

# TBEST: A Transit Service Planning Solution

Demonstration of Modeling Applications in NOVA Region

COUNCIL OF GOVERNMENTS

REGIONAL PUBLIC TRANSPORTATION SUBCOMMITTEE (RPTS)

JANUARY 28, 2020

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# TBEST Overview

## TBEST: Transit Boardings Estimation and Simulation Tool

- FDOT Objective: to provide a “comprehensive transit network modeling, management, and analysis software with a focus on short to mid-term transit planning available to all Florida transit agencies”
- Developed to support agencies’ transit development plans (TDPs), via FDOT approved ridership estimation methodology
- A software solution for short-term transit service and strategic planning for local agencies
- Joint development with CUTR at University of South Florida

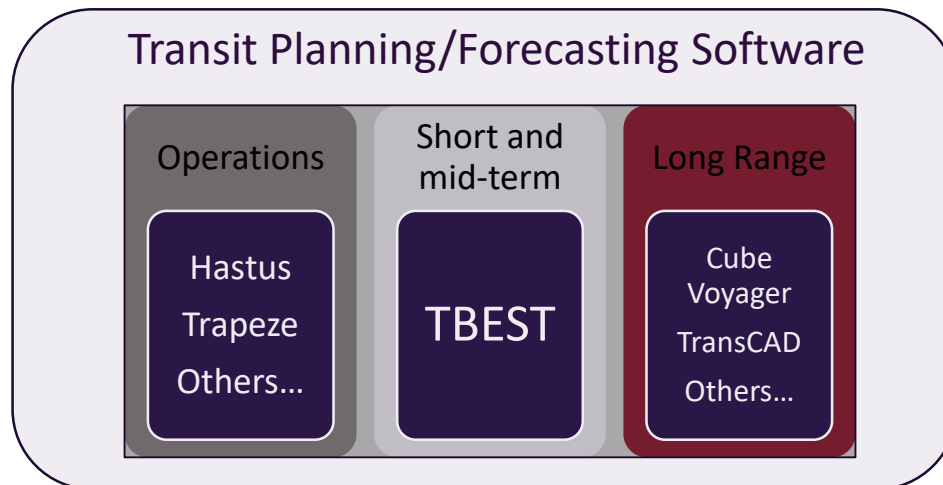


$$D_n^s = g(C^s, A_{1n}^s, A_{2n}^s, A_{3n}^s, A_{4n}^s, X_n^s), n = 1, \dots, N$$

# TBEST Overview

## TBEST Planning Analysis Market

- Operational: Hastus, Trapeze, Clever, etc.
- Short- to Mid-Term: **TBEST**, Remix
- Long Range: Cube Voyager, TransCAD, etc.



# TBEST Modeling Framework

## Data Inputs

- Socio-Economic (ACS, Census, TAZ EMP, Parcel Level)
- GTFS, Schedule, Stops, Special Generators

## Model Structure

- TBEST Model, LA Model, MTA

## Model Development

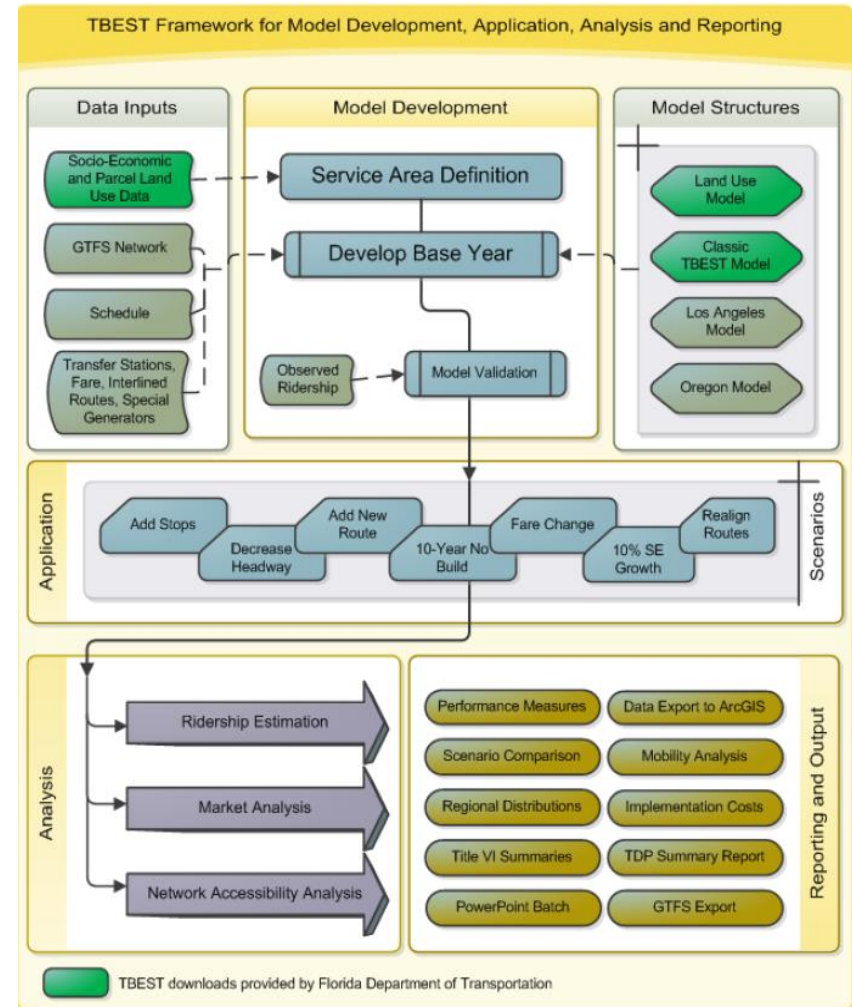
- Validation to Base Year Ridership

## Application

- Service Changes/Network Redesign
- Socioeconomic Adjustments

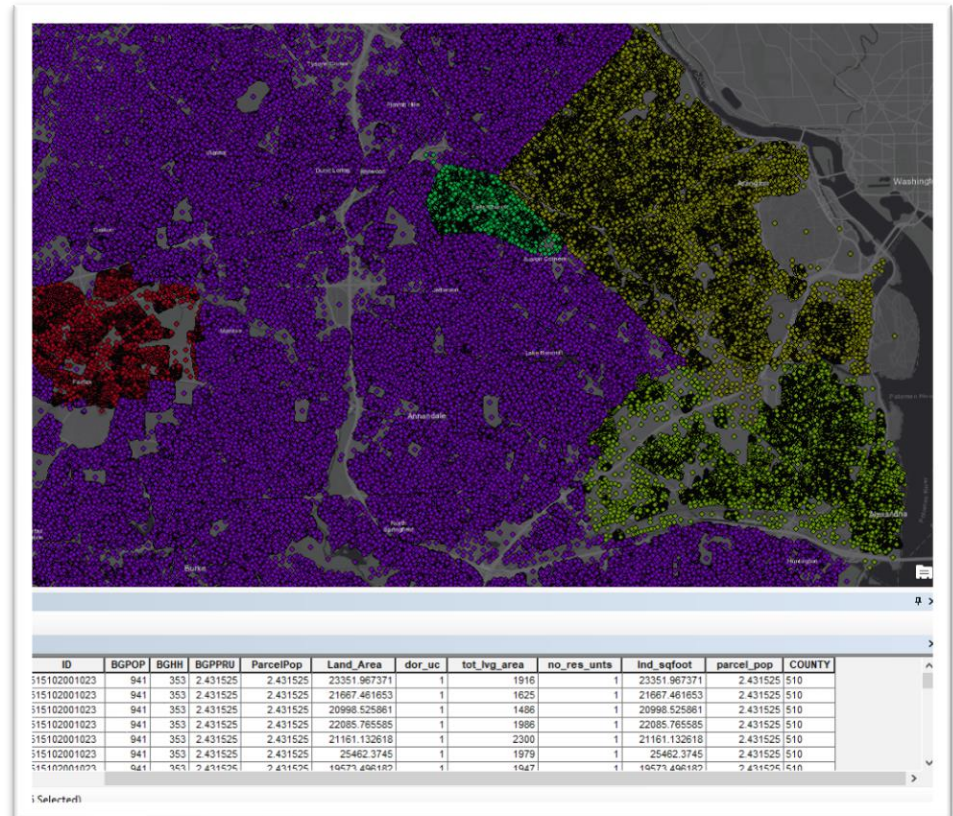
## Analysis

- Ridership Estimate
- Stop Level Demand Projection
- Market Analysis
- Network Accessibility



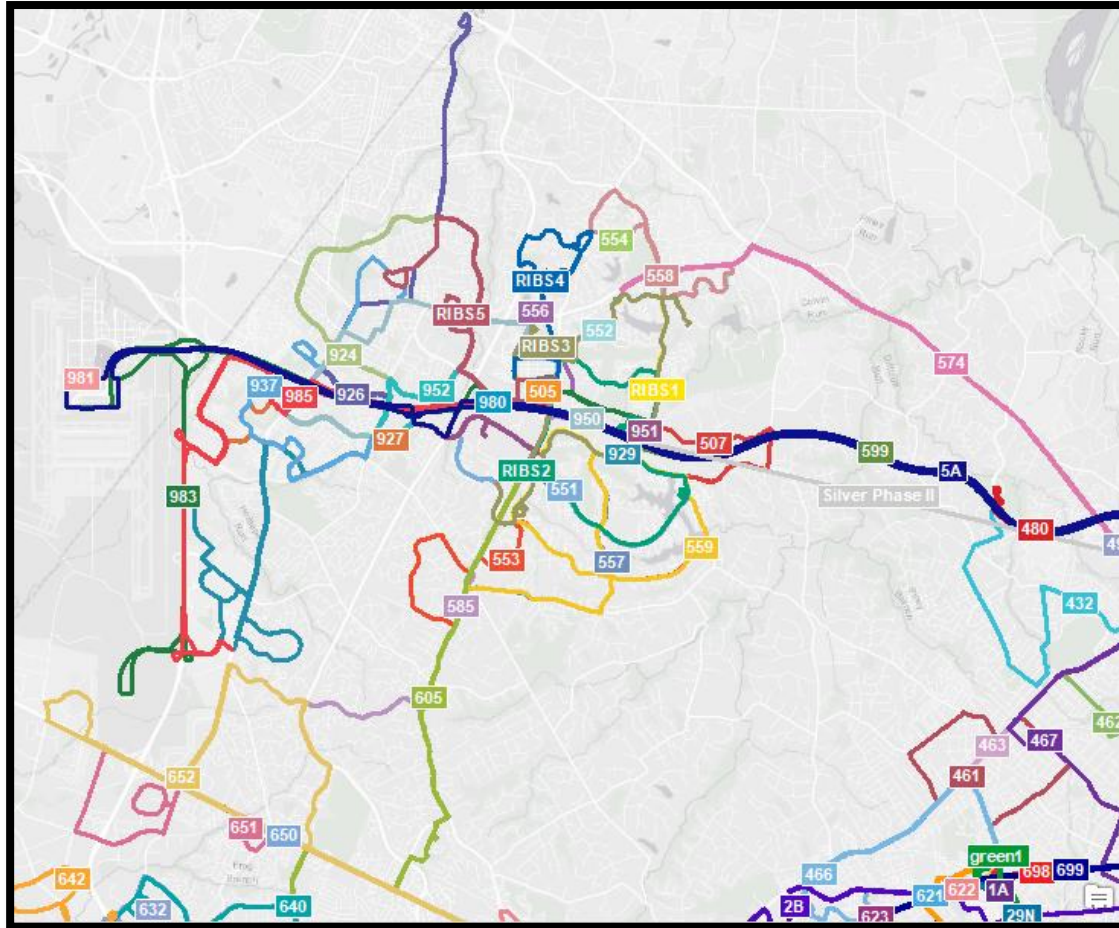
# TBEST Data Requirements

- Socio-demographic: Census 2010 and ACS
- Employment: InfoUSA or TPB Model
- Land Use: parcel land use data from jurisdictions
- Transit Network (GTFS, shapefiles, or otherwise: routes, stops, schedules, fare)
- Special generators and stop amenities
- Socioeconomic growth rates (system-wide or zone-based)
- Observed ridership for validation (route level, stop level optional)





# Model Application



## Example

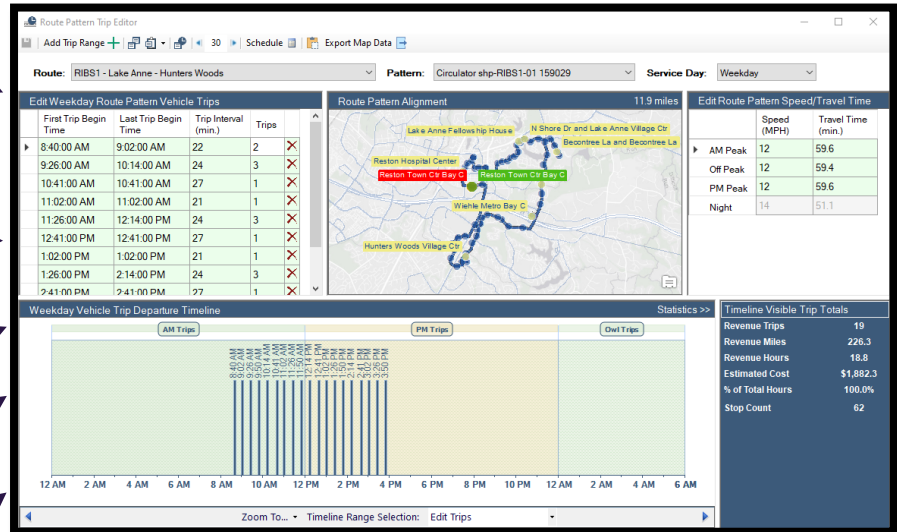
- Fairfax Connector Restructuring-- Silver Line Phase II
- Forecast Year 2020
- 33 Routes
- 87 Buses
- 1,163 Revenue Service Trips
- 5 Metrorail Stations
- 446,508 Population
- 683,485 Jobs

# Model Application



GTFIS\_Alternative1.zip

	Full Span	Weekday						Total Weekday Trip
		Early AM (4:00AM-Headway)	AM Peak (6:00AM-Headway)	Offpeak (9:00AM-Headway)	PM Peak Headway	Night Headway	Late Night Headway	
RIBS 1	5:08 AM-12:47 AM	60	25	20	25	25	60	41
RIBS 2	8:06 AM-10:04 PM		40	40	40	40	40	21
RIBS 3	5:08 AM-1:47 AM	60	25	20	25	25	60	41
Assume Two: trip=1 way loop	0:26 PM	40	40	40	40	40	60	24



Observed Ridership

Fare Levels/Operating Costs

Socioeconomic Conditions %

Base

1. Alternative Scenario
2. Alternative Scenario
3. Alternative Scenario

# TBEST Model Outputs

Summary Variables		Scenario Comparison Report																				
<input checked="" type="checkbox"/> Boardings <input checked="" type="checkbox"/> Total Boardings <input checked="" type="checkbox"/> Direct Boardings <input checked="" type="checkbox"/> Transfer Boardings <input type="checkbox"/> Population <input type="checkbox"/> Household <input type="checkbox"/> Income <input type="checkbox"/> Employment <input type="checkbox"/> Network <input type="checkbox"/> Service <input type="checkbox"/> Performance <input type="checkbox"/> Cost		<b>Boardings, Population, Employment, Service, Performance and Cost Variables</b> <b>Transit System:</b> Fairfax Silver Line Phase II PreferredV2 <b>Scenario A:</b> Base 2018_V2 <b>Scenario B:</b> Preferred V2 <b>Summary Span:</b> Weekday Summary <b>Report Date:</b> 1/24/2020 11:44:20 AM																				
Route Summary																						
Route Name	Additional Boardings (+/-)	Direct Boardings			Transfer Boardings			Total Boardings			Total Population			Total Employment			Stop Visits			Estimated Buses		
		A	B	% Change	A	B	% Change	A	B	% Change	A	B	% Change	A	B	% Change	A	B	% Change	A	B	% Change
632	-19	377	364	-3.4%	43	37	-14%	420	401	-4.5%	11,223	11,676	4%	10,921	10,921	0%	402	402	0%	3	3	0%
634	3	117	120	2.6%	61	61	0%	178	181	1.7%	3,209	3,339	4.1%	384	384	0%	34	34	0%	2	2	0%
640	4	124	126	1.6%	6	8	33.3%	130	134	3.1%	20,703	21,538	4%	22,199	22,199	0%	420	420	0%	2	2	0%
641	26	221	236	6.8%	12	23	91.7%	233	259	11.2%	14,689	15,280	4%	5,315	5,315	0%	410	410	0%	3	3	0%
642	73	326	392	20.2%	13	20	53.8%	339	412	21.5%	18,876	19,639	4%	11,123	11,123	0%	575	575	0%	5	5	0%
644	23	255	268	5.1%	93	103	10.8%	348	371	6.6%	4,091	4,255	4%	657	657	0%	50	50	0%	8	8	0%
650	13	176	189	7.4%	12	12	0%	188	201	6.9%	15,747	16,370	4%	20,019	20,019	0%	534	534	0%	2	2	0%
651	23	198	220	11.1%	22	23	4.5%	220	243	10.5%	16,732	17,398	4%	16,775	16,775	0%	548	548	0%	3	3	0%
652	11	192	202	5.2%	18	19	5.6%	210	221	5.2%	20,054	20,853	4%	12,526	12,526	0%	519	519	0%	4	4	0%
698	4	164	167	1.8%	179	180	0.6%	343	347	1.2%	2,075	2,159	4%	8,441	8,441	0%	40	40	0%	3	3	0%
699	7	446	452	1.3%	95	96	1.1%	541	548	1.3%	7,634	7,939	4%	70,084	70,084	0%	187	187	0%	4	4	0%
721	3	255	258	1.2%	28	28	0%	283	286	1.1%	6,982	7,259	4%	36,881	36,881	0%	1,543	1,543	0%	2	2	0%
724	1	108	108	0%	16	17	6.2%	124	125	0.8%	6,385	6,643	4%	11,841	11,841	0%	646	646	0%	2	2	0%
gold1	28	636	661	3.9%	96	99	3.1%	732	760	3.8%	26,429	27,488	4%	20,604	20,604	0%	1,930	1,930	0%	2	2	0%
gold2	25	560	582	3.9%	89	92	3.4%	649	674	3.9%	26,917	27,995	4%	21,057	21,057	0%	1,866	1,866	0%	2	2	0%
green1	21	460	479	4.1%	84	86	2.4%	544	565	3.9%	24,084	25,051	4%	16,313	16,313	0%	1,674	1,674	0%	2	2	0%
green2	19	425	442	4%	69	71	2.9%	494	513	3.8%	24,016	24,980	4%	16,296	16,296	0%	1,504	1,504	0%	2	2	0%
METROWAY	44	2,340	2,383	1.8%	91	92	1.1%	2,431	2,475	1.8%	20,748	21,582	4%	46,678	46,678	0%	2,784	2,784	0%	9	9	0%
REX	3	199	202	1.5%	26	26	0%	225	228	1.3%	28,192	29,326	4%	28,948	28,948	0%	2,320	2,320	0%	9	9	0%
S80	1	88	88	0%	67	68	1.5%	155	156	0.6%	3,357	3,493	4.1%	9,978	9,978	0%	1,113	1,113	0%	4	4	0%
S91	0	19	19	0%	26	26	0%	45	45	0%	1,665	1,732	4%	3,287	3,287	0%	140	140	0%	1	1	0%

## Summary Report

- Boardings (Direct, Transfer)
- Market Population, Employment, Title VI, Income
- Performance (Boardings per Service Hour, Avg Boardings per Stop Visit etc.)
- Cost (Total Route Cost, Cost per Passenger Trip)



# TBEST Model Outputs

## Population

Route Summary												
Route Name	Total Boardings	Total Population	Black	Female	Foreign Born	Hispanic	Over 65	Under 18	Poverty Population	Working Population	Population in Multi-Family DU	
505	616	4,880	238	2,503	1,185	230	911	596	267	3,013	2,233	
507	159	2,323	110	1,338	365	238	460	413	79	1,412	316	
551	859	16,955	2,979	8,719	5,389	3,470	2,079	3,557	1,507	10,021	2,692	
552	129	11,814	1,385	6,087	3,217	1,461	1,787	2,327	1,408	6,703	2,744	
553	113	14,045	1,224	7,368	2,743	1,286	2,217	2,843	690	7,970	1,138	
554	121	9,446	831	5,061	2,046	931	1,301	1,759	724	5,259	1,652	

## Household

Route Summary				
Route Name	Total Boardings	Median HH Income	Avg Household Income	Per Capita Income
505	616	\$143,982	\$175,414	\$100,991
507	159	\$142,019	\$160,860	\$70,193
551	859	\$97,366	\$118,297	\$49,344
552	129	\$107,943	\$127,209	\$53,557
553	113	\$139,563	\$158,614	\$60,766
554	121	\$127,827	\$148,121	\$62,823

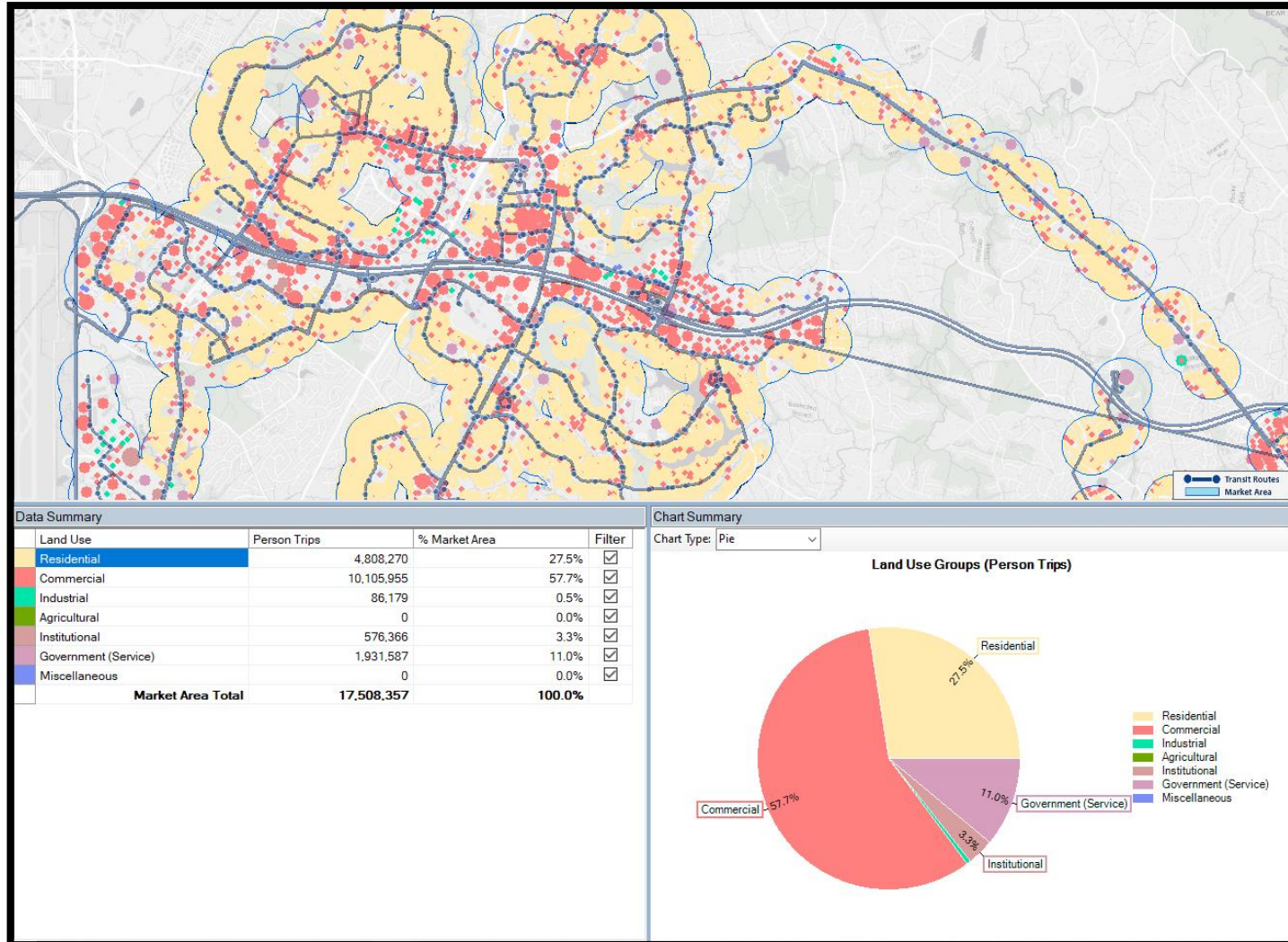
## Performance

Route Summary						
Route Name	Total Boardings	Boardings Per Service Hour	Boardings Per Service Mile	Boardings Per Service Trip	Avg Boardings Per Stop Visit	
505	616	40.6	2.7	5.5	0.6	
507	159	13.3	0.9	3.8	0.2	
551	859	21.4	1.4	9.2	0.3	
552	129	16.3	1.1	5.4	0.2	
553	113	9.1	0.6	5.4	0.1	

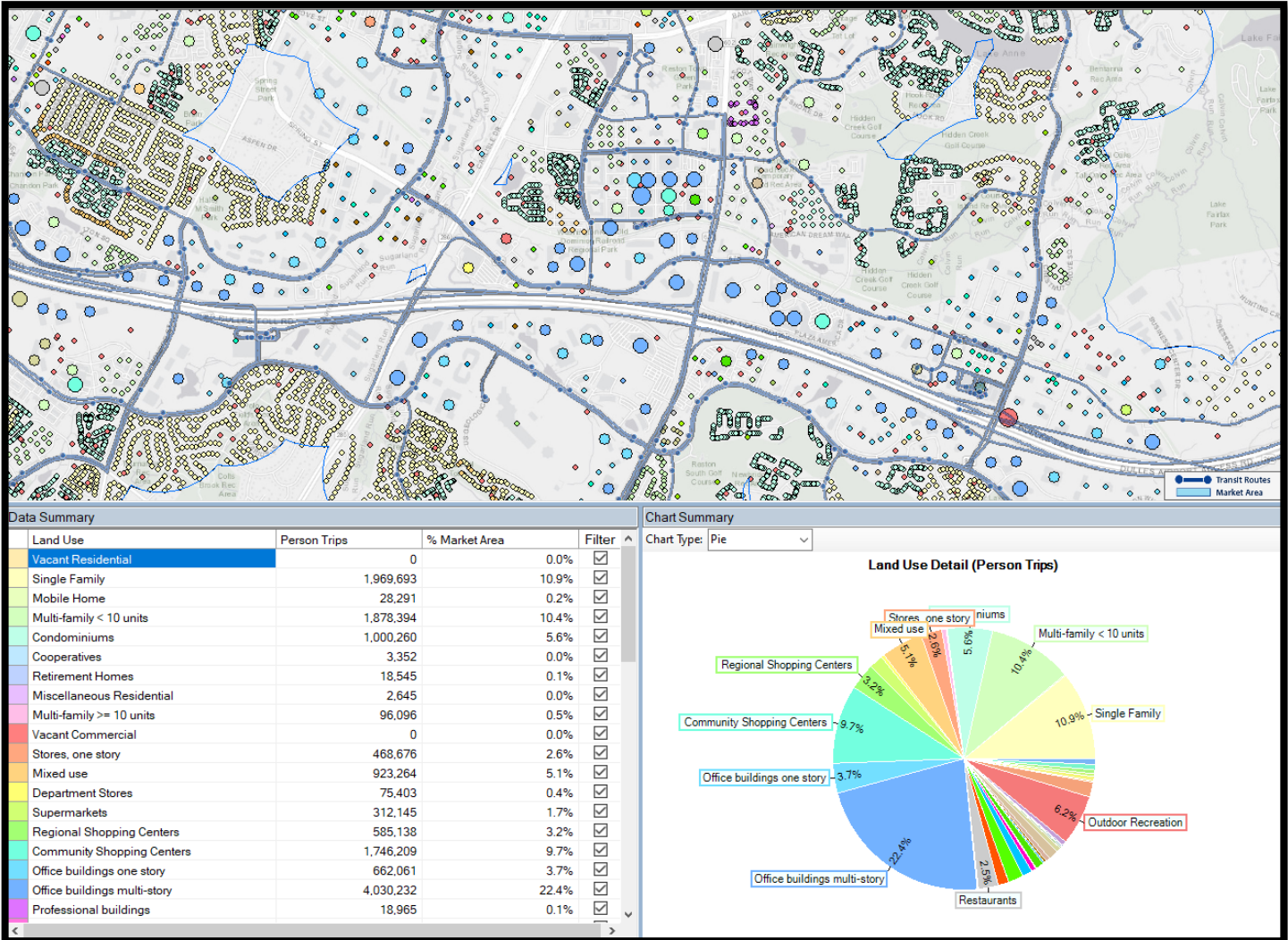
## Service

Route Summary										
Route Name	Total Boardings	Stop Visits	Estimated Buses	Headway	Service Span (Hours)	Speed (MPH)	Round Trip Travel Time (min)	Revenue Service Trips	Revenue Service Miles	Revenue Service Hours
505	616	998	2	21	20	15	16	111	228.1	15.2
507	159	756	1	24	16.8	15	17	42	179.2	12
551	859	3,023	3	25	20.5	15.1	51.5	93	605.5	40.2
552	129	733	3	18	7.3	15	40	24	119	7.9
553	113	823	4	18	7	14.5	71	21	179.7	12.4

# TBEST Model Outputs

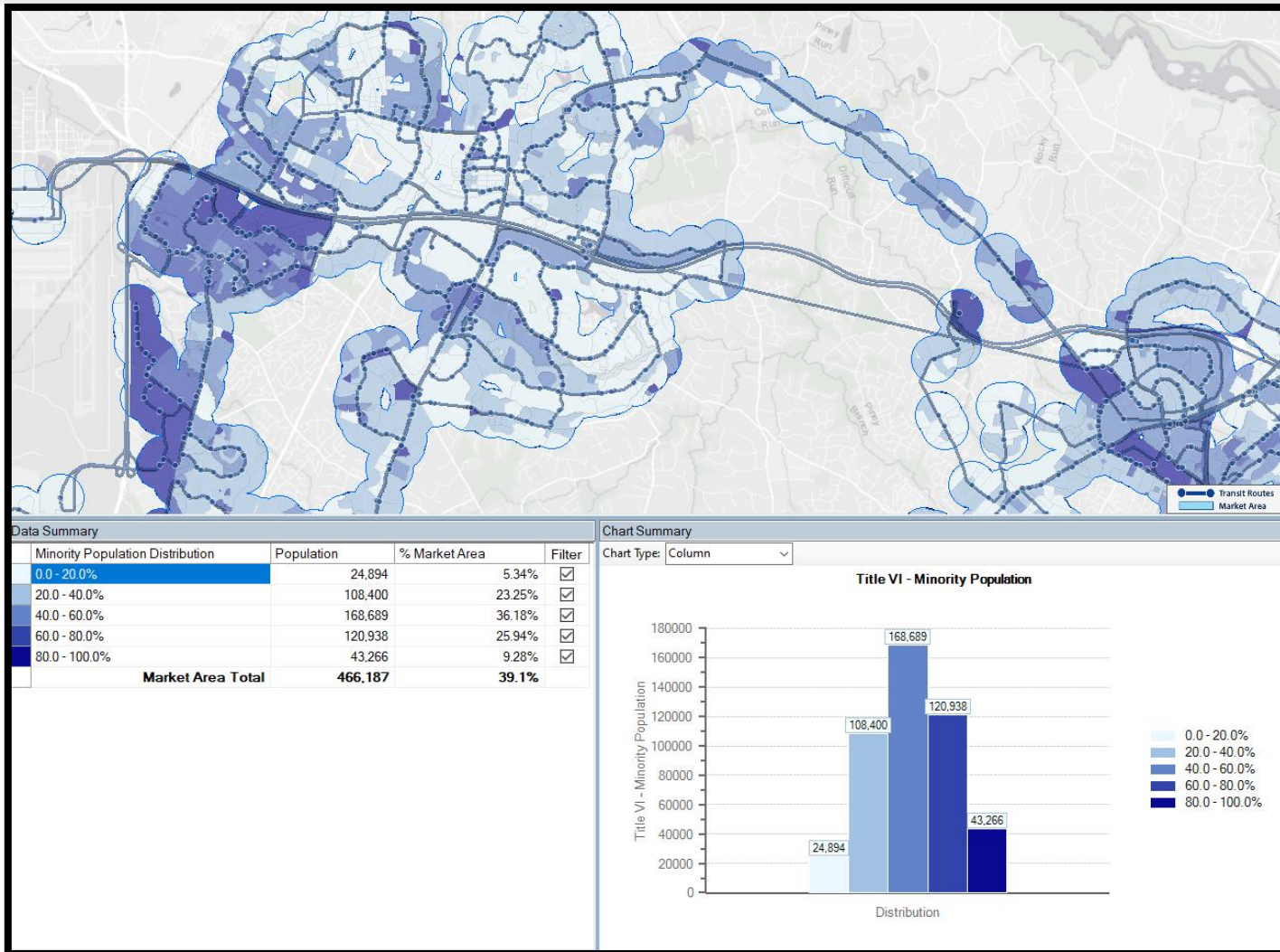


# TBEST Model Outputs





# TBEST Model Outputs



# TBEST Analysis Example

Scenarios	Parameters
Base	Current Service
Preferred Alternative	Route Realignment & Service Change

Route Name Model Run	Route 951	
	Base	Preferred
Direct Boardings	99	498
Transfer Boardings	27	66
Total Boardings	126	564
Boardings Per Service Hour	17.2	18
Boardings Per Service Trip	4.7	15.6
Population	3,861	33,717
Employment	20,319	34,861
Estimated Buses	2	6
Average Headway	30	20
Average Speed	15	15

347% Increase in  
Total Boardings

951 Extension  
Increases Route  
Coverage



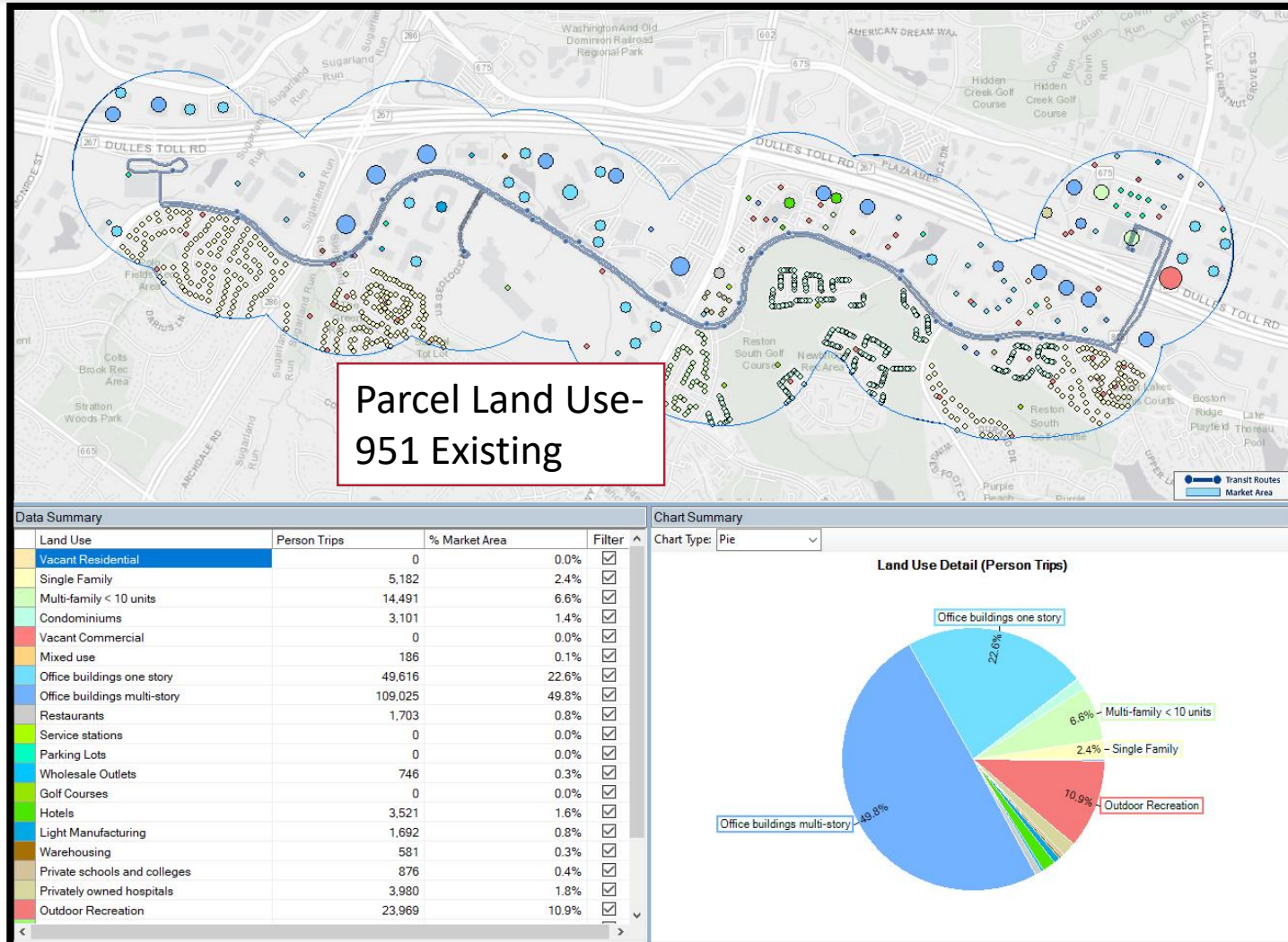
# TBEST Analysis Example

Scenarios	Parameters
Base	Current Service
Preferred Alternative	Route Realignment & Service Change

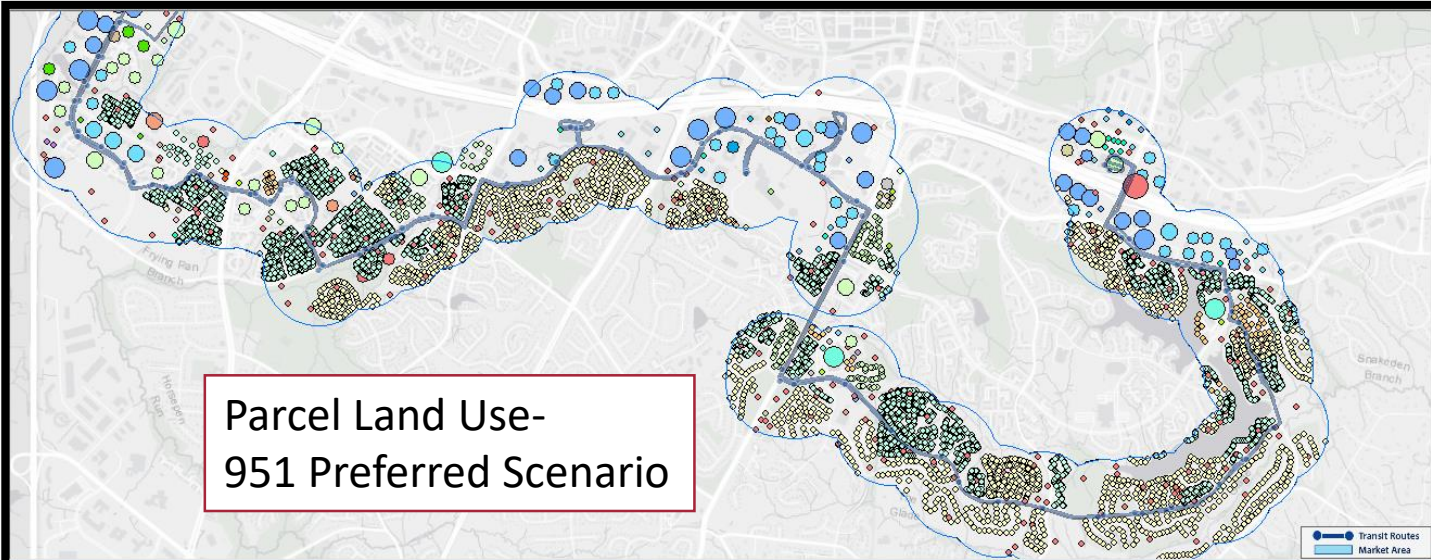
Route Name Model Run	Route 951	
	Base	Preferred
Total Boardings	126	564
Poverty Pop.	240	1,573
Working Pop.	2,358	19,428
Zero Vehicle Households	42	585
Avg Household Income	\$134,821	\$137,268
Households w/Children/Dependent	378	4,496
Commercial Employment	18,532	30,864
Revenue Hours	7.3	31.2
Route Cost	\$730	\$3,120
Cost Per Passenger Trip	\$5.8	\$5.5

Route Cost  
Efficiency Neutral

# TBEST Analysis Example

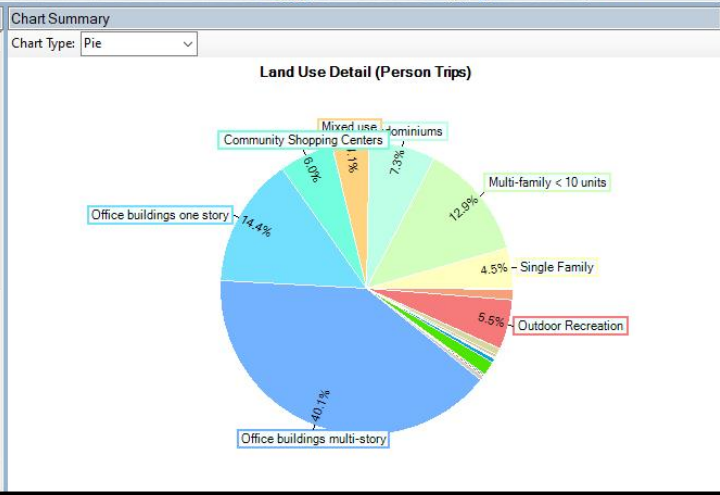


# TBEST Analysis Example



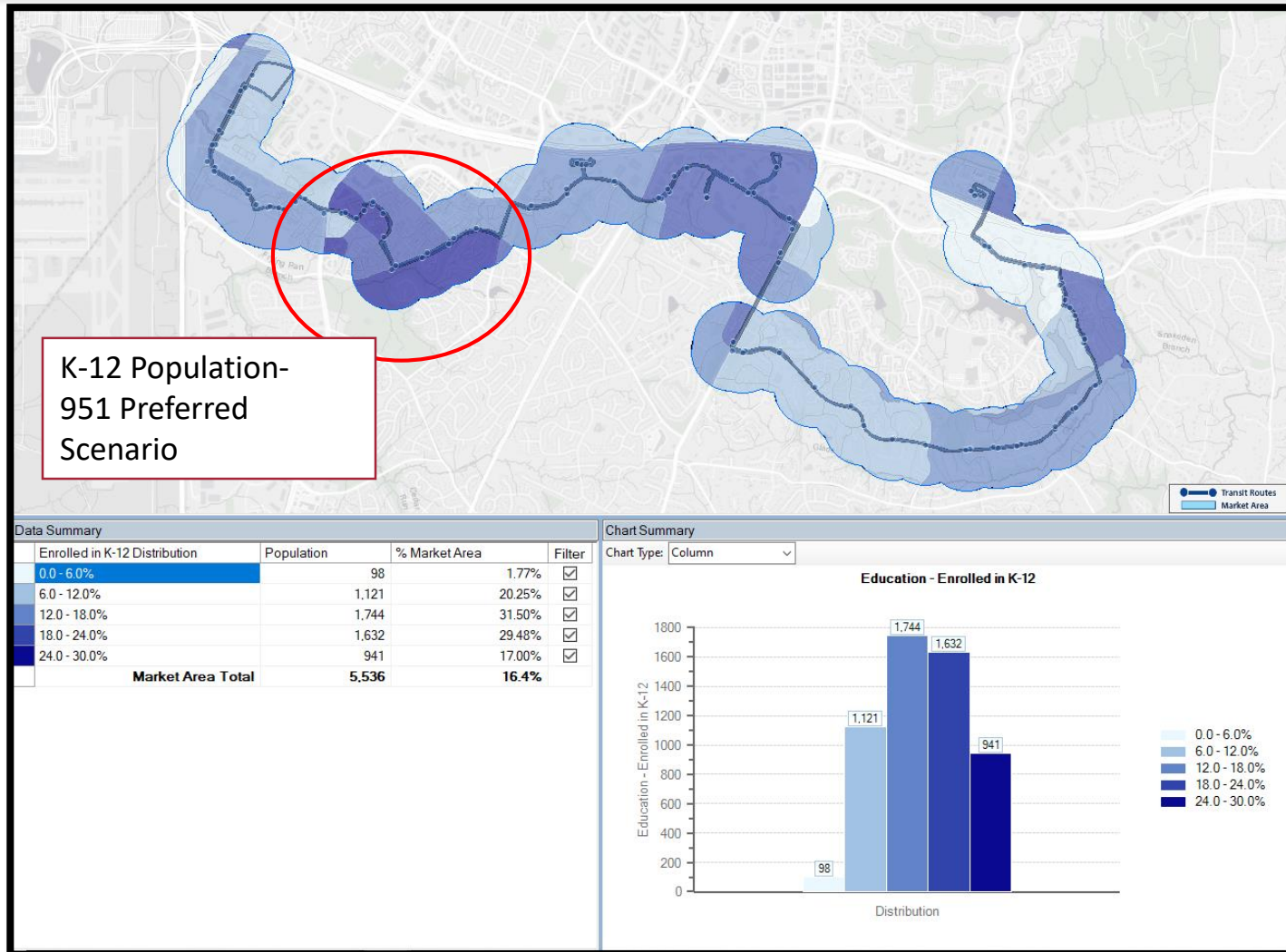
Parcel Land Use-  
951 Preferred Scenario

Land Use	Person Trips	% Market Area	Filter
Vacant Residential	0	0.0%	<input checked="" type="checkbox"/>
Single Family	25,250	4.5%	<input checked="" type="checkbox"/>
Multi-family < 10 units	72,973	12.9%	<input checked="" type="checkbox"/>
Condominiums	41,555	7.3%	<input checked="" type="checkbox"/>
Multi-family >= 10 units	7	0.0%	<input checked="" type="checkbox"/>
Vacant Commercial	0	0.0%	<input checked="" type="checkbox"/>
Mixed use	23,074	4.1%	<input checked="" type="checkbox"/>
Community Shopping Centers	34,008	6.0%	<input checked="" type="checkbox"/>
Office buildings one story	81,293	14.4%	<input checked="" type="checkbox"/>
Office buildings multi-story	226,859	40.1%	<input checked="" type="checkbox"/>
Restaurants	2,484	0.4%	<input checked="" type="checkbox"/>
Financial institutions	940	0.2%	<input checked="" type="checkbox"/>
Service stations	0	0.0%	<input checked="" type="checkbox"/>
Parking Lots	0	0.0%	<input checked="" type="checkbox"/>
Wholesale Outlets	776	0.1%	<input checked="" type="checkbox"/>
Golf Courses	0	0.0%	<input checked="" type="checkbox"/>
Hotels	8,705	1.5%	<input checked="" type="checkbox"/>
Light Manufacturing	2,516	0.4%	<input checked="" type="checkbox"/>
Heavy Manufacturing	78	0.0%	<input checked="" type="checkbox"/>

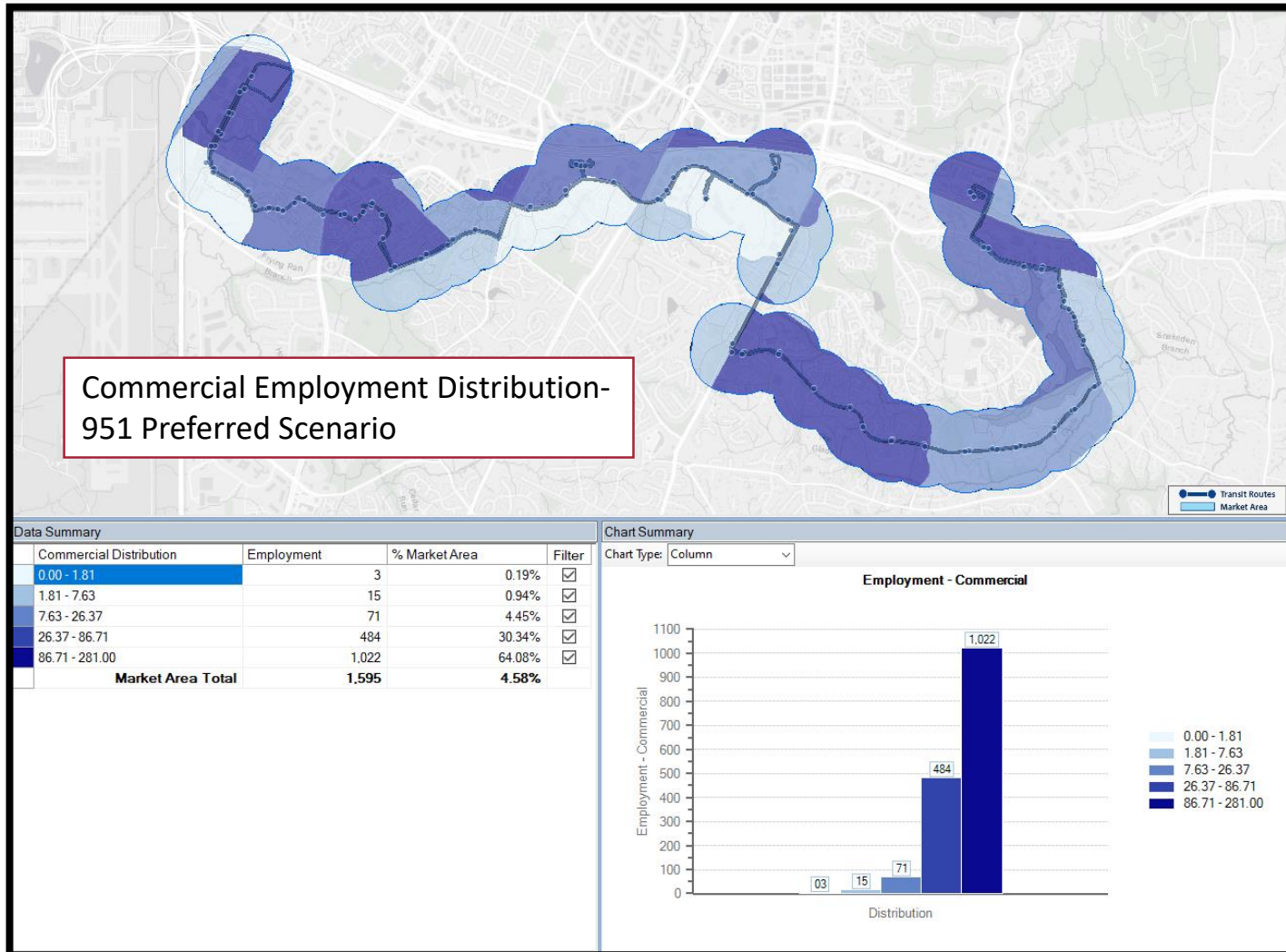




# TBEST Analysis Example



# TBEST Analysis Example





# TBEST Analysis Example

Scenarios	Parameters
Base	Current Service
Preferred Alternative	Route Realignment & Service Change
Preferred Plus Alternative	“Wishlist” Network

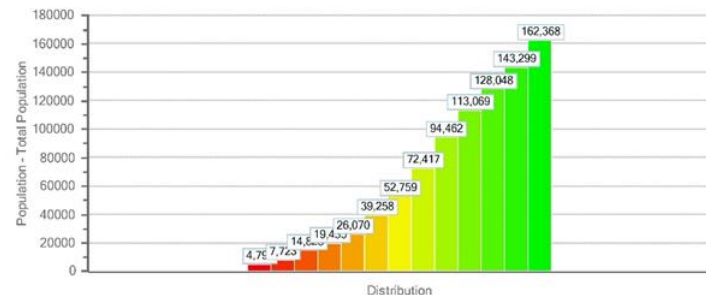
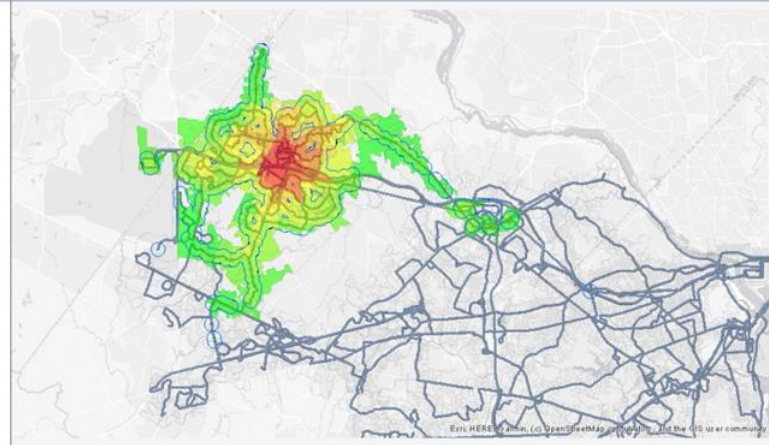
Route Name Model Run	Route 951		
	Base	Preferred	Pref. Plus
Direct Boardings	99	498	963
Transfer Boardings	27	66	112
Total Boardings	126	564	1,075
Boardings Per Service Hour	17.2	18	17.2
Boardings Per Service Trip	4.7	15.6	18.5
Population	3,861	33,717	34,849
Employment	20,319	34,861	37,991
Estimated Buses	2	6	8
Route Cost	\$730	\$3,120	\$6,260
Cost Per Passenger Trip	\$5.8	\$5.5	\$5.9

# TBEST Network Accessibility

## Fairfax Silver Line Phase II PreferredV2 - Base 2018\_V2\_Accessibility

Market Variable Travel Time Summary for Population - Total Population within the Mobility Area

Travel Time (min)	Total	% Market
0 - 2	4,791	2.95%
3 - 5	7,723	4.76%
6 - 9	14,828	9.13%
10 - 14	19,435	11.97%
15 - 17	26,070	16.06%
18 - 21	39,258	24.18%
22 - 24	52,759	32.49%
25 - 27	72,417	44.60%
28 - 30	94,462	58.18%
31 - 34	113,069	69.64%
35 - 38	128,048	78.86%
39 - 41	143,299	88.26%
42 - 45	162,368	100.00%
<b>Accessible Market Total</b>	<b>162,368</b>	<b>100%</b>



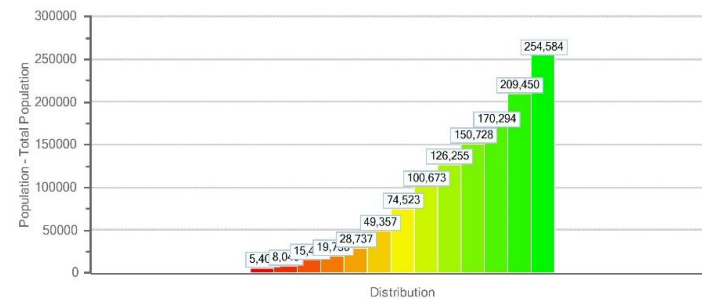
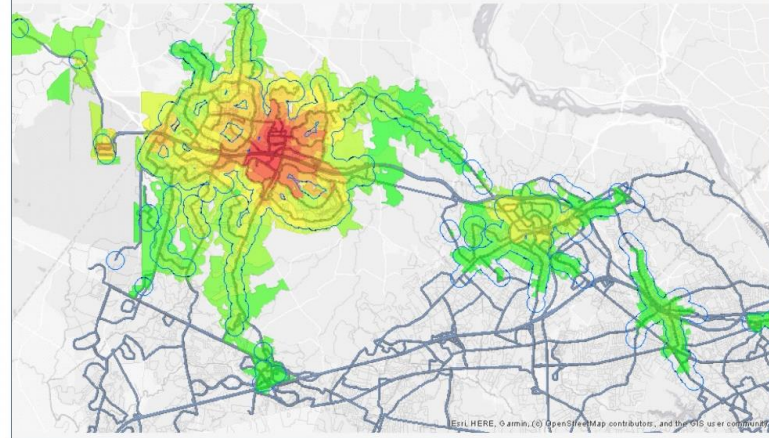
Population Data Source: Census and 5-Year American Community Survey data grown to represent 2018 conditions  
 Employment Data Source: Local Zonal Data file

# TBEST Network Accessibility

## Fairfax Silver Line Phase II PreferredV2 - Preferred V2

Market Variable Travel Time Summary for Population - Total Population within the Mobility Area

Travel Time (min)	Total	% Market
0 - 2	5,409	2.12%
3 - 5	8,040	3.16%
6 - 9	15,435	6.06%
10 - 13	19,750	7.76%
14 - 17	28,737	11.29%
18 - 20	49,357	19.39%
21 - 23	74,523	29.27%
24 - 27	100,673	39.54%
28 - 30	126,255	49.59%
31 - 34	150,728	59.21%
35 - 38	170,294	66.89%
39 - 42	209,450	82.27%
43 - 45	254,584	100.00%
<b>Accessible Market Total</b>	<b>254,584</b>	<b>100%</b>



Population Data Source: Census and 5-Year American Community Survey data grown to represent 2020 conditions  
 Employment Data Source: Local Zonal Data file

# TBEST Challenges & Opportunities

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## Challenges

- Maintaining socioeconomic database, controlling for vacancies, version control
- Heavy Rail, Light Rail, BRT modes
- Development of Northern Virginia model set

## Opportunities

- Open Software Development, Interoperability, Exportability w/ other planning tools
- Use for Program/Policy Evaluation
- Mobility Area Analysis Features
- DRPT exploring TBEST opportunities in Virginia

# Thank you

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