Accessibility as the Lens for Integrated Land Use and Transportation Planning?

TRB Committee ADD30
January 12, 2015

RENAISSANCE PLANNING GROUP

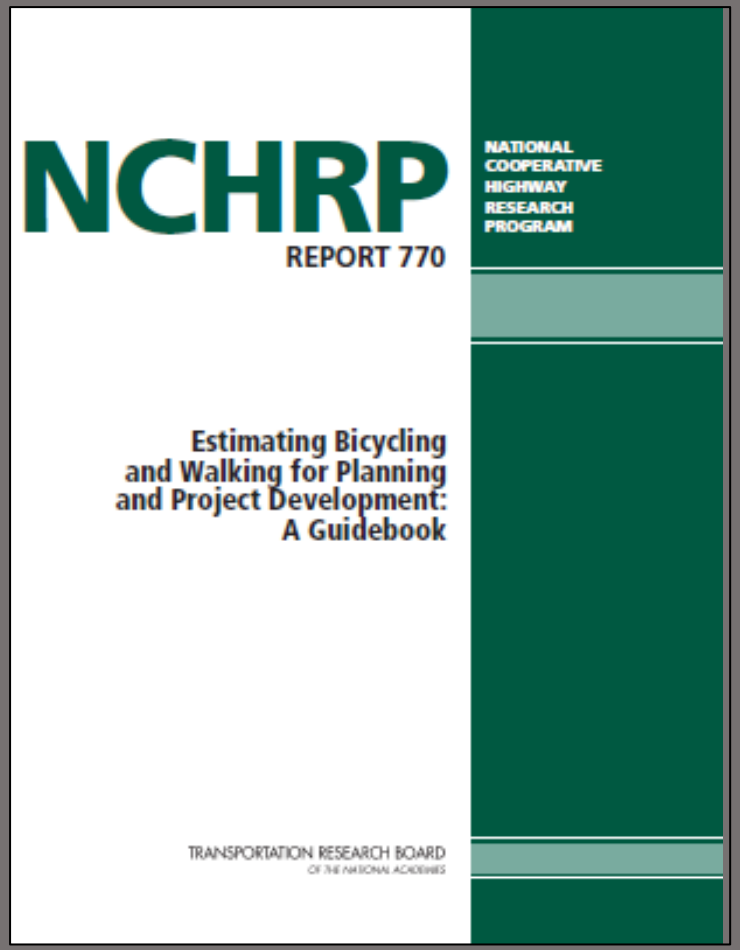
Background

- Long-standing interest in TR + LU connection
- Dabbled in 3D's models (BMC, SCAG, AzDOT)
- Selected to do NCHRP 08-78: Bike-Ped Demand
- Connected with Renaissance: GIS-assisted city planning
- Found new ways to use GIS to capture bike-ped relationships
- Opens a much broader platform for land use and multimodal planning

Discussion Focus

- Brief overview of NCHRP 8-78 (Report 770)
- Highlight GIS-accessibility model developed & tested in Arlington VA
- Share recent pilot test at regional corridor level for Maryland DOT
- New applications underway

NCHRP 8-78/Report 770



- **Purpose**: Develop responsive tools for estimating bike/walk demand
- **Major Needs/Concerns**:
  - Effect of Land Use
  - Role of Facilities
  - Impact on motorized travel
- **Response**:
  - Need finer geographic resolution
  - Major role for GIS data/tools

Guidebook Tools: A "Best Practices" Compendium

Entirely New

- Arlington GIS Walk Accessibility Model (walk only)
- Seattle Tour Generation & Mode Choice (walk & bike)
- Seattle Enhanced 4-Step Model (walk & bike)

Tool Selection Keyed To:

- Problem application
- Geographic Scale
- Accuracy requirements
- Key variables
- Data resources
- Skill level

Useful Pre-Existing

Walk Models:
- Ped Context
- MoPeD
- Portland (PIE)

Bike Route Choice:
- Portland State
- San Francisco (SFCTA)

Facility Demand:
- Santa Monica
- Seamless Travel

Overview of New Tools

Seattle/Puget Sound

Tour-Generation & Mode Choice*

Estimates number of daily "tours" and mode choice by purpose

Modes: walk, bike, transit, auto

Key Variables:
- Demographics
- Land use
- Facility characteristics
- Accessibility

Enhanced Trip- Based (TAZ) Model

Sensitizes each model step to land use; keeps walk & bike alive into mode choice step

Key Variables:
- Demographics
- Land use
- Accessibility

Arlington, VA

GIS Accessibility Approach*

Uses GIS data and tools to calculate modal accessibility scores

Score relationships tied to mode choice

Key Variables:
- Land use
- Transport networks
- Accessibility

* = Spreadsheet version of model on CD-ROM

Arlington GIS Accessibility Model

Goal:

- Emulate intuitive appeal of Walk Score
- Apply transportation and land use knowledge to put theory behind the measures
- Build on earlier discovery experience at BMC with a "Walk Opportunities Index" using GIS to create a comprehensive measure of local accessibility
- Use GIS as a central part of the methodology, but also to add greater visualization to planning process

Arlington GIS Accessibility Model

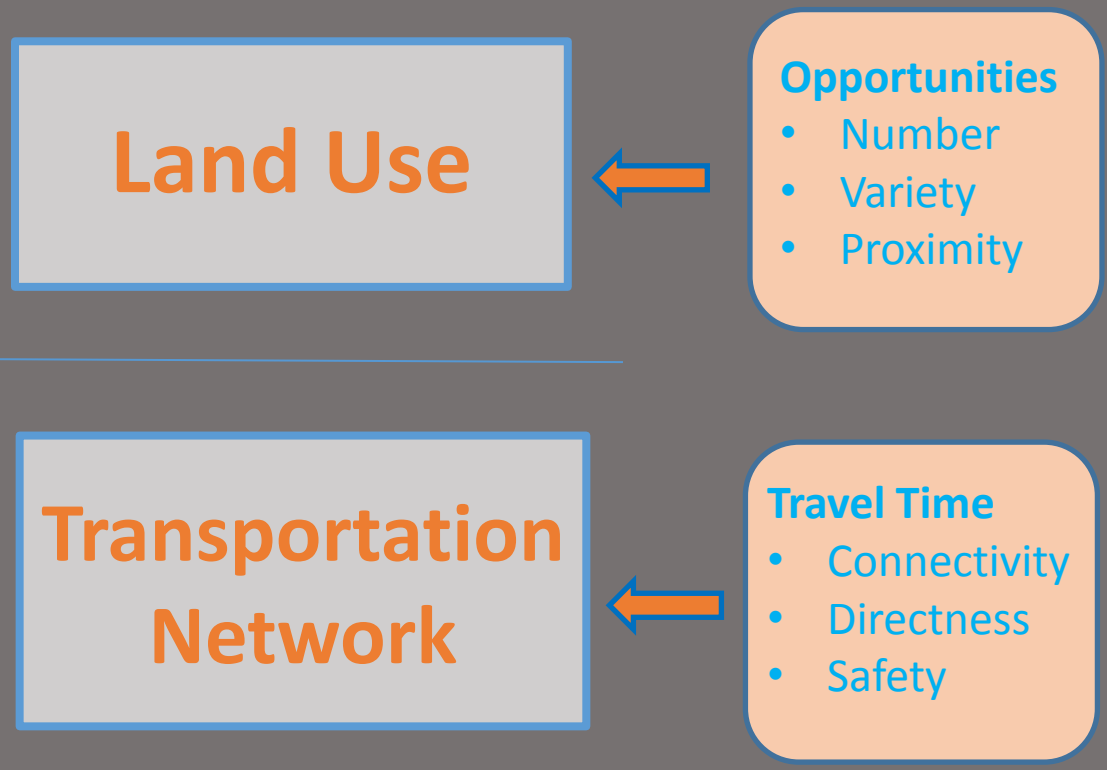
Goal:

- Intuitive appeal of Walk Score
- Apply transportation and land use knowledge Push capability outside regional 4-step models
- Take advantage of modern GIS capabilities
- Use GIS to calculate Accessibility Scores (like Walk Score) – link to travel behavior
- *Accessibility* incorporates both Land Use and Transportation
- Add greater visualization to planning process

A Simple but Elegant Framework

ACCESSIBILITY =

What opportunities can I reach within a given travel time by each mode?

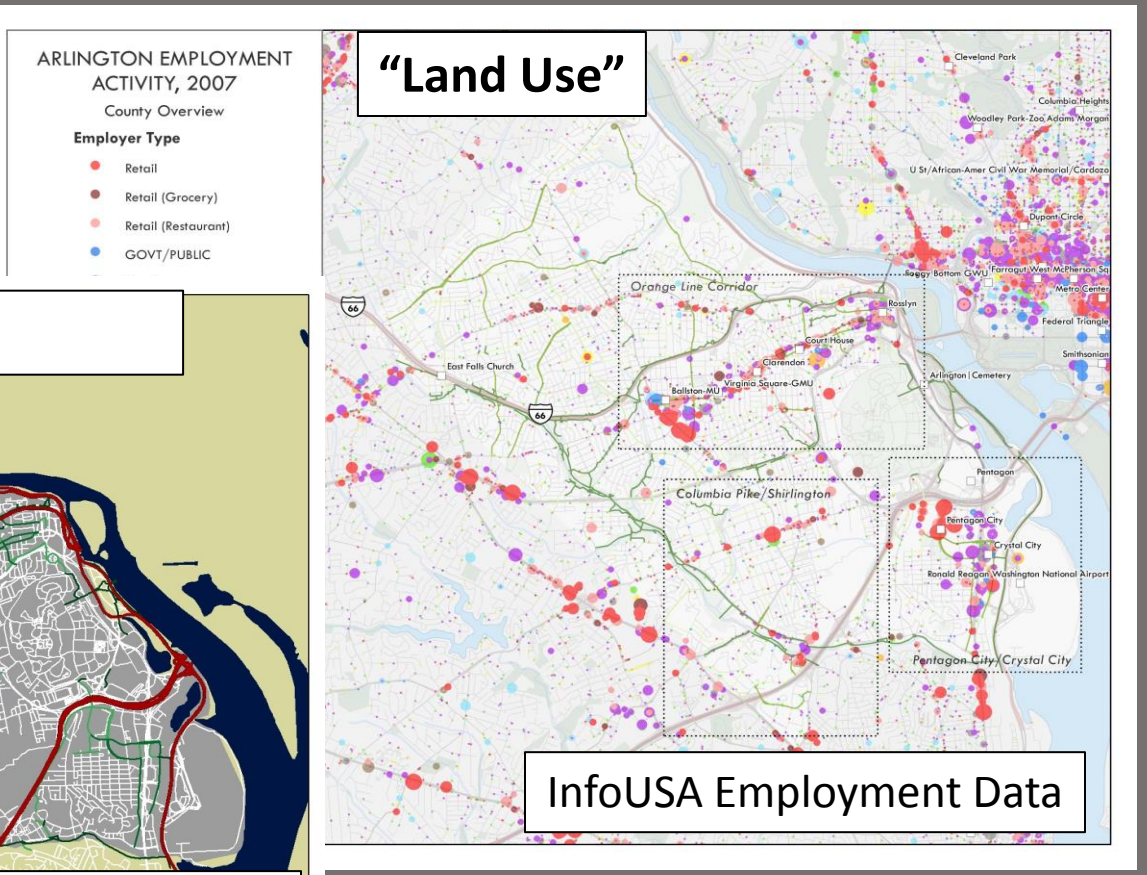


Data and Tools (all from MWCOG)

- Land Use:
  - **InfoUSA** Employment & # establishments by NAICs
  - Exact x,y location
- Travel Networks:
  - MWCOG highway and transit skims
  - All streets NAVTEQ network, enhanced to include walk/bike facilities
  - Path selection – **Network Analyst** (ArcGIS)
- Travel Behavior:
  - **Regional HH Travel Survey**

Using GIS to Calculate Relationships

Land Use & Network Overlay



Calculating Accessibility Scores

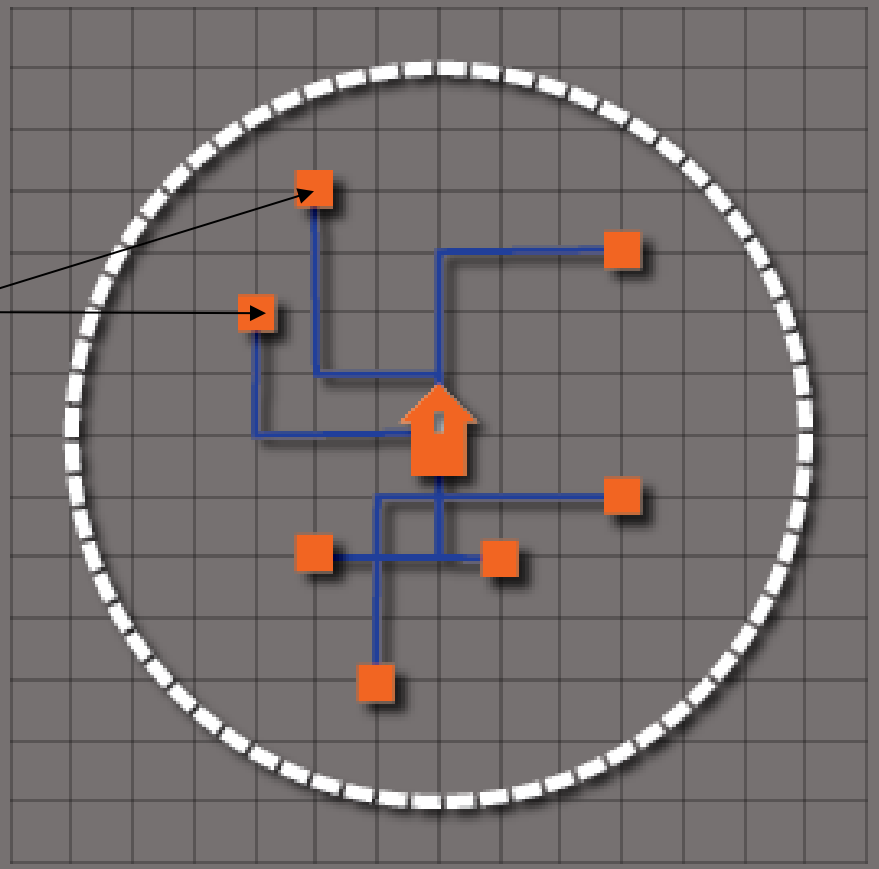
$$\text{Accessibility} = \sum \frac{Opportunity}{Travel\ Time * Decay}$$

Where:

Opportunities = Number of Jobs (HBW) or Number of Retail/Service Establishments (HBNW)

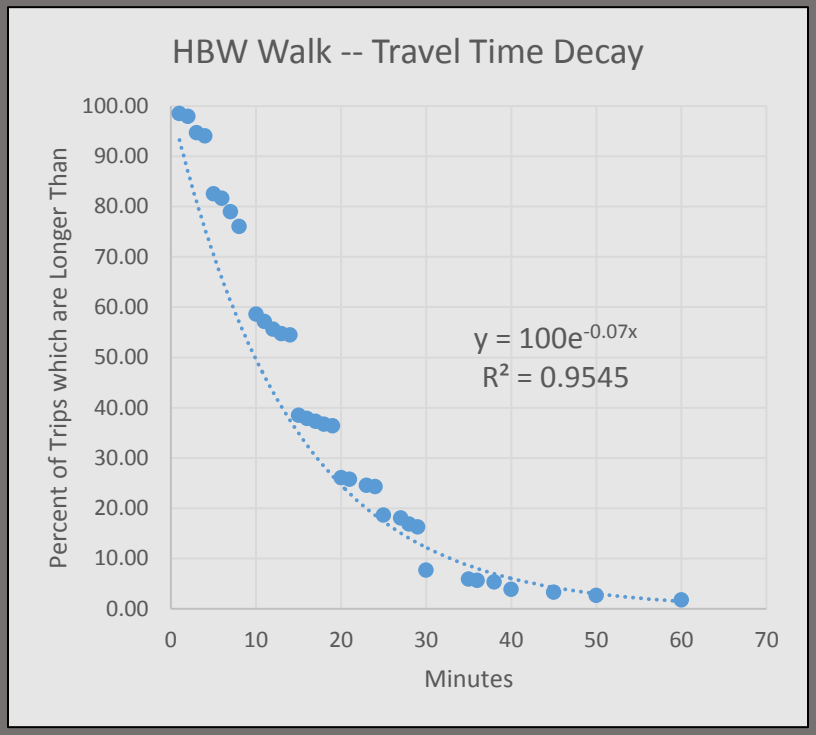
Travel Time = Time to reach opportunity over *actual network* (Network Analyst)

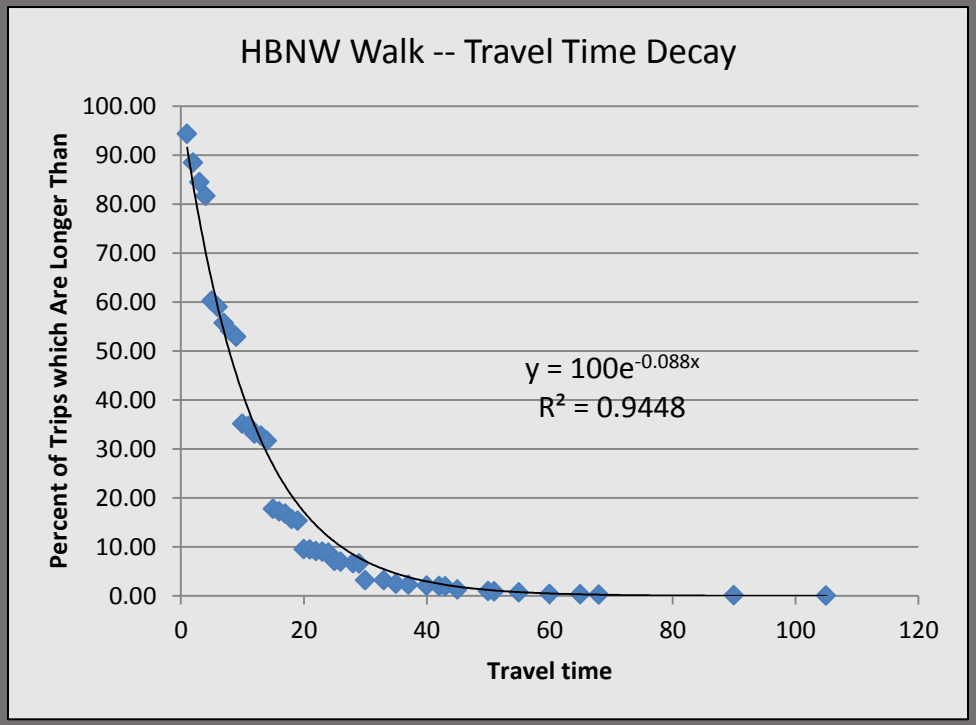
Decay = Factor reflecting decrease in value of opportunities that are farther away



Distance-Decay Relationships

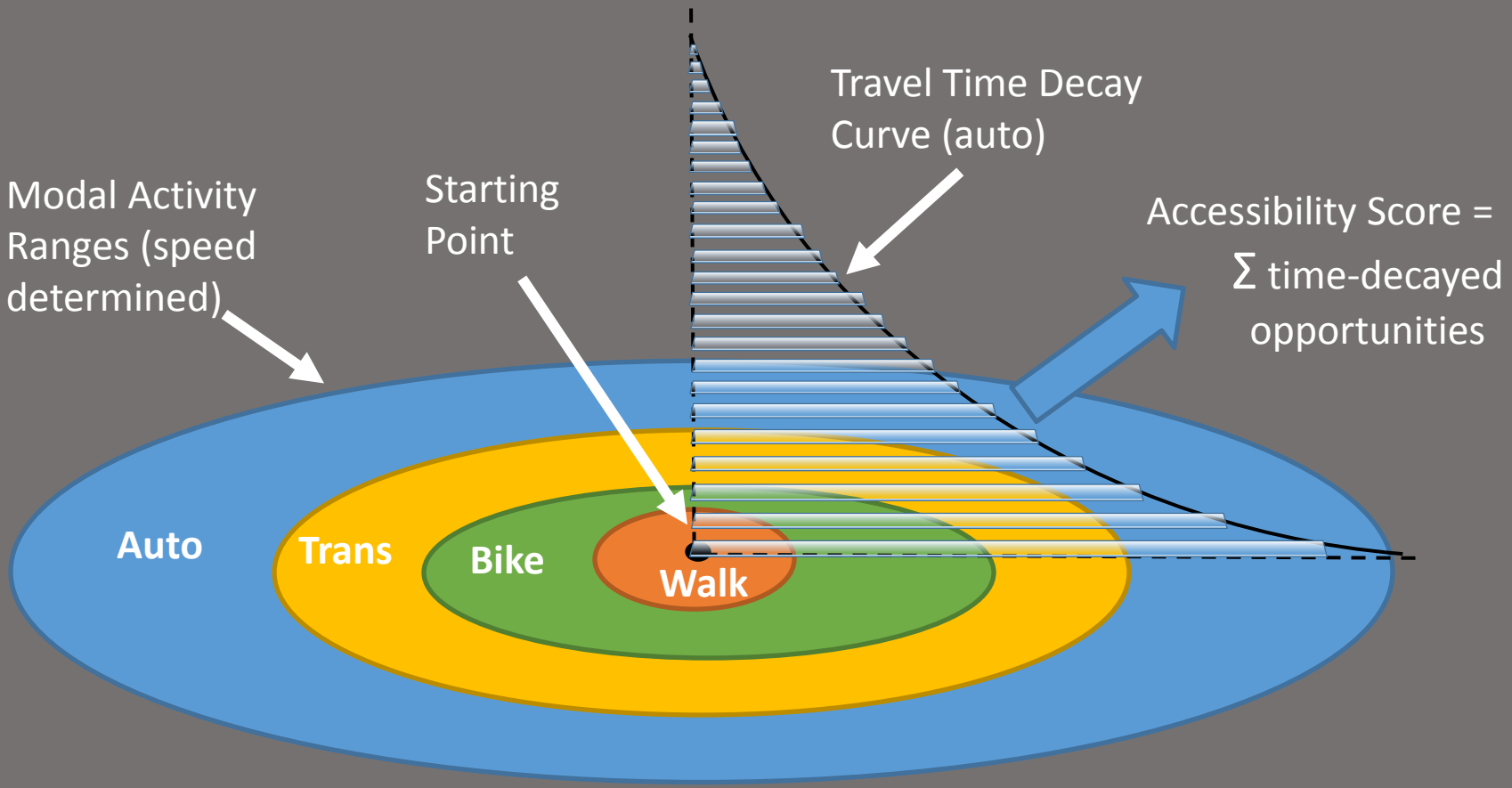
(derived from travel survey trip distributions)





Calculated for all modes and travel purposes

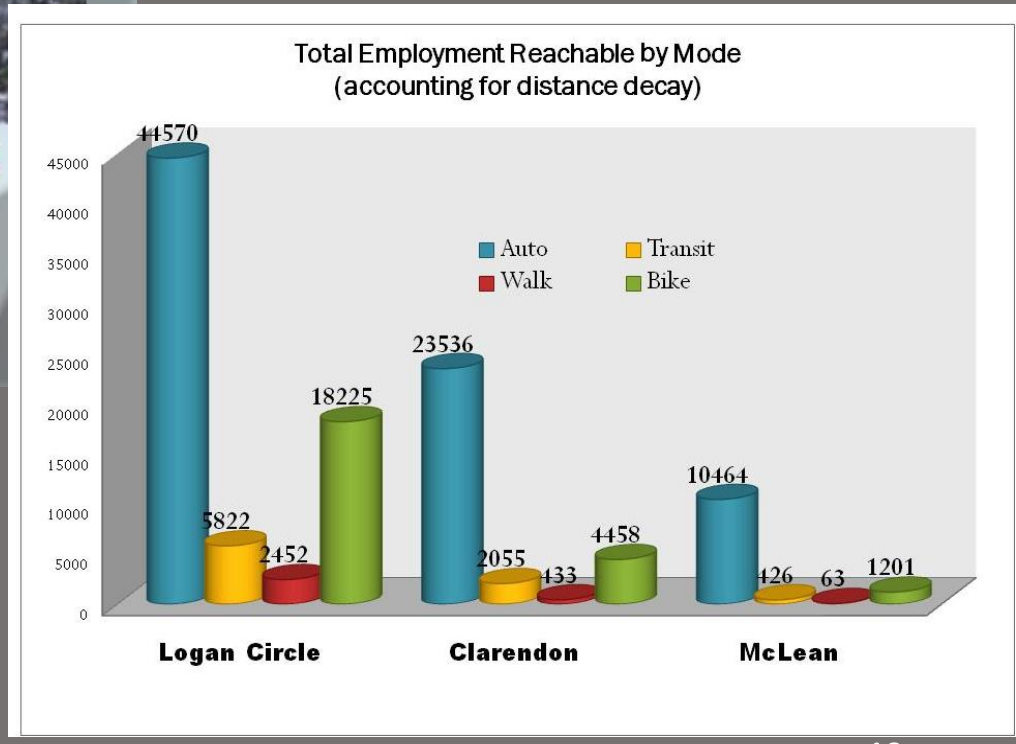
Scores Calculated for Each Mode



What We Do with the Scores

- **Accessibility Maps:** Readily show patterns in accessibility by mode across areas, scenarios
- **Travel Demand Models:** Use scores to explain mode choice
- **Forecasting:** Predicting mode choice from existing conditions or alternative scenarios

Comparing Accessibility Scores for Different Settings

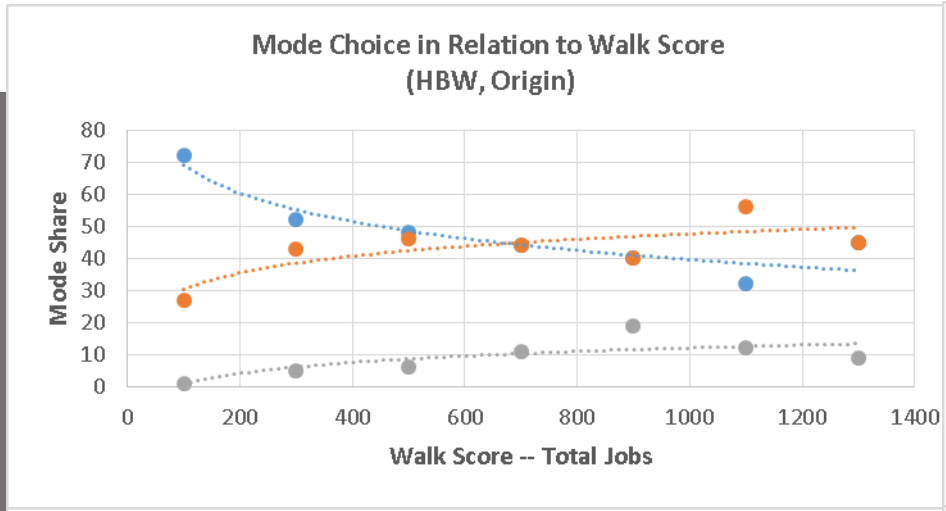


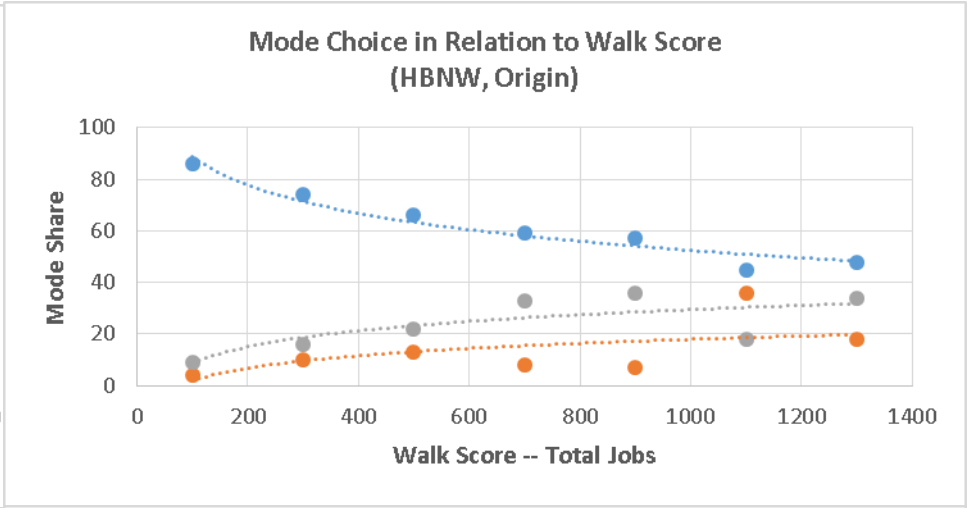
Accessibility's Influence on Mode Choice

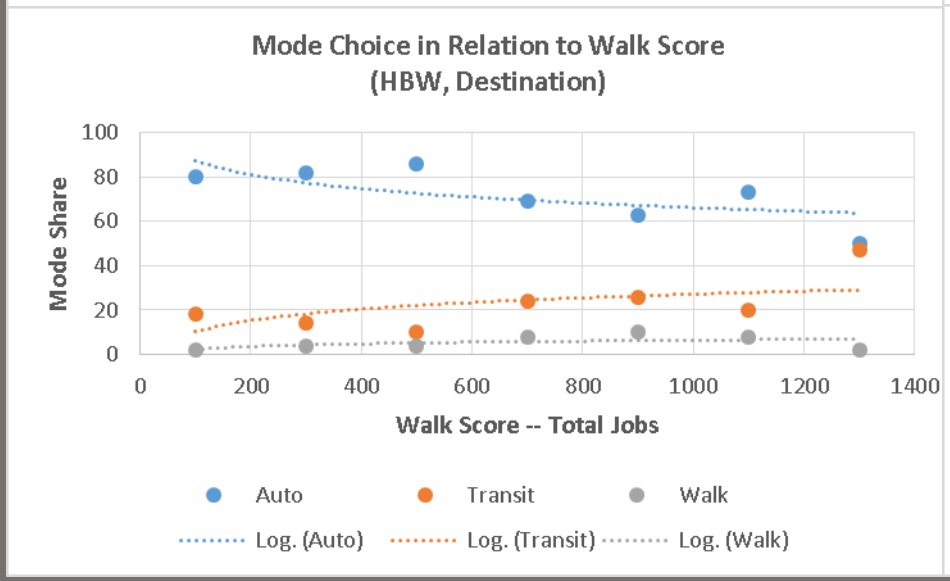
Comparative Accessibilities			
	Logan Circle	**Clarendon**	**McLean**
Auto	4.26	2.25	1.0
Transit	13.6	4.82	1.0
Bike	15.17	3.71	1.0
Walk	38.9	6.9	1.0

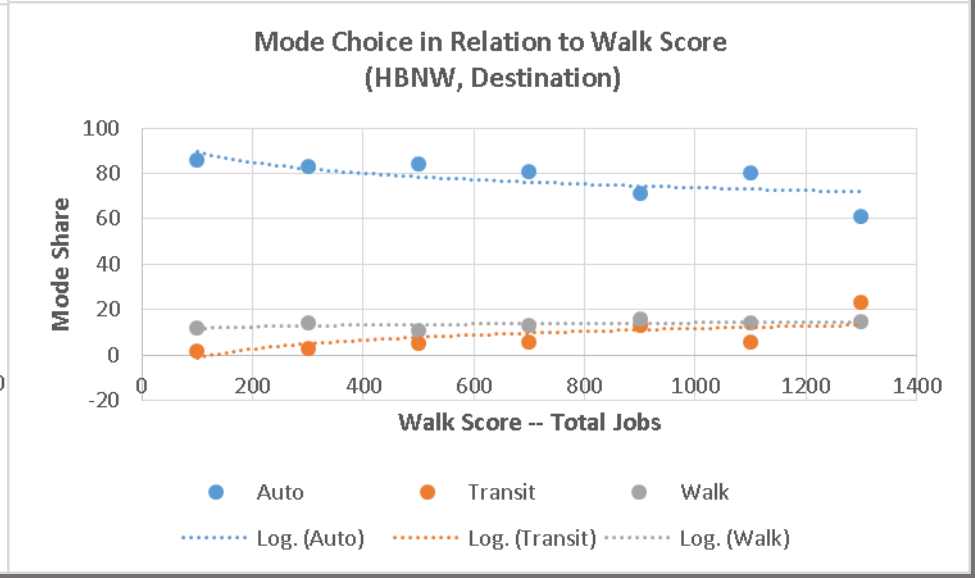
Non-Motorized Mode Share (HH survey)	
Logan Circle	41%
Clarendon	21%
McLean	8%

Statistically Linking Accessibility Scores with Mode Choice Patterns in Travel Survey

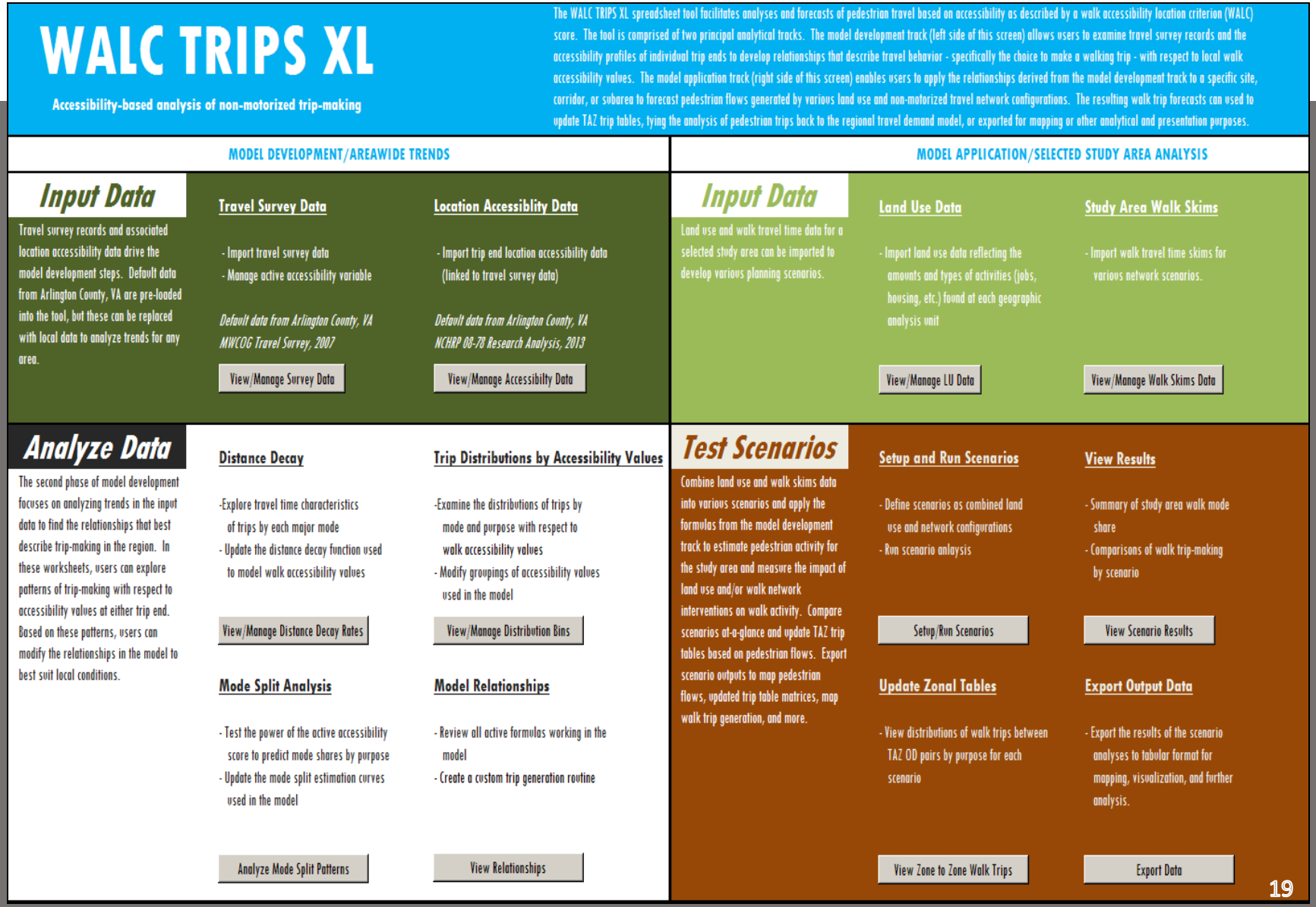




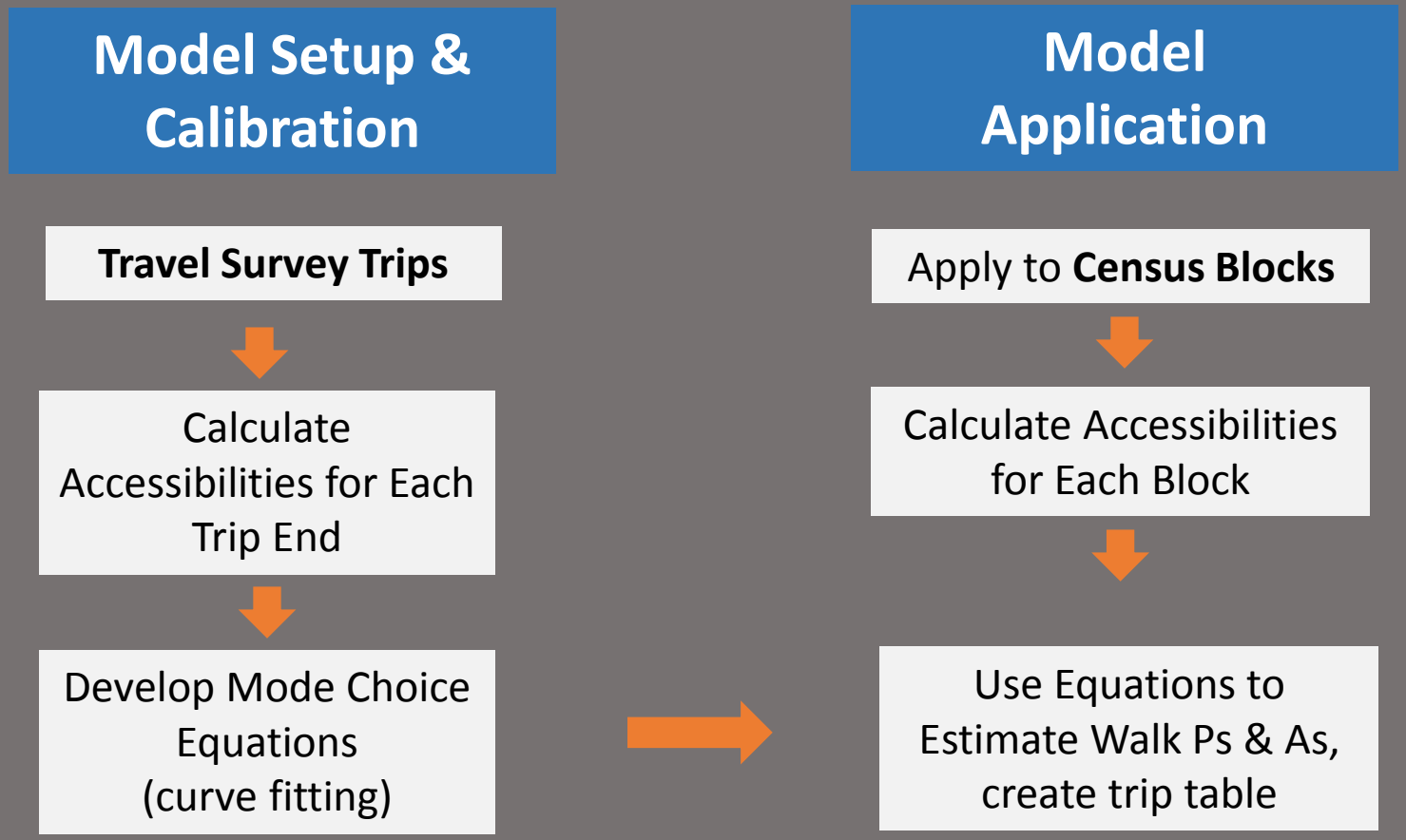




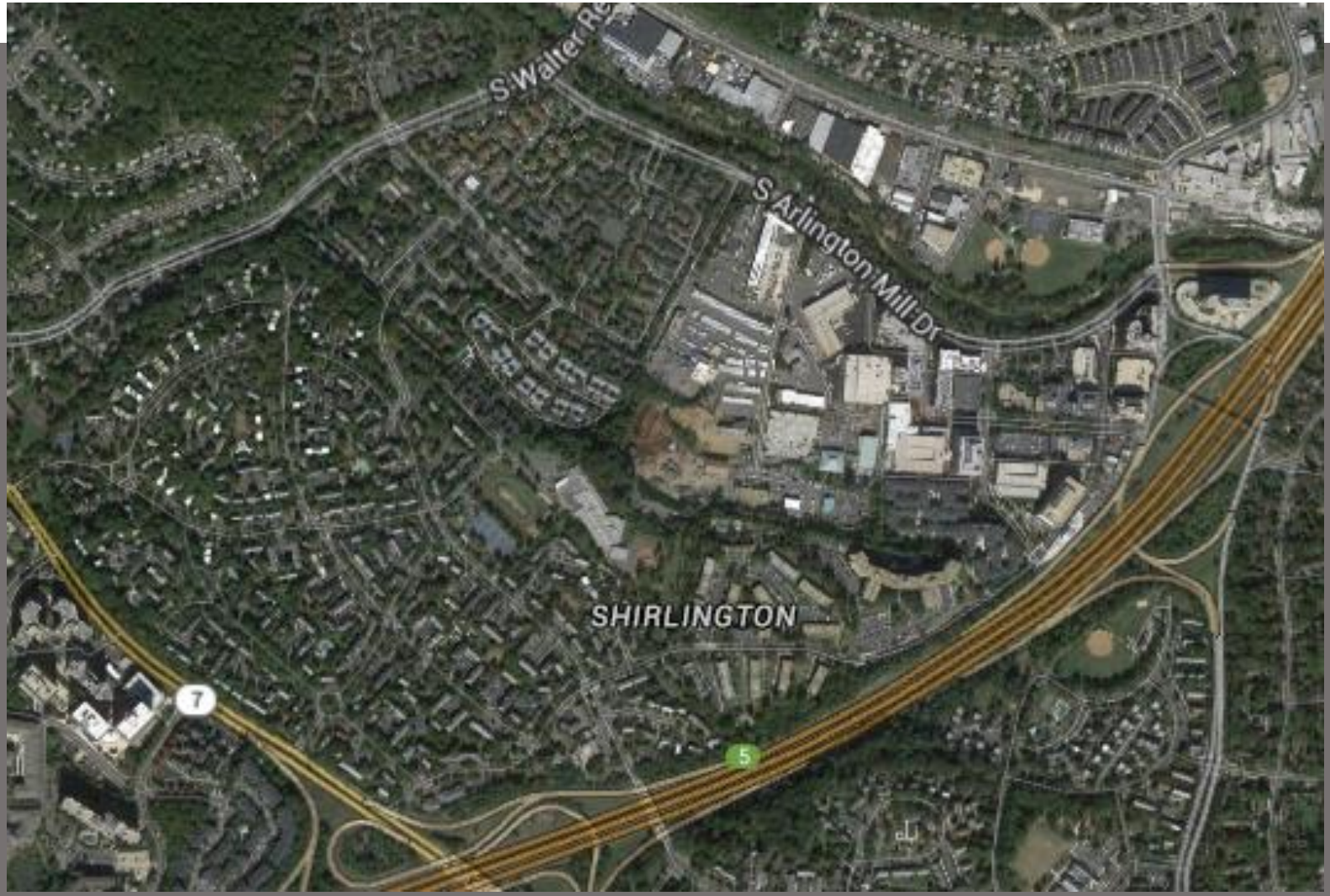
Report 770 Walk Accessibility Model



Model Development vs Application

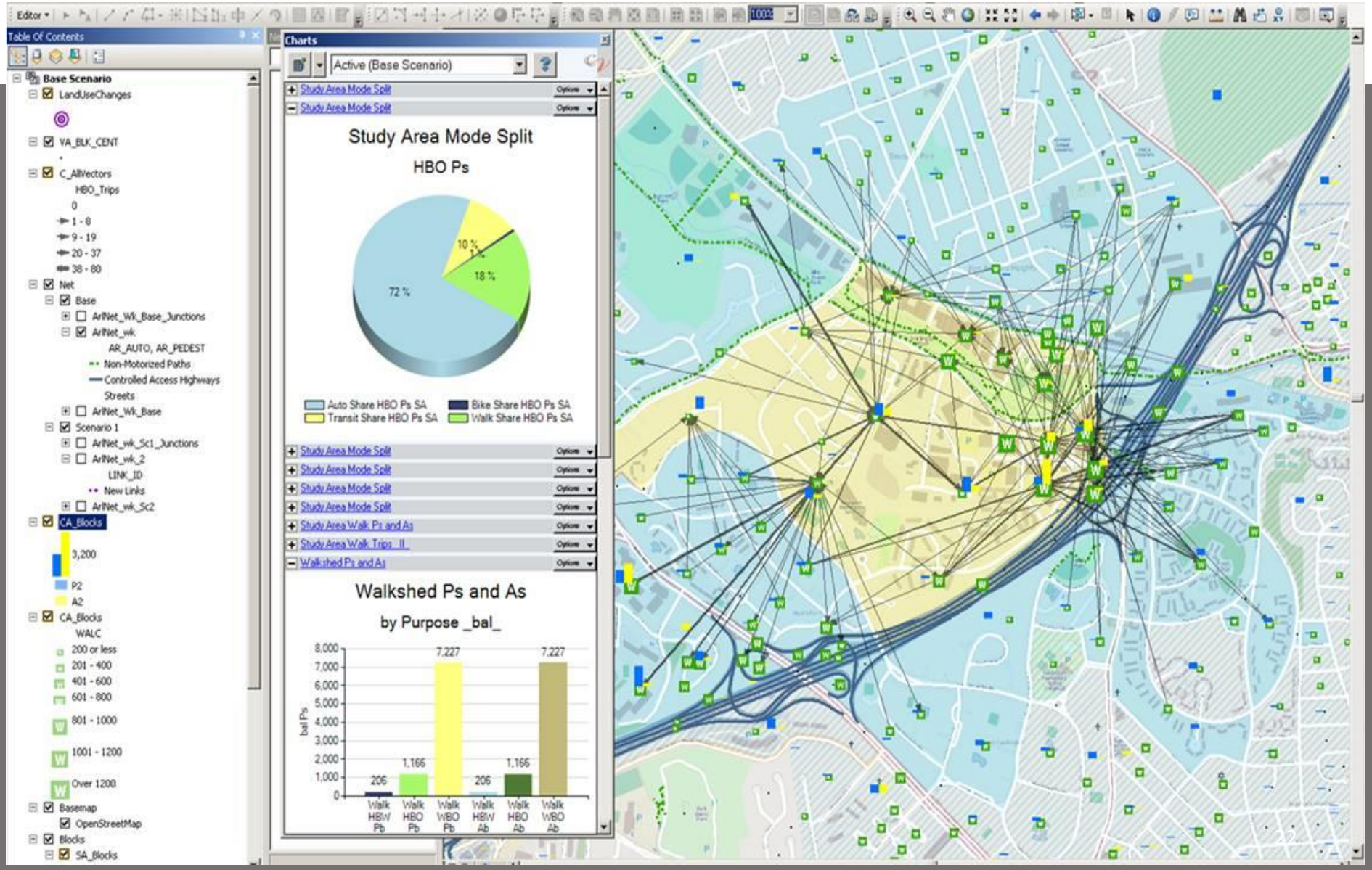


Test Application to Shirlington

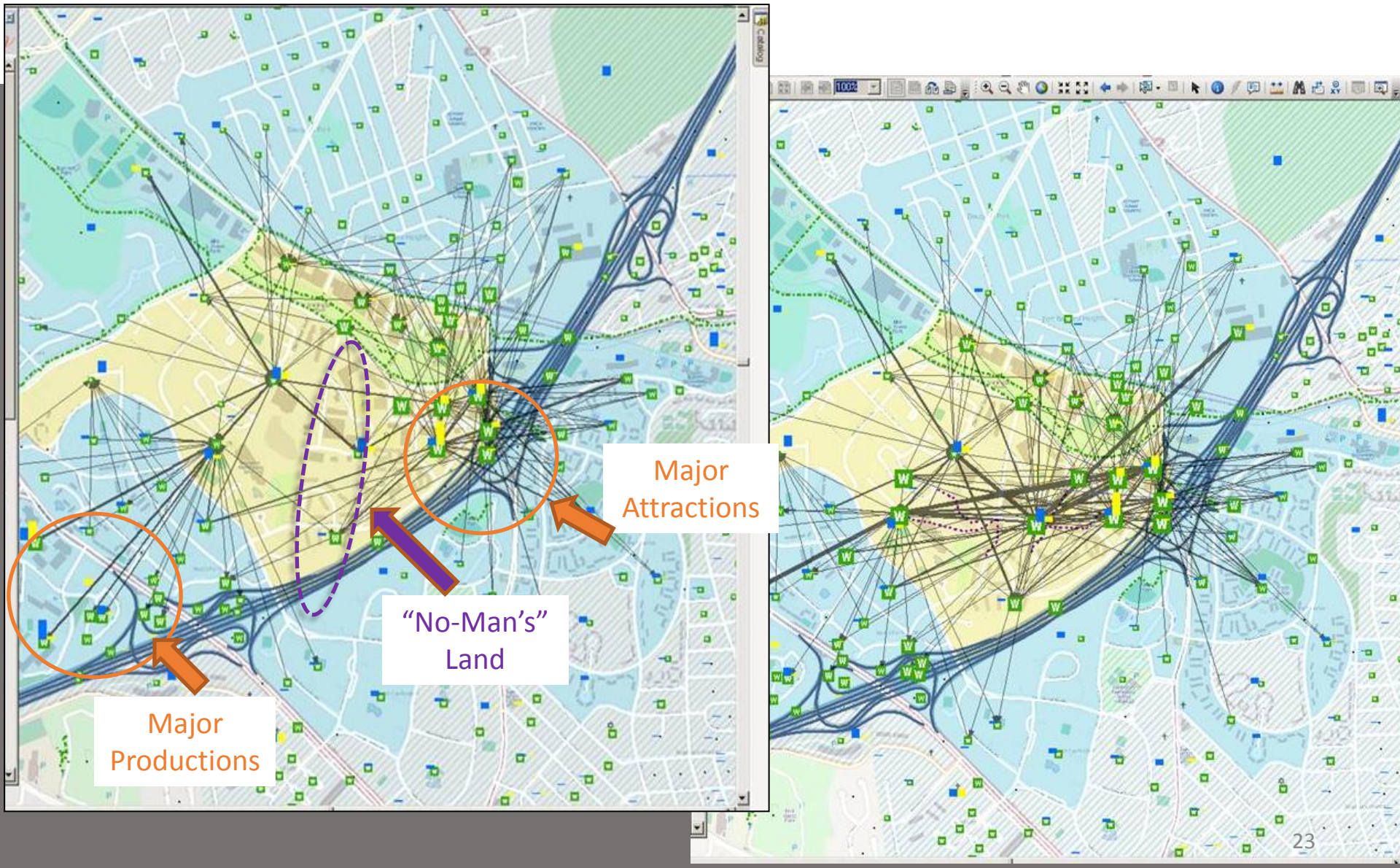


Using Model to Estimate Walk Trip Flows

(WALC model available in NCHRP Report 770)



Identifying Unmet Walk Opportunities



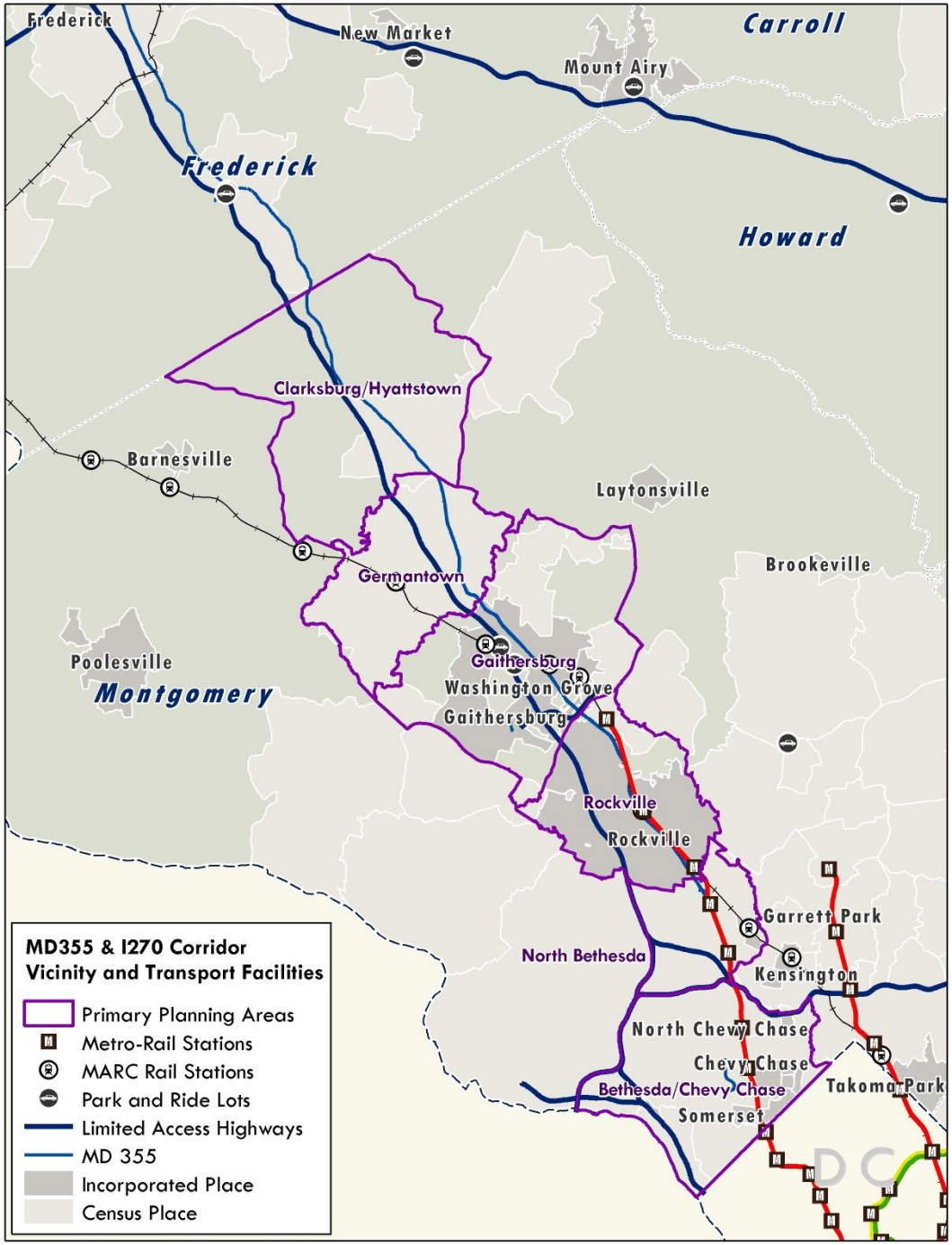
Maryland Department of Transportation: Analytic Tool Support

- Want more sensitivity in planning tools
- Policies and evaluation criteria more complex
- Want to account for land use and non-motorized
- Visualization for working with jurisdictions

➢ ***Recommend pilot study of Arlington approach in major corridor***

MD 355/I-270 Pilot Study Corridor

- 26 miles
- I-270 makes MD 355 more of a “Main Street”
- Multimodal: Metrorail & MARC, BRT under study
- Still very auto-oriented
- Concerns about impact of planned growth on transport sustainability



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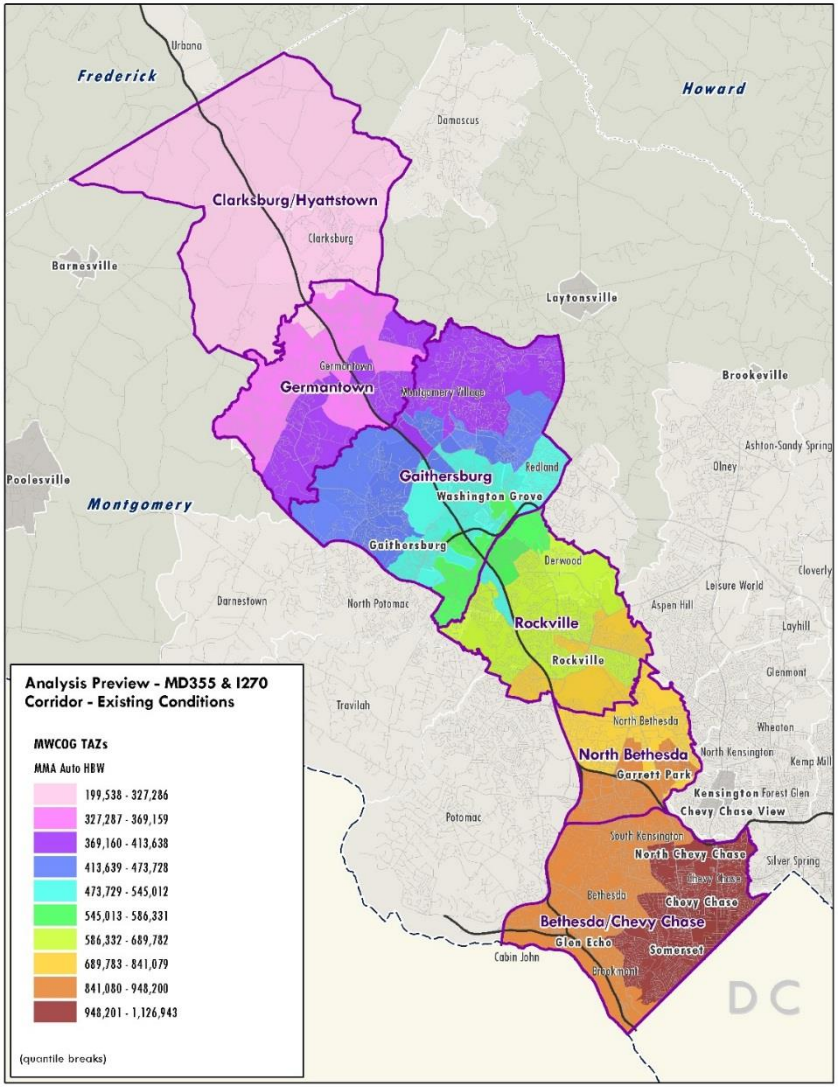
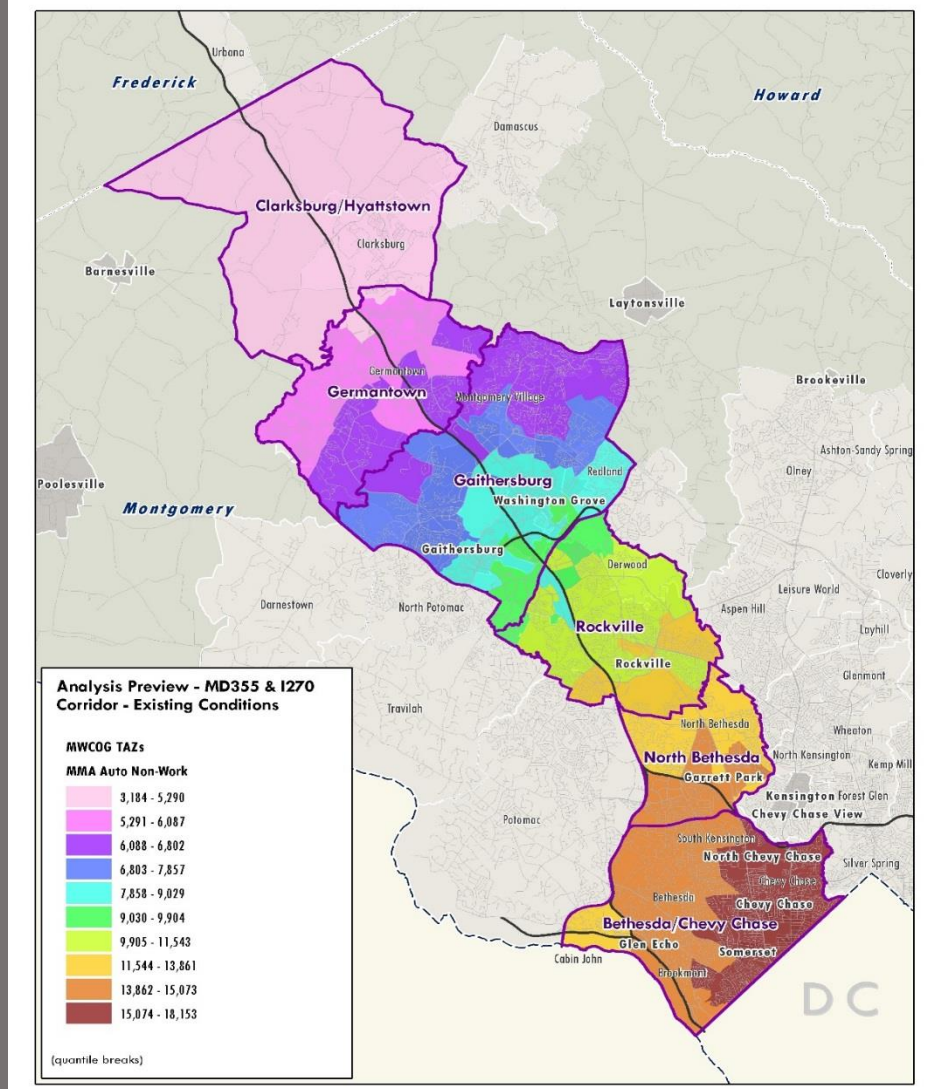
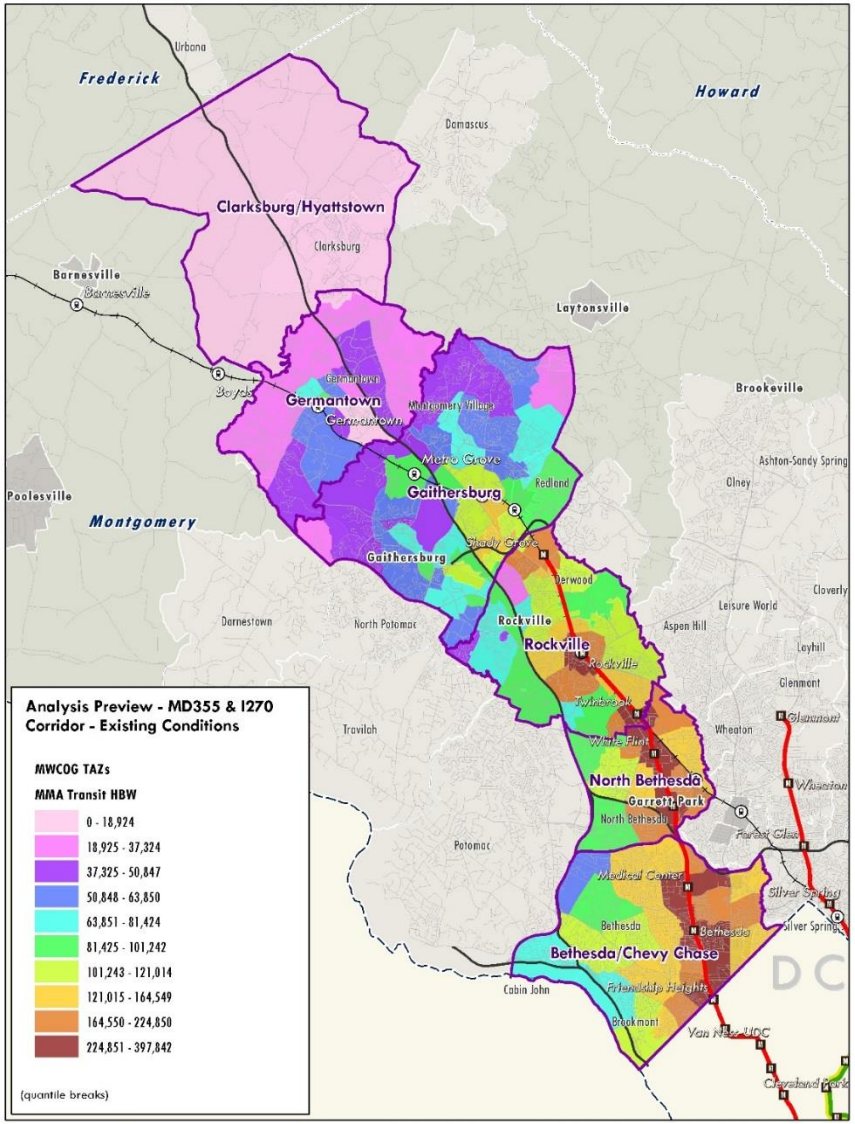
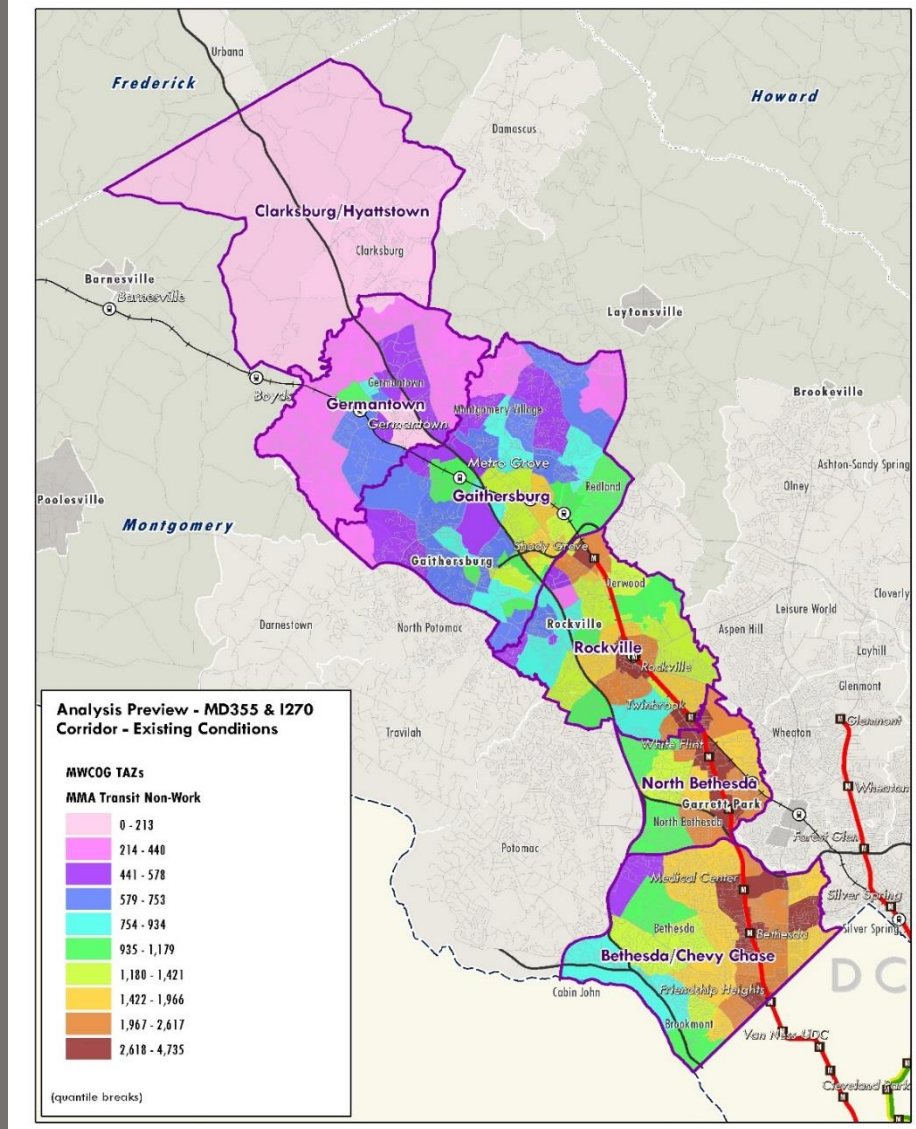
Auto Accessibilities: Work & Non-Work (TAZ)



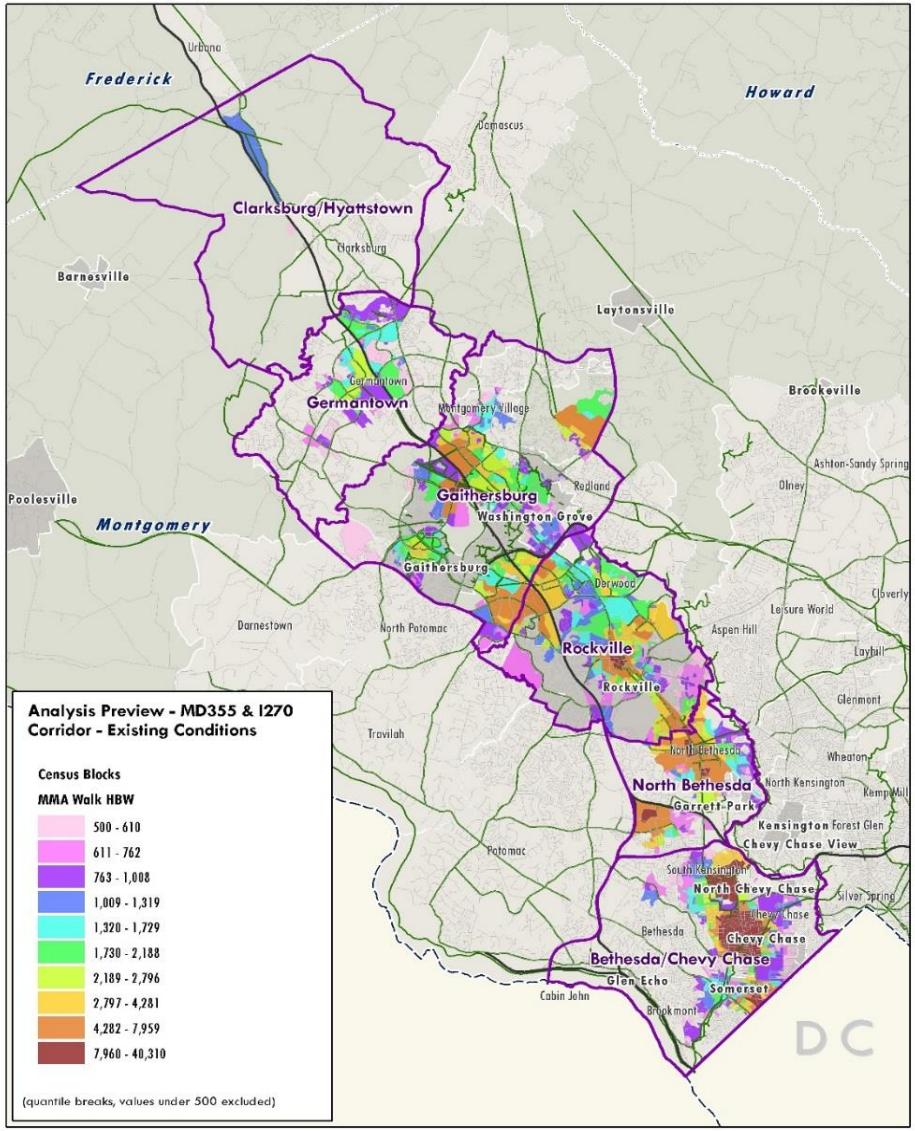


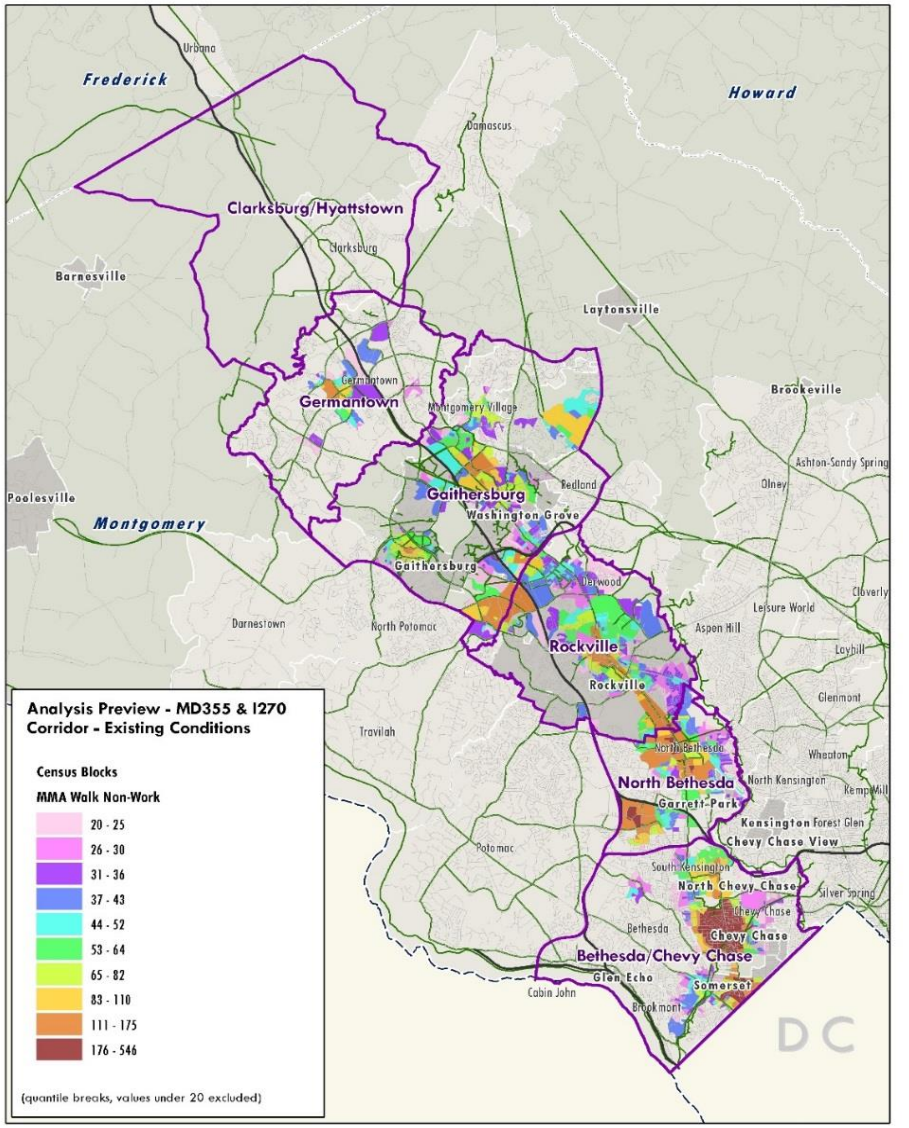
Transit Accessibilities: Work & Non-Work (TAZ)



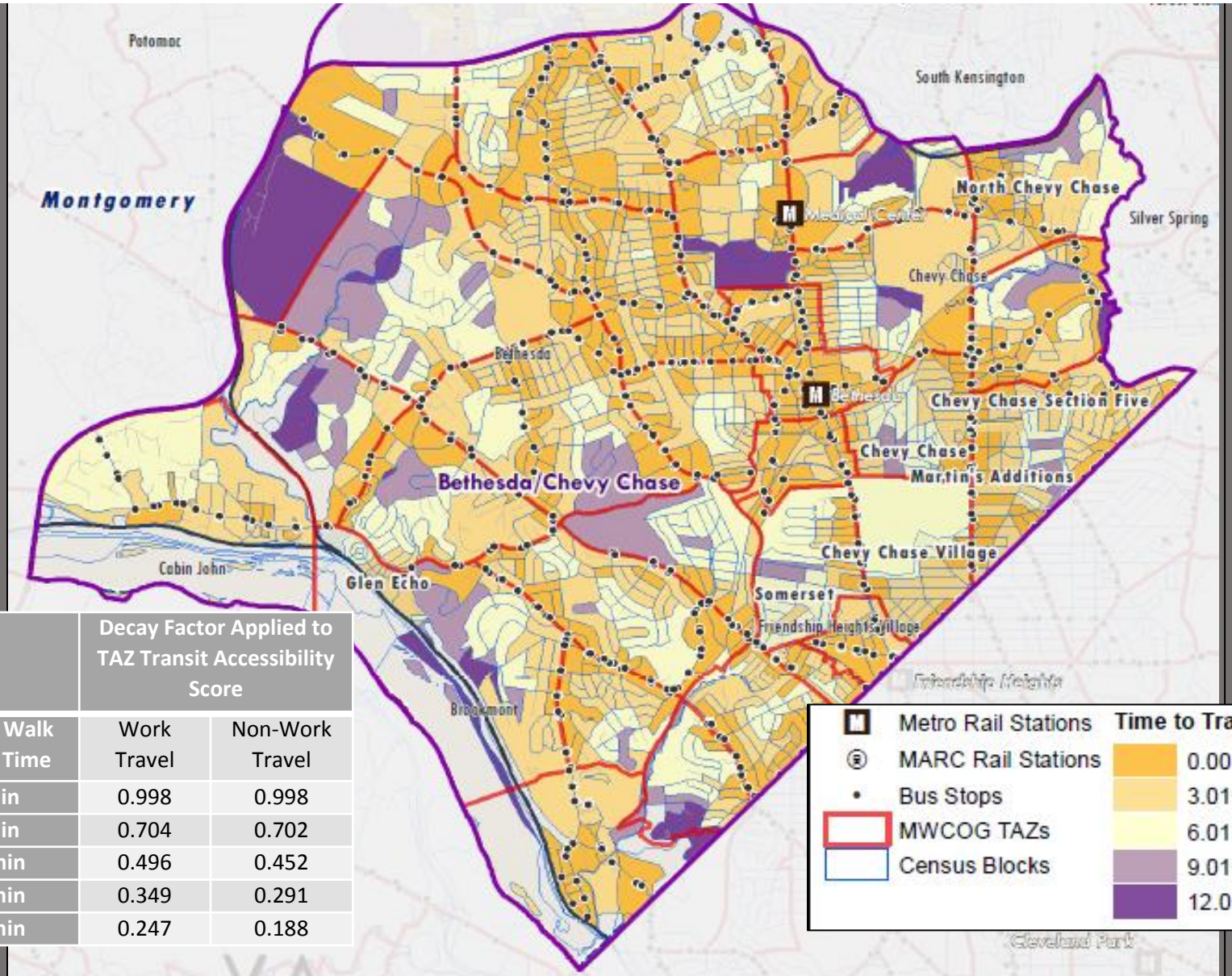


Walk Accessibilities: Work & Non-Work (Block)





Bringing Transit Accessibility Down to Block Level



	Decay Factor Applied to TAZ Transit Accessibility Score	
Transit Walk Access Time	Work Travel	Non-Work Travel
1 min	0.998	0.998
5 min	0.704	0.702
10 min	0.496	0.452
15 min	0.349	0.291
20 min	0.247	0.188

Converting MMA Scores to Mode Shares

Mode Share = f (MMA-A, MMA-T, MMA-W)

Modes Predicted

HBW	HBO
Auto Driver	Auto Driver
Drive-Transit	Auto Passenger
Walk-Transit	Transit
Walk	Walk

Data Source: MWCOG Household Travel Survey

- Individual trips by purpose & mode
- MMA scores for each trip end (x, y address)

MWCOG Survey Sample for Corridor

Trip Purpose	Number of Trips by Purpose and Mode								Pct of All Trips	Pct Less Return Home
	Transit walk or feeder access	Drive Alone	Auto Passenger	Auto Access Transit	Walk	Bicycle	Other	Total		
Return home (not used)	349	2523	754	6	550	45	69	4296	39%	
Home to Work	206	696	39	69	28	14	7	1059	10%	16%
Home to Other	92	1503	549	20	362	33	50	2609	24%	39%
Home to School	30	66	203	2	42	8	233	584	5%	9%
Work based Other	121	628	64	7	322	9	24	1175	11%	17%
Non-home Based	42	721	267	2	225	3	39	1299	12%	19%
Total	840	6137	1876	106	1529	112	422	11022	100%	100%

Trip Purpose	Mode Shares by Trip Purpose							
	Transit walk or feeder access	Drive Alone	Auto Passenger	Auto Access Transit	Walk	Bicycle	Other	Total
Return home (not used)	8%	59%	18%	0%	13%	1%	2%	100%
Home to Work	19%	66%	4%	7%	3%	1%	1%	100%
Home to Other	4%	58%	21%	1%	14%	1%	2%	100%
Home to School	5%	11%	35%	0%	7%	1%	40%	100%
Work based Other	10%	53%	5%	1%	27%	1%	2%	100%
Non-home Based	3%	56%	21%	0%	17%	0%	3%	100%
Total	8%	56%	17%	1%	14%	1%	4%	100%

Mode Use in Relation to MMA Scores: HBW

Average MMA score for Selected Mode

	Origin			Destination		
Primary Mode	Auto MMA	Transit MMA	Walk MMA	Auto MMA	Transit MMA	Walk MMA
Transit (walk or feeder access)	898,331	203,697	4,914	868,766	252,350	19,297
Drive Alone	765,126	119,075	2,333	727,857	160,075	7,899
Auto Passenger	818,698	136,886	2,242	830,702	180,060	13,910
Transit (auto access)	703,321	92,636	1,428	819,131	240,922	21,679
Walk	949,747	237,472	8,369	937,842	281,701	13,414
Bicycle	870,642	168,220	2,848	787,965	194,222	19,798
Other	664,930	115,538	1,159	789,573	240,773	19,391
Total	794,625	138,509	2,932	759,838	178,601	9,984

Ratio of MMA score to Drive Alone (= 1.0)

	Origin			Destination		
Primary Mode	Auto MMA	Transit MMA	Walk MMA	Auto MMA	Transit MMA	Walk MMA
Transit (walk or feeder access)	1.17	1.71	2.11	1.19	1.58	2.44
Drive Alone	1.00	1.00	1.00	1.00	1.00	1.00
Auto Passenger	1.07	1.15	0.96	1.14	1.12	1.76
Transit (auto access)	0.92	0.78	0.61	1.13	1.51	2.74
Walk	1.24	1.99	3.59	1.29	1.76	1.70
Bicycle	1.14	1.41	1.22	1.08	1.21	2.51
Other	0.87	0.97	0.50	1.08	1.50	2.45
Total	1.04	1.16	1.26	1.04	1.12	1.26

Mode Split Equations: Applying MMA Scores to MWCOG Travel Survey Data

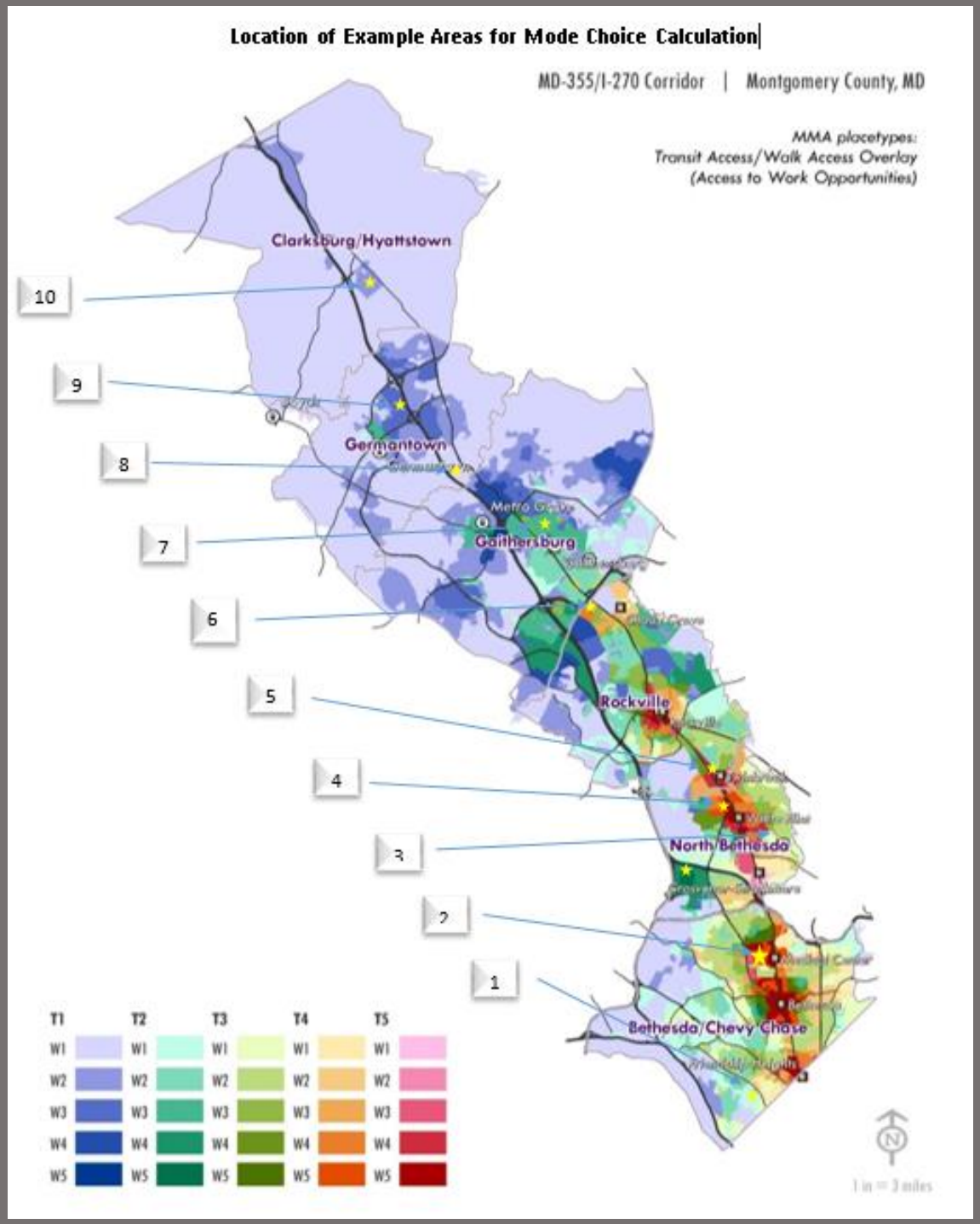
	HBW Mode Choice			
	Auto	Drive-to-Transit	Walk-to-Transit	Walk
Constant	0.826	0.116	0.052	0.003
t	*94.600*	*21.700*	*6.510*	*1.260*
Auto MMA	1.38E-07	-1.21E-08	-1.23E-07	
t	*9.350*	*-1.340*	*-8.976*	
Transit MMA	-1.45E-06	-2.58E-07	1.41E-06	2.98E-07
t	*-27.700*	*-8.030*	*29.100*	*16.087*
Walk MMA	-6.71E-06	-1.11E-06	-1.23E-07	1.89E-06
t	*-6.840*	*-1.850*	*-8.976*	*4.260*
R Square	0.788	0.313	0.830	0.327
Est. Share at Mean	0.657	0.057	0.205	0.062

	HBO Mode Choice			
	Drive Alone	Auto Passenger	Transit	Walk
Constant	.589	.360	.032	.019
t	*75.676*	*55.689*	*9.236*	*2.811*
Auto MMA	4.050E-06	-6.663E-06	-3.026E-06	5.639E-06
t	*5.162*	*-10.218*	*-8.672*	*8.336*
Transit MMA	-2.028E-05	-1.165E-05	2.258E-05	9.357E-06
t	*-6.005*	*-4.150*	*15.027*	*3.213*
Walk MMA	-5.409E-04	-2.766E-04	1.130E-04	7.045E-04
t	*-18.456*	*-11.353*	*8.666*	*27.876*
R Square	0.364	0.375	0.351	0.597
Est. Share at Mean	0.557	0.223	0.048	0.171

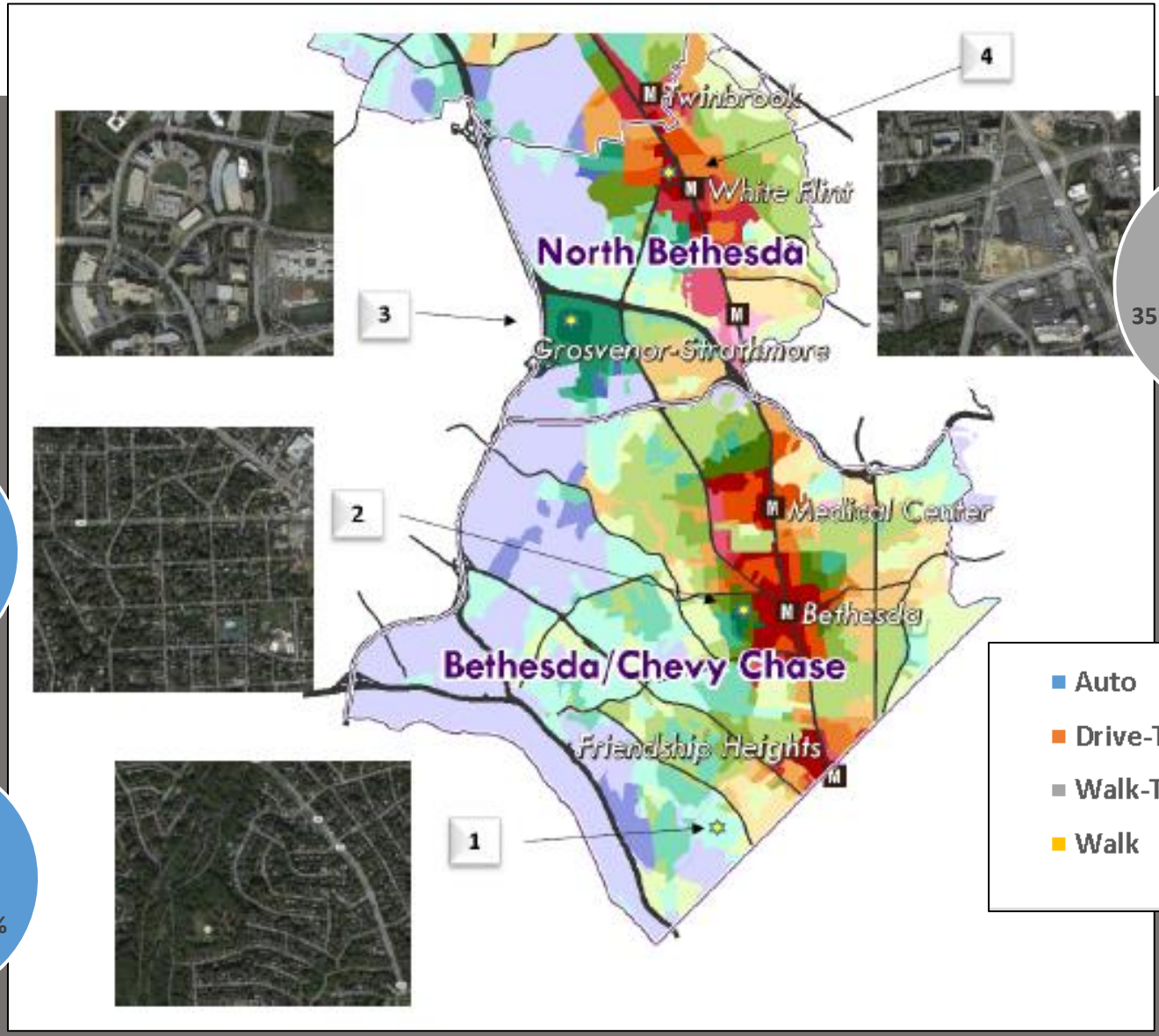
Equations Tested on Selected Areas with different combinations of Transit and Walk Score levels

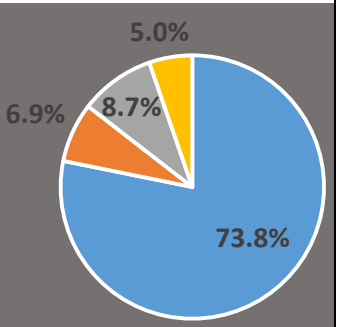
Transit	
Tier	**MMA Range**
T1	<67k
T2	67k - 102k
T3	103k - 151k
T4	152k - 228k
T5	> 228k

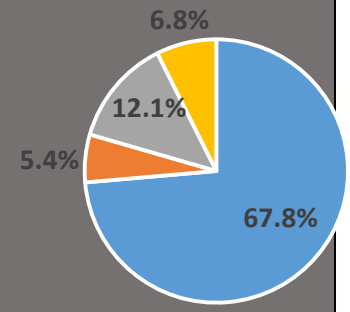
Walk	
Tier	**MMA Range**
W1	<329
W2	329 - 1513
W3	1514 - 3577
W4	3578 - 7607
W5	>7607

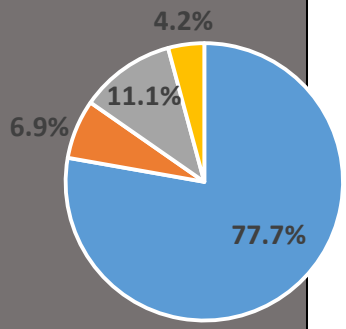


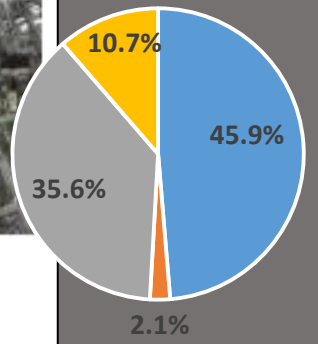
MMA Model Application to Selected Areas: Mode Shares for Home-Based Work Travel



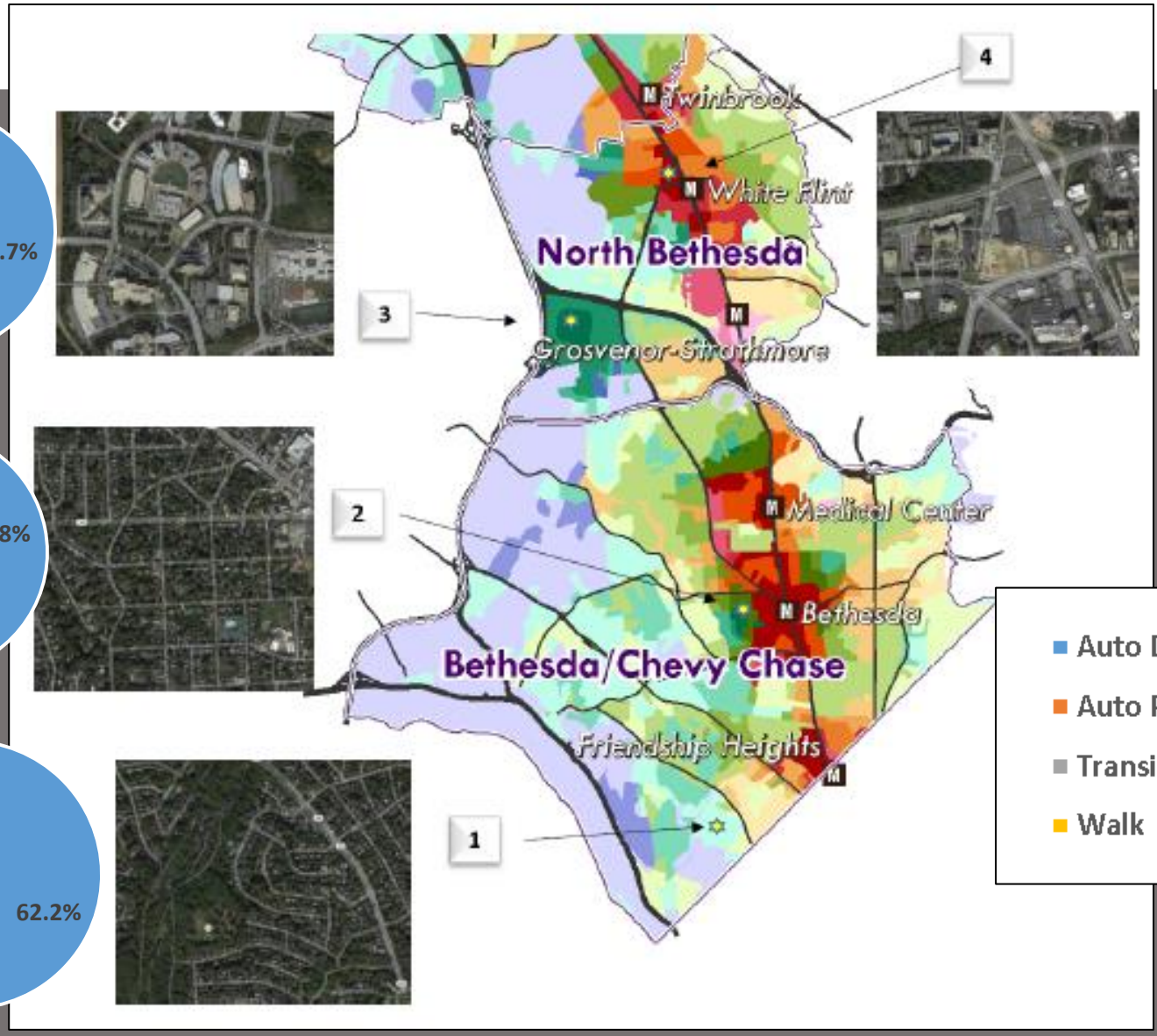


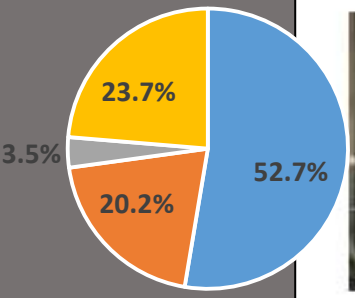


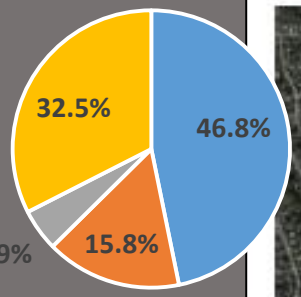


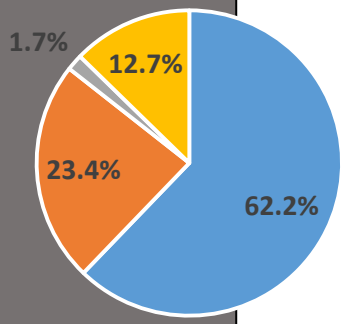


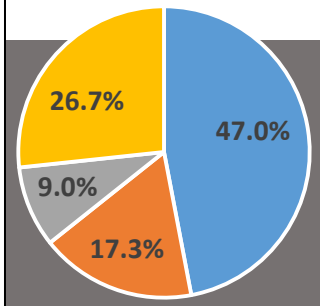
MMA Model Application to Selected Areas: Mode Shares for Home-Based Non-Work Travel











Comparing MMA Model Estimated Mode Shares by Planning Area with MWCOG and ACS Household Surveys for Journey-to-Work

Absolute Mode Shares

	Estimated Mode Shares			
	PPA	Auto	Transit	Walk
Bethesda	1	67.3%	28.3%	4.8%
N Bethesda/W Flint	2	68.5%	27.5%	4.5%
Rockville	3	73.4%	22.8%	3.6%
Gaithersburg	4	81.8%	16.2%	2.2%
Germantown	5	85.5%	13.1%	1.5%
Clarksburg	6	88.8%	10.2%	0.9%

	MWCOG Survey Mode Shares			
	PPA	Auto	Transit	Walk
Bethesda	1	62.7%	29.9%	7.4%
N Bethesda/W Flint	2	69.3%	28.4%	2.4%
Rockville	3	71.4%	24.3%	4.3%
Gaithersburg	4	84.3%	15.0%	0.7%
Germantown	5	75.3%	23.3%	1.4%
Clarksburg	6	90.0%	10.0%	0.0%

	ACS Mode Shares			
	PPA	Auto	Transit	Walk
Bethesda	1	72.1%	20.2%	7.7%
N Bethesda/W Flint	2	73.7%	22.6%	3.7%
Rockville	3	77.3%	19.7%	3.0%
Gaithersburg	4	86.0%	11.6%	2.4%
Germantown	5	87.3%	11.4%	1.2%
Clarksburg	6	90.4%	7.2%	2.4%

Percentage Differences

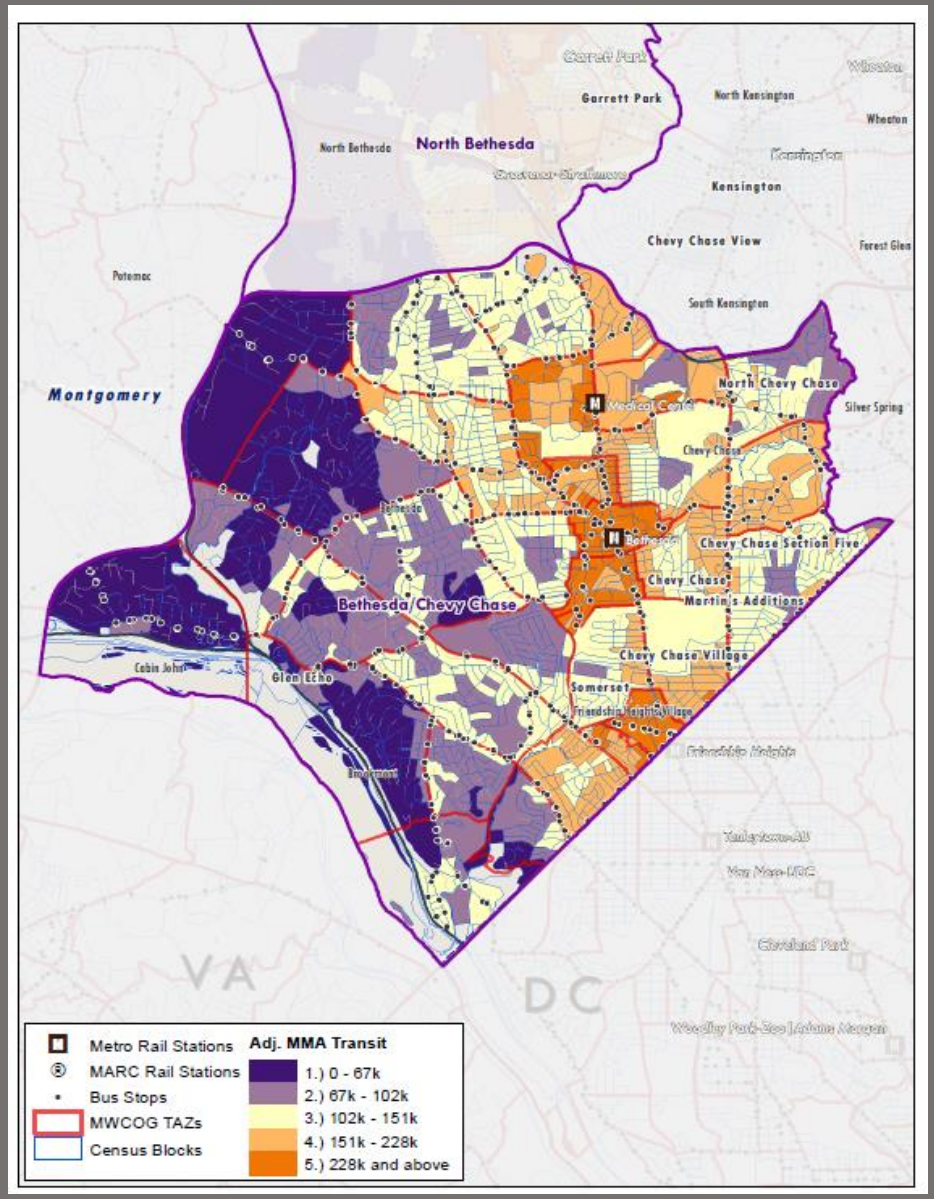
	ACS minus COG survey			
	PPA	Auto	Transit	Walk
Bethesda	1	9.4%	-9.6%	0.3%
N Bethesda/W Flint	2	4.5%	-5.8%	1.3%
Rockville	3	5.8%	-4.5%	-1.3%
Gaithersburg	4	1.7%	-3.4%	1.7%
Germantown	5	12.0%	-11.9%	-0.1%
Clarksburg	6	0.4%	-2.8%	2.4%

	Estimated minus ACS			
	PPA	Auto	Transit	Walk
Bethesda	1	-4.8%	8.1%	-2.9%
N Bethesda/W Flint	2	-5.2%	4.9%	0.8%
Rockville	3	-3.9%	3.1%	0.6%
Gaithersburg	4	-4.2%	4.6%	-0.2%
Germantown	5	-1.9%	1.7%	0.3%
Clarksburg	6	-1.6%	3.0%	-1.5%

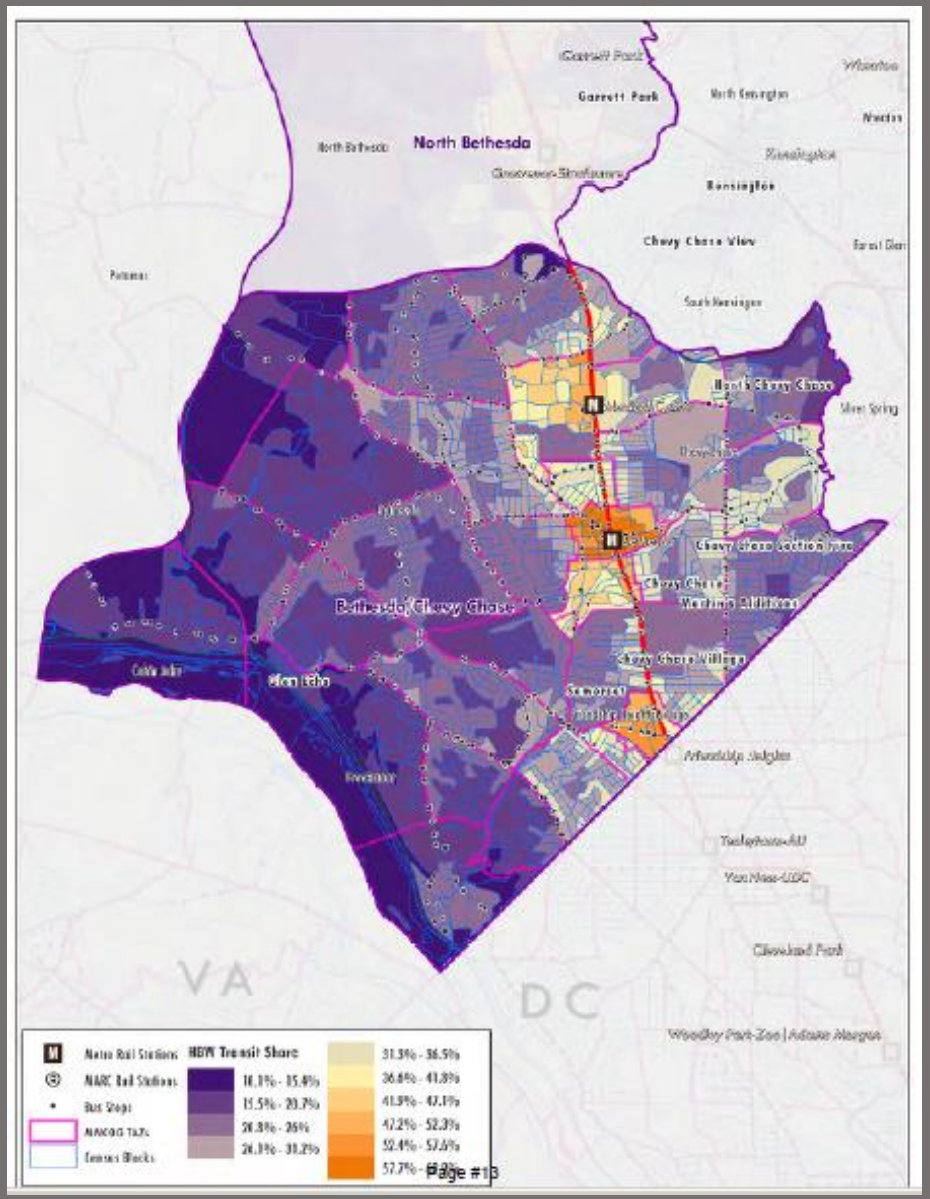
	Estimated minus MWCOG			
	PPA	Auto	Transit	Walk
Bethesda	1	4.6%	-1.5%	-2.6%
N Bethesda/W Flint	2	-0.7%	-0.8%	2.1%
Rockville	3	2.0%	-1.5%	-0.7%
Gaithersburg	4	-2.5%	1.2%	1.5%
Germantown	5	10.1%	-10.2%	0.1%
Clarksburg	6	-1.2%	0.2%	0.9%

Predicting Mode Shares at Block Level

Transit Accessibility: HBW

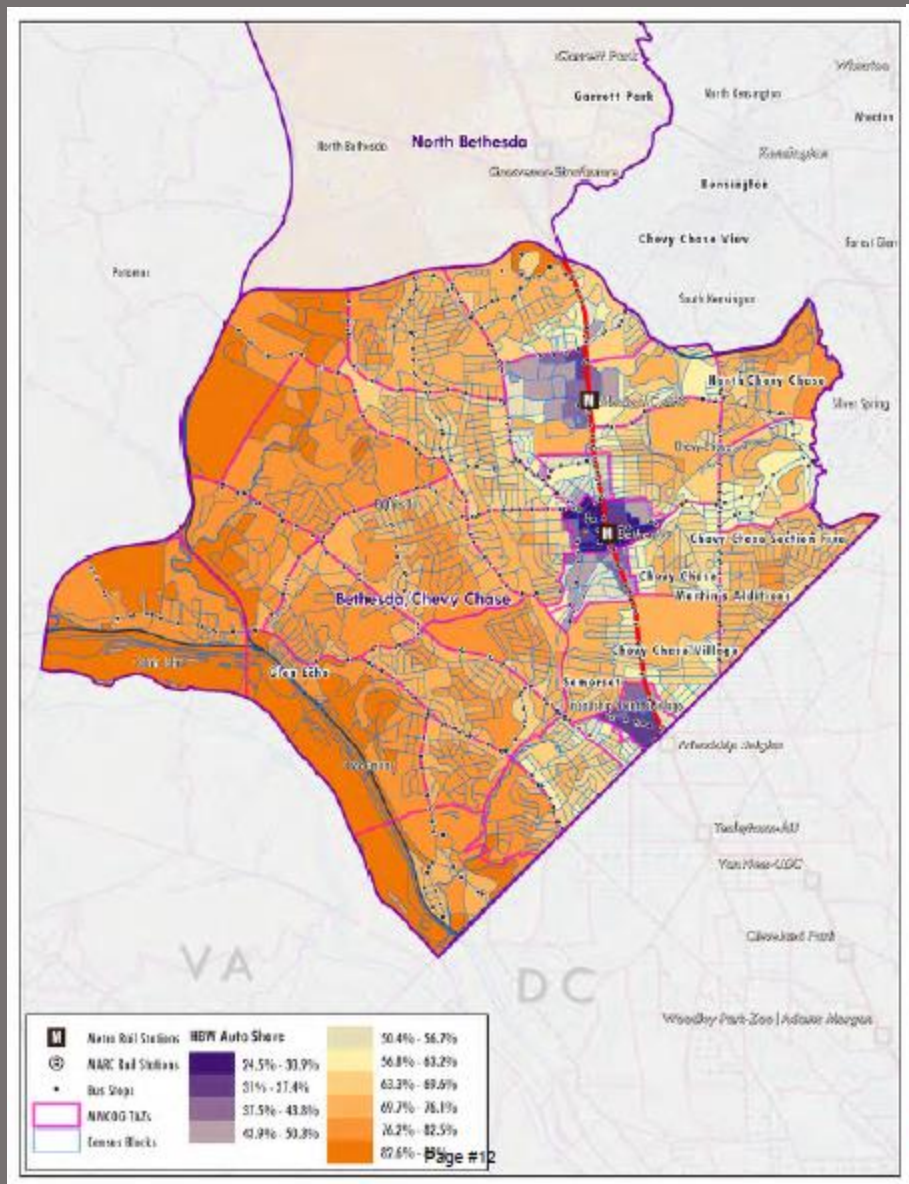


Transit Mode Share: HBW

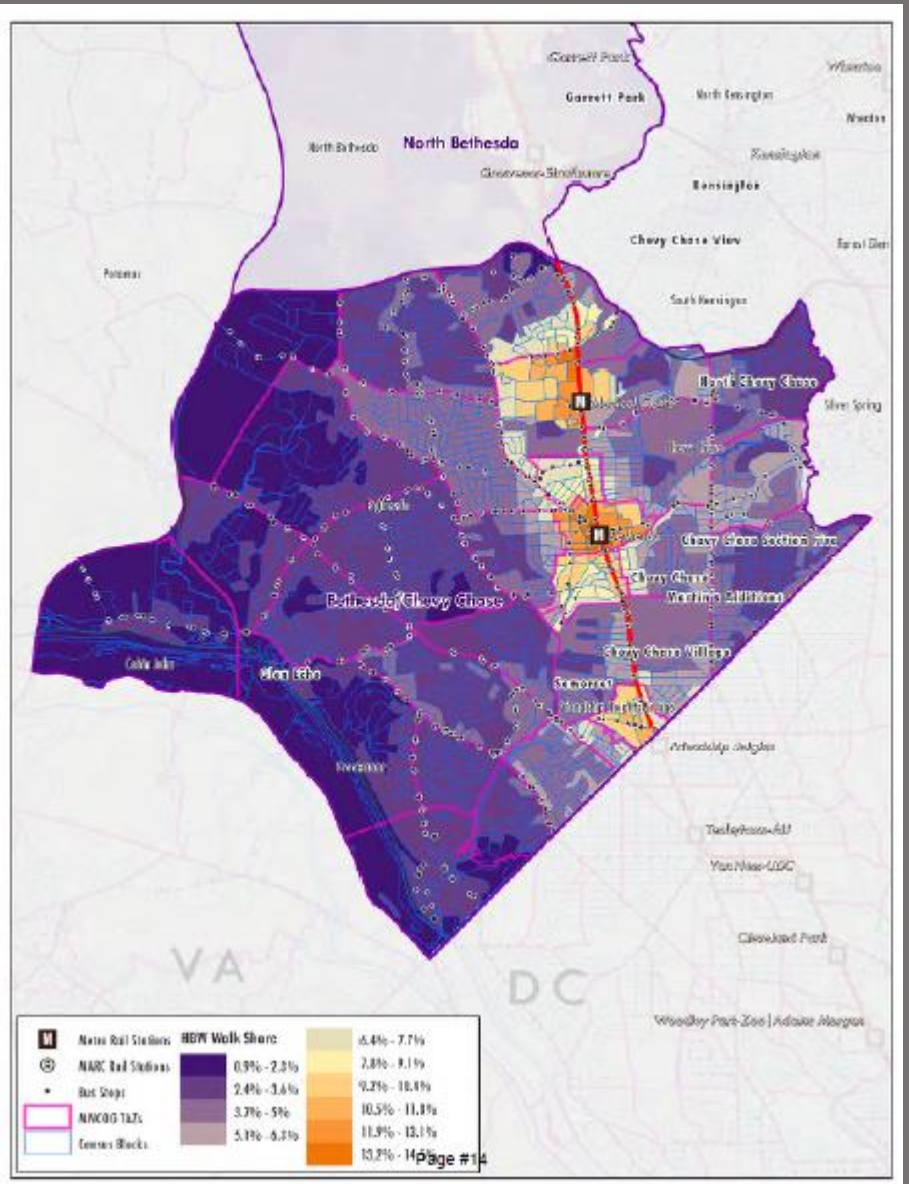


Predicting Mode Shares at Block Level

Auto HBW



Walk HBW



Findings from Work to Date

1. Surprisingly strong relationships (also used scores to develop probability choice models)
2. Including Socio-Dem variables didn't add much
3. Provides two types of products:
   - Mode split calculations for modeling
   - Illustrative patterning through maps
4. Can work independent of or in tandem with regional TAZ models

Additional Applications Under Way

1. Under contract (MDOT) to extend MMA coverage to entire Central MD region
2. Will be testing as part of upcoming BRT Purpose & Needs studies
3. Using to calculate accessibility measures for HB2 and needs assessment in Virginia
4. Supporting analysis of bike/ped improvements along Lee Highway (TLC project)
5. Will use for testing LU + TR alternatives in MWCOG Multi-Sector Work Group GHG study