WWW Modeling Effort

Vincent Post, III

Transportation/GIS Specialist

Wood-Washington-Wirt Interstate Planning Commission

Paul Ricotta

P.E.

Caliper Corporation

Where We Were…

- Original QRS II model developed during Comprehensive LRP in 2003 by Wilbur Smith.

- Following quick turnover of Transportation Engineer position at WWW, Ohio Department of Transportation Staff began updating and maintaining QRS II model in 2005.

- Model basically became an ODOT product, WWW staff did not have the technical ability to deal with the complexity the ODOT version of QRS II model had taken.
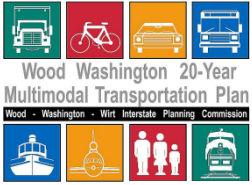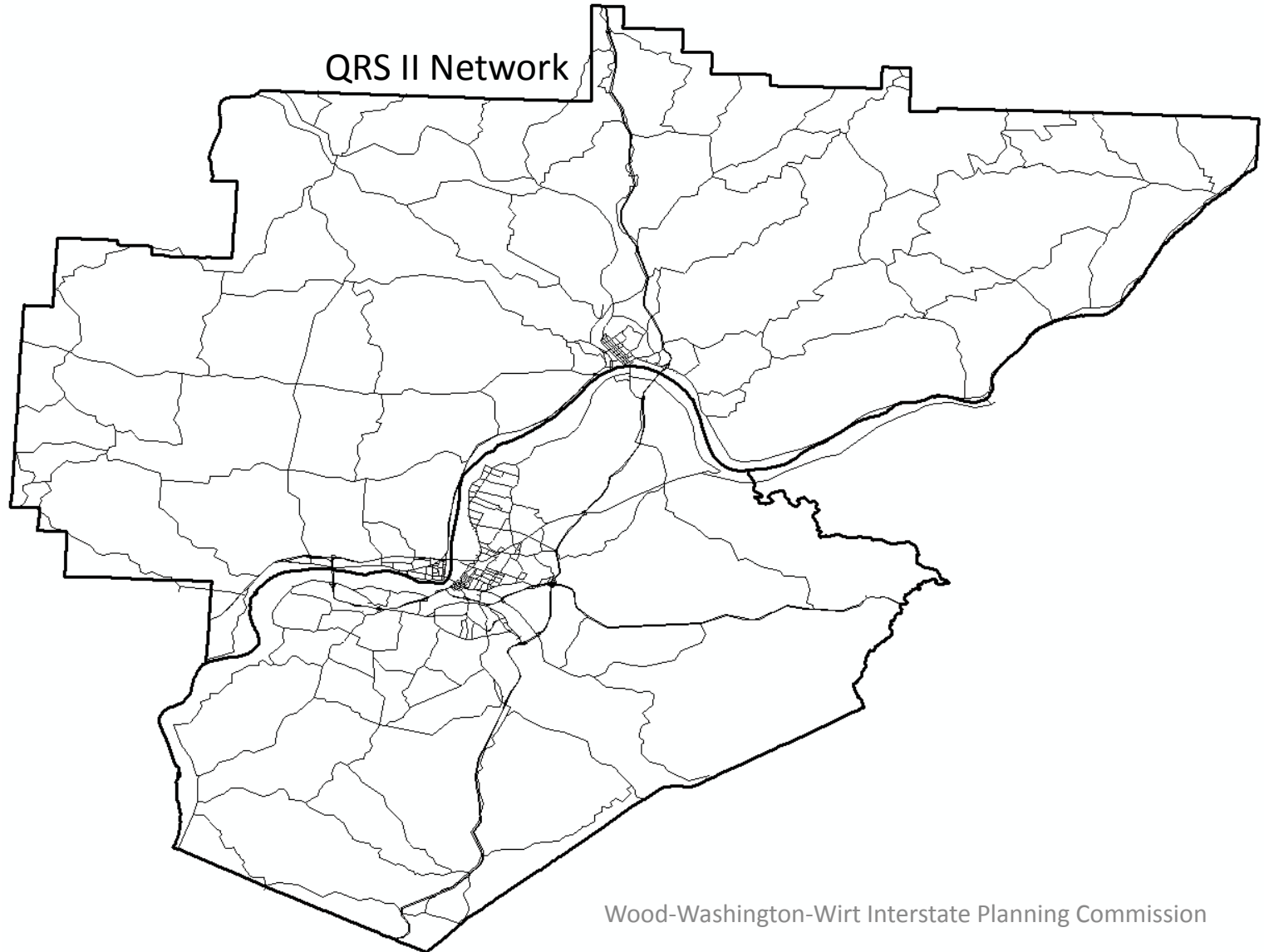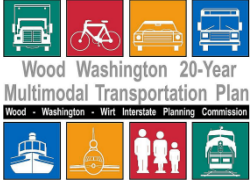
WWW Modeling Effort

98 TAZ's – Washington County
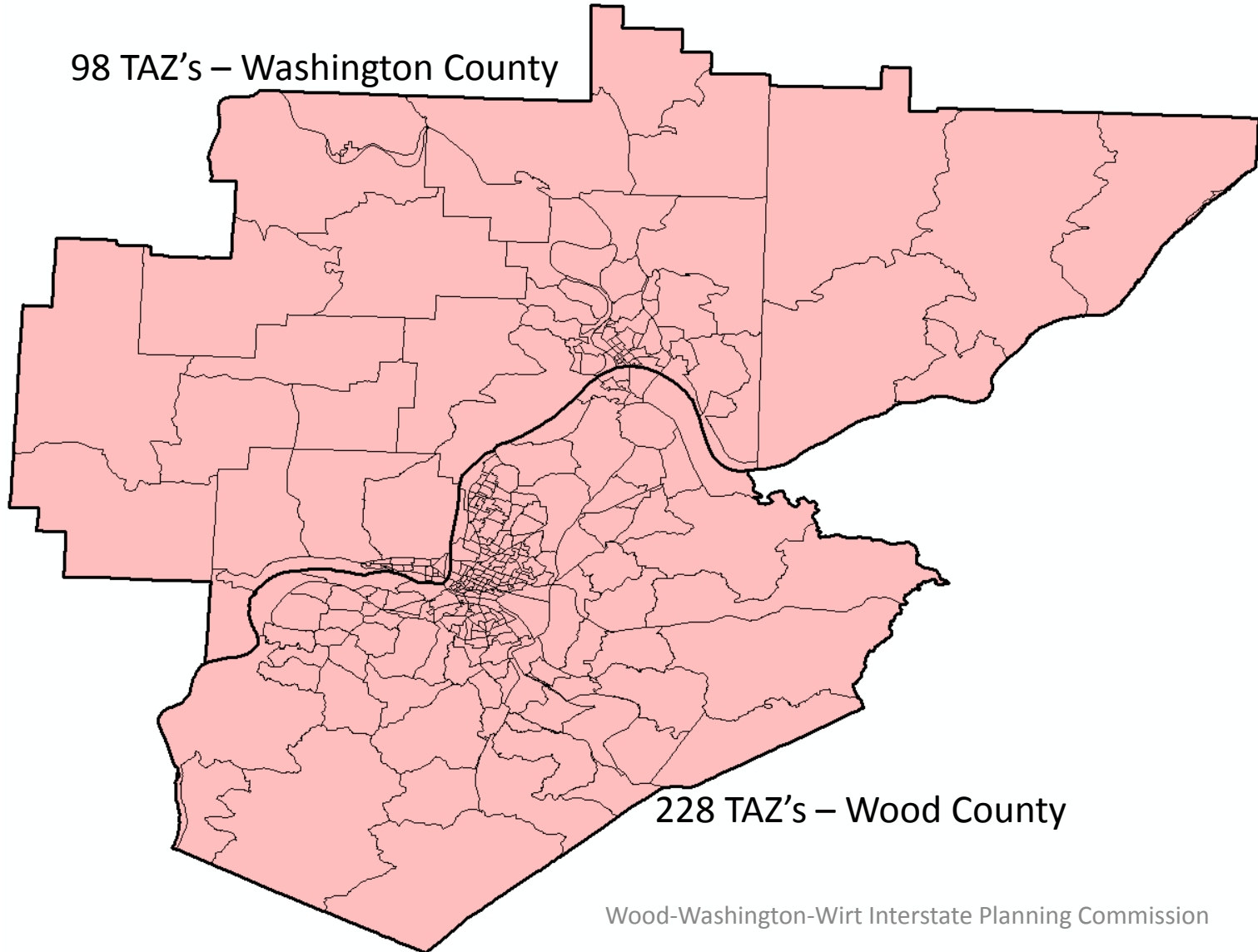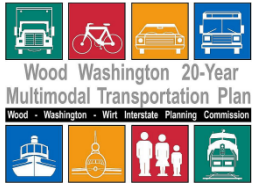
228 TAZ's – Wood County

WWW Modeling Effort
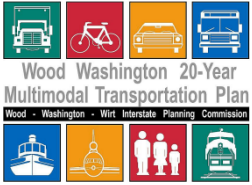
QRS II Network

Where We Were…

- 2009 Planning Conference - State of WV and MPO's decided to begin statewide model conversion to TransCAD.

- Caliper began doing model conversions of the QRS II existing model in 2010.

- QRS II model was still model of record for the 2007 LRP.
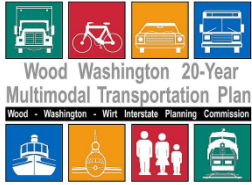
WWW Modeling Effort

Let's Get Started!

- Paul Ricotta with Caliper worked with WWW staff and WVDOH Staff during the latter part of 2011 through 2012 developing Base Year and E+C Network Models.

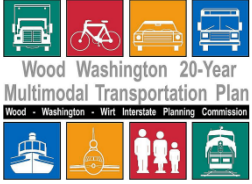# Steps We Took

- Created new Traffic Analysis Zones
- Collected demographics and traffic counts for base year
- Reviewed network for accuracy (number of lanes & speeds)
- Trip Generation
- Trip Distribution
- Trip Assignment
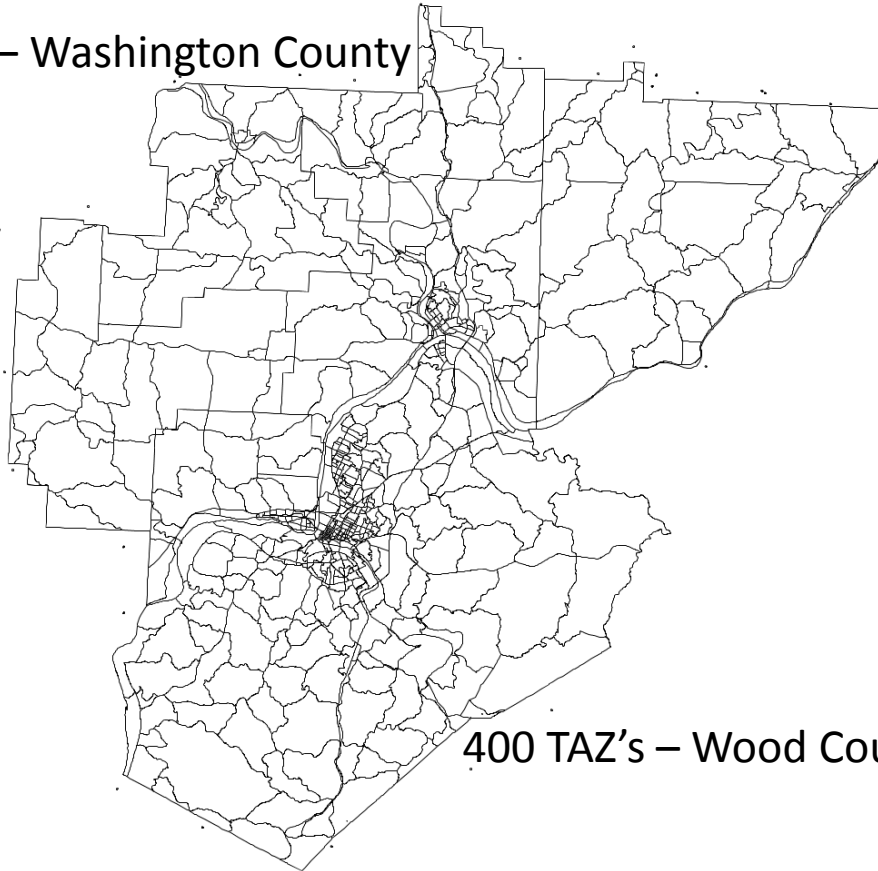- Calibration
- Validation

Created New Traffic Analysis Zones
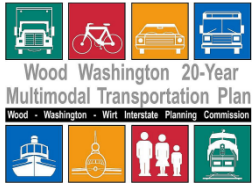
302 TAZ's – Washington County

400 TAZ's – Wood County

Collected Demographics and Traffic Counts

Collected Demographics and Traffic Counts

WWW Modeling Effort

Reviewed Network For Accuracy (Number Of Lanes & Speeds)
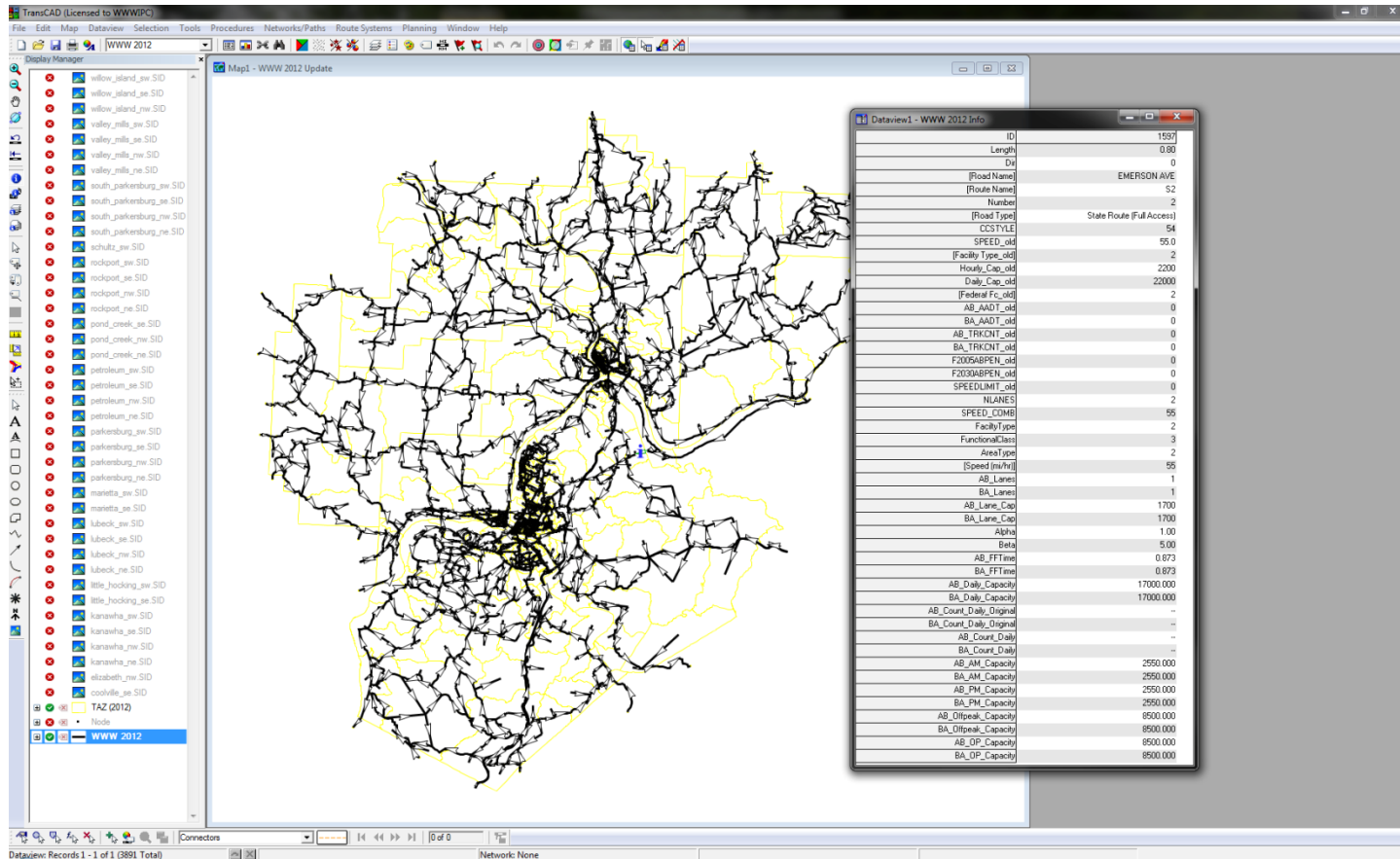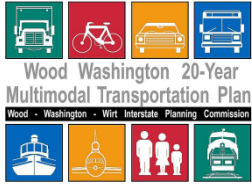
Trip Generation

- Predicts daily productions and attraction by trip purpose.

- Three trip purposes are considered in the model
  - Home-Based Work
  - Home-Based Other
  - Non-Home-Based

Trip Generation

- # Home-Based Work & Home-Based Other
  - Home based trip purposes, the trip production ends are the home zones (since it is people in household who make trips) and trip attraction ends are deemed to be the non-home zone.

- # Non-Home-Based
  - Non-home-based purpose, both the trip production and the trip attraction origin and destination ends are non-home zones.

Trip Generation

- The trip production and attraction are calculated as person trips.
- Daily Trip Productions rates are based on the number of vehicles available and the geographic region of the residence.
- Trip Attractions are based on employment by NAICS code (office, industrial, retail, services employment etc.) and school enrollment (for school trips).
- Special generators assist with trip balancing for the TAZs containing the largest employers in the region.
- External trips are added to the daily trip productions and attractions.
- Finally trip balancing is performed in the last step in preparing the daily Production and Attraction table.

Trip Production Rates

HBO (Home-based Other):

District	0 Autos/HH	1 Auto/HH	2 Autos/HH	3+ Autos/HH
Belpre, OH	1.842633	3.139551	5.17522	5.949694
Williamstown, WV	1.668425	2.874215	4.657564	5.273604
Parkersburg, WV	1.8466	3.13605	5.058948	5.750297
Marietta, OH	1.577096	2.731011	4.365985	4.893726
Rural Wash. Co., OH	1.672287	2.881253	4.683583	5.312392
Rural Wood Co., WV	1.596473	2.767095	4.501356	5.093826

Trip Production Rates

HBW (Home-based Work):

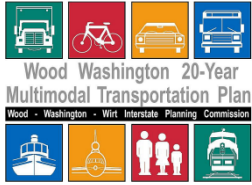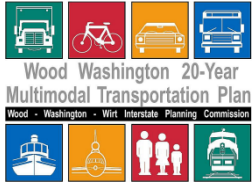| District	0 Autos/HH	1 Auto/HH	2 Autos/HH	3+ Autos/HH
Belpre, OH	0.724285	0.9472	2.306301	3.558497
Williamstown, WV	0.898316	1.187804	2.843136	4.320473
Parkersburg, WV	0.910019	1.186216	2.826533	4.311904
Marietta, OH	1.028849	1.367477	3.229178	4.857741
Rural Wash. Co., OH	0.870954	1.151778	2.765533	4.209936
Rural Wood Co., WV	0.876593	1.166174	2.802179	4.255803

Trip Production Rates

NHB (Non-Home-based):

District	0 Autos/HH	1 Auto/HH	2 Autos/HH	3+ Autos/HH
Belpre, OH	1.833082	2.213249	3.218479	4.091809
Williamstown, WV	1.833259	2.23798	3.1993	4.005923
Parkersburg, WV	1.64338	1.977734	2.814519	3.537799
Marietta, OH	1.794056	2.201512	3.104837	3.848533
Rural Wash. Co., OH	1.856759	2.266969	3.250884	4.077672
Rural Wood Co., WV	1.926934	2.366731	3.396465	4.250371

Trip Attraction Rates
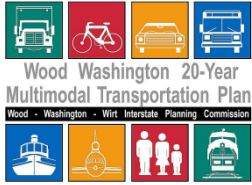
Land Use Description	HBW	HBO	NHB
Households	0	0.7	1.4
School Enrollment	0	1.1	0
Basic Employees	1.45	0.7	0
Retail Employees	1.45	8.4	6.9
Service Employees	1.45	3.5	0.9

Trip Balancing

Trip Purpose	Production Total	Attraction Total
Home-based Work (HBW)	162361	112495
Home-based Other (HBO)	287502	377220
Non-home-based (NHB)	191594	223977

Trip Purpose	Production Total	Attraction Total
Home-based Work (HBW)	162361	162361
Home-based Other (HBO)	287502	287502
Non-home-based (NHB)	207785	207785
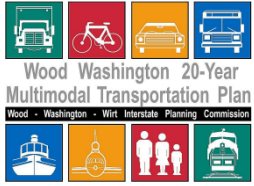
Trip Distribution

- Doubly constrained gravity model generates the Production & Attraction matrices by purpose.

- During the model application within the feedback structure, the AM skims are used for distribution of the home-based trips (HBW, HBO) trips.

- Off-peak skims are used for distribution of the non-home-based trips (NHB).

- Gamma Friction factor curves calibrated primarily from the previous survey are used as inputs to the process.
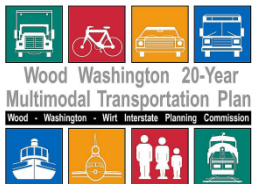
Average Trip Duration

Trip Purpose	Average Trip Duration (min.)	Standard Deviation
Home-based Work (HBW)	17.3	8.6
Home-based Other (HBO)	15.9	9.3
Non-home-based (NHB)	12.7	7.4

Friction Factors

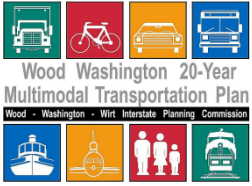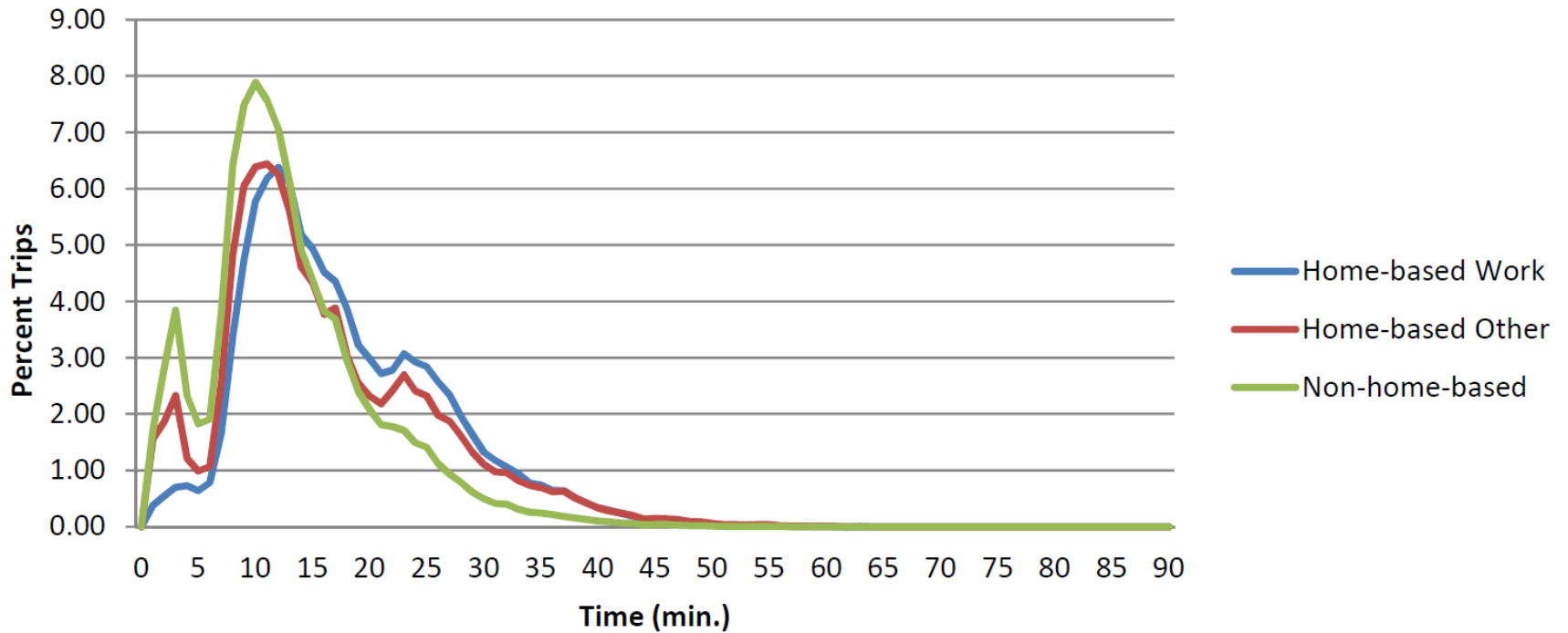| Trip Purpose	a	b	c
Home-based Work (HBW)	1	0.02	0.123
Home-based Other (HBO)	1	1.285	0.094
Non-home-based (NHB)	1	0.791	0.195

Percent Trips by Purpose and Time

Gamma-based Friction Factors
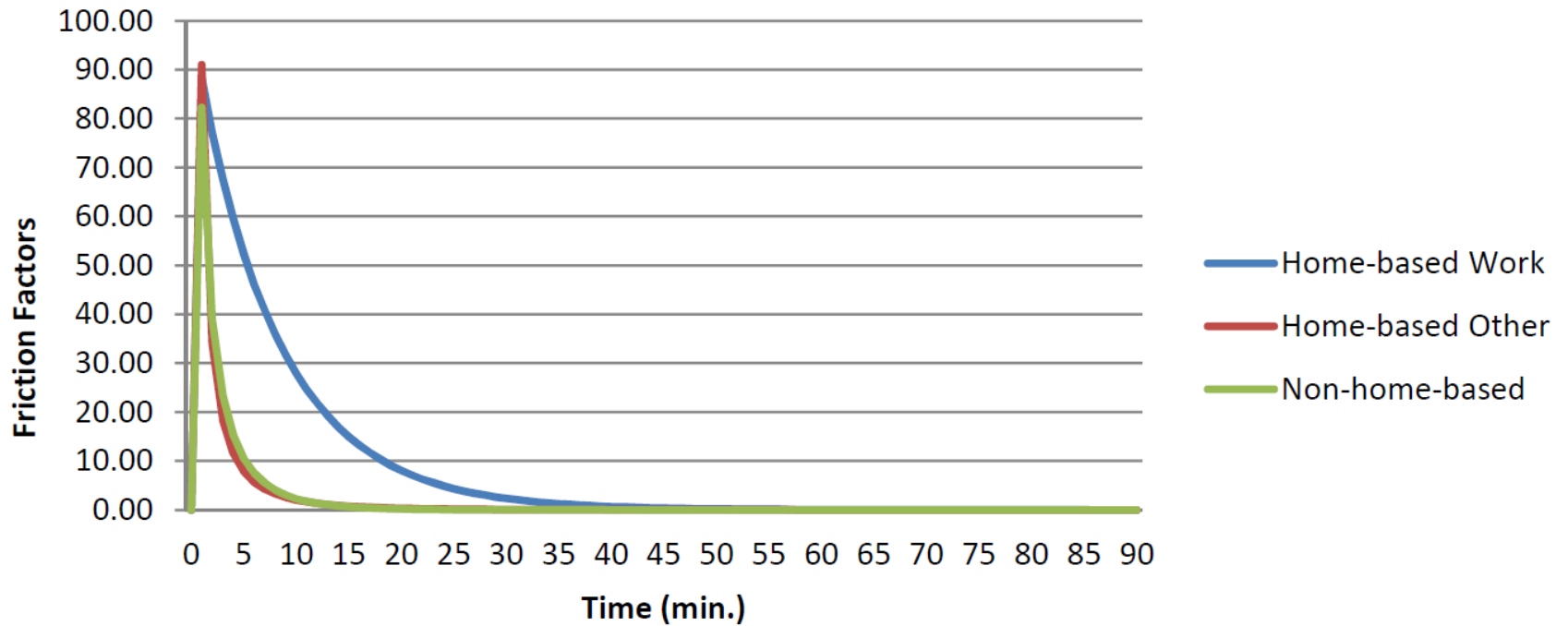
Trip Distribution

- The Time of Day procedure is used to split the trip distribution output matrix into AM, PM, and Off-peak period matrices.

- The procedure also converts person trips to auto trips and converts the PA matrices into OD matrices.

- The time of day procedure yields vehicle OD matrices for the three model time periods (AM, PM, and Off-peak).

O-D Matrices

AM Period (7:00 - 9:00AM)

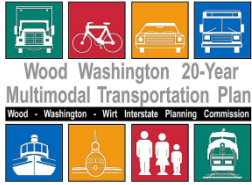| Trip Purpose	Departure Rate (%)	Return Rate (%)
Home-based Work (HBW)	22	0.20
Home-based Other (HBO)	11.8	2.3
Non-home-based (NHB)	10	10

PM Period (3:00 - 5:00PM)

Trip Purpose	Departure Rate (%)	Return Rate (%)
Home-based Work (HBW)	2.6	25.7
Home-based Other (HBO)	9.5	15.3
Non-home-based (NHB)	24.7	24.7

Off-peak Period (All Other Hours)

Trip Purpose	Departure Rate (%)	Return Rate (%)
Home-based Work (HBW)	25.4	24.1
Home-based Other (HBO)	28.7	32.4
Non-home-based (NHB)	15.3	15.3

Auto Occupancies

Trip Purpose	Auto Occupancy
Home-based Work (HBW)	1.1
Home-based Other (HBO)	1.75
Non-home-based (NHB)	1.5

Trip Totals

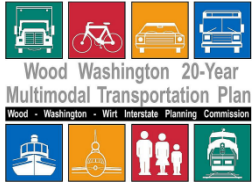| Trip Purpose	AM Trips	PM Trips	Off Peak Trips
Home-based Work (HBW)	32767	41771	73063
Home-based Other (HBO)	23164	40743	100379
Non-home-based (NHB)	27705	68431	42388
Through Trips	812	1416	24134
Total Trips	*84449*	*152361*	*218244*

Traffic Assignment

- Assigns the AM, PM, and Off-peak trips onto the network.
- Based on the TransCAD Origin-based User Equilibrium method using the Bureau of Public Roads (BPR) Volume Delay function.
- The assignment generates congested travel times for all the three model periods.
- Feedback component in the model achieves model consistency in travel times used for the trip distribution.
- The feedback loop is run until a fixed point solution is obtained, usually when the assigned link flows and travel time skims between successive feedback iterations are considered stable.
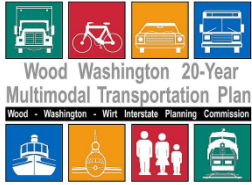 - For the WWW model, this occurs within five feedback loops.

Traffic Assignment

- The key features of the traffic assignment deployed in the WWW model are:
  - The assignment method is user equilibrium run to a relative gap of 1e-06 (0.000001) through a maximum of 250 iterations of assignment.
  - The assignment consists of a single class of vehicles, although could easily be modified to multiclass should we wish to pursue separation of vehicle classes (e.g. Trucks).
  - The assignment employs the Bureau of Public Roads (BPR) Volume Delay Function (VDF) using link-type specific parameters for calibration parameters alpha (α) and beta (β).
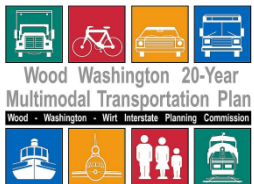
Volume Delay Function

$$t = t_f \left[1 + \alpha \left(\frac{v}{c} \right)^{\beta} \right]$$

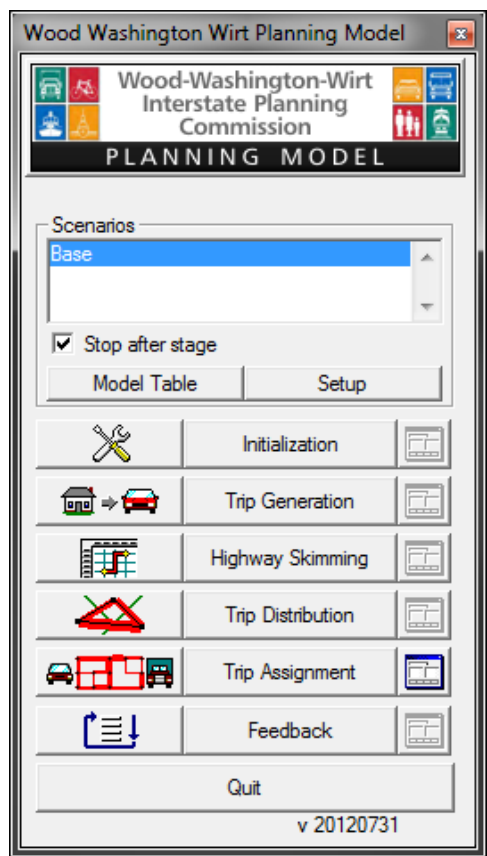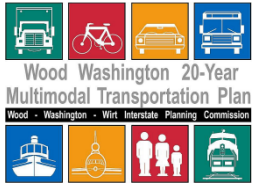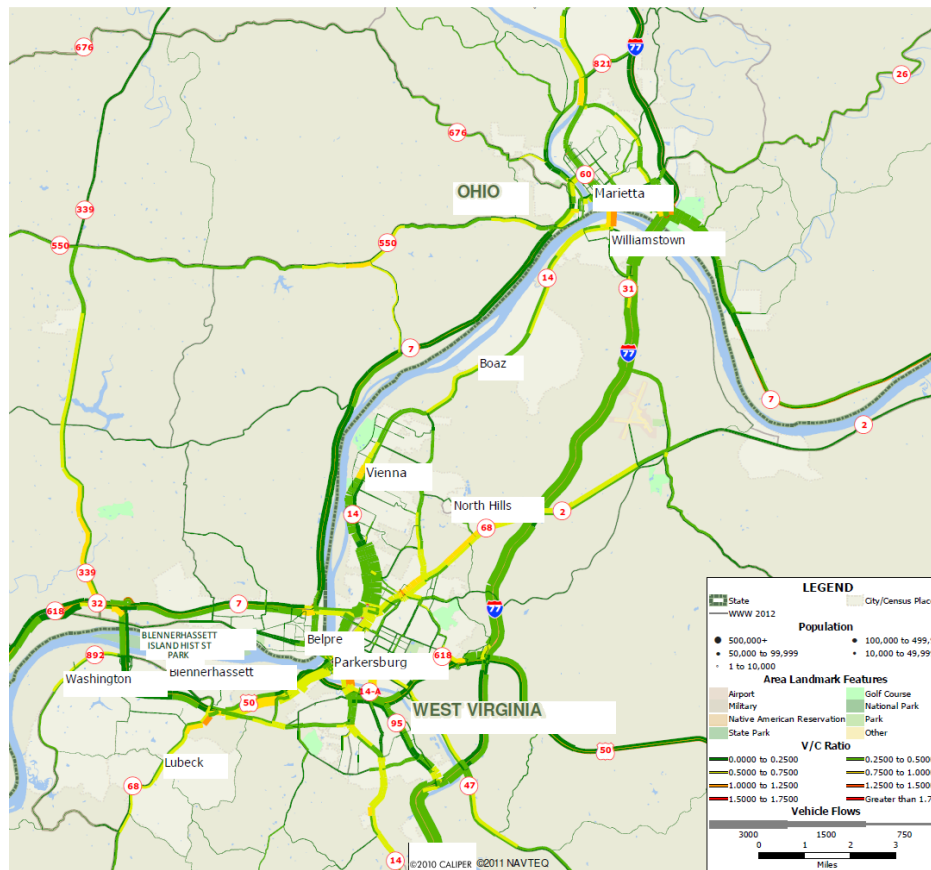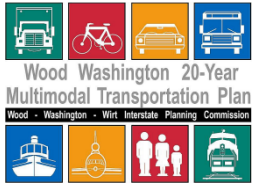| Link Type	Alpha (α)	Beta (β)	Hourly Capacity
Interstate	0.9	9	2000
Freeways and Expressways	0.75	6	1900
Principal Arterial	1	5	1700
Minor Arterial	1.25	5	1200
Major Collector	1.5	5	1100
Minor Collector	1.75	5.5	900
Local	2	5.5	600
Ramps	1.5	10	1200
Centroid Connector	0.000001	4	99999

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User Interface

Assignment Results – AM Peak (7-9 am)

Assignment Results – PM Peak (3-5 am)
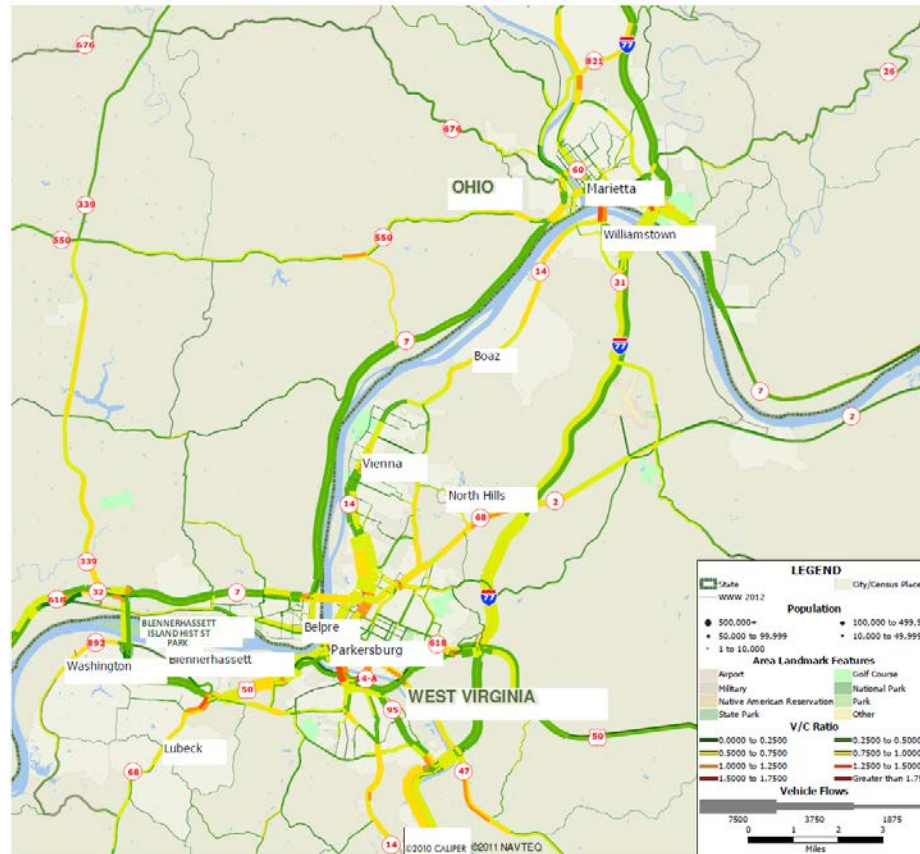
Assignment Results – Off-Peak
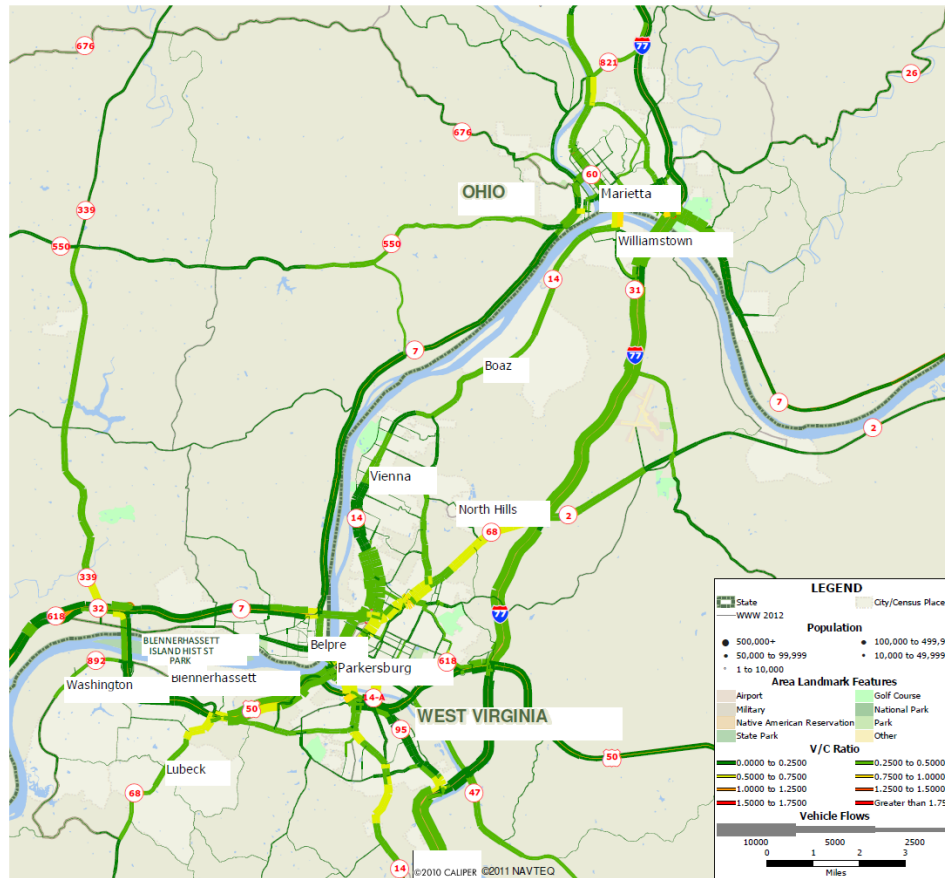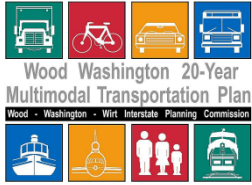
Calibration

- Average Daily Traffic (ADT) counts were used for the calibration.
- Caliper used the ODOT model calibration and validation standards.
  - Three Primary Measures:
    - Percent Root Mean Square Error (%RMSE) overall and by facility type
    - Screenline Analysis
    - Vehicle Miles of Travel (VMT) comparison
- Of the three primary measures, the %RMSE is the most stringent to and challenging to meet.

$$\% RMSE = 100 * \sqrt{(\sum_i (Model_i - Count_i)^2 / (Number of counts - 1)} / (\sum_i (Count_i / Number of Counts)$$
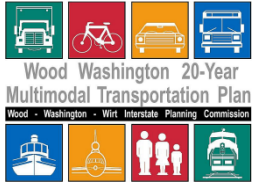
Calibration – %RMSE By Volume Group

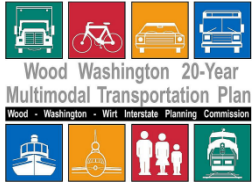| Volume Group	%RMSE	Number of Observations	ODOT Standard (max. %RMSE)	ODOT Standard Met?
All Links	33.73	725	40	Yes
[0, 500)	159.09	190	200	Yes
[500, 1500)	68.70	136	100	Yes
[1500, 2500)	41.63	111	64	Yes
[2500, 3500)	50.49	52	54	Yes
[3500, 4500)	45.05	51	48	Yes
[4500, 5500)	27.64	49	45	Yes
[5500, 7000)	24.10	44	42	Yes
[7000, 8500)	18.40	32	39	Yes
[8500, 10000)	16.87	17	36	Yes
[10000, 12500)	10.37	21	34	Yes
[12500, 15000)	16.21	22	31	Yes
[15000, 17500)	4.68	4	30	Yes
[17500, 20000)	7.75	8	28	Yes
[20000, 25000)	11.79	2	26	Yes

Calibration – %RMSE By Link Type

| Link Type	%RMSE	Number of Observations	ODOT Standard (max. %RMSE)	ODOT Standard Met?
All Links	33.73	725	40	Yes
Interstates and Freeways	12.69	26		n/a
Principal Arterials	18.63	137		n/a
Minor Arterials	29.45	115		n/a
Major Collectors	61.90	256		n/a
Minor Collectors	94.60	90		n/a
Local Roads	98.66	76		n/a
Ramps	49.71	25		n/a
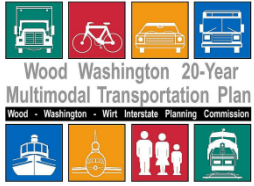
Screenlines – %RMSE By Link Type

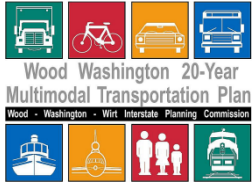| Screenline Name	Total Flow	Total Count	Num. Counts	% Error	%RMSE	ODOT Stand. (% Error)	Met?
Ohio River	83,718	74,032	6	13	19.42	28	Yes
Little Kanawha River	47,888	48,727	10	-2	6.88	33	Yes
Muskingum River	15,229	17,585	5	-13	23.45	48	Yes
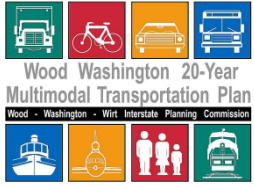
WWW Modeling Effort

VMT Comparison

Link Type	Model VMT	Count VMT	% Error	ODOT Standard (max. % Error)	ODOT Standard Met?
All Links	1,080,255	1,067,979	1.01	3	Yes
Interstates	449,515	455,616	1.34	7	Yes
Other Freeways	29,110	27,189	-7.06	7	Yes
Principal Arterials	276,912	271,159	-2.12	7	Yes
Minor Arterials	119,406	124,765	4.30	10	Yes
Major Collectors	141,680	138,045	-2.63	15	Yes
Minor Collectors	29,861	19,659	-51.89	>15	Yes
Local Roads	14,456	13,102	-10.33	>15	Yes
Ramps	19,315	18,441	-4.74	15	Yes

VMT and VHT

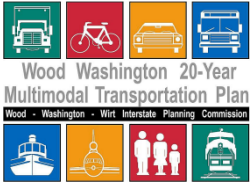| Link Type	Model VMT	Model VHT
All Links	3,984,539	96,405
Interstates	820,247	12,874
Other Freeways	200,454	3,504
Principal Arterials	955,265	21,853
Minor Arterials	663,264	16,898
Major Collectors	635,591	15,775
Minor Collectors	126,440	2,974
Local Roads	128,837	4,300
Ramps	64,593	3,033
Centroid Connectors	389,847	15,597

Validation

- Two test projects selected to see model response to scenarios.
    - Putman Street (Marietta) Bridge Closure
    - South Vienna Connector
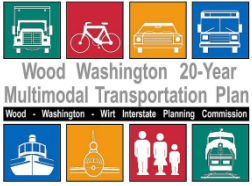
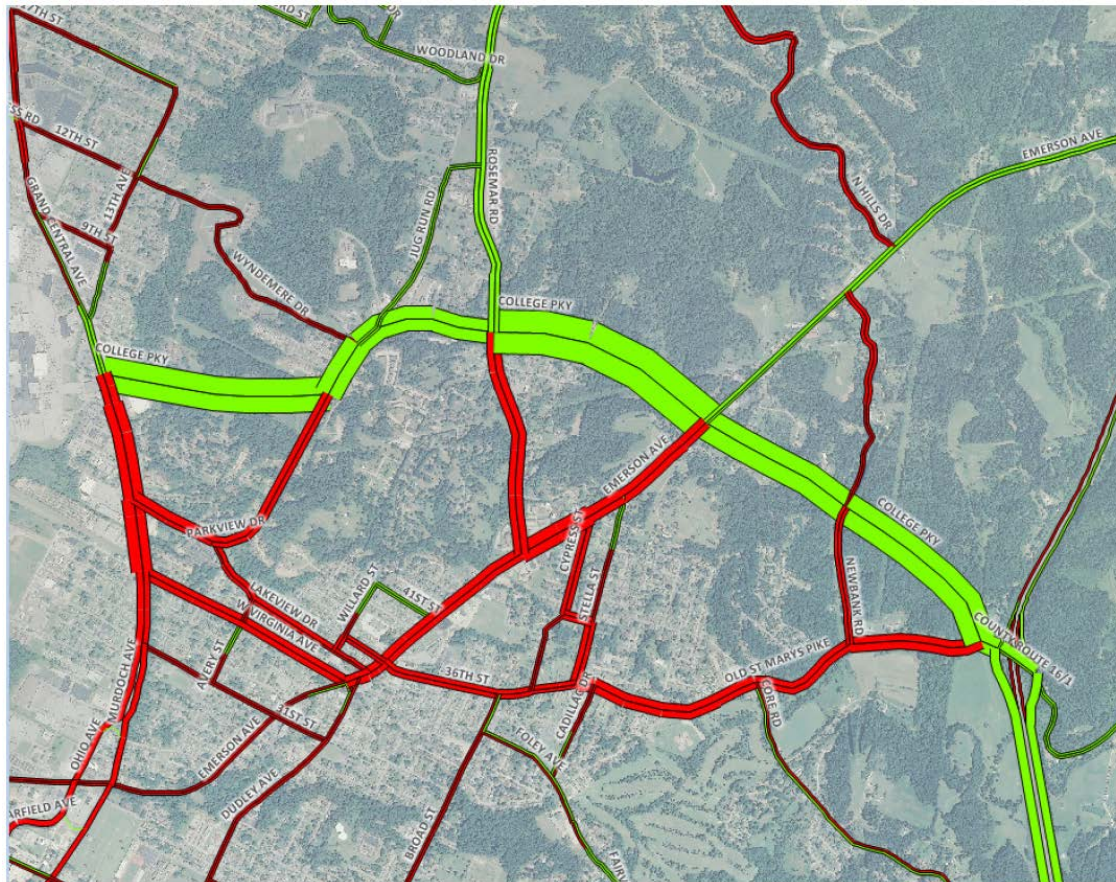# Putnam Street Bridge
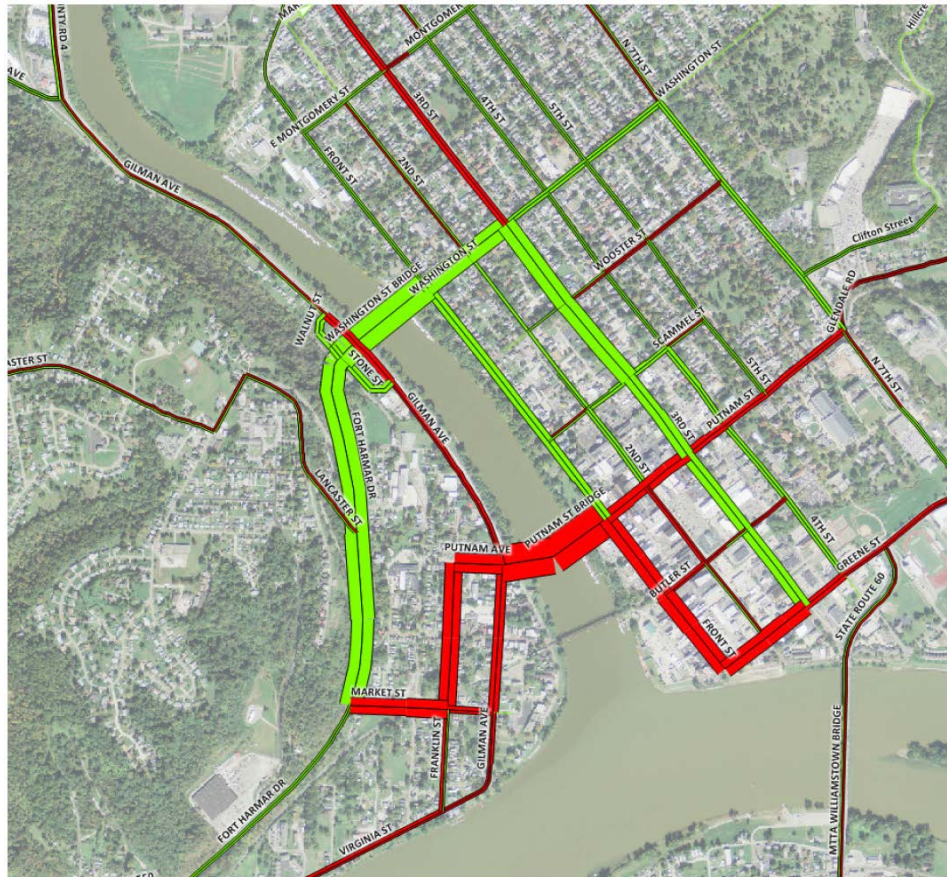
South Vienna Connector

Where Do We Go From Here???

- Existing + Committed Network Creation

- Demographics for 2035, LRP Out Year

- A network including recommended, fiscally constrained program of projects

- Air quality

Questions, Comments, Concerns, or Smart Remarks?

- Vincent Post, III
    - vince.post@movrc.org

- Paul Ricotta
    - paul@caliper.com