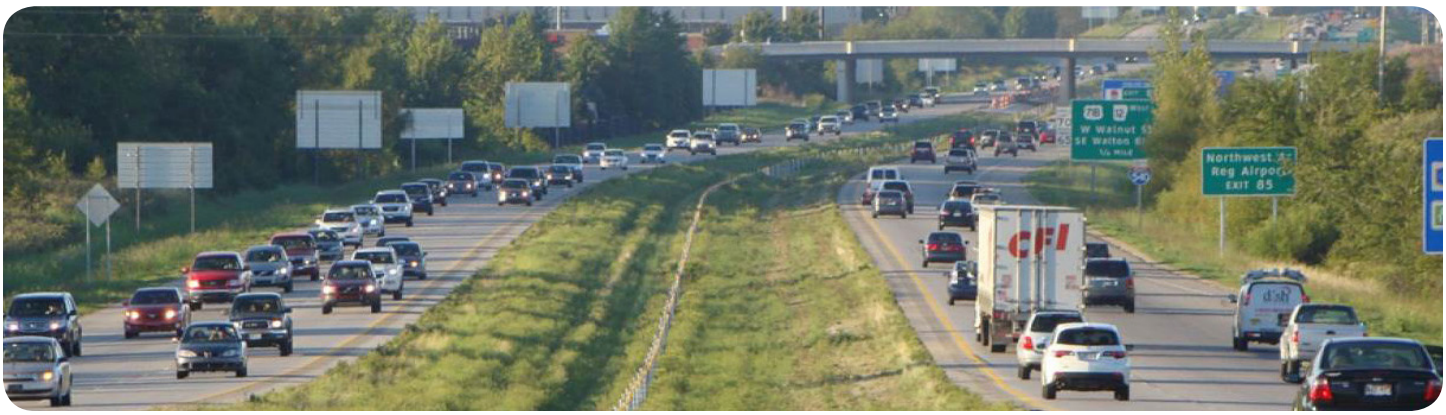


CHAPTER 7. TRAVEL PATTERNS AND TRAVEL FORECASTING

TRAVEL PATTERNS

Northwest Arkansas has experienced unprecedented growth in population and employment in the past 25 years. The economic vitality and diversity of population have been strong catalysts for the growth of the region.

In Northwest Arkansas, the majority of the population uses an automobile for work related trips. According to the American Community Survey (ACS) 5 year estimate of 2013, the vast majority, over 90 percent of workers 16 years and over in Benton and Washington Counties in Arkansas and McDonald County in Missouri, commuted to work by car, truck, or van.

Figure 7.1 and Figure 7.2 illustrate the percentages for each mode of transportation that workers 16 years and over used to commute to work for two five-year estimates (2005-2009 and 2009-2013). In Benton County, the percent of workers who drove alone increased from 79.9 percent in 2009 to 82.4 percent in 2013. In Washington County this group decreased from 79.3 percent in 2009 to 76.8 in 2013. McDonald County experienced an increase from 76.2 to 78.6 percent. A notable difference from 2009 to 2013 was estimated for the public transportation mode in Washington County which increased from 0.4 percent to 1 percent by 2013. In the same category, Benton County percent stayed at 0.4 percent while McDonald County's decreased from 0.4 percent to 0.1 percent.

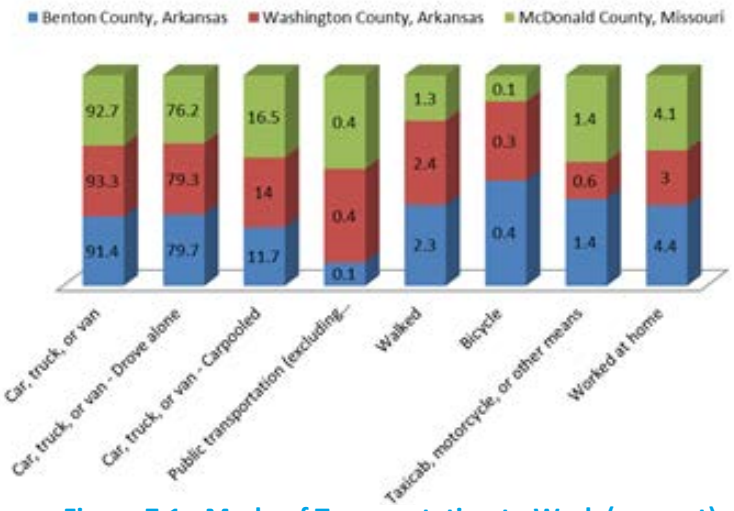


Figure 7.1 - Mode of Transportation to Work (percent) ACS 2005-2009

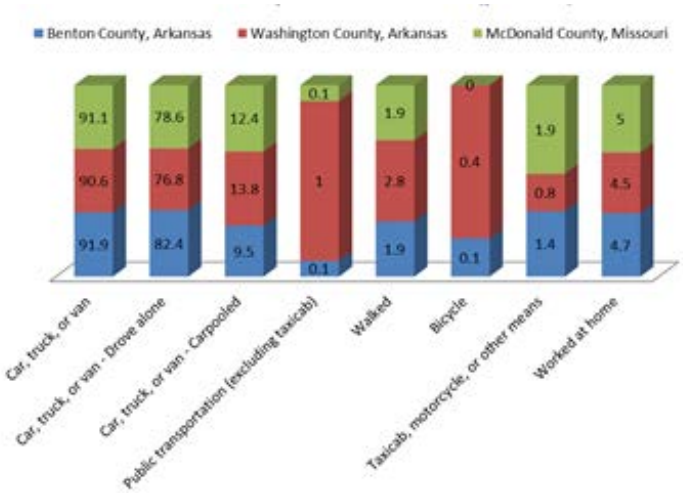
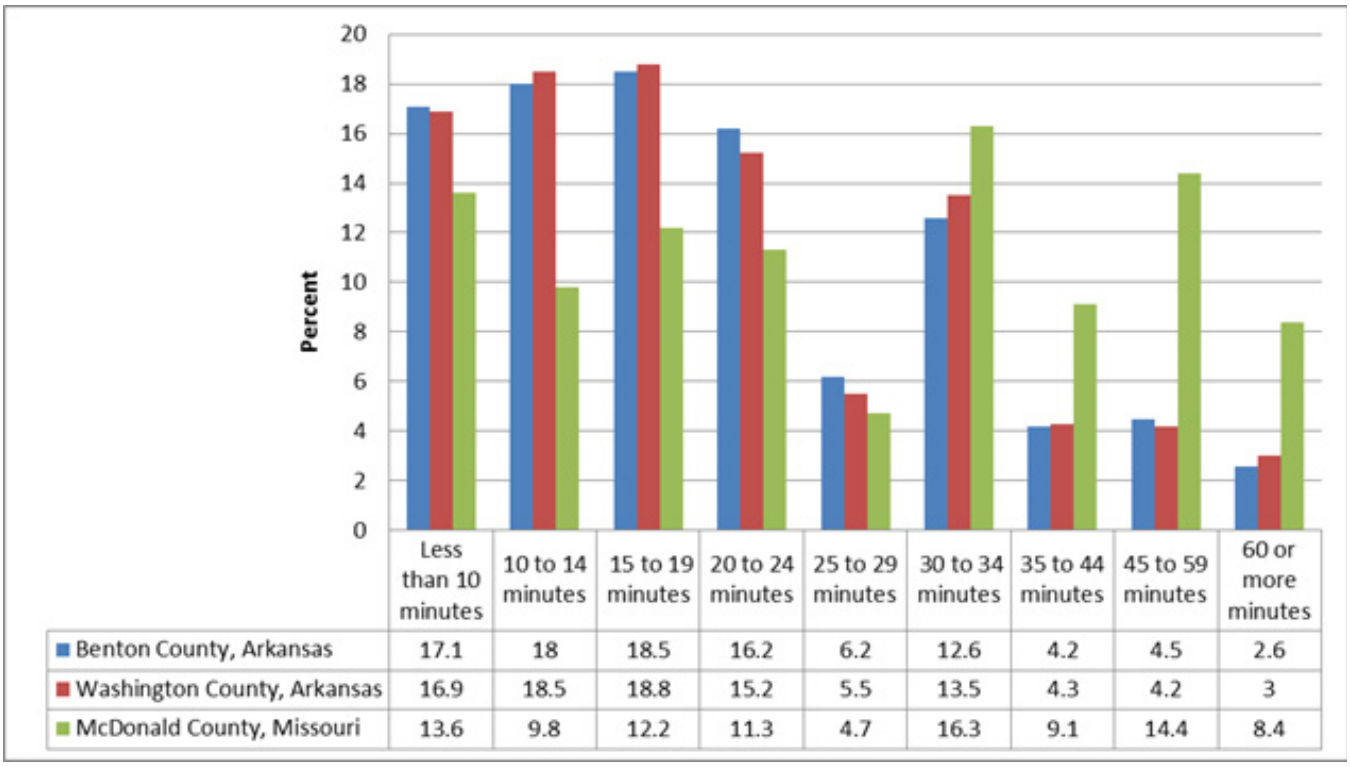


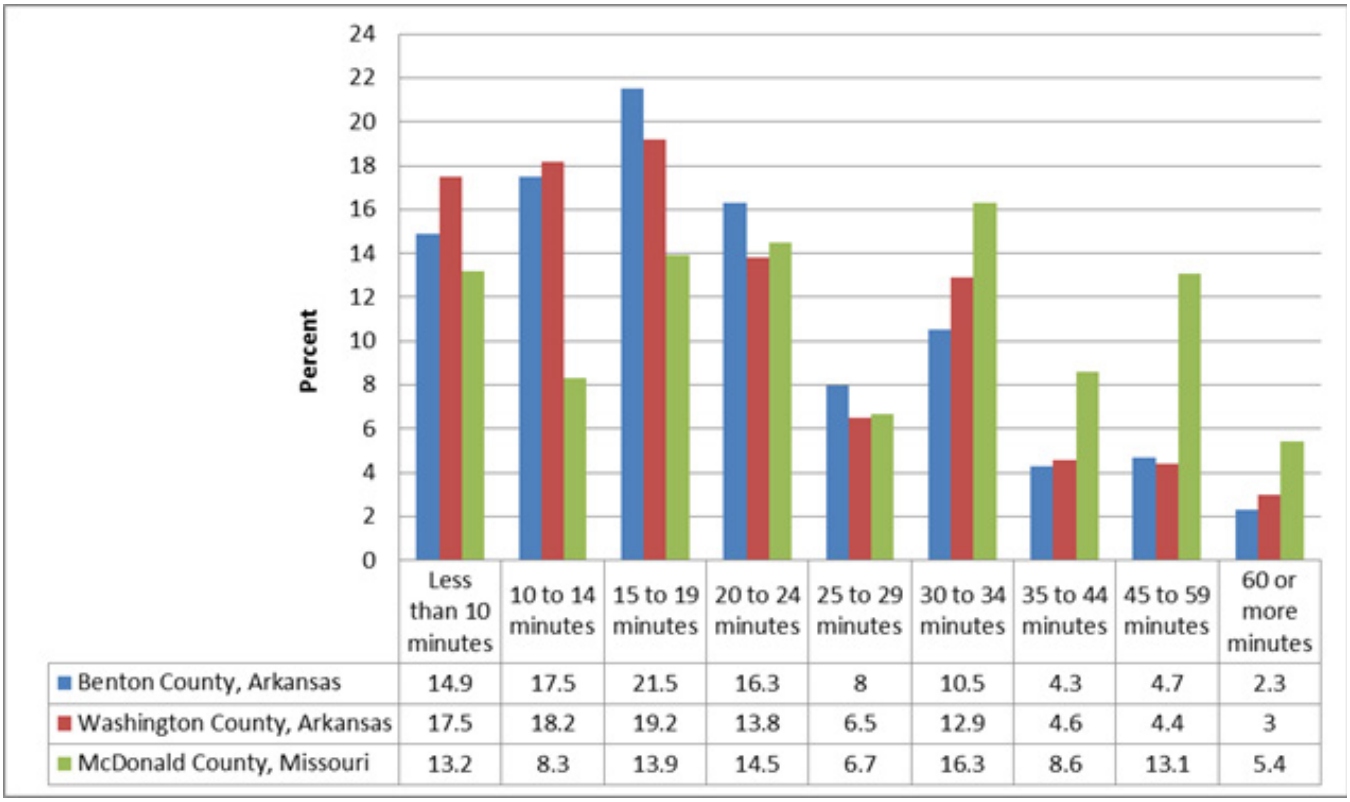
Figure 7.2 - Mode of Transportation to Work (percent) ACS 2009-2013

In terms of travel time, the ACS data collected between 2005-2009 illustrates the following percent by travel time in minutes and patterns by county:



	Less than 10 minutes	10 to 14 minutes	15 to 19 minutes	20 to 24 minutes	25 to 29 minutes	30 to 34 minutes	35 to 44 minutes	45 to 59 minutes	60 or more minutes
Benton County, Arkansas	17.1	18	18.5	16.2	6.2	12.6	4.2	4.5	2.6
Washington County, Arkansas	16.9	18.5	18.8	15.2	5.5	13.5	4.3	4.2	3
McDonald County, Missouri	13.6	9.8	12.2	11.3	4.7	16.3	9.1	14.4	8.4

Figure 7.3 -Travel Time Estimate ACS 2005-2009



	Less than 10 minutes	10 to 14 minutes	15 to 19 minutes	20 to 24 minutes	25 to 29 minutes	30 to 34 minutes	35 to 44 minutes	45 to 59 minutes	60 or more minutes
Benton County, Arkansas	14.9	17.5	21.5	16.3	8	10.5	4.3	4.7	2.3
Washington County, Arkansas	17.5	18.2	19.2	13.8	6.5	12.9	4.6	4.4	3
McDonald County, Missouri	13.2	8.3	13.9	14.5	6.7	16.3	8.6	13.1	5.4

Figure 7.4 -Travel Time Estimate ACS 2009-20013

Daily Vehicle Miles Traveled

Table 7.1 and Table 7.2 summarize the daily vehicle miles traveled in 2014 by road functional class for Benton and Washington Counties.

Route Sign	Functional Class	Pop: < 5,000 Rural		Pop: 5,000 to 49,999 Small Urban		Pop: >=50,000 Urbanized		Total	
		Road Length	DVMT	Road Length	DVMT	Road Length	DVMT	Road Length	DVMT
State Highway	Interstate	0.00	0	0.00	0	17.30	1,117,250	17.30	1,117,250
	Other Freeways & Expressways	0.00	0	0.00	0	0.43	18,920	0.43	18,920
	Other Principal Arterials	22.52	298,747	5.26	120,975	36.92	950,692	64.70	1,370,414
	Minor Arterials	48.55	178,891	18.42	168,231	77.20	639,667	144.17	986,789
	Major Collectors	88.23	191,422	7.56	27,733	40.81	151,844	136.60	370,999
	Minor Collectors	0.00	0	0.00	0	0.00	0	0.00	0
	Locals	0.00	0	0.20	26	0.00	0	0.20	26
	Total	159.30	669,060	31.44	316,965	172.66	2,878,372	363.40	3,864,398
County Roads	Other Freeways & Expressways	0.00	0	0.00	0	0.00	0	0.00	0
	Other Principal Arterials	0.00	0	0.00	0	0.00	0	0.00	0
	Minor Arterials	2.65	1,677	0.00	0	3.55	4,470	6.20	6,147
	Major Collectors	105.46	53,738	9.65	11,443	37.87	96,128	152.98	161,310
	Minor Collectors	59.53	17,345	0.00	0	12.06	3,375	71.59	20,720
	Locals	1,807.37	162,761	28.85	5,653	119.87	23,210	1,956.09	191,623
	Total	1,975.01	235,521	38.50	17,096	173.35	127,183	2,186.86	379,800
City Streets	Other Freeways & Expressways	0.00	0	0.00	0	0.00	0	0.00	0
	Other Principal Arterials	0.00	0	0.00	0	0.00	0	0.00	0
	Minor Arterials	0.32	51	9.53	40,070	98.90	747,585	108.75	787,706
	Major Collectors	16.25	4,872	24.97	39,083	180.63	310,657	221.85	354,612
	Minor Collectors	4.00	3,413	1.26	728	8.75	3,283	14.01	7,424
	Locals	53.19	14,428	132.62	46,452	1,481.58	581,474	1,667.39	642,355
	Total	73.76	22,764	168.38	126,333	1,769.86	1,643,000	2,012.00	1,792,097
BENTON County Total		2,208.07	927,346	238.32	460,394	2,115.87	4,648,556	4,562.26	6,036,296

Table 7.1 - Benton County Daily Vehicle Miles Traveled (DMVT) for 2014 – Source: AHTD

Route Sign	Functional Class	Pop: < 5,000 Rural		Pop: 5,000 to 49,999 Small Urban		Pop: >=50,000 Urbanized		Total	
		Road Length	DVMT	Road Length	DVMT	Road Length	DVMT	Road Length	DVMT
State Highway	Interstate	16.35	321,679	0.00	0	17.73	959,464	34.08	1,281,143
	Other Freeways & Expressways	0.00	0	0.00	0	3.24	87,440	3.24	87,440
	Other Principal Arterials	10.34	124,705	0.00	0	47.32	998,575	57.66	1,123,280
	Minor Arterials	70.90	179,406	0.00	0	55.99	459,119	126.89	638,525
	Major Collectors	79.95	76,445	0.00	0	16.43	44,296	96.38	120,741
	Minor Collectors	6.07	3,678	0.00	0	0.00	0	6.07	3,678
	Locals	2.59	135	0.00	0	5.80	4,236	8.39	4,371
	Total	186.20	706,048	0.00	0	146.51	2,553,131	332.71	3,259,179
County Roads	Other Freeways & Expressways	0.00	0	0.00	0	0.00	0	0.00	0
	Other Principal Arterials	0.00	0	0.00	0	0.00	0	0.00	0
	Minor Arterials	0.00	0	0.00	0	2.60	9,480	2.60	9,480
	Major Collectors	98.47	81,409	0.00	0	44.09	49,456	142.56	130,865
	Minor Collectors	148.02	48,492	0.00	0	19.48	13,780	167.50	62,271
	Locals	1,466.17	127,169	0.00	0	55.06	8,453	1,521.23	135,622
	Total	1,712.66	257,069	0.00	0	121.23	81,169	1,833.89	338,238
City Streets	Other Freeways & Expressways	0.00	0	0.00	0	0.00	0	0.00	0
	Other Principal Arterials	0.00	0	0.00	0	1.02	17,380	1.02	17,380
	Minor Arterials	0.00	0	0.00	0	61.20	496,529	61.20	496,529
	Major Collectors	9.14	5,919	0.33	204	174.43	517,324	183.90	523,447
	Minor Collectors	3.42	5,062	0.00	0	10.06	6,509	13.48	11,571
	Locals	41.95	12,353	0.00	0	851.71	319,637	893.66	331,990
	Total	54.51	23,335	0.33	204	1,098.42	1,357,379	1,153.26	1,380,917
WASHINGTON County Total		1,953.37	986,452	0.33	204	1,366.16	3,991,679	3,319.86	4,978,335

Table 7.2 - Benton County Daily Vehicle Miles Traveled (DMVT) for 2014 – Source: AHTD

As it can be noted from Table 7.3, the Daily and Annual VMT have increased comparing 2009 to 2014; however, the daily VMT per capita in the two county area has remained constant.

Year	Population Estimate July 1st	Daily VMT	Annual VMT	Daily VMT per capita
2009	416,394	9,840,518	3,591,789,070	23.63
2010	426,942	9,983,349	3,643,922,385	23.38
2011	435,662	10,094,273	3,684,409,645	23.17
2012	444,473	10,514,234	3,848,209,644	23.66
2013	454,054	10,761,582	3,927,977,430	23.70
2014	463,113	11,014,630	4,020,340,096	23.78

Table 7.3 - Annual Vehicles Miles of Travel in the Two County Area
Source: Arkansas Highway and Transportation Department

Both the Table 7.4 and Figure 7.5 indicate an increasing trend of the VMT in both Washington and Benton Counties.

	2009		2010		2011		2012		2013		2014	
	DVMT	AVMT	DVMT	AVMT	DVMT	AVMT	DVMT	AVMT	DVMT	AVMT	DVMT	AVMT
Benton	5,209,912	1,901,617,880	5,273,634	1,924,876,410	5,297,149	1,933,459,385	5,561,922	2,035,663,452	5,690,060	2,076,871,900	6,036,296	2,203,247,952
Washington	4,630,606	1,690,171,190	4,709,715	1,719,045,975	4,797,124	1,750,950,260	4,952,312	1,812,546,192	5,071,522	1,851,105,530	4,978,335	1,817,092,144
2 Counties	9,840,518	3,591,789,070	9,983,349	3,643,922,385	10,094,273	3,684,409,645	10,514,234	3,848,209,644	10,761,582	3,927,977,430	11,014,630	4,020,340,096
Statewide	90,854,940	33,162,052,936	92,188,754	33,648,895,210	90,288,068	32,955,144,820	91,423,220	33,460,898,520	91,756,533	33,491,134,545	93,169,936	34,007,026,742

Table 7.4 - Daily Vehicles Miles of Travel and Annual Vehicles Miles of Travel in the 2 County Area and Statewide Arkansas (2009-2014)
Data Source: AHTD

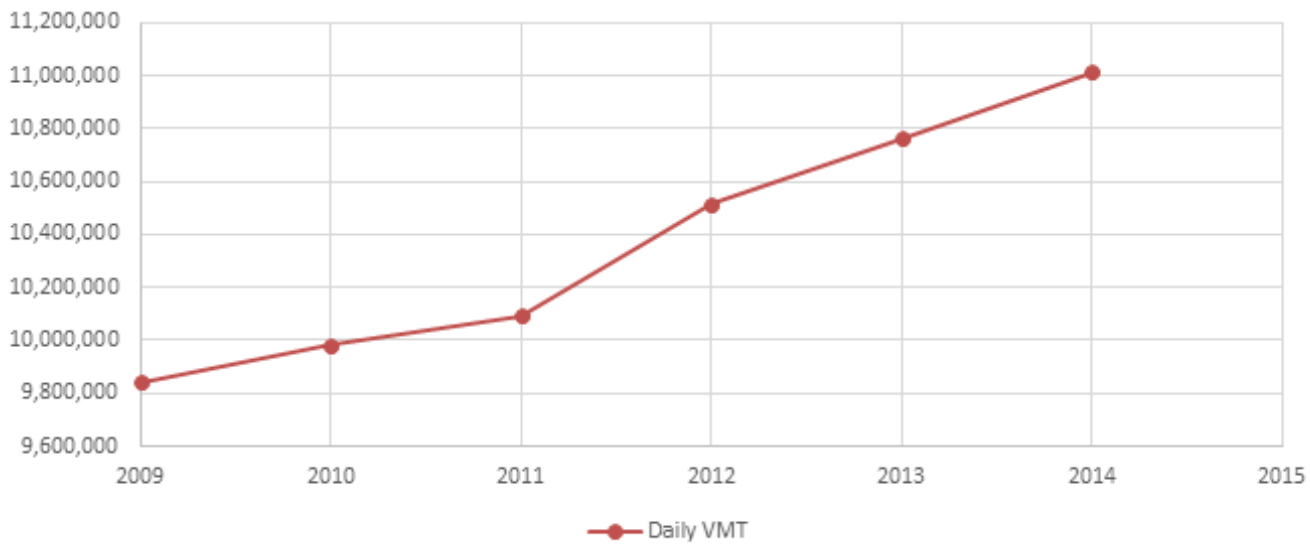


Figure 7.5 - Daily Vehicle Miles of Travel (VMT) Benton and Washington Counties 2009-2013

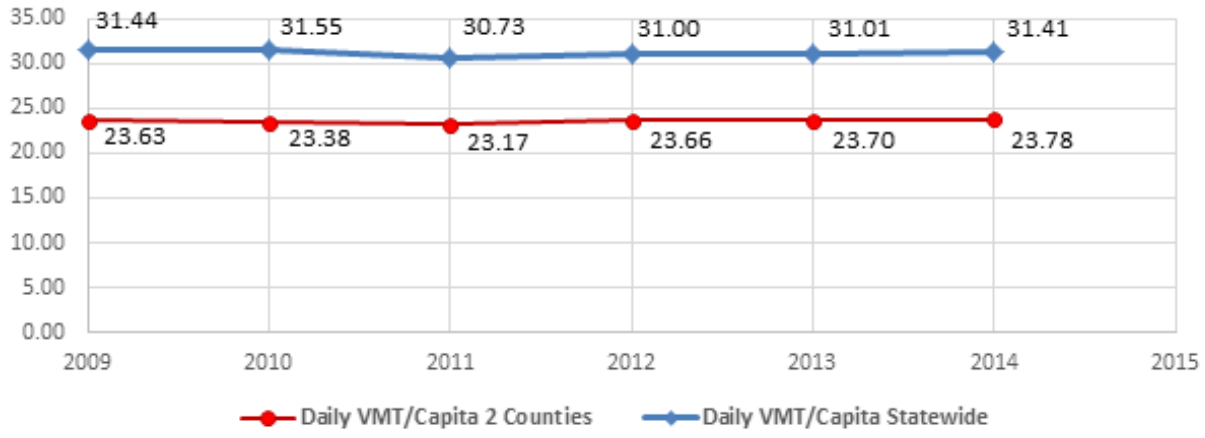
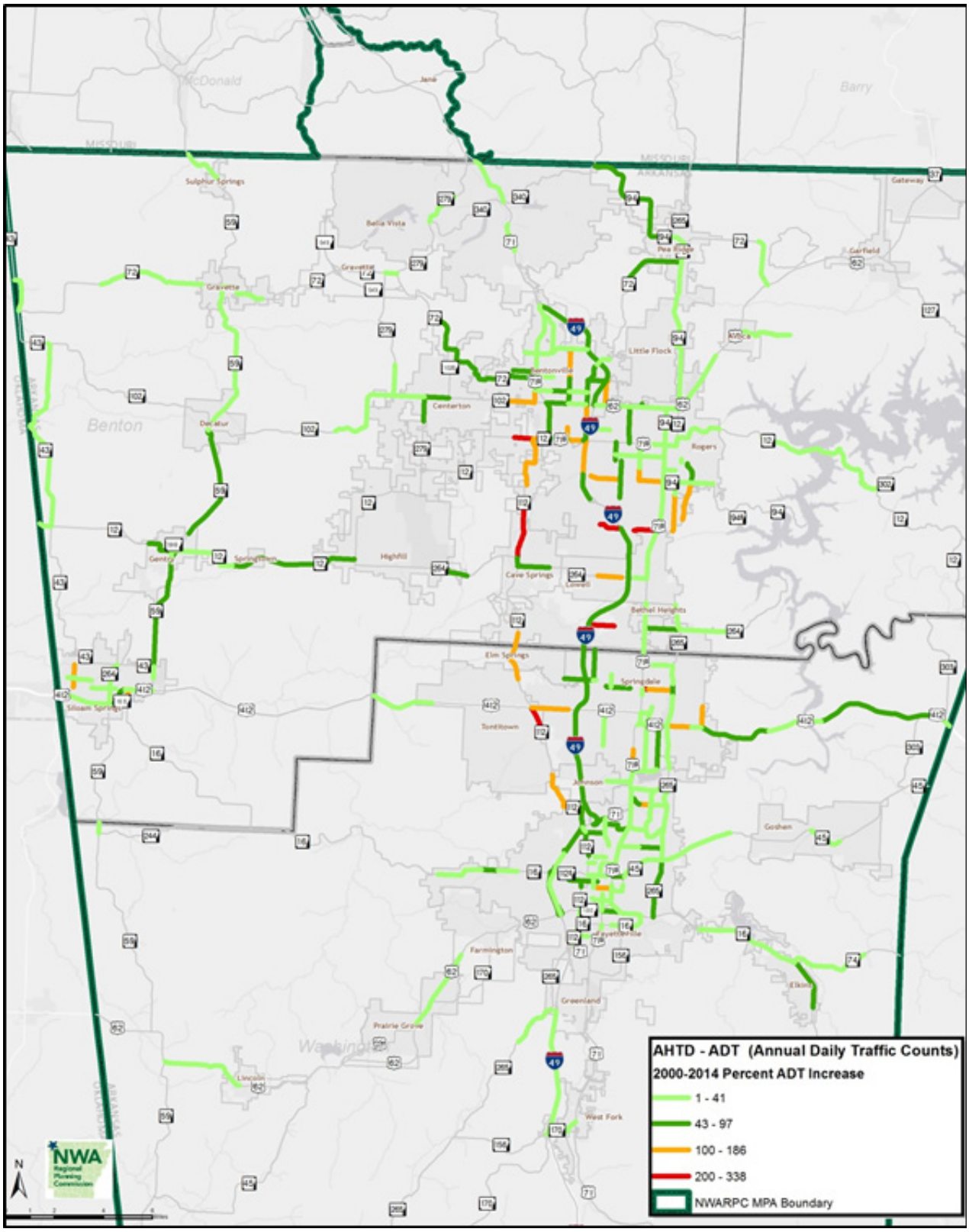


Figure 7.6 - Daily Vehicles Miles Traveled Per Capita for Benton and Washington Counties and Arkansas Statewide

In terms of the amount of travel geographically, Map 7.1 illustrates the percent increase of ADT between 2000 and 2014. Only the road segments that have a recorded count for this period of time were included in this map. The data is collected and reported by AHTD.

Notable road segments that have experienced an increase in ADT over 100 percent are on I-49, Hwy. 412, Hwy. 112, and Hwy. 102. Increases in ADT within this period between 43 and 97 percent occurred on I-49, Hwy. 412, Hwy. 59, Hwy. 72, Hwy. 265 and Hwy. 12.



Map 7.1 - Annual Daily Traffic Counts – Percent Increase between 2000-2014 – Data Source: AHTD

TRAVEL FORECASTING MODEL

A travel demand or forecasting model is typically utilized by planners, engineers, MPOs and state departments of transportation to forecast future year transportation system deficiencies that may not exist today. These agencies also use models to evaluate the impact of alternative transportation solutions for development of long range transportation plans. They are primarily used to forecast traffic flows on the transportation system. Models are generally mathematical expressions that are used to replicate the movement of people and vehicles within a transportation system. The traffic forecasts are based on forecasted land use, demographic data, socio-economic factors and travel patterns unique to the region. Travel models are also created to support decision making by providing information about the impacts of alternative transportation and land use policies, as well as demographic and socio-economic trends.

A Travel Forecasting Model can be used in a variety of ways, such as for:

Specific Highway Construction Projects

- Five to thirty year forecasts
- Traffic impact of changes in land use and development
- Traffic pattern and volumes that are used by city and regional planners before deciding on roads improvements or construction

Transportation Studies

- Major investment studies
- Interchange justification studies
- Bypass studies
- Freight studies
- Corridor studies

General Highway Planning

- Traffic impact of changes in land use and development
- Traffic impacts of new roadways or closing roadways
- Evaluate bypasses
- Generate inputs to micro simulation models
- Accident prone locations identification

Development of Long Range Transportation Plans

- State and Regional Plan and TIP development
- Traffic impact of changes in land use and development
- Congestion Management Programs
- Forecast regional pollution from vehicles
- Evaluate Environmental Justice
- Transit route planning

Other uses for the model:

- Provides inputs for site-specific studies (including whole cities) that will make studies more accurate (by looking at the big picture) and less costly (future projections for major roads will be readily available to cities and consultants).
- Gives the local jurisdictions an on-going resource of traffic count projections to answer “what-if” questions such as:
    - » What if we build a four lane segment here versus a three lanes road segment?
    - » What if we add an additional lane?
    - » What if a large shopping mall will be built at this location versus that location?
    - » What if we put in this east/west corridor?

- Provides jurisdictions with results for traffic scenarios such as:
  - » Projected traffic counts for the base year as well as forecast years
  - » Traffic counts for different road improvement scenarios
  - » Traffic counts for intersection improvement and signalization analysis
  - » Daily vehicle miles traveled in a region

NORTHWEST ARKANSAS TRAVEL FORECASTING MODEL

In 2004 NWARPC and the AHTD hired Bernardin, Lochmueller & Associates, Inc. to develop the Northwest Arkansas Travel Demand Model for Benton and Washington Counties, AR. The base year for the model was 2005 and scenario runs have been developed for 2010, 2030 and 2035.

Between the years 2007-2010 NWARPC maintained the model in-house with continuous updates to the network, TAZs, socio-economic data, land use, etc. and used it for projects prioritization, scenarios and the 2035 Regional Transportation Plan and TIP.

In 2010, NWARPC hired Parsons Brinckerhoff to conduct a Western Beltway Corridor Study in Benton and Washington County that would connect to the future Hwy. 549 (Bella Vista bypass) in the northern part of Benton County. Part of the Study was to update the existing model to add McDonald County, Missouri to the study area. The model structure and code were also improved as part of the analysis.

In 2010, NWARPC also administered a study to develop a Transit Development Plan (TDP) in cooperation with the two area transit agencies, Ozark Regional Transit, Inc. and the University of Arkansas Razorback Transit, and Connetics Transportation Group consulting firm.

In November 2012, NWARPC started a Transportation Alternatives Analysis Study that was funded by FTA and NWARPC matching funds as part of an Alternatives Analysis grant awarded that year. NWARPC contracted URS Corporation to determine the need for a major transit investment in the corridor, and to estimate costs, benefits and possible environmental impacts of the various alternatives. As part of the analysis, the consultants used the existing travel demand model to generate ridership estimates in the analyzed corridor. Alliance Transportation Group was the sub-consultant hired to develop the conceptual transit ridership for the Study.

As a requirement of the Census Bureau, the MPO delineated new TAZs and Transportation Analysis Districts (TADs) for the 2010 Census Bureau data collection. The newly delineated 673 internal TAZs and 11 TADs were accepted by the Census Bureau in 2011 and are available at NWARPC.

In July of 2014, the upgrade of the existing travel forecasting model began which added mode choice to the model for the purpose of modeling vehicular travel as well as transit in the MPA. Under this scope of work NWARPC hired Parsons Brinckerhoff to conduct a travel forecasting model upgrade that addressed all the model needs for a functional true mode choice model. The purpose of the project was to develop the mode choice model to include the transit component; upgrade the model from the 2005 base year to 2010 base year; add the Missouri portion of the MPA into the model; and develop the 2020, 2030 and 2040 forecast years. The upgraded model also incorporated a special generator that is easier to configure and update, reconfigured the GISDK code to current industry standards, and identified ways of utilizing the travel time results from the model to aid the local transit agencies in their route planning, evaluation and needs assessment.

The Northwest Arkansas Travel Forecasting Model is a regional model based on the traditional four-step sequential modeling method with a feedback loop. The process is summarized in the following steps:

- Skims – Calculation of travel times and cost between origin and destination zones using the various modes of transportation.
- Household Generation – The Population synthesizer generates synthetic households i with attributes x_i to match total counts and TAZ average characteristics x_a.

- Trip Generation – Trip Generation calculates P_{ip}, the decimal number of trips of each purpose produced by each household. It does this via regression models estimated on data collected in a 2005 household travel survey.
- Trip Distribution – Trip Distribution aggregates the household trip productions by purpose and by TAZ and calculates the trip attractions by purpose by TAZ. Productions (Ps) and Attractions (As) are matched up based on a gravity model whereby productions are pulled towards TAZs based on their number of attractions and the travel time from the production TAZ. The skims are used to determine travel times.
- Mode Choice – The mode of travel for each PA pair is determined based on a logit model which takes the level of service characteristics, the household attributes and the cost of each mode into consideration. The skims are used to determine level of service and cost for each mode.
- Time Of Day – The PA matrices are transformed into origin/destination pairs by time period (am peak, pm peak, off-peak) based on observed percentages of daily traffic.
- Assignment – The auto trips are assigned to the highway network and the transit trips are assigned to the transit network. Travel times and costs are re-calculated and are fed back to the trip distribution and mode choice steps. This feedback is done multiple times so that congested travel times are considered in the final set of choices.

Figure 7.7 also illustrates the model steps:

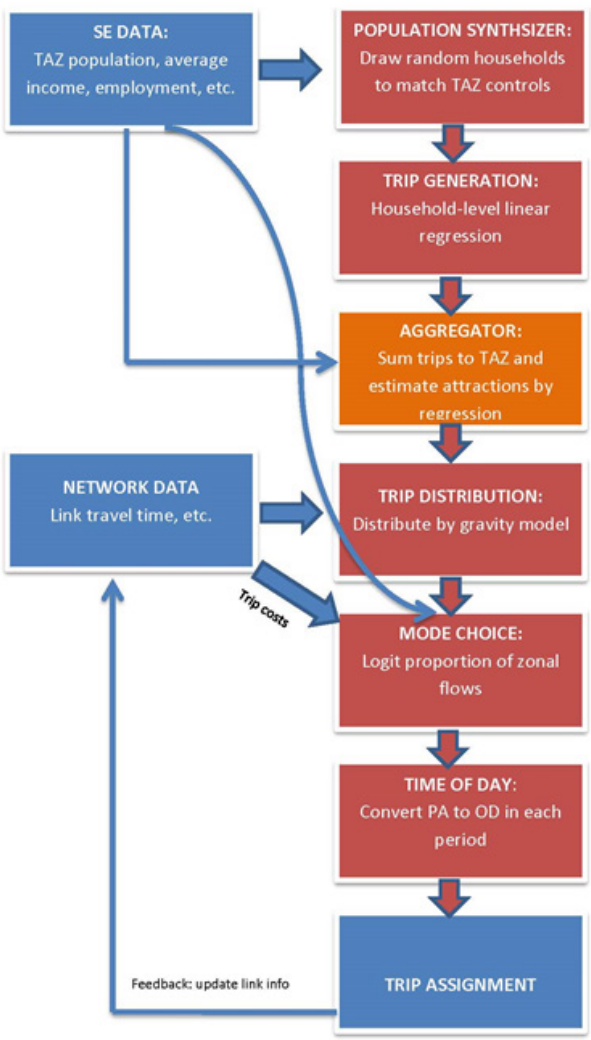
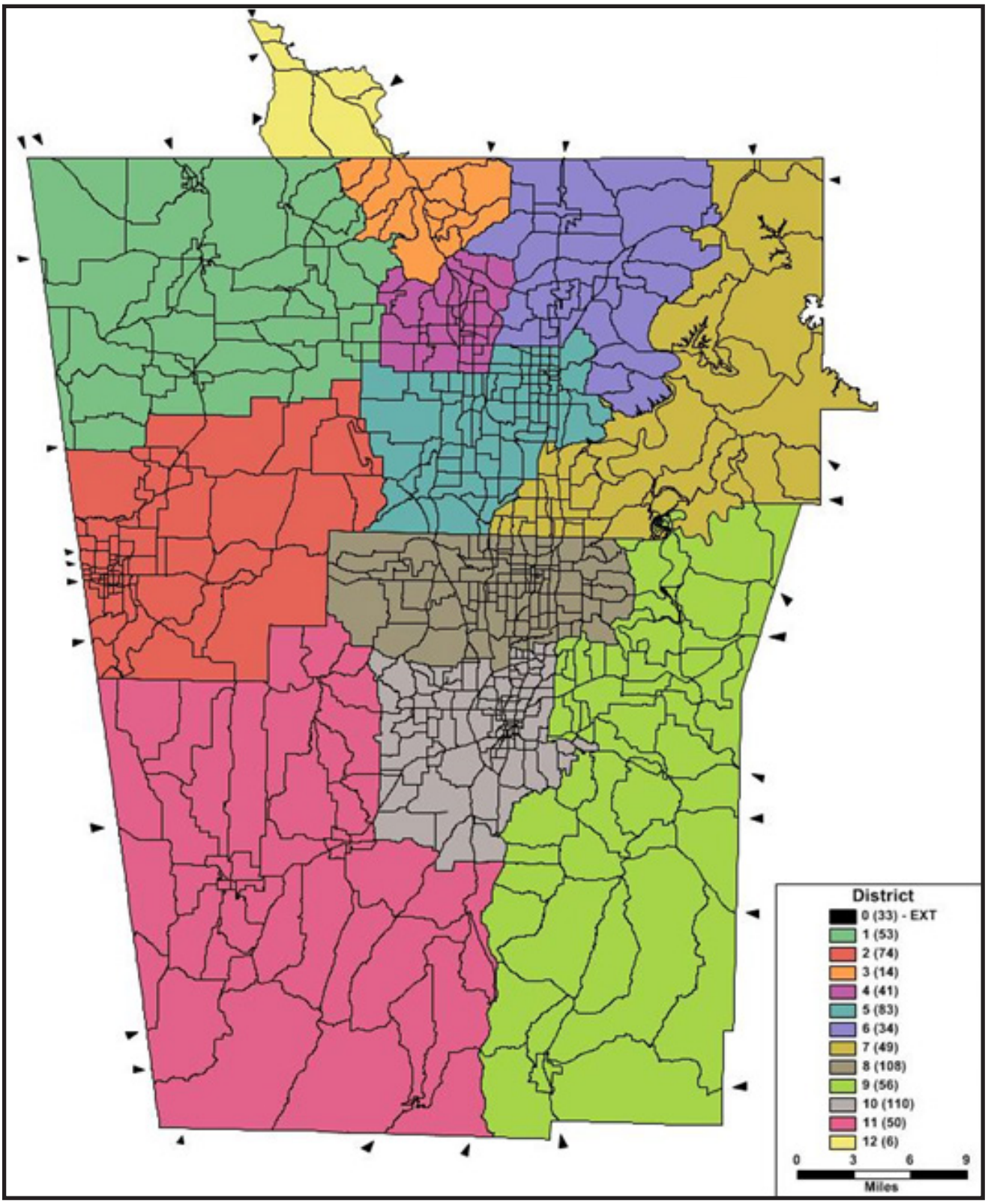
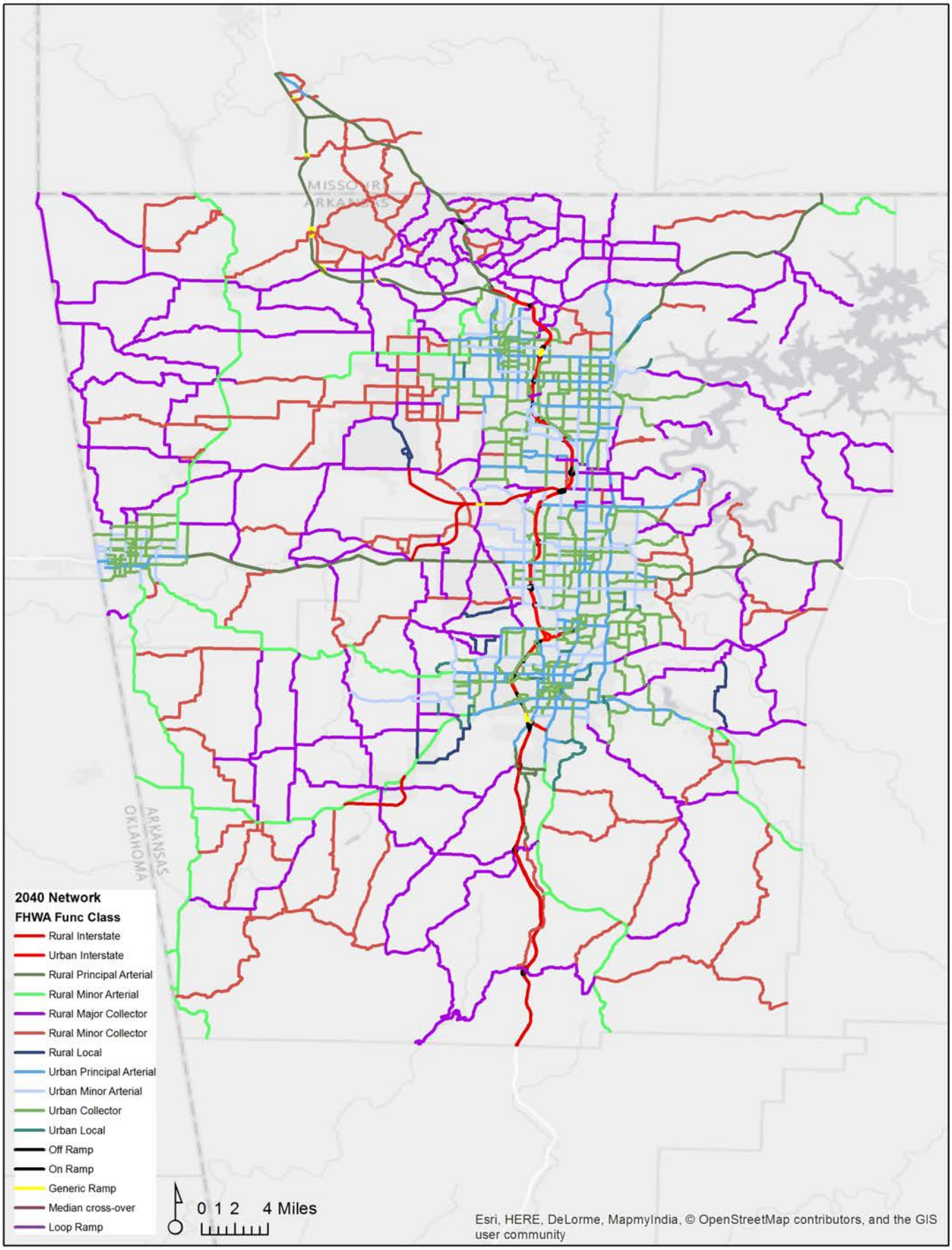


Figure 7.7 -Travel Demand Forecasting Steps

The model area includes Washington and Benton Counties in Arkansas and the McDonald County, Missouri portion of the MPA. This area encompasses 711 TAZs (Traffic Analysis Zones) as illustrated in Map 7.2, which were also grouped into 11 TADs (Traffic Analysis Districts).



Map 7.2 -Transportation Analysis Districts and Zones



Map 7.3 - Northwest Arkansas Travel Forecasting Model Traffic 2040 Road Network (by FHWA Functional Classification)

The model road network consists of local roads, collectors, arterials and highways and is summarized in Table 7.5 and Table 7.6 for the base year 2010 and forecast year 2040. As a note, the model network is dualized for the entire Urban Interstate and part of the Rural Interstate, as well as for a portion of the Rural Principal Arterial (Hwy. 412), and so the tables below reflect the model's network mileage and not the actual road mileage.

2010 Road Network Types	Miles
Rural Interstate	40.02
Rural Principal Arterial	89.30
Rural Minor Arterial	144.92
Rural Major Collector	623.73
Rural Minor Collector	365.40
Rural Local	21.49
Urban Interstate	67.06
Urban Principal Arterial	175.08
Urban Minor Arterial	127.85
Urban Collector	313.57
Urban Local	21.26
Off-Ramp	11.37
On-Ramp	11.66
Generic Ramp	2.68
Median Cross-Over	1.16
Total	2,016.55

Table 7.5 - 2010 Road Network Miles
Source: NWARPC Travel Forecasting Model
(2010 Base Model Network)

2040 Road Network Types	Miles
Rural Interstate	58.66
Rural Principal Arterial	108.90
Rural Minor Arterial	144.92
Rural Major Collector	624.44
Rural Minor Collector	365.40
Rural Local	21.49
Urban Interstate	67.06
Urban Principal Arterial	180.19
Urban Minor Arterial	141.88
Urban Collector	324.19
Urban Local	21.26
Off-Ramp	12.80
On-Ramp	12.54
Generic Ramp	8.42
Median Cross-Over	1.16
Total	2,093.32

Table 7.6 - 2040 Road Network Miles
Source: NWARPC Travel Forecasting Model
(2040 Forecast Fiscally Constrained Model Network)

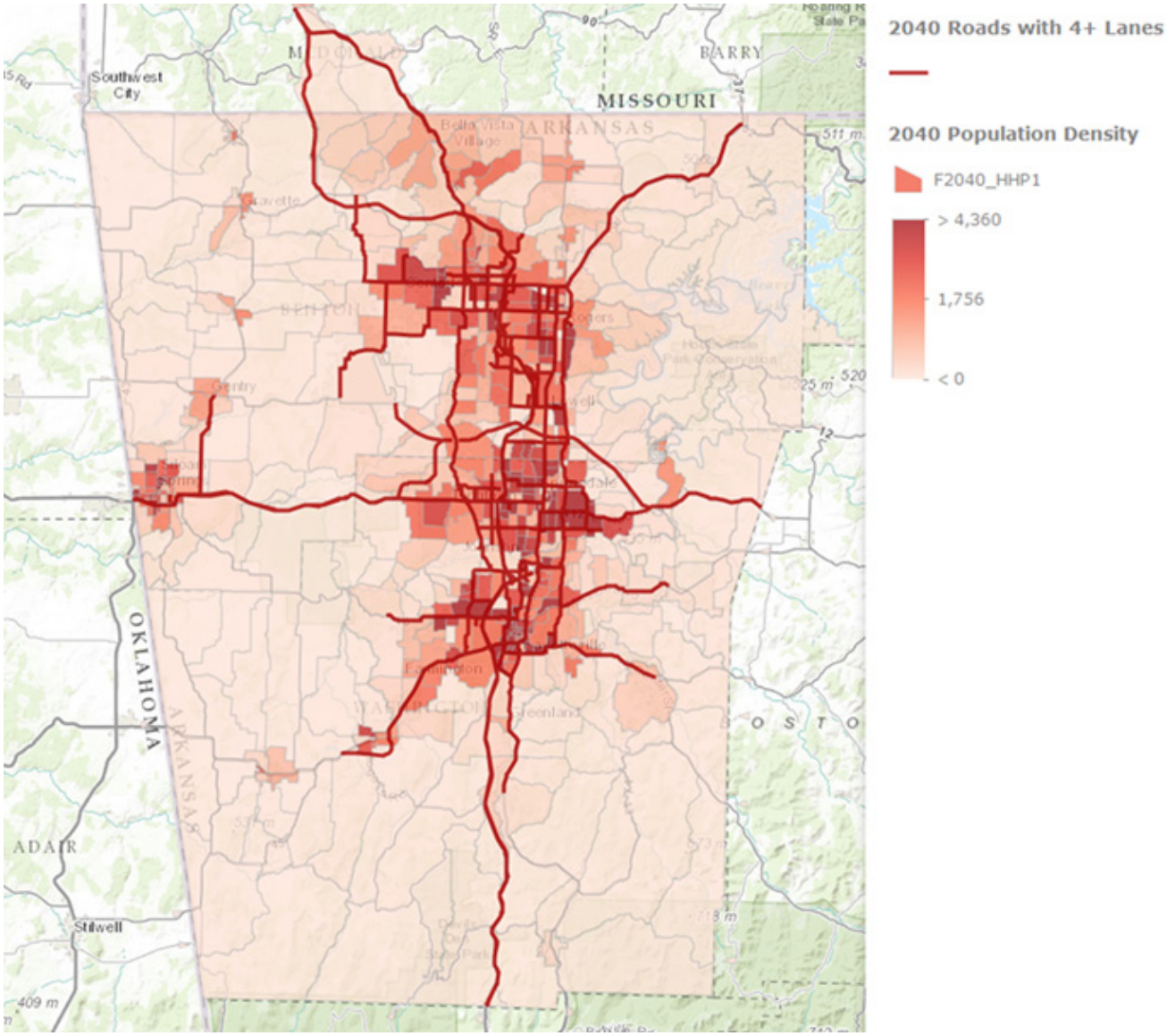
Types of Trips: In the Regional Travel Forecasting Model, trips are classified by trip purpose. Broadly, trips are grouped into the following purposes:

Home-Based Work (HBW): These trips are from home to work and from work back to home. They occur more in peak hours and are a large component of congestion.

Home-Based Shop/Personal Business (HBSB): These trips begin or end at home and cover the range of other trips that people make - shopping, visiting friends, or appointments.

Non-Home-Based (NHB): These are the trips made while people are out of their residence, either at work (e.g., a trip to lunch), or between stops while running errands (e.g., a trip from the grocery store to the cleaners). Generally, given their nature, non-home-based trips are shorter than home-based trips and are often made at off-peak travel times.

In addition to these trips, the model also includes the following types of trips: **Home-Based School (HBSC), Home-Based University/College (HBU) and Home-Based Other (HBO)** as well as **Non-Home Based Work (NHBW).**

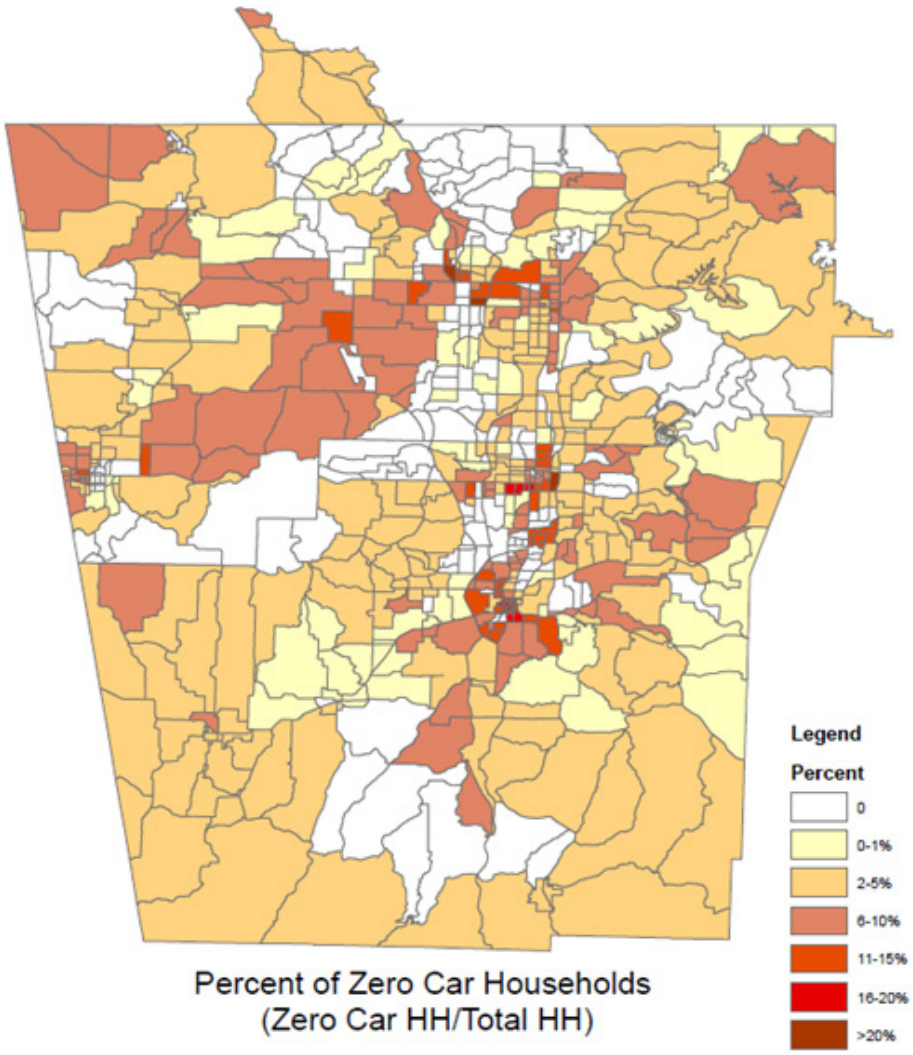


Map 7.4 - NWARPC Projected Population Density For 2040 by TAZ and Arterial Roads (4 lanes and more)

The mode choice model segments by trip purpose as well as by income level and vehicle sufficiency for HBW trips. That is, for HBW trips, the following segments were included:

- Zero-vehicle
- Insufficient high income
- Insufficient low income
- Sufficient high income
- Insufficient low income

Map 7.5 illustrates the observed zero-vehicles households by TAZ based on the CTPP data for 2010. Figure 7.8 represents the average traveled distance from the 2010 Base Year validation report that illustrates these mode choice segments by trip purpose and vehicle sufficiency:



Map 7.5 - Zero-Vehicle Households by TAZ (CTPP data)

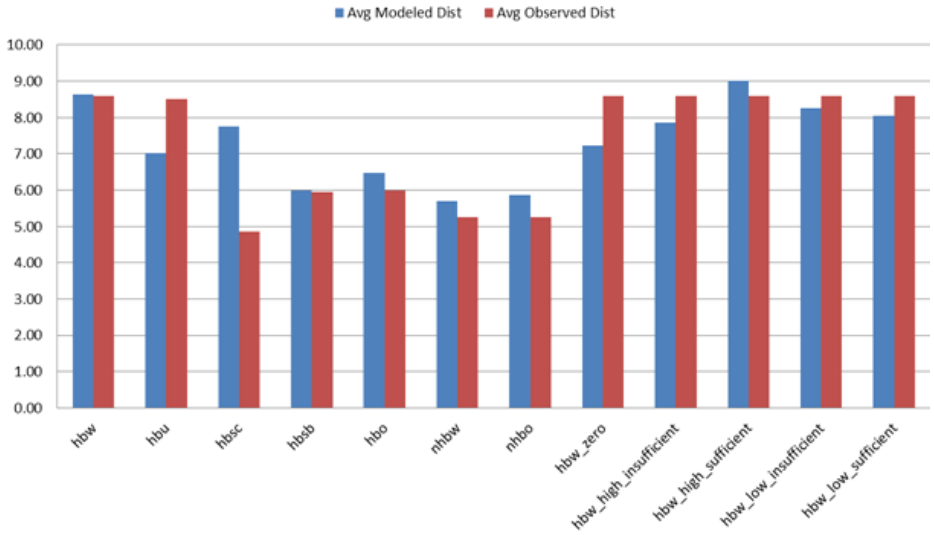


Figure 7.8 - Average Traveled Distance

Another example from the validation report is the table below that depicts the trip length frequency for the Home-Based-Work trip type. Figure 7.9 suggests that the majority of the trips is concentrated in the 5-25 minute time interval and also suggests that commutes to work longer than 40 minutes are not very prevalent in the region.

Trips are made either by driving alone or carpooling/vanpooling with others; by riding transit; or by biking or walking. Two other major groups of travelers use the roadway system and include commercial vehicle/truck trips and external/internal trips.

Internal/External trips are those that start in the region and end outside the region, or conversely, those that start outside of the region and end at a destination inside of the region. These trips also include those that pass through without stopping.

There are a number of indicators that can be used to help measure the efficiency of the transportation system and how well the system is supporting the mobility needs of the public. These indicators include trip related information as well as infrastructure related data. Utilizing these indicators planners can identify deficiencies and steps to help address these deficiencies. These indicators can include person trips, vehicle trips, roadway lane miles, daily vehicle miles of travel and volume over capacity ratio.

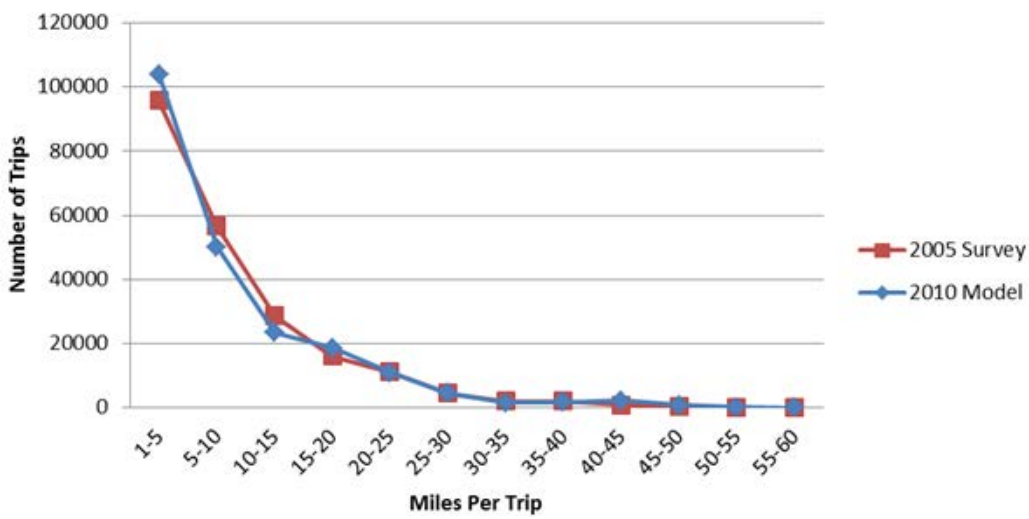


Figure 7.9 - Estimated Trip Length Frequency (Home Based Work trips)

Mode Choice Model

The mode of travel is a critical part of the model upgrade. The mode choices that were included in the model are the following:

- Vehicle
  - » DA: Drive alone
  - » SR2: Shared ride 2
  - » SR3+: Shared ride 3+

- Transit: There are three access nests, each with the transit modes listed under Walk.
  - » Walk: walk-access transit
    - o LB: Local bus (Ozark Transit)
    - o RT: Razorback Transit, University of Arkansas
    - o Additional modes can be added such as BRT, LR, Express Bus – currently none of those modes exist in the region

    - » PNR: park-and-ride
        - o RT: Razorback Transit
    - » KNR: “kiss-and-ride”/drop-off
        - o RT: Razorback Transit
- Non-Motorized
    - » Bike
    - » Walk

Figure 7.10 illustrates the nested mode choice model:

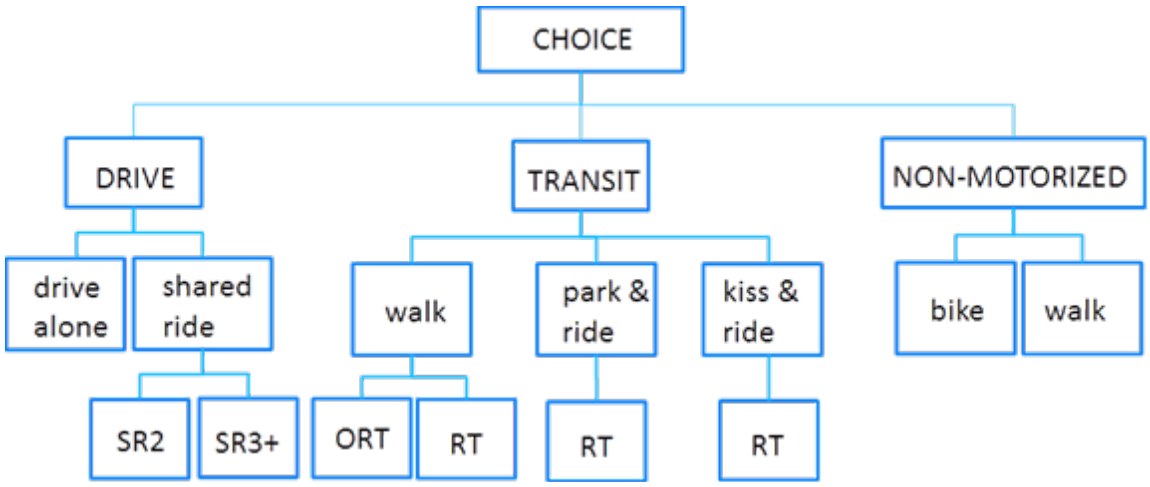


Figure 7.10 -Mode Choice Model Nests

The newly implemented mode choice can identify the type of trips by trip purpose and mode. Figure 7.11 shows the number of trips by Home-Based-University trip purpose in the 2010 model validation (which also includes observed data):

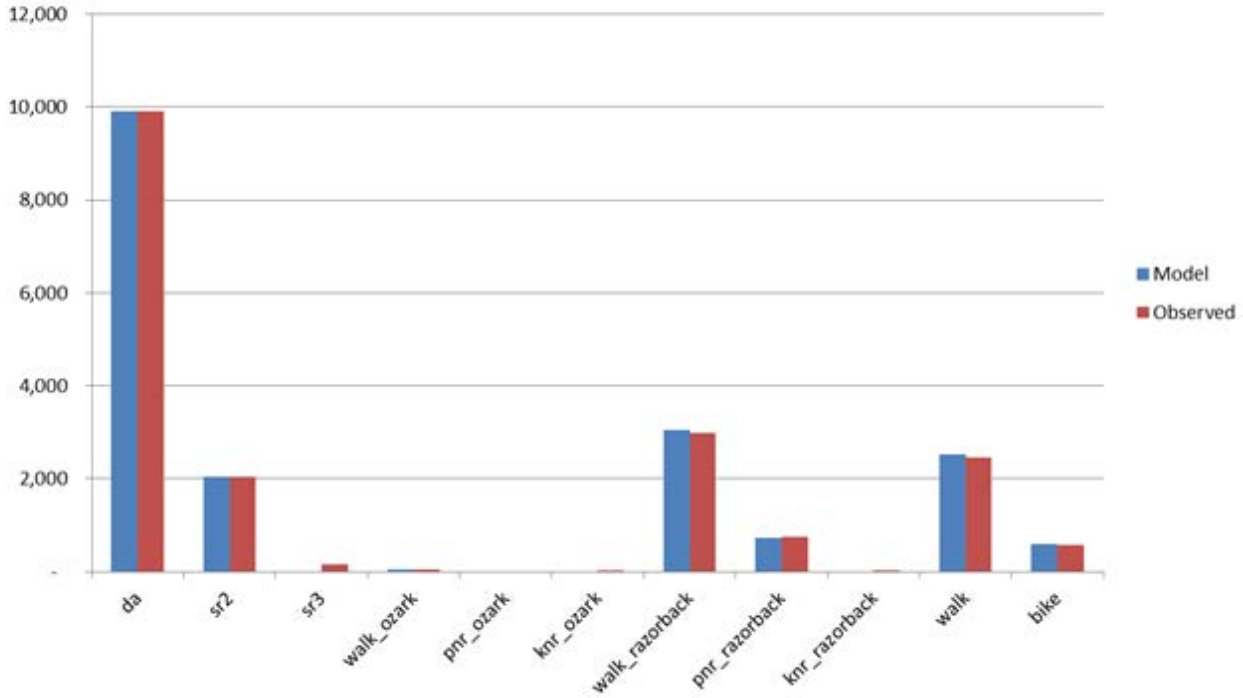


Figure 7.11 -Home Based University Trip Purpose (Auto, transit and Non-Motorized)

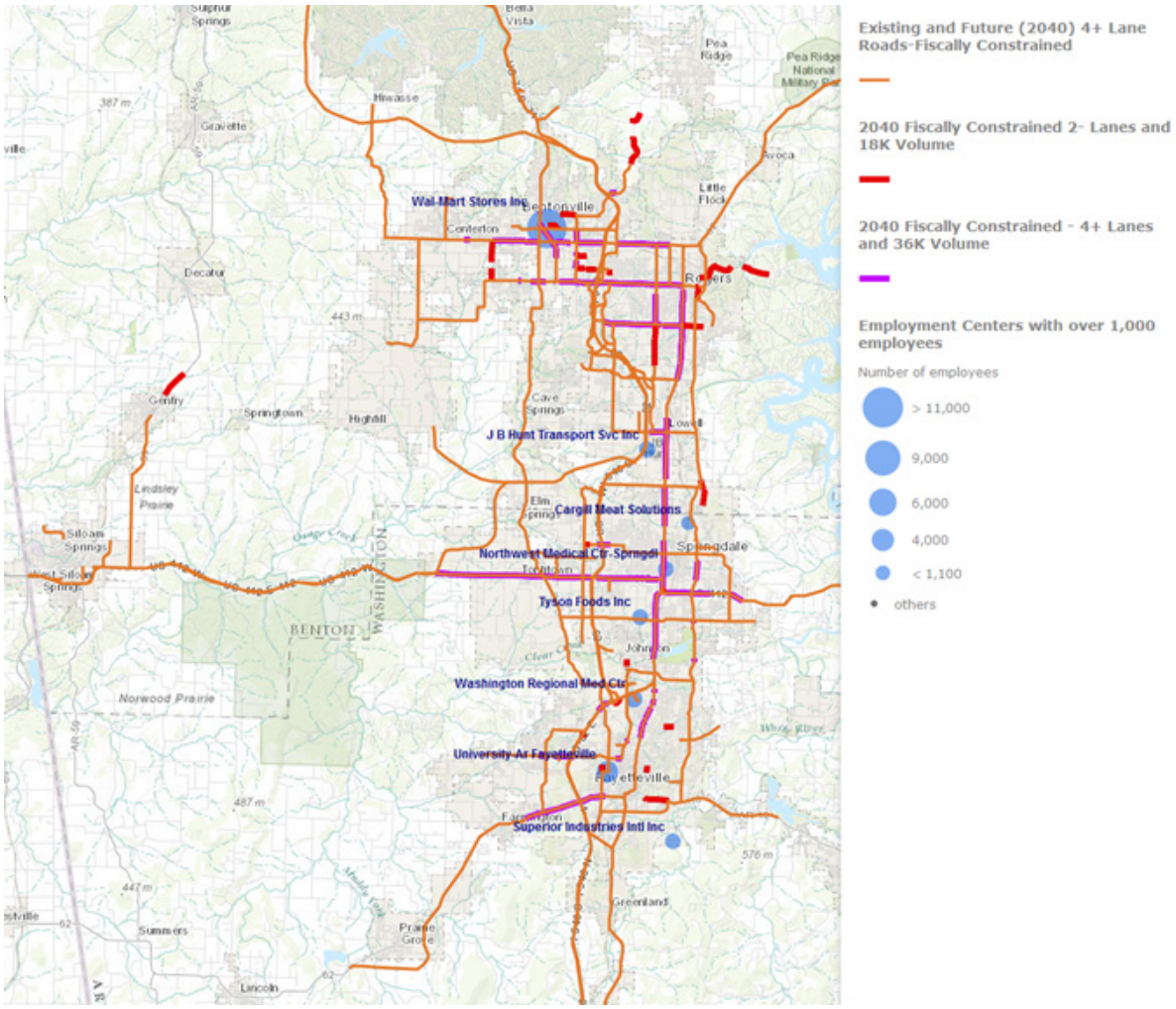
Travel Forecasting Results

The 2040 forecast model has proved beneficial in identifying segments of the network that may need improvements in the next 25 years. A series of selection sets have been developed based on a 2040 Fiscally Constrained and Unconstrained List of projects and using forecasted socio-economic data from the model.

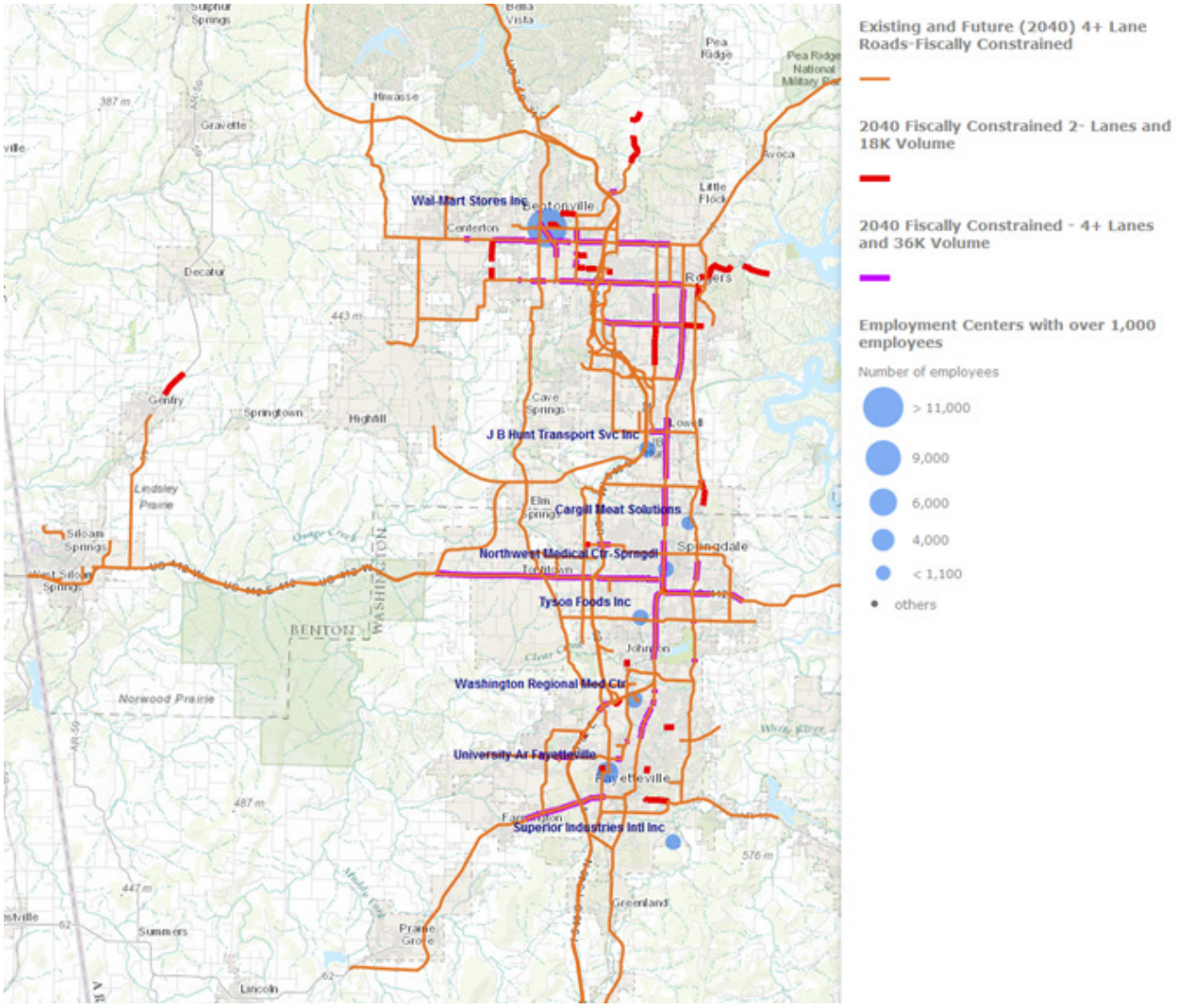
The Fiscally Constrained List for the road network consists of projects that can reasonably be expected to be funded with Federal-aid funds during the 25 year planning period. This is determined by estimates of Federal-aid funds that can reasonably be expected to come to the area given the area's highway network, Urbanized Area, population, etc. These estimates are provided by AHTD and MoDOT and are not limits, nor are they guarantees of funding. They are conservative, reasonable estimates of future funding to guide development of the 2040 MTP. The Fiscally Unconstrained List includes projects not limited to the estimated available funding.

The following two maps represent selections from the 2040 Constrained and Unconstrained Model runs with the following specifications:

- Two lane roads with at least 18,000 vehicles per day (vpd) and roads with four lanes or more and 36,000 vpd for the Constrained List of Projects (Map 7.6)
- Two lane roads with at least 18,000 vpd and roads with four lanes or more and 36,000 vpd for the Unconstrained List of Projects (Map 7.7)

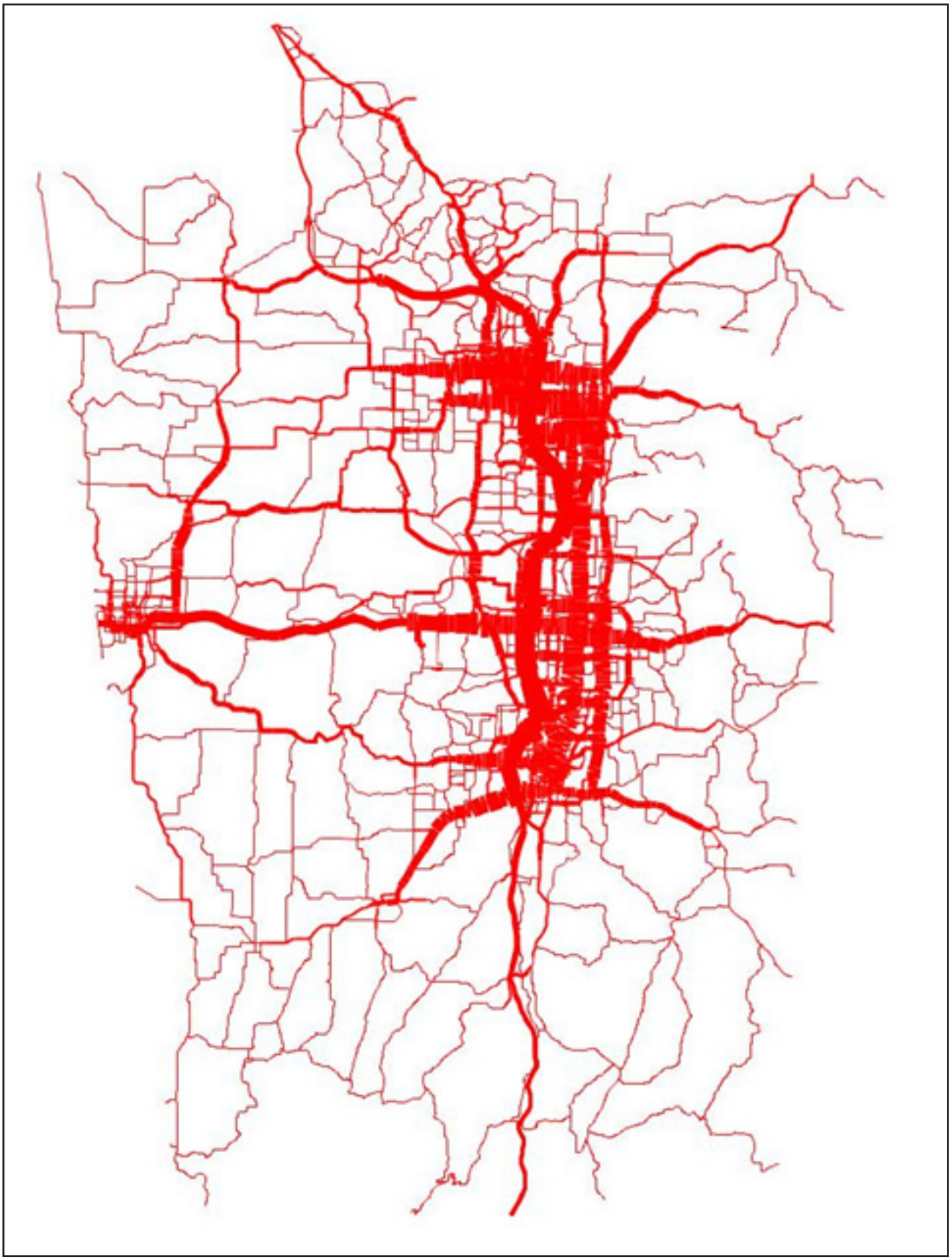


Map 7.6 - 2040 Constrained List of Projects with selected 2 lanes and 18,000+ volumes and 4+ lanes and 36,000+ volumes



Map 7.7 - 2040 Unconstrained List of Projects with selected 2 lanes and 18,000+ volumes and 4+ lanes and 36,000+ volumes

Map 7.9 illustrates the total volume of traffic as a gradient on the 2040 Constrained forecast network.



Map 7.8 - 2040 Total Volume Map – NWA Travel Forecasting Model