CAMBRIDGE SYSTEMATICS

Oversize/Overweight (OS/OW) Truck Impact on Tennessee Roadways

draft

report

prepared for

Tennessee Department of Transportation

prepared by

Cambridge Systematics, Inc.

July 29, 2010

www.camsys.com

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1.0 Introduction

Tennessee's leading industries rely heavily on efficient goods movement. Examples of these industries include manufacturing of machinery, manufactured housing, agriculture, and construction support. In addition, government organizations such as the Tennessee Valley Authority and the U.S. Department of Defense are generating demand for an increasing of shipments of loads which exceed legal dimension and weight.

Innovations in manufacturing, especially computer-aided manufacturing, over the past decade have increased both the number and size of loads which require special permits for transportation. These oversize and Overweight (OS/OW) trucks are of increasing concern for transportation agencies. While these industries can assist Tennessee's economy, if not managed properly, the increasing numbers of large trucks can restrict mobility, increase safety issues and cause damage to roadway infrastructure.[1]

OS/OW trucks therefore have unique operations and impact on road networks, and this is especially true for states like Tennessee that harbor major transportation hubs. State transportation agencies should be mindful of how OS/OW operations affect a variety of factors of freight operations, maintenance, and safety. Examples of impacts include design implications for both signalized and unsignalized intersections, asset management prioritization decisions around bridge strengthening and raising, and work zone operations and traveler information.

In this report, we will focus on the relationship of OS/OW trucks to the roadway infrastructure in Tennessee in the specific area of safety and road conditions. Solutions will then be offered to better match OS/OW truck operations to infrastructure to improve public safety, preserve roadway assets, and improve operational efficiency.

1.1 STRUCTURE OF REPORT

The report contains the following remaining sections:

- **Section 2.0 – Background** documents the OS/OW truck permitting process in Tennessee.

[1] American Association of State Highway and Transportation Officials (2009). *A Synthesis of Safety Implications of Oversize/Overweight Commercial Vehicles*. Washington, D.C.: American Association of State Highway and Transportation Officials.

- **Section 3.0 – Key OS/OW Routes** identifies the routes taken by those OS/OW permittees in Tennessee for which a pre-defined route is required, and maps out the top 10 OS/OW routes, and the top 100 OS/OW segments that makes up the routes.
- **Section 4.0 – Key Safety Issues** identifies the locations with the most crashes and the highest crash rates on Tennessee roadways, and overlays that information with key OS/OW segments to determine locations with both high OS/OW truck volumes and high crash rates.
- **Section 5.0 – Roadway Conditions** identifies the roadway segments in poor conditions and overlaps that information with high crash locations.
- **Section 6.0 – Major Infrastructure Deficiencies** summarizes information collected from interviewing OS/OW staff to determine infrastructure deficiencies in roadways that prevented certain routes from being used.
- **Section 7.0 – Findings and Recommendations** summarizes the key results from this report and offers recommendations for improving OS/OW truck operation efficiencies and safety in Tennessee.

2.0 Background

To preserve the nation's infrastructure and to maintain efficient movement of vehicles, Federally mandated weight and size standards were established for trucks moving on the National System of Interstate and Defense Highways.[2] However, there are instances where the limits needs to be exceeded, such as when the intended use of the vehicle is compromised, the value of the load is destroyed, or the man-hours it takes to break the load is too many. In such instances, States can issue permits for oversize and overweight vehicles so that such vehicles can move along corridors despite exceeding weight and size limitations.[3]

2.1 TDOT OS/OW Truck Permitting Process

The Tennessee Department of Transportation (TDOT) establishes specific rules for the issuance of special permits to oversize and overweight trucks in the interest of public safety and highway preservation. Generally, a vehicle is overweight if its gross weight exceeds 80,000 pounds, with some additional special cases. A vehicle is oversize if it exceeds either a height of 13 feet 6 inches or a width of 8 feet 6 inches. In addition, it can be oversize if its length is beyond a certain limit for a specific kind of truck. For instance, a straight truck has a limit of 40 feet in length. Details and exceptions apply to the rules.[4]

Once a truck is established to be either overweight or oversize, or both, it can obtain either an annual special permit or single trip permit through the permitting office. A single trip permit has a duration of six weekdays, where the truck can take its single trip any day within that time period. Whereas annual special permits do not limit the route choices of trucks, Tennessee's single trip permits can limit the travel of OS/OW trucks to specific routes if there is height or weight conditions requiring a permit. Single trip permits purchased solely because of width or length issues do not require the designation of a specific route. Regardless, OS/OW trucks can only travel on interstates, U.S. highways and state roads and need to obtain permission from specific cities and counties to travel on local roads.

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[2] http://ops.fhwa.dot.gov/freight/sw/permit_report/index.htm; http://ops.fhwa.dot.gov/freight/sw/index.htm.

[3] http://ops.fhwa.dot.gov/freight/sw/permit_report/index.htm.

[4] The information from this section is extracted from Chapter 1680-7-1 of the Tennessee DOT Central Service Division Rules found here: http://www.state.tn.us/sos/rules/1680/1680-07/1680-07-01.pdf.

There are two types of routes that are permitted for single trips. The DOT has identified a subset of the route network which is both most commonly used and is suitable for overheight and overweight vehicles. This subset has been compiled as a series of logical sections ranging from a single ramp to many miles.

From this network, a set of "envelope routes" have been published in the agency's Tennessee Oversize/Overweight Permitting System (TOOPS)[5], and are available for customers to select when purchasing a permit. These routes have the advantage for customers that the maximum height and much of the engineering analysis has already been conducted, allowing carriers a substantially faster turnaround time. Origins and destinations are primarily state border crossings, major borders of larger cities such as Nashville, Memphis, and Knoxville, and a smaller number of specific points of interest such as major manufacturing facilities.

This set of envelope routes has never been intended to capture one hundred percent of permit applications for height and weight. There are always unusual height or weight distributions, and unusual points of origin or destination. Therefore, customers are allowed to request "custom routes" for their applications. These custom routes are entered as free form text strings.

At the present time due to data and resource limitations, TOOPS' underlying data is not connected to the agency's Geographic Information Systems. Such an enhancement has been contemplated but is not in the agency's current plans for the FY10-11 or FY11-12 activities.

[5] The TOOPS system was developed by Cambridge Systematics for the Tennessee Department of Transportation. It entered pilot deployment in August, 2008 and full deployment on October 31, 2008. It is the successor to the Computerized Permit System (CPI), also developed by Cambridge Systematics, which was in operation from 1998-2008.

3.0 Key OS/OW Routes

The first step to understanding the impact of OS/OW trucks on Tennessee roadways is to determine the routes taken by trucks between key origins and destinations, and the OS/OW truck volume on those routes.

3.1 DATA AND METHODOLOGY

The TOOPS system contains information on every permit issued by the State of Tennessee. The specific information captured is dependent on the type of permit purchased, and for single trip permits, for the size and weight of the vehicle. For envelope routes, the customer selected the route through a "radio button" dialog box. For custom routes, the customer enters a free-form text string. For annual permits or for single trip permits with legal height and legal weight, the system automatically skips this screen as the route is not required.

As a result, the primary source of data for this analysis is the set of single-trip permits with envelope routes. It is reasonable to assert that the custom routes selected by customers would in individual route be a minority compared to the envelope routes.

The project team analyzed an extract of permit data from 2009. The data shows that for single trip permits issued in 2009:

- 100,200 permits were issued for trips where the movement was overdimensional but not overweight (called OW for short);
- 31,399 permits were issued for trips where the movement was overweight but not overdimensional (OS); and
- 26,500 permits were issued for trips where the movement was both overdimensional and overweight (OS/OW).

From this set of permits, about 70 percent of OW permits utilized envelope routes, about 30 percent of OS permits utilized envelope routes and about 76 percent of OS/OW permits utilized envelope routes. Given that vehicles requesting OS permits are often not overheight, and thus do not need a route at all, the disparity is understandable.

Because the OS vehicles often do not require a route at all, we focused our analysis for consistency on the category of vehicles which do always require a route: OW and OS/OW permits. To merge the analysis of the routes with other data needed for the safety analysis, we needed to convert the data to a GIS platform. As the text strings for custom routes are not always in an appropriate format for converting to a base map, we have focused the analysis on the permits for which an envelope route was approved.

The project team converted the individual route segments from TOOPS to GIS format. From there, each permit's envelope route has a known set of individual route segments, so each approved permit could be placed on one or more segments as appropriate. Finally, the individually mapped out segments are then joined together to form a complete route. Both the number of trucks using each segment, and the number of trucks using each complete route are computed, and used to map out key OS/OW corridors in Tennessee.

3.2 KEY OS/OW TRUCK ROUTES

For 2009, there are 21,960 OW permits and 20,183 OS/OW permits issued with an envelope route. Appendix A shows the top 25 envelope routes and the number of vehicles using it, arranged in descending order by number of vehicles.

The paths of the top 10 routes with the most of number of OS/OW trucks are shown in Table 3.1 and mapped out in Figures 3.1 to 3.10. Not surprisingly, Interstates 24, 65, 40, and 75 are identified as major truck corridors, along with SR 3.

Table 3.1 Top 10 OS/OW Truck Routes in Tennessee
2009

Route Number	Number of Trucks	Begin	End	Via
877	1,656	Kentucky	Georgia	I-24
878	1,529	Georgia	Kentucky	I-24
654	1,308	Kentucky	Alabama	I-65
802	1,290	Arkansas	Kentucky	I-40
716	1,267	Virginia	Arkansas	I-81, I-40
109139	1,234	Georgia	Kentucky	I-24, SR 65
528	1,126	Mississippi	Kentucky	SR 3
717	1,030	Kentucky	Arkansas	I-65, I-40
863	968	Georgia	Kentucky	I-75
864	961	Kentucky	Georgia	I-75

Figure 3.1 Route 877 – Kentucky to Georgia via I-24

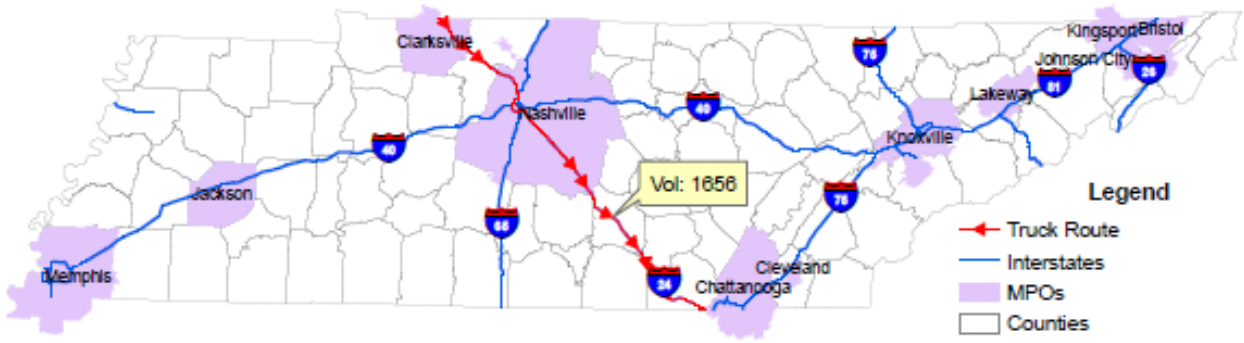


Figure 3.2 Route 878 – Georgia to Kentucky via I-24

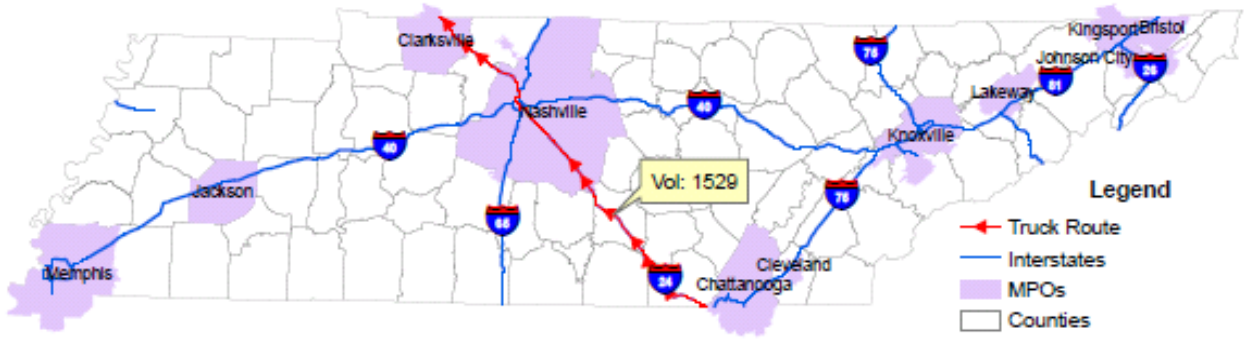


Figure 3.3 Route 802 – Kentucky to Alabama via I-65

Figure 3.4 Route 716 – Arkansas to Kentucky via I-40

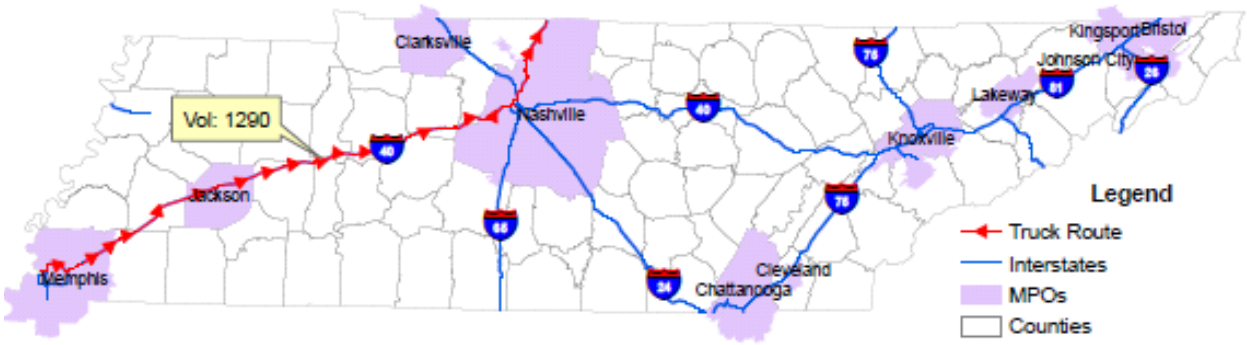


Figure 3.5 Route 654 – Virginia to Arkansas via I-81, I-40

Figure 3.6 Route 109139 – Georgia to Kentucky via I-24, SR 65

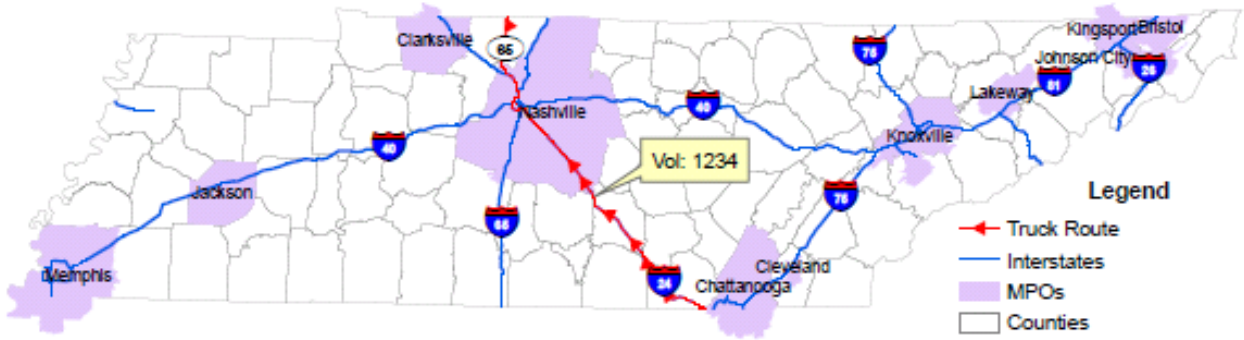


Figure 3.7 Route 528 – Mississippi to Kentucky via SR 3

Figure 3.8 Route 717 – Kentucky to Arkansas via I-65, I-40

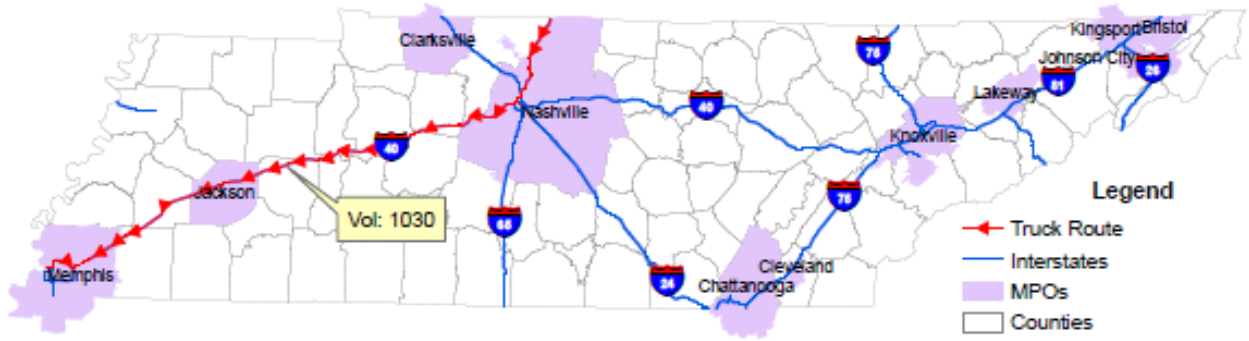


Figure 3.9 Route 893 – Georgia to Kentucky via I-75

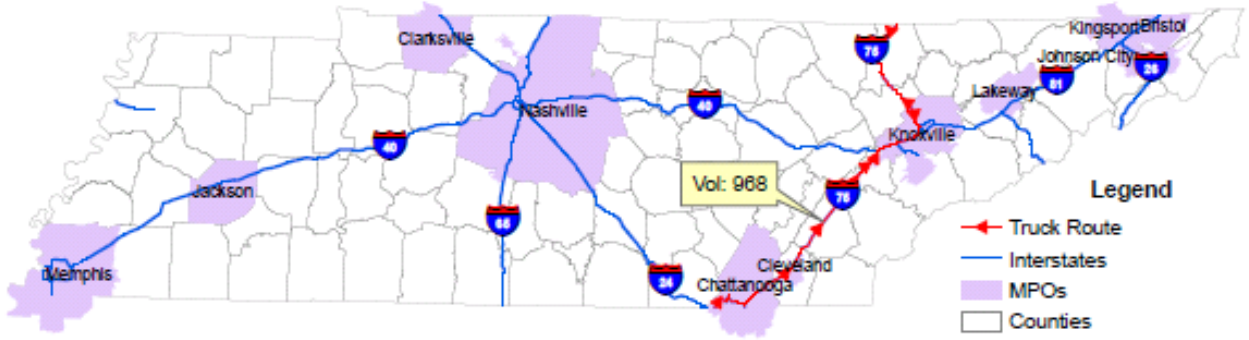
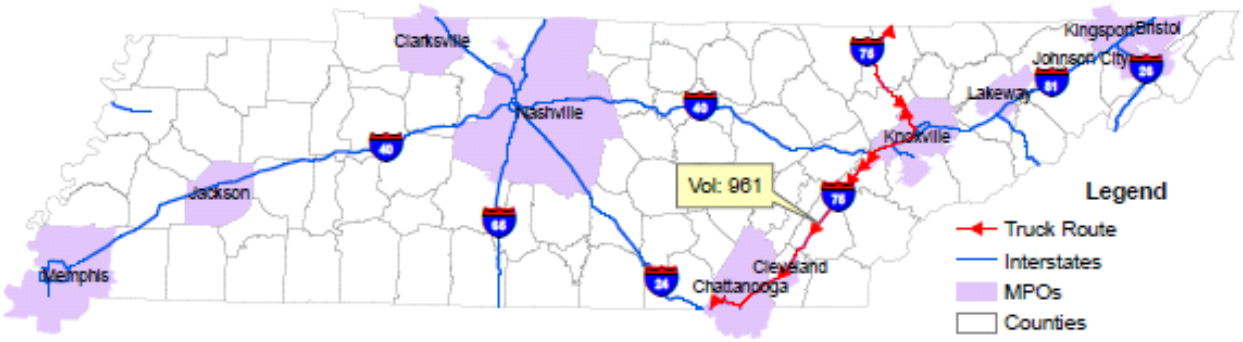


Figure 3.10 Route 864 – Kentucky to Georgia via I-75



3.3 KEY OS/OW TRUCK SEGMENTS

The 100 most utilized OS/OW truck segments are also mapped out in Figure 3.11 to illustrate the most frequently used OS/OW truck route segments in Tennessee. Note that ramp-off/ramp-on operations to avoid particular bridges where the transported height exceeds the underpass height are not modeled in these maps, but are available upon request.

A list of the 100 most utilized segments is provided in Appendix B. The segments map is useful in addition to mapping out individual routes because it shows the overall amount of OS/OW traffic on roadways. As Figure 3.11 indicates, the most frequently used segments make up I-40 from Memphis to Nashville and I-40/I-81 around the Knoxville metropolitan area.

Figure 3.11 100 Route Segments with Highest OS/OW Truck Volumes *2009*

4.0 Safety Issues

The impact of OS/OW trucks on roadway safety is perhaps the most important issue for understanding the concepts used in approving permits for OS/OW loads. While it can be thought that larger truck may reduce safety, no firm conclusions have previously been reached on the relationship between OS/OW trucks and safety.[6]

This section focuses on key accident locations in Tennessee by first reviewing crash locations by county and by major routes in the State. Detailed locations with the most crashes and the highest crash rates in Tennessee are then identified before being overlaid onto key OS/OW segments to determine locations with both high OS/OW truck volumes and high crash rates.

4.1 DATA AND METHODOLOGY

The primary source of data for the analysis done in this section is the crash data obtained from TDOT's Safety Planning Section within the Project Planning Division. The data provided are for the years 2006-2008, and includes total crashes and crash rates of roadway locations that have rates that are twice the statewide average and have traffic volumes greater than or equal to 25,000 vehicles per day with the number of crashes equal to or greater than 50. The criteria generated 355 top crash locations, with location types classified as either a section, spot or intersection. A spot is a roadway segment 0.1 of a mile or less. Sections are of variable length with the termini determined by changes in cross section or traffic volumes. Sections also will break at major intersection, urban boundaries, and county lines. Intersections are at intersecting roadways and have zero lengths. Because of how the locations are classified, there are overlaps in the data as crash data for sections will include data for spots and intersections that are within its boundaries.[7]

In order to overlay the crash data mentioned above with truck volumes, the crash data is joined with an existing roadway GIS layer obtained from TDOT. The join is done based on the unique segment ID of roadways in each Tennessee county.

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[6] Sources: http://www.utexas.edu/research/ctr/pdf_reports/2122_S.pdf

American Association of State Highway and Transportation Officials (2009). *A Synthesis of Safety Implications of Oversize/Overweight Commercial Vehicles*. Washington, D.C.: American Association of State Highway and Transportation Officials.

[7] Information obtained from Harold Dilmore of TDOT's Safety Planning Section.

4.2 OVERVIEW OF TOP CRASHES

Table 4.1 shows the 355 crash locations summarized by county. Shelby County contains 32.4 percent of all crashes, while Davidson County follows in close second with 24.5 percent of all crashes. Robertson and Lincoln County, while having few crashes, have the highest crash rates.

Table 4.1 Top Crash Locations in Tennessee by County
Sorted in Descending Order by Total Crashes, 2006-2008

County	Total Crashes	Average Crash Rate	County	Total Crashes	Average Crash Rate
Shelby	10,732	3.07	Sumner	311	3.54
Davidson	8,141	2.61	Marion	245	0.90
Knox	2,574	2.73	Lincoln	220	7.60
Hamilton	2,215	3.30	Bradley	209	5.48
Rutherford	1,626	4.52	Maury	191	4.05
Madison	1,332	3.67	Warren	166	2.65
Sevier	1,295	3.49	Williamson	140	5.38
Washington	1,087	3.26	Greene	131	4.58
Montgomery	638	4.03	Loudon	127	5.82
Blount	434	2.23	Dickson	106	2.31
Wilson	377	3.25	Dyer	84	2.29
Sullivan	339	3.38	Hamblen	71	2.22
Campbell	317	3.16	Robertson	56	7.93

Table 4.2 shows the 355 crash locations sorted by route. SR 1 contains the most number of crashes at 2,632 crashes, followed by I-24 in close second at 2,242 crashes. From the table, it is also clear that state routes have much higher crash rates than interstates, even though the number of crashes for the two are comparable in magnitude.

Table 4.2 Top Crash Locations in Tennessee by Route
Sorted in Descending Order by Total Crashes, 2006-2008

Route	Total Crashes	Average Crash Rate	Route	Total Crashes	Average Crash Rate
SR 1	2,632	3.17	SR 386	400	1.82
I-24	2,242	0.92	SR 171	377	3.25
I-40	1,823	0.84	SR 35	373	3.00
I-240	1,795	0.64	SR 204	372	2.79
SR 3	1,214	3.89	SR 62	334	2.30
SR 15	1,191	4.02	SR 115	328	2.07
SR 177	1,131	3.56	SR 13	305	5.71
SR 57	1,123	4.36	SR 319	285	4.91
SR 6	1,018	3.80	SR 131	254	3.16
SR 96	873	5.20	SR 106	244	8.49
SR 10	849	5.22	SR 12	243	2.40
SR 11	796	6.14	SR 73	233	4.78
I-65	792	0.70	SR 14	232	2.27
SR 23	725	6.29	SR 153	228	2.98
SR 34	710	3.48	SR 176	219	5.71
I-75	690	1.27	SR 60	209	5.48
SR 5	680	3.77	SR 2	206	1.87
SR 9	677	3.14	SR 320	200	4.36
SR 175	614	2.64	SR 20	147	2.99
SR 385	611	0.74	SR 36	146	2.06
SR 4	605	2.30	SR 8	134	4.38
SR 255	547	4.48	SR 67	111	3.01
SR 71	536	4.42	SR 46	106	2.31
SR 186	505	3.69	I-275	95	2.05
SR 381	468	3.23	SR 76	90	2.16
SR 66	463	2.71	SR 441	65	2.27
SR 155	446	5.59	SR 50	62	5.88
SR 33	431	2.80	I-440	54	0.48
SR 24	414	2.18	SR 58	54	10.11
I-55	405	3.24	SR 254	52	6.94

4.3 TOP LOCATIONS WITH MOST CRASHES

The top 20 locations with the highest number of crashes are pulled out and looked at in detail. Table 4.3 shows that the locations with the highest number of crashes are mostly along urban Interstates with segment lengths of around one mile.

Table 4.3 Top 20 Locations with Highest Number of Crashes
2006-2008

County	Route	Length[a]	Functional Class	Location Type	Total Crashes	Crash Rate[b]
Shelby	I-240	1.11	Urban Interstate	Section	416	2.65
Davidson	I-24	0.98	Urban Interstate	Section	365	2.66
Davidson	I-65	0.84	Urban Interstate	Section	338	2.45
Hamilton	I-75	1.08	Urban Interstate	Section	316	2.20
Shelby	SR 385	1.18	Urban Freeway/Expressway	Section	294	2.03
Davidson	I-40	0.95	Urban Interstate	Section	291	2.17
Madison	SR 5	0.83	Urban Minor Arterial	Section	282	11.86
Marion	I-24	5.32	Urban Interstate	Section	245	0.90
Davidson	SR 386	1.72	Urban Freeway/Expressway	Section	235	2.38
Sevier	SR 35	0.88	Urban Other Principal Arterial	Section	223	5.84
Lincoln	SR 10	0.95	Urban Other Principal Arterial	Section	220	7.60
Hamilton	I-24	0.77	Urban Interstate	Section	217	2.41
Blount	SR 115	0.00	Urban Other Principal Arterial	Intersection	216	4.04
Shelby	I-24	0.75	Urban Interstate	Section	210	2.66
Shelby	SR 177	0.67	Urban Other Principal Arterial	Section	195	5.87
Shelby	SR 4	0.00	Urban Other Principal Arterial	Intersection	186	2.82
Shelby	SR 57	0.00	Urban Other Principal Arterial	Intersection	183	2.91
Wilson	SR 171	1.03	Urban Minor Arterial	Section	177	6.13
Shelby	SR 15	0.82	Urban Other Principal Arterial	Section	176	6.32
Shelby	SR 175	0.00	Urban Other Principal Arterial	Intersection	174	3.46

[a] Unit: Miles.

[b] Unit: Crashes per million vehicle miles (location type: sections); spots rates are crashes per million vehicles (location type: spot); crashes per million entering vehicles (location type: intersections).

4.4 TOP LOCATIONS WITH HIGHEST CRASH RATES

The 20 locations with the highest crash rates also are looked at in more detail. Table 4.4 shows that locations with highest crash rates are mostly urban state routes, with segment lengths between one to two tenths of a mile.

Table 4.4 Top 20 Locations with the Highest Crash Rate
2006-2008

County	Route	Length[a]	Functional Class	Location Type	Total Crashes	Crash Rate[b]
Rutherford	SR 96	0.20	Urban Other Principal Arterial	Section	133	17.66
Shelby	SR 177	0.12	Urban Other Principal Arterial	Section	95	15.98
Shelby	SR 3	0.16	Urban Other Principal Arterial	Section	89	14.79
Hamilton	SR 319	0.13	Urban Other Principal Arterial	Section	66	13.88
Davidson	SR 155	0.12	Urban Minor Arterial	Section	52	13.85
Montgomery	SR 13	0.21	Urban Other Principal Arterial	Section	103	13.69
Davidson	SR 106	0.14	Urban Minor Arterial	Section	52	13.42
Shelby	SR 57	0.23	Urban Other Principal Arterial	Section	114	12.49
Shelby	SR 23	0.25	Urban Other Principal Arterial	Section	104	12.30
Rutherford	SR 10	0.12	Urban Other Principal Arterial	Section	53	12.27
Madison	SR 5	0.83	Urban Minor Arterial	Section	282	11.86
Shelby	SR 23	0.23	Urban Other Principal Arterial	Section	84	10.80
Davidson	SR 255	0.20	Urban Other Principal Arterial	Section	104	10.78
Shelby	SR 23	0.40	Urban Other Principal Arterial	Section	141	10.43
Hamilton	SR 58	0.13	Urban Other Principal Arterial	Section	54	10.11
Bradley	SR 60	0.18	Urban Other Principal Arterial	Section	52	9.90
Davidson	SR 11	0.28	Urban Other Principal Arterial	Section	95	9.63
Shelby	SR 23	0.55	Urban Other Principal Arterial	Section	163	9.60
Davidson	SR 11	0.47	Urban Other Principal Arterial	Section	155	9.36
Shelby	SR 57	0.21	Urban Other Principal Arterial	Section	58	9.06

[a] Unit: Miles.

[b] Unit: Crashes per million vehicle miles (location type: sections); spots rates are crashes per million vehicles (location type: spot); crashes per million entering vehicles (location type: intersections).

4.5 Overlap between Crash Locations and OS/OW Routes

The high crash and high crash rate locations are overlaid with the top 100 OS/OW truck segments to identify areas of overlap. Figure 4.1 shows the overlap of high crash locations graphically and Table 4.5 lists the location of overlap upon manual inspection, indicating that all of the areas with high OS/OW truck volume and high number of crashes happened in urban areas.

Figure 4.1 Overlap between High Crash Locations and OS/OW Truck Segments

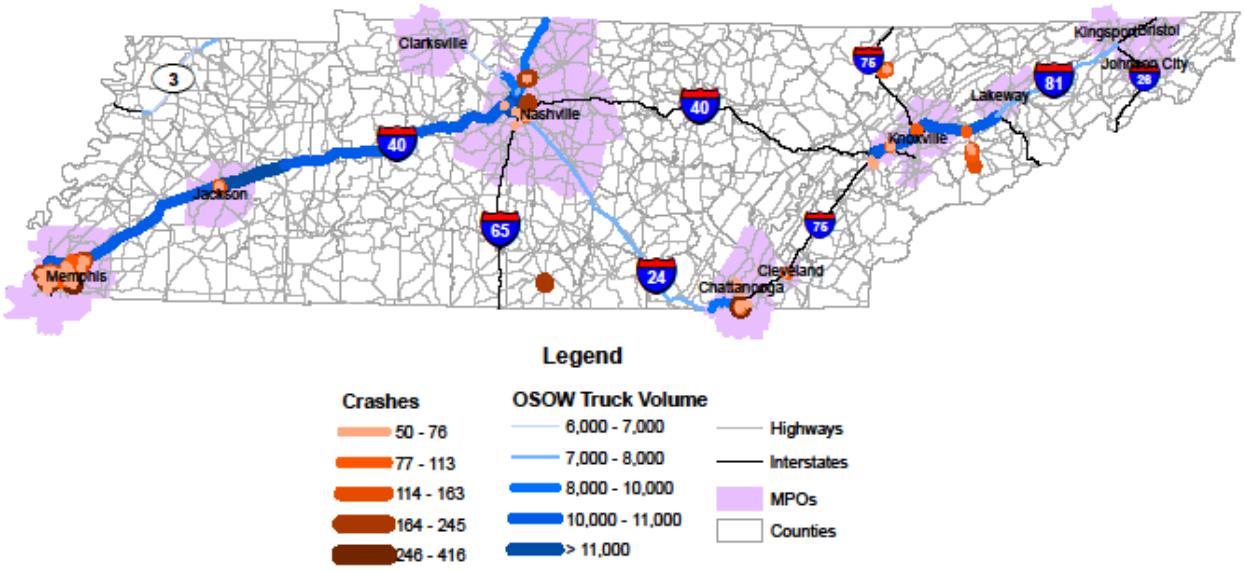


Table 4.5 Overlapping High Crash Segments with OS/OW Truck Volume

County	Route	Length	Functional Class	Location Type	Total Crashes	Crash Rate	Truck Volume
Davidson	SR 386[a]	1.72	Urban Freeway/Expressway	Section	235	2.38	8,202
Davidson	I-440	0.10	Urban Interstate	Spot	54	0.48	17,276
Hamilton	I-75[b]	0.10	Urban Interstate	Spot	70	0.55	9,184

[a] Note truck volume is on I-65. Considered an overlap due to proximity.

[b] Note truck volume on I-24 junction with I-75. Considered an overlap due to proximity.

Figure 4.2 shows the overlap between high crash rate locations and OS/OW truck segments. It tells a similar story as Figure 4.1, with the intensity of crash rates even more pronounced near urban areas. Table 4.6 shows the areas of overlap from Figure 4.2, which are identical to that identified in Table 4.5. Blow-up maps of Memphis, Nashville, and Chattanooga are provided in Figures 4.3, 4.4, and 4.5, respectively, to analyze the areas of overlap in more detail.

Figure 4.2 Overlap between High Crash Rate Locations and OW/OW Truck Segments

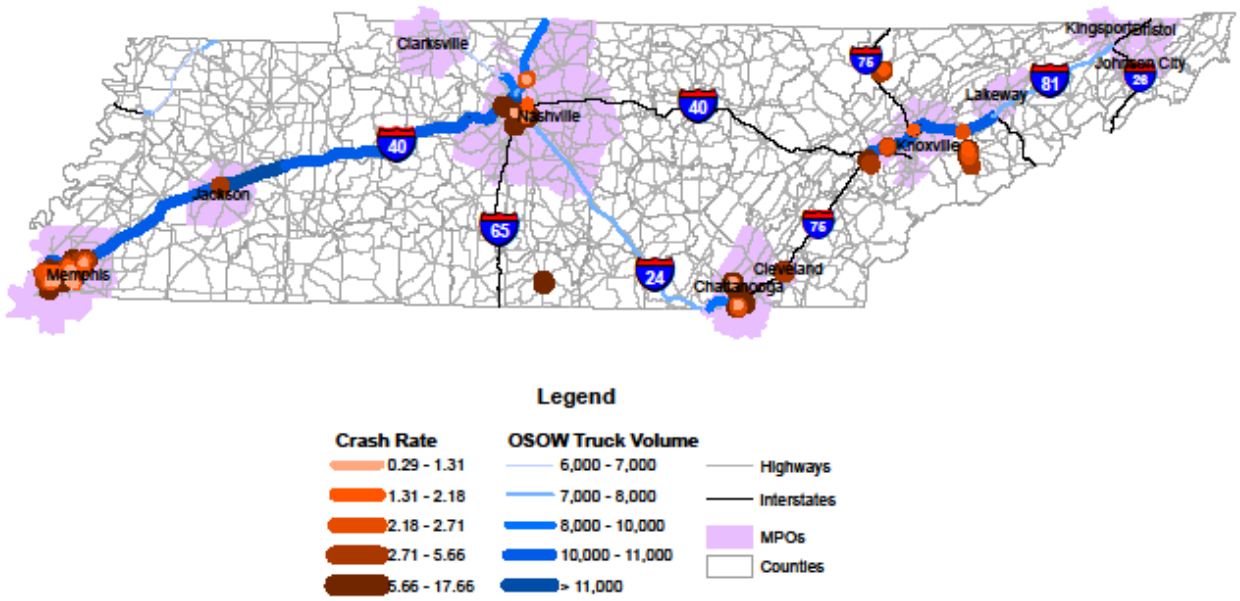


Table 4.6 Overlapping High Crash Rate Segments with High OS/OW Truck Volume

County	Route	Length	Functional Class	Location Type	Total Crashes	Crash Rate	Truck Volume
Davidson	SR 386[a]	1.72	Urban Freeway/Expressway	Section	235	2.38	8,202
Davidson	I-440	0.10	Urban Interstate	Spot	54	0.48	17,276
Hamilton	I-75[b]	0.10	Urban Interstate	Spot	70	0.55	9,184

[a] Note truck volume is on I-65. Considered an overlap due to proximity.

[b] Note truck volume on I-24 junction with I-75. Considered an overlap due to proximity.

Memphis contains the most number of crashes out of any metropolitan area. Figure 4.3, however, shows that even though there are many crashes, most of the crashes happen at state route locations that act as feeders to the Interstates. High OS/OW truck segments seems to have few crashes.

The pattern of overlap between crash rates and OS/OW truck segments in Nashville is similar to Memphis. As Figure 4.4 shows, the only overlap between the two happens on a small segment of I-440. Chattanooga exhibits a similar pattern as shown in Figure 4.5.

Figure 4.3 Overlap between High Crash Rate Locations and OS/OW Segments *In Memphis*

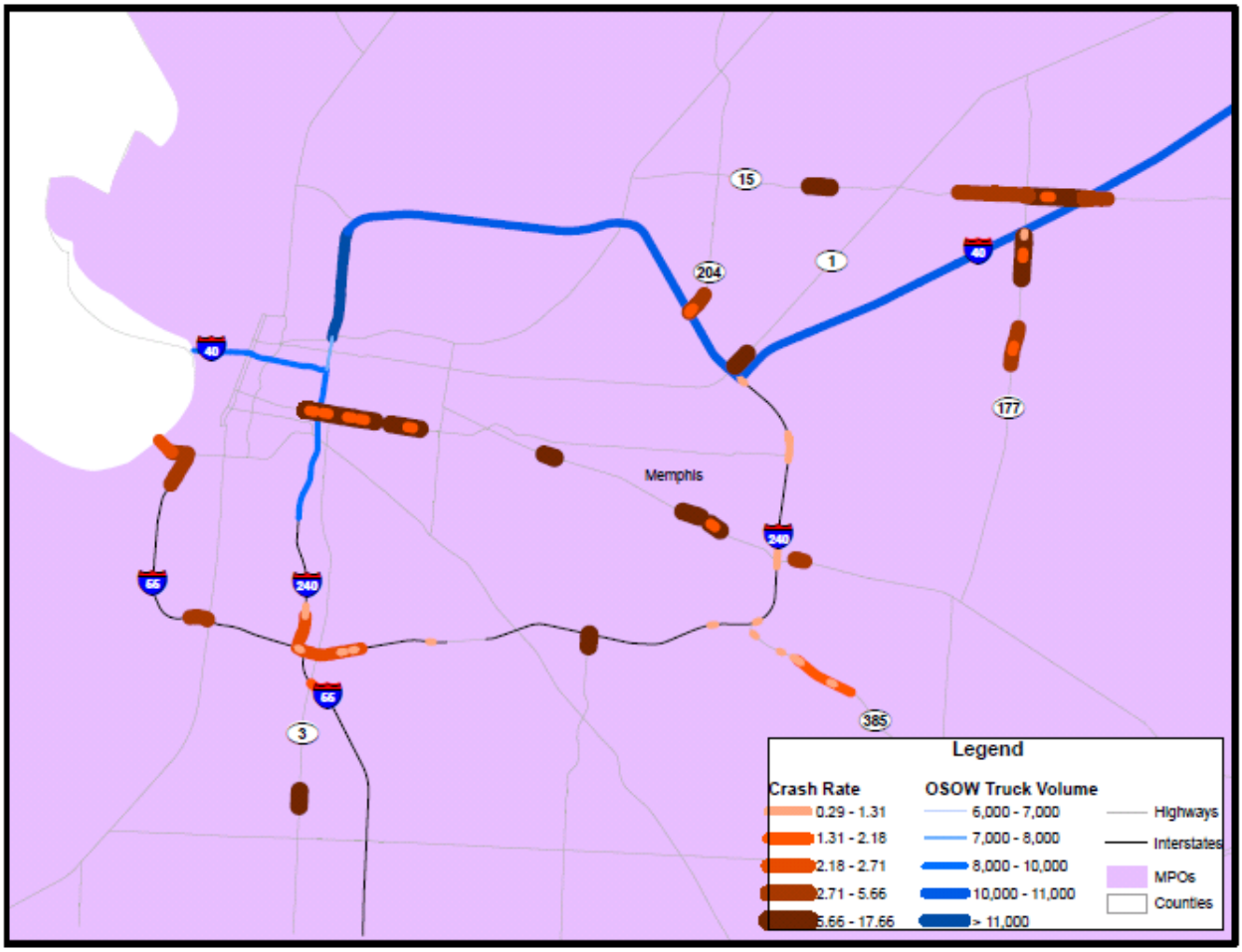


Figure 4.4 Overlap between High Crash Rate Locations and OS/OW Truck Segments *In Nashville*

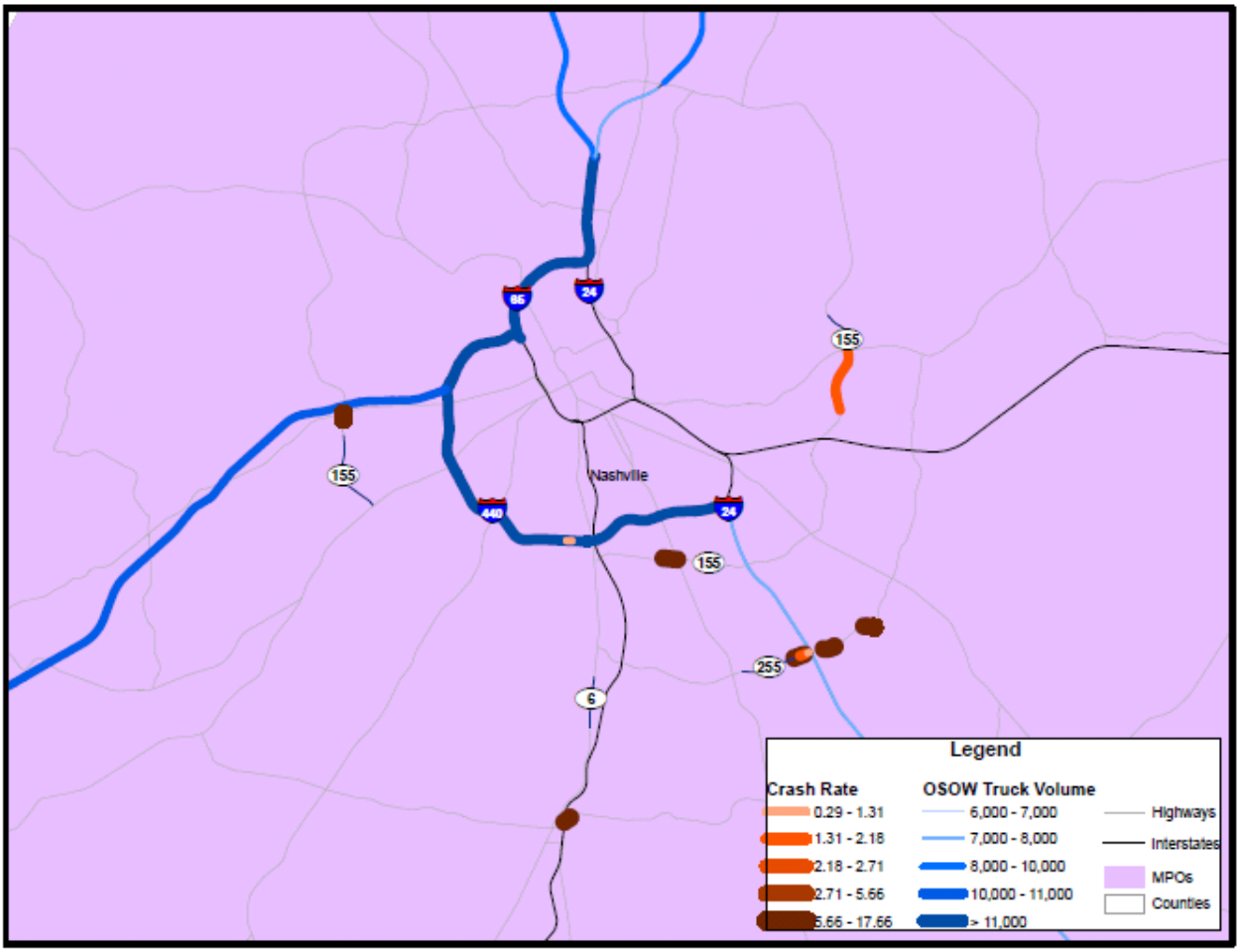
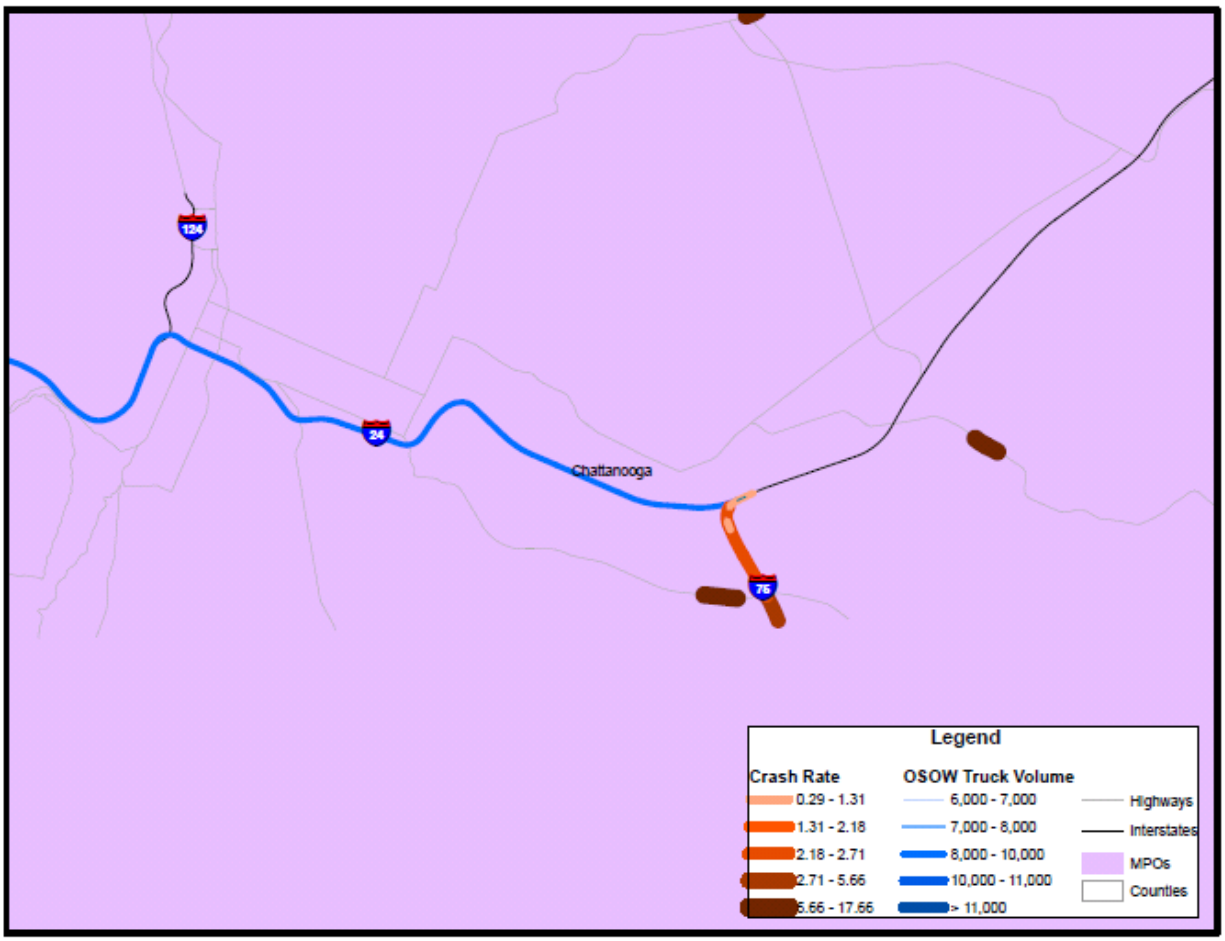


Figure 4.5 Overlap between High Crash Rate Locations and OS/OW Truck Segments *In Chattanooga*



5.0 Roadway Conditions

The relationship between truck weight and roadway conditions remain an uncertain issue. On one hand, adding more payload on to a given truck without increasing number of axles will normally increase pavement damage. In the worst case scenario, a single vehicle can increase pavement cost by about $50,000 per year and bridge cost by up to 42 percent. On the other hand, there are reasons why using heavier trucks with additional axles can leave pavements better or unchanged. The two reasons are: 1) heavier trucks increases the payload per truck, so fewer trips are required; and 2) heavier trucks have less weight per axle since the load is distributed over more axles, and therefore reduces pavement damage. An increase in axle weight of 10 percent will increase pavement damage by about 46 percent. Studies done have shown that liberalizing weight restrictions and adding more axles can lower pavement costs by up to 1.6 percent.[8]

Clearly, no consensus have been reached on the relationship between OS/OW trucks and pavement conditions. This section of the report therefore does not attempt to determine such a relationship but rather identifies locations with poor roadway conditions and high volumes of OS/OW traffic specifically in Tennessee to help prioritize future maintenance needs.

5.1 DATA AND METHODOLOGY

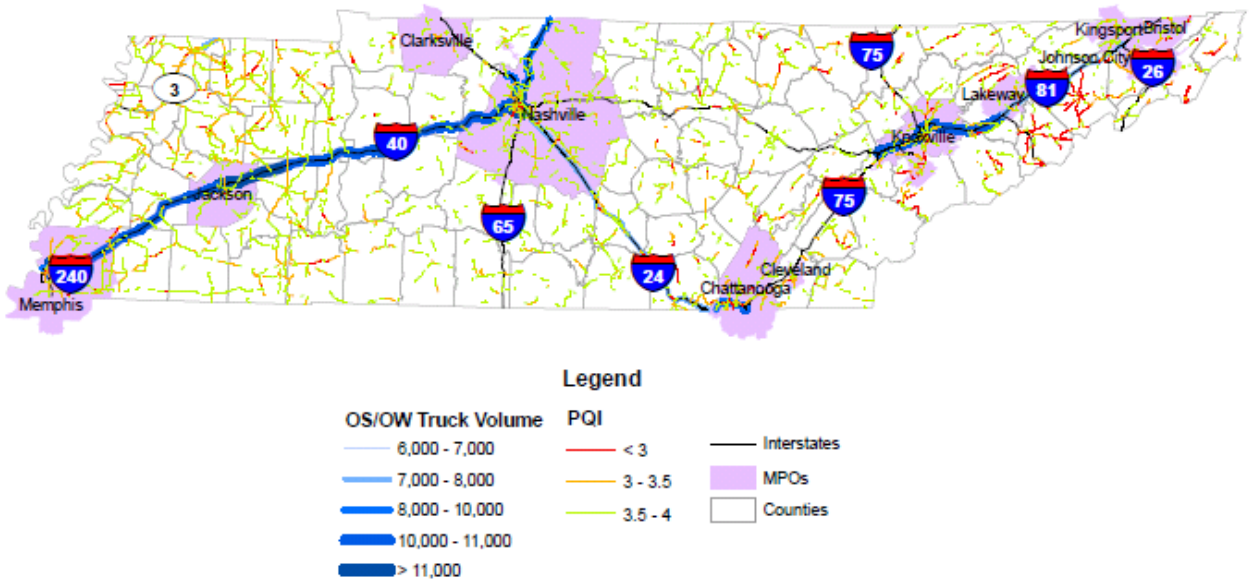
The primary source of data for this section is the Pavement Quality Index (PQI) data obtained from TDOT's TRIMS database through the GIS Mapping and Facilities Data Office. The PQI is an overall index that measures the condition of Tennessee roadways on a scale from 0 to 5, with 5 being the highest rating. Appendix C explains how the PQI is calculated. The data for the PQI is mapped in GIS format and is divided into four Tennessee regions. The data for regions 1 and 2 (east Tennessee) are from the year 2008, while the data for regions 3 and 4 (west Tennessee) are from the year 2009. Interstates have PQI ratings for both directions of the roadway, while state routes have PQI ratings only in one direction (north or east) of the roadway. The data includes the PQI rating for 1,104 miles of Interstates and 12,465 miles of state roads, including all roadway bridges, generating an average statewide PQI of 4.07. The data is then overlapped with the OS/OW truck segments from Section 3.0.

[8] Source: http://www.utexas.edu/research/ctr/pdf_reports/2122_S.pdf.

5.2 OVERLAP BETWEEN ROADWAY CONDITIONS AND OS/OW ROUTES

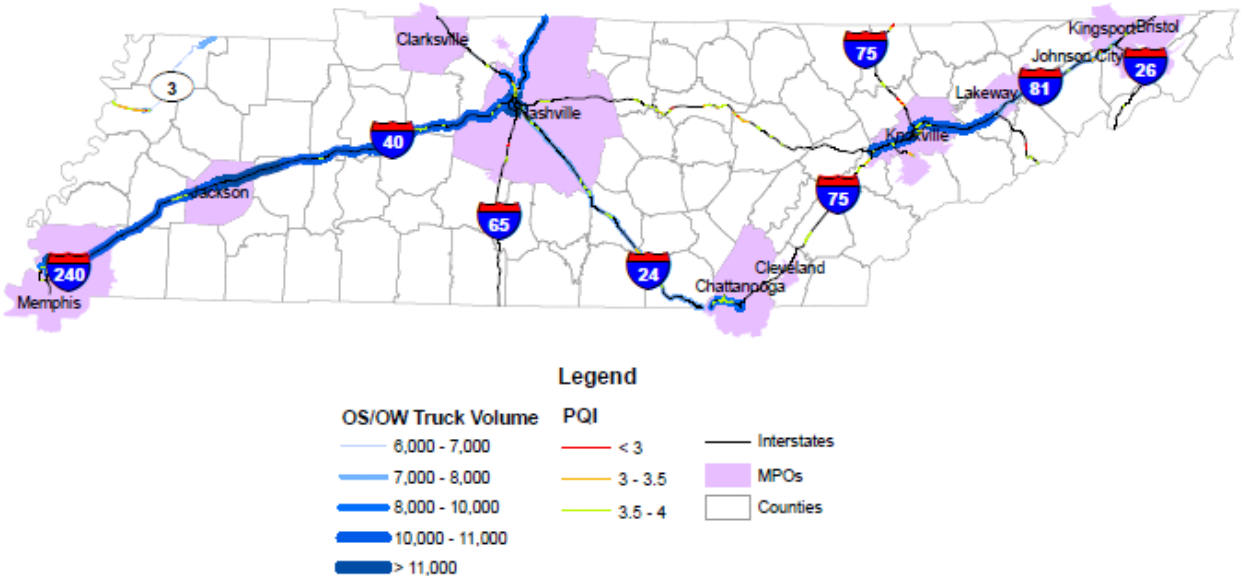
Figure 5.1 and Figure 5.2 shows the PQI ratings overlaid with top OS/OW truck segments in the Eastbound/Northbound and Westbound/Southbound directions respectively. Ratings less than 3.5 are assumed to be unsatisfactory.[9] Overall, the pavement qualities are worst in the eastern part of Tennessee, and qualities are worse on state roads than interstates.

Figure 5.1 Overlap between PQI Rating and OS/OW Truck Segments
In Eastbound/Northbound Direction



[9] Based on the Performance Measures found in TDOT's Long-Range Transportation Plan: http://www.tdot.state.tn.us/plango/pdfs/plan/PerfMeasures.pdf.

Figure 5.2 Overlap between PQI Rating and OS/OW Truck Segments
In Westbound/Southbound Direction



Places where the PQI is below 3.5 and where it overlaps with the OS/OW truck segments in the Eastbound/Northbound direction are displayed in Figure 5.3. Table 5.1 also lists these locations with PQI and OS/OW Truck volume information. As can be seen, the majority of these locations are concentrated along I-24 from Nashville to Chattanooga, and along I-24 from Lakeway to Kingsport-Bristol.

Figure 5.3 Unsatisfactory PQI Segments Overlapped with Top OS/OW Truck Segments
In Eastbound/Northbound Direction

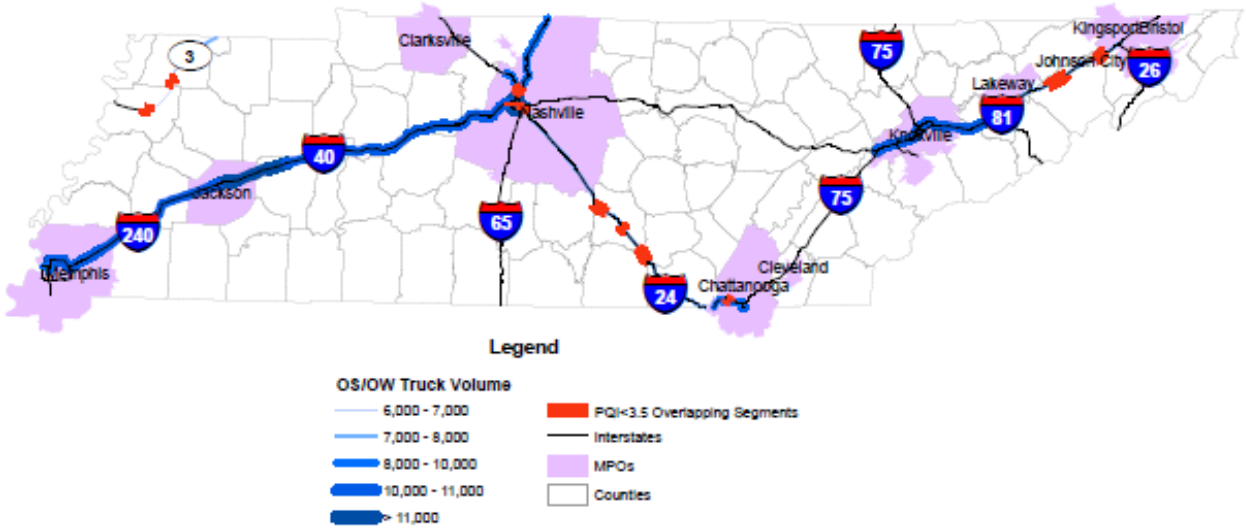


Table 5.1 Segments with Unsatisfactory PQI and High OS/OW Truck Volumes
In Eastbound/Northbound Direction

County	Route ID	PQI	OS/OW Truck Volume
Dyer	I-155	3.25	7,405
Dyer	I-155	3.26	7,405
Obion	SR 3	3.49	6,845
Obion	SR 3	3.39	6,845
Davidson	I-24	3.43	9,038
Davidson	I-65	3.34	7,885
Davidson	I-440	3.29	17,276
Davidson	I-441	3.41	13,450
Coffee	I-24	2.98	7,361
Coffee	I-24	3	7,361
Coffee	I-24	3.14	7,361
Coffee	I-24	3.4	7,361
Coffee	I-24	3.52	7,361
Coffee	I-24	3.49	7,361
Coffee	I-24	3.25	7,361
Grundy	I-24	2.55	7,361
Grundy	I-24	2.71	7,367
Grundy	I-24	3.38	7,367

County	Route ID	PQI	OS/OW Truck Volume
Hamilton	I-24	3.23	9,184
Greene	I-81	2.64	7,357
Greene	I-81	0.45	7,357
Greene	I-81	2.6	7,357
Greene	I-81	2.15	7,357
Greene	I-81	0.58	7,357
Greene	I-81	2.16	7,357
Greene	I-81	3.25	7,357
Greene	I-81	2.13	7,357
Greene	I-81	3.3	7,357
Greene	I-81	3.48	7,357
Greene	I-81	3.07	7,357

Similarly, places where the PQI is below 3.5 and where it overlaps with the OS/OW truck segments in the Westbound/Southbound direction are displayed in Figure 5.4. Table 5.2 also lists these locations with PQI and OS/OW Truck volume information. The overlapping locations in this direction in pattern to that in the other direction, but the roadway conditions seems to be better in this direction, indicated by the fewer number of overlapping locations as shown in Table 5.2.

Figure 5.4 Unsatisfactory PQI Segments Overlapped with Top OS/OW Truck Segments *In Westbound/Southbound Direction*

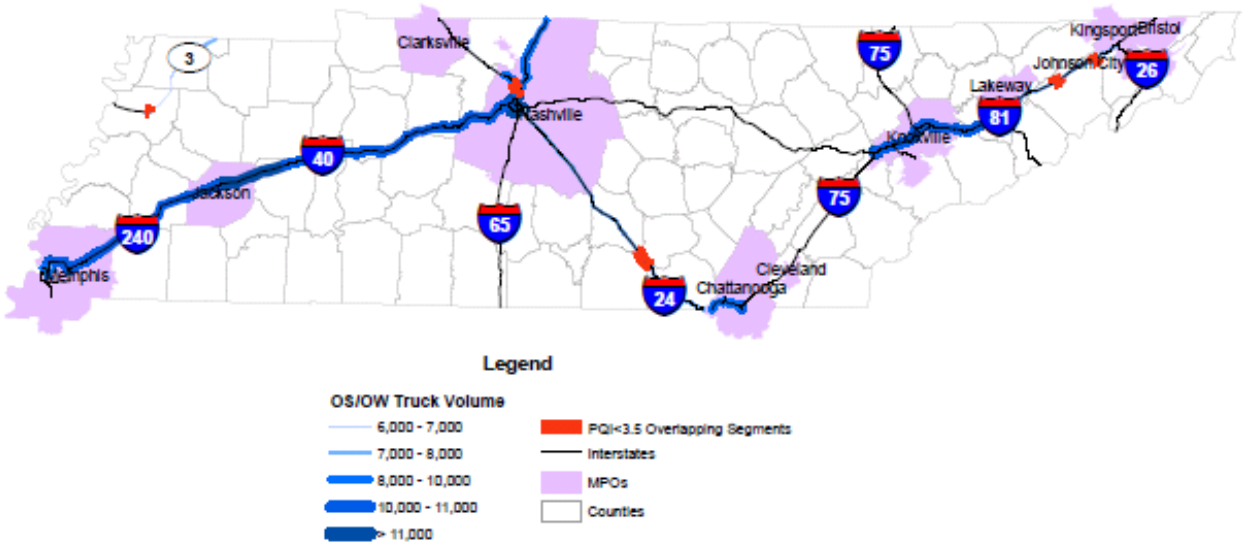


Table 5.2 Segments with Unsatisfactory PQI and High OS/OW Truck Volumes
In Westbound/Southbound Direction

County	Route ID	PQI	OS/OW Truck Volume
Dyer	I-155	2.97	7,405
Davidson	I-24	3.38	8,229
Davidson	I-65	3.43	7,885
Coffee	I-24	3.09	7,361
Grundy	I-24	3.11	7,367
Grundy	I-24	3.36	7,367
Grundy	I-24	3.13	7,367
Grundy	I-24	3.47	7,367
Greene	I-81	2.71	7,357
Greene	I-81	3.32	7,357
Greene	I-81	3.18	7,357

Figure 5.5 shows the blow-up map of Memphis. While many state roads around the interstate segments have unsatisfactory ratings, the interstates themselves are in good condition.

Figure 5.5 Overlap between PQI Ratings and OS/OW Truck Segments
In Memphis

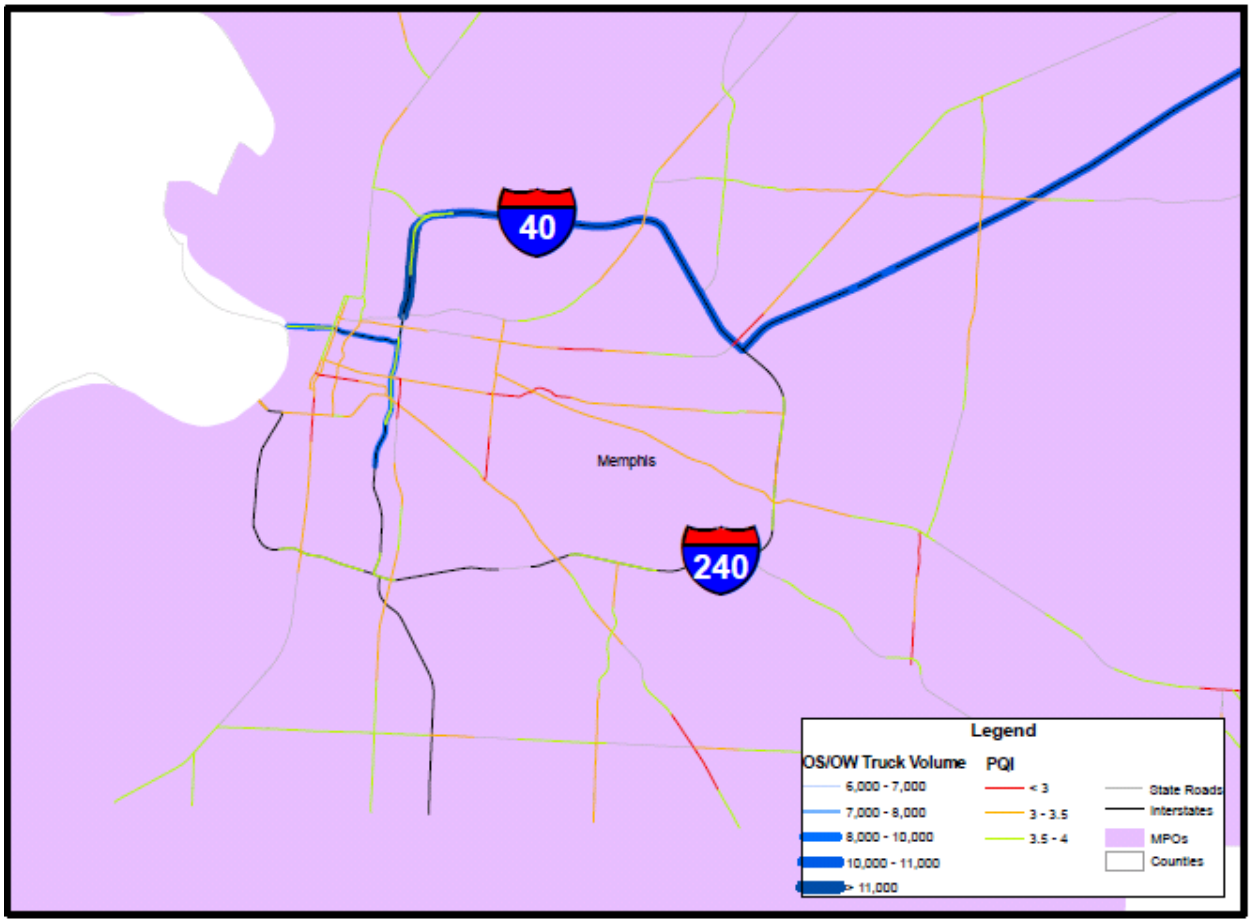
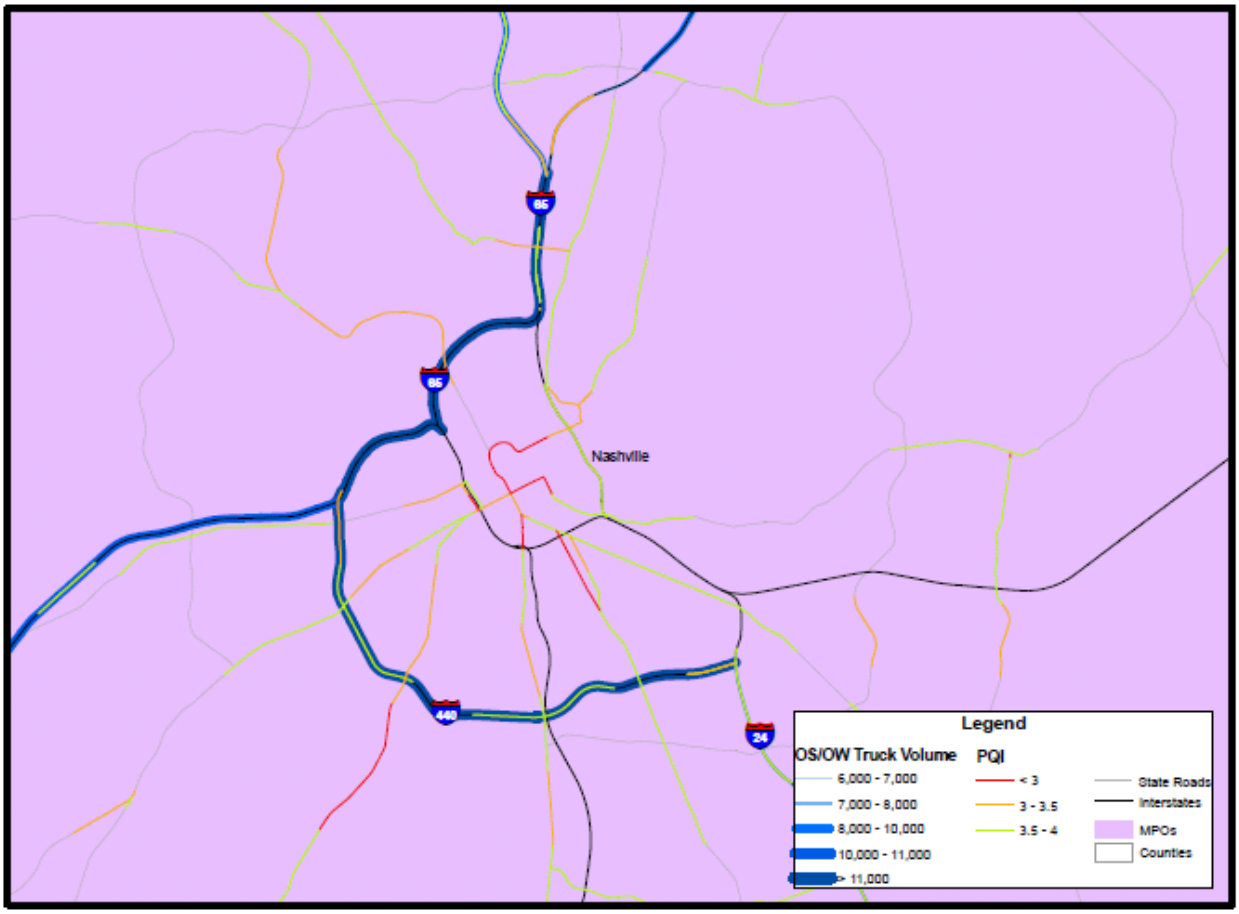


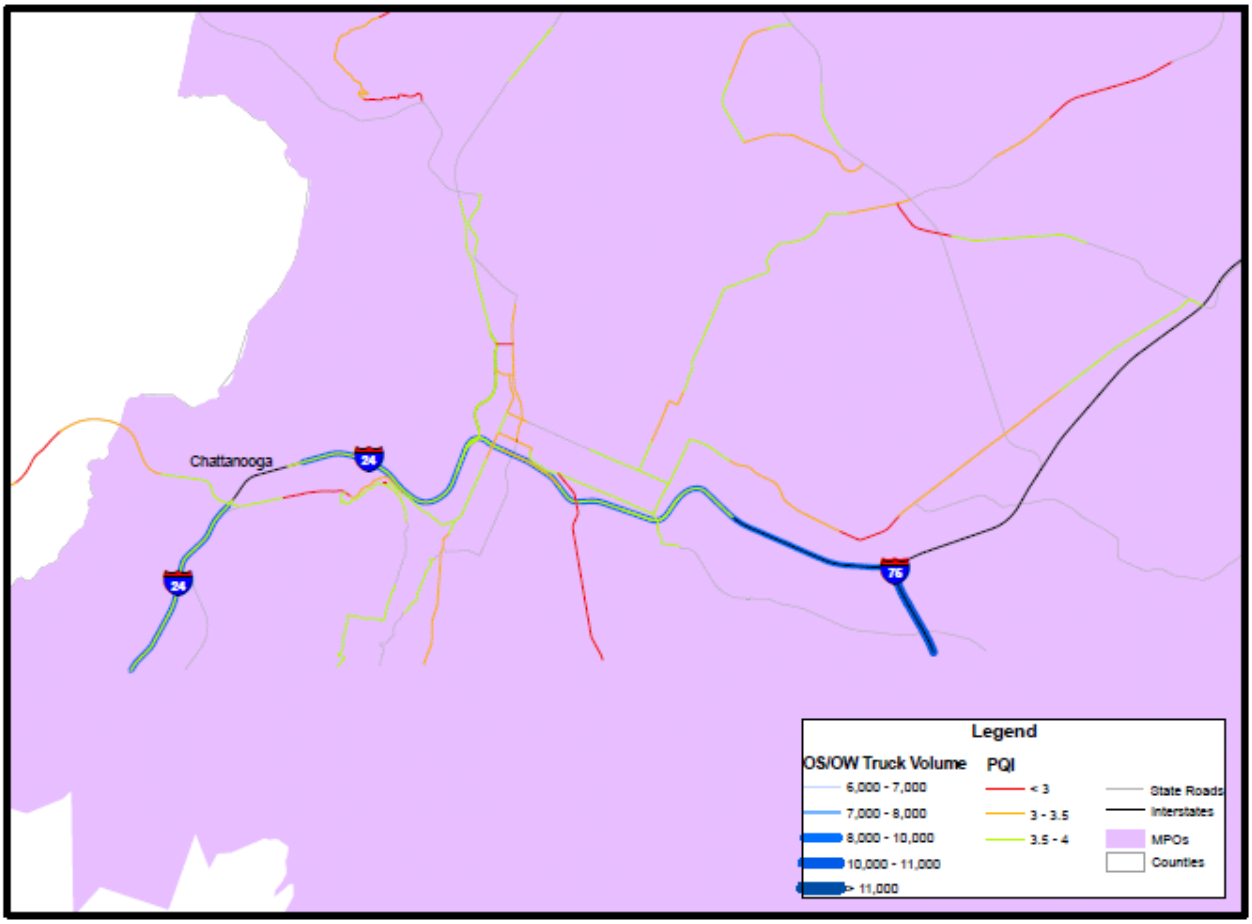
Figure 5.6 shows the blow-up map of Nashville. As can be seen, a segment of I-65, I-24, and I-440 have unsatisfactory PQI ratings and also high OS/OW truck volumes.

Figure 5.6 Overlap between PQI Ratings and OS/OW Truck Segments *In Nashville*



The blow-up map of Chattanooga is shown in Figure 5.7. Apart from a small section of I-24, the pavement condition along OS/OW truck segments is relatively good.

Figure 5.7 Overlap between PQI Ratings and OS/OW Truck Segments *In Chattanooga*



6.0 Defining Major Infrastructure Deficiencies Related to OS/OW Volumes

It is quite common nationwide for OS/OW carriers to have circuitous routes between their origins and destinations. In some cases, entire states are bypassed due to either legal, infrastructure, or customer service issues[10].

With that caveat, it is still appropriate to consider the question of where OS/OW traffic is experiencing circuitous travel in Tennessee due to infrastructure issues. A vehicle being diverted onto a circuitous route due to a bridge strengthening or raising need, for example, is often traveling over even more bridges to avoid the problem bridge. Failure to address strengthening or raising issues in a timely manner, therefore, can cause even more long-term damage on other parts of the Tennessee bridge inventory.

Identifying the specific issues, however, is a complex process. The impact of a permit vehicle on a bridge, for example, is not a linear problem with weight, but requires analysis of specific axle weight and spacing combinations to determine the specific impact of the vehicle on the bridge. Furthermore, the impact will be affected by issues such as travel speed, the ability of the equipment to spread the load over multiple lanes for short periods of space (commonly referred to as "dual lane" operations) and the presence or absence of other traffic on the bridge.

One simplification is that we can safely minimize the relevance of the annual permit vehicles in this analysis. The load ratings and clearance heights of the vast majority of bridges are well above the largest standard annual permit vehicle. Conversely, one complication is that infrastructure near the 100 most commonly used trip permit segment must also be considered, to account for the impacts of the agency's long-term construction program on likely detours during the construction period. Similar issues arise in pavement management as well as intersection and roundabout design.

The level of analysis needed to conduct an thorough assessment of likely infrastructure improvements within the timeframe of this project is beyond the level of reasonable availability of TDOT's Permit Office and Bridge Inspection and Repair department. As an alternative, we will outline the process needed to perform such an analysis as part of those departments' general operations and

[10] Examples identified in previous motor carrier outreach interviews conducted by Cambridge Systematics.

present a list of known candidate bridge strengthening and raising projects based on conversations with staff from these agency departments.

6.1 A Long-Term Process For Incorporating OS/OW Knowledge Into Asset Management Prioritization

Information Elements Required

Our proposed process is based on an incremental analysis of known permits where the shortest route (the one a regular 80,000 pound truck would take) was not utilized because the infrastructure could not accept the weight distribution and or total height of the permitted vehicle. We suggest utilizing a three-month or six-month volume of permit applications with a gross vehicle weight of 250,000 pounds and/or a maximum height of 17 feet as a starting point.

These permit loads have to then be matched up against the following elements:

- The current infrastructure inventory in TRIMS;
- The current multi-year infrastructure improvement program; and
- The immediate construction program for the next year.

Determining Prioritization Level

As described above, diversions from shortest path is a way of life in the OS/OW industry, especially at the weights and heights we are considering. To identify a candidate infrastructure project because of one or two loads is inappropriate. Instead, we are generally looking for "pinch points" on the network where a variety of origin/destination combinations are being affected.

Blending Historical Permit Volume with Future Improvement Plans

For each of the permit loads, we will want to plot both the shortest path trip as well as the actual permitted trip. This pair of plots will yield the candidate network for consideration.

Frequent segments on the shortest path map which are absent from the permitted travel map will be a flag for identifying bridges, pavement section, interchanges, intersections and roundabouts for further consideration. TRIMS data should regarding these entries should be superimposed over the travel networks, with an emphasis on identifying elements which impede OS/OW travel.

On top of this network, we then will want to superimpose the immediate construction program. To the extent that there will be construction in the coming

year, detours will need to be developed. Today, those detours are often identified for the first time when the carrier is ready to purchase a permit. For the likely detour routes, similar TRIMS data will need to be superimposed to identify which detours will and will not be appropriate.

Finally, we will want to superimpose the long-term infrastructure improvement plan, to identify which candidate projects have already been identified. For many of these projects, OS/OW volume may become a factor in deciding to accelerate the timing of the project. For others, such as roundabouts near divided highway interchanges, there may be implications on the design process when the project is approved for design.

Identifying Candidate Projects

The reader will note that the process of identifying candidate projects is truly "semi-structured." There is some structure provided by the permit volumes and the known infrastructure issues, but there is also a substantial amount of intuition required. The candidate identification process needs to be a joint effort between those involved in planning and prioritization of infrastructure projects (to provide insight about general resources and standards) and those in reviewing and approving OS/OW permit travel (to provide insight about the pitfalls during operations.)

What we expect will arise from this process is two sets of projects:

1. Some projects already being considered for other reasons, but for which OS/OW issues provide additional prioritization criteria; and
2. Other projects new to the candidate programming process.

6.2 General Examples of Projects For Immediate Consideration

In the immediate time frame, however, we wished to develop a set of projects for consideration in the FY11 planning cycle. The complexity of the problem precludes us from developing a formal list. As an alternative, we have compiled the following examples of project categories based on conversations with the Permit Office.

Bridge Raising to At Least 16 Feet in Height. The specialized hauling industry has many different types of vehicle designs, many of which are proprietary. For some of the tallest loads, carriers can utilize "basket" approaches which hydraulically suspend the load less than one foot off the ground. These approaches do add length to the total vehicle, but can often keep the maximum height closer to 16 feet than to 18 feet. By identifying bridges on and near the top 100 segments which are less than sixteen feet in height which have a reasonable probability of being successfully raised, TDOT may be able to prevent a substantial number of detours in the future.

Roundabout Projects and Signalized Intersections Near the Top 100 Segments. This is actually a caution about potential projects being developed by TDOT for other reasons. Most of the vehicles discussed in this report fare poorly when attempting to traverse a roundabout designed for standard truck traffic. There is generally not enough articulation on, for example, a 400,000 pound factory turbine to successfully navigate anything other than a right turn. Similarly, signalized intersections in the area should have the appropriate equipment to enable escort vehicles to temporarily remove or move elements interfering with the vehicles. It is imperative that the areas near the highways identified in the top 100 segments have additional prioritization and design criteria established to appropriately consider OS/OW traffic.

7.0 Findings and Recommendations

While the available data from the Permit Office cannot provide specific routes for all trips for which an OS/OW permit was purchased, the data is sufficiently illustrative both to assert findings regarding the overlap of OS/OW routes with roadway issues, as well as to assert recommendations for strengthening the linkage between OS/OW operations and safety- and infrastructure- planning functions.

Findings Regarding Safety

The analysis utilized the vast majority of the largest vehicles traveling through the State of Tennessee. It is unlikely that many vehicles with extreme widths (for example 18′ or more) or extreme lengths (for example 175′ or more) would not also be overweight. The analysis utilized over twenty months of live permit data.

When compared to the locations within Tennessee with the most accidents, either by number or by rate, there was an occasional but not consistent overlap with the highest volume segments for OS/OW traffic. While our sampling is not a true experimental design with a control set, it is highly unlikely that in general OS/OW traffic is a cause of unusual amounts of accidents on Tennessee roadways.

Findings Regarding Pavement Deterioration

Similarly, the general OS/OW traffic does not appear to have a substantial overlap with pavement deterioration. This can be explained at least in part by Tennessee's limits on maximum axle weight for permits, generally at 20,000 pounds per axle. This value, while not the lowest in the nation, is lower than many states.

The sample of vehicles, however, which are at higher rates (such as over 300,000 pounds) is relatively small. It is more difficult to assert with confidence that such loads do not cause pavement deterioration. Several states require an analysis of pavement issues on the requested route for loads exceeding a threshold weight; in Wisconsin, for example, the threshold is 270,000 pounds.

7.2 RECOMMENDATIONS

The analysis in this report highlights several key issues with the integration of the OS/OW permit issuance process to freight planning and design. Many of the laws surrounding the permit process are over fifteen years old, from an era when very few loads per year exceed 250,000 pounds, 170 feet long, or 17 feet high.

Today, these loads are far more prevalent, and loads exceeding one million pounds have utilized Tennessee's roadways.

The differences between the annual permit traffic and the heavier single-trip permit traffic trigger several items of importance for freight planning. Different parts of the Tennessee highway network have to assume different sets of vehicle mixes. On most of the state highway network, one should consider the annual permit threshold vehicle as being a candidate for utilizing the facility. But for highways on the higher volume OS/OW single-trip network, such as those segments identified in this report, a larger set of vehicles needs to be considered. Our recommendation is that the agency develop processes for targeting when OS/OW considerations need to be considered in various areas of network planning, safety analysis, asset management, and work zone operations.

The implications for safety planning primarily involve the road safety audit process (when applicable) and the design of countermeasures. For the accident sites with heavy OS/OW traffic, one must utilize a mix of the heavier OS/OW vehicle configurations to achieve the appropriate countermeasures. Staff with OS/OW permit review experience should be incorporated into the countermeasure planning and evaluation process.

While not explicitly reviewed in this report, work zone operations play a major role in both overall safety as well as safe and efficient OS/OW movement. Utilizing tools from general traveler information systems, tailoring those tools to the OS/OW community, and tying the tools back to the work zone coordinators would reduce the likelihood that a miscommunication results in a permit vehicle attempting to enter a work zone for which it will not fit.

In the area of asset management, the OS/OW volumes should be considered when developing prioritization criteria for improvement. In areas with heavy OS/OW volume, additional weight might be given to different pavement options, as well as to projects involving bridge strengthening, raising, and widening.

A. Top OS/OW Routes

Table A.1 Top 25 OS/OW Routes in Tennessee
Sorted in Descending Order

Rank	Route Number	Number of Permits	Percent Total	Cumulative Percent Total Permits
1	877	1,656	3.9	3.9
2	878	1,529	3.6	7.6
3	654	1,308	3.1	10.7
4	802	1,290	3.1	13.7
5	716	1,267	3.0	16.7
6	109139	1,234	2.9	19.7
7	528	1,126	2.7	22.3
8	717	1,030	2.4	24.8
9	863	968	2.3	27.1
10	864	961	2.3	29.4
11	537	877	2.1	31.4
12	784	872	2.1	33.5
13	880	832	2.0	35.5
14	879	827	2.0	37.4
15	803	808	1.9	39.4
16	653	699	1.7	41.0
17	738	698	1.7	42.7
18	824	657	1.6	44.2
19	785	654	1.6	45.8
20	800	614	1.5	47.2
21	737	567	1.3	48.6
22	801	502	1.2	49.8
23	618	467	1.1	50.9
24	538	461	1.1	52.0
25	576	446	1.1	53.0

B. Top 100 OS/OW Segments

Table B.1 Top 100 Non-Ramp OS/OW Segments in Tennessee
Sorted in Descending Order

Segment Number	OS/OW Truck Volume	Route Segment Description	End Point	Mileage	Beginning Point
148	17,276	I-440 Exit 3 in Davidson County to Exit 5	I-65	1.60	SR 106 (U.S. 431)
146	17,276	I-440 Exit 1 in Davidson County to Exit 3	SR 106 (U.S. 431)	1.15	SR 1 (U.S. 70S)
143	17,276	I-440 Mile Marker "0" in Davidson County to Exit 1	SR 1 (U.S. 70S)	1.27	I-40
237	16,096	I-40 Exit 206 in Davidson County to Exit 208	I-65	1.30	I-440
198	16,096	I-65 Exit 85 in Davidson County to Mile Marker 86.4	I-24 Junction	1.30	SR 12
196	16,096	I-65 Mile Marker 84 to Exit 85 in Davidson County	SR 12	1.00	I-40
201	16,092	I-65 Mile Marker 86.4 in Davidson County to Exit 88	I-24 Junction	2.20	I-24 Jct.
270	15,301	I-40 Exit 1F in Shelby County to Exit 3	SR 300	2.60	SR 14
153	13,450	I-440 Exit 5 in Davidson County to Exit 7	I-24	1.15	SR 11 (U.S. 31A/41A)
150	13,450	I-440 Exit 5 in Davidson County to Exit 6	SR 11 (U.S. 31A/41A)	1.27	I-65
292	11,336	I-40 Exit 79 in Madison County to Exit 80	SR 186 (U.S. 45 By-Pass)	0.90	SR 20 (U.S. 412)
617	11,131	I-40 Exit 368 in Loudon County to Exit 369	Watt Road (1248/2422)	1.00	I0075
298	11,004	I-40 Exit 87 in Madison County to Exit 108 in Henderson County	SR 22	20.90	SR 1 (U.S. 70)
296	11,004	I-40 Exit 82 in Madison County to Exit 87	SR 1 (U.S. 70)	4.60	SR 5 (U.S. 45)
294	11,004	I-40 Exit 80 in Madison County to Exit 82	SR 5 (U.S. 45)	1.20	SR 186 (U.S. 45 By-Pass)
622	10,978	I-40 Exit 376 in Knox County to Exit 385 @ I-640	I0640	8.70	I0140/SR162
529	10,978	I-40 Exit 374 to Exit 376 in Knox County	SR 162	1.10	SR 131 (Lovell Road)
145	10,978	I-640 Exit 1 to Exit 3 in Knoxville	I0275 Junction	1.62	SR 062
123	10,978	I-640 Exit "0" to Exit "1" in Knoxville	SR062	1.18	I0040
619	10,973	I-40 Exit 369 in Knox County to Exit 374	SR131	5.20	Watt Road (1248/2422)
227	10,616	I-40 Exit 182 in Williamson County to Exit 196 in Davidson County	SR 1 (U.S. 70S)	13.90	SR 96
276	10,498	I-40 Exit 12 in Shelby County to Exit 16	SR 177	5.80	I-240
274	10,498	I-40 Exit 8 in Shelby County to Exit 12C	I-240	3.40	SR 14

Segment Number	OS/OW Truck Volume	Route Segment Description	End Point	Mileage	Beginning Point
272	10,498	I-40 Exit 3 in Shelby County to Exit 8	SR 14	4.30	SR 300
301	10,485	I-40 Exit 108 in Henderson County to Exit 126 in Decatur County	SR 69 (U.S. 641)	17.60	SR 22
496	10,474	I-40 Exit 16 to Exit 18 in Memphis	U.S. 64 (SR 15)	1.10	SR 177
290	10,474	I-40 Exit 76 in Madison County to Exit 79	SR 20 (U.S. 412)	2.40	SR 233
287	10,474	I-40 Exit 66 in Haywood County to Exit 76 in Madison County	SR 223	10.00	SR 1 (U.S. 70)
285	10,474	I-40 Exit 56 in Haywood County to Exit 66	SR 1 (U.S. 70)	8.90	SR 76
283	10,474	I-40 Exit 35 in Fayette County To Exit 56 in Haywood County	SR 76	20.70	SR 59
281	10,474	I-40 Exit 24 in Shelby County to Exit 35 in Fayette County	SR 59	10.60	SR 385
279	10,474	I-40 Exit 18 in Shelby County to Exit 24	SR 385	6.90	SR 15 (U.S. 64)
231	10,421	I-40 Exit 201 in Davidson County to Exit 204	SR 155 (Briley Parkway)	2.40	SR 24 (U.S. 70)
229	10,421	I-40 Exit 196 in Davidson County to Exit 201	SR 24 (U.S. 70)	4.40	SR 1 (U.S. 70S)
225	10,421	I-40 Exit 176 in Dickson County to Exit 182 in Williamson County	SR 96	4.90	SR 840
223	10,421	I-40 Exit 172 in Dickson County to Exit 176	SR 840	3.70	SR 46
219	10,421	I-40 Exit 143 in Humphreys County to Exit 172 in Dickson County	SR 46	29.30	SR 13
217	10,421	I-40 Exit 126 in Decatur County to Exit 143 in Humphreys County	SR 13	16.50	SR 69 (U.S. 641)
36	10,155	I-75 Exit 1 in Hamilton County to Mile Marker 2	I0024	0.48	SR008
33	10,155	I-75 from Georgia to Exit 1 in Hamilton County	SR008	0.10	Georgia State Line
366	10,120	I-640 Exit 6 to I-40 Exit 393 in Knoxville	I0040 East End	4.19	SR 033 (U.S. 441)
344	10,120	I-640 Exit 3 to Exit 6 in Knoxville	SR033 (U.S. 441)	1.93	I0275
614	10,106	I-40 Exit 415 in Jefferson County to Exit 417	SR092	2.13	SR009 (U.S.25E/U.S. 70)
592	10,106	I-40 Exit 407 in Sevier County to Exit 415 in Jefferson County	SR009 (U.S. 25E/U.S. 70)	7.42	SR066
443	10,106	I-40 Exit 398 in Knox County to Exit 407 in Sevier County	SR066	9.07	Strawberry Plains Road (1124)
221	10,106	I-40 Exit 394 in Knox County to Exit 398	Strawberry Plains Road (1124)	3.00	SR009 (U.S. 11E)
1	10,106	I-40 Exit 393 in Knox County to Exit 394	SR009 (U.S. 11E)	0.53	I0640 East End
13	10,098	I-40 Exit 417 in Jefferson County to Exit 421	I0081	3.07	SR092
234	10,086	I-40 Exit 204 in Davidson County to Exit 206	I-440	1.60	SR 155 (Briley Parkway)
139	9,184	I-24 Exit 180 in Hamilton County to Exit 185	I0075	3.80	U.S. 27 (SR 27)

Segment Number	OS/OW Truck Volume	Route Segment Description	End Point	Mileage	Beginning Point
137	9,184	I-24 Exit 178 in Hamilton County to Exit 180	U.S. 27 (SR 27)	1.40	U.S. 27 (I-124)
260	9,154	I-24 Georgia State Line to Exit 174 in Hamilton County	SR 2 (U.S. 41/64/72)	2.70	Georgia State Line
135	9,154	I-24 Exit 174 in Hamilton County to Exit 178	U.S. 27 (I-124)	4.20	U.S. 41/64/72 (SR 2)
168	9,038	I-24 Exit 35 in Davidson County to Exit 44	I-65	1.00	SR 155 (Briley Parkway)
265	8,615	I-40 Exit 1A/1B in Shelby County to Exit 1E	I-240 Junction	0.70	SR 1 (U.S. 51)
263	8,615	I-40 from Arkansas State Line to Exit 1A, 1B, and 1C in Shelby County	SR 1 (U.S. 51)	1.20	Arkansas State Line
165	8,229	I-24 Exit 35 in Davidson County to Exit 43	SR 155 (Briley Parkway)	8.10	SR 65 (U.S. 431)
215	8,202	I-65 Exit 117 in Robertson County to Kentucky Border	Kentucky Border	3.60	SR 52
213	8,202	I-65 Exit 112 in Robertson County to Exit 117	SR 52	4.60	SR 25
211	8,202	I-65 Exit 98 in Sumner County to Exit 112 in Robertson County	SR 25	13.30	SR 41 (U.S. 31W)
208	8,202	I-65 Exit 95 in Davidson County to Exit 98 in Sumner County	SR 41 (U.S. 31W)	3.10	SR 386
206	8,202	I-65 Exit 90-B in Davidson County to Exit 95	SR 386	6.30	SR 155
334	8,092	I-240 Exit 29 in Shelby County to Exit 28	South Parkway	1.50	SR 4 (U.S. 72)
330	8,092	I-240 Exit 30 in Shelby County to Exit 29	SR 4 (U.S. 78)	0.30	SR 3 (U.S. 72)
328	8,092	I-240 Exit 31 in Shelby County to Exit 30	SR 3 (U.S. 72)	0.60	I-40
268	7,916	I-40 Exit 1E in Shelby County to Exit 1F	SR 14	0.20	I-240 Junction
203	7,885	I-65 Exit 88 in Davidson County to Exit 90-A	SR 11 (U.S. 31W/41)	0.90	I-24 Junction
410	7,811	I-81 Exit 1 in Jefferson County to Exit 8 in Hamlen County	SR032 (U.S. 25E)	8.00	I0040
132	7,491	I-24 Exit 161 in Marion County to Georgia State Line	Georgia State Line	5.60	SR 156
130	7,491	I-24 Exit 155 in Marion County to Exit 161	SR 156	5.40	SR 28
128	7,491	I-24 Exit 152 in Marion County to Exit 155	SR 28	3.20	U.S. 72 (SR 27)
315	7,405	I-155 Exit 13 (SR 78) to Exit 15 (U.S. 412) in Dyer County	SR 20	2.50	SR 78
126	7,367	I-24 Exit 135 in Marion County to Exit 152	U.S. 72 (SR 27)	18.40	U.S. 41 (SR 2)
124	7,367	I-24 Exit 134 in Marion County to Exit 135	U.S. 41 (SR 2)	1.00	U.S. 41A (SR 15)
121	7,367	I-24 Exit 127 in Grundy County to Exit 134 in Marion County	U.S. 41A (SR 15)	6.50	U.S. 64 (SR 50)
92	7,366	I-24 Exit 53 in Davidson County to Exit 54	SR 155	1.00	I-440
119	7,361	I-24 Exit 114 in Coffee County to Exit 127 in Grundy County	U.S. 64 (SR 50)	13.30	U.S. 41 (SR 1)
117	7,361	I-24 Exit 111 in Coffee County to Exit 114	U.S. 41 (SR 1)	2.10	SR 55

Segment Number	OS/OW Truck Volume	Route Segment Description	End Point	Mileage	Beginning Point
115	7,361	I-24 Exit 105 in Coffee County to Exit 111	SR 55	6.00	U.S. 41 (SR 2)
113	7,361	I-24 Exit 97 in Coffee County to Exit 105	U.S. 41 (SR 2)	8.00	SR 64
109	7,361	I-24 Exit 81 in Rutherford County to Exit 97 in Coffee County	SR 64	15.20	U.S. 231 (SR 10)
107	7,361	I-24 Exit 78 in Rutherford County to Exit 81	U.S. 231 (SR 10)	2.90	SR 96
105	7,361	I-24 Exit 74 in Rutherford County to Exit 78	SR 96	3.00	SR 840
103	7,359	I-24 Exit 66 in Rutherford County to Exit 74	SR 840	7.30	SR 266
101	7,359	I-24 Exit 64 in Rutherford County to Exit 66	SR 266	1.60	Waldron Road
98	7,359	I-24 Exit 62 in Davidson County to Exit 64 in Rutherford County	Waldron Road	1.40	SR 171
96	7,359	I-24 Exit 59 in Davidson County to Exit 62	SR 171	2.60	SR 254
94	7,359	I-24 Exit 54 in Davidson County to Exit 59	SR 254	5.40	SR 155
499	7,357	I-81 Exit 50 in Washington County to Exit 57 in Sullivan County	I0026	6.10	SR093
477	7,357	I-81 Exit 30 in Greene County to Exit 50 in Washington County	SR093	19.50	SR070
455	7,357	I-81 Exit 23 in Greene County to Exit 30	SR070	7.00	SR034 (U.S. 25E)
432	7,297	I-81 Exit 8 in Hamblen County to Exit 23 in Greene County	SR034 (US11E)	14.60	SR032 (U.S. 25E)
322	7,204	SR 3 (U.S. 51) from SR 22 in Obion County to SR 215 (U.S. 51 By-Pass)	SR 215 (U.S. 51 By-Pass)	7.00	SR 22
157	6,999	I-24 from KY State Line to Exit 4 in Montgomery County	SR 13 (U.S. 79)	2.60	Kentucky State Line
163	6,993	I-24 Exit 24 in Robertson County to Exit 35 in Davidson County	SR 65 (U.S. 431)	9.50	SR 49
161	6,993	I-24 Exit 11 in Montgomery County to Exit 24 in Robertson County	SR 49	13.50	SR 76
159	6,993	I-24 Exit 4 in Montgomery County to Exit 11	SR 76	5.90	SR 13 (U.S. 79)
318	6,845	SR 3 (U.S. 51) from SR 431 in Obion County to SR 5	SR 5	0.80	SR 431
317	6,845	SR 3 (U.S. 51) from SR 20 (U.S. 412) in Dyer County to SR 431 in Obion County	SR 431	28.40	SR 20 (U.S. 412)
319	6,831	SR 3 (U.S. 51) from SR 5 in Obion County to SR 22	SR 22	4.20	SR 5

C. Definition of Pavement Condition Terms

Explanation of Terms

IRI – International Roughness Index

- Measurement of the number of vertical deviations over a section of road.
- (i.e. inches/mile)
- Perfect is a "0"

HC IRI – Half-Car IRI

- Half-Car IRI is used by TDOT's profilers for acceptance testing and warranty jobs. The standard method that is collected by our consultants is Quarter-Car IRI. Half-Car IRI values tend to be slightly better than Quarter-Car IRI values obtain from the same location.

PSI – Present Serviceability Index

- Measure of the ROUGHNESS of the road on a scale of 0 – 5.
- Perfect is a "5"
- Roughness is defined as: "The deviations of a pavement surface from a true planar surface with characteristic dimensions that affect vehicle dynamics, ride quality, dynamic loads, and drainage; for example, longitudinal profile, transverse profile, and cross slope."
- Relates to IRI through: $PSI = 5 * e^{(-0.0055*IRI)}$

PDI – Pavement Distress Index

- A measurement of the roadway DISTRESS on a scale from 0 – 5.
- Perfect is a "5"
- Distresses that are evaluated include the following: Fatigue, Rutting, Longitudinal Cracks In the Wheel Path, Patching, Block Cracking, Raveling, Transverse Cracks, Longitudinal Cracks (Non-Wheel Path), & Longitudinal Cracks In the Lane Joints.
- Each individual Distress mentioned above receives a DEDUCT VALUE based on the severity & number of distresses on a given stretch of road surface.
- All of the D.V.s are given a weight and subtracted from 5.

PQI – Pavement Quality Index

- Overall Index of the roadway on a scale from 0 – 5.
- Perfect is a "5"
- $PQI = PDI^{0.7} * PSI^{0.3}$
- PDI encompasses the largest portion of this index because Pavement Distresses indicate current problems and future deterioration of the roadway surface.