
Total	**+29,000**	+18%

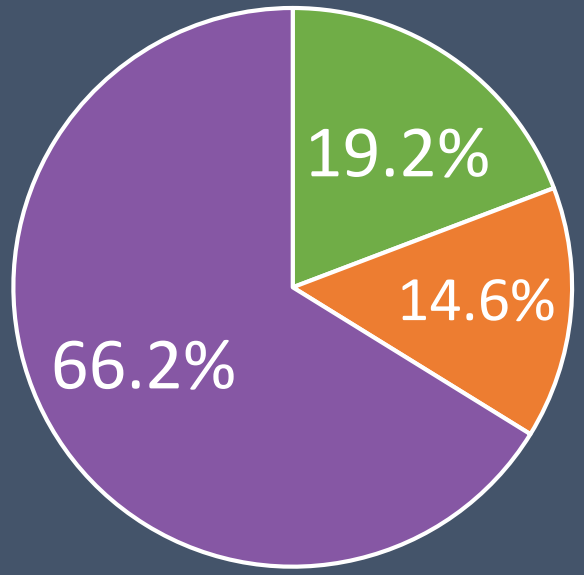
4a. Mode Share

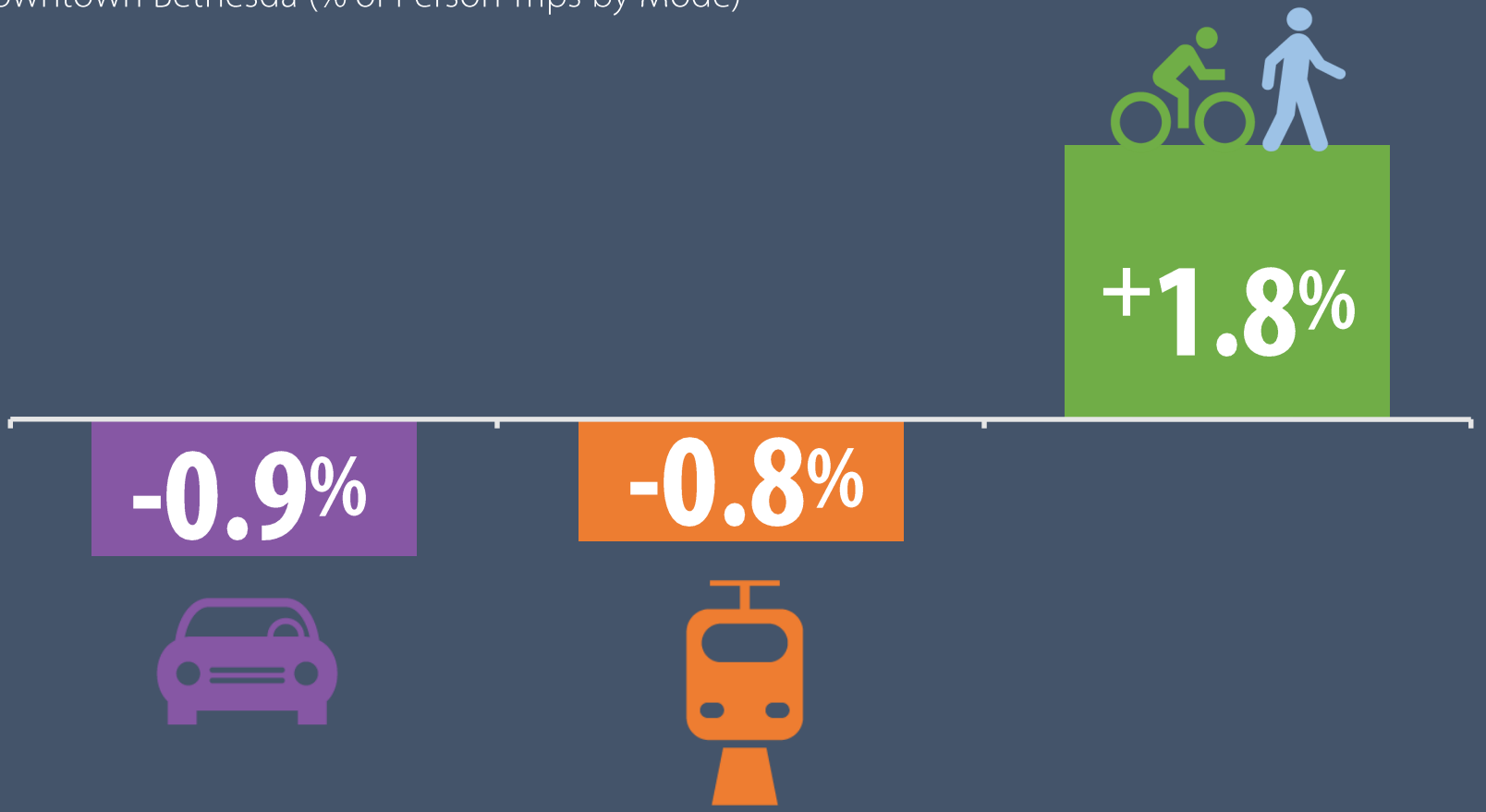
Downtown Bethesda (% of Person Trips by Mode)

2040 Base

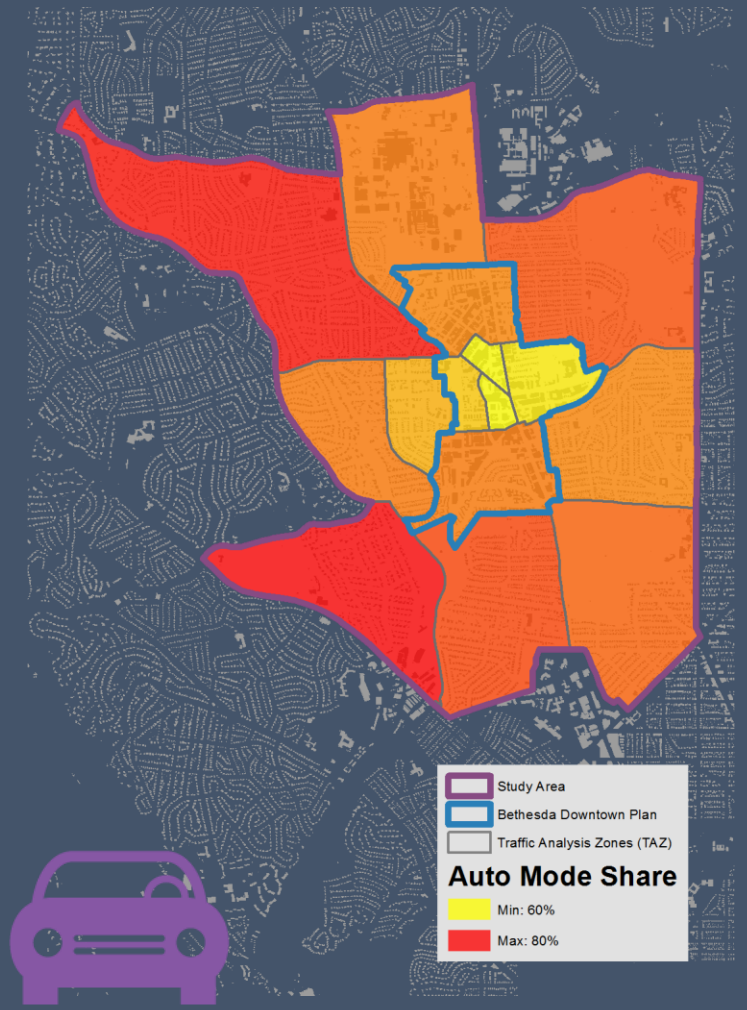


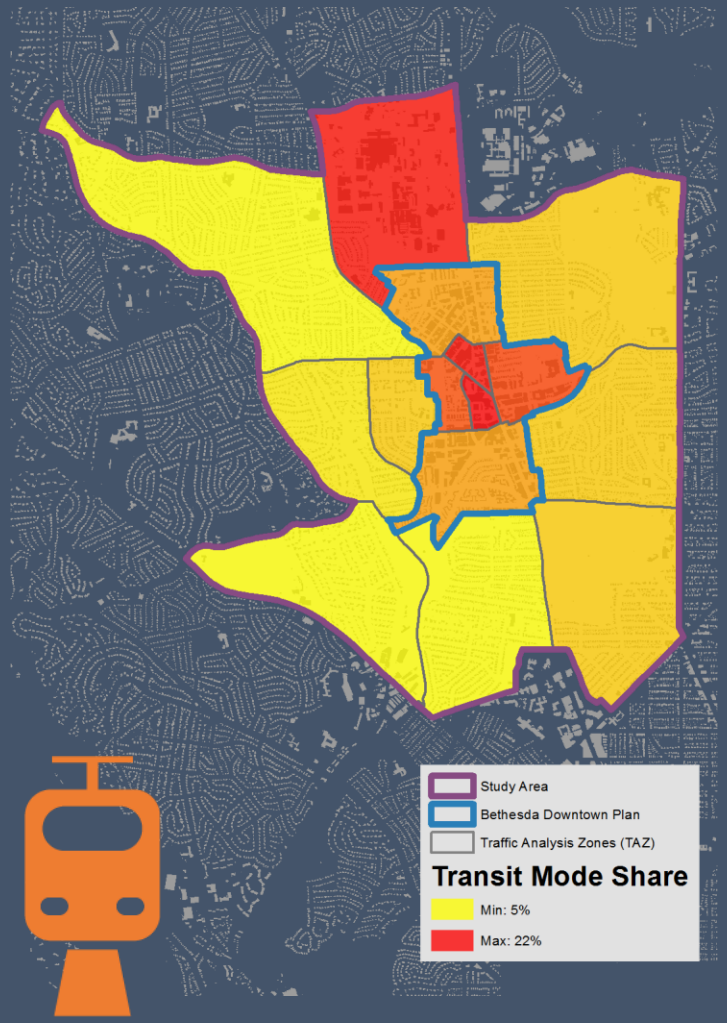
Bethesda Downtown Plan

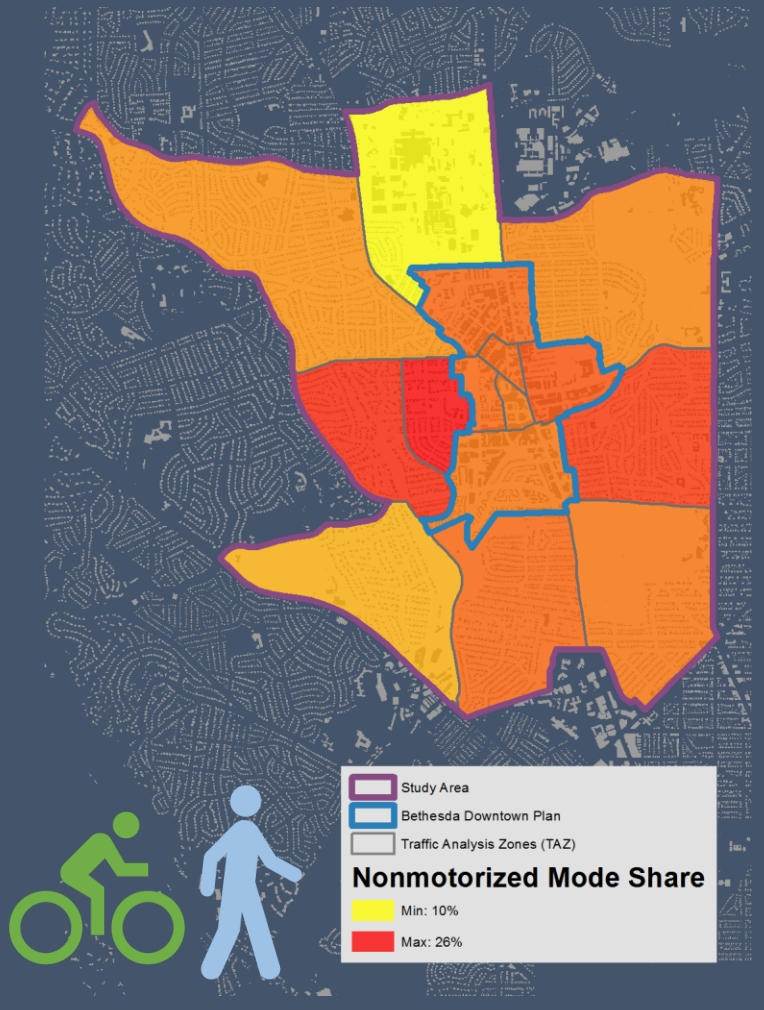




4a. Sector Plan Mode Share (% of Person Trips by Mode)







ACTIVITY

4b. Daily Person Trips Per Capita by Mode

Number of trips completed per person served

Includes residents and workers

ACTIVITY

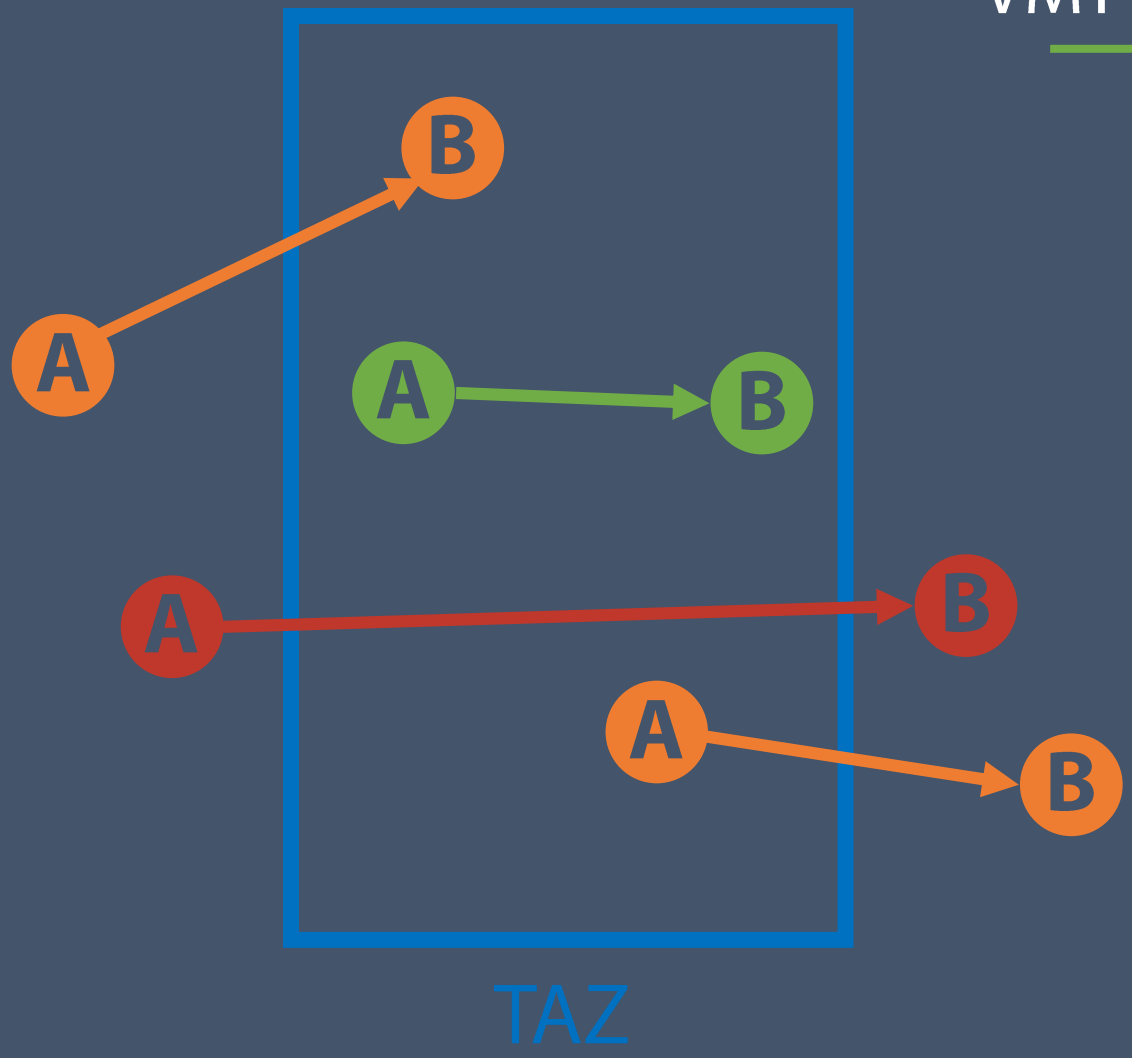
VMT per Capita

Reflects average amount of vehicle travel per person served

Includes residents and workers

ACTIVITY

VMT per Capita



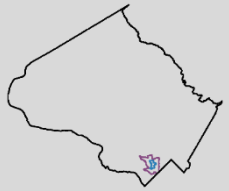
Includes:

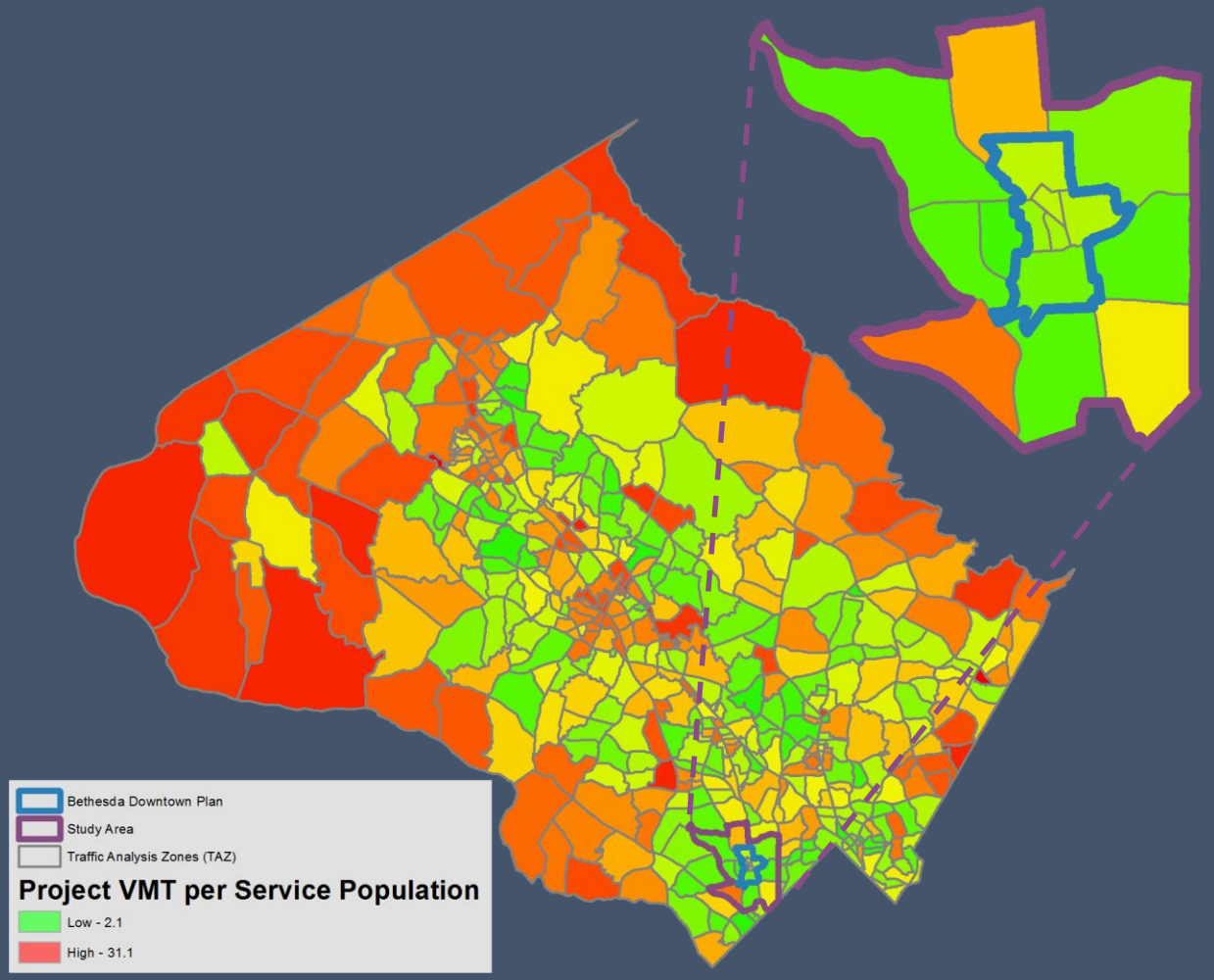
100% of mileage from trips completely within the zone

50% of mileage from trips that begin OR end in the zone

0% of mileage from trips that only pass through the zone

VMT per Capita

	2040 Base	Change	2040 Project	% Change
 Downtown Bethesda	10.3	-0.8	9.5	-8.2%
 Study Area	10.2	-0.5	9.7	-5.5%
 Montgomery County	11.0	-0.1	10.9	-0.7%



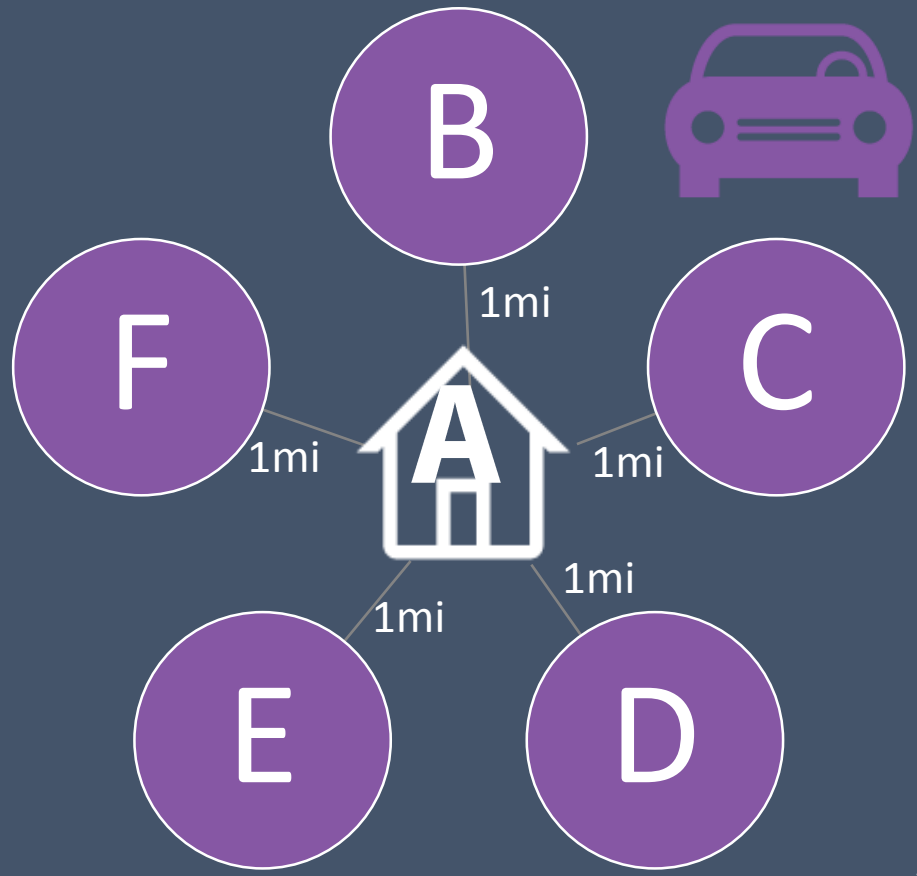
ACTIVITY

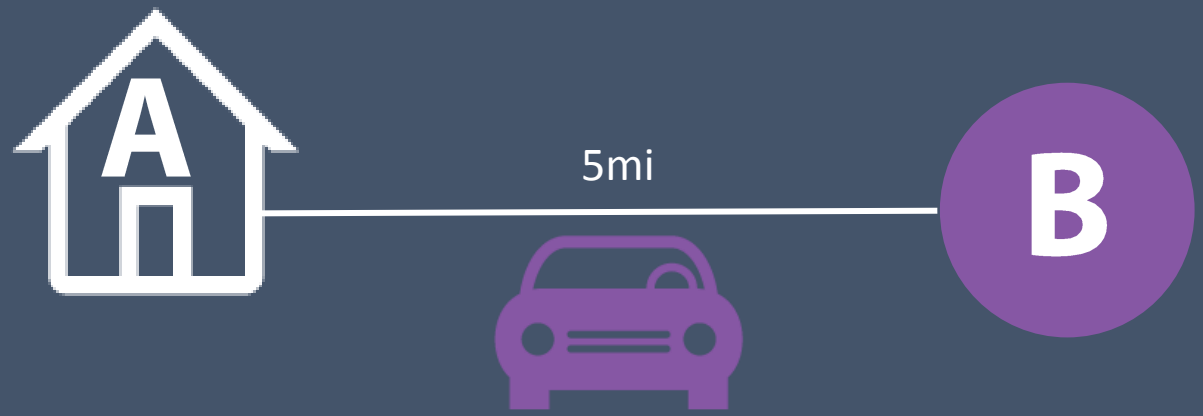
4c. VMT per Person Trip

Reflects average amount of vehicle travel needed to accomplish each trip

ACTIVITY

4c. VMT per Person Trip





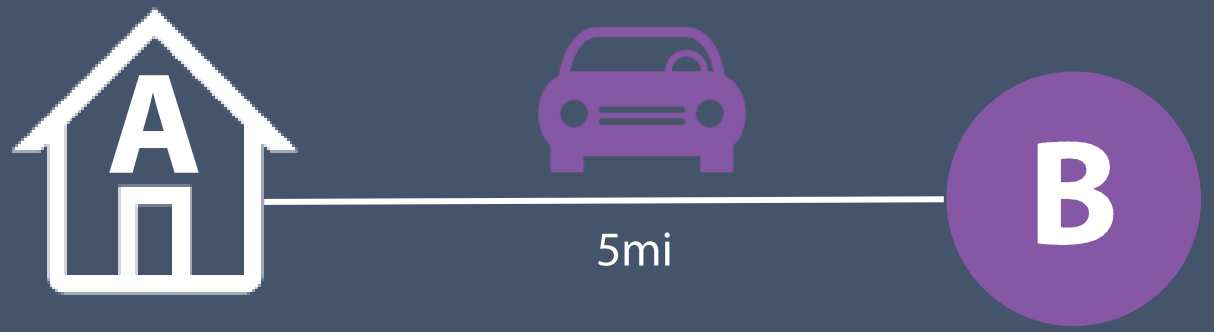
5 VMT = **5** VMT

5 Person Trips > **1** Person Trip

1 VMT per Person Trip < **5** VMT per Person Trip

ACTIVITY

4c. VMT per Person Trip



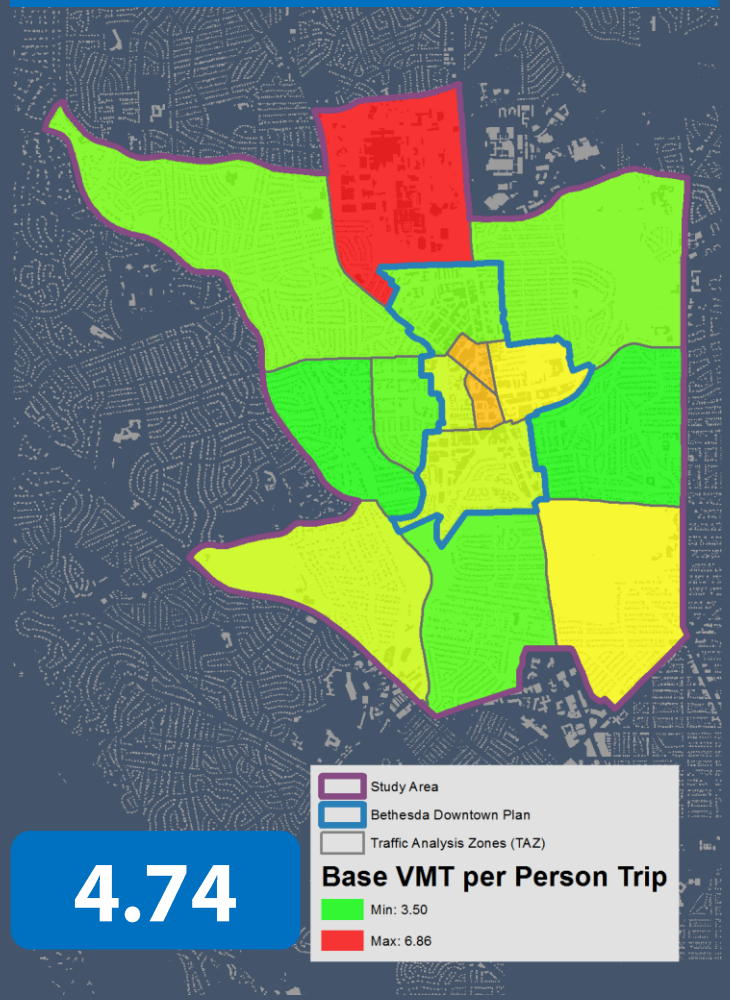
5 VMT = **5** VMT

10 Person Trips > **1** Person Trip

0.5 VMT per Person Trip < **5** VMT per Person Trip

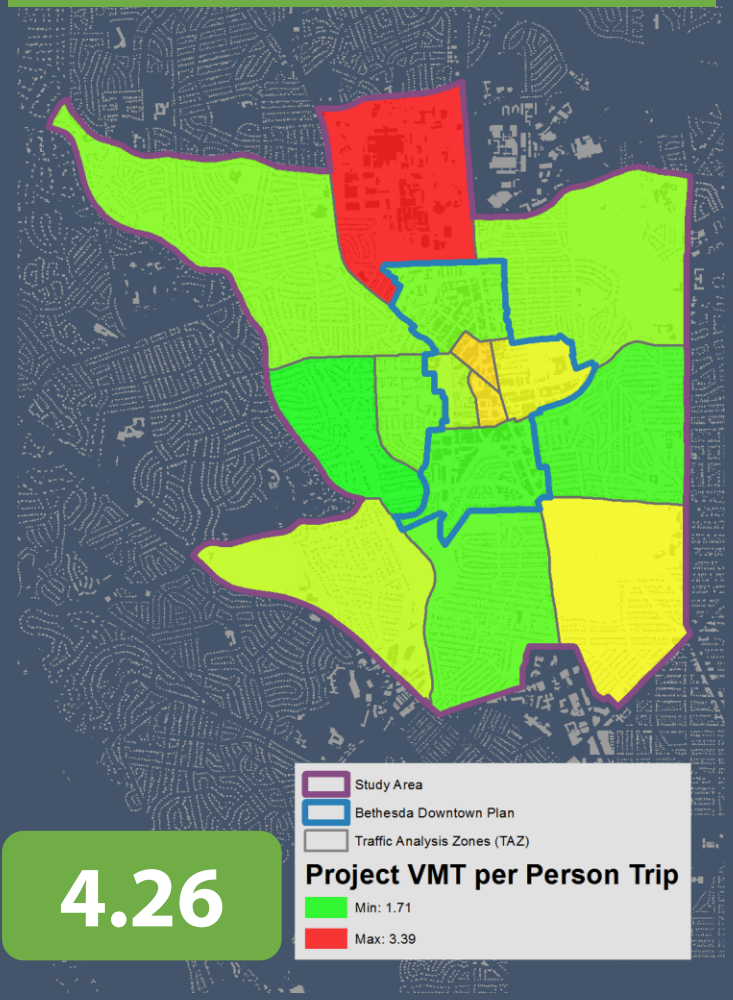
4c. VMT per Person Trip (All Modes) – Downtown Bethesda

2040 BASE



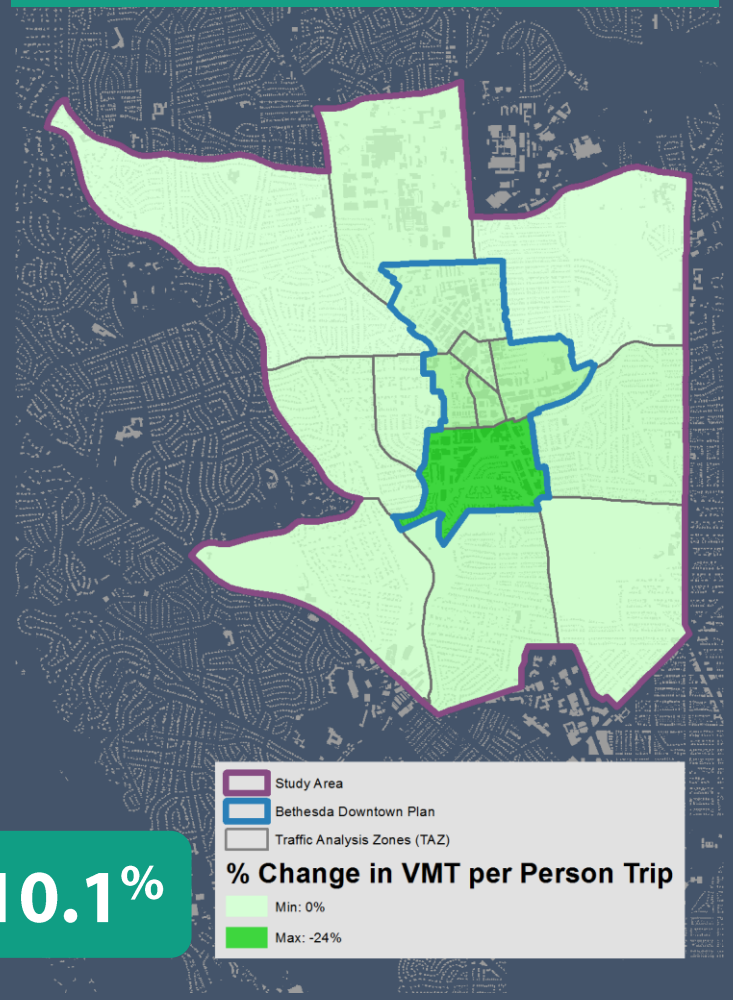
4.74

2040 PROJECT



4.26

CHANGE



-10.1%

4d. Vehicle Hours of Travel per Person Trip

Downtown Bethesda (All Modes)

Reflects average amount of time spent in an automobile to accomplish each trip

Base: 9.9 mins

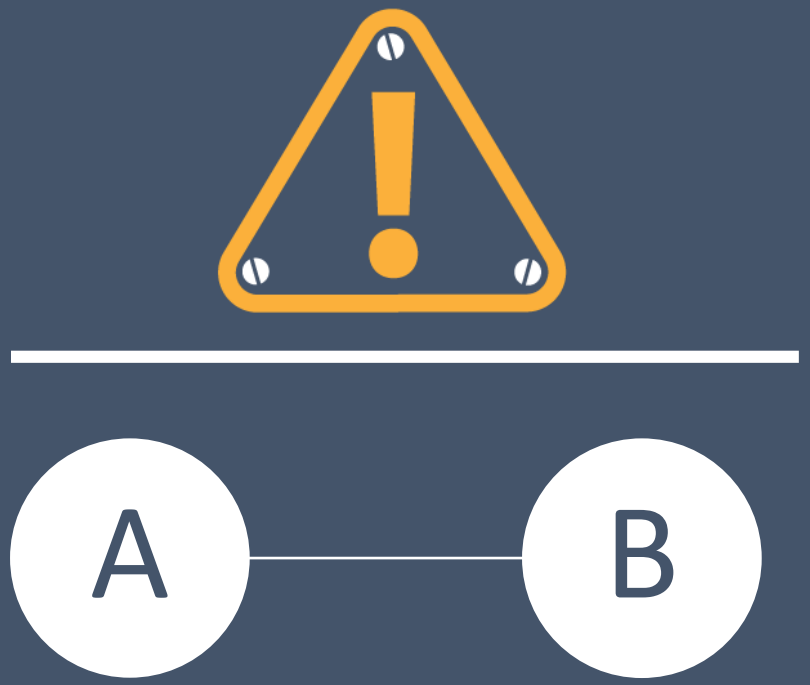
Project: 8.9 mins

% Change: -9.5%

ACTIVITY

4e. Collisions per Person Trip

(All Modes)



Normalizes number of collisions by number of person trips accomplished

Removes bias in collision counts toward high-activity areas

Summary: Transportation Performance Metrics

01 ACCESSIBILITY

- Jobs Accessible within 45 minutes by Mode
- Person Trips Accessible within 45 minutes by Mode
- Jobs Accessible by Travel Time by Mode
- Person Trips Accessible by Travel Time by Mode
- Person Trip Duration by Mode
- Access to Transit by Mode

02 TRAVELER EXPERIENCE

- Frequency of Service
- Span of Service
- Reliability
- Bicyclist Comfort
- Pedestrian Comfort

03 INTERSECTION PERFORMANCE

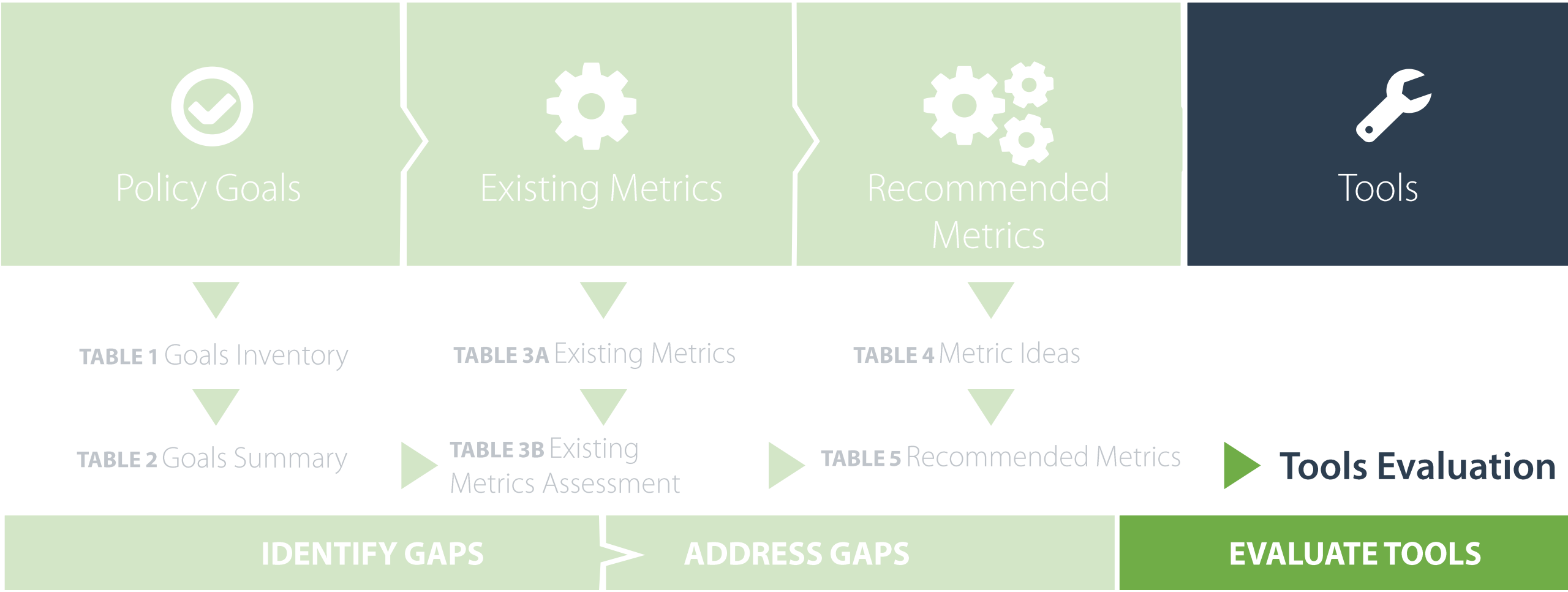
- Person Delay

04 ACTIVITY

- Raw Person Trips by Mode
- Person Trips Per Capita by Mode
- Vehicle Miles of Travel per Person Trip
- Vehicle Hours of Travel per Person Trip
- Person Trips per Collision

Next Steps

Tools Evaluation and Metrics and Tools Strategic Plan




QUESTIONS