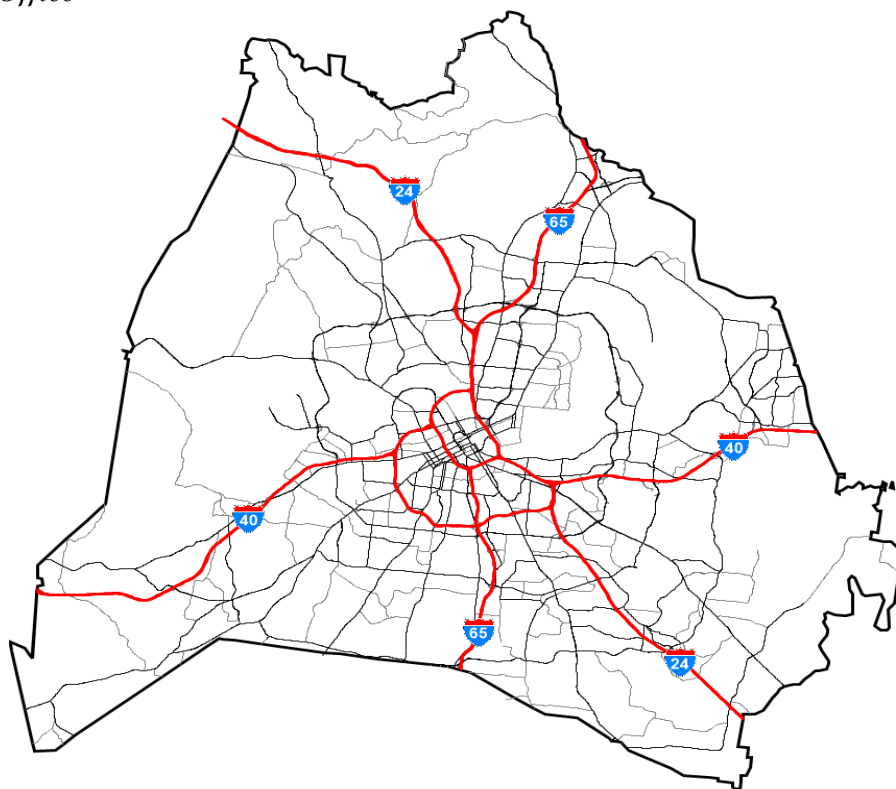


Davidson County, Tennessee Auto Travel Analysis

Tennessee Department of Transportation

*Ryan Wenger – Planning Specialist / Modeler
Long Range Planning Division
Forecasting Office*



The purpose of this analysis is to provide a detailed visual of the auto trips that are made within Davidson County. This analysis breaks up Davidson County into 10 zones in order to get a more detailed representation of the auto trips, which was then compared to the number of bus routes that serve each zone to determine if auto trips decrease when public transit is provided.

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Tennessee Department of Transportation

John Schorer
Commissioner

Toks Omishakin
Deputy Commissioner

Larry McGoogin
Acting Director
Long Range Planning Division

Produced Under the direction of:

David Lee
Assistant Director
Long Range Planning

Jaehoon Kim
Planning Supervisor
Forecasting Office , Long Range Planning

Major Contributor:

Ryan Wenger
Planning Specialist
Forecasting Office, Long Range Planning

Contributor:

January 8, 2019

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CHAPTER 1. INTRODUCTION

The purpose of this report is to evaluate the auto travel patterns for the anticipated 2020 year. Davidson County is a county located in the U.S. state of Tennessee. According to the United States Census Bureau, Davidson County had an estimated population of 691,243. Its county seat is Nashville, the state capital. The reasoning for evaluating the auto trips in Davidson County is because as Nashville continues to grow there is going to be an increase in the number of residents who are moving into Davidson County, which overall means there will be an increase in the number of vehicle trips being made.

This analysis targets to find out where the auto trips are being generated from and where the major destinations are for 2020. In order to determine where the major attraction and production locations in Davidson County are located. In order to get a better evaluation of the auto trips in Davidson County, the county was split up into 10 zones based on the current traffic analysis zones and the zip codes in Davidson County. Davidson County has 231 traffic analysis zones that were used for this report. **Figure 1.0** represents the 10 zones that were created for the analysis of Davidson County.

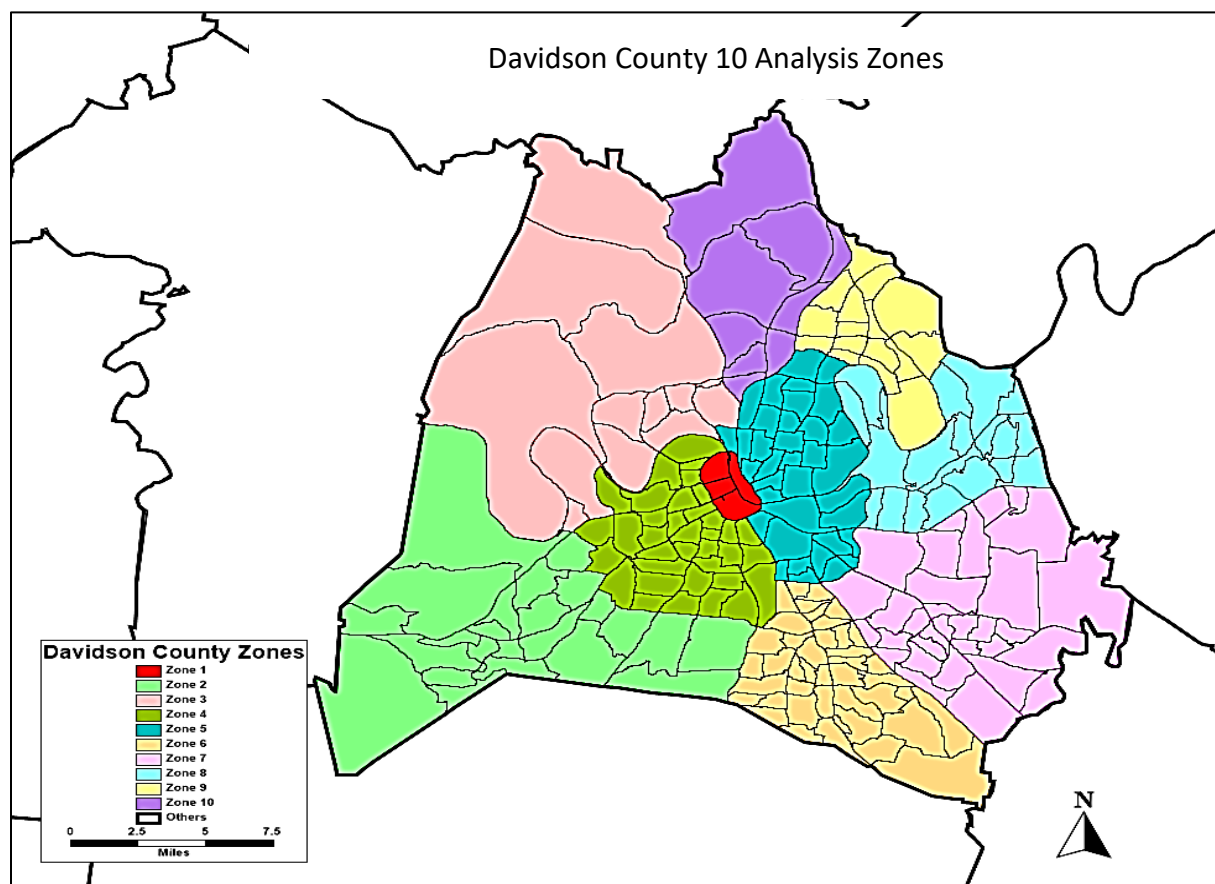


Figure 1.0. Davidson County 10 Analysis Zones

Within this analysis there will be two major components that help shape the results of this analysis. The following components are:

- Current Commuting Pattern Analysis
- Future Commuting Pattern Analysis

Using these two pieces in this analysis it will be easy to determine which zones in Davidson County are producing the most auto trips and which zones are attracting the most auto trips. After figuring out which zones are has the highest rate of auto trips, the next step will be to compare these zones with the current bus system that serves Davidson County. The reasoning for comparing the zones to the bus system is to determine if there is an increase in the number of auto trips being made in locations that are not served by public transportation.

With this analysis it will most likely be anticipate that the zones that are further away from downtown Nashville will have more auto trips than the zones that are closer to Nashville. The reasoning for this is because these zones are not as served with public transportation than the zones that are closer to Nashville.

CHAPTER 2. DAVIDSON COUNTY CHARACTERISTICS

Chapter 2 is designed to provide the basic background information on Davidson County. The background information will cover the demographic information of each of the zones that Davidson County was broken up into. Along with the demographic background, there will be brief background coverage on the transportation in Davidson County.

Section 2.1. Davidson County Demographic Background

Referring back to *figure 1.0* the zones that Davidson County was broken up into for this analysis. Each of these 10 analysis zones will be analyzed using the Tennessee Statewide Model, using desire lines. An important factor for these zones in determining where the major flow of traffic is going to be made to will be based on the demographic factors of the zone, as each zone is relatively different. **Table 2.0** shows the basic demographic factors for 2016, for each of the 10 zones that are being analyzed in Davidson County.

	Population	Households	Household Size	Household Income	Total Employment	Average Number of Workers Household	Average Vehicles per Household
Davidson County	626,667	259,492	2.3	\$60,503	862,261	2.1	1.9
Zone 1	8,971	4,093	1.5	\$37,642	67,672	2.3	0.7
Zone 2	64,095	28,119	2.4	\$119,991	21,243	1.7	2.3
Zone 3	38,481	13,886	2.5	\$52,960	19,057	3.2	2.1
Zone 4	104,544	44,965	2.1	\$74,607	174,507	2.1	1.7
Zone 5	96,336	39,662	2.4	\$42,308	63,131	2.3	1.9
Zone 6	109,427	44,646	2.5	\$62,743	363,340	1.3	2.3
Zone 7	88,641	34,860	2.4	\$55,793	57,980	1.6	1.9
Zone 8	52,851	23,175	2.3	\$61,875	61,600	2.4	2.1
Zone 9	39,121	16,489	2.4	\$43,959	23,072	1.9	2.0
Zone 10	24,200	9,597	2.5	\$53,154	10,659	2.0	2.3

Table 2.0. Demographic Factors for Davidson County 10 Analysis Zones

Looking at the statistic in **table 2.0** there is a clear indication that zone 1; the zone that contains Nashville has the lowest household income. This can be anticipated that this zone will produce lower auto trips. The reasoning for this is because, with this zone having the lowest household income, there is a greater chance that the people living here do not own vehicles and rely more on

public transportation for their daily commutes. Where zone 2 has the highest household income, it could be assumed that auto trips will be the opposite then what will show in zone 1.

Section 2.2. Transportation Characteristics

One of the most important understanding with the number of auto trips being produced and the population in each of the zones, is getting an understanding of the number of trips that are made daily per person. The will allow for an understanding of how many auto trips are being made per person in a day. **Table 2.1** shows the number of auto trips with the population in each zone determining the number of trips per person.

	Number of Auto Trips	Population	Auto Trips/Population
Zone 1	65,593	8,971	7.31
Zone 2	67,612	64,095	1.05
Zone 3	61,087	38,481	1.59
Zone 4	193,096	104,544	1.85
Zone 5	139,951	96,336	1.45
Zone 6	101,790	109,427	0.93
Zone 7	82,802	88,641	0.93
Zone 8	71,145	52,851	1.35
Zone 9	43,882	39,121	1.12
Zone 10	41,381	24,200	1.71
Davidson County	868,339	626,667	1.39

Table 2.1. Auto Trips to Population Ratio

One of the important things to remember when looking at the origin and destination matrix for the auto trips in Davidson County is that it is using a balanced table meaning that the productions are equal to the attractions. Referring to **table 2.1** there is an average of 1.39 auto trips made per person that is living within Davidson County. This is calculated using the total trips that are made whether the trips are a work trips or a non-work trip.

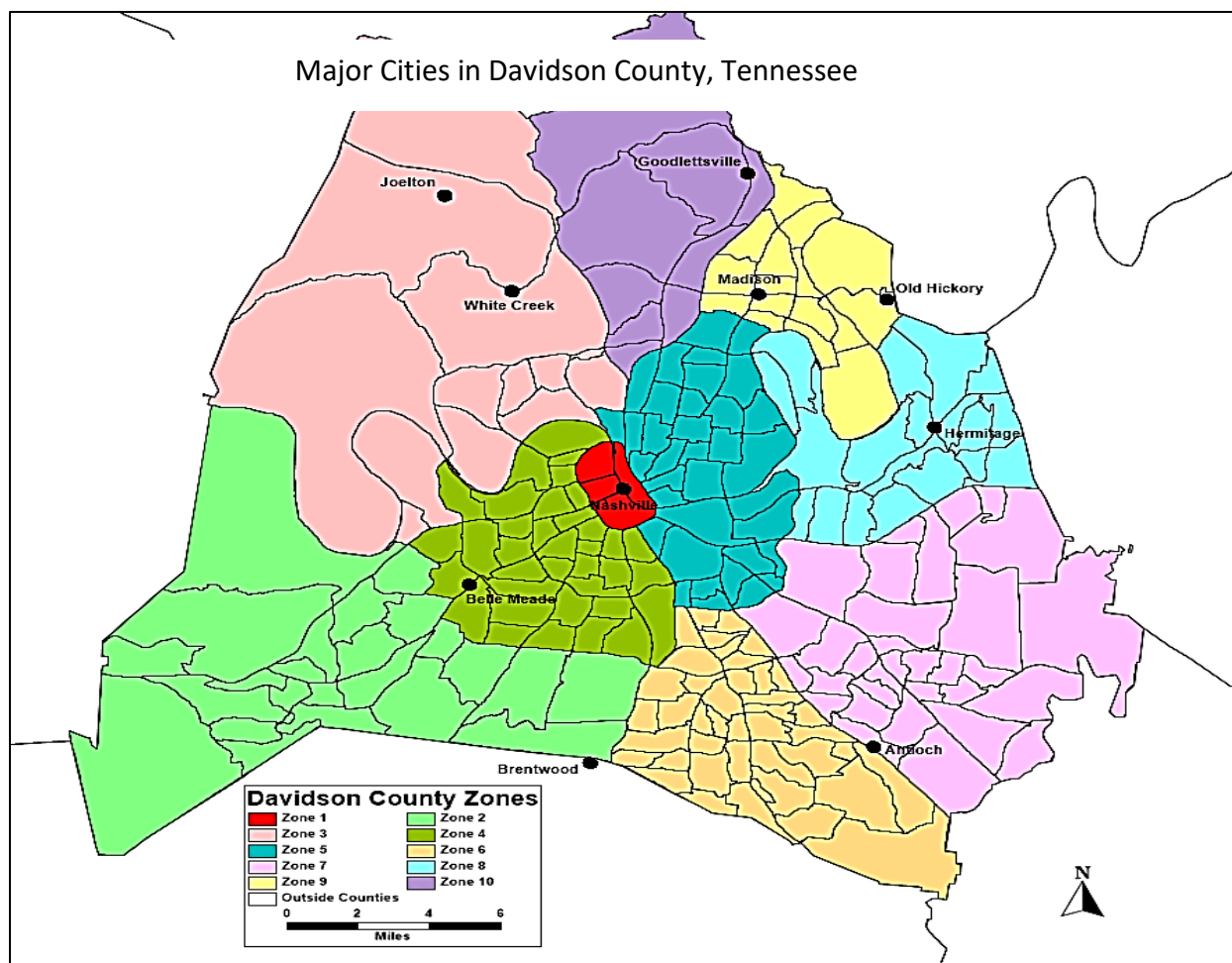


Figure 2.0. Major Cities in Davidson County, Tennessee

Table 2.0 illustrates the 10 zones that will be used for this analysis along with the major cities in Davidson County that fall within each of those zones. Showing where the location of major cities in Davidson County is important because these are the major locations for employment and shopping which are two of the major drivers that influence auto travel amongst individuals. **Table 2.2** shows the number of auto trips that are made within Davidson County based on the number of employment opportunities that are within each of the 10 zones in the county.

	Number of Auto Trips	Employment	Auto Trips/Employment
Zone 1	65,593	67,672	0.97
Zone 2	67,612	21,243	3.18
Zone 3	61,087	19,057	3.21
Zone 4	193,096	174,507	1.11
Zone 5	139,951	63,131	2.22
Zone 6	101,790	363,340	0.28
Zone 7	82,802	57,980	1.43
Zone 8	71,145	61,600	1.15
Zone 9	43,882	23,072	1.90
Zone 10	41,381	10,659	3.88
Davidson County	868,339	862,261	1.01

Table 2.2. Auto Trips to Employment Ratio

Based on the data provided in *table 2.2* there is an average of 1.01 trips made per each employment opportunity. *Figure 2.1* uses the InfoGroup data from 2013 to determine how many firms are in each of the zones that Davidson County is broken up into. This will most likely play a critical role when evaluating how many auto trips are being made to each of the zones in Davidson County.

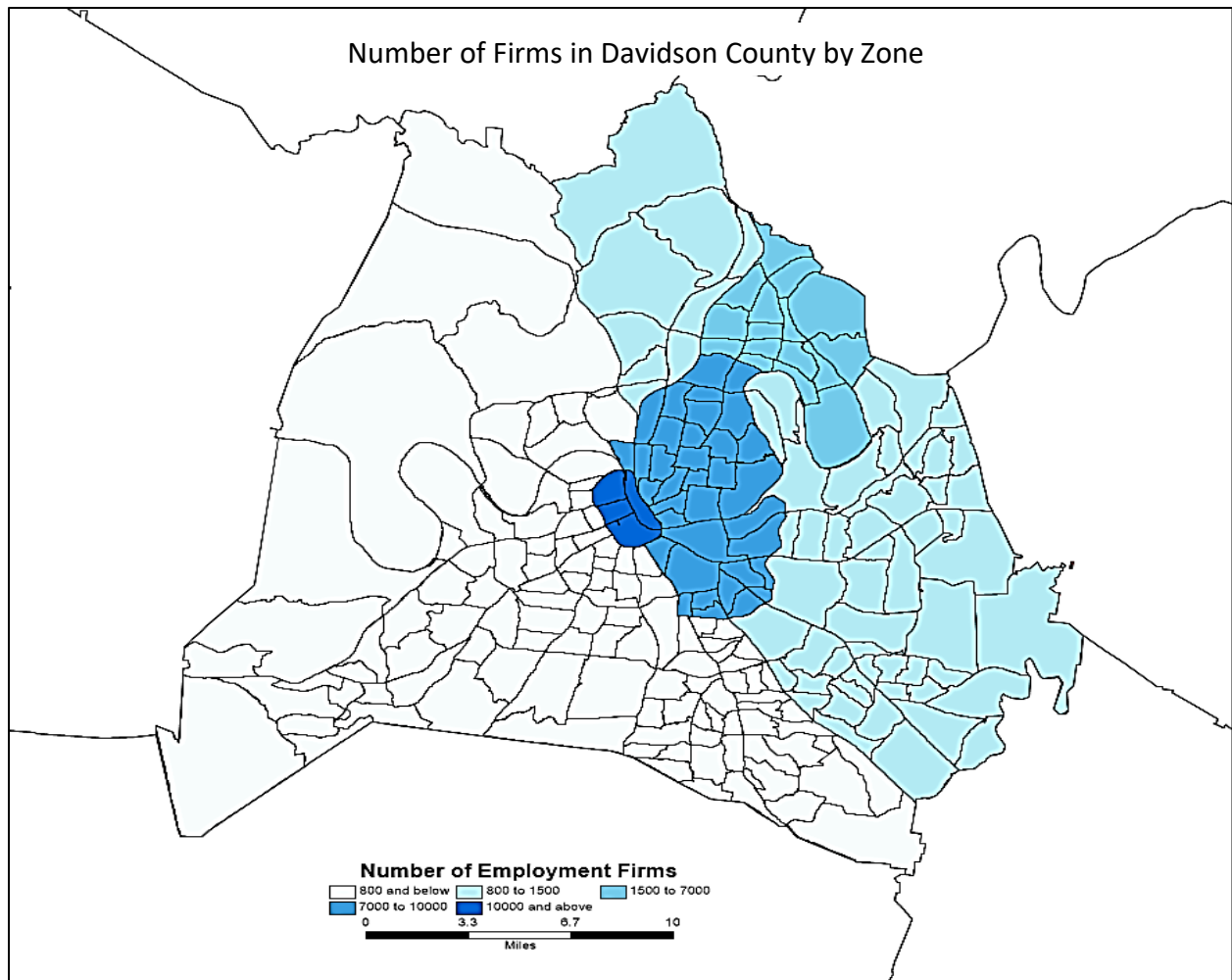


Figure 2.1. 2013 InfoGroup Data Number of Firms in Each Davidson County Zone

From the statistics provided in the InfoGroup data on the number of firms in Davidson County, there is a clear indication that the eastern part of Davidson County has the vast majority of the firms in Davidson County. From this data it can be suggested that there will be more auto trips made to this region of Davidson County because of the number of employment firms that are located in this area.

CHAPTER 3. CURRENT COMMUTING PATTERN ANALYSIS

Chapter 3 is designed to provide a visual of the auto travel patterns in Davidson County using various techniques. The first visualization will use desire lines to create a visual between the 10 zones, illustrating the amount of auto trips that each zone is producing and attracting. The second set of data will look at the travel times of commuting trips in Davidson County, and the final set of data will be to show the traffic volume on the interstates, expressways, and arterials that run through Davidson County.

Section 3.1. Desire Line Analysis

Section 3.1 is designed to create 10 sets of desire lines based on the auto trips that are made to each of the zones in Davidson County. The origin and destination matrix was created by using the existing traffic analysis zones that were selected in each of the zones and joining them into one group and summing the total trips created to each zone. The desire lines are created to show that with the thicker the line the more auto trips that are made to that zone. **Figure 3.0** through **figure 3.9** shows the desire lines from each of the zones in Davidson County to the other zones. As the desire lines don't illustrate an exact **table 3.0** provides the origin and destination matrix for the auto trips between the 10 created zones in Davidson County.

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10
Zone 1	-	3,222	4,016	28,737	14,404	5,628	3,485	3,650	1,452	999
Zone 2	3,222	-	2,120	41,440	3,845	11,865	2,728	1,745	378	269
Zone 3	4,016	2,120	-	26,606	13,861	2,754	1,364	2,858	3,317	4,191
Zone 4	28,737	41,440	26,606	-	30,750	33,800	14,134	8,745	5,474	3,410
Zone 5	14,404	3,845	13,861	30,750	-	14,818	13,303	19,490	20,595	8,886
Zone 6	5,628	11,865	2,754	33,800	14,818	-	26,340	5,408	817	360
Zone 7	3,485	2,728	1,364	14,134	13,303	26,340	-	18,957	1,558	933
Zone 8	3,650	1,745	2,858	8,745	19,490	5,408	18,957	-	10,291	3,425
Zone 9	1,452	378	3,317	5,474	20,954	817	1,558	10,291	-	18,907
Zone 10	999	269	4,191	3,410	8,886	360	933	3,425	18,907	-

Table 3.0. Davidson County 10 Zones Origin and Destination Matrix

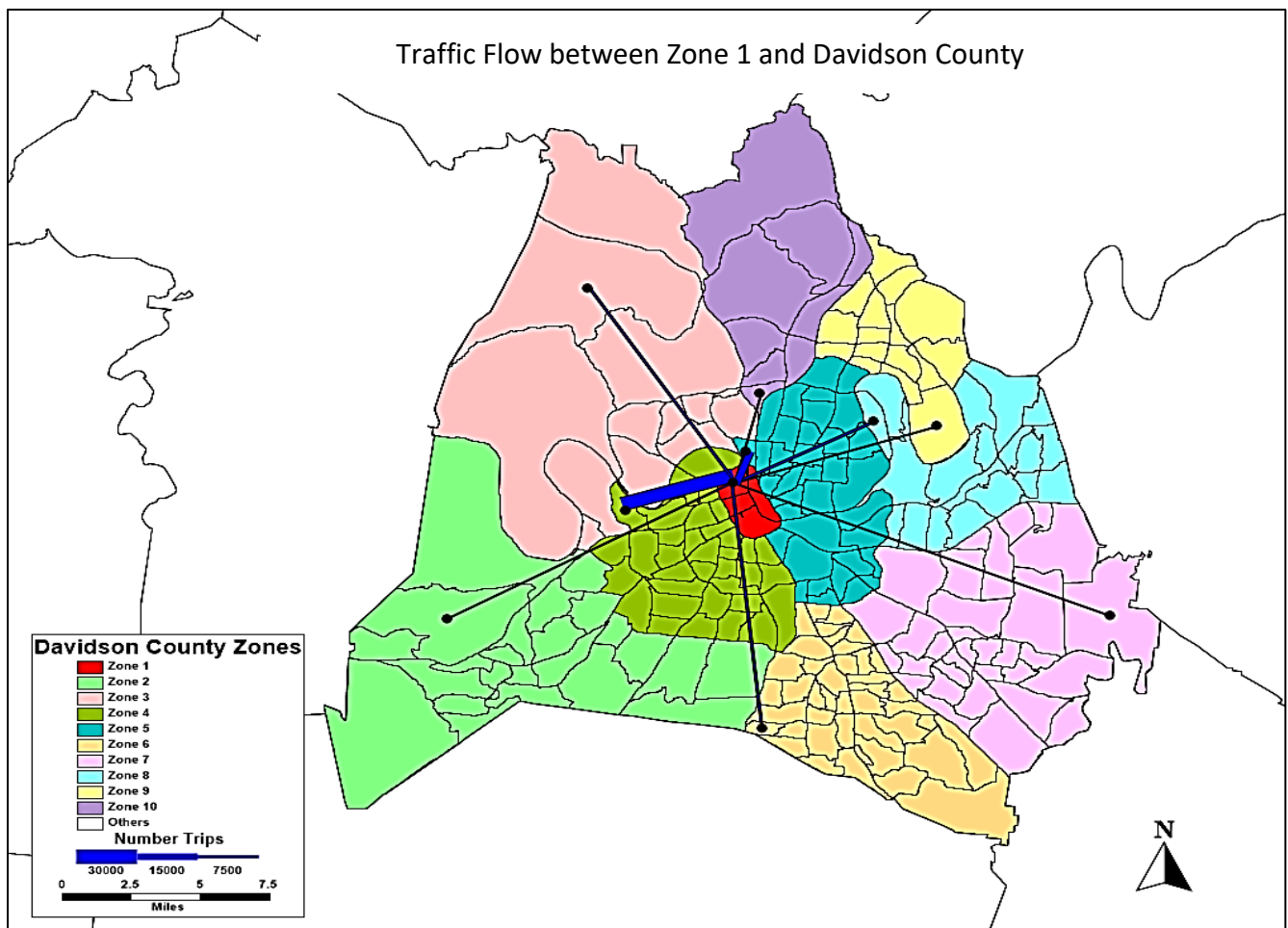


Figure 3.0. Auto Trips Originating in Zone 1

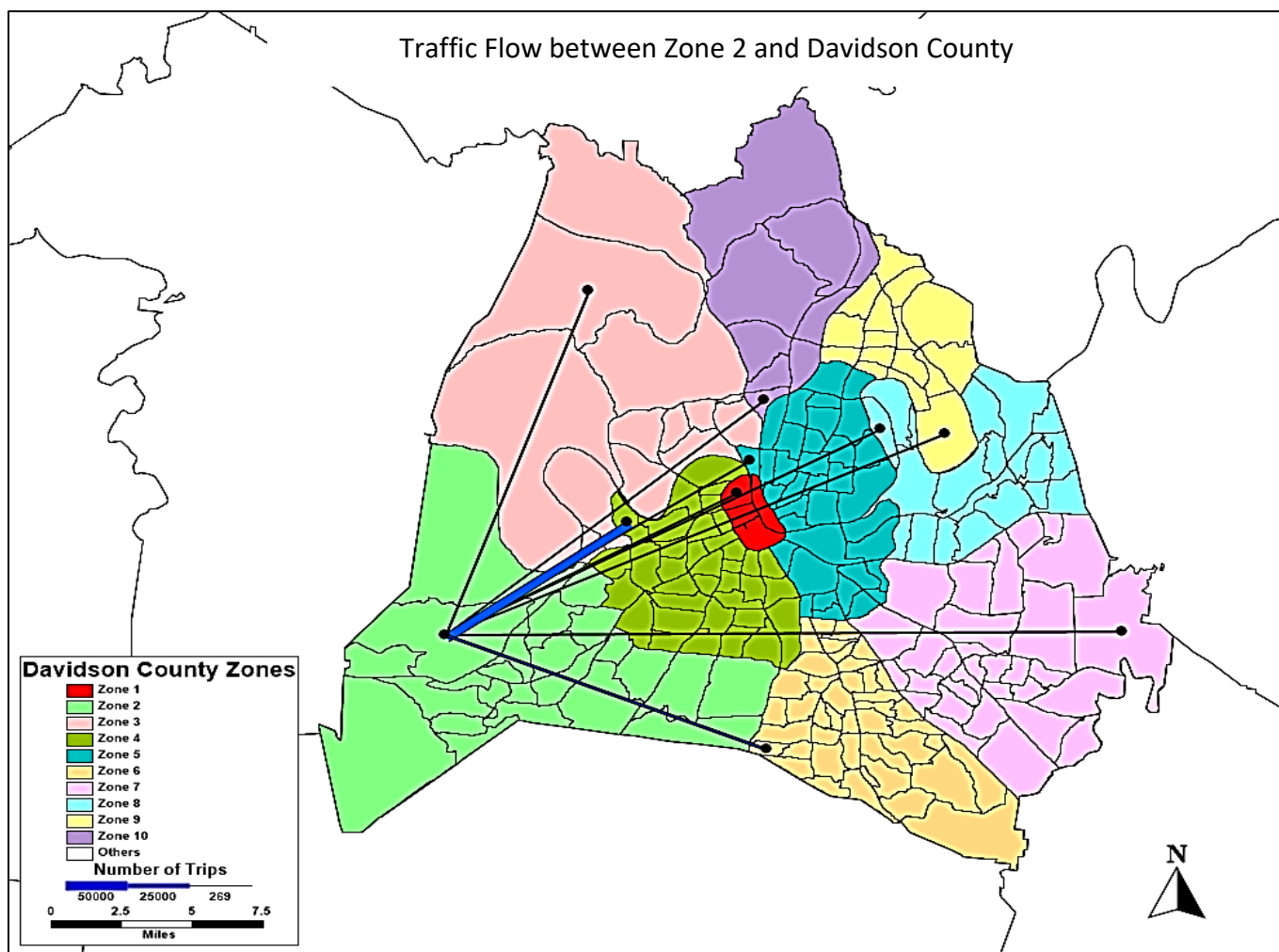


Figure 3.1. Auto Trips Originating in Zone 2

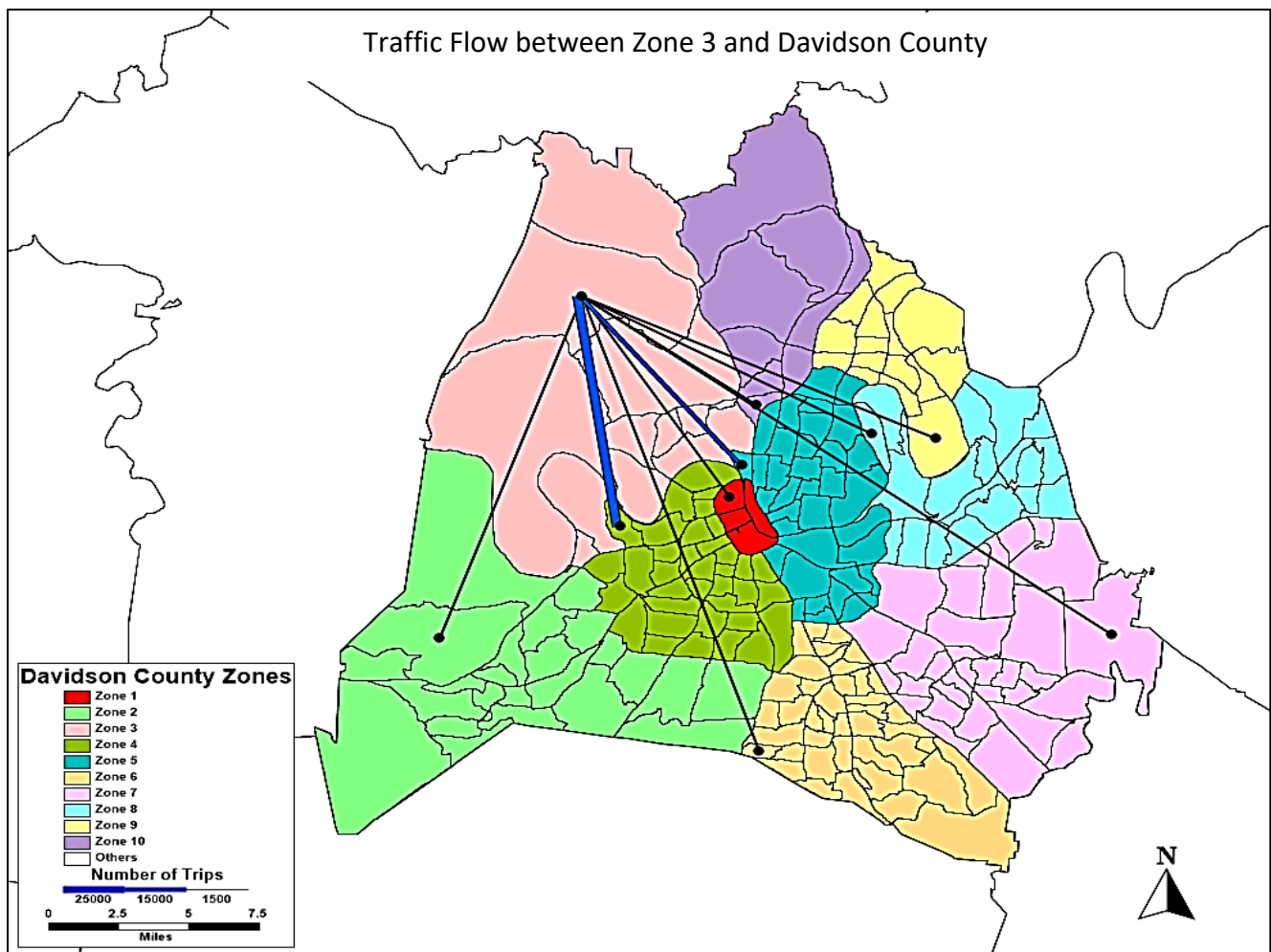


Figure 3.2. Auto Trips Originating in Zone 3

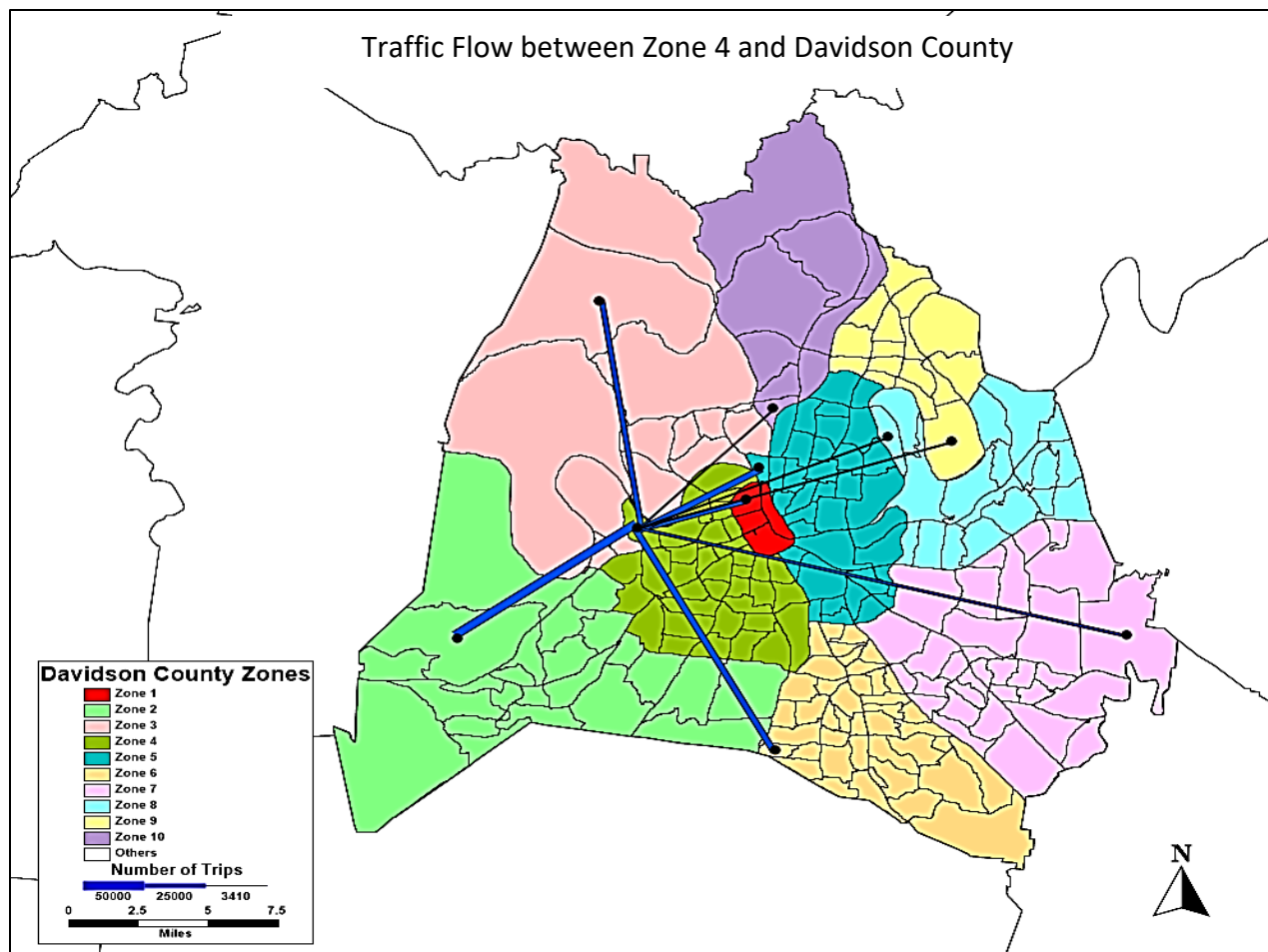


Figure 3.3. Auto Trips Originating in Zone 4

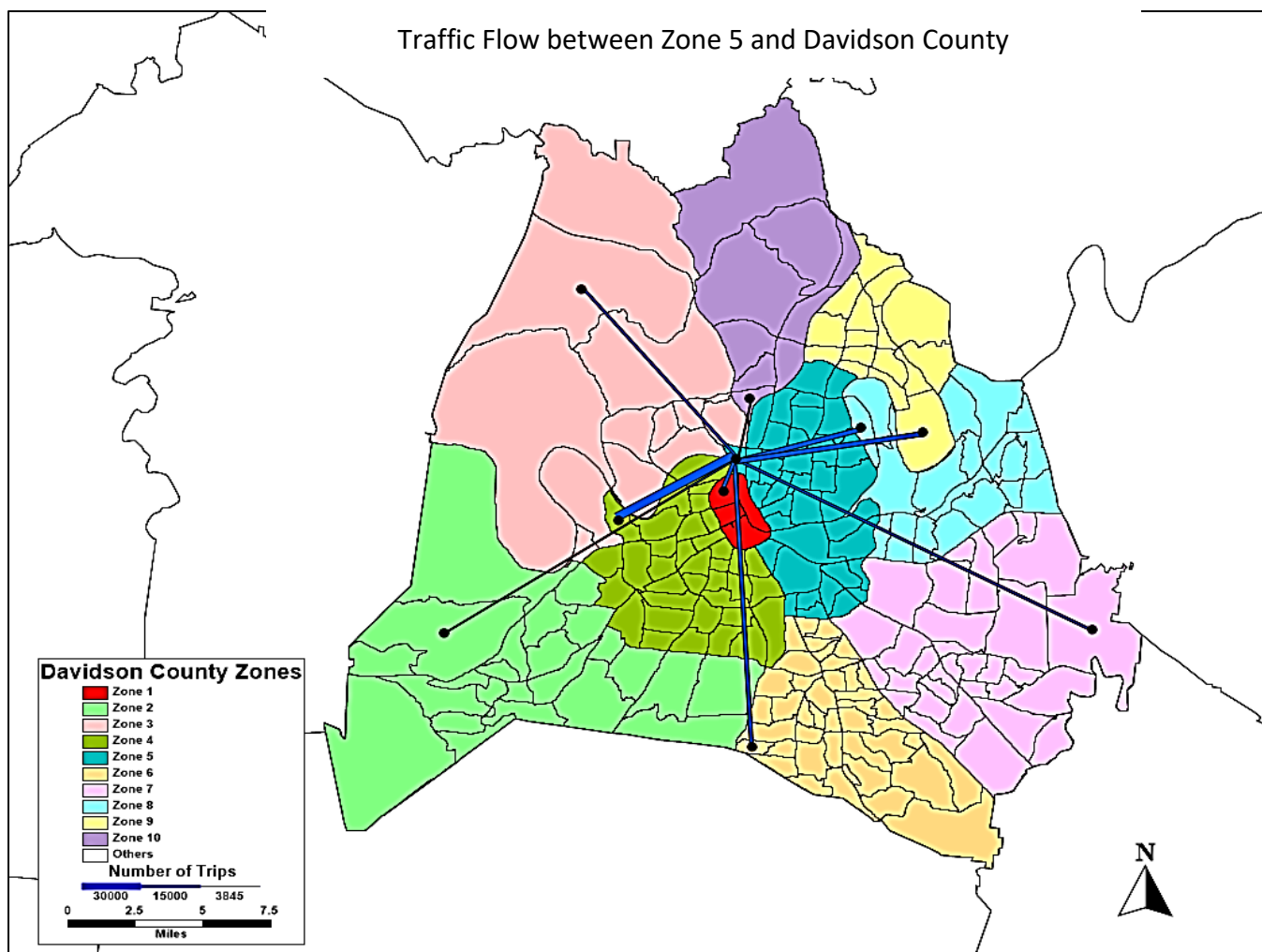


Figure 3.4. Auto Trips Originating in Zone 5

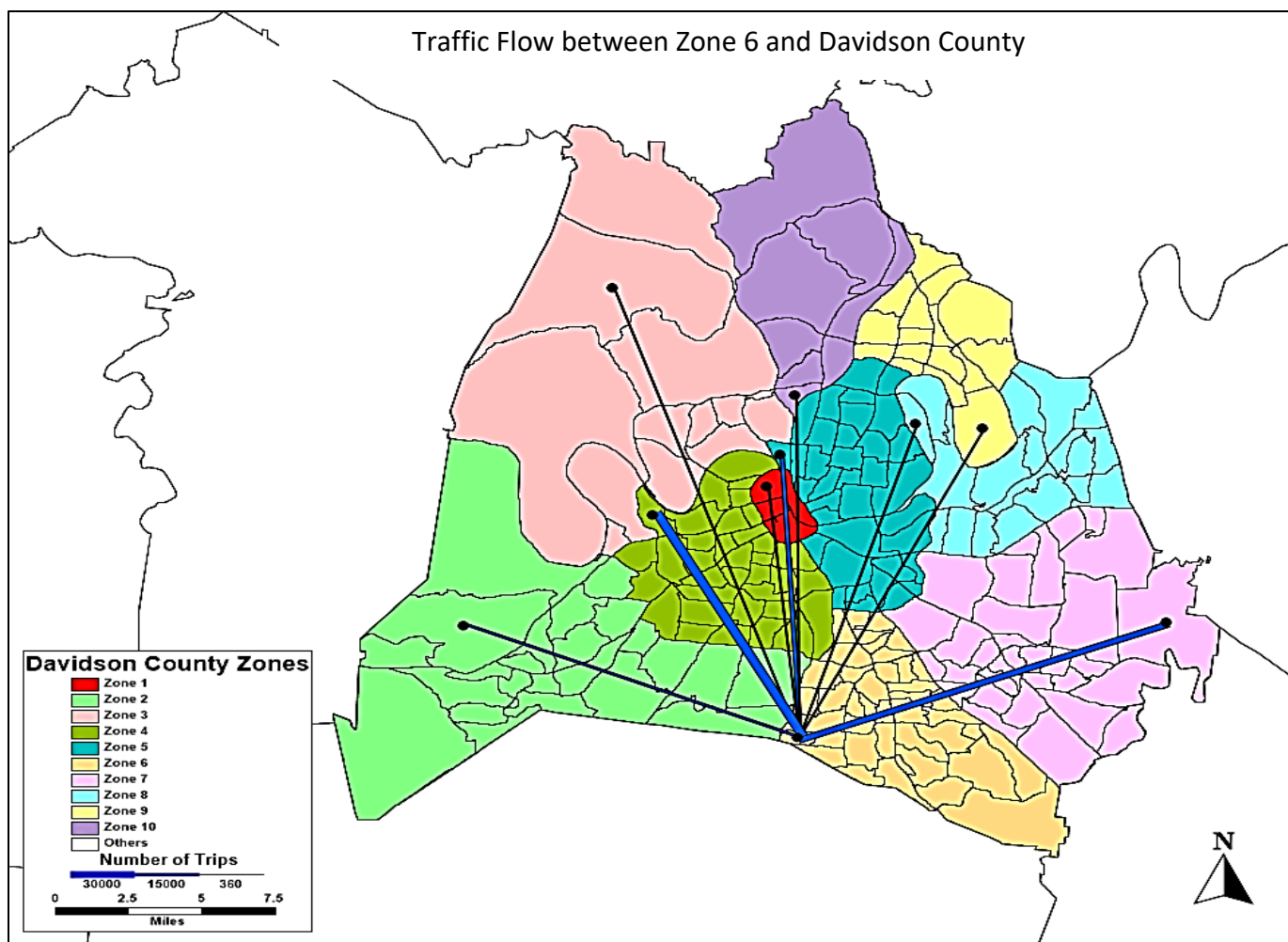


Figure 3.5. Auto Trips Originating in Zone 6

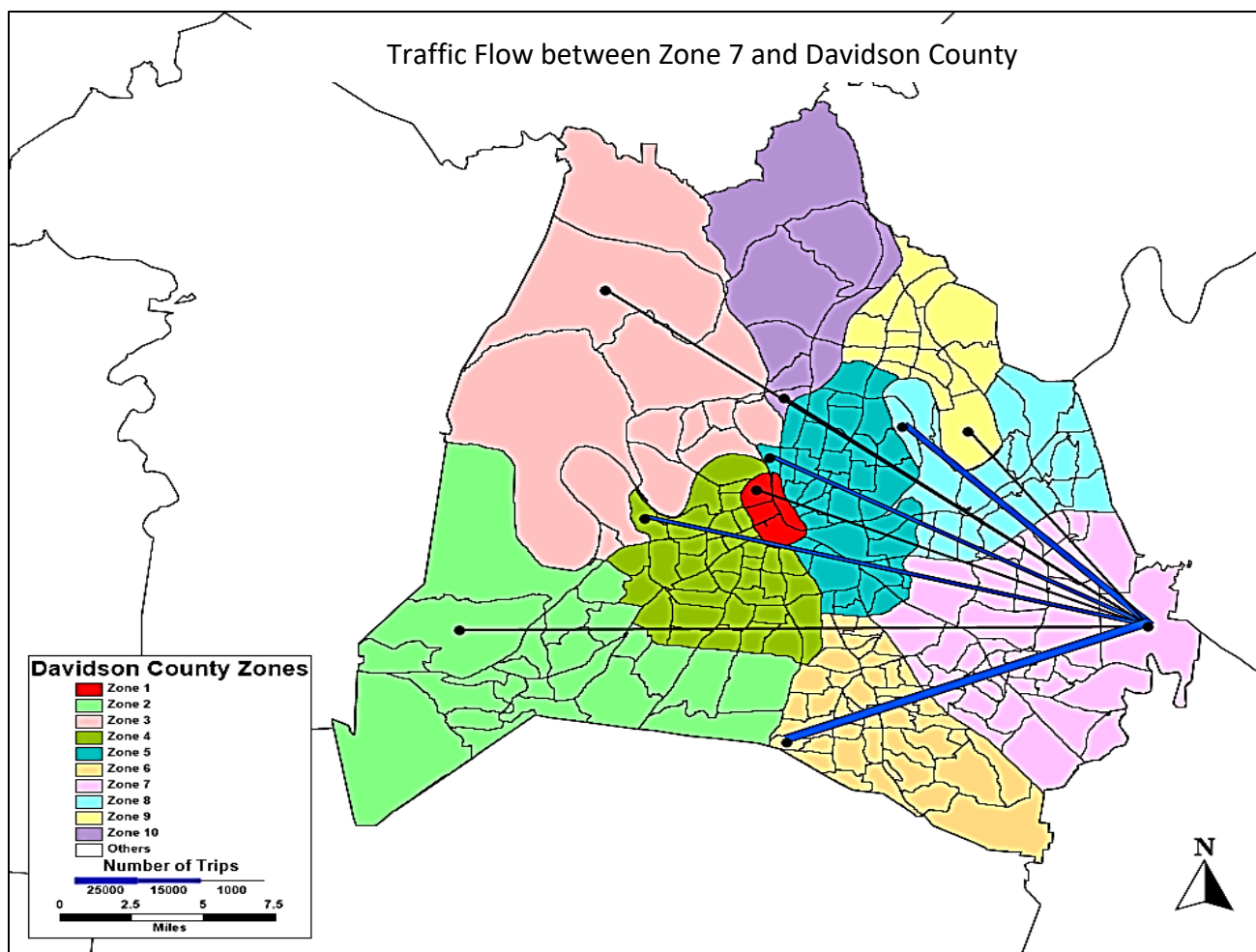


Figure 3.6. Auto Trips Originating in Zone 7

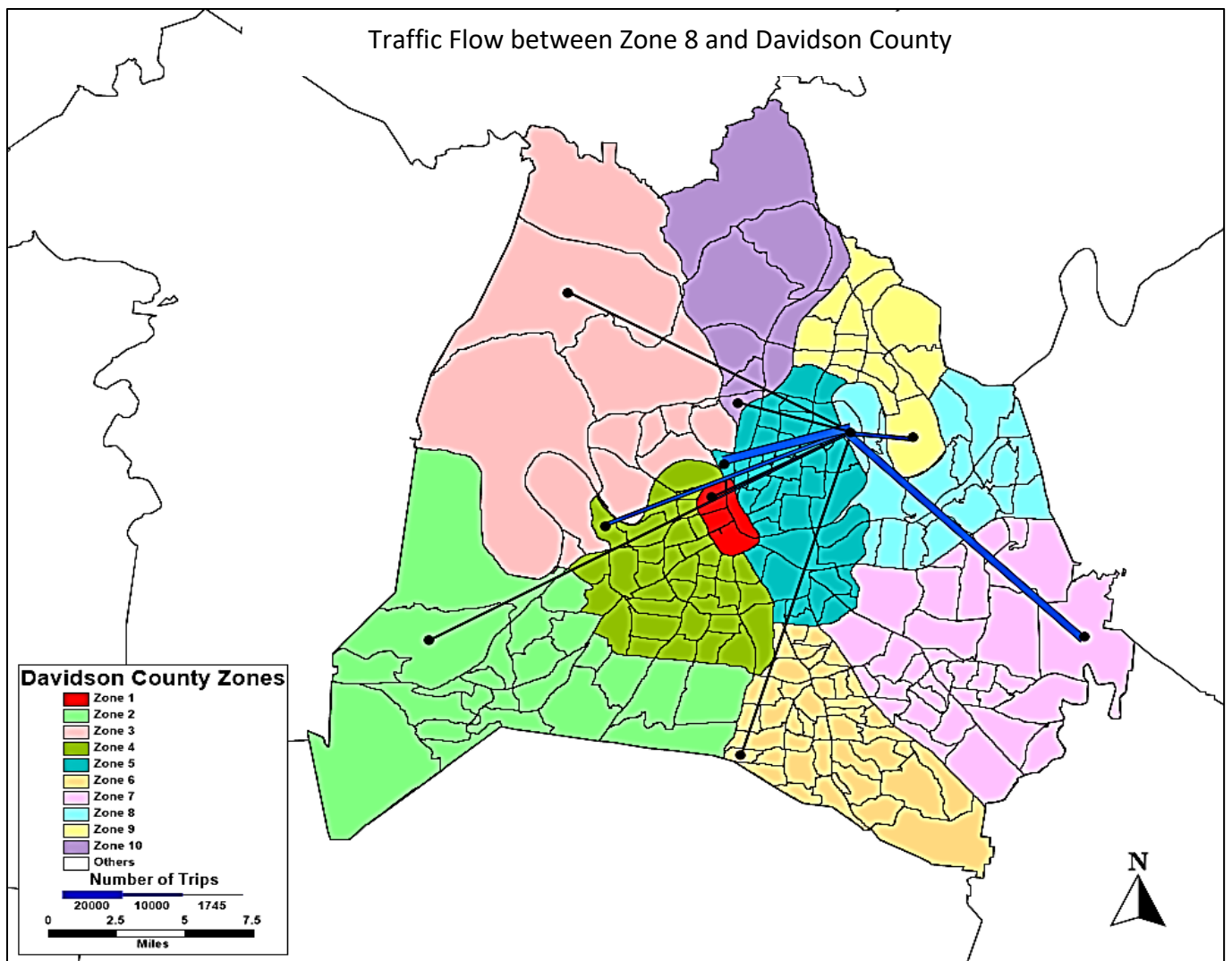


Figure 3.7. Auto Trips Originating in Zone 8

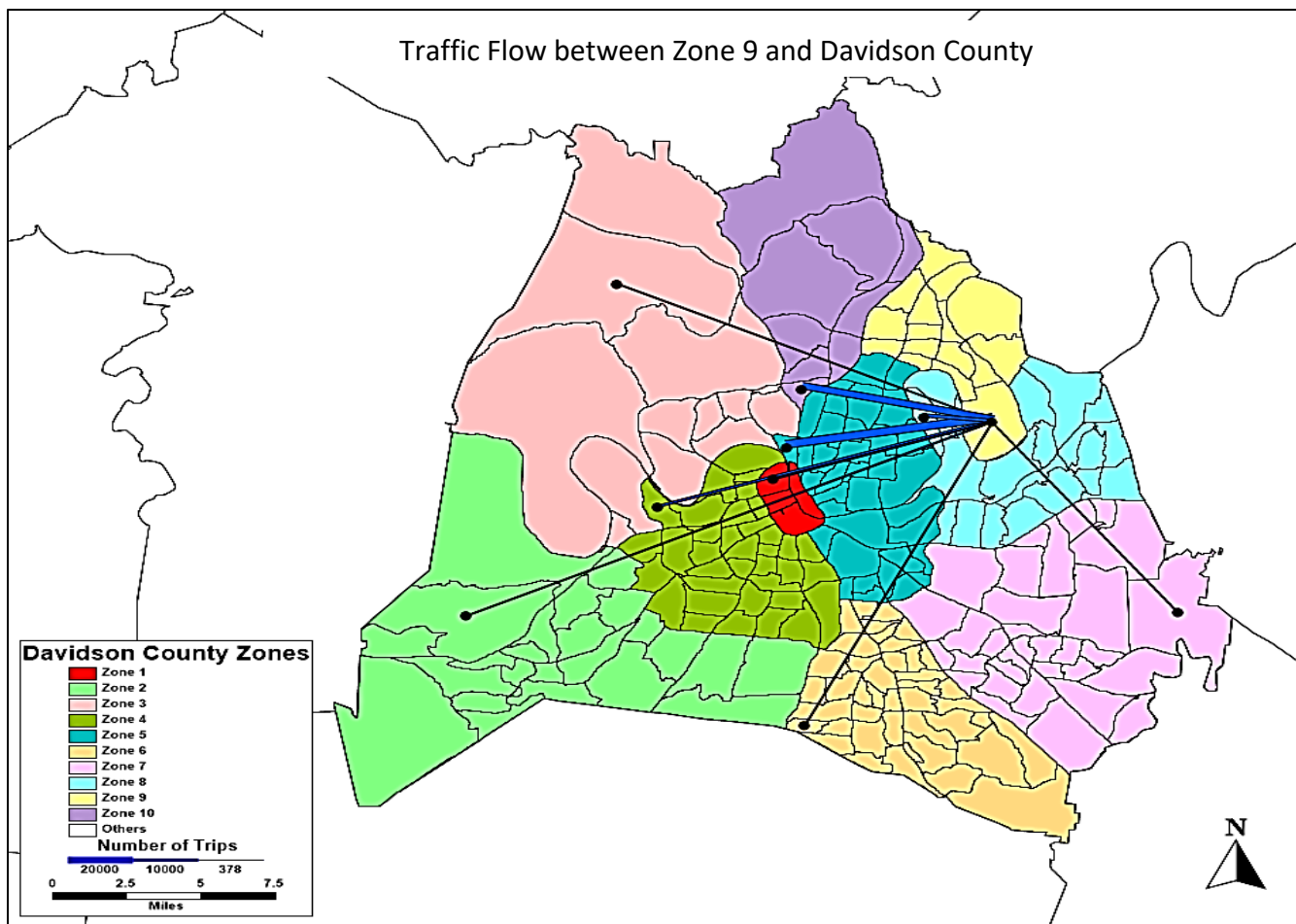


Figure 3.8. Auto Trips Originating in Zone 9

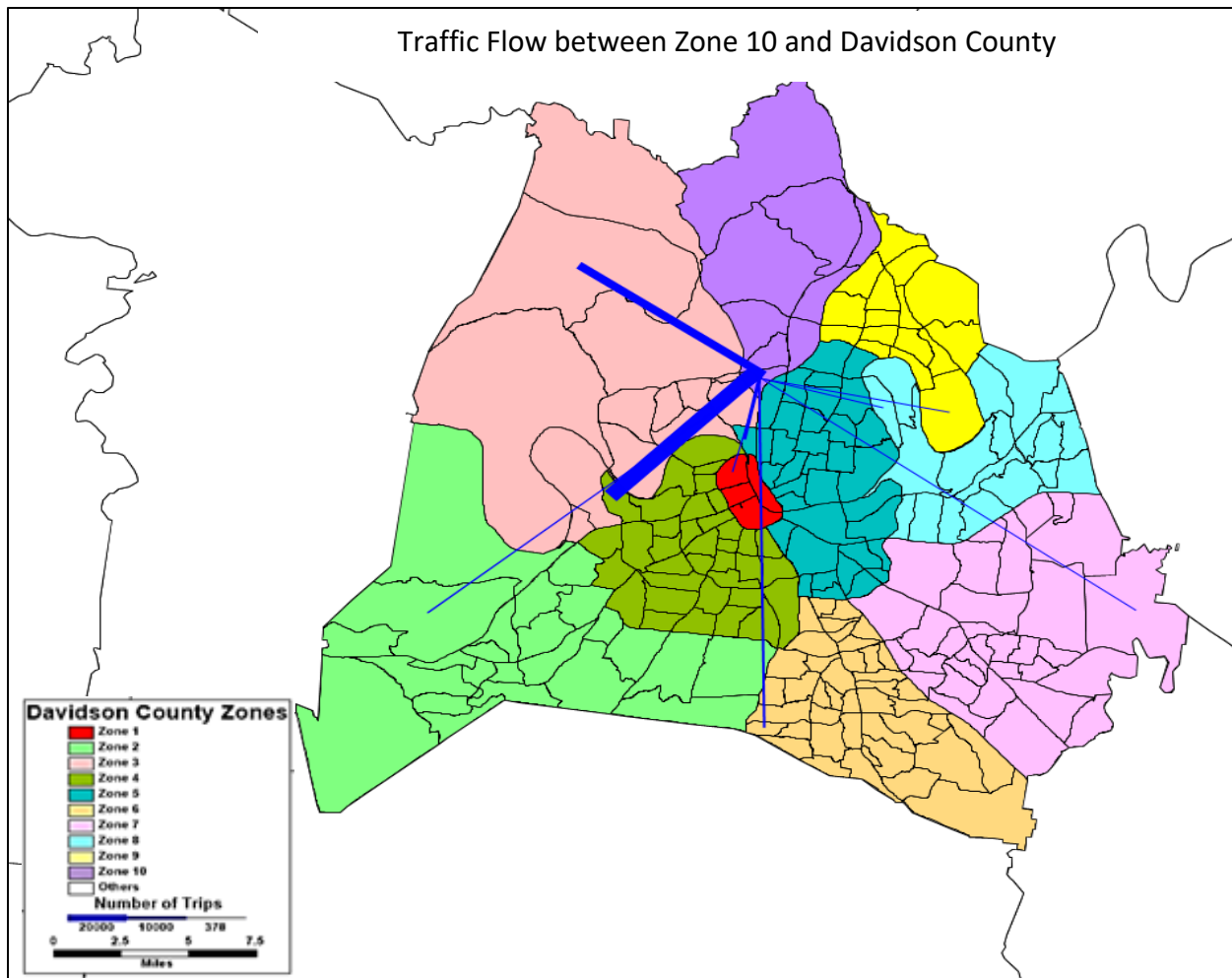


Figure 3.9. Auto Trips Originating in Zone 10

With the desire lines shown for each of the zones in Davidson County and the origin and destination matrix in *table 3.0* illustrates that zone 3 and zone 5 attract the highest number of auto trips for Davidson County, with 45% of the total 201,039 daily trips. Comparing this to *figure 3.1* the major cities in Davidson County, there are one main city in each zone. *Table 3.1* shows how many trips each zone attracts and the percentage of total trips that destined there. Since this origin and destination matrix is a balanced table with auto trips the number of trips that is attracted to a zone is also the same number of trips that is produced to that zone.

Zone	Number of Attracted Trips	Percentage of Trips
1	75180	6%
2	72734	5%
3	273859	20%
4	224863	17%
5	202231	15%
6	134721	10%
7	104257	8%
8	107250	8%
9	93913	7%
10	64655	5%

Table 3.1. Highest to Lowest Trips Attraction and Production

Section 3.2. Home Based Work Trips vs Home Based Other Trips

The following section breaks apart the commuting trips that are made within Davidson County to determine how many of them are home based work trips and how many are home based other trips. A home based work trips is any trips in which one end of the trip is home and the other is work, where a home based other trip is a trip in which one end is a home trips and the other end is any trip besides work. This is important because it will allow for an understanding of whether or not the trips that are being made within Davidson County are for work or for another purpose. **Table 3.2** shows the origin and destination matrix for home based work trips, showing that on average about 42% of the trips that are being made within Davidson County are connected to work. Where looking at **table 3.3** the origin and destination matrix for home based other trips, where an average of 58% of the trips connects to another location besides work.

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10
Zone 1	-	1,547	1,928	13,794	6,914	2,701	1,673	1,752	697	479.52
Zone 2	1,547	-	1,018	19,891	1,846	5,695	1,309	838	181.44	129.12
Zone 3	1,928	1,018	-	12,771	6,653	1,322	655	1,372	1,592	2,012
Zone 4	13,794	19,891	12,771	-	14,760	16,224	6,784	4,198	2,628	1,637
Zone 5	6,914	1,846	6,653	14,760	-	7,113	6,385	9,355	9,886	4,265
Zone 6	2,701	5,695	1,322	16,224	7,113	-	12,643	2,596	392.16	172.8
Zone 7	1,673	1,309	655	6,784	6,385	12,643	-	9,099	748	447.84
Zone 8	1,752	838	1,372	4,198	9,355	2,596	9,099	-	4,940	1,644
Zone 9	697	181.44	1,592	2,628	10,058	392.16	748	4,940	-	9,075
Zone 10	479.52	129.12	2,012	1,637	4,265	172.8	447.84	1,644	9,075	-

Table 3.2. Home Based Work Trips for 2020

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10
Zone 1	-	1675.44	2088.32	14943.24	7490.08	2926.56	1812.2	1898	755.04	519.48
Zone 2	1,675	-	1,102	21,549	1,999	6,170	1,419	907	196.56	139.88
Zone 3	2,088	1,102	-	13,835	7,208	1,432	709	1,486	1,725	2,179
Zone 4	14,943	21,549	13,835	-	15,990	17,576	7,350	4,547	2,846	1,773
Zone 5	7,490	1,999	7,208	15,990	-	7,705	6,918	10,135	10,709	4,621
Zone 6	2,927	6,170	1,432	17,576	7,705	-	13,697	2,812	424.84	187.2
Zone 7	1,812	1,419	709	7,350	6,918	13,697	-	9,858	810	485.16
Zone 8	1,898	907	1,486	4,547	10,135	2,812	9,858	-	5,351	1,781
Zone 9	755	196.56	1,725	2,846	10,896	424.84	810	5,351	-	9,832
Zone 10	519.48	139.88	2,179	1,773	4,621	187.2	485.16	1,781	9,832	-

Table 3.3. Home Based Other Trips for 2020

Section 3.3. Traffic Volume Analysis

Section 3.3 addresses the traffic volume on the major roads in Davidson County. The reasoning for visualizing the traffic volume is to determine which roads in Davidson County are being utilized the most by auto vehicle traffic. Within this section only certain roads will be used to analyze the traffic volume, these roads are the interstates, the expressways, and the minor and major arterials. **Figure 3.10** shows the roads in Davidson County that will be analyzed for the traffic volume.

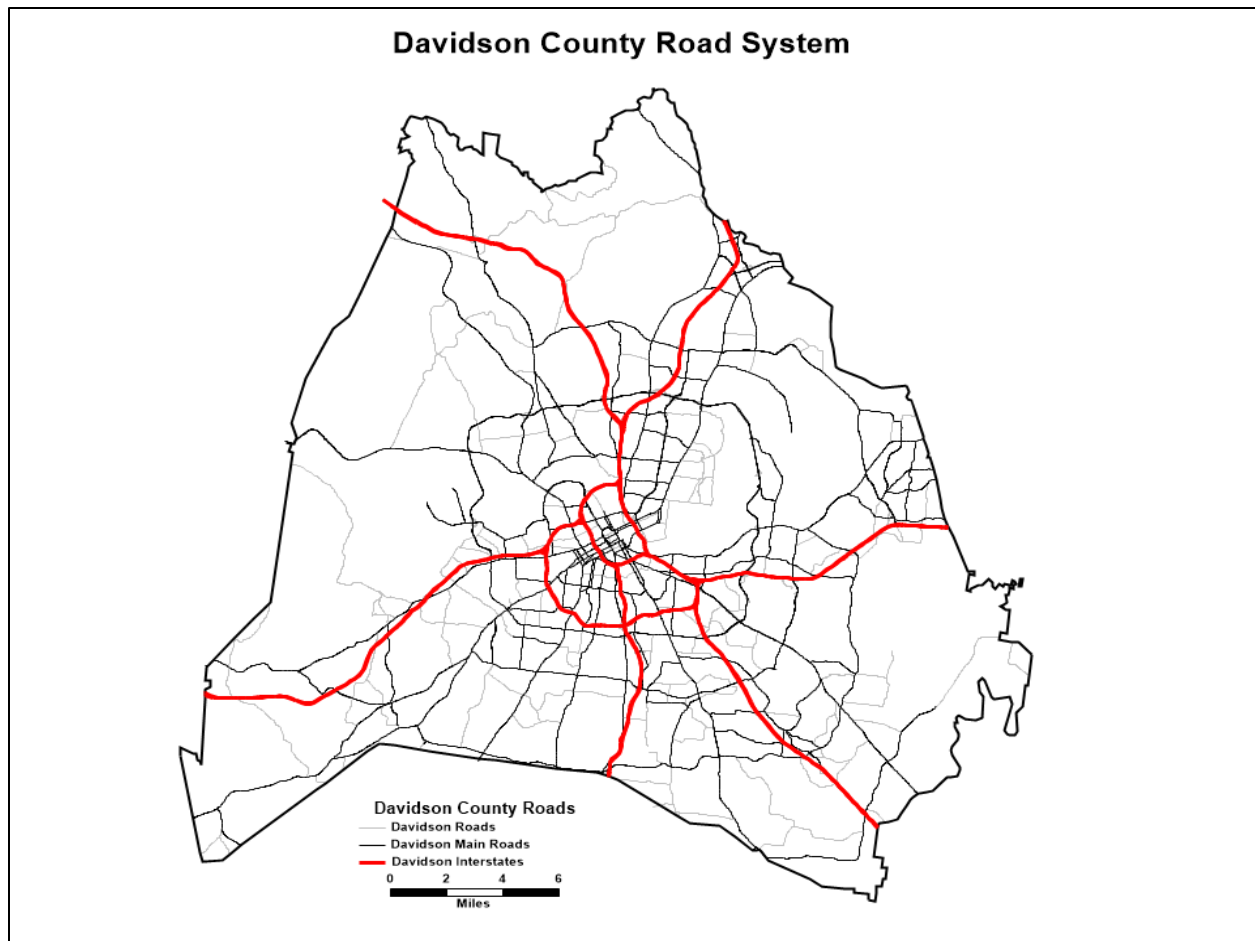


Figure 3.10. Davidson County Road System

Knowing where the major roads are at in Davidson County from *figure 3.10*, the next step is to determine what the travel volume is for auto trips on these roads. The travel volume will be broken up into three different categories, such as: auto travel volume in the morning, auto travel volume in the afternoon, and finally the total auto volume. *Figure 3.11* though *figure 3.13* shows the travel volume for Davidson Counties main roads.

AM Auto Traffic Volume in Davidson County

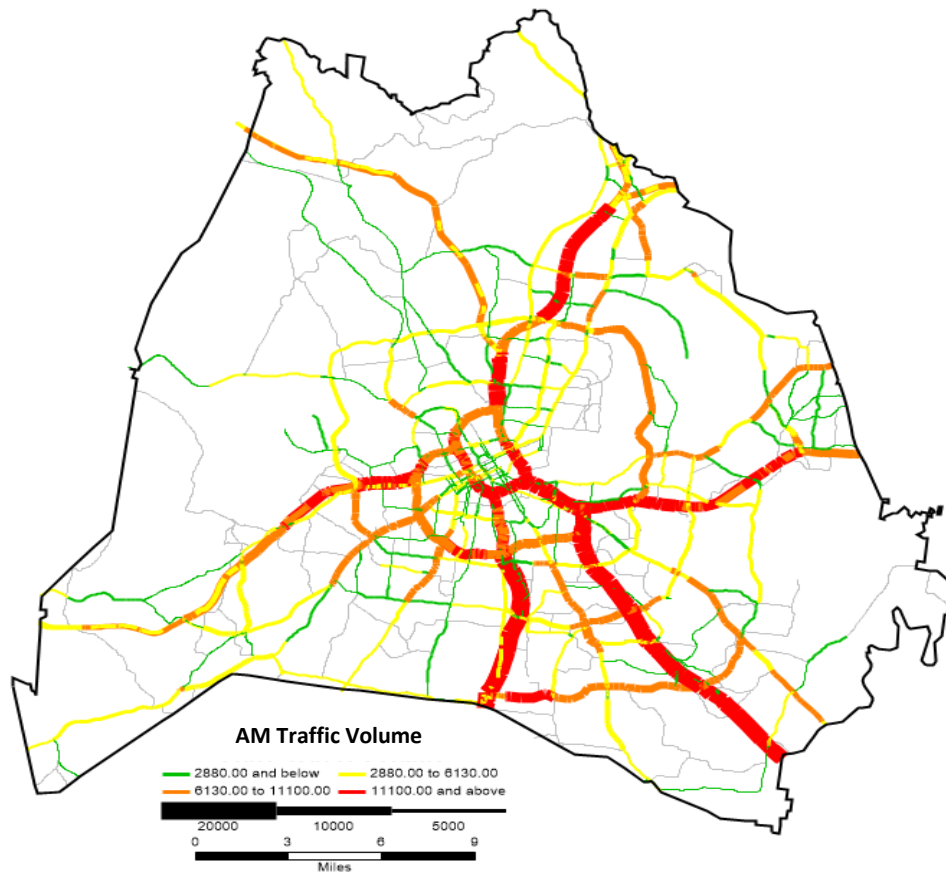


Figure 3.11. Morning Auto Traffic Volume

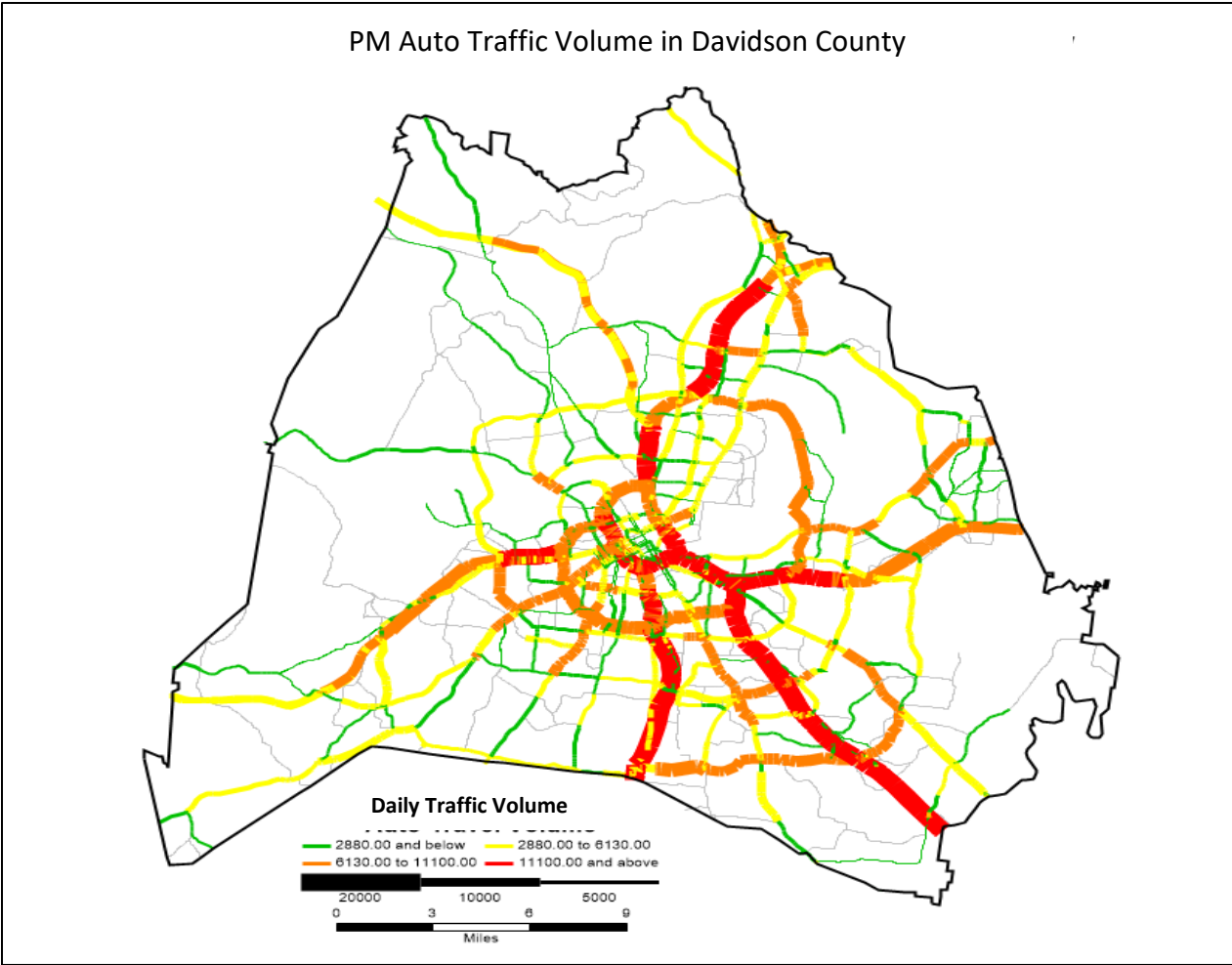


Figure 3.12. Afternoon Auto Traffic Volume

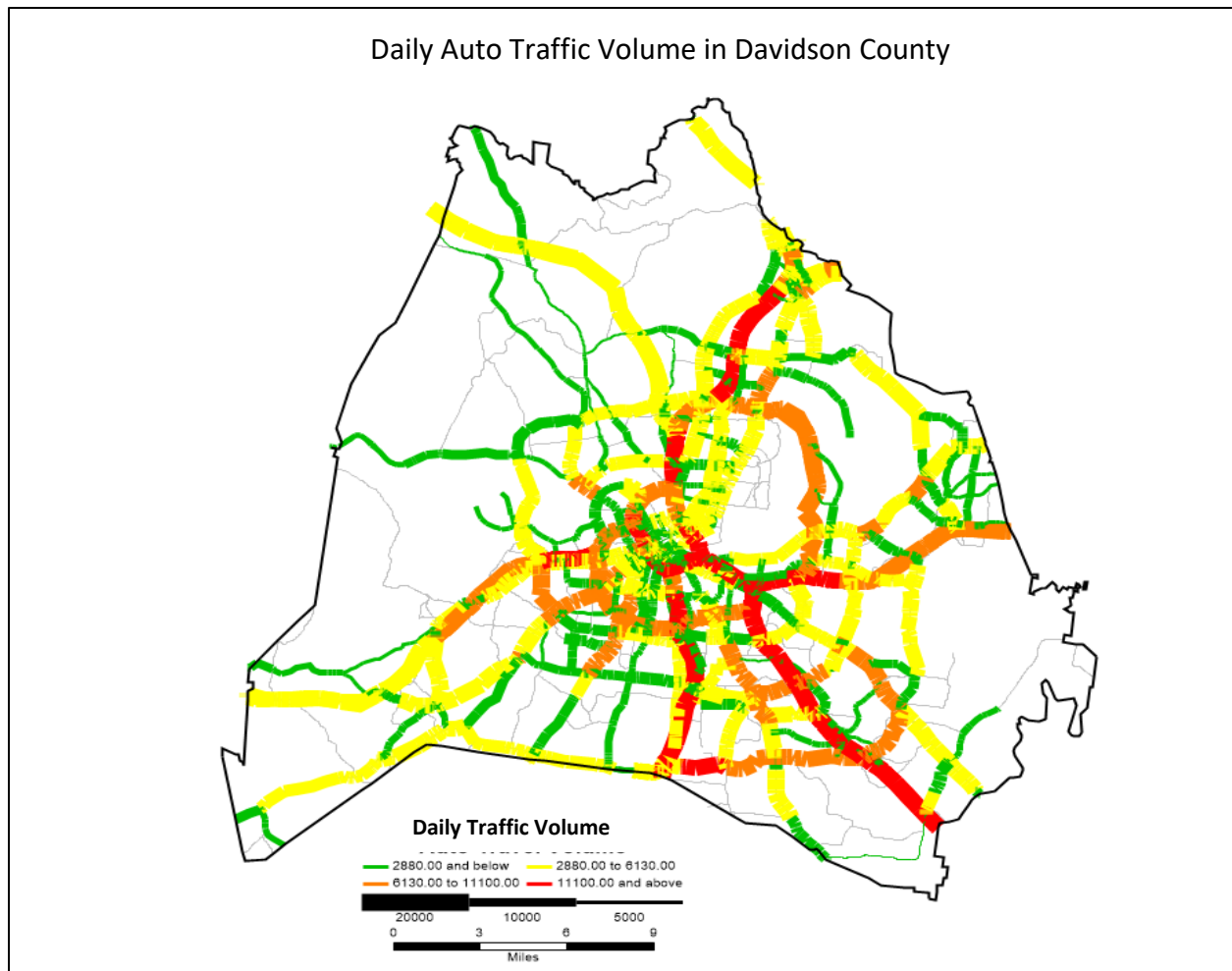


Figure 3.13. Daily Auto Traffic Volume

Evaluating the three different travel volume times, there is a clear common characteristic between the three visuals, and that is that the interstates are the main road that is used for auto travel in Davidson County. The smaller arterial produce little travel volume compared to the rest of Davidson County. This could show that once the vehicles make it to the smaller arterial they are more disperse than they are on the interstates.

Section 3.4. Travel Time Analysis

The last section for the future 2020 year is to look at the travel time in Davidson County for auto trips. The analysis done on the travel time will look at two sets of data; the first will be the free-flow running time, which represents the travel time with no traffic. The second will be the average daily congestion time. **Figure 3.14** will show the daily free-flow running time and **figure 3.15** will shows the average daily congestion for Davidson County.

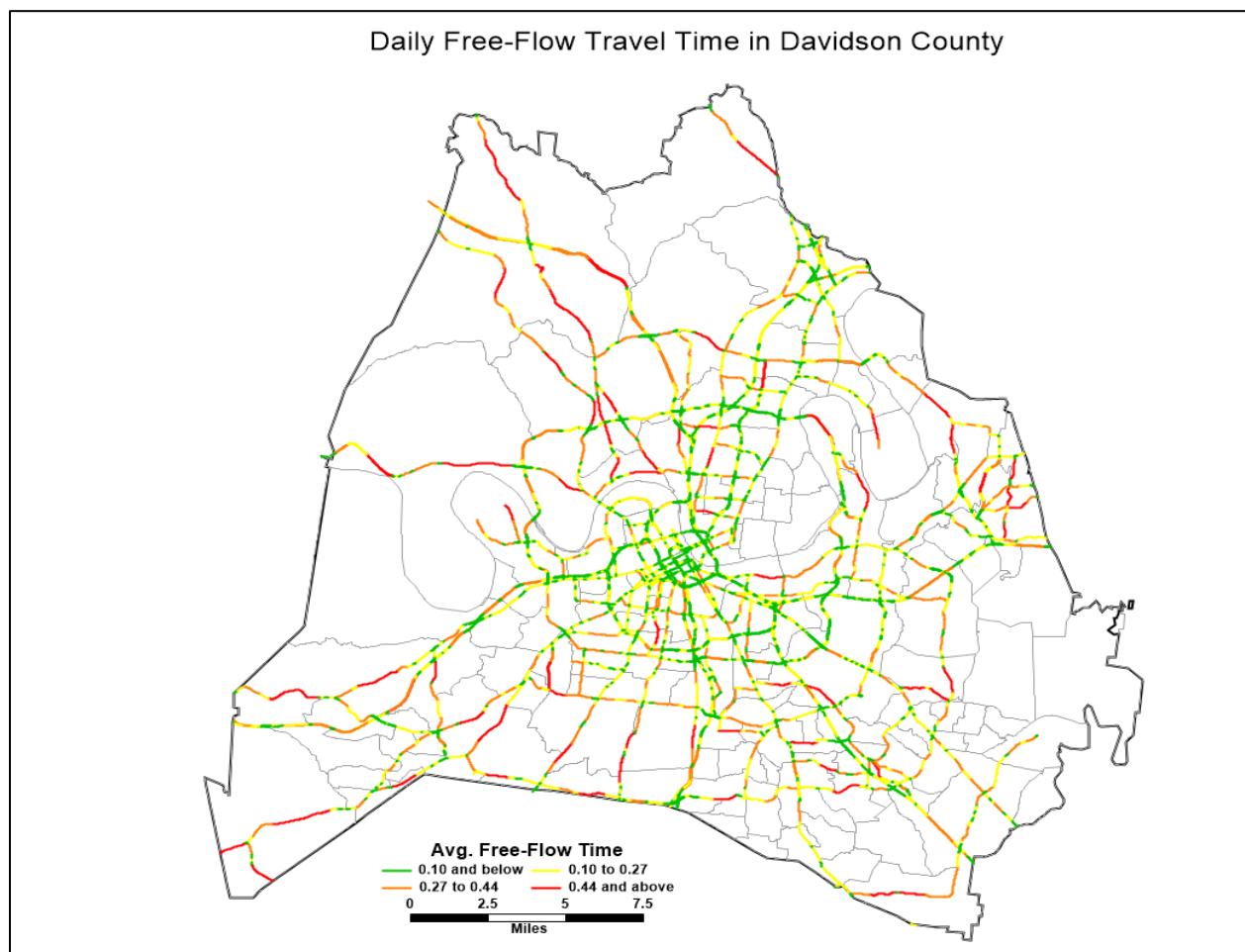


Figure 3.14. Davidson County Daily Free-Flow Travel Time

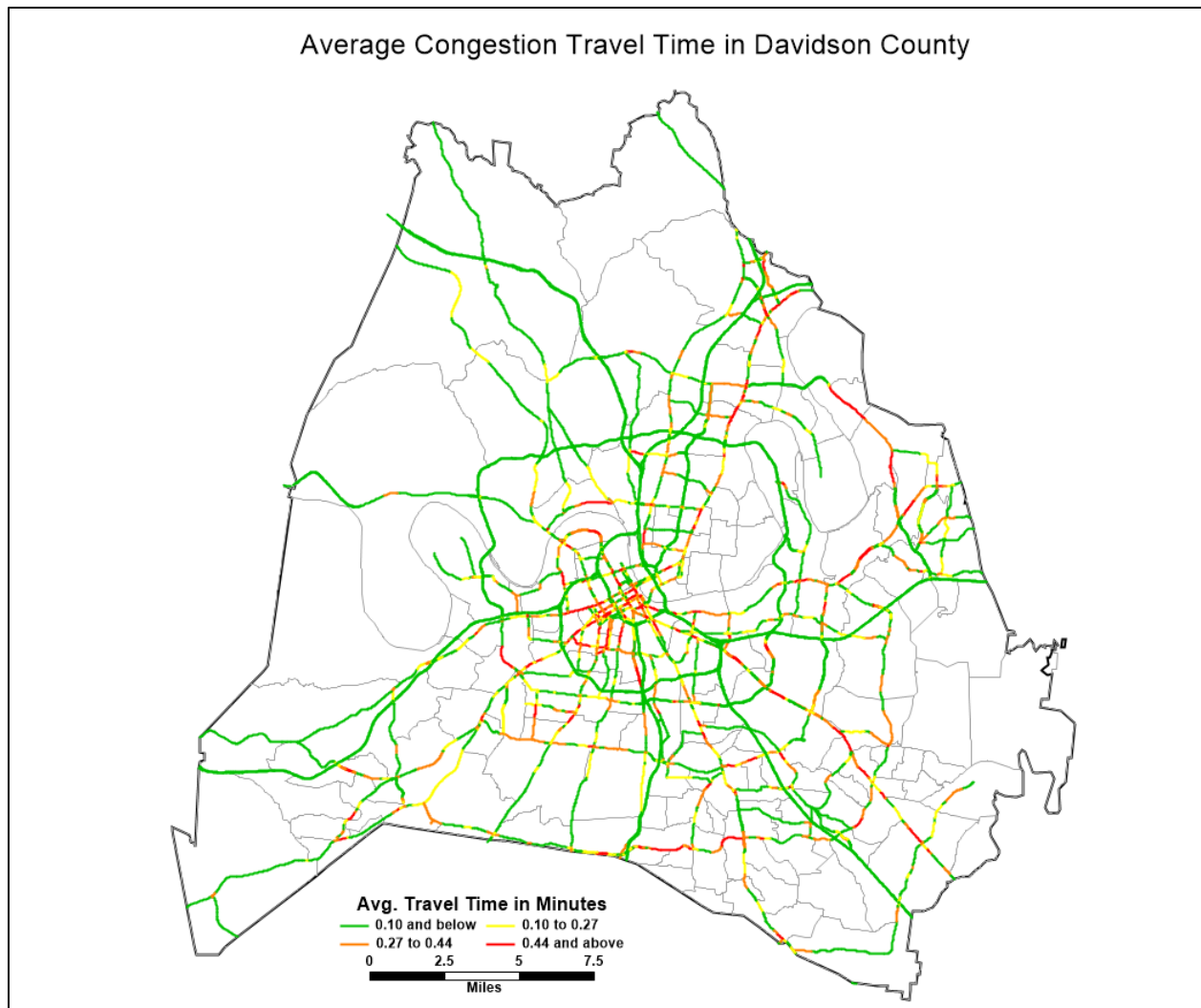


Figure 3.15. Davidson County Daily Average Congestion Travel Time

According to the 2020 free flow travel time there is little to no delays in the traffic flow, and that a large majority of Davidson County travels at less than 2 minutes. However there are the occasional roads where the travel time is over 2 minutes, but there are no location in Davidson County that have a free-flow travel time of over 4 minutes. When looking at the average congestion travel time in Davidson County, there is very little travel delay in time. There are however the few locations that have a travel time of over 6 minutes, but these are at a minimum.

CHAPTER 4. FUTURE COMMUTING PATTERN ANALYSIS

Chapter 4 is designed similar to chapter 3; however, it is going to look at the future 2040 commuting patterns for Davidson County. The first visualization will use desire lines to create a visual between the 10 zones, illustrating the amount of auto trips that each zone is producing and attracting. The second set of data will look at the travel times of commuting trips in Davidson County, and the final set of data will be to show the traffic volume on the interstates, expressways, and arterials that run through Davidson County.

Section 4.1. Desire Lines

Section 4.1 is designed to create 10 sets of desire lines based on the auto trips that are made to each of the zones in Davidson County. The origin and destination matrix was created by using the existing traffic analysis zones that were selected in each of the zones and joining them into one group and summing the total trips created to each zone. The desire lines are created to show that with the thicker the line the more auto trips that are made to that zone. **Figure 4.0** through **figure 4.9** shows the desire lines from each of the zones in Davidson County to the other zones. As the desire lines don't illustrate an exact **table 4.0** provides the origin and destination matrix for the auto trips between the 10 created zones in Davidson County.

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10
Zone 1	-	3,335	4,157	29,743	14,908	5,825	3,607	3,778	1,503	1,034
Zone 2	3,335	-	2,194	42,890	3,980	12,280	2,823	1,806	391	278
Zone 3	4,157	2,194	-	27,537	14,346	2,850	1,412	2,958	3,433	4,338
Zone 4	29,743	42,890	27,537	-	31,826	34,983	14,629	9,051	5,666	3,529
Zone 5	14,908	3,980	14,346	31,826	-	15,337	13,769	20,172	21,316	9,197
Zone 6	5,825	12,280	2,850	34,983	15,337	-	27,262	5,597	846	373
Zone 7	3,607	2,823	1,412	14,629	13,769	27,262	-	19,620	1,613	966
Zone 8	3,778	1,806	2,958	9,051	20,172	5,597	19,620	-	10,651	3,545
Zone 9	1,503	391	3,433	5,666	21,687	846	1,613	10,651	-	19,569
Zone 10	1,034	278	4,338	3,529	9,197	373	966	3,545	19,569	-

Table 4.0. Davidson County 10 Zones Origin and Destination Matrix

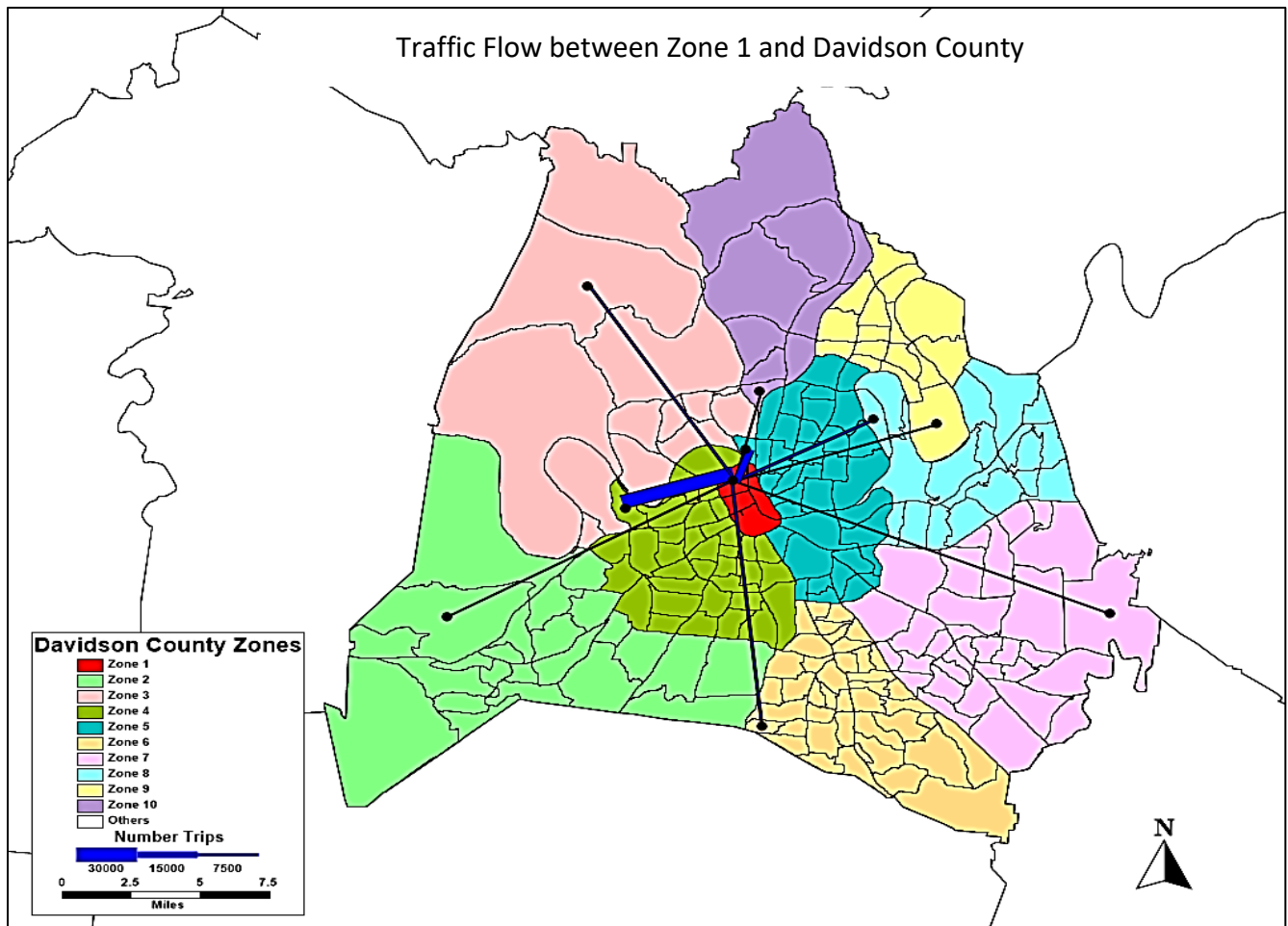


Figure 4.0. Auto Trips Originating in Zone 1

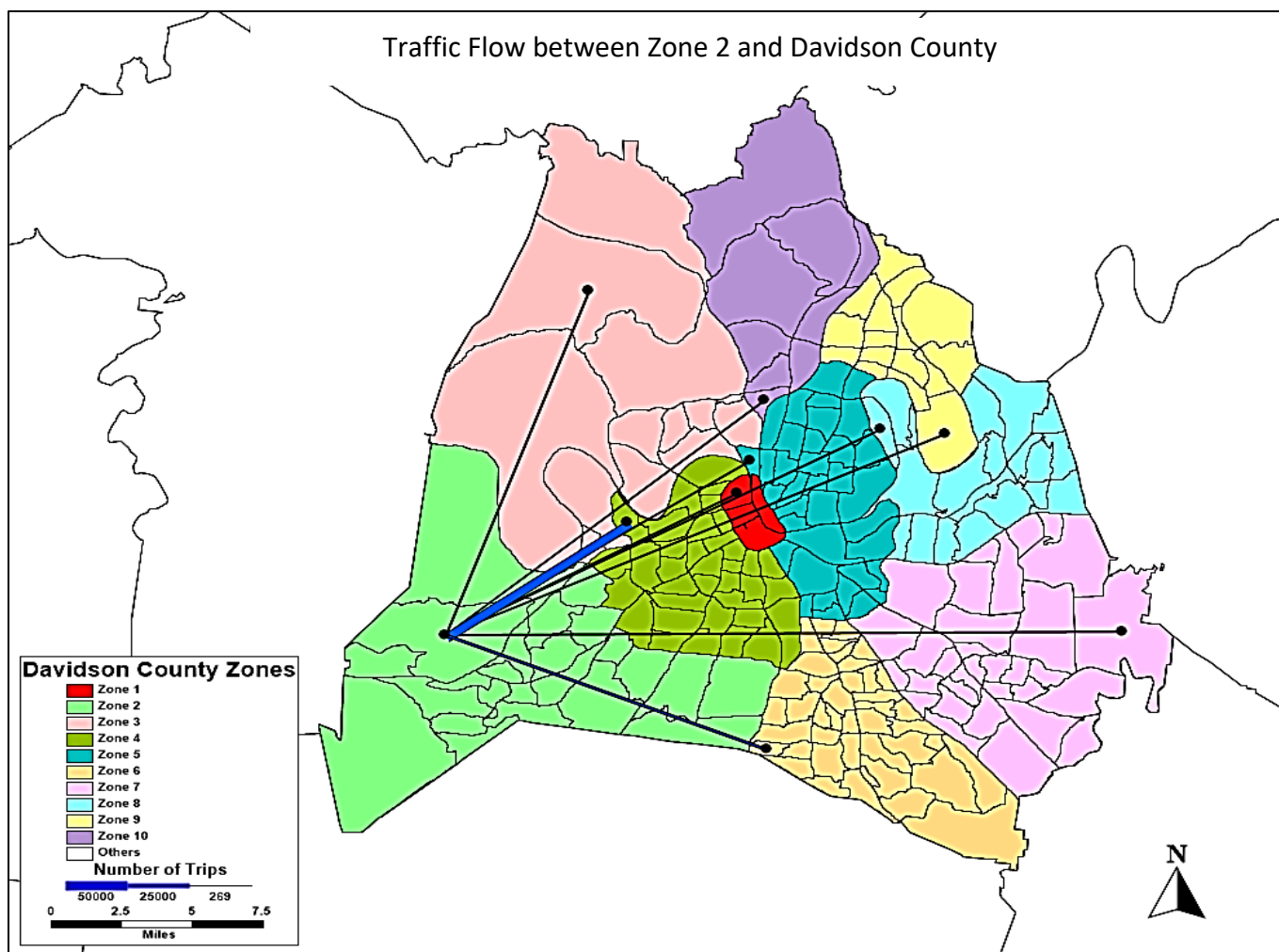


Figure 4.1. Auto Trips Originating in Zone 2

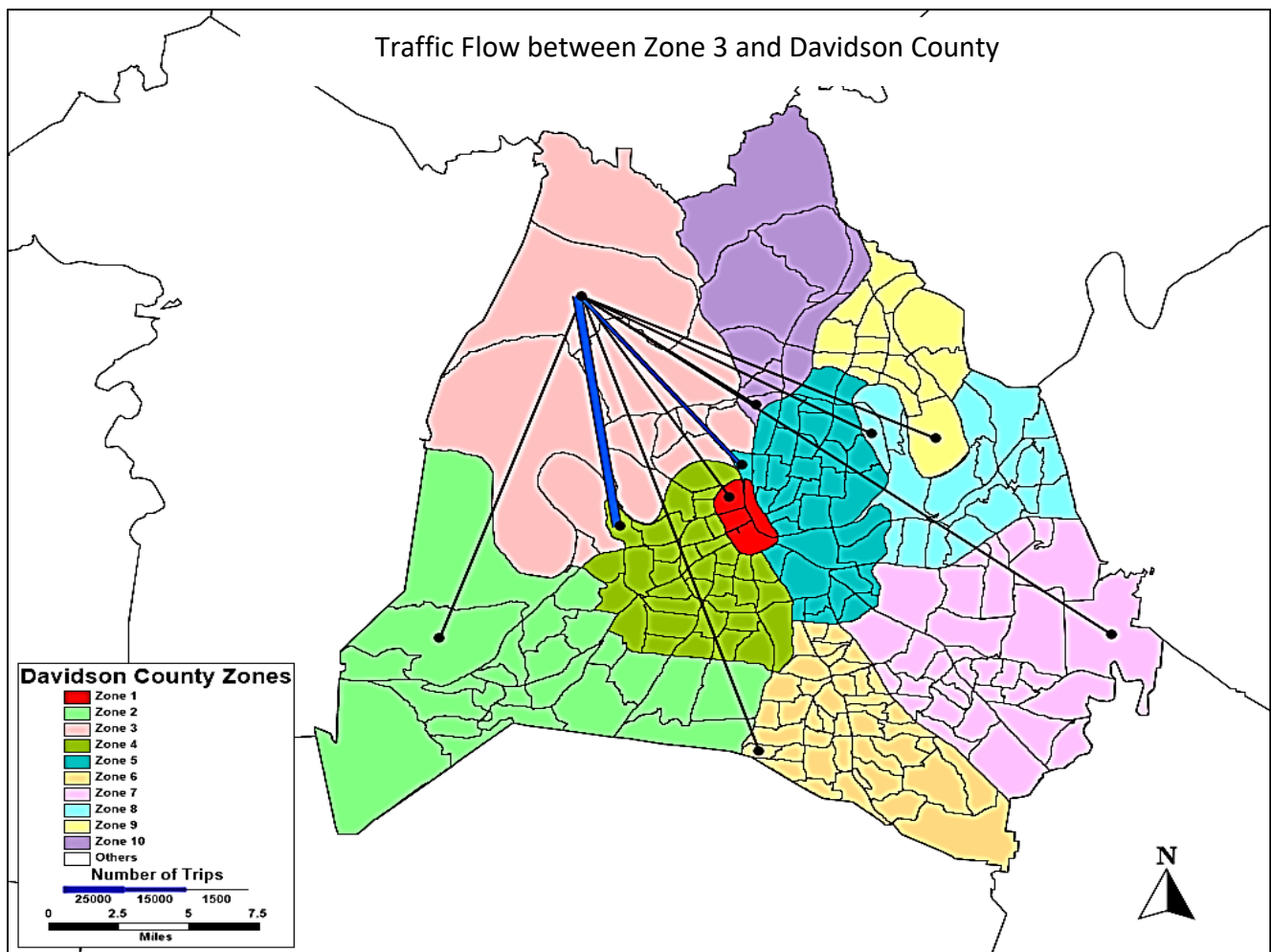


Figure 4.2. Auto Trips Originating in Zone 3

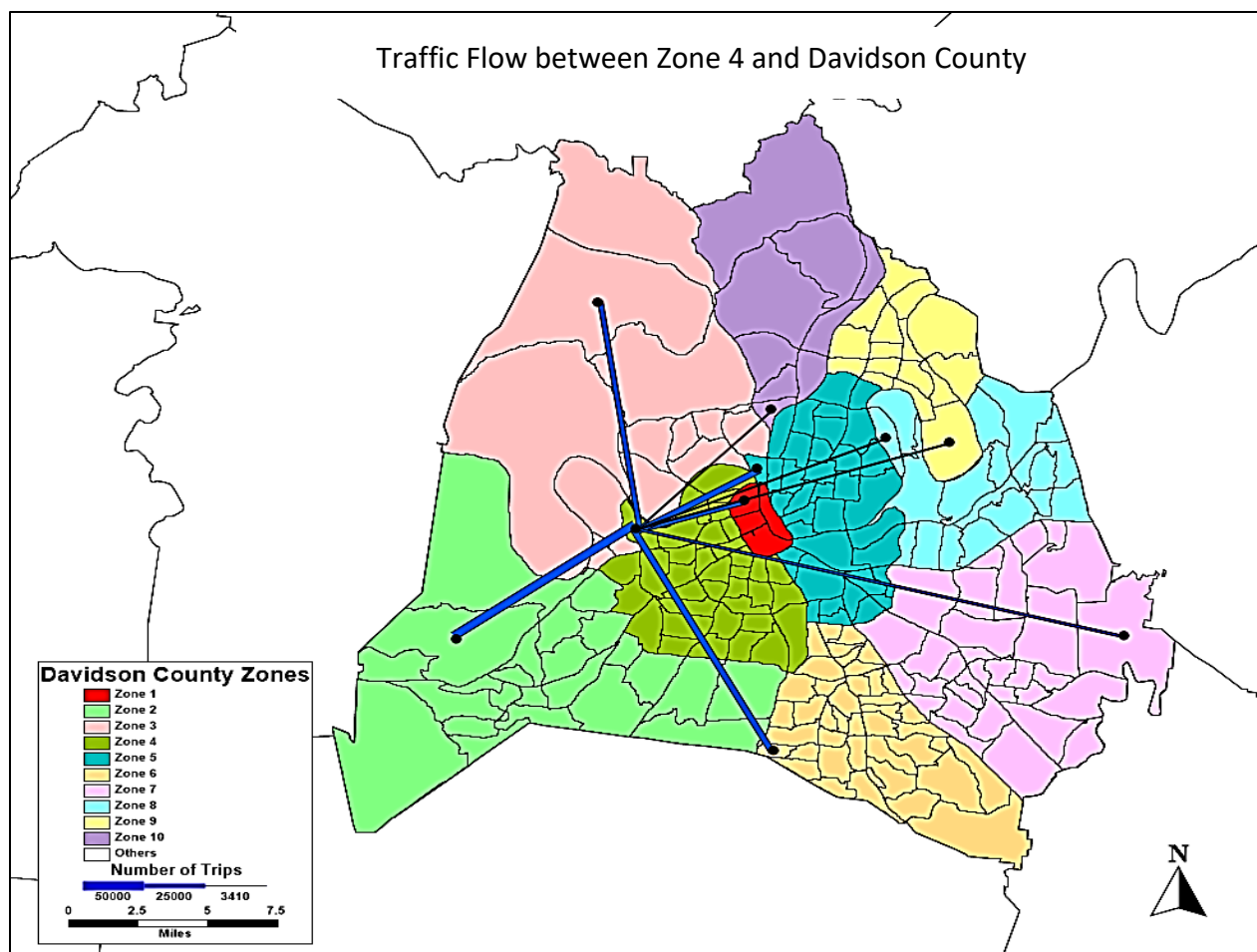


Figure 4.3. Auto Trips Originating in Zone 4

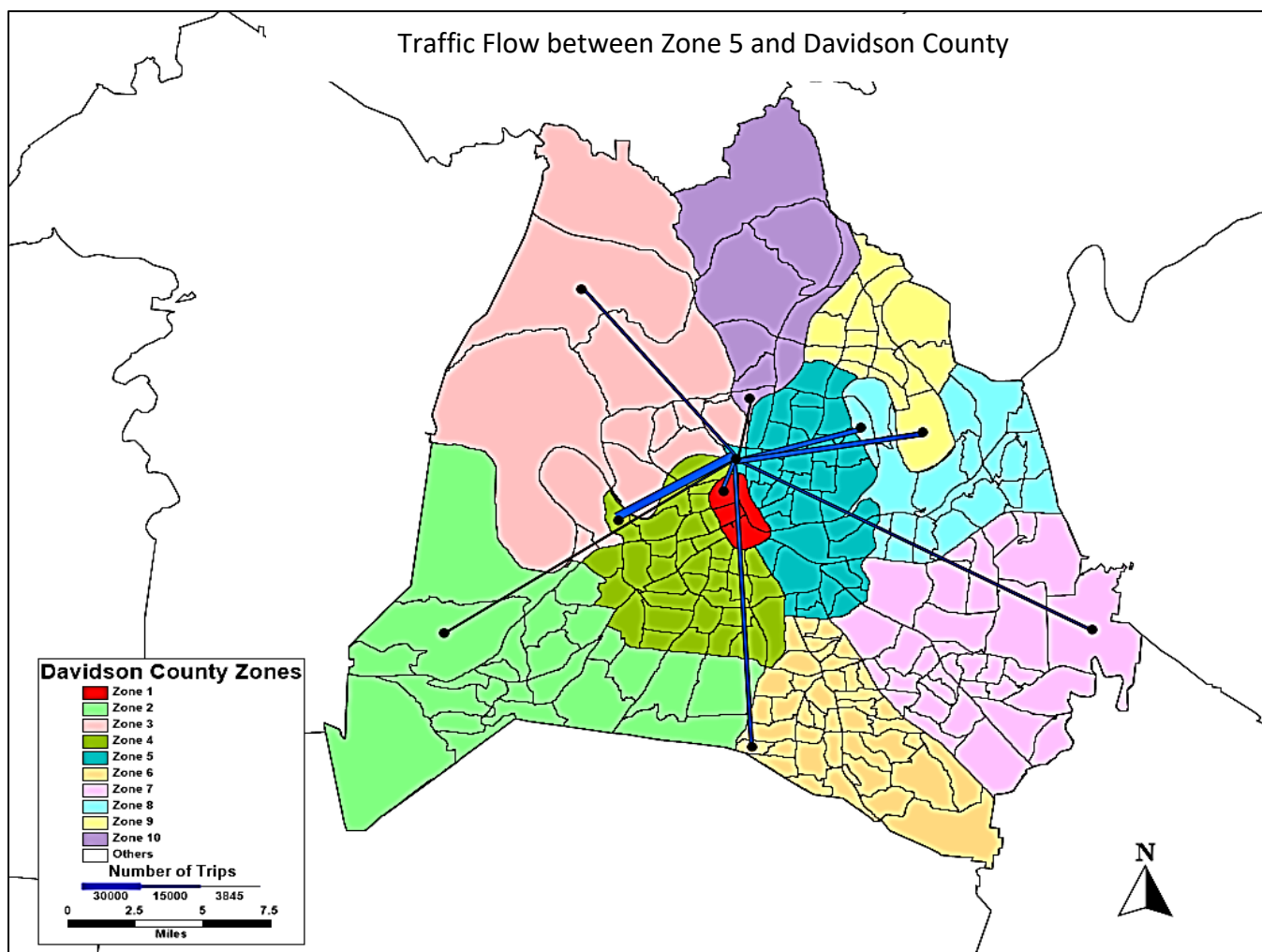


Figure 4.4. Auto Trips Originating in Zone 5

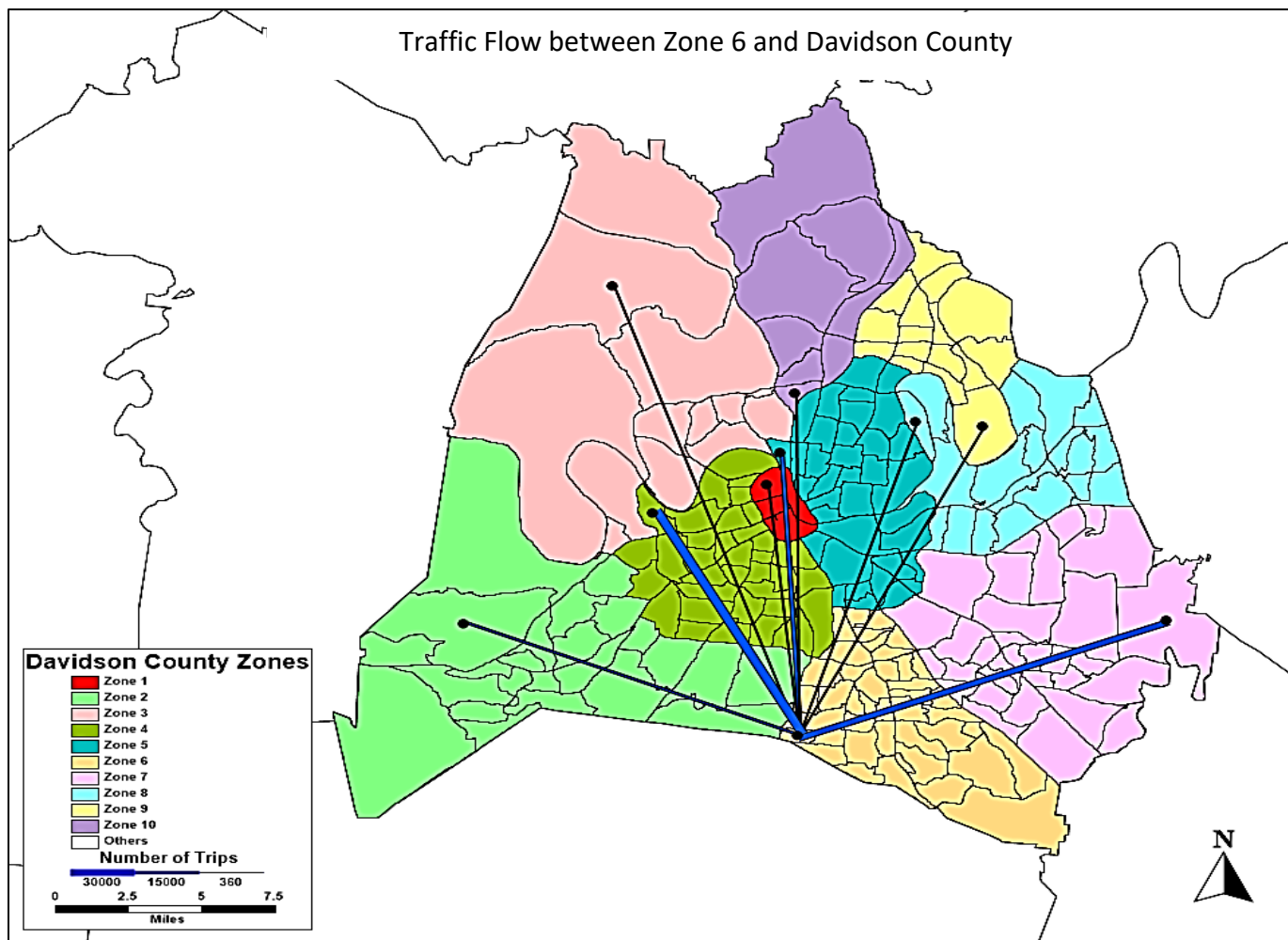


Figure 4.5. Auto Trips Originating in Zone 6

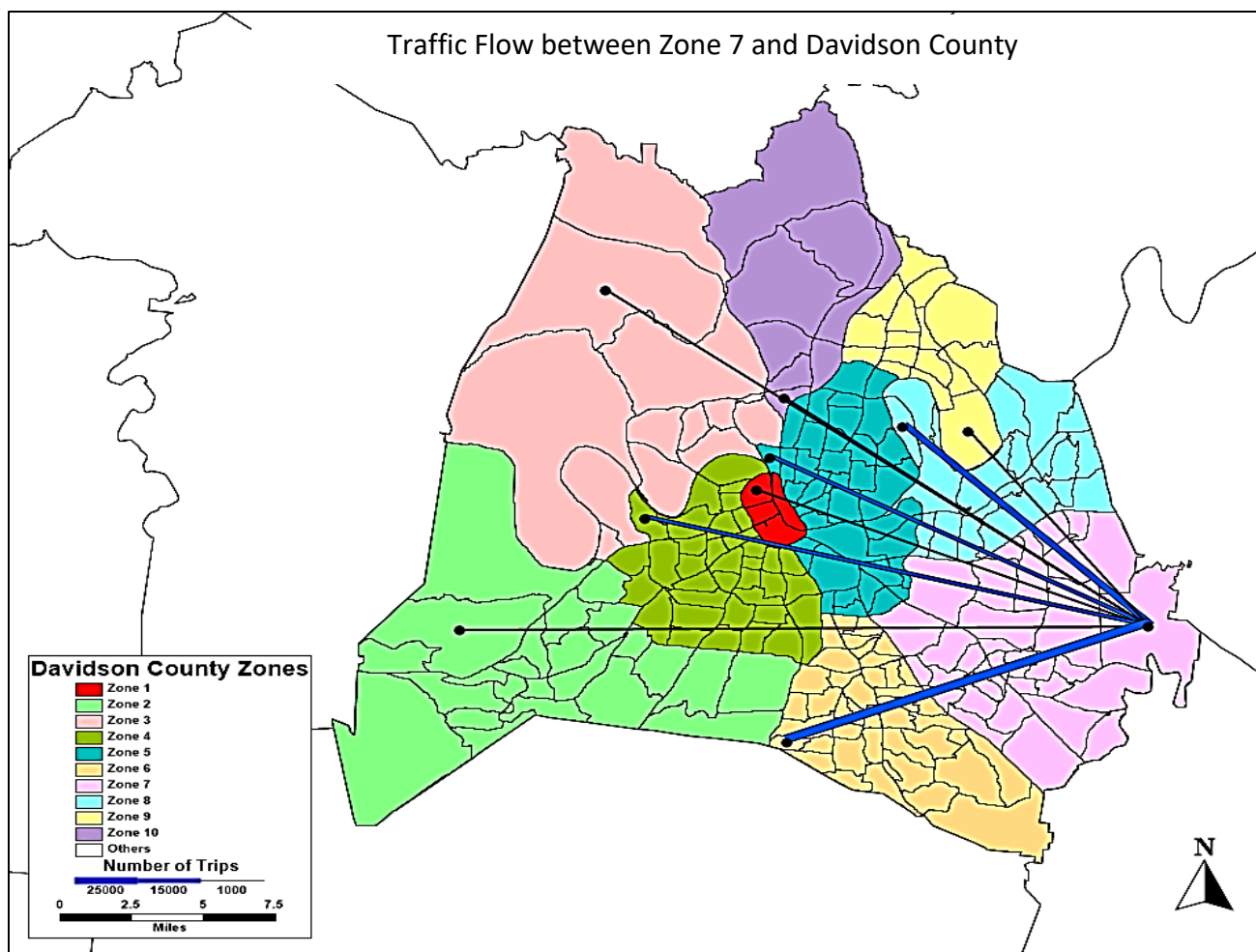


Figure 4.6. Auto Trips Originating in Zone 7

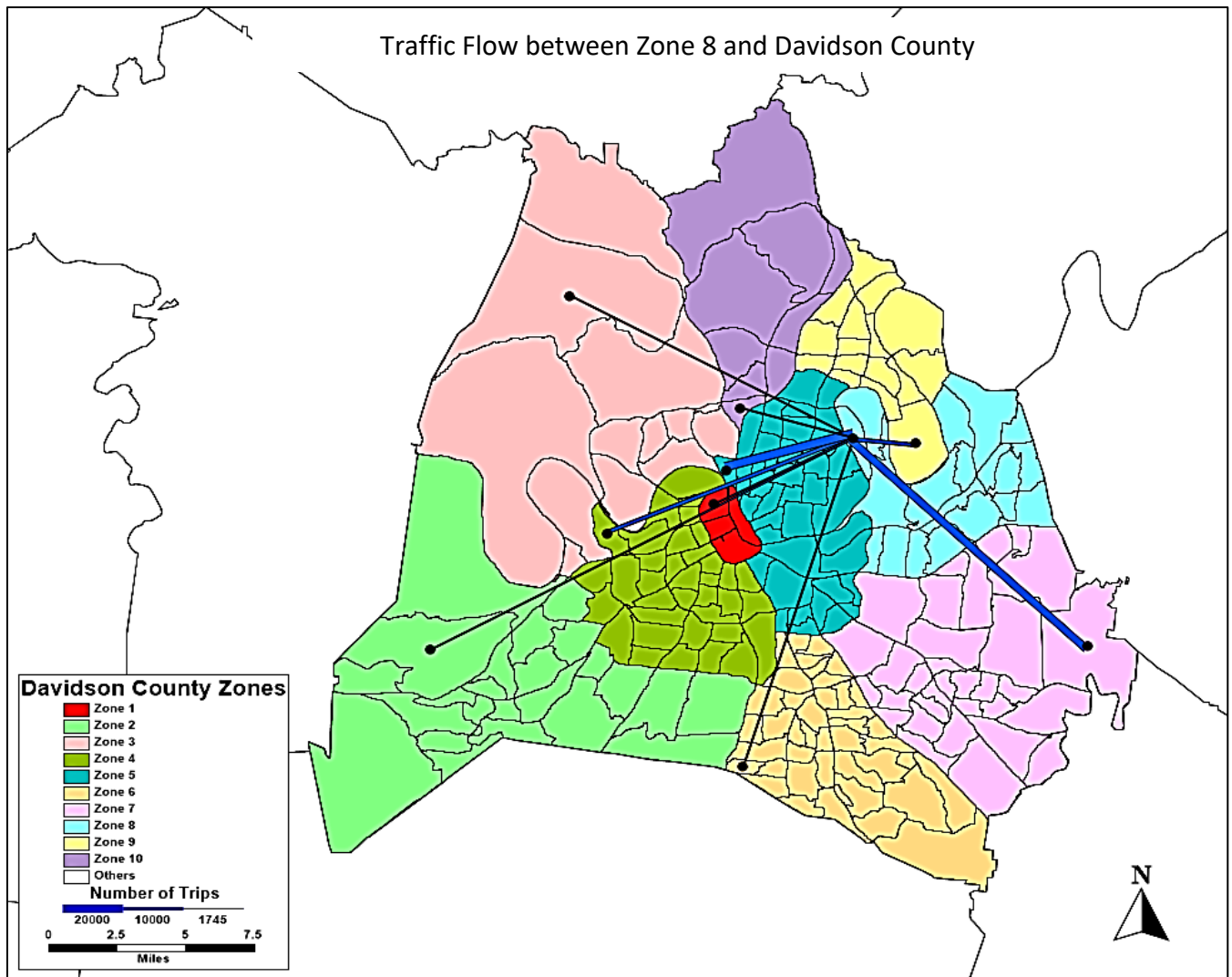


Figure 4.7. Auto Trips Originating in Zone 8

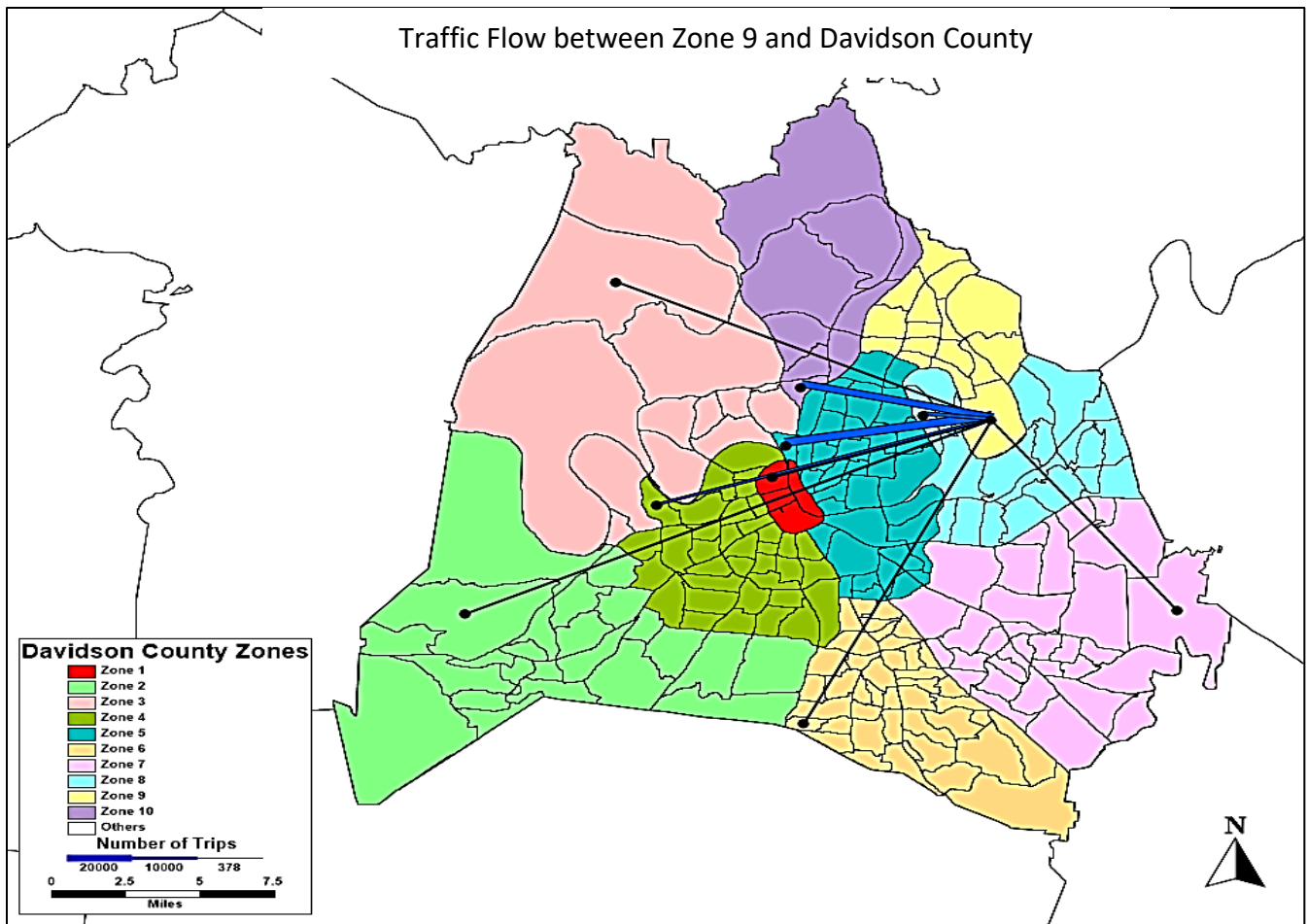


Figure 4.8. Auto Trips Originating in Zone 9

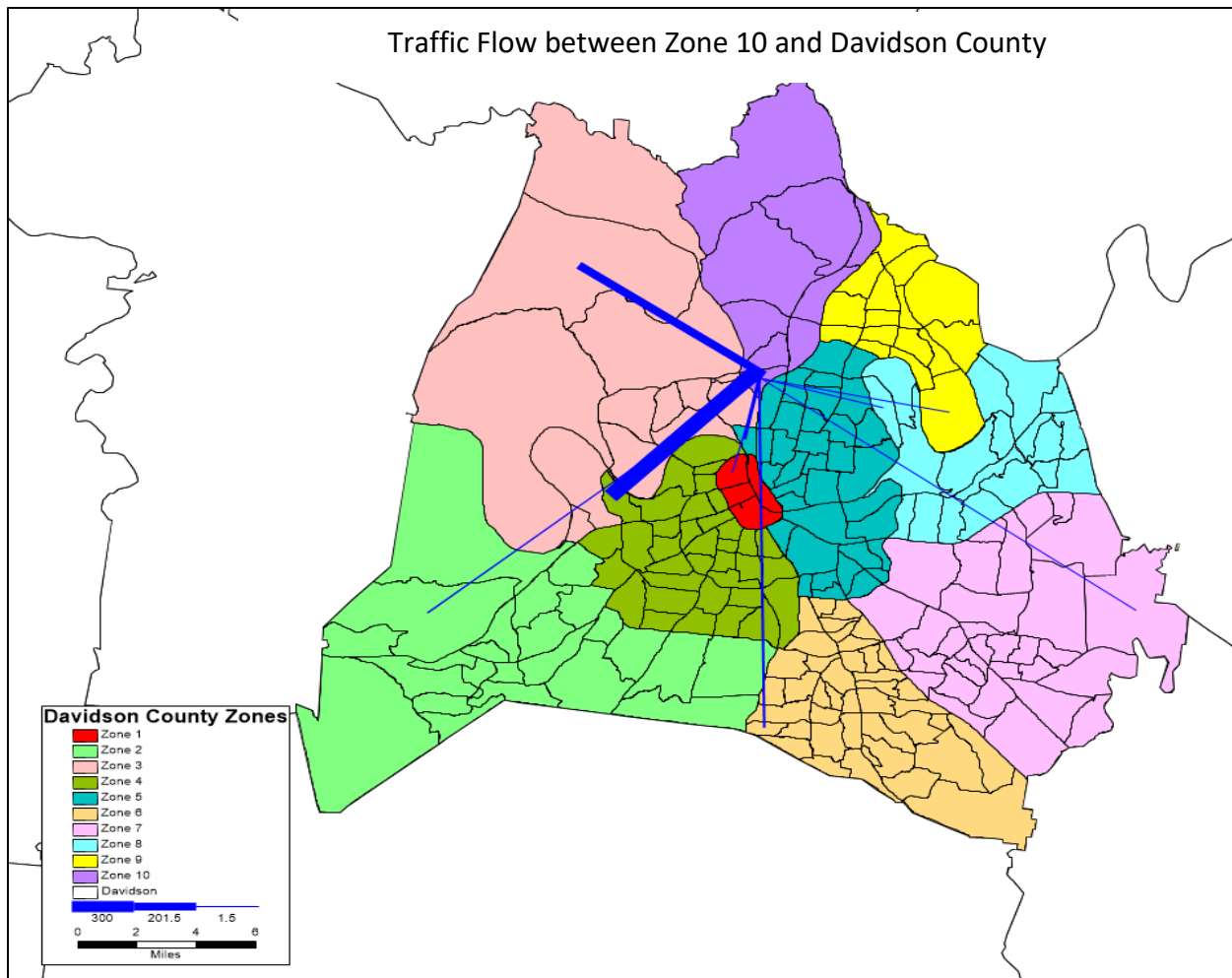


Figure 4.9. Auto Trips Originating in Zone 10

With the desire lines shown for each of the zones in Davidson County and the origin and destination matrix in *table 4.0* illustrates that zone 3 and zone 4 attract the highest number of auto trips for Davidson County, with 49% of the total 8,418 daily trips. *Table 4.1* shows how many trips each zone attracts and the percentage of total trips that destined there. Since this origin and destination matrix is a balanced table with auto trips the number of trips that is attracted to a zone is also the same number of trips that is produced to that zone.

Zone	Number of Attracted	
	Trips	Percentage of Trips
1	83638	6%
2	87557	7%
3	78219	6%
4	267716	21%
5	224647	17%
6	139437	11%
7	135169	10%
8	116599	9%
9	98047	8%
10	67292	5%

Table 4.1. Highest to Lowest Trips Attraction and Production

Section 4.2. Home Based Work Trips vs Home Based Other Trips

The following section breaks apart the commuting trips that are made within Davidson County to determine how many of them are home based work trips and how many are home based other trips. A home based work trips is any trips in which one end of the trip is home and the other is work, where a home based other trip is a trip in which one end is a home trips and the other end is any trip besides work. This is important because it will allow for an understanding of whether or not the trips that are being made within Davidson County are for work or for another purpose. **Table 4.2** shows the origin and destination matrix for home based work trips, showing that on average about 53% of the trips that are being made within Davidson County are connected to work. Where looking at **table 4.3** the origin and destination matrix for home based other trips, where an average of 47% of the trips connects to another location besides work.

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10
Zone 1	-	1,768	2,203	15,764	7,901	3,087	1,912	2,002	797	548
Zone 2	1,768	-	1,163	22,732	2,109	6,508	1,496	957	207.23	147.34
Zone 3	2,203	1,163	-	14,595	7,603	1,511	748	1,568	1,819	2,299
Zone 4	15,764	22,732	14,595	-	16,868	18,541	7,753	4,797	3,003	1,870
Zone 5	7,901	2,109	7,603	16,868	-	8,129	7,298	10,691	11,297	4,874
Zone 6	3,087	6,508	1,511	18,541	8,129	-	14,449	2,966	448.38	197.69
Zone 7	1,912	1,496	748	7,753	7,298	14,449	-	10,399	855	511.98
Zone 8	2,002	957	1,568	4,797	10,691	2,966	10,399	-	5,645	1,879
Zone 9	797	207.23	1,819	3,003	11,494	448.38	855	5,645	-	10,372
Zone 10	548	147.34	2,299	1,870	4,874	197.69	511.98	1,879	10,372	-

Table 4.2. Home Based Work Trips for 2040

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10
Zone 1	-	1,567	1,954	13,979	7,007	2,738	1,695	1,776	706	486
Zone 2	1,567	-	1,031	20,158	1,871	5,772	1,327	849	183.77	130.66
Zone 3	1,954	1,031	-	12,942	6,743	1,340	664	1,390	1,614	2,039
Zone 4	13,979	20,158	12,942	-	14,958	16,442	6,876	4,254	2,663	1,659
Zone 5	7,007	1,871	6,743	14,958	-	7,208	6,471	9,481	10,019	4,323
Zone 6	2,738	5,772	1,340	16,442	7,208	-	12,813	2,631	397.62	175.31
Zone 7	1,695	1,327	664	6,876	6,471	12,813	-	9,221	758	454.02
Zone 8	1,776	849	1,390	4,254	9,481	2,631	9,221	-	5,006	1,666
Zone 9	706	183.77	1,614	2,663	10,193	397.62	758	5,006	-	9,197
Zone 10	486	130.66	2,039	1,659	4,323	175.31	454.02	1,666	9,197	-

Table 4.3. Home Based Other Trips for 2040

Section 4.3. Future Traffic Volume

Section 4.3 addresses the traffic volume on the major roads in Davidson County. The reasoning for visualizing the traffic volume is to determine which roads in Davidson County are being utilized the most by auto vehicle traffic. Within this section only certain roads will be used to analyze the traffic volume, these roads are the interstates, the expressways, and the minor and major arterials. **Figure 4.10** shows the roads in Davidson County that will be analyzed for the traffic volume.

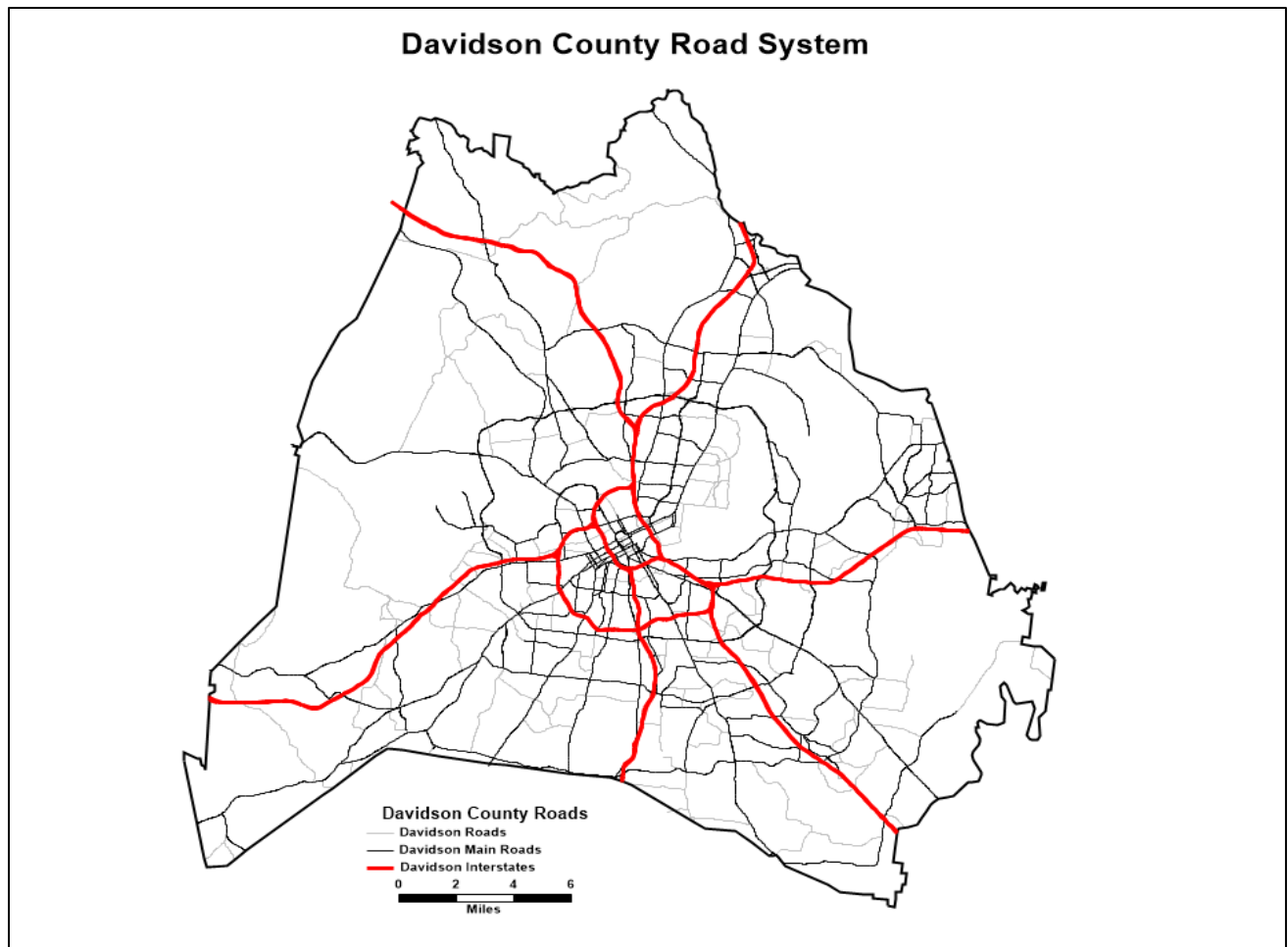


Figure 4.10. Davidson County Road System

Knowing where the major roads are at in Davidson County from *figure 4.10*, the next step is to determine what the travel volume is for auto trips on these roads. The travel volume will be broken up into three different categories, such as: auto travel volume in the morning, auto travel volume in the afternoon, and finally the total auto volume. *Figure 4.11* though *figure 4.13* shows the travel volume for Davidson Counties main roads.

AM Auto Traffic Volume in Davidson County

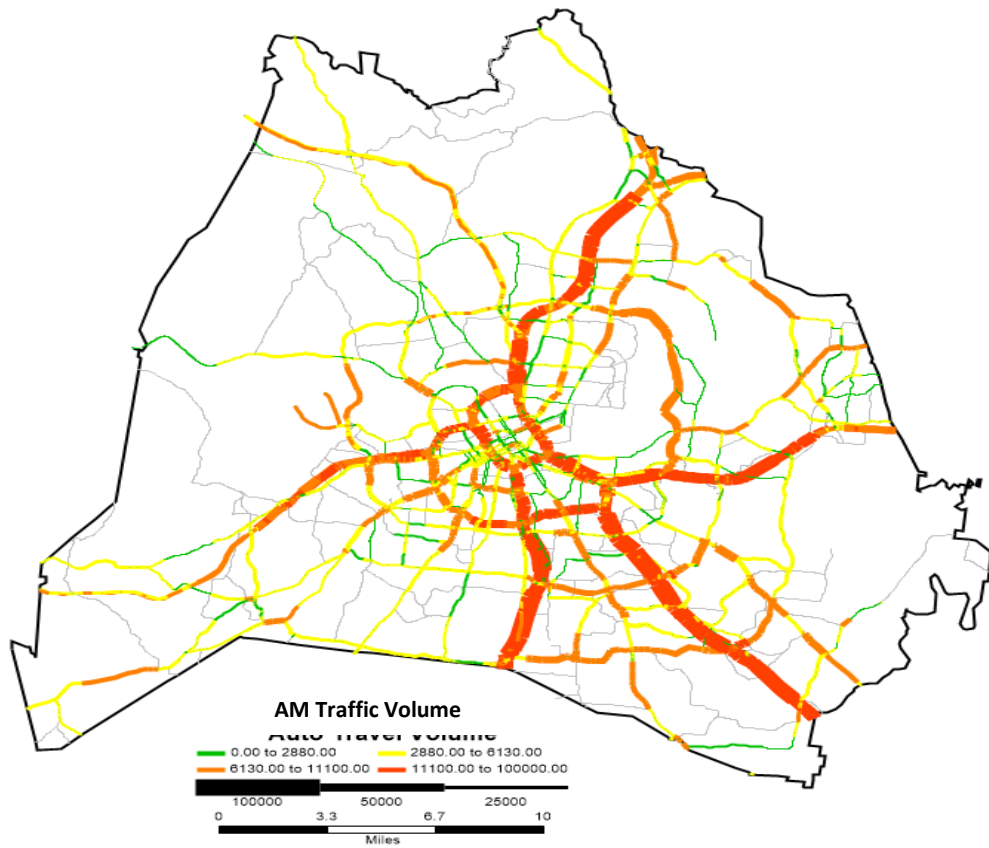


Figure 4.11. Morning Auto Traffic Volume

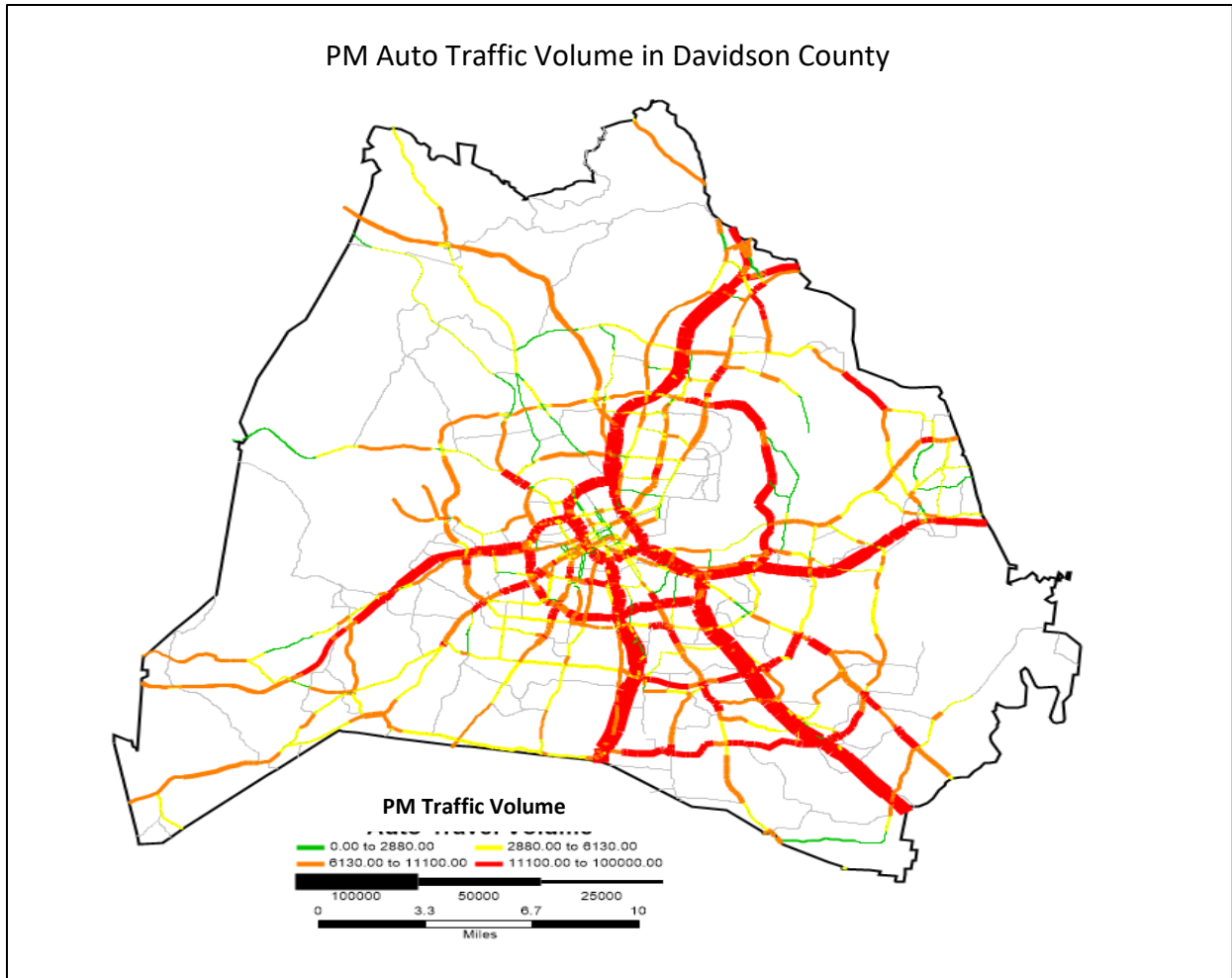


Figure 4.12. Afternoon Auto Traffic Volume

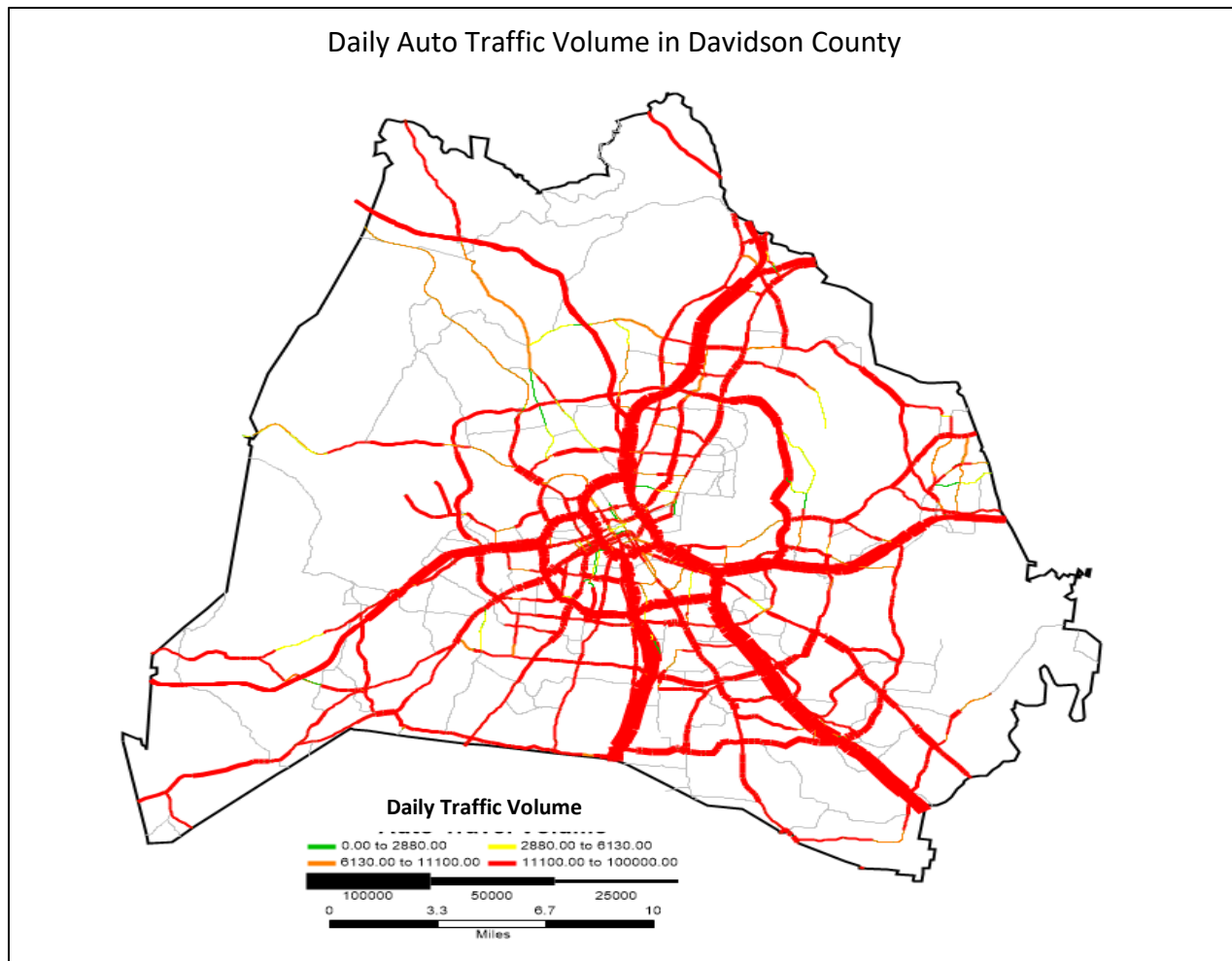


Figure 4.13. Daily Auto Traffic Volume

Evaluating the three different travel volume times, there is a clear common characteristic between the three visuals, and that is that the interstates are the main road that is used for auto travel in Davidson County. The smaller arterial produce little travel volume compared to the rest of Davidson County. This could show that once the vehicles make it to the smaller arterial they are more disperse than they are on the interstates. However, there is a major increase in the auto travel volume in 2040 than there was in 2020.

Section 4.3. Travel Time Analysis

The last section for the future 2040 year is to look at how the travel time has changed for auto since 2020. The analysis done on the travel time will look at two sets of data; the first will be the free-flow running time, which represents the travel time with no traffic. The second will be the average daily congestion time. The reasoning for this is to show the difference in travel time

when there is no traffic at all on the roads and then showing what travel time looks like when there is traffic on the roads. **Figure 4.14** will show the daily free-flow running time and **figure 4.15** will shows the average daily congestion for Davidson County.

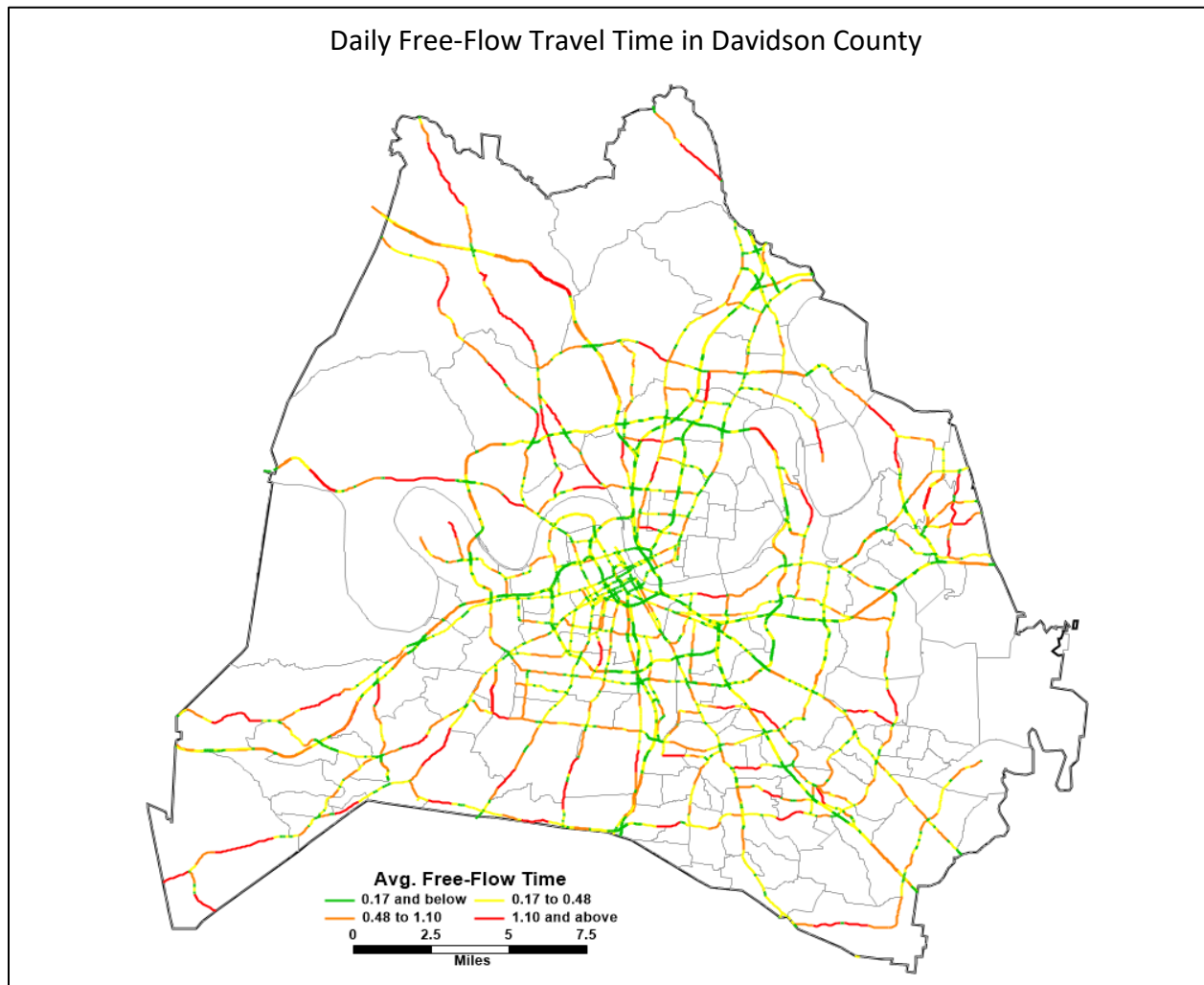


Figure 4.14. Davidson County Daily Free-Flow Travel Time

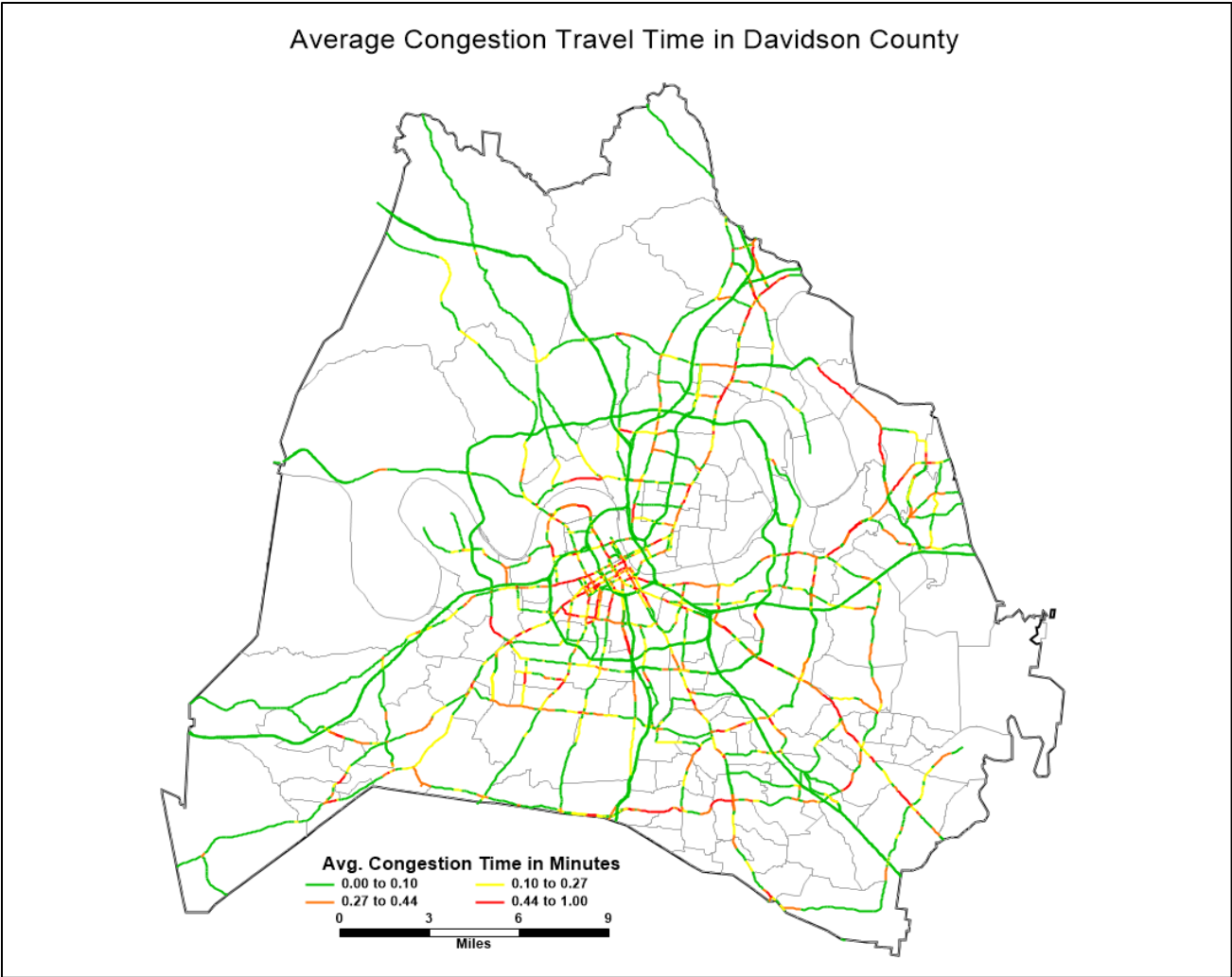


Figure 4.15. Davidson County Daily Average Congestion Travel Time

CHAPTER 5. COMMUTING PATTERN RESULTS

The purpose of chapter 5 is to provide the results from the 2020 and 2040 commuting patterns in Davidson County from auto trips. This chapter is broken up into two sections, the first provides the commuting pattern results from 2020, and the second provides the commuting pattern results from 2040. Within each of the section in this chapter there will be a summary of the results from the desire line analysis, with an illustration showing which zones are the main destinations. There will also be a summary of the commuting time and travel volume, which will help to illustrate which segments in Davidson County are the main ones used for auto travel.

Section 5.1. 2020 Commuting Pattern Results

Section 5.1 looks at the 2020 commuting patterns between the 10 zones in Davidson County using arrows to illustrate which zones are the main producers and consumers of traffic flow for the zone that is being looked at.

Sub-Section 5.1.1. Desire Line Analysis

The first set of results will come from the data that was collected in section 3.1, the desire line analysis for the auto trips made in Davidson County between the 10 zones for 2020. In order to provide a simple visual of the major zones that each produce the most auto trips from the other zones, the created of **figure 5.0** was done. **Figure 5.0** shows an arrow from the origin zone to the destination zones that produces the largest amount of auto trips for 2020.

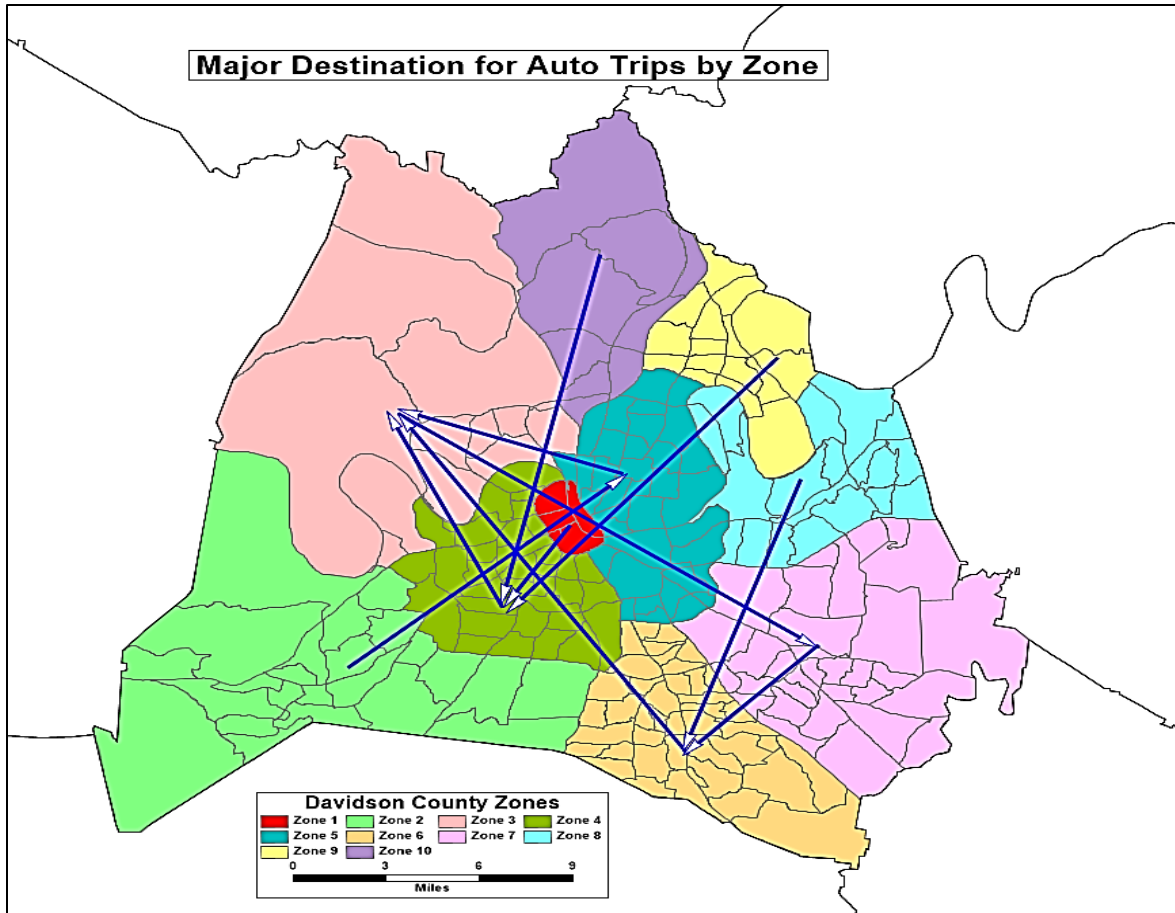


Figure 5.0. Major Destination Zones for Each Davidson County Zone

With the use of *figure 5.0*, there is a clear indication that zone 3 and zone 4 are the two locations with the highest main destinations between the 10 zones. However, zone 3 and zone 5 are the two zones that produce the highest amount of auto trips for 2020. An explanation for how zone 4 is a main destination between the 10 zones and not one of the top two zones for most trips is because the rest of the contributing zones produce a low amount of auto trips to zone 4. Looking further into the travel patterns in Davidson County for 2020, it would be important to connect the desire line analysis with the InfoGroup data that was done. The InfoGroup data looks at the number of employment firms that are within each of the Tennessee Zones. *Figure 5.1* represents the 10 zones in Davidson County based on the number of employment firms.

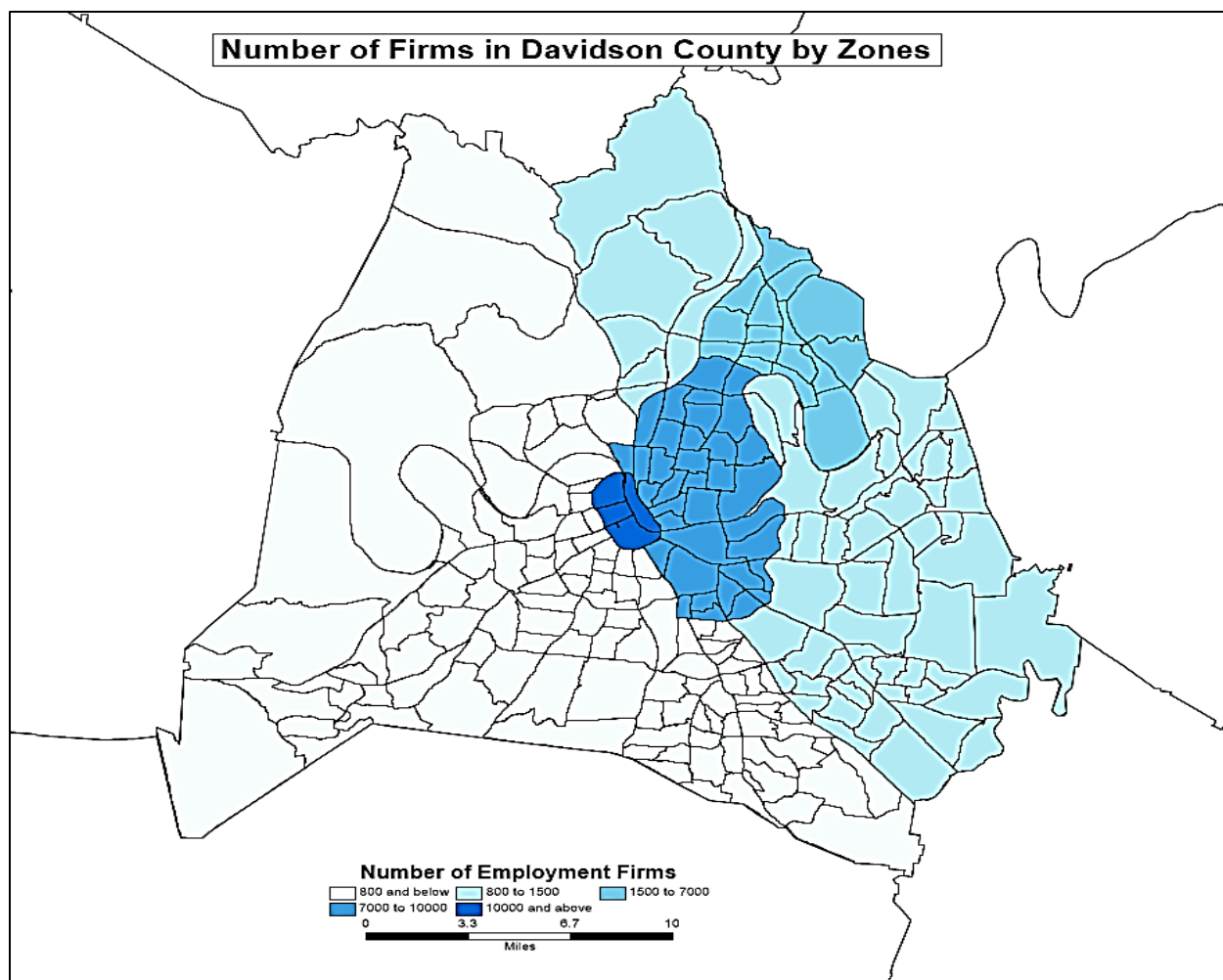


Figure 5.1. 2013 InfoGroup Data Number of Firms in Each Davidson County Zone

It was anticipated that there would be more auto trips made to the zones that have a more employment firms, such as zones 1, zone 5, zone, 7, zone 8, zone 9, and zone 10. However, this was not the results that were concluded from the auto trips created in the desire line analysis. **Table 5.0** summarizes the number of auto trips for 2020, showing that most of the zones with the exception of zone 5 are in the lower area of having the most auto trips attracted in Davidson County in 2020. From the 2020 travel analysis there seems to be very little connection between the number of auto trips being made and the number of employment firms in a given area.

Zone	Number of Attracted Trips	Percentage of Trips
1	75180	6%
2	72734	5%
3	273859	20%
4	224863	17%
5	202231	15%
6	134721	10%
7	104257	8%
8	107250	8%
9	93913	7%
10	64655	5%

Table 5.0. Trips Attraction and Production

Sub-Section 5.1.2. Travel Time and Volume

The second result discussion for the 2020 auto analysis for Davidson County is the travel volume on the main road segments and the travel time in Davidson County. In Davidson County for the year 2020, the main route for daily auto trips is on the interstates, referring back to *figure 3.13*, where the interstates are displayed in showing that they have a large auto volume than the rest of the roads. This was anticipated since Nashville being the center of Davidson County is connected with interstate 40, interstate 65, and interstates 24. Breaking the travel volume up into the time of day, the morning traffic for auto on the interstates is relatively equal to the travel volume on the interstates in the afternoon. This was also anticipated as it is capturing both the peak hour morning traffic and the afternoon peak hour traffic. Unlike the traffic pattern based on the employment firms, the road segments were anticipated to have the results that it did. This would be that having heavier traffic on the interstates and lower auto traffic on the smaller streets, as the traffic from the interstates is now being spread out through a larger range of roads.

Section 5.2. 2040 Commuting Pattern Results

Section 5.2 looks at the 2040 commuting patterns between the 10 zones in Davidson County using arrows to illustrate which zones are the main producers and consumers of traffic flow for the zone that is being looked at.

Sub-Section 5.2.1. Desire Line Analysis

The first set of results will come from the data that was collected in section 4.1, the desire line analysis for the auto trips made in Davidson County between the 10 zones for 2040. In order to provide a simple visual of the major zones that each produce the most auto trips from the other zones, the same creation of the major destinations that was created in the previous subsection will be conducted for 2040. **Figure 5.2** shows an arrow from the origin zone to the destination zones that produces the largest amount of auto trips for 2040.

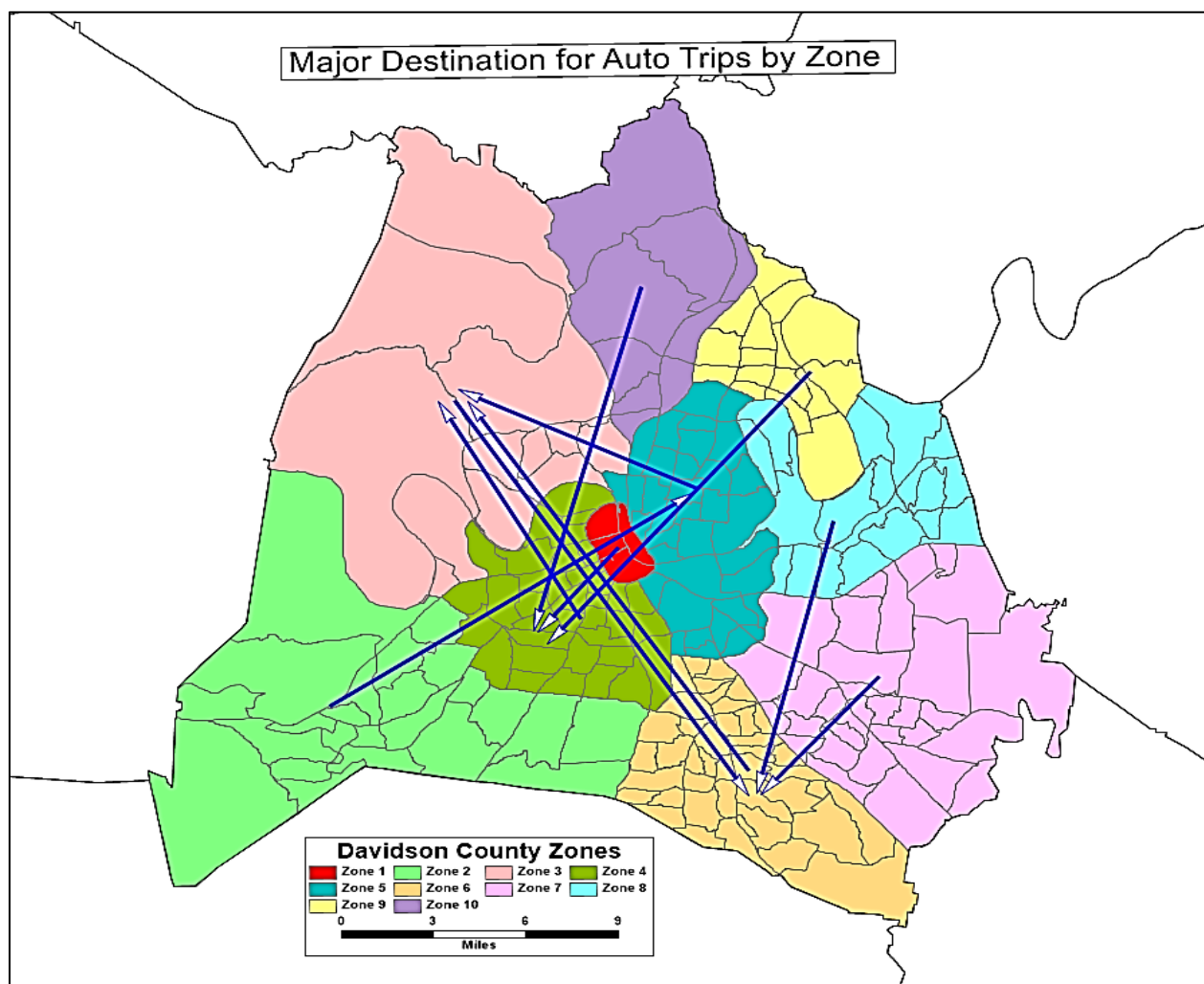


Figure 5.2. Major Destination Zones for Each Davidson County Zone

Using **figure 5.2**, there is a clear pattern between the auto trips in 2020 and the auto trips in 2040, meaning that zone 3 and zone 4 are two of the main destination zones for the trips made within Davidson County. However, zone 6 was added in 2040, showing that zone 3, zone 4, and zone 6

were tied with having 3 zones each as their major destination site. Another common feature in 2040 that was the same in 2020, is that the areas in Davidson County that have the largest employment firms are still the locations that are producing the lowest amount of auto trips. This means there is another factor that is drawing the number of auto trips in Davidson County besides the number of employment firms. However, there is also a chance that the InfoGroup Data does not provide all the employment firms in Davidson County and there is actually more employment in the zones that are producing the larger amount of trips than is actually showed. **Figure 5.3** shows a comparison of the major destination for auto trips from 2020 to 2040 from each of the 10 zones.

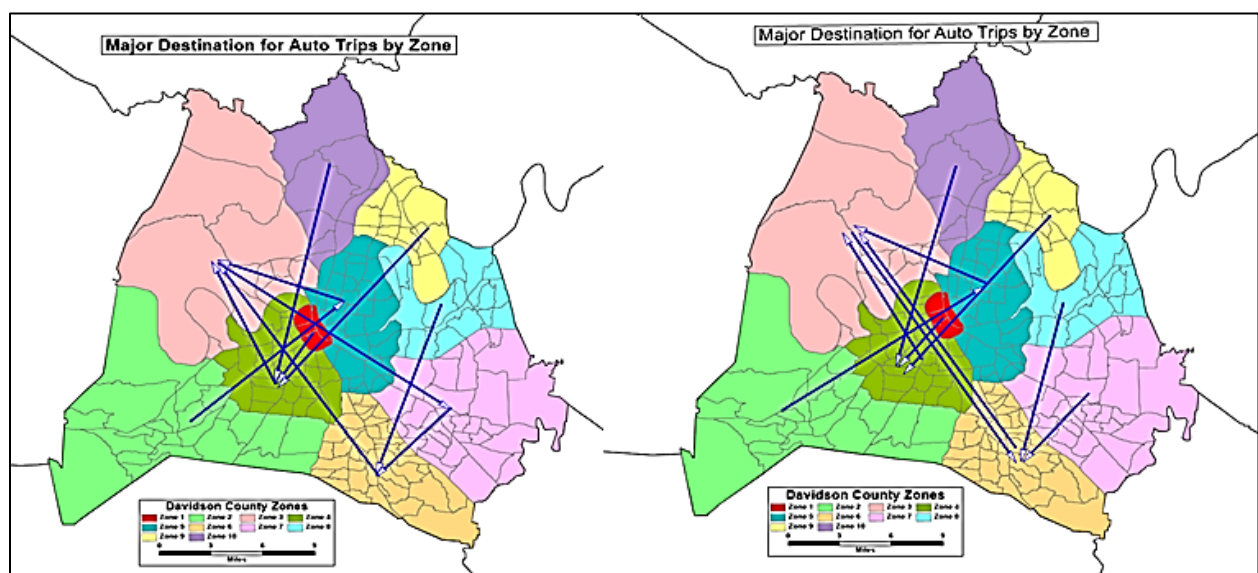


Figure 5.3. Major Zone Destination for Auto Travel. Left Image 2020. Right Image 2040.

Sub-Section 5.2.2. Travel Time and Volume

The final results that can be concluded from the travel pattern analysis in Davidson County for 2040, is the change in travel volume from 2020 to 2040. From the 2020 analysis there was an increase in the level of auto trips being made on the interstates and a small amount of trips being made on the arterials in Davidson County. However, moving forward 20 years there is a continuous pattern when it comes to the travel volume for auto trips, and that the interstates are still the heavy traveled areas. There was a shift in the travel volume showing that it is anticipated that there will be an increase in the travel volume in 2040 than there was in 2020. One reasoning behind this could be because there an expected increase in the number of residents who will be living in Davidson County in 2040 than there was in 2020. **Figure 5.4** through **figure 5.6** shows a side by side comparison of the auto travel volume in Davidson County.

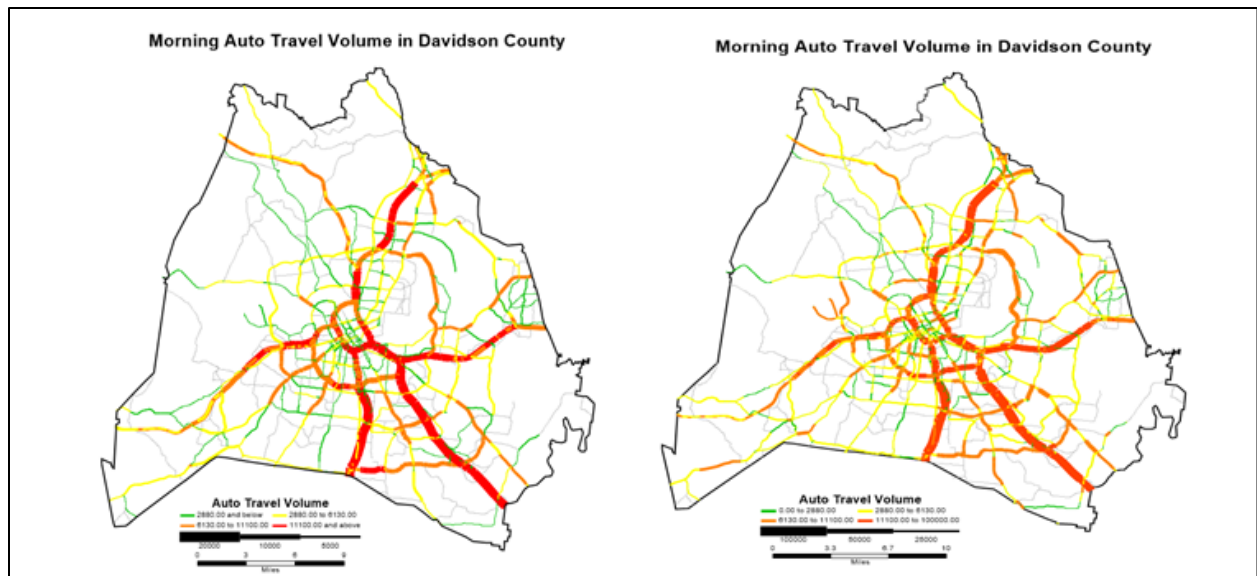


Figure 5.4. Morning Auto Travel Volume. Left Image 2020. Right Image 2040.

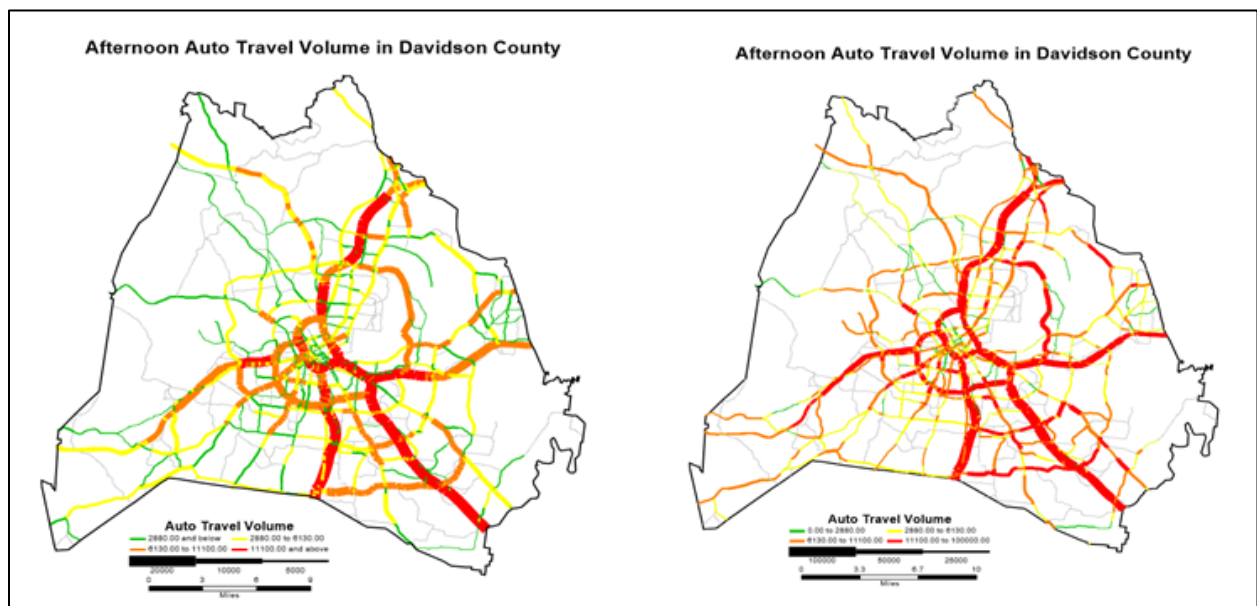


Figure 5.5. Afternoon Auto Travel Volume. Left Image 2020. Right Image 2040.

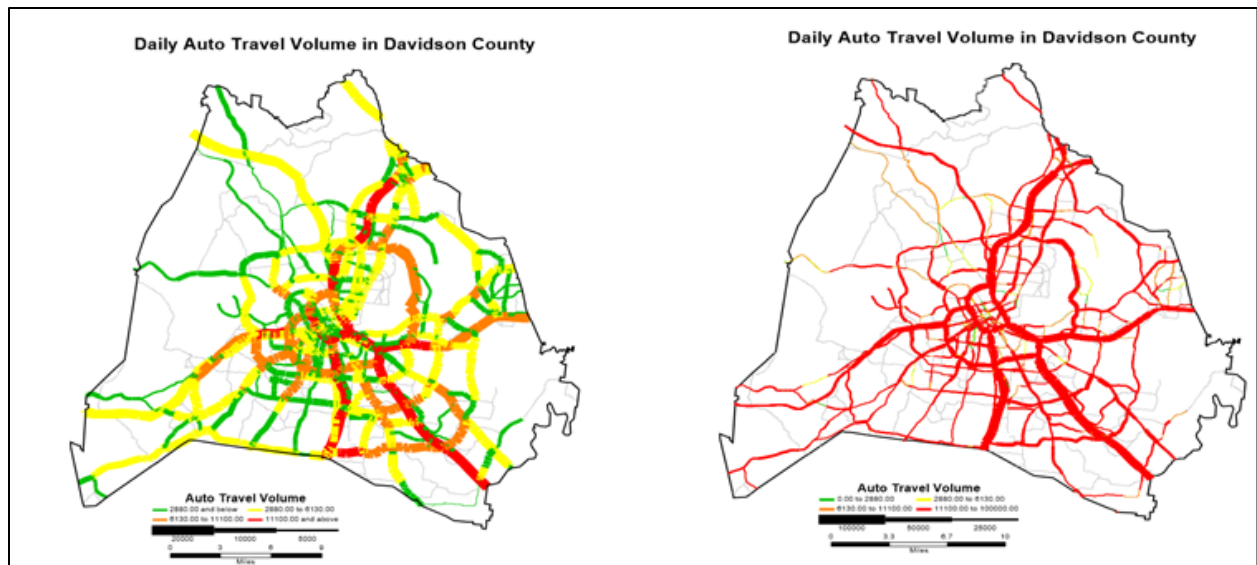


Figure 5.6. Daily Auto Travel Volume. Left Image 2020. Right Image 2040.

The final analysis for the travel time in Davidson County is to evaluate the change in travel time from the non-peak hours to the peak hours. This analysis will help with determining where the major congestion locations are in Davidson County when it comes to the auto travel. **Figure 5.7** shows the 2020 (left) and 2040 (right) change in travel time when it comes to non-peak and peak hours.

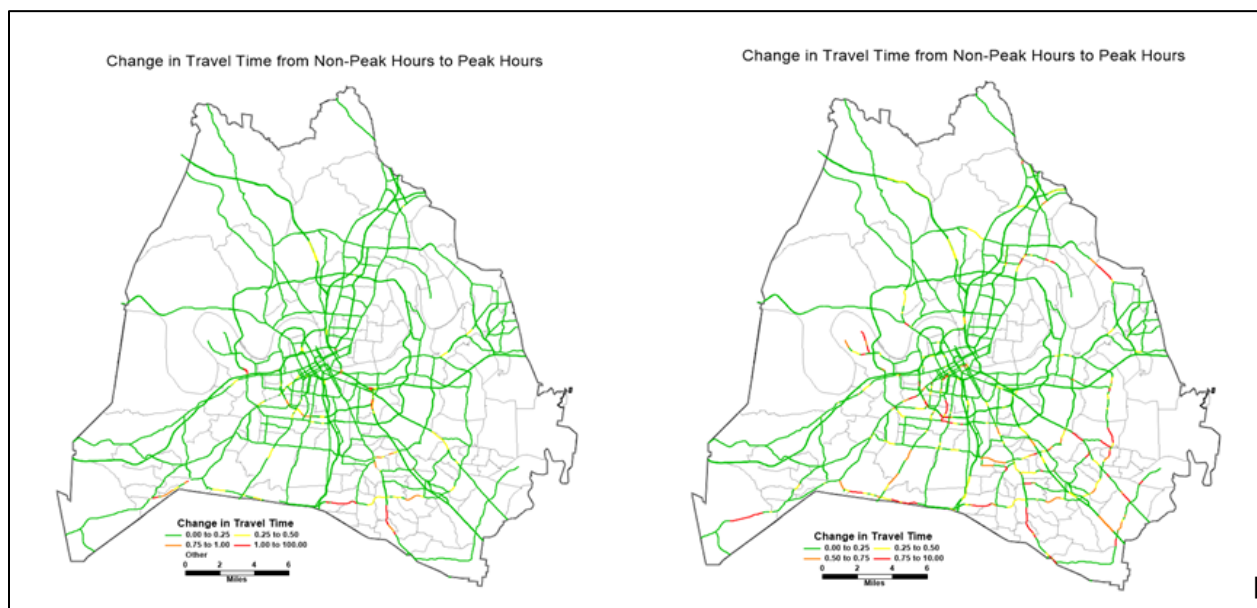


Figure 5.7. Change in Travel Time from Peak to Non-Peak Hours

Based on the two maps in figure 5.7, there is predicted to be an increase in the amount of congestion in 2040 based on the difference in travel time from non-peak and peak hours. This is most likely driven by an increase in the number of residents that will be moving to the Davidson County area.

CHAPTER 6. DAVIDSON COUNTY PUBLIC TRANSPORTATION

Chapter 3, is designed to evaluate the public transportation system in Davidson County, referred to as Nashville Metropolitan Transit Authority (*MTA*) or recently rebranded to WeGo Transit. During this evaluation there will be a comparison to the number of auto trips that are produced in each zone with the number of bus stops that are located in each of the 10 zones in Davidson County. The reasoning for this is to see if zones with a lower number of transit stops have a high number of auto trips. The WeGo bus system (*or MTA*) in Davidson County has 55 bus routes that are served by 137 buses, 40 Access Ride, which accommodate approximately 30,000 riders a day. **Figure 6.0** shows the bus system in Davidson County, showing that it serves a large majority of the county.

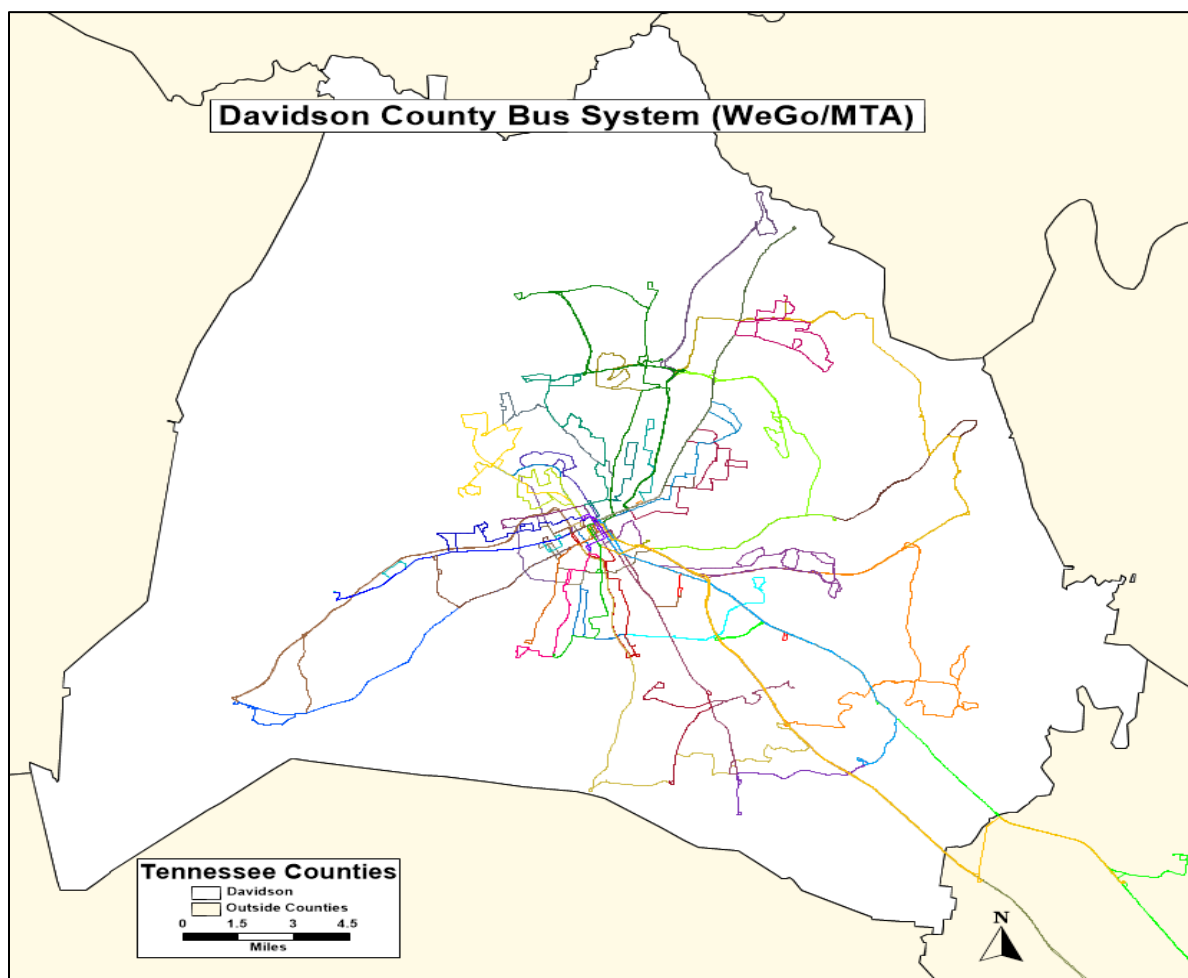


Figure 6.0. Bus System in Davidson County, Tennessee

Without having the bus routes overlaid with the 10 zones in Davidson County, it is easy to see that there is going to be more bus opportunities near the center of Davidson County near Nashville than there is in the periphery of Davidson County. **Figure 6.1** shows the overlay of the bus system and the 10 zones in Davidson County.

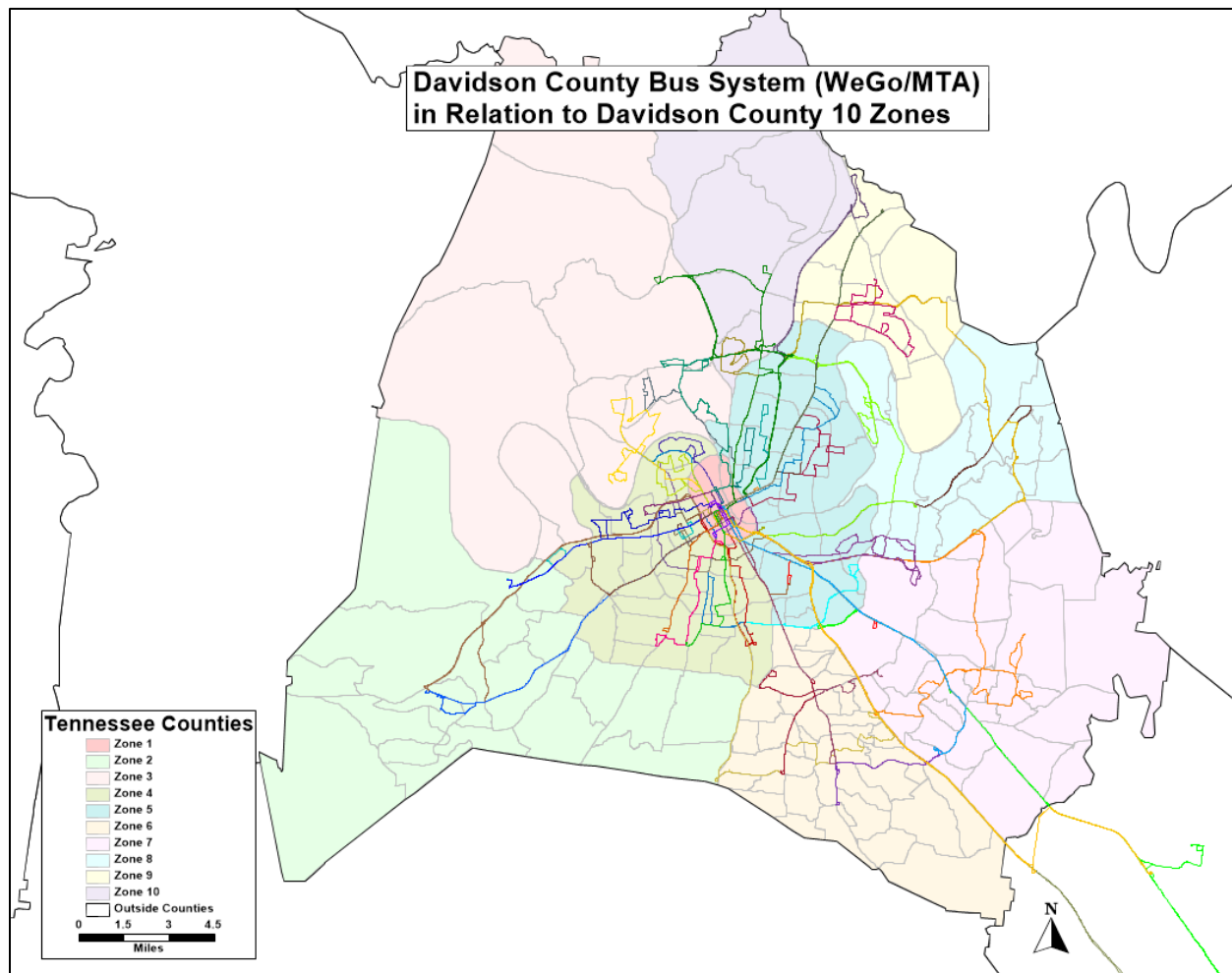


Figure 6.1. Bus System and Davidson County Zones

Comparing the locations of the public transit routes with the zones that were created in Davidson County, it is clear that zone 1, zone 4, and zone 5 are strongly served by public transportation. Whereas with zone 3, zone 2, and zone 10 are the zones with the least amount of public transportation. **Table 6.0** shows how many bus routes are serving each of the zones in Davidson County.

	Number of Bus Routes	Percentage of Route
Zone 1	44	92%
Zone 2	5	10%
Zone 3	8	17%
Zone 4	28	58%
Zone 5	31	65%
Zone 6	9	19%
Zone 7	12	25%
Zone 8	5	10%
Zone 9	6	13%
Zone 10	4	8%
Routes in Davidson County	48	-

Table 6.0. Number of Routes in Each Zone

Table 6.0 shows the number of bus routes that are supporting the different zones in Davidson County, however, a more in-depth comparison of the number of auto trips and the number of bus stops is needed to accurately determine if there is an increase in the number of auto trips in the regions that are not supported by public transportation. **Figure 6.2** shows a graph showing the number of auto trips from each Davidson County zone with response to the number of bus stops that is present in that zone.

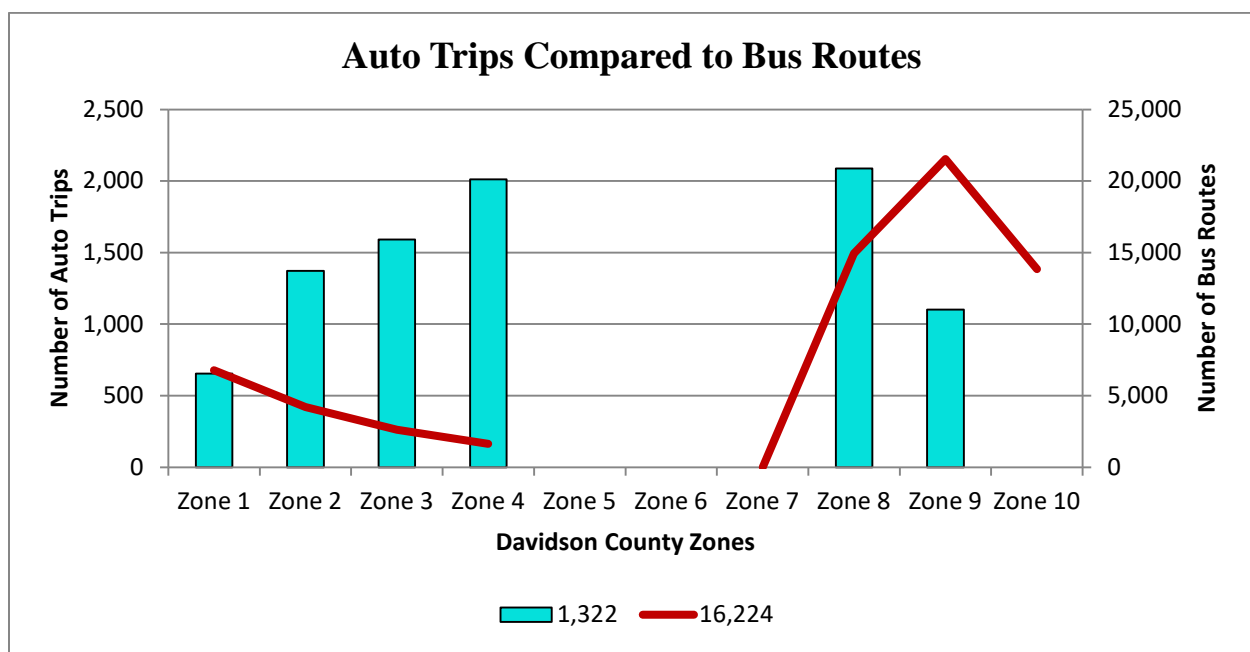


Figure 6.2. Number of Auto Trips by Zone Compared to the number of Present Bus Routes

With the anticipation that when there is a higher level of public transportation available to the public that there would be a decrease in the number of auto trips being done, is not completely supported in this situation. In zone 1 there is a high number of bus routes and a low number of auto trips being done. However, this is the only zone where this is present. Referring back to *figure 6.2* the number of auto trips being done is followed by the same pattern as the number of bus lanes that is serving that zone.

CHAPTER 7: DAVIDSON COUNTY URBAN REGIONS

From the last chapter, there was an understanding that the public transportation system did not have any impact on the number of auto trips that were being completed. Chapter 4 is designed to look at the urbanized and non-urbanized areas in Davidson County and evaluate which regions produced more auto trips. This analysis will provide an understanding of where the major traffic analysis zones are in Davidson County. **Figure 7.0** represents the urbanized areas and non-urbanized areas in Davidson County.

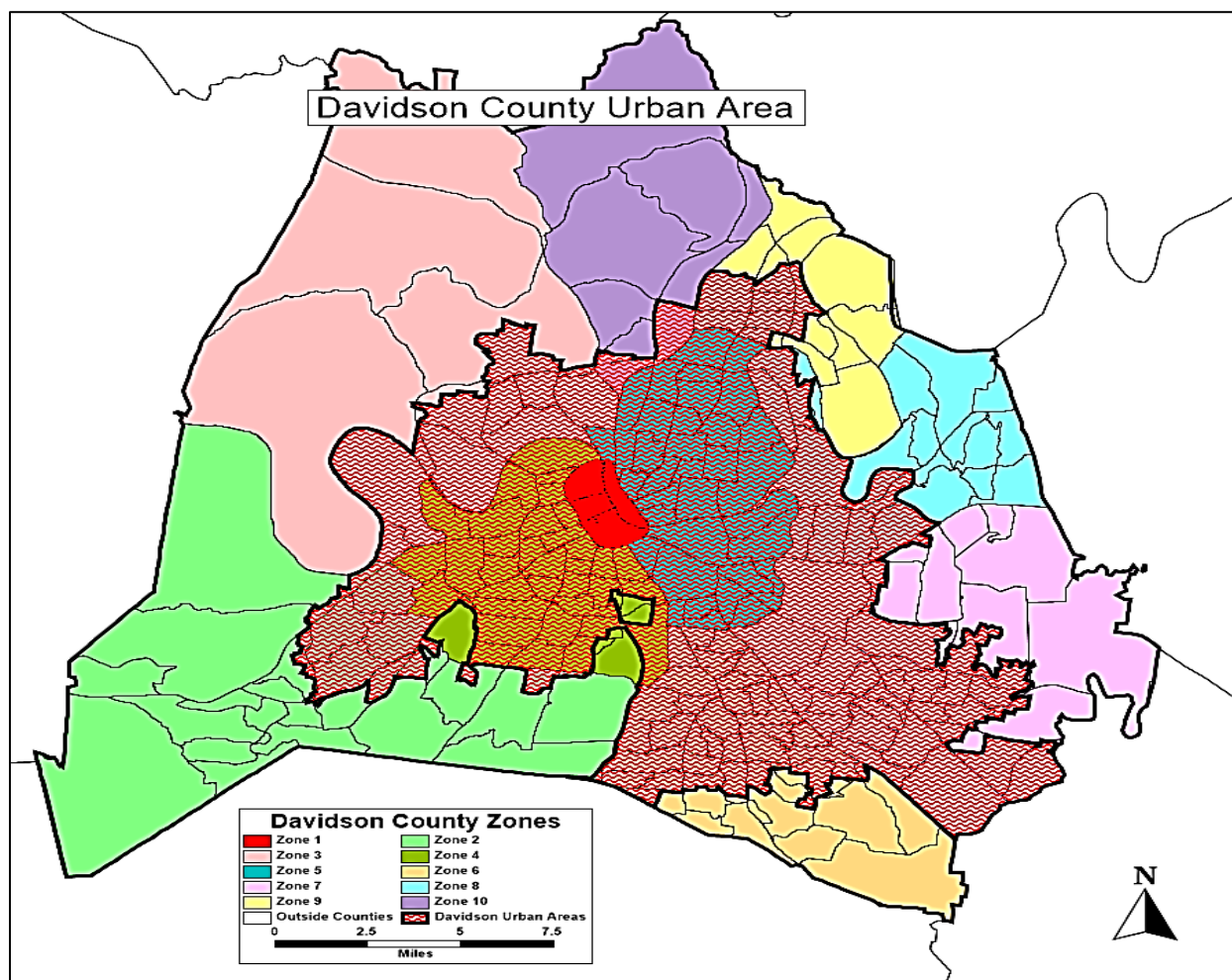


Figure 7.0. Urbanized Areas in Davidson County

Looking at **figure 7.0** it is indicated that around 50% of Davidson County is in an urban area, which is located mainly in the center of the county, where the periphery is non-urban/rural. However, one issue with connecting the urbanized layer with the traffic analysis zones in Davidson County is that some of the traffic analysis zones contain both an urban area and a non-

urban area. For determining which traffic analysis zones are going to be urban and non-urban for creating the desire lines, if the traffic analysis zone contains at least 50% of an urban area than it will be classified as an urban area. **Figure 7.1** shows the urbanized zones in Davidson County based on the 10 different zones, which will be used to create desire lines for auto traffic flow.

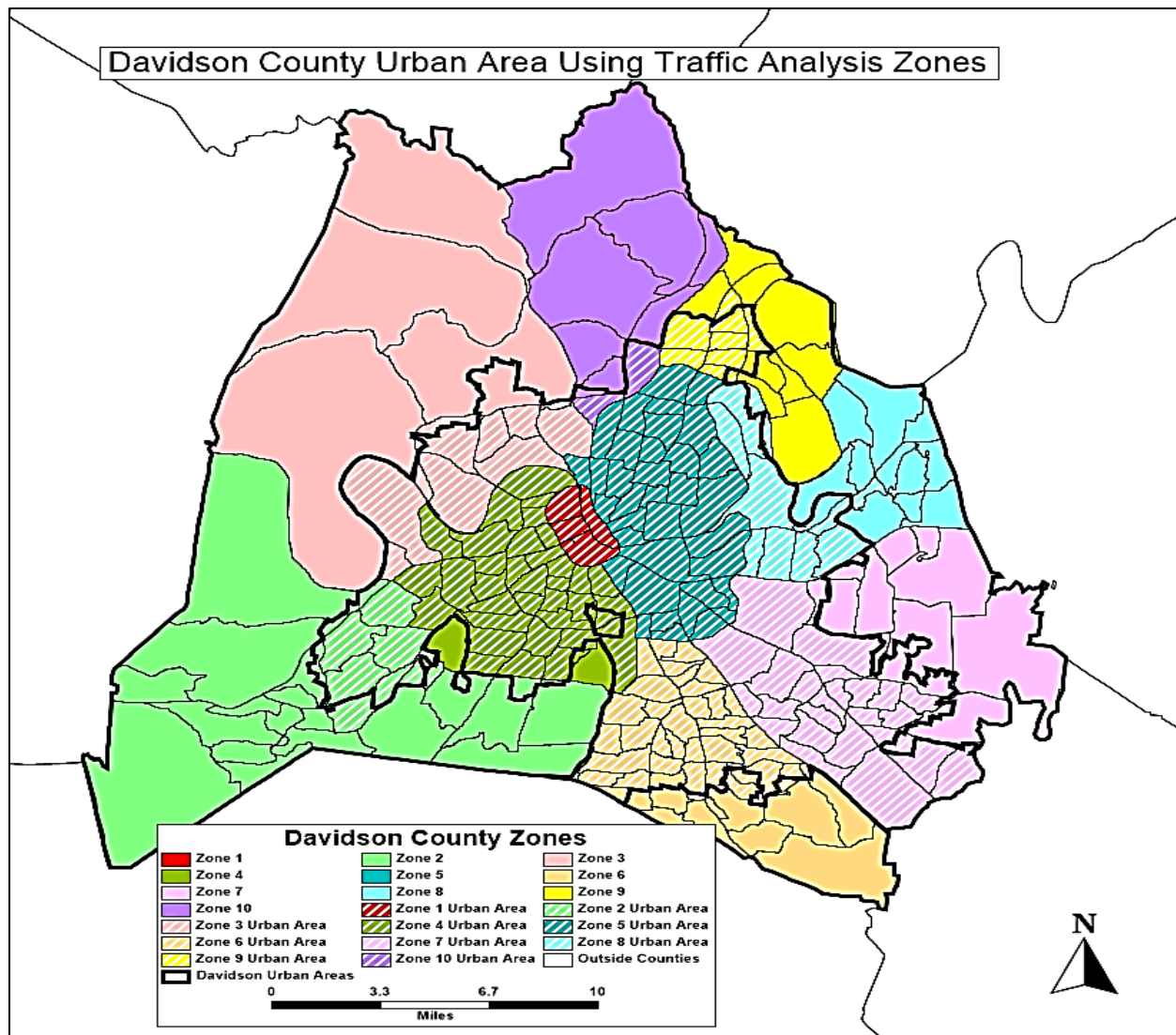


Figure 7.1. Davidson County Urbanized Area Using TAZ and Urban Boundary Buffer

Comparing the two maps in **figure 7.0** and **figure 7.1**, there is a slight difference in the urban areas. This slight variation in the borders for the urban areas should not show a significant change in the results when it comes to the flow of auto traffic. The analysis of the desire lines for the urbanized areas will look at the flow of traffic from the specified zone to the urbanized areas. Creating the new origin and destination matrix with this format will allow a simple subtraction of

the whole zone from the urban zone to get the number of auto trips from each zone to the non-urbanized areas. **Figure 7.2** through **figure 7.11** illustrates the desire lines maps for the auto flow to the urbanized areas in Davidson County

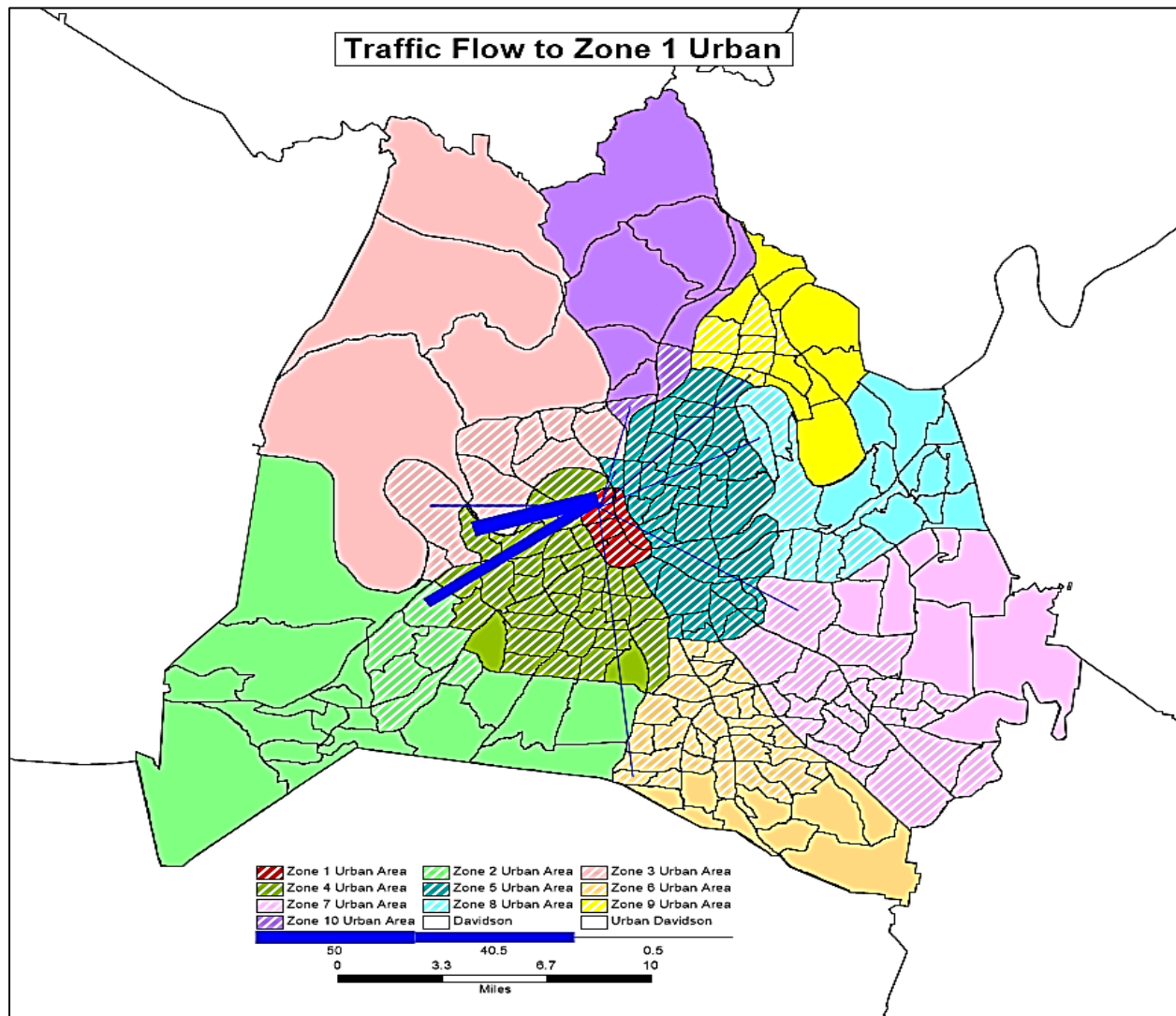


Figure 7.2. Auto Trips Originating in Zone 1

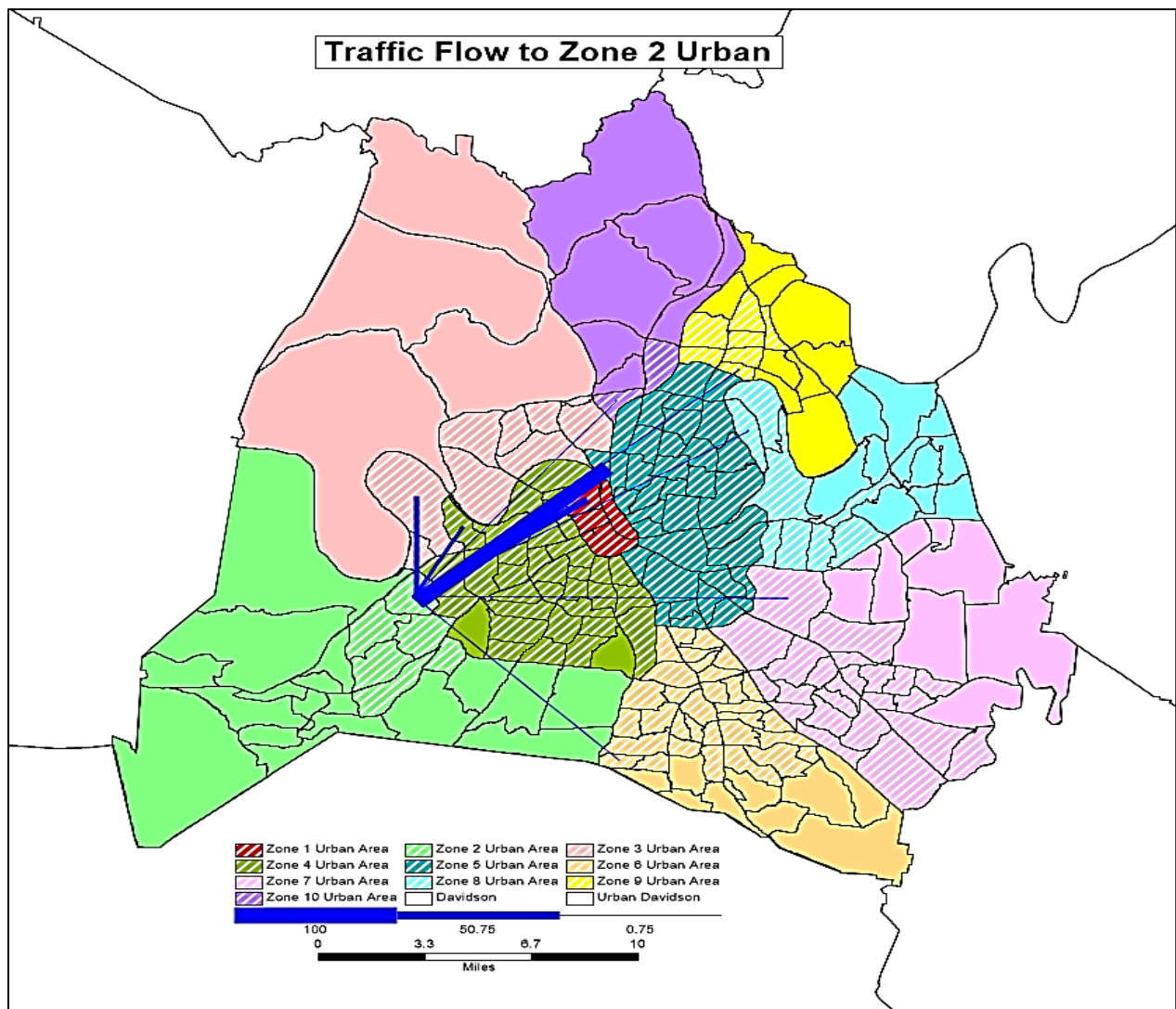


Figure 7.3. Auto Trips Originating in Zone 2

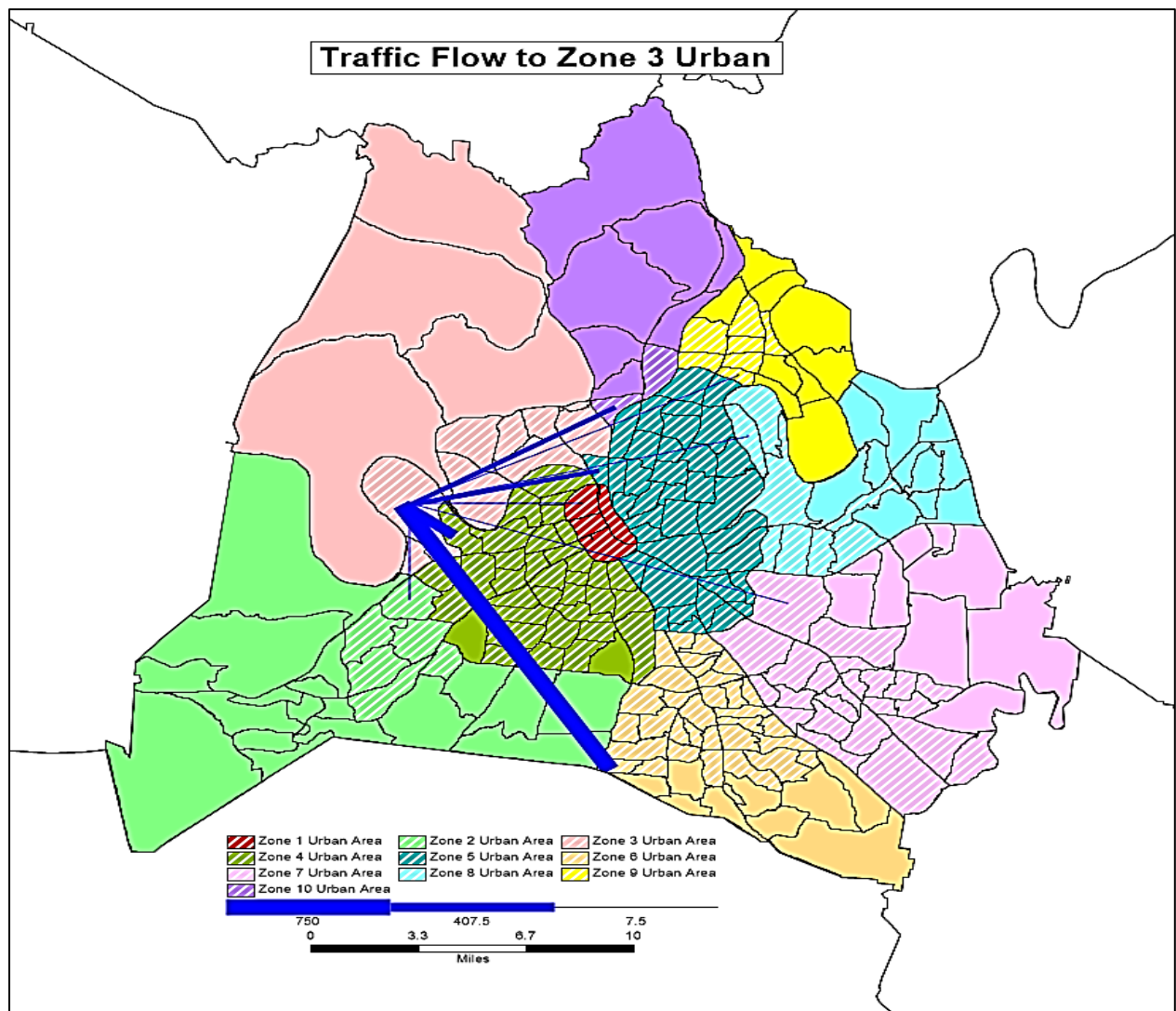


Figure 7.4. Auto Trips Originating in Zone 3

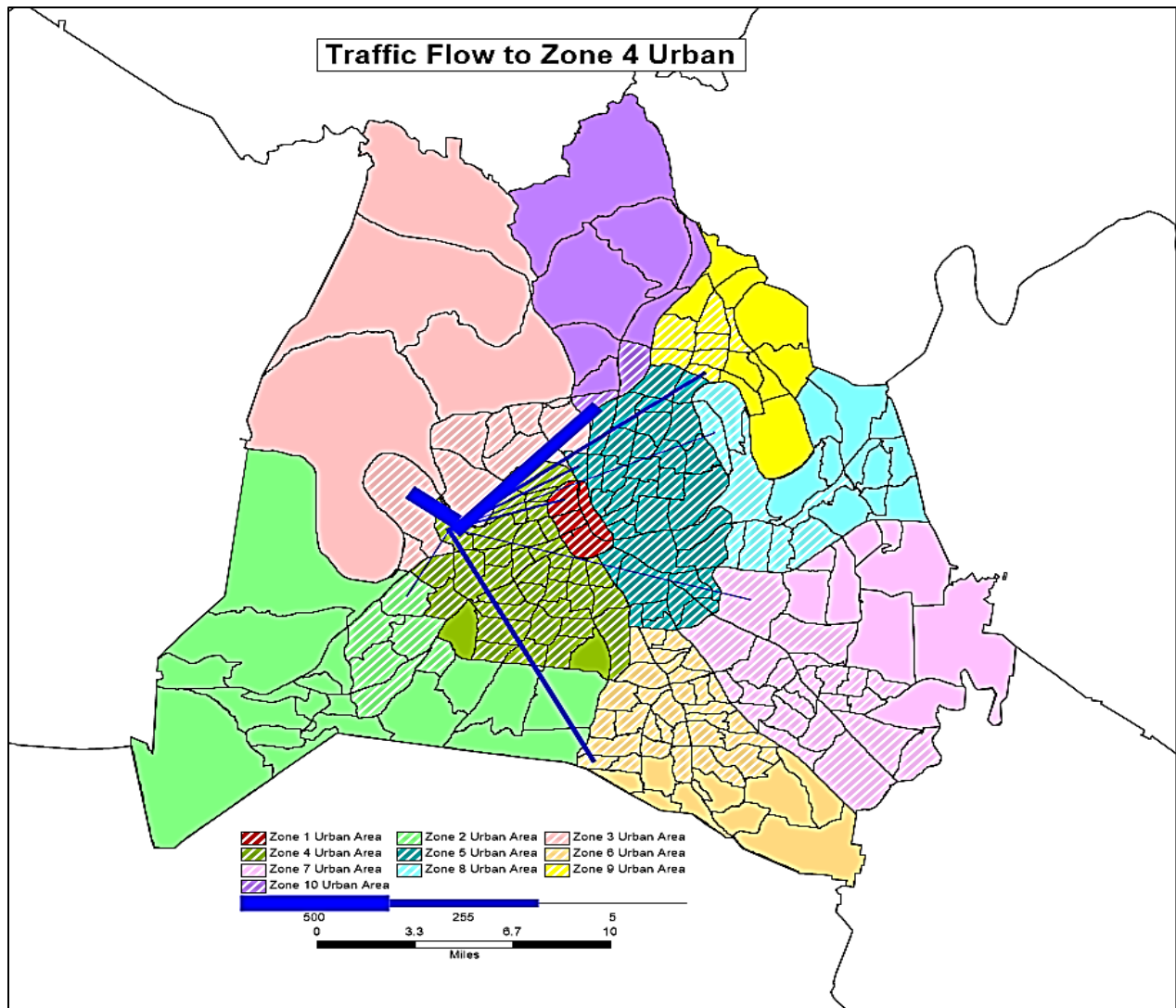


Figure 7.5. Auto Trips Originating in Zone 4

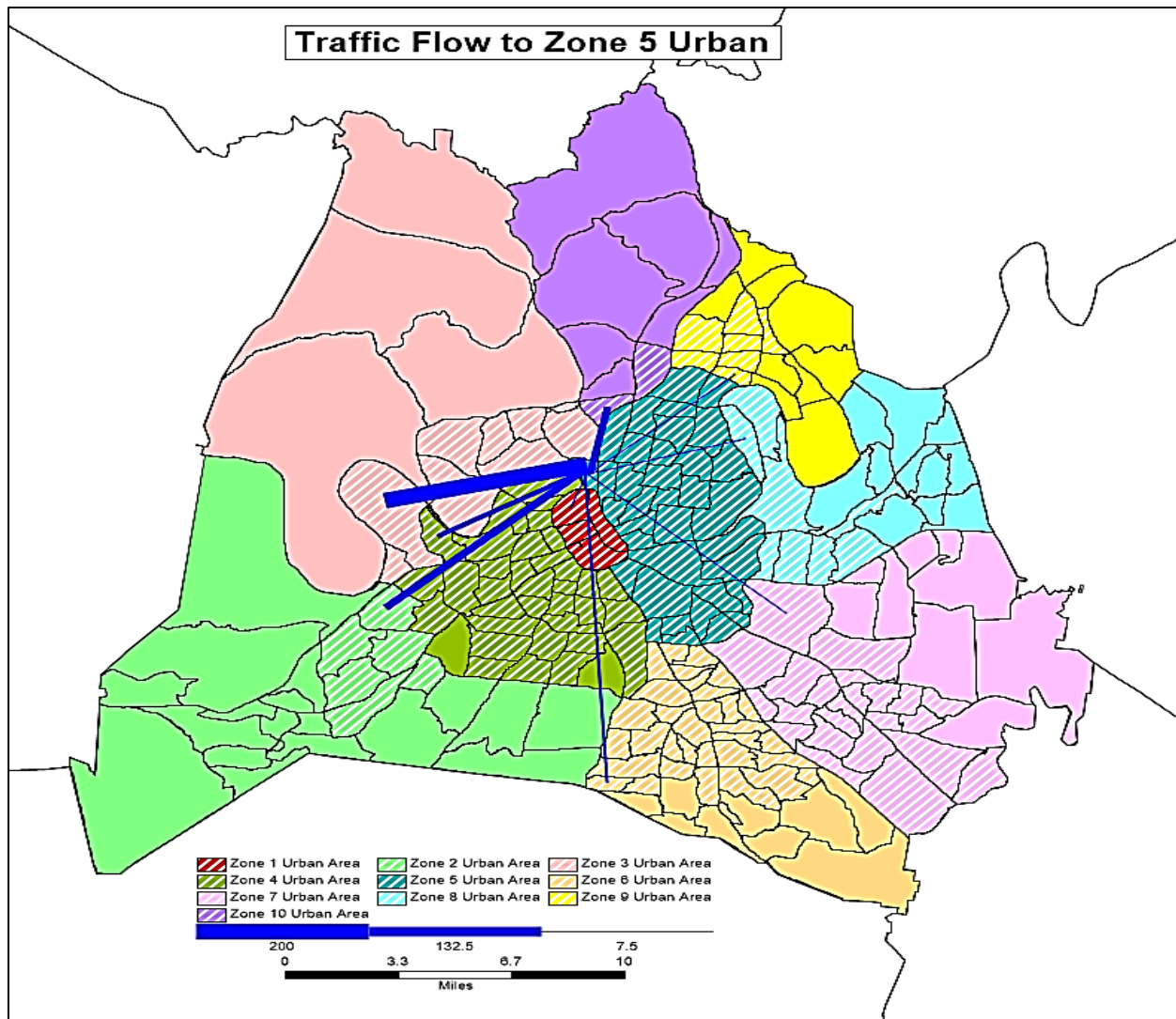


Figure 7.6. Auto Trips Originating in Zone 5

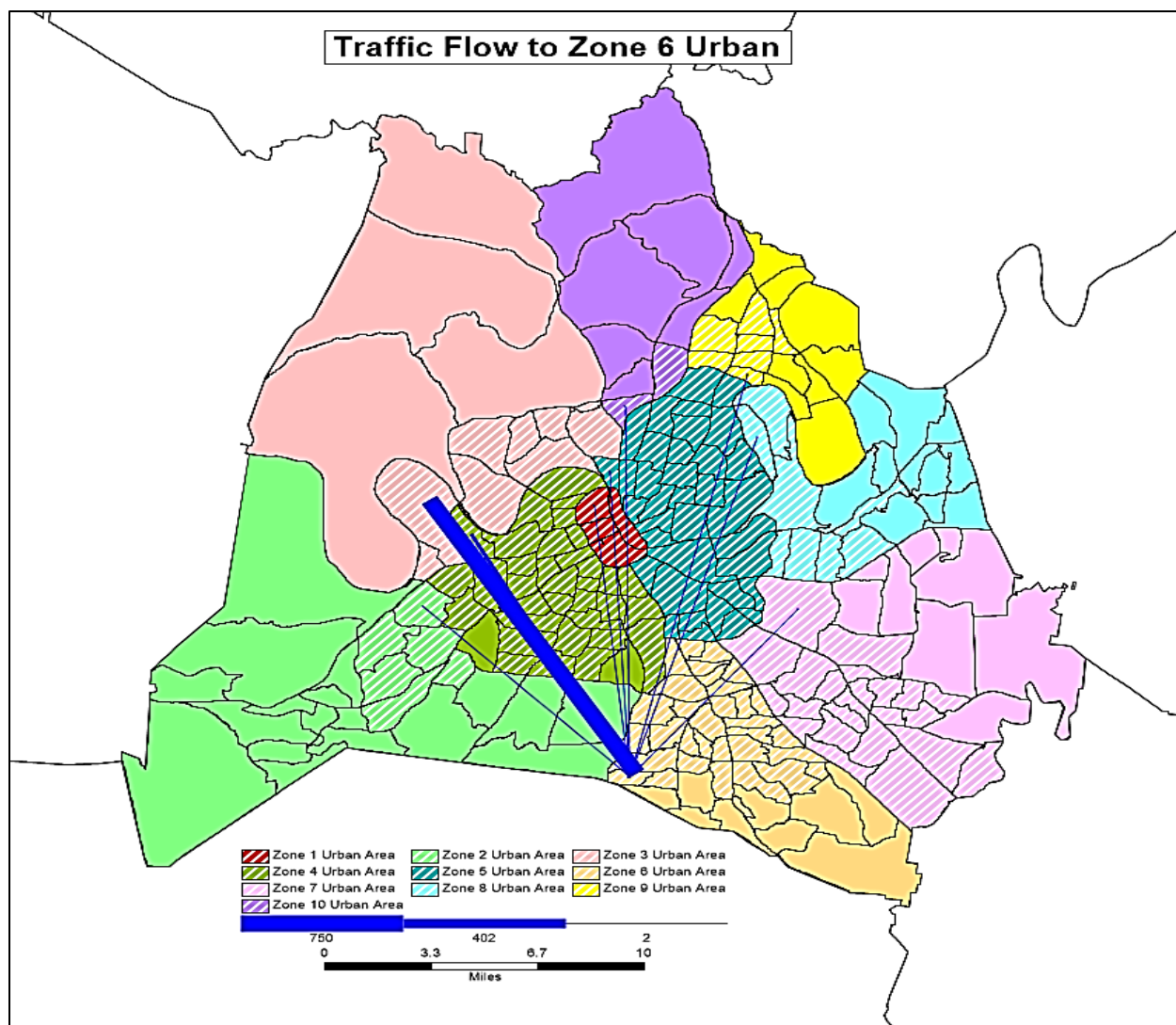


Figure 7.7. Auto Trips Originating in Zone 6

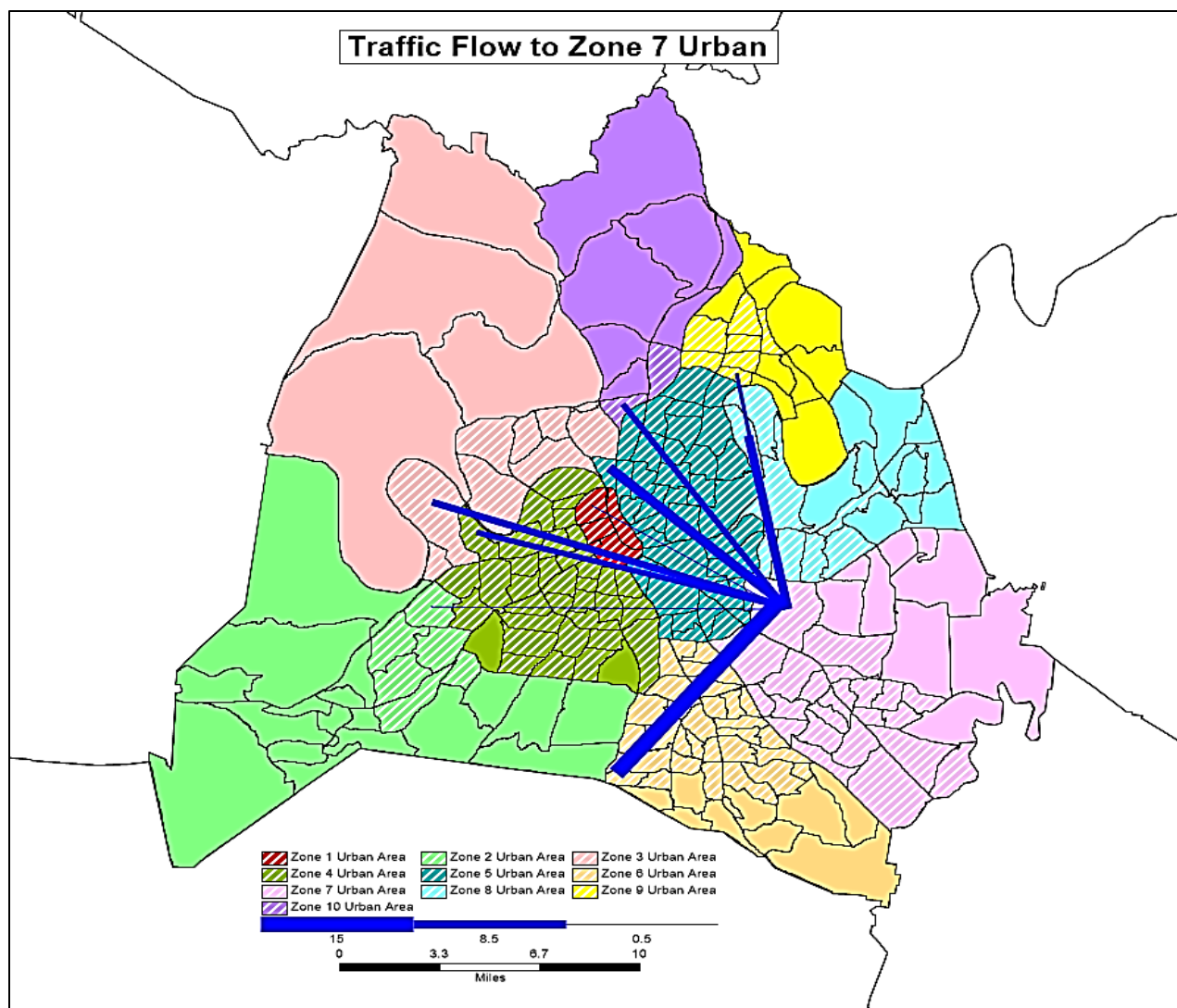


Figure 7.8. Auto Trips Originating in Zone 7

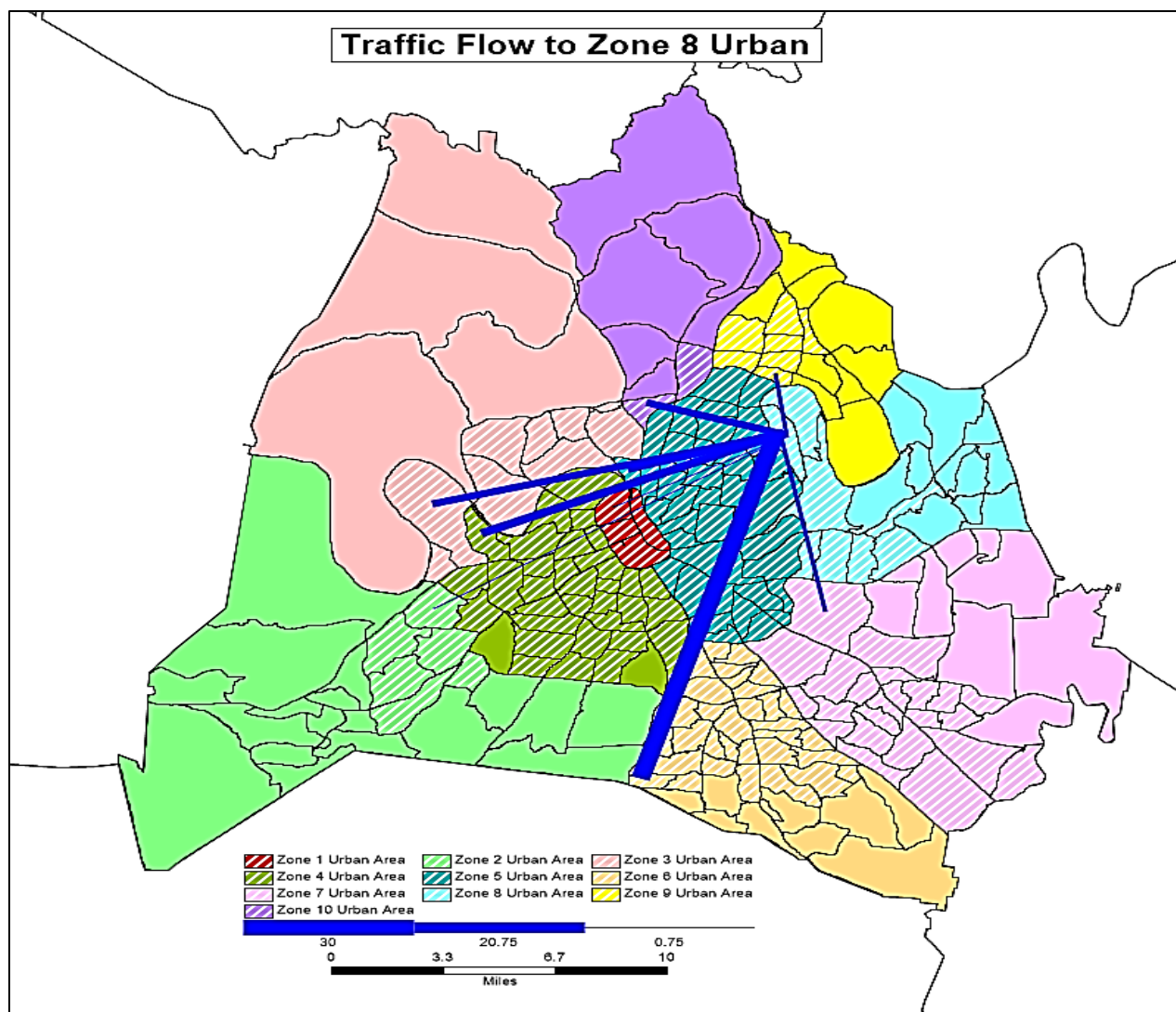


Figure 7.9. Auto Trips Originating in Zone 8

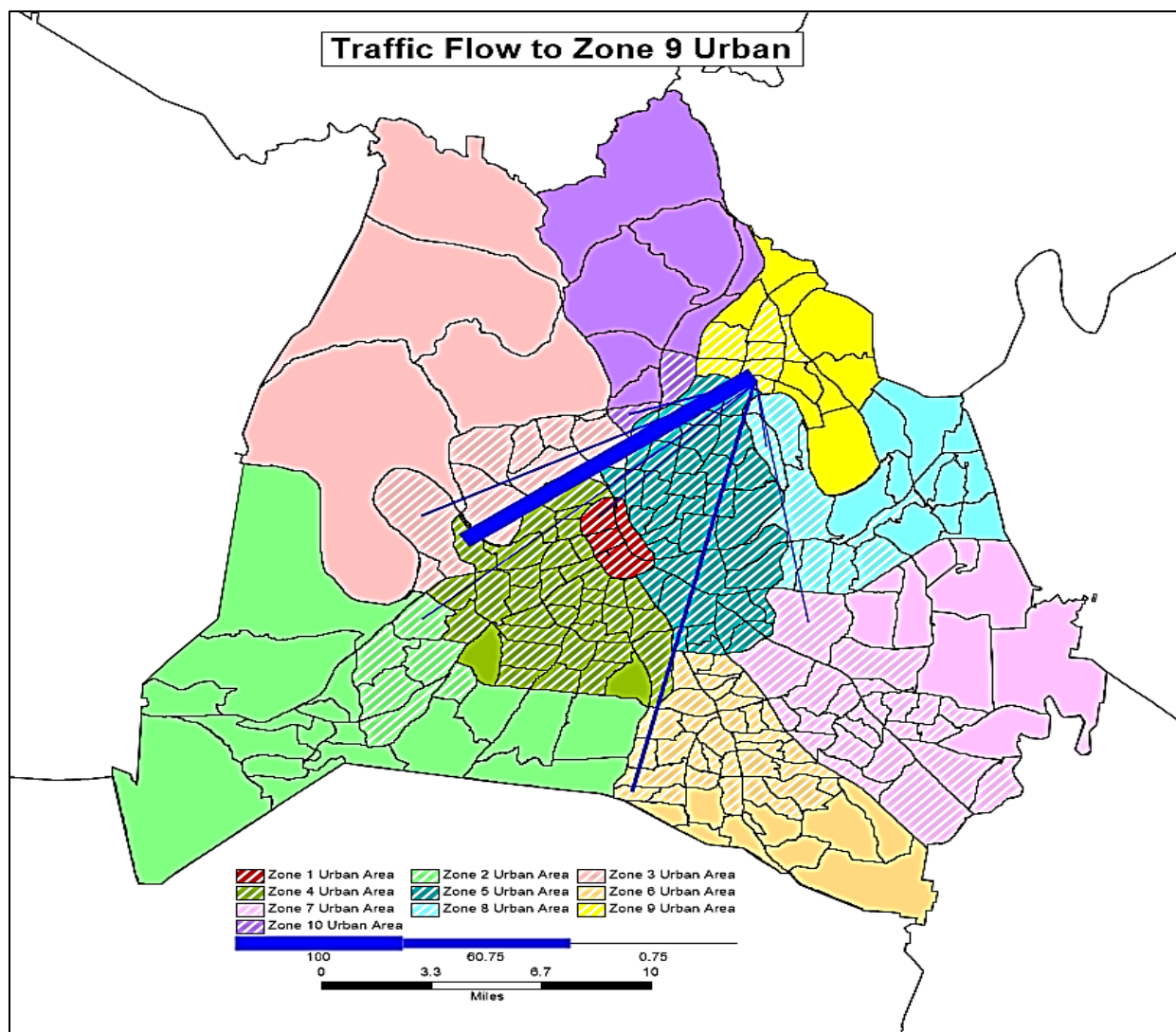


Figure 7.10. Auto Trips Originating in Zone 9

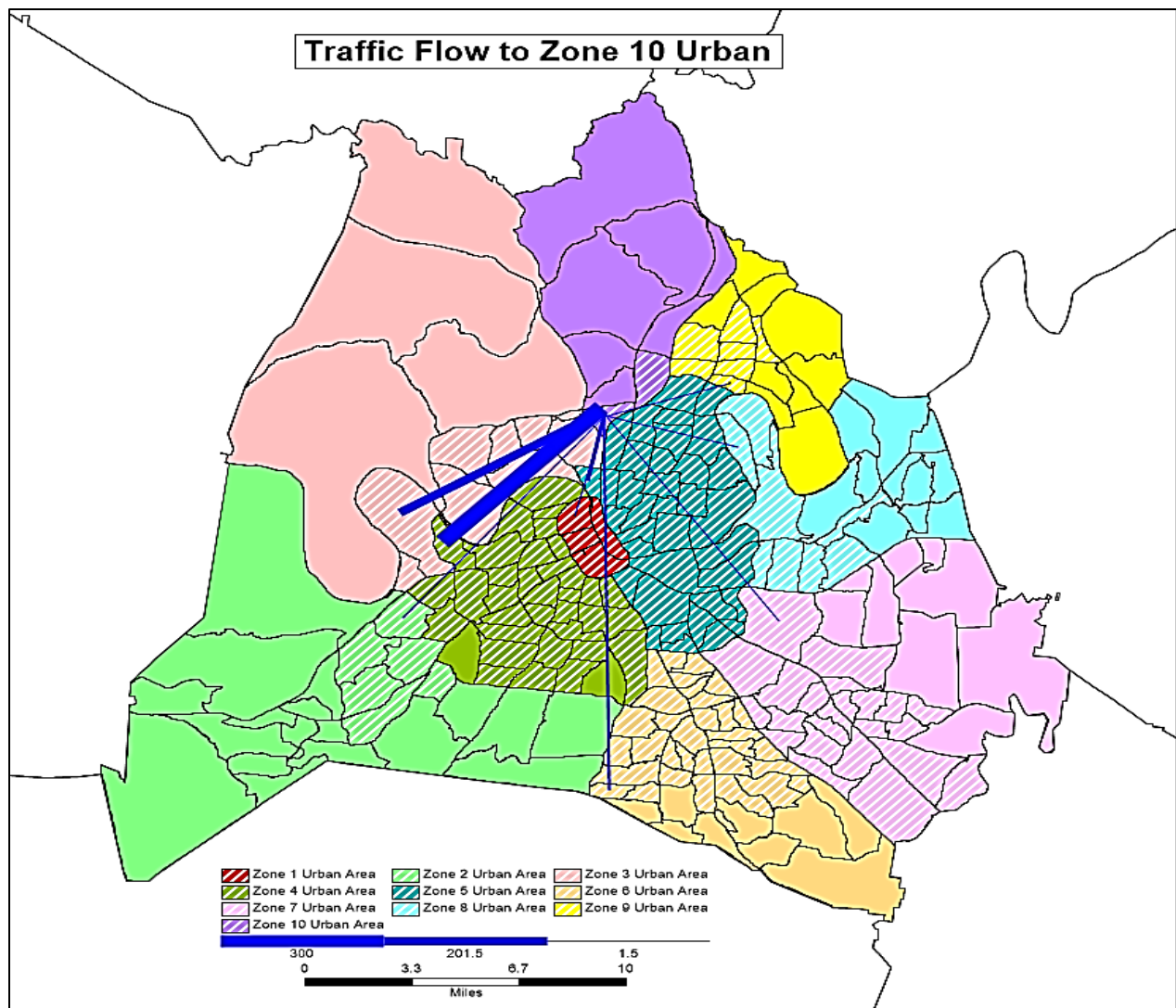


Figure 7.11. Auto Trips Originating in Zone 10

Analyzing the traffic patterns between the whole zone and the urban part of the zone, there is a similar pattern showing that the major destination location when looking at the zone as a whole is still the main destination when looking at just the urban area, there is just a decrease in the number of auto trips that are being made to that zone.

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10
Zone 1	-	900	3,313	28,495	14,403	4,688	2,913	2,837	553	267
Zone 2	3,222	-	1,760	38,021	3,844	11,119	2,289	1,389	115	85
Zone 3	4,016	768	-	26,490	13,860	2,477	1,205	2,432	1,542	1,595
Zone 4	28,736	21,505	23,547	-	30,749	29,409	11,298	6,216	1,826	931
Zone 5	14,403	1,190	13,860	30,338	-	13,512	11,352	16,338	14,564	3,918
Zone 6	5,628	1,073	2,548	33,505	14,818	-	24,782	4,376	325	132
Zone 7	3,485	489	1,197	13,958	13,303	21,719	-	12,791	542	377
Zone 8	3,650	592	2,233	8,412	19,490	4,641	10,550	-	2,299	1,247
Zone 9	1,452	117	2,547	5,438	20,954	723	1,280	4,548	-	2,510
Zone 10	999	100	2,928	3,379	8,886	324	933	2,618	5,688	-

Table. 7.0. Origin and Destination Matrix for Urban Based Trips

CHAPTER 8. CONCLUSION

In a final conclusion with the auto travel patterns in Davidson County for 2020 and the anticipated 2040 years, there is a clear indication that the population in Davidson County is going to increase in 2040, which will result in an increase in the number of daily auto trips being made within the county. It is difficult to get an exact number of auto trips that will be made in 2040, because of the difficulty with predicting the future of 20 years from now. However, it can be estimated based on the current trends in data, which was done in this report showing that traffic volumes and travel time is going to increase in Davidson County. Especially since there is a negative correlation between the number of auto trips being made and the number of public transportation options being made. The result showed that individuals in Davidson County would rather drive than ride on the bus system, and there is going to need to be a major change in the public transportation network that will persuade people to leave their cars and start using alternative options for transportation. With the future being a difficult concept to predict, the best option for planners is to continue to monitor the travel patterns in Davidson County and the alternative transportation options to see if eventually alternative options become a better mode for commuters.