I-40 / I-81 Corridor Feasibility Study

Task 3.0

Multi-Modal Solutions

Technical Memorandum

April 2008

Executive Summary

In 2005 the Tennessee Department of Transportation (TDOT) completed the State's first 25-Year Long Range Transportation Plan (PLAN *Go*). A major component of the 25-Year Vision Plan included the advancement of a 10-Year Strategic Investment Plan. The 10-Year Strategic Investment Plan established three interrelated core investment initiatives: Congestion Relief, Transportation Choices, and Key Corridors.

The Interstate 40/Interstate 81 (I-40/I-81) Corridor from Bristol to Memphis was identified through the statewide planning effort as a strategic statewide corridor and several projects along the corridor are included in the 10-Year Plan as a high priority. The purpose of the I-40/I-81 Corridor Feasibility Study is begin to develop a more detailed understanding of the deficiencies of the corridor and to develop corridor level multi-modal solutions to address these deficiencies. The study will consider improvements to the I-40/I-81 corridor, look at parallel arterials to I-40/I-81 that could be used for local travel, examine rail lines that could be candidates for freight diversion from the interstate, and also consider major inter-modal hubs located along the corridor.

The study's final product will be a prioritized listing of multi-modal projects that can be considered by TDOT for the Department's transportation improvement program. Identified multi-modal solutions will address capacity, operations and maintenance, safety, freight movement, inter-modal connections, and economic access issues along the study corridor.

The study area for the I-40/I-81 corridor extends from Memphis to Bristol, a distance of about 550 miles, and traverses 27 of the 95 counties within Tennessee. The study area falls within nine of the twelve Rural Planning Organization (RPO) boundaries and eight of the eleven Metropolitan Planning Organization (MPO) and Transportation Planning Organization (TPO) areas. Numerous cities including Memphis, Jackson, Nashville, Lebanon, Cookeville, Crossville, Knoxville, Sevierville, Jefferson City, Morristown, Ridgeway, Kingsport, Johnson City and Bristol are dependent upon this corridor for commerce, tourism, and daily access. The study area also includes parallel Class I railroads, including their junctions with short-line railroads.

The Technical Memorandum for Task 3, Multi-Modal Solutions, identifies multi-modal solutions within the study corridor to address deficiencies associated with:

- Capacity
- Operations and Safety
- Freight Movement/Diversion and Intermodal Facilities

The report describes the results of a screening analysis conducted on possible multi-modal solutions for the I-40/I-81 corridor. The analysis was performed on four "packages" of initial solutions that exhibited strong potential for addressing corridor deficiencies:

- Roadway Capacity – providing additional capacity to I-40/I-81 by widening the existing interstate

- Corridor Capacity – providing additional capacity to parallel highway routes (by-passes or widening parallel arterials) as well as implementing high capacity transit projects in Memphis and Nashville

- Rail-Focused Improvements – diverting freight from trucks traveling along I-40 to rail lines

- Intelligent Transportation System (ITS)/Operational Solutions – providing variable message signs, traveler information, weather management systems, interchange improvements, truck climbing lanes, etc. This package also includes improvements to existing high occupancy vehicle (HOV) lanes along I-40 in Memphis and Nashville.

The analysis tools used for the Roadway Capacity and Corridor Capacity "packages" of solutions were the TDOT Statewide Travel Demand Model in conjunction with the MPO models for Memphis, Nashville, and Knoxville. The proposed projects were coded into the model's network and the output statistics of each model run was tabulated separately across each of the following geographic regions:

- Memphis MPO area;

- Memphis to Jackson;

- Jackson MPO area;

- Jackson to Nashville;

- Nashville MPO area;

- Nashville to Knoxville; and

- Lakeway and Tri-Cities MPO areas east to the Virginia state line

For the Rail-Focused improvements scenario, the truck-rail diversion tool developed in Task 2 was used to estimate the impact of the Trans-Tennessee corridor and the new Mississippi River Bridge Crossing. Truck-rail diversion from the Crescent Corridor was estimated with a combination of tools. First, information on the proposed rail service characteristics and market size were extracted from Norfolk Southern material. The 2002 Bureau of Transportation Statistics Commodity Flow Survey was used to estimate the market share of the rail service by obtaining market share information from other corridors with a similar competitive position as the Crescent Corridor. Truck origin-destination surveys conducted in Virginia were used to estimate the routes taken by diverted trucks and therefore the amount of trucks diverted from I-40/I-81. For the Operational Solutions "package", the ITS Deployment Analysis System (IDAS) software was employed to estimate the benefits of ITS solutions for both recurring and nonrecurring criteria.

To estimate safety improvements for each of the packages, accident rates and fatality rates were extracted from TDOT's crash database. Accident rates were estimated as a function of road classification, volume and volume-to-capacity ratios. These rates were applied to each of the packages to estimate the change in accidents on I-40/I-81 for each scenario.

Each “package” of solutions was evaluated using throughput, congestion, and safety criteria as shown in **Table E-1**. This table also compares each package to the existing-plus-committed (E+C) highway networks for horizon years 2011 and 2030. Full results of the evaluation are shown for each package and each geographic region in **Appendix D** of this technical memorandum. The results of the evaluation of these broad “packages” of improvements are:

- The overall benefits of the ITS/Operational Solutions “package” are minor. Because of these solutions’ low costs and ease of implementation, they likely will have acceptable benefits-to-cost (B/C) ratios. These solutions can likely be implemented relatively quickly.

- The Rail-Focused “package” provides modest improvements to delay and safety, and potential solutions will be pursued in Task 4 to determine individual B/C ratios. Analysis to date shows greater benefits for this scenario occur in eastern Tennessee than in the western region of the state.

- The Corridor Capacity “package” of solutions appears to be most viable in the Memphis, Nashville and Knoxville regions. It does provide the best results in terms of safety for the corridor. Because delay improvements are modest, this scenario can not be a standalone alternative.

- The Roadway Capacity scenario provides the best overall results in terms of vehicle throughput and delay reduction for the I-40/I-81 corridor.

In Task 4, each solution found to be significant along the corridor will be prioritized based on individual B/C ratios.

Table E-1: Evaluation Results for Solution "Packages"

Evaluation Criteria	Baseline		Packages			
	2011 Existing + Committed Network	2030 Existing + Committed Network	2030 Roadway Package	2030 Corridor Package	2030 Rail Package	2030 Operations Package
Number of Hours of Auto Travel	412,470	613,653	574,882	562,833	613,653	613,653
Number of Hours of Recurring Auto Delay	149,281	307,783	95,232	272,948	277,526	307,783
Total Auto VMT	25,512,997	30,714,634	34,271,150	29,948,652	30,714,634	30,714,634
Number of Hours of Truck Travel	149,731	275,201	250,055	252,373	268,531	275,201
Number of Hours of Recurring Truck Delay	56,757	153,050	105,265	135,213	138,003	153,050
Total Truck VMT	9,170,315	14,396,805	14,537,649	13,673,388	13,227,005	14,396,805
Time to Travel Across Entire Corridor	634	753	649	729	735	748
Average Delay Time to Travel Across Entire Corridor	66	189	86	169	172	189
Total Number of Accidents	7,700	9,114	8,733	8,560	8,844	9,086
Total Number of Fatalities	77	94	90	87	91	94
Total Accidents at High Crash Locations	2,779	3,248	1,321	n/a	n/a	3,248

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1.0 INTRODUCTION

1.1 Project Background

In 2005 the Tennessee Department of Transportation (TDOT) completed the State's first 25-Year Long Range Transportation Plan (PLAN *Go*). A major component of the 25-Year Vision Plan included the advancement of a 10-Year Strategic Investment Plan. The 10-Year Strategic Investment Plan established three interrelated core investment initiatives: Congestion Relief, Transportation Choices, and Key Corridors.

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The study's final product will be a prioritized listing of multi-modal projects that can be considered by TDOT for the Department's transportation improvement program. Identified multi-modal solutions will address capacity, operations and maintenance, safety, freight movement, inter-modal connections, and economic access issues along the study corridor.

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1.2 Purpose of Report

The Technical Memorandum for Task 3, Multi-Modal Solutions, identifies multi-modal solutions within the study corridor to address deficiencies associated with:

- Capacity
- Operations and Safety
- Freight Movement/Diversion and Intermodal Facilities
- Economic Access

The report describes the results of two screening analyses conducted on possible multi-modal solutions for the I-40/I-81 corridor. The first analysis was performed on four "packages" of initial solutions that exhibited strong potential for addressing corridor

deficiencies. The results of the evaluation of these "packages" were summarized for eight geographical areas along the study corridor. This preliminary screening of improvement concepts was followed by a more detailed screening of projects to be prioritized in the next phase of the study.

1.3 Organization and Content

Multi-modal solutions identified through this task are presented as follows:

- Chapter 2, Capacity, examines addressing traffic congestion issues along I-40 and I-81 from two perspectives:

    - By widening existing I-40 and I-81 to accommodate current and projected traffic volumes generated by TDOT's Statewide Model and travel demand models for the Nashville, Memphis, Knoxville, Jackson, Bristol, Kingsport, Johnson City and Lakeway urban areas.
    - By widening parallel arterials and constructing roadway alternatives, such as urban area by-passes, within the study corridor in order that less traffic uses I-40 and I-81.

- Chapter 3, Operations and Safety, identifies solutions to improve operations and safety at locations along I-40 and I-81 where poor highway geometrics affect traffic flow and safety. These solutions include strategies such as interchange improvements and construction of truck climbing lanes. The chapter also lists recommended improvements in Tennessee's Intelligent Transportation System (ITS) and Incident Management programs as well as changes to the operation of existing high occupancy vehicle (HOV) lanes in Nashville and Memphis.

- Chapter 4, Freight Movement/Diversion and Intermodal Facilities, identifies opportunities for diverting freight movements in the I-40/I-81 corridor from truck to rail. As part of improving the attractiveness of rail for corridor freight movements, the need for new or improved intermodal facilities is discussed.

- Chapter 5, Evaluation, describes the methodology and results from analyzing four "packages" of potential solutions for the I-40/I-81 corridor.

2.0 CAPACITY

In the technical memorandum for Task 2, Identification of Deficiencies, 2030 congestion levels were identified based on TDOT's Statewide Model and the urban travel demand models along the I-40/ I-81 corridor. This group of TransCAD models forecasts future traffic volumes based on 2030 population and employment projections and committed roadway improvements as shown in TDOT's latest Transportation Improvement Plan (TIP) which extends to 2008-2010.

Two approaches were used to address the forecasted congestion along the corridor:

- Widening existing I-40 and I-81 to the number of lanes required to accommodate projected traffic volumes along the interstate highway.
- Widening parallel roadways and/or building new highways, such as urban area by-passes, within the study corridor in order that less traffic uses I-40 and I-81.

2.1 Roadway Capacity

This "package" of improvements includes widening projects along existing I-40 and I-81 that would achieve a minimum of LOS D in rural areas and LOS E in urban areas in 2030 based on results from TDOT's Statewide Model and the urban area models. All model runs using the Statewide Model assumed an existing-plus-committed (E+C) highway network. **Appendix A** lists the projects from the E+C highway network included in the model runs performed for the study. Adjustments were made to number of coded lanes to reflect programmed facility widening, and future planned corridors were added or removed from the network, as necessary. In the case of urban area models, adjustments were made to external trip estimates on I-40 and I-81 to achieve consistency with future year forecasts from the Statewide Model. Table 2-1 summarizes the I-40 and I-81 segments which were widened to test how effectively these improvements accommodate forecasted traffic volumes along the corridor.

Figure 2-1 through **Figure 2-8** shows the portions of I-40 and I-81 that would be widened in the roadway capacity "package".

Table 2-1: Roadway Capacity "Package" of Solutions

Region	Solution or Project
Memphis	* Add lanes to provide an 8-lane facility along the east-west segment from the river through downtown to I-240 Midtown. * Add north 2nd/3rd Street connector from north of downtown to SR-300. * Widen to 8 lanes from SR-300 to US-64. * Existing 4-lane segments east of Memphis would be widened to 6 lanes out to MPO/model boundary.
Memphis to Jackson	* Widen to 6 lanes
Jackson	* Widen to 6 lanes
Jackson to Nashville	* Widen to 6 lanes to SR-840
Nashville (Dickson to Lebanon)	* Widen from 4 lanes to 6 lanes between SR-840 and US-70. * Widen from 6 lanes to 8 lanes between US-70 and SR-155. * Add 4 managed lanes between I-440 and I-24 (widen from 6 lanes to 10 lanes). * Add 4 managed lanes from I-24 (West) to I-24 (East)(widen from 8 lanes to 12 lanes). * Widen from 6 lanes to 8 lanes between I-24 (East) and SR-155. * Widen from 4 lanes to 6 lanes between SR-171 and Lebanon.
Lebanon to Knoxville	* Widen to 6 lanes from Lebanon to I-75 west of Knoxville.
Knoxville	* Widen from 7 lanes to 8 lanes between I-75 (South) and Watt Rd. * Widen from 6 lanes to 8 lanes between Watt Rd and I-140. * Widen from 8 lanes to 10 lanes between I-140 and I-75 (North). * Widen from 6 lanes to 8 lanes between I-275 (North) and North 5th Ave.
Lakeway & Tri-Cities	* Widen I-81 to 6 lanes from I-40 to VA state line.

2.1.1 Constructability

The feasibility of widening I-40 and I-81 from four to six lanes, in those locations where the interstate has fewer than three lanes in each direction, was determined based on overall construction cost and photolog analysis. A visual inspection of the entire corridor was conducted using photologs available through the Tennessee Roadway Information Management System (TRIMS) to determine constructability. This visual inspection identified areas with steep side-slopes and guardrail, indicating the need for extensive earthwork to

widen the interstate. Elevation differences between eastbound and westbound lanes indicated potential constraints to widening in the median. Locations with limited right-of-way because of frontage roads or substantial rock cuts also were identified.

The aforementioned analysis required sub-dividing the corridor into roadway segments that maintained a uniform length and cross-section characteristics to the maximum extent possible. **Figure 2-9** to **Figure 2-11** show segmentation for the three regions crossed by the corridor.

A segment-by-segment assessment of constructability is included in **Appendix B**. The appendix provides images which were extracted from the TRIMS database and reflect either a typical cross-section for the study segment or the most challenging example for widening that segment. The segments are denoted by county log miles (LM) as used in TRIMS.

2.1.2 Construction Cost Estimates

Construction costs for each segment were estimated using the values shown in **Table 2-2**. These values are based on average costs for similar projects as supplied by TDOT's Long Range Planning Division.

In estimating construction costs, segments including medians with concrete barriers were considered more challenging and expensive to build because these segments can not be widened to the inside. Right-of-way costs based on the values shown in **Table 2-2** were determined for the length of I-40 or I-81 which contained barrier sections. For all segments, the per-mile cost for construction was multiplied by the length of the segment to determine a preliminary figure, which was in turn adjusted by appropriate factors to generate a base cost estimate.

As a final step in estimating I-40 and I-81 widening costs, expenses for bridges, interchanges and constructability constraints were estimated for each segment. By using TRIMS data, the number of bridges and interchanges per segment that would need to be replaced or modified if I-40 or I-81 was widened to six lanes was identified. The photologs were reviewed to estimate the percentage of each segment with constructability constraints, and an additional construction cost of $10 million per mile was applied to the percentage of the segment with constructability issues. Preliminary engineering costs were estimated at 10 percent of the projected construction amount. The total estimated cost for each segment is shown in **Table 2-3**.

Table 2-2: Cost Estimation Factors

Base Per Mile ROW Cost	$850,000
Right Of Way (ROW) Factor	
Area	Factor
Central Business District, Urbanized	12.50
Commercial	3.25
Fringe (Mixed, Residential/Commercial)	1.75
Residential	1.75
Rural	1.00
Base Per Mile Construction Cost	$2,700,000
Terrain Factor	
Area	Factor
Flat	1.00
Rolling	1.30
Mountainous	2.30
Major River Crossing	$16,500,000
Bridges (Overpass, Underpass)	$4,000,000
Interchanges	$8,000,000
Major Interstate Interchange	$12,000,000
Constructability Cost	$10,000,000
Preliminary Engineering Cost (Percent of Construction Cost)	10%

Table 2-3: Estimated Construction Costs by Segment for Widening I-40 and I-81 from Four to Six Lanes

(All Costs are in Thousands of Dollars)

Map Tile	Segment	Begin Log Mile	Begin Log Mile County	End Log Mile	End Log Mile County	Length (mi)	ROW Width	Structure Value	% Barrier	% Grade	% Const. Constraints	Estimated Cost	Cost Per Mile
1	A	22.35	Shelby	27.1	Shelby	4.75	300	1.68	0%	15%	0%	$ 42,340	$ 8,914
1	B	27.1	Shelby	8.23	Fayette	11.73	300	1.62	0%	11%	0%	$ 109,290	$ 9,317
1	C	8.23	Fayette	15	Fayette	6.75	300 - 500	0.59	0%	0%	0%	$ 46,062	$ 6,824
1	D	15	Fayette	4.04	Haywood	5.15	300 - 500	0.97	0%	0%	0%	$ 40,285	$ 7,822
1	E	4.04	Haywood	13.1	Haywood	9.08	300	0.66	0%	3%	0%	$ 71,468	$ 7,871
1	F	13.1	Haywood	22.5	Haywood	9.39	300	0.32	0%	0%	0%	$ 55,888	$ 5,952
1	G	22.5	Haywood	7.59	Madison	8.97	300	1.34	0%	0%	0%	$ 69,404	$ 7,737
1	H	7.59	Madison	13.1	Madison	5.51	300	0.91	0%	0%	0%	$ 77,274	$ 14,024
1	I	13.1	Madison	19.6	Madison	6.48	300	1.08	0%	0%	0%	$ 81,019	$ 12,503
1	J	19.6	Madison	26.2	Madison	6.64	300	0.60	0%	0%	0%	$ 49,637	$ 7,475
1	K	26.2	Madison	5.6	Henderson	7.32	300	0.27	0%	10%	0%	$ 44,263	$ 6,047
1	L	5.6	Henderson	12.8	Henderson	7.22	300	0.14	0%	0%	0%	$ 39,876	$ 5,523
1	M	12.8	Henderson	20.9	Henderson	8.11	300 - 700	0.74	0%	13%	7%	$ 69,557	$ 8,577
1	N	20.9	Henderson	5.45	Decatur	8.31	300 - 700	0.36	0%	24%	35%	$ 84,078	$ 10,118
1	O	5.45	Decatur	6.95	Benton	7.11	300	0.84	0%	0%	0%	$ 43,452	$ 6,111
1	P	6.95	Benton	7.93	Humphreys	9.44	300	0.53	19%	12%	20%	$ 127,299	$ 13,485
1	Q	7.93	Humphreys	13.3	Humphreys	5.35	300	0.19	0%	18%	0%	$ 32,656	$ 6,104
1	R	13.3	Humphreys	4.08	Hickman	4.15	300	1.20	0%	0%	0%	$ 56,523	$ 13,620
1	S	4.08	Hickman	2.52	Hickman	11.04	300	0.45	0%	46%	25%	$ 100,985	$ 9,147
1	T	2.52	Hickman	9.2	Dickson	9.03	300	0.33	0%	13%	50%	$ 104,530	$ 11,576
1	U	9.2	Dickson	0.79	Williamson	8.43	300 - 900	0.83	0%	33%	75%	$ 134,096	$ 15,907
1	V	0.79	Williamson	3.46	Cheatham	5.77	300	0.35	0%	22%	70%	$ 86,707	$ 15,027
1	W	3.46	Cheatham	3.65	Davidson	7.33	300	0.82	13%	25%	66%	$ 120,169	$ 16,394

Table 2-3 continued

Estimated Construction Costs by Segment for Widening I-40 and I-81 from Four to Six Lanes

(All Costs are in Thousands of Dollars)

Map Tile	Segment	Begin Log Mile	Begin Log Mile County	End Log Mile	End Log Mile County	Length (mi)	ROW Width	Structure Value	% Barrier	% Grade	% Const. Constraints	Estimated Cost	Cost Per Mile
2	A	4.61	Wilson	8.76	Wilson	5.07	300 - 500	0.59	13%	13%	0%	$ 28,557	$ 5,633
2	B	8.76	Wilson	12.1	Wilson	3.36	300 - 500	0.89	0%	0%	0%	$ 24,973	$ 7,432
2	C	12.1	Wilson	16.5	Wilson	4.33	300	1.62	0%	0%	25%	$ 76,626	$ 17,697
2	D	16.5	Wilson	21.8	Wilson	5.30	300	0.94	0%	7%	0%	$ 40,463	$ 7,635
2	E	21.8	Wilson	3.9	Smith	9.42	300	0.42	0%	27%	40%	$ 101,819	$ 10,809
2	F	3.9	Smith	8.02	Smith	4.12	300	0.97	0%	61%	30%	$ 53,503	$ 12,986
2	G	8.02	Smith	0.73	Putnam	9.88	300 - 550	1.11	7%	0%	65%	$ 162,695	$ 16,467
2	H	0.73	Putnam	6	Putnam	5.27	300	0.38	100%	44%	100%	$ 107,766	$ 20,449
2	I	6	Putnam	12.6	Putnam	6.58	300 - 400	0.76	7%	0%	100%	$ 119,139	$ 18,106
2	J	12.6	Putnam	18.2	Putnam	5.61	400 - 500	1.25	0%	0%	100%	$ 103,370	$ 18,426
2	K	18.2	Putnam	22.6	Putnam	4.44	400 - 500	1.13	0%	10%	70%	$ 79,331	$ 17,867
2	L	22.6	Putnam	33.1	Putnam	10.44	300 - 1500	0.86	14%	51%	65%	$ 164,561	$ 15,763
2	M	33.1	Putnam	33.9	Putnam	0.81	400	0	0%	0%	100%	$ 24,037	$ 29,675
2	N	33.9	Putnam	6.23	Cumberland	9.29	300 - 400	1.18	0%	6%	55%	$ 116,073	$ 12,494
2	O	6.23	Cumberland	13.1	Cumberland	7.01	400 - 500	0.71	0%	14%	20%	$ 58,488	$ 8,344
2	P	13.1	Cumberland	17.5	Cumberland	4.25	300 - 600	1.18	0%	74%	0%	$ 40,409	$ 9,508
2	Q	17.5	Cumberland	24.7	Cumberland	6.23	300 - 600	0.80	0%	60%	75%	$ 99,452	$ 15,963
2	R	24.7	Cumberland	36	Cumberland	11.37	300 - 400	0.79	0%	44%	100%	$ 202,009	$ 17,767
2	S	36	Cumberland	7.28	Roane	7.28	300 - 600	0.27	10%	24%	100%	$ 161,262	$ 22,151

Table 2-3 continued

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(All Costs are in Thousands of Dollars)

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2	T	7.28	Roane	12.1	Roane	4.82	150 - 300	0.62	36%	33%	60%	$ 88,357	$ 18,331
2	U	12.1	Roane	16	Roane	3.89	300 - 350	0.26	0%	41%	20%	$ 47,577	$ 12,231
2	V	16	Roane	0.38	Loudon	7.37	300	0.68	0%	9%	0%	$ 68,456	$ 9,288
2	W	0.38	Loudon	4.65	Loudon	4.27	300 - 600	0.47	0%	0%	10%	$ 29,183	$ 6,834
3	A	0	Jefferson	4	Jefferson	4.00	300 - 650	1.00	0%	0%	0%	$ 35,444	$ 8,861
3	B	4	Jefferson	4.29	Hamblen	7.87	300	0.89	0%	7%	0%	$ 78,386	$ 9,960
3	C	4.29	Hamblen	7.4	Hamblen	3.11	300	0.64	0%	29%	15%	$ 33,139	$ 10,656
3	D	7.4	Hamblen	5.14	Greene	7.66	300	0.91	0%	0%	20%	$ 82,427	$ 10,761
3	E	5.14	Greene	12.6	Greene	7.46	300	0.54	0%	0%	40%	$ 85,627	$ 11,478
3	F	12.6	Greene	18.6	Greene	6.02	300	0.66	0%	0%	40%	$ 73,731	$ 12,248
3	G	18.6	Greene	26.7	Greene	8.12	300	0.62	0%	10%	10%	$ 68,283	$ 8,409
3	H	26.7	Greene	0.88	Washington	6.35	300 - 400	0.47	0%	8%	30%	$ 65,472	$ 10,311
3	I	0.88	Washington	1.97	Sullivan	5.03	250 - 400	0.99	0%	27%	30%	$ 56,020	$ 11,137
3	J	1.97	Sullivan	9.39	Sullivan	7.43	250	1.48	0%	46%	45%	$ 121,966	$ 16,415
3	K	9.39	Sullivan	15.5	Sullivan	6.14	250	1.79	0%	21%	40%	$ 82,723	$ 13,473
3	L	15.5	Sullivan	20.6	Sullivan	5.03	250	2.98	0%	0%	40%	$ 66,437	$ 13,208
Total:						387.7						$ 4,534,600	11,700

Figure 2-1: Capacity Solutions for Memphis

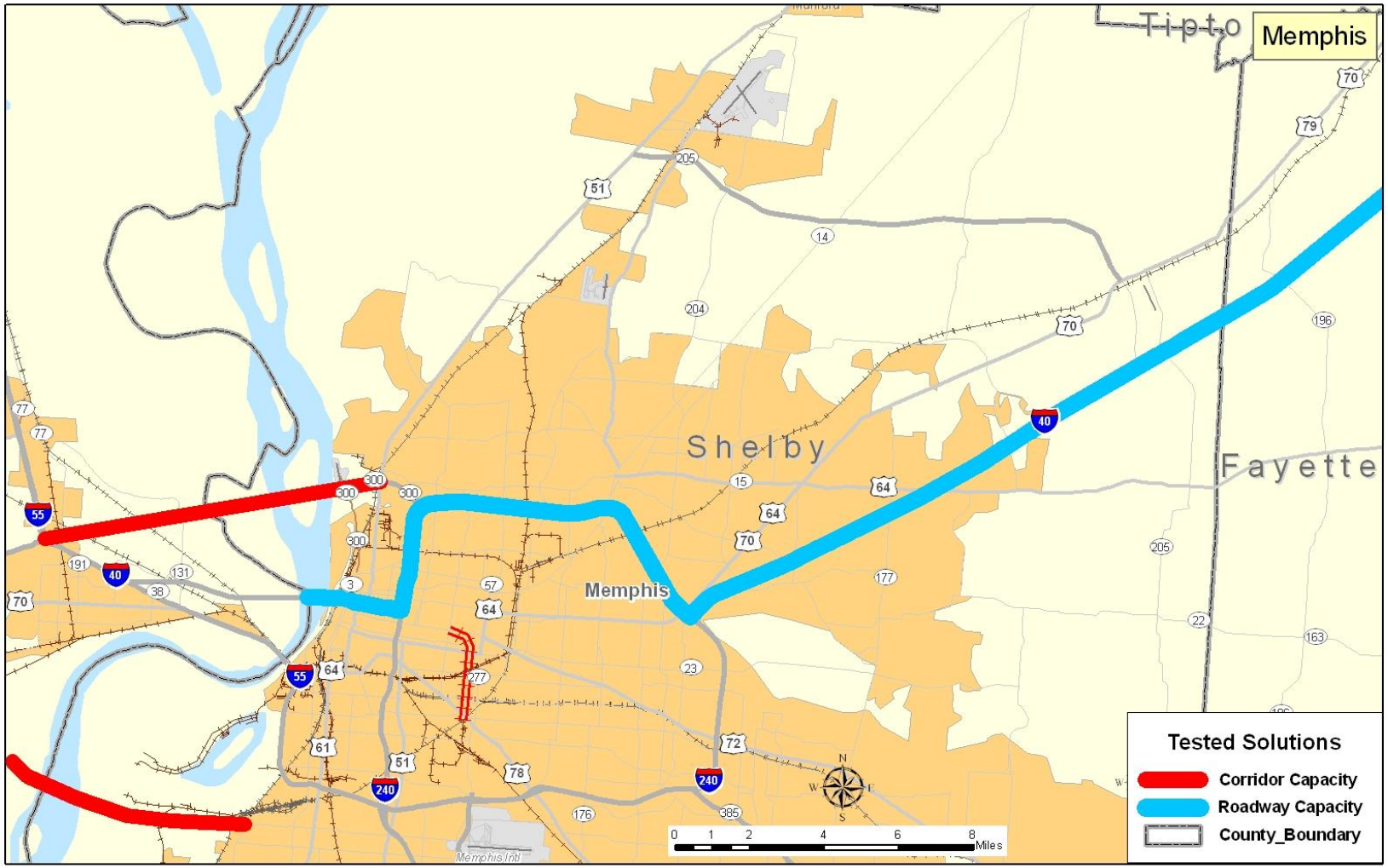


Figure 2-2: Capacity Solutions (Memphis to Jackson)

Figure 2-3: Capacity Solutions (Jackson)

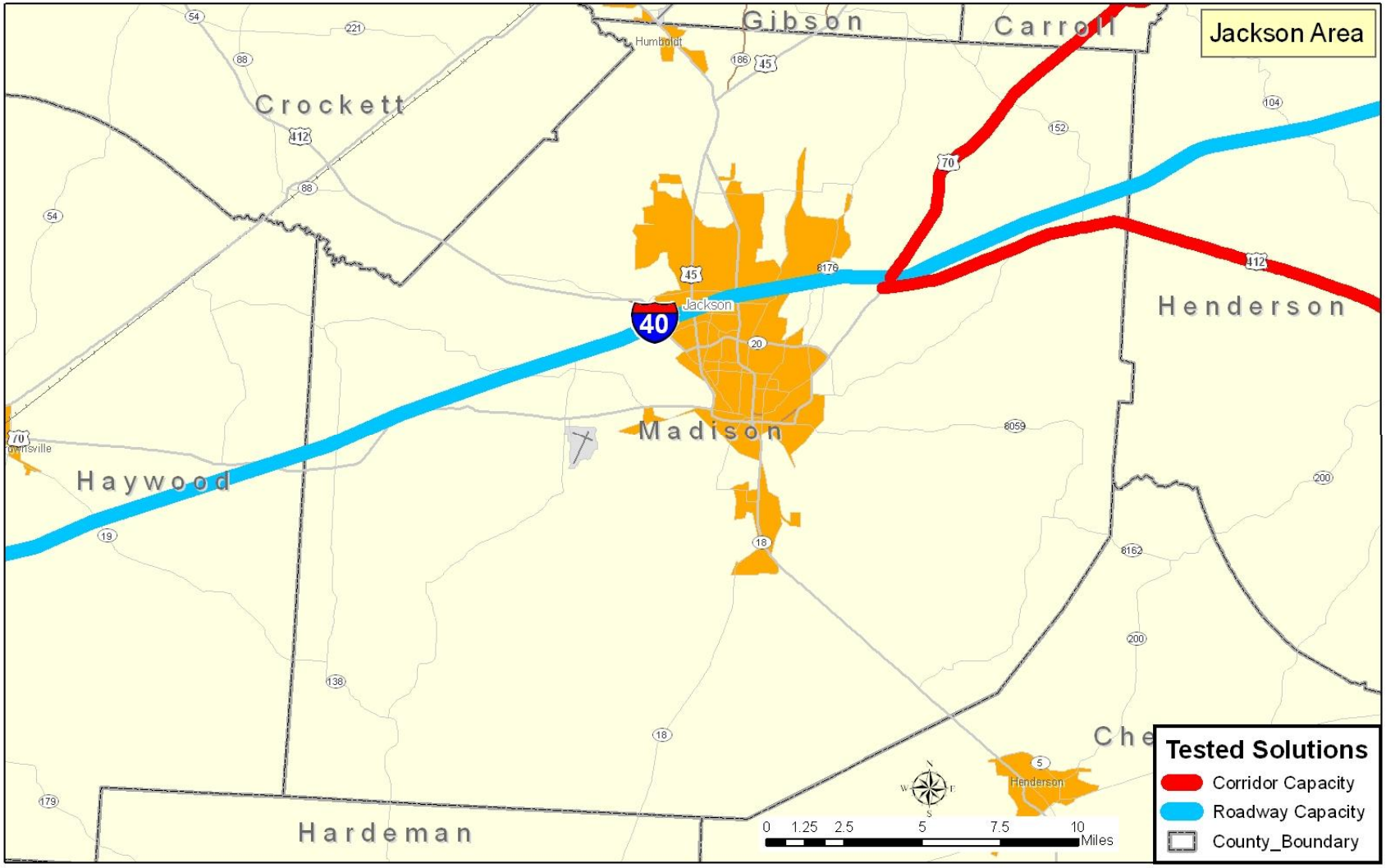


Figure 2-4: Capacity Solutions (Jackson to Nashville)

Figure 2-5: Capacity Solutions (Nashville) (Dickson to Lebanon)

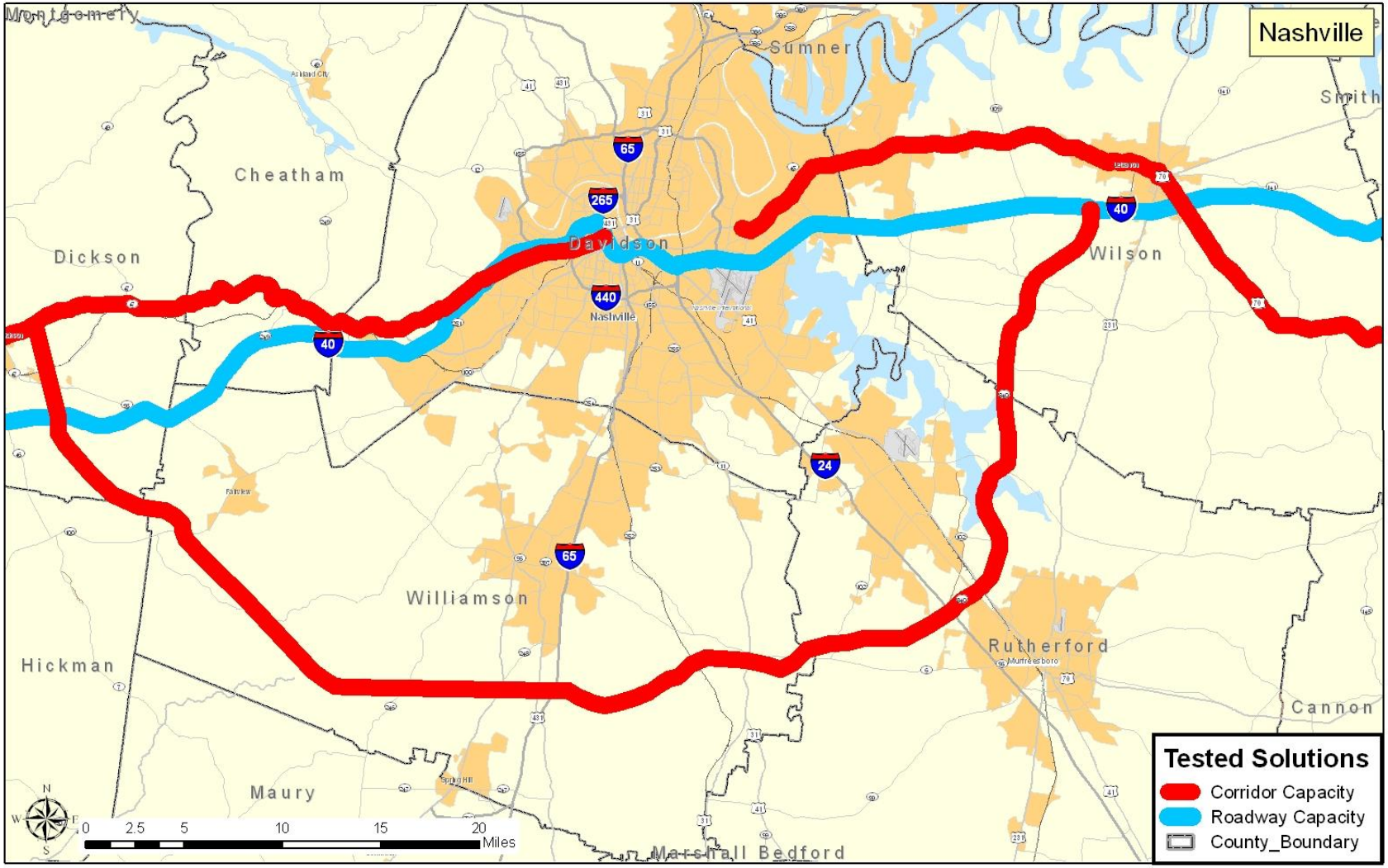


Figure 2-6: Capacity Solutions (Lebanon to Knoxville)

Figure 2-7: Capacity Solutions (Knoxville)

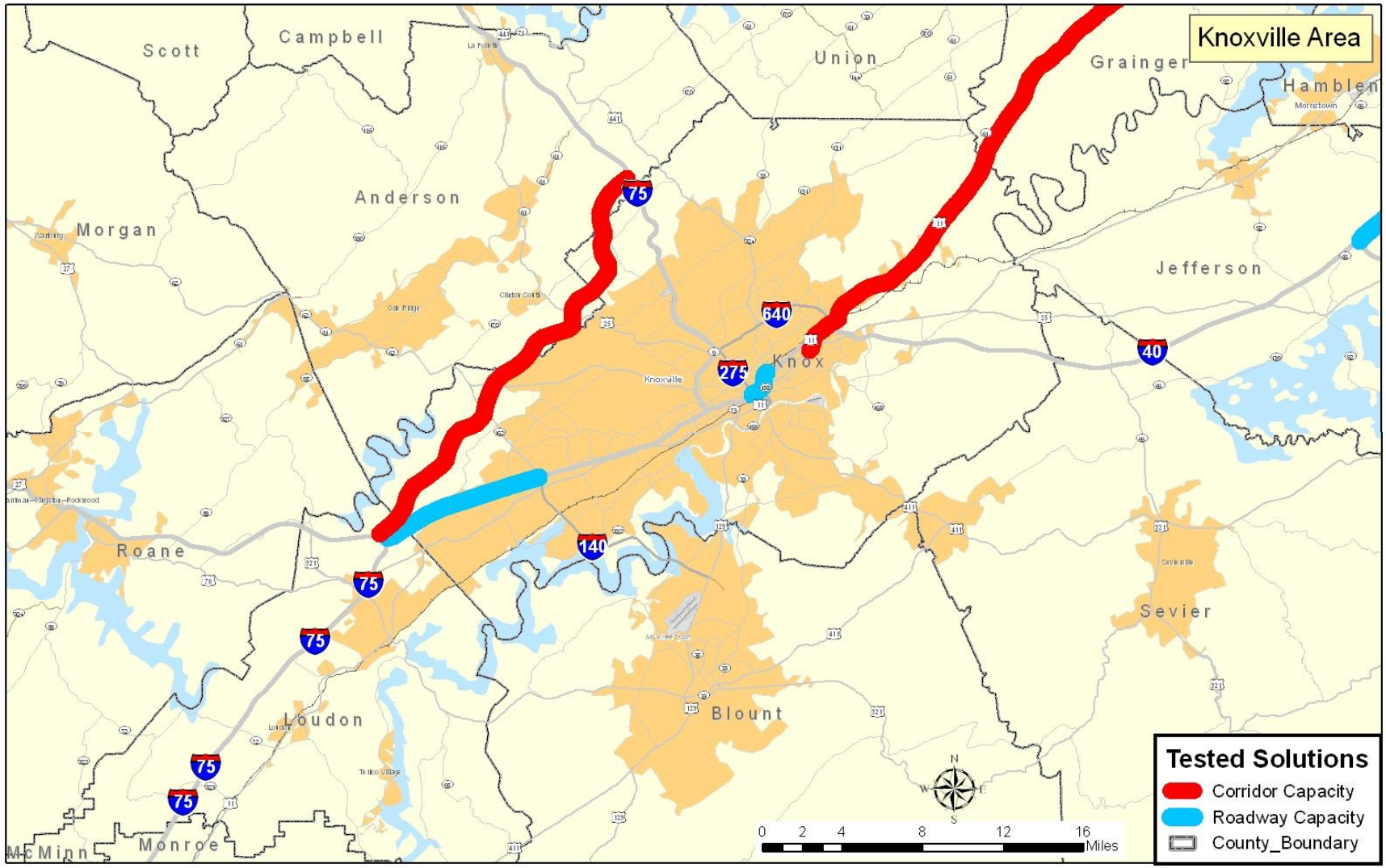


Figure 2-8: Capacity Solutions (Lakeway & Tri-Cities)

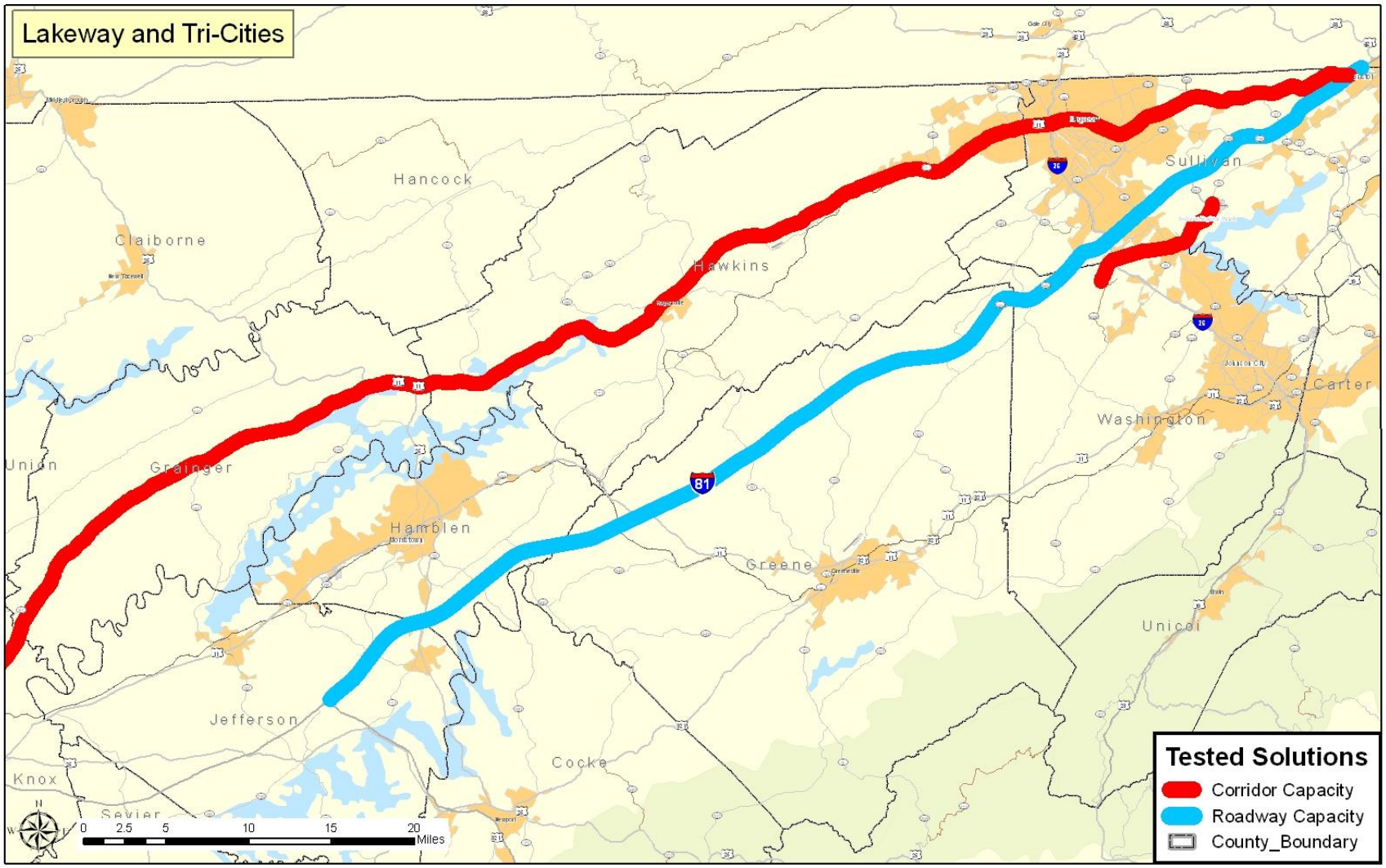


Figure 2-9: I-40/I-81 Constructability Review, Section 1 Segments

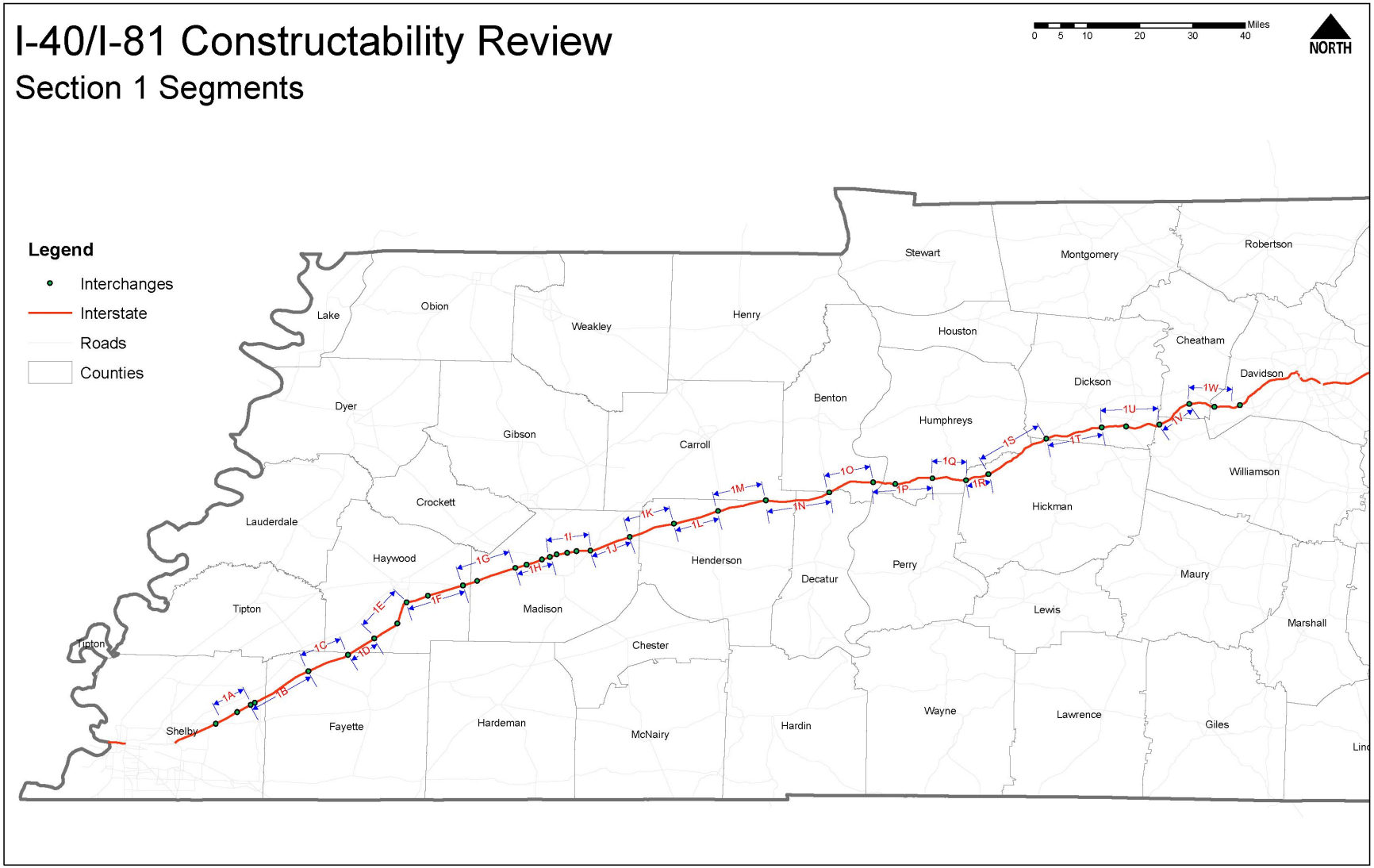


Figure 2-10: I-40/I-81 Constructability Review, Section 2 Segments

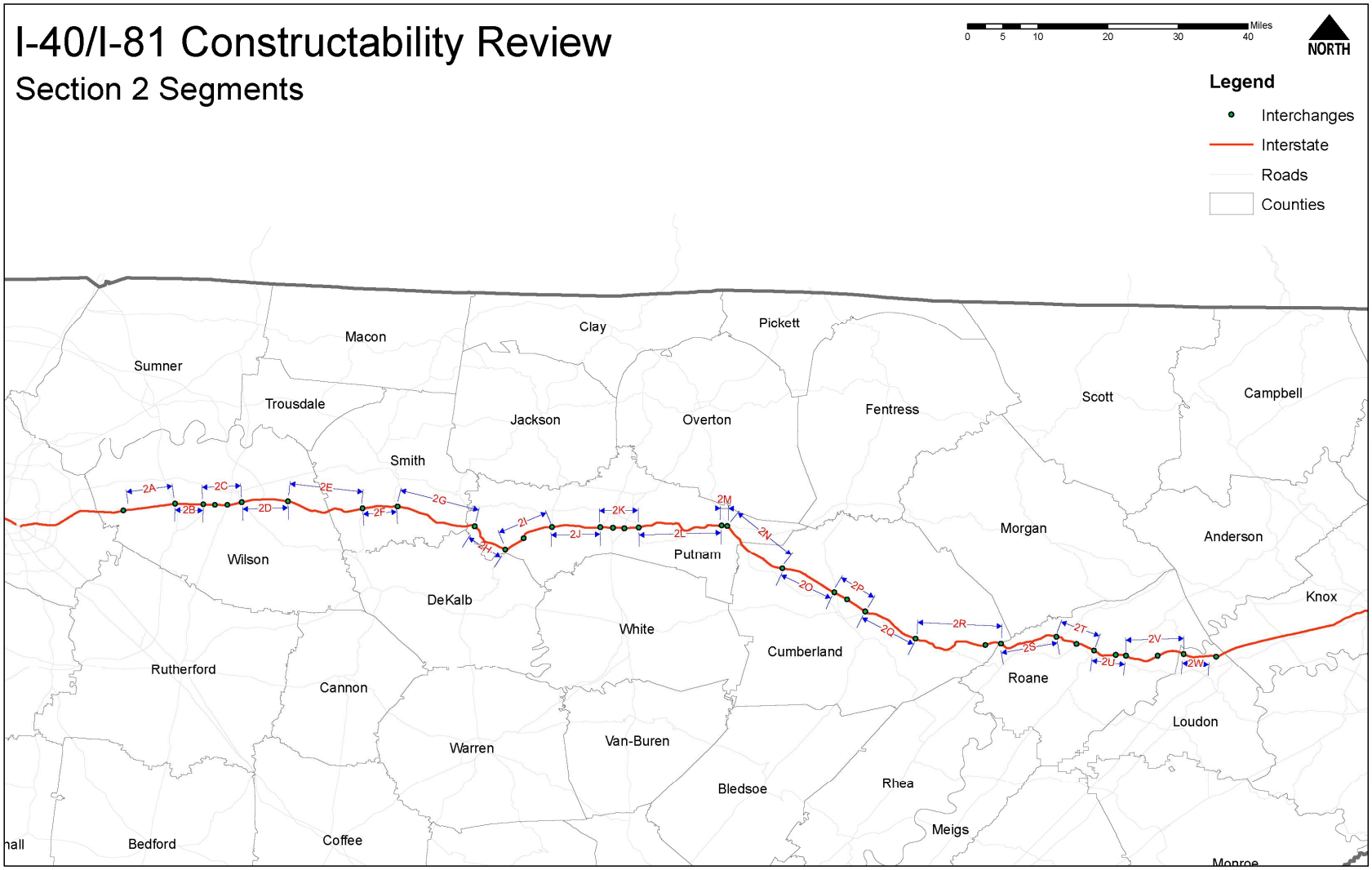
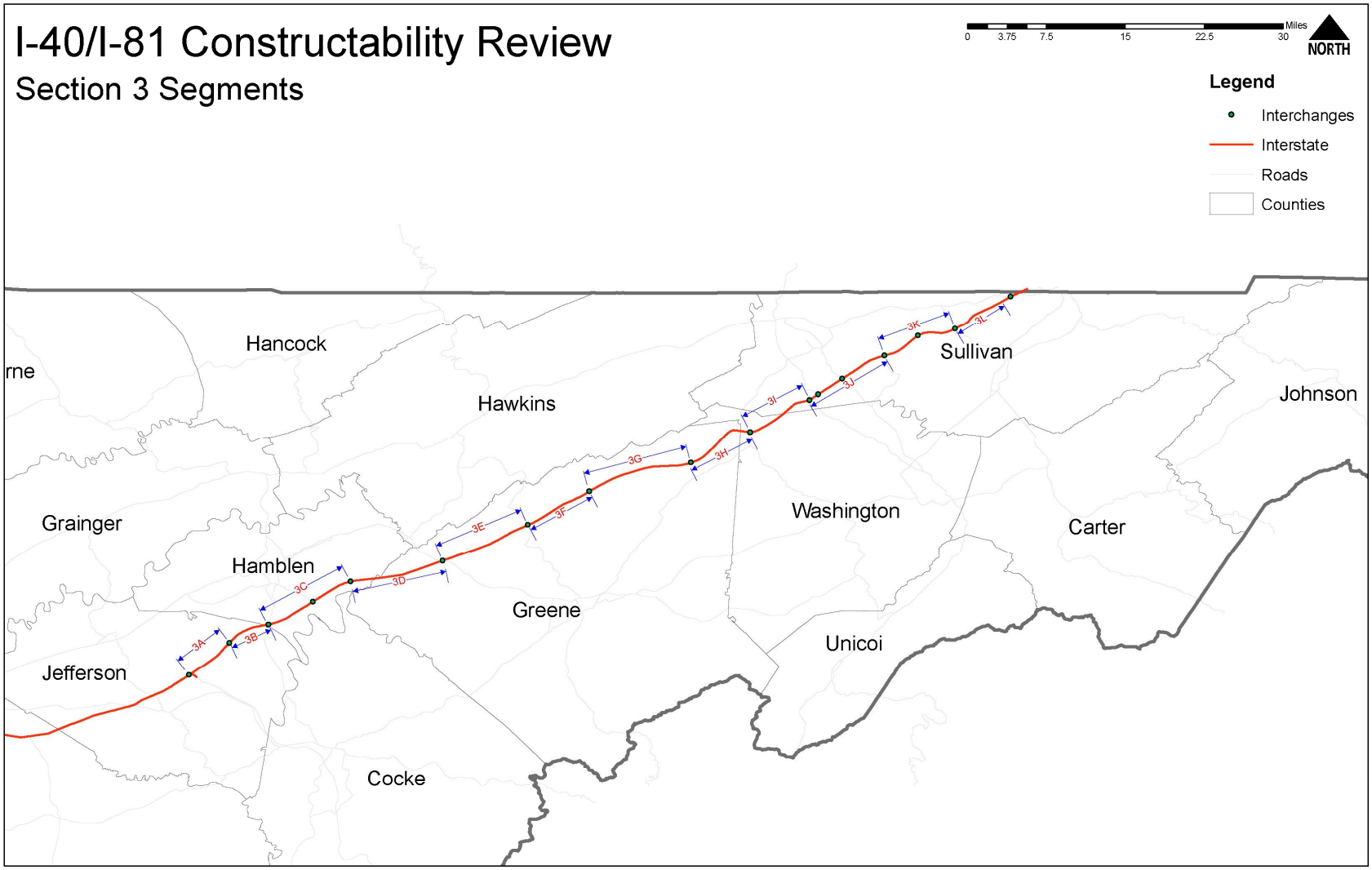


Figure 2-11: I-40/I-81 Constructability Review, Section 3 Segments



2.1.3 Environmental Review

The environmental issues associated with widening I-40 and I-81 from four to six lanes were identified through a review based upon current available literature and databases. This "red flag", high-level review highlights potential environmental concerns with regard to interstate widening.

This red-flag assessment was conducted using existing and available data on wetlands, wildlife areas, parks, community facilities, cultural resources, and Superfund sites, using 500-foot buffer on either side of the existing roadway, The results of the database searches were plotted on GIS and compared with the roadway capacity projects identified in Table 2-1. **Table 2-4** summarizes environmental concerns that may be associated with the roadway capacity improvement segments along I-40 and I-81.

Table 2-4: Environmental Summary

Region	Environmental Issues
Memphis	Potential Solutions: * Add lanes to provide an 8-lane facility along the east-west segment from the river through downtown to I-240 Midtown. * Add north 2nd/3rd Street connector from north of downtown to SR-300. * Widen to 8 lanes from SR-300 to US-64. Potential Environmental Concerns: ▪ Extensive development along these sections; widening beyong existing right-of-way will require displacements and relocations. ▪ Potential Environmental Justice communities that may be affected. ▪ Potential noise sensitive locations (residences, schools and churches) Potential Solutions: * Existing 4-lane segments east of Memphis would be widened to 6 lanes out to MPO/model boundary. (1A and 1B) Potential Environmental Concerns: ▪ 82 wetlands (about 3 acres) along existing roadway ▪ Numerous stream crossings ▪ 1 golf course ▪ Air Quality issues (Shelby County non-attainment for ozone and carbon monoxide maintenance) ▪ Potential Environmental Justice communities that may be affected. ▪ Potential noise sensitive locations (residences, schools and churches)
Memphis to Jackson	Potential Solutions: * Widen to 6 lanes (1C to 1G)

Region	Environmental Issues
	Potential Environmental Concerns: ▪ At least 141 wetlands (about 7.5 acres) along I-40. ▪ Numerous stream crossings, including the Hatchie River (a designated state Scenic River). ▪ Hatchie National Wildlife Refuge ▪ 1 school ▪ Potential Environmental Justice communities that may be affected. ▪ Potential noise sensitive locations (residences, schools and churches)
Jackson	Potential Solutions: * Widen to 6 lanes (1H & 1I) Potential Environmental Concerns: ▪ 1 school ▪ About 31 wetlands related to South Fork Forked Deer River and its floodplain (about 2.5 acres) ▪ Numerous stream crossings ▪ Extensive commercial development adjacent to I-40 between Exits 79-85. ▪ Potential Environmental Justice communities that may be affected. ▪ Potential noise sensitive locations (residences, schools and churches)
Jackson to Nashville	Potential Solutions: * Widen to 6 lanes to SR-840 – (1J to IT) Potential Environmental Concerns: ▪ 167 wetlands, about 15 acres along roadway. Extensive wetlands in the area between Exits 133 and 143 in Benton and Humphreys Counties, east and west of the Tennessee River crossing. ▪ Crossing of Tennessee River and numerous tributary streams. ▪ Duck River Unit Wildlife Management Area of the Tennessee National Wildlife Refuge. With the longitudinal crossing of Tennessee River, the roadway widening would cross wetlands and Refuge land that are contentrated between the west side of the river and Exit 137 east of the river. ▪ Natchez Trace State Park extends north and south of I-40 in vicinity of Exit 116. ▪ 4 schools ▪ Historic resources adjacent to the roadway include Wildersville School and Parkers Crossroad (Civil War) Battlefield (listed on National Register) ▪ 1 church (historic Mt. Zion church)

Region	Environmental Issues
	▪ 6 Cemeteries within 500 feet of roadway ▪ Potential Environmental Justice communities that may be affected. ▪ Potential noise sensitive locations (residences, schools and churches)
Nashville (Dickson to Lebanon)	<u>Potential Solutions:</u> * Widen from 4 lanes to 6 lanes between SR-840 and US-70. (1U,V, W) <u>Potential Environmental Concerns:</u> ▪ 2 Cemeteries within 500 feet of roadway ▪ 1 school ▪ 3 wetlands (about 4 acres) ▪ Harpeth River (State Scenic River) ▪ Potential Environmental Justice communities that may be affected. ▪ Potential noise sensitive locations (residences, schools and churches) <u>Potential Solutions:</u> * Widen from 6 lanes to 8 lanes between US-70 and SR-155. * Add 4 managed lanes between I-440 and I-24 (widen from 6 lanes to 10 lanes). * Add 4 managed lanes from I-24 (West) to I-24 (East)(widen from 8 lanes to 12 lanes). * Widen from 6 lanes to 8 lanes between I-24 (East) and SR-155. <u>Potential Environmental Concerns:</u> ▪ Extensive development along these sections; widening beyong existing right-of-way may require displacements and relocations. ▪ Numerous streams would be crossed, including Cumberland River and tributary streams. ▪ Potential Environmental Justice communities that may be affected. ▪ Potential noise sensitive locations (residences, schools and churches) ▪ Air Quality issues (Davidson County non-attainment for ozone and Early Action Compact) <u>Potential Solutions:</u> * Widen from 4 lanes to 6 lanes between SR-171 and Lebanon. (2A to 2C) <u>Potential Environmental Concerns:</u> ▪ 1 Cemetery . ▪ 40 wetlands (about 2.3 acres)

Region	Environmental Issues
	▪ Extensive commercial and residential development occuring along this section; widening beyong existing right-of-way may require displacements and relocations. ▪ Potential Environmental Justice communities that may be affected. ▪ Potential noise sensitive locations (schools and churches) ▪ Air Quality issues (Wilson County non-attainment for ozone and Early Action Compact)
Lebanon to Knoxville	<u>Potential Solutions:</u> * Widen to 6 lanes from Lebanon to I-75 west of Knoxville. (2D to 2W) <u>Potential Environmental Concerns:</u> ▪ 234 wetlands (25.5 acres) ▪ Numerous creek crossings, including the Caney Fork River (5 crossings), and the Clinch River. ▪ Mt. Roosevelt Wildlife Management Area ▪ 10 cemeteries ▪ 3 churches, including 1 historic church ▪ 6 schools, 5 of which are listed as historic ▪ 1 golf course ▪ Mountainous terrain ▪ Potential Environmental Justice communities that may be affected. ▪ Potential noise sensitive locations (residences, schools and churches)
Knoxville	<u>Potential Projects:</u> * Widen from 7 lanes to 8 lanes between I-75 (South) and Watt Rd. * Widen from 6 lanes to 8 lanes between Watt Rd and I-140. * Widen from 8 lanes to 10 lanes between I-140 and I-75 (North). * Widen from 6 lanes to 8 lanes between I-275 (North) and North 5th Ave. <u>Potential Environmental Concerns:</u> ▪ Extensive development along these sections; widening beyong existing right-of-way may require displacements and relocations. ▪ Potential Environmental Justice communities that may be affected. ▪ Potential noise sensitive locations (residences, schools and churches) ▪ Stream crossings, including Holston River. ▪ Air Quality issues (Knox, Loudon and Jefferson Counties non-attainment for ozone; and Knox, Roane and Loudon Counties non-attainment for PM 2.5).

Region	Environmental Issues
Lakeway & Tri-Cities	Potential Projects: * Widen I-81 to 6 lanes from I-40 to VA state line. (3A to 3L) Potential Environmental Concerns: ▪ 76 wetlands (about 14 acres) ▪ Crossing of Holston River ▪ 2 schools, including 1 special education school ▪ 3 churches ▪ 11 cemeteries ▪ Potential Environmental Justice communities that may be affected. ▪ Potential noise sensitive locations (residences, schools and churches) ▪ Air Quality issues (Jefferson County non-attainment for ozone, and Sullivan County ozone non-attainment and Early Action Compact).

The environmental review revealed a number of environmental issues that would need to be addressed for individual projects that emerge from this corridor feasibility study. However, the review has not revealed any environmental issues that would stop a project at this level of investigation.

Rigorous environmental reviews will be required for projects pursued following the conclusion of this study. Any interstate widening project will involve federal funding and thus the projects will be subjected to an environmental impact assessment in conformance with the requirements of the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ).

2.2 Corridor Capacity

This approach for addressing forecasted interstate congestion involves improving highways along the corridor that would provide an alternative to traveling along I-40 or I-81. Improvements to parallel arterials offer local traffic an option to using the interstate for short-distance trips. Construction of urban area by-passes enables motorists traveling longer distances an alternative to congested I-40 segments, particularly in urban areas.

Table 2-5 is the “package” of solutions designed to increase corridor roadway capacity rather than widening existing I-40 and I-81. The list of possible projects is summarized by the eight geographical areas used in earlier technical memoranda for the corridor study.

The projects proposed under the corridor capacity “package” also are shown in **Figure 2-1** through **Figure 2-8**.

Table 2-5: Corridor Capacity "Package" of Solutions

Region	Solution or Project
Memphis	* Add new Mississippi River bridge crossing: 1) north of I-40 or 2) south of I-40. * Extend light rail transit from medical center area to Memphis International Airport. * Extension of SR-285 at southern terminus (SR-100) to Mississippi state line (I-269).
Memphis to Jackson	* Widening of US-412 to 4 lanes west of Jackson to intersection with US-70.
Jackson to Nashville	* Widen US-70 to 4 lanes where it is not already four. * Widen US-412/US-100 to four lanes east to I-65 south of Nashville.
Nashville (Dickson to Lebanon)	* Complete SR-840 South. * Commuter rail from Nashville to Dickson. * Widen US-70 to 4 lanes where it is not already four.
Lebanon to Knoxville	* Widen US-70 to 4 lanes where it is not already four, east to Crossville.
Knoxville	* Construct SR-475 (Knoxville Parkway). * Widen US-11E to 4 lanes from US-25E to I-81 Exit 23.
Lakeway & Tri-Cities	* Widen US-11E/US-25/US-11W to 4 lanes where it is not already four. * Widen SR-75 to 4 lanes between SR-81 and SR-394.

3.0 OPERATIONS AND SAFETY

In Task 2, locations along I-40 and I-81 where steep grades or poor geometrics regularly affect traffic flow were identified based on interviews with TDOT Region Directors and TDOT's Incident Management Program manager. Interviews also were conducted with representatives of the Tennessee Department of Safety including the Highway Patrol and the Commercial Vehicle Compliance office to obtain their input on this topic. The interviews also identified actions to expand Tennessee's Intelligent Transportation System (ITS) and the current Incident Management program (HELP).

In Task 1, Systems Inventory and Data Collection, locations along the study corridor where accidents exceed the critical accident rate based on information provided by TDOT were identified. TDOT's critical accident rate takes into account traffic exposure and is unique for each location. The use of this measure ensures that the accident rate at a location is not due to chance but to some unfavorable characteristic of local conditions.

In Task 2, the aforementioned crash data was supplemented with field observations provided during interviews conducted with the Regional Directors in TDOT Regions 1, 2, 3 and 4 and the Director of TDOT's Incident Management Program. Representatives of the Tennessee Highway Patrol and Commercial Vehicle Compliance also offered input on locations with a high number or severity of crashes and identified areas which occasionally experience hazardous weather conditions, such as fog, high winds or ice and snow. Interviews conducted with representatives of Tennessee's MPOs, TPOs and RPOs added to this list of safety issues in the I-40 and I-81 corridor, again based on field observations of existing conditions.

The effectiveness of the existing I-40 HOV lanes in Memphis and Nashville was analyzed in Task 2 using person and vehicle counts provided by TDOT for 2002 and 2005. Based on the results of this evaluation, changes are proposed to HOV lane operations in both urban areas.

3.1 Interchange and Ramp Improvements

Table 3-1 lists initial solutions which were developed to address operations and safety issues at selected roadway segments, interchanges, rest areas, and weigh stations along I-40 and I-81. These locations were identified during the stakeholder interviews described in the preceding section.

Appendix C includes conceptual designs for improving operations and safety at 13 locations along the corridor.

Table 3-1: Operational Improvements (Interchanges, Rest Areas and Weigh Stations)

Region	Solution or Project
Memphis to Jackson	* Lengthen acceleration/deceleration lanes at I-40 weigh station near Exit 52. * Lengthen ramps at I-40/SR-76 interchange (Exit 56).
Jackson	* Re-design I-40/US-45 BP interchange. * Widening US-412 (Hollywood Drive) from I-40 to Miller Drive to 5 lanes (only segment of I-40 just west of Jackson that is not already improved to 4 lanes).
Jackson to Nashville	* Extend on/off ramps at I-40/SR-50 interchange.
Nashville (Dickson to Lebanon)	* Improve ramp from I-40 East to I-440 South.
Lebanon to Knoxville	* Add lighting to I-40/SR-56 interchange. * Improve I-40 interchanges at Exits 320 and 322 in Crossville.
Knoxville	* Extend ramp from I-140 SB to I40/I-75 WB. * Ramps at weigh station need to be extended.
Lakeway & Tri-Cities	* Re-design I-40/I-81 interchange, lengthen ramps at rest area near this interchange. * Improve I-81 interchange at Exit 8 near Morristown * Review exit ramp capacity at I-81 interchange at Exit 69 * Re-design I-81/I-26 interchange

3.2 ITS and HELP Program Enhancements

Table 3-2 summarizes proposed enhancements to TDOT's ITS and HELP programs in four regions of the study corridor. The table also includes improvements to SR-13 to provide a diversion route for incidents occurring at the Tennessee River bridge.

Table 3-2: ITS and HELP Program Enhancements

Region	Solution or Project
Jackson to Nashville	* Rural ITS (Cameras, VMS, weather station) at Tennessee River/Cuba Landing River Crossing. * Widen SR-13 between US-70 and US-412 to provide diversion route for incidents. * Improve pavement, signage and consider rural ITS at Piney River Bridge. * Extend HELP, cameras, VMSs from Nashville out to SR-46 (Exit 172).
Nashville (Dickson to Lebanon)	* Extend ITS east of Nashville from I-24 to existing SR-840 (HELP, cameras, VMSs).
Lebanon to Knoxville	* Rural ITS for Cumberland Plateau, including weather monitoring.
Lakeway & Tri-Cities	* ITS (HELP, cameras, VMSs) in Tri-Cities.

3.3 Truck Climbing Lanes

Under Task 2, the I-40/I-81 corridor was reviewed to identify those segments that did not meet the steepness and length of grade criteria specified in *A Policy on Geometric Design of Highways and Streets* published by the American Association of State Highway and Transportation Officials (AASHTO). However, a truck climbing lane may not be warranted for these segments depending on the projected traffic volumes for the time period which is analyzed.

Table 3-3 identifies the 15 I-40 and I-81 segments where truck climbing lanes appear to have the greatest benefits. The table lists the possible lanes by county using the log miles system in the Tennessee Roadway Information Management System (TRIMS). Estimated costs of each climbing lane also are provided in the following table.

Table 3-3: Possible Truck Climbing Lanes

(All Costs are in Thousands of Dollars)

County	Begin Log Mile	End Log Mile	Length (mi)	Median Width	ROW	Bridges	Bridge Cost	ROW Cost	Constr Cost	PE Cost	% Barrier	% Constraints	Cost of Constraints	Total Cost
BENTON	7	8.13	1.13	2	300	1	$4,000	$3,122	$3,966	$1,527	100%	100%	$11,300	$23,915
HICKMAN	0.34	1.44	1.1	52	300		$0	$0	$3,861	$1,486		100%	$11,000	$16,347
DICKSON	16.5	17.83	1.33	100	300	1	$4,000	$0	$4,668	$1,797		100%	$13,300	$23,765
CHEATHAM	1.35	2.63	1.28	54	300	1	$4,000	$0	$4,493	$1,601		90%	$11,520	$21,614
CHEATHAM	5.09	5.64	0.55	60	300	2	$8,000	$0	$1,931	$743		100%	$5,500	$16,174
SMITH	0.04	0.6	0.56	50	300	1	$4,000	$0	$1,966	$757		100%	$5,600	$12,322
PUTNAM	3.03	4.74	1.71	2	300		$0	$4,724	$6,353	$2,345	100%	100%	$17,100	$30,522
PUTNAM	25.32	29.32	4	2 - 999	400 - 1500	2	$8,000	$2,265	$21,962	$6,196	21%	100%	$40,000	$78,423
CUMBERLAND	21.24	22.26	1.02	90	300		$0	$0	$3,580	$1,378		100%	$10,200	$15,158
CUMBERLAND	34.55	35.85	1.3	52	300	1	$4,000	$0	$4,563	$1,756		100%	$13,000	$23,319
ROANE	0.2	1.35	1.15	54 - 300	300 - 600	1	$4,000	$2,486	$6,467	$1,797		100%	$11,500	$26,249
ROANE	1.53	2.64	1.11	300	600		$0	$3,066	$6,893	$1,799		100%	$11,100	$22,859
ROANE	9.64	10.68	1.04	30	350	2	$8,000	$0	$3,650	$1,305		90%	$9,400	$22,355
ROANE	12.39	13.15	0.76	44	300 - 350	1	$4,000	$0	$2,668	$647		50%	$3,800	$11,114
SULLIVAN	6.78	7.98	1.2	32	250	1	$4,000	$0	$4,212	$1,621		100%	$12,000	$21,833
TOTAL			**19.24**				**$56,000**	**$15,663**	**$81,232**	**$26,755**			**$186,320**	**$365,971**

3.4 Managed Lanes Feasibility

3.4.1 Background on HOV Lanes along I-40 in Memphis and Nashville

TDOT supports the development and operation of HOV lanes (one type of managed lanes) which meet the goal of maximizing people-moving capability of the highway system while mitigating transportation-related pollution. HOV lanes were implemented along I-40 in Nashville and Memphis in May 2002.

TDOT defines a "successful" HOV facility as a lane that carries at least the same number of persons in fewer vehicles than the adjacent non-HOV lanes, based on the purpose of an HOV lane to encourage ridesharing and the use of mass transit. TDOT has set a target (vehicles to persons) for an HOV facility of 800 vehicles transporting 1600 persons, which requires at least two persons per vehicle. The department considers 1600 persons per hour as the number which would be carried in a non-HOV lane at capacity (level-of-service E).

In Task 2, use of the I-40 HOV lanes was analyzed based on data collected in 2005 by TDOT. The I-40 HOV facility in Memphis was clearly shown as providing a level of benefits that generates a reasonably good volume of HOVs. However, the level of violations along all portions of I-40 where HOV data had been collected was concerning. The compliance rates ranged from 38 to 52 percent in both Memphis and Nashville, placing these projects among the ten most serious for enforcement breaches from more than 120 projects across the country. The HOV lane vehicle-carrying capacity appeared capped by the number of violators (i.e., the mix of eligible and ineligible users equals the same vehicle flow as adjacent lanes). A more aggressive enforcement program to address this shortcoming and divert violators could inadvertently create level of service E or worse in the remaining lanes, thus triggering TDOT's procedures to reassess HOV lane viability.

The amount of HOV use is directly related to the adjacent roadway level of service being experienced, in which higher levels of HOV use are found where travel time savings potential exists, and a lower proportionate level of use is observed where no benefit seems to exist. The lack of speed data made this observation difficult to confirm with certainty for I-40 HOV facilities in Memphis and Nashville. Some HOV segments such as I-40 in Wilson County reflected a level of HOV use of the dedicated lanes between 27 and 39 percent of "before" volumes. Because it appeared that a significant number of multi-occupant vehicles are still traveling in the general purpose lanes, this portion of the I-40 HOV lane in the Nashville region is likely not providing meaningful travel time savings.

3.4.2 Definition of Managed Lanes

The basis for determining managed lane feasibility primarily relates to urban areas along the I-40/I-81 corridor where traffic volumes of all modes and freeway congestion are greatest - in the greater Memphis, Nashville and Knoxville areas. The following definition is applied from the latest Transportation Research Board (TRB) Managed Lanes Committee guidance:

> *Managed Lanes: Dedicated lanes or roadways that optimize performance and throughput by offering travel time savings and reliability through the application of management strategies including pricing, vehicle eligibility, and access control. Historically, person throughput on many managed lanes has been considered the highest form of optimization, but looking at goods movement is also being considered.*

Table 3-4 lists other definitions for managed lanes developed over the last decade by various agencies. All of the definitions stress the principles of dedicated lanes that are proactively managed to a higher level of operations than the rest of the transportation network.

The TRB definition was used for managed lanes in determining their feasibility for the I-40/I-81 corridor study area. Managed lanes can consist of high occupancy vehicle (HOV) lanes, high occupancy toll (HOT) lanes, truck-only lanes (TOL) or truck-only toll (TOT) lanes, express lanes, toll facilities and combinations thereof that have as a common goal the intent of using pro-active traffic management strategies to preserve a high operational efficiency and mobility in the managed lanes, thereby promoting the noted benefits in the definition. Most commonly, managed lanes are a single directional lane adjacent to the general purpose lanes. Managed lanes may operate full time or part-time, reverting to a general purpose lane outside peak demand periods. **All managed lane concepts only make sense where congestion is present in order to provide the desired benefits.** Thus, managed lanes typically are considered when other strategies to address congestion through capacity expansion and other transportation demand management (TDM) strategies are not expected to reduce existing or forecast congestion.

Based on data collection and traffic forecast and analysis activities for the I-40/I-81 corridor study, peak and off-peak deficiencies exist that are related to 1) commuting into and through major urban areas and 2) high intercity through-trip demand generated by increasing freight movement activities which are not solely related to peak-period travel. Both of these deficiencies may represent markets for managed lanes.

3.4.3 Application of Managed Lanes Evaluation

The assessment of managed lanes feasibility in the I-40/I-81 corridor study was performed at a high level because of the extensive corridor length, data availability and the desire to examine deficiencies in both a short- and long-range context.

Two primary forms of data were considered: 1) current and forecast traffic conditions (primarily congestion) and 2) physical corridor attributes.

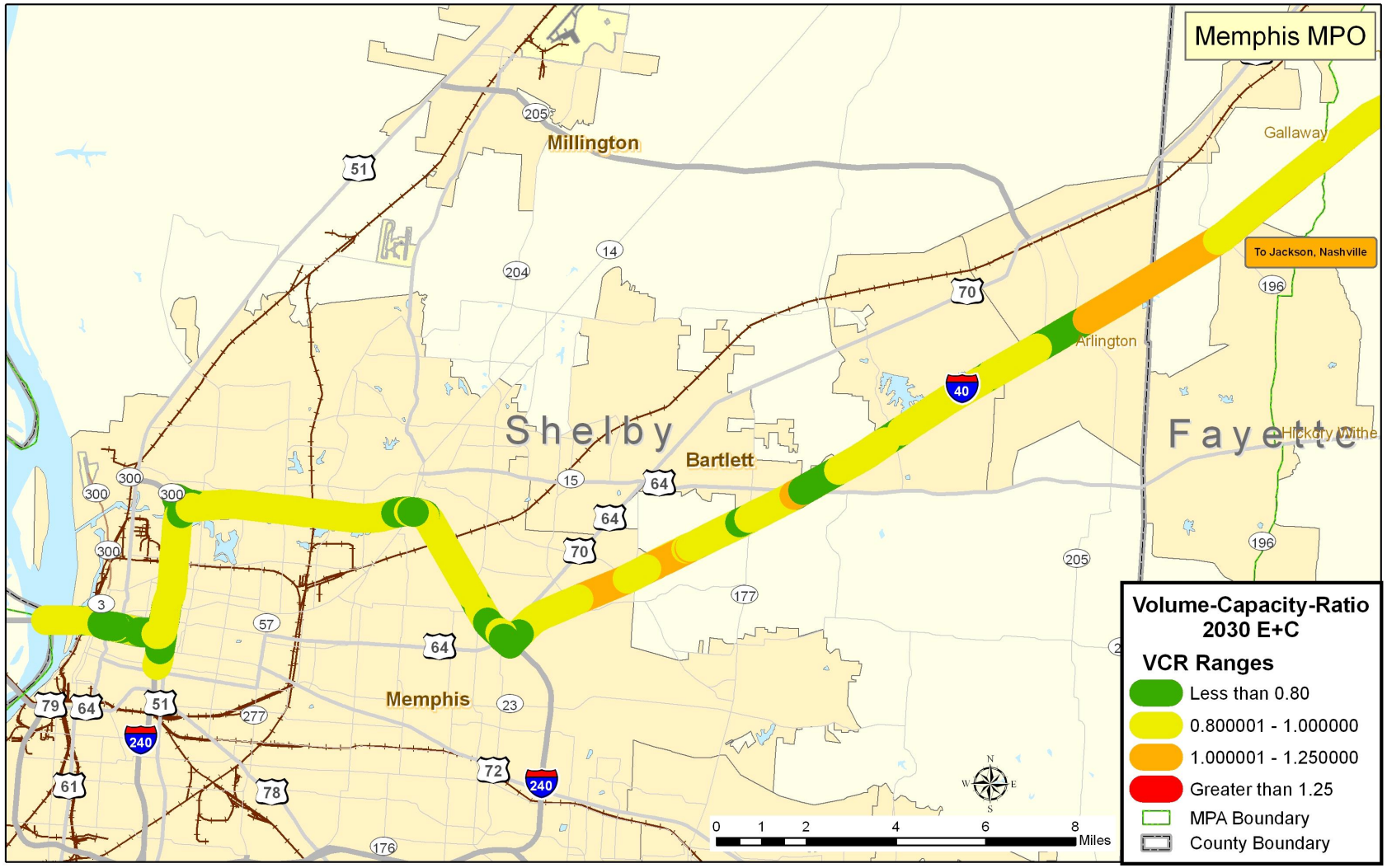
Forecast Conditions

Evaluating forecast conditions helps determine if congestion is or will be present, which will drive demand for managed lane treatments. A good proxy for congestion is an assessment of the vehicle/capacity (V/C) ratio. **Figure 3-1**, **Figure 3-2**, and **Figure 3-3** provide forecast V/C ratios for the Memphis, Nashville and Knoxville major urban areas along the corridor. This forecast assesses conditions in the horizon year of 2030, including future traffic demands and committed interstate improvements (the existing-plus-committed highway network).

Table 3-4: Managed Lanes Definitions from Other Agencies

Agency	Definition
Federal Highway Administration	". . . set of lanes where operational strategies are proactively implemented and managed in response to changing conditions."
Texas DOT	". . . a facility that increases freeway efficiency by packaging various operational and design actions. Lane management operations may be adjusted at any time to better match regional goals."
Texas DOT for LBJ Corridor Project (variation on Texas statewide definition)	"…lanes that increase freeway efficiency by offering a predictable trip with little congestion for those who carpool, ride bus transit, vanpool, ride a motorcycle or if driving alone, are willing to pay a toll. Lane management operations and pricing structure may be adjusted at anytime to better serve modal needs."
Georgia DOT (Atlanta)	"…. a system of lanes that could use eligibility, access, and/or pricing to preserve mobility."
Nevada DOT	"…. dedicated lanes and various supporting facility improvements such as access treatments, park-and-ride lots and bus transit terminals, and programs such as rideshare and marketing, that are intended to provide and promote mobility options to highway users and help grow and sustain transit and carpool/vanpool ridership."
Washington State DOT	"….any roadway lane that can be managed to prevent congestion from occurring. In managed lanes, one or more of these techniques is used to control the number of vehicles using the lane or roadway: o Limiting access -- providing infrequent on-ramps, as on the I-5 and I-90 express lanes o User eligibility requirements -- such as HOV-only, truck-only, permit-only, etc. o Pricing -- tolls can be varied by time of day to control traffic volumes. By considering these as different forms of traffic management, it is possible to plan the best combination of tools to keep a roadway from becoming congested over time, and to optimize traffic to achieve the best person and vehicle throughput."

Figure 3-1: **Memphis Area Daily V/C Ratios Projected for 2030**



Source: I-40/I-81 Corridor Feasibility Study, *Task 2.0, Assessment of Deficiencies Technical Memorandum*, August 2007

Figure 3-2: Nashville Area Daily V/C Ratios Projected for 2030

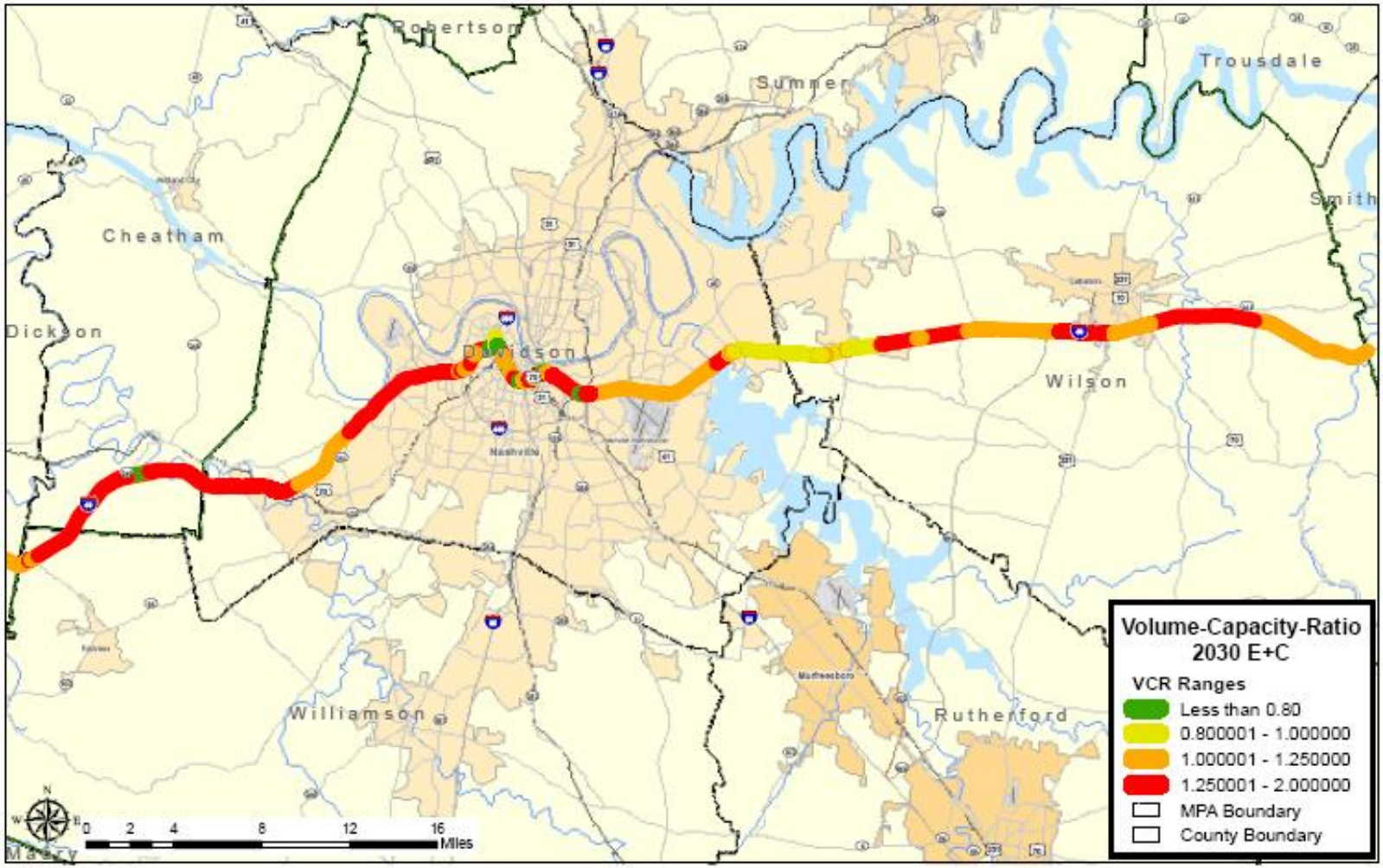
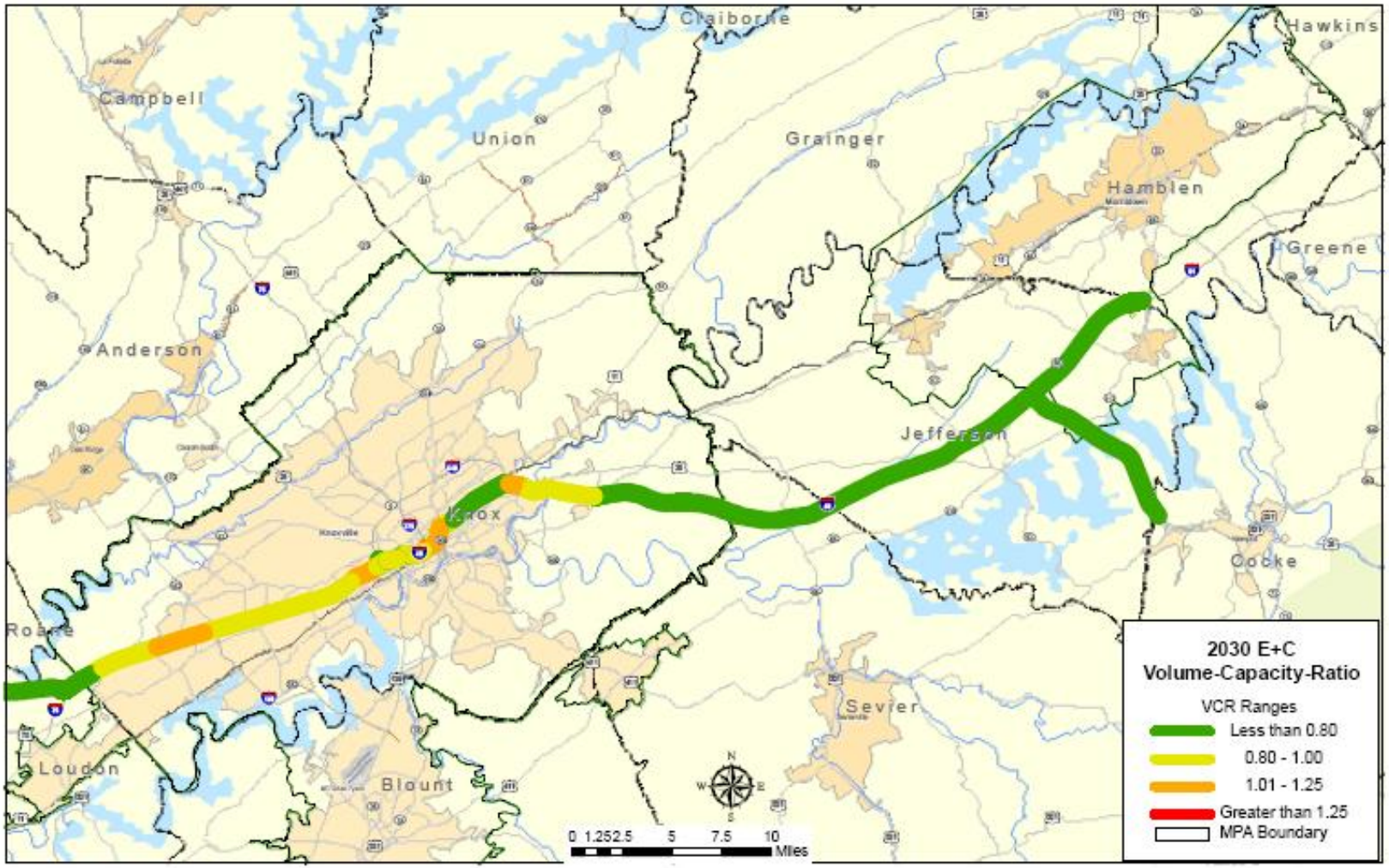


Figure 3-3: Knoxville Area Daily V/C Ratios Projected for 2030



These 2030 V/C maps suggest that the greatest need for managed lanes exists in the greater Nashville area. Memphis reflects a potential need for some form of managed lane treatment on I-40 east of I-240, and this need will likely grow beyond the forecast horizon year because corridor growth will be more dynamic in the exurban area as far east as Arlington and possibly Jackson. Improvements planned or currently underway in the Knoxville area indicate that congestion will not need to be addressed through managed lanes.

Specific demand for both general traffic and target users—HOVs, long distance commuters, intra- or interstate trips and trucks—could not be easily assessed, at least for peak periods. But current levels of use of HOV lanes in Memphis and Nashville suggest attaining moderate thresholds for HOVs in the future as these corridors presently have volumes comparable to national averages for similar-type corridors. Along I-40 segments in Memphis and Nashville, the volumes are within managed lanes capacity thresholds of about 1500 vehicles/hour, which would allow single-occupant vehicles to "buy-in" to the HOV lanes, without causing major speed reductions or a loss of mobility in these lanes. HOT volumes typically mirror HOV demand and may be even higher because of a larger pool of potential users which include HOVs and commuters who are willing to pay. Recent technological advancements to control HOT-lane tolling and enforcement electronically, such as the HOT lanes implemented on I-395 in Minneapolis, Minnesota, may make conversion of I-40 lanes in Memphis and Nashville from HOV to HOT possible even where there is no permanent barrier to control HOT lane use. For the current HOV lanes in Nashville and Memphis, electronic enforcement could provide adequate control of HOT lane use, negating the need to construct costly enforcement areas where the corridor is narrow. Daily truck volumes also appear high enough to justify consideration of truck lane provisions in some sections of the I-40 corridor.

Changes in state law would be required in order to permit tolling along existing HOV facilities because charging motorists for use of existing interstates is currently prohibited in Tennessee.

Available data suggest that HOT lanes represent a strategy for back-filling current HOV lane operational capacity and helping to address the number of observed HOV lane violators. If 50 percent of the current HOV lane capacity of approximately 1500 vehicles/hour is occurring, near-term demand for HOT lanes exists. If this threshold is not met, adequate HOT lane demand may be further into the future.

Both short and long-term projects to increase managed lane use could include implementation of direct access ramps for vehicles using managed lanes, as proposed in the "System 5" recommendation in the *Nashville Metropolitan Planning Organization HOV Study* completed in 1995. The radial HOV corridors in Nashville and Memphis currently end before reaching the business core areas. Providing alternate connections from the HOV system directly into downtown core areas or other land use generators without comparable access from the general purpose lanes will create an exclusivity of access and potential time savings which could attract additional lane users, particularly if and when the system is converted to HOT lanes. Exclusive ramps also ease enforcement of the lane policy (HOV or HOT) by providing additional enforcement areas where violators cannot exit the system to avoid being cited.

Physical Attributes of I-40 Corridor

A wide range of corridor attributes exists in each of the three urban areas. Each is reviewed in this section with respect to the potential to add a form of managed lanes. There has never been a successful application of converting *existing* general purpose lanes to managed lanes in the United States because the resulting level-of-services on the remaining general purpose lanes provokes public and political opposition. Adding new capacity is easier (less environmental and right-of-way impacts) in some portions of I-40 than others.

In Memphis, the portion of I-40 east of I-240 is not fully "built-out" and generally contains sufficient right-of-way and median area to support adding new capacity with minimal impacts. The existing HOV lanes also could be converted to HOT lanes. Some ramps and ramp gores may be impacted, but the potential for adding managed lanes generally seems feasible. There will be a need for significant improvements along the northern side of I-240 as that corridor connects with the future I-69 project and a potential new Mississippi River crossing into Arkansas. This section of I-240 is not "built-out" and generally contains sufficient right-of-way and median area to support adding new capacity with minimal impacts.

In Nashville, physical attributes of I-40 vary widely. In particular, the inner city portion of this route reflects deficient interchange spacing, substandard acceleration, deceleration and weave areas, frequently spaced major interchanges, and limited right-of-way. Adding at-grade or elevated lanes in this portion would likely be cost prohibitive and difficult from an environmentally perspective. Providing dedicated HOV, HOT or truck lane ramps with I-65 appears to be infeasible. Portions of I-40 recently widened to include HOV lanes could be modified as HOT lanes without widening. In the exurban areas, I-40 could be widened within the existing right-of-way.

In Knoxville, an inner portion of I-40 through downtown has recently been re-constructed to full design standards, and other portions of I-40 in the urban area also have been widened. By supplementing I-40 with a programmed Knoxville Parkway (which will decouple the portion of I-75 that is currently operating along I-40 between I-75 and I-675 in western Knoxville), the need to develop a through-routed managed lane along I-40 significantly decreases. The existing I-40 roadway would be difficult to widen in Knoxville, particularly along those segments which have just been improved.

Managed Lanes Feasibility for Memphis

A portion of I-40 east of I-240 should be considered for managed lanes for both near- and long-term time horizons. In the near term, HOT lanes (one concurrent lane in each direction) should be implemented along the existing HOV lanes and extended as congestion grows eastward in this corridor. HOT lane traffic on I-40 should have good accessibility, by implementing dedicated ramps where possible, to I-240. If truck traffic is addressed as a longer-term strategy, HOT lanes could be re-defined as two separated, directional lanes in each direction or two reversible lanes in the median. This lane treatment should consider mixing HOVs, tolled commuters and trucks in the same lane system, with some form of physical separation (i.e., traffic channelizers or concrete barriers) applied. The distance of this treatment would likely extend from I-240 to Arlington. Truck-toll lane justification would probably require upgrading or widening ramps between I-40 and I-240 so traffic would be allowed to distribute into other lanes.

If a new tolled Mississippi River bridge crossing and connecting freeway is constructed north of the downtown area (that would connect the I-240/future I-69 interchange to the east with the I-40/I-55 interchange in Arkansas to the west), this project could introduce an opportunity to expand an HOT system along I-240 between the I-240/I-40 interchange and the I-240/future I-69 interchange (approximately 12 miles) to provide a consistent managed-lane tolled corridor of one or two additional lanes in each direction to match the recommended I-40 managed lane corridor east of the I-240/I-40 interchange (as described above). It may also provide the opportunity to designate this corridor as the preferred route for I-40 through trips, thus removing through trips from the urbanized sections of I-40 and I-55 through the downtown area. **Figure 3-4** illustrates proposed managed lanes for Memphis.

Managed Lanes Feasibility for Nashville

The greater Nashville area presents many challenges in developing a single managed lane solution. No solution appears to easily fit within the inner city portion of I-40 bounded by I-440 on the west and I-24 on the east. A short-term recommendation is to modify the current HOV lanes on I-40 east to HOT lanes, allowing use by single-occupant vehicles willing to pay a toll through the use of electronic transponders. Similarly, HOT lanes provided in the median should also be considered for I-40 west on Nashville beginning in the vicinity of I-440. These lane treatments, shown in **Figure 3-5**, will help address HOV needs and peak commute demand as well as provide access to a diverse employment base not entirely focused on the core business area of Nashville.

In the longer term, two parallel managed lane strategies should be considered and studied further:

- Improved access to managed lanes in the inner portions on Nashville, perhaps involving limited lane extensions and queue bypass treatments for selected movements within the interchanges. Because this strategy does not assume that managed lane continuity will be possible, it should be supplemented by more aggressive active traffic management, including interchange connector metering, dynamic speed controls, temporary use of hard shoulder running and ultimately, dynamic rerouting of through traffic along SR-840.

- Adding managed lanes primarily for through trucks using SR-840, with the potential of serving two toll/express/truck lanes in each direction. As SR-840 is completed to I-40 west of Nashville, through and truck trips could be diverted around Nashville using these lanes to “manage” mobility by limiting access and implementing a tolling policy. Right-of-way along SR-840 appears to be sufficient to provide for a lower cost approach to facilitating through movements with limited access rather than rebuild the existing I-40 alignment or use viaducts for managed lanes. Selected direct access ramps between the proposed managed lanes along SR-840 and I-65 and I-24 will be needed.

Both of these longer-term strategies need more detailed study to ascertain demand, potential revenue and environmental feasibility.

Managed Lanes Feasibility for Knoxville

No managed lane treatments are recommended for I-40 in the Knoxville urban area. The limited number of congested segments and the lack of available options to widen the recently completed roadway do not make Knoxville a good candidate. Other TDM

strategies, including active traffic management and further improvements to the current ITS network, may help to address any forecast congested segments.

3.4.4 Re-assessment of Current Operations of I-40 HOV Lanes

Public perceptions of accepted HOV violation levels may not be as critical in settings where benefits, in terms of travel time savings, are marginalized. Typically, such savings should generate five minutes of travel time savings between the HOV and general purpose lanes for a trip made during peak commute periods. The HOV lanes in Memphis and Nashville do not meet this threshold for all operation periods or all segments of the current projects. For this reason, HOV projects experiencing enforcement breaches similar to I-40 in Nashville and Memphis have continued to function because they provide some modest level of benefit to HOVs and are not usually political targets to be converted to general purpose lanes as long as the remaining lanes generally operate below capacity. This dynamic can change if corridor congestion is worsening and noticeable, and police are not able to adequately enforce. Pro-active policies and operational changes are desirable to address such project shortcomings prior to becoming politicized. The HOV projects in both Nashville and Memphis may be candidates for re-assessment based on a broader criteria base which could examine:

- Demand, expressed by potential eligible user groups, in terms of meeting minimum person movement and vehicle movement thresholds
- Benefits, expressed as time savings differential between the HOV and general purpose lanes
- Enforcement compliance as a percentage of eligible HOV lane users (not all traffic)
- Corridor efficiency, expressed as a total of vehicle-hours of delay saved or changed from the current operation assuming an HOV or HOT operation policy
- If pricing is considered, ability to improve lane management and compliance and enforcement presence based on revenues generated to cover operation costs.
- Measuring attitudes among public and agencies (i.e., surveys) toward operational changes that improve perception of use and respect for specific changes in operation policies

Only the demand criterion for HOV and adjacent lanes is presently being considered in TDOT's evaluation procedures.

Long-range needs suggest dedicated lane treatments that serve HOVs and perhaps other users are appropriate because congestion is projected to extend over longer segments of the urban and exurban portions of I-40 surrounding Memphis and Nashville. The ability to meet demand will be challenging due to limited available rights-of-way, available route options, and funding availability. Better management of existing HOV lanes and whatever roadway capacity can be added will be critical to preserving mobility and offering various travelers choices during periods of greatest demand.

Near-term and long-term potential solutions at this stage in the study include:

- Re-assessing current HOV lane operations to regain credibility in active management and compliance, through improved enforcement practice, closer monitoring, dedication of funding resources, or sanctioning of new user groups who could be priced to fund dedicated monitoring and enforcement activities. Identifying legislative changes required in order to toll existing HOV facilities.

- Studying opportunities for managed lanes along programmed roadway expansions on I-40 and parallel routes, with consideration of how such expansions can best be preserved for managing a portion of the overall roadway as a long-term goal.

- Evaluating opportunities for extending current dedicated lane treatments along segments forecast to experience congestion, in accordance with a set of criteria that evaluates all potential users with preference to transit and person movement.

- Evaluating long-distance trip needs for managed lane feasibility, particularly among commercial goods movements on routes that may bypass congested urban corridors used primarily for commutation.

Each of these possible solutions would apply similar criteria to assess user demand, potential benefits and impacts, and public attitudes among both users and non-users.

As potential managed lanes are prioritized in Task 4, guidance in applying targeted evaluation criteria to candidate projects will be developed to augment the current policy.

3.5 Operational Solutions Summary

Figure 3-6 through **Figure 3-12** summarize the proposed operational solutions for the different geographical areas along I-40 and I-81.

Figure 3-4: Managed Lanes Solutions for Memphis

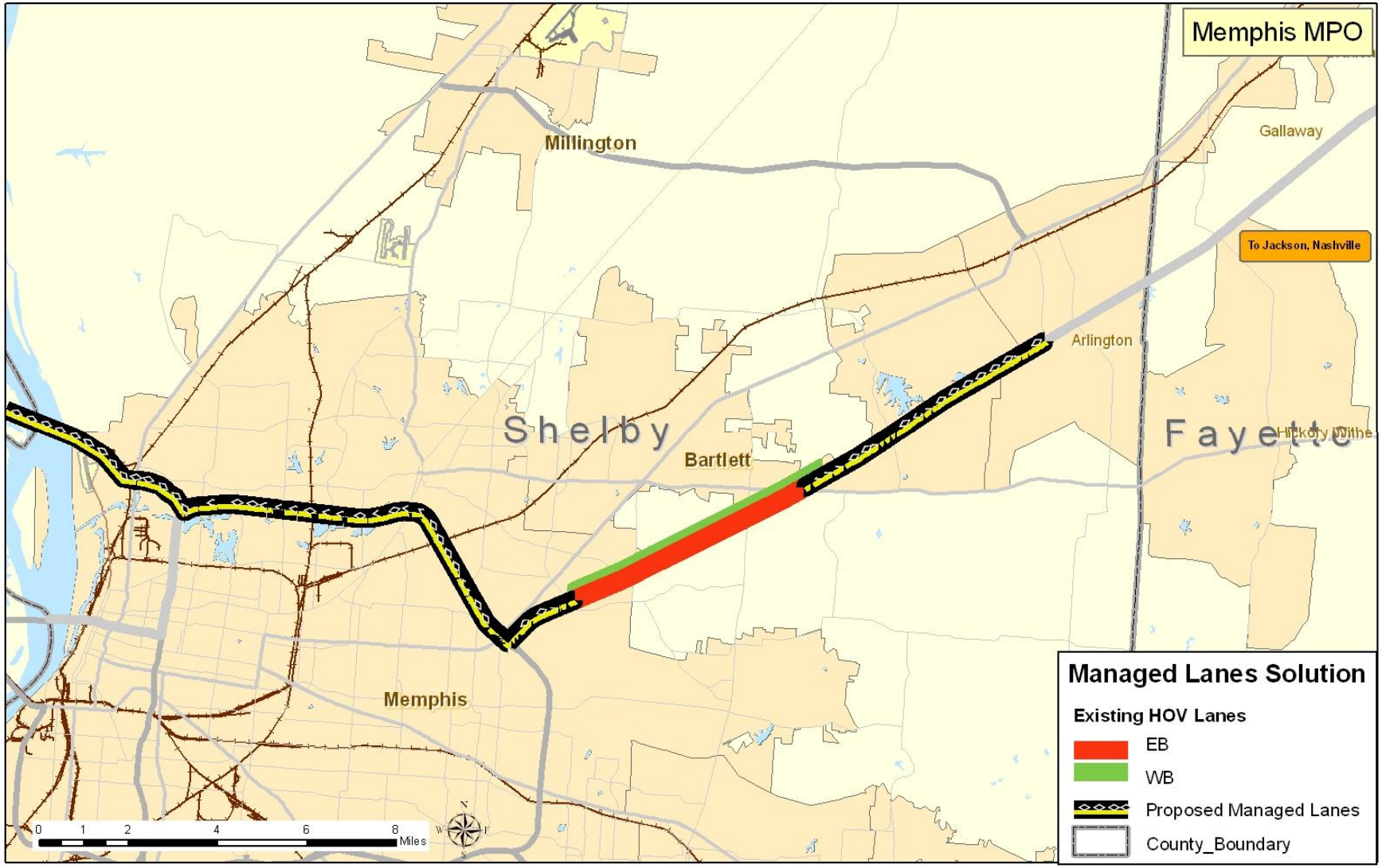


Figure 3-5: Managed Lanes Solutions for Nashville

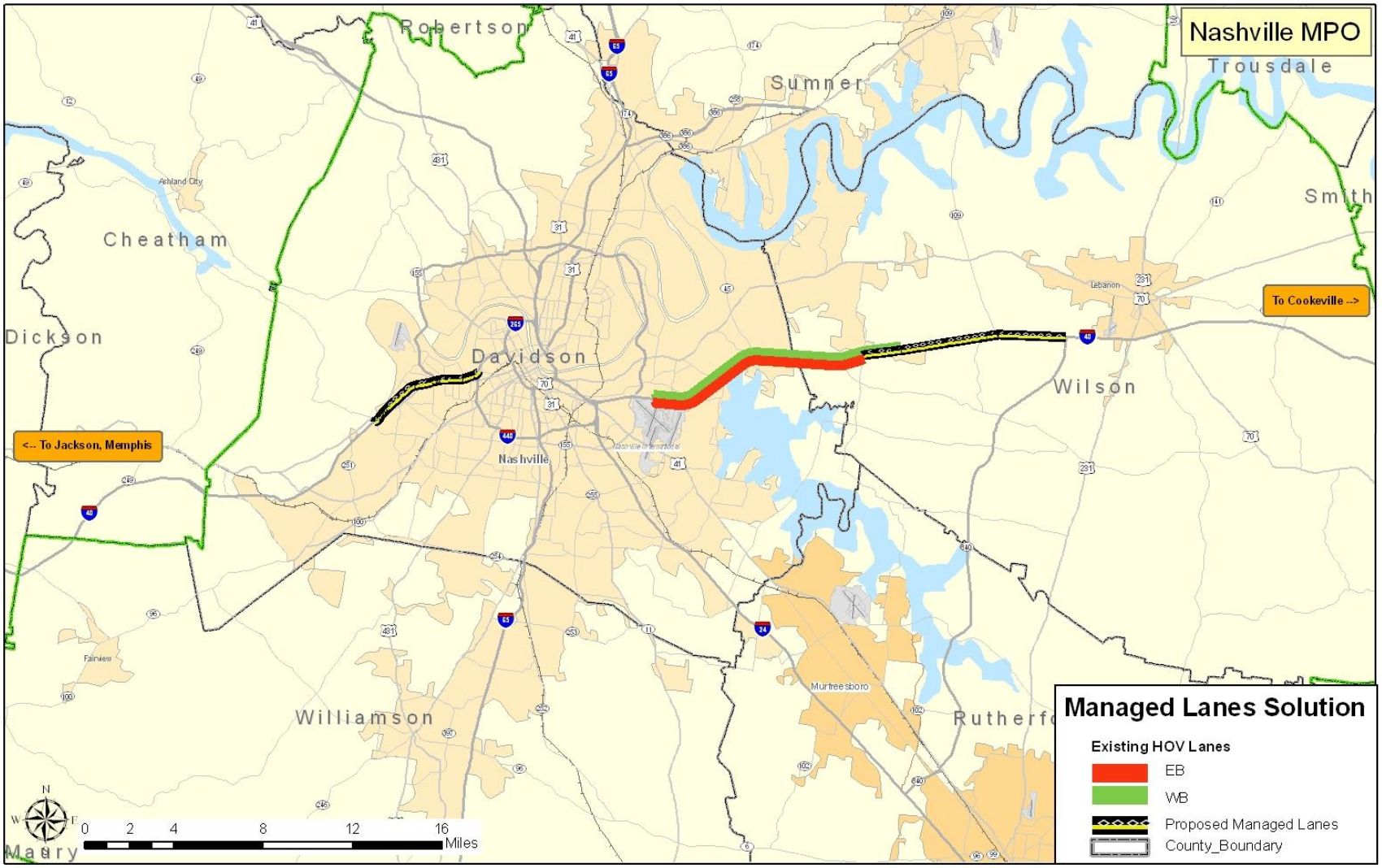


Figure 3-6: Operational Solutions (Memphis to Jackson)

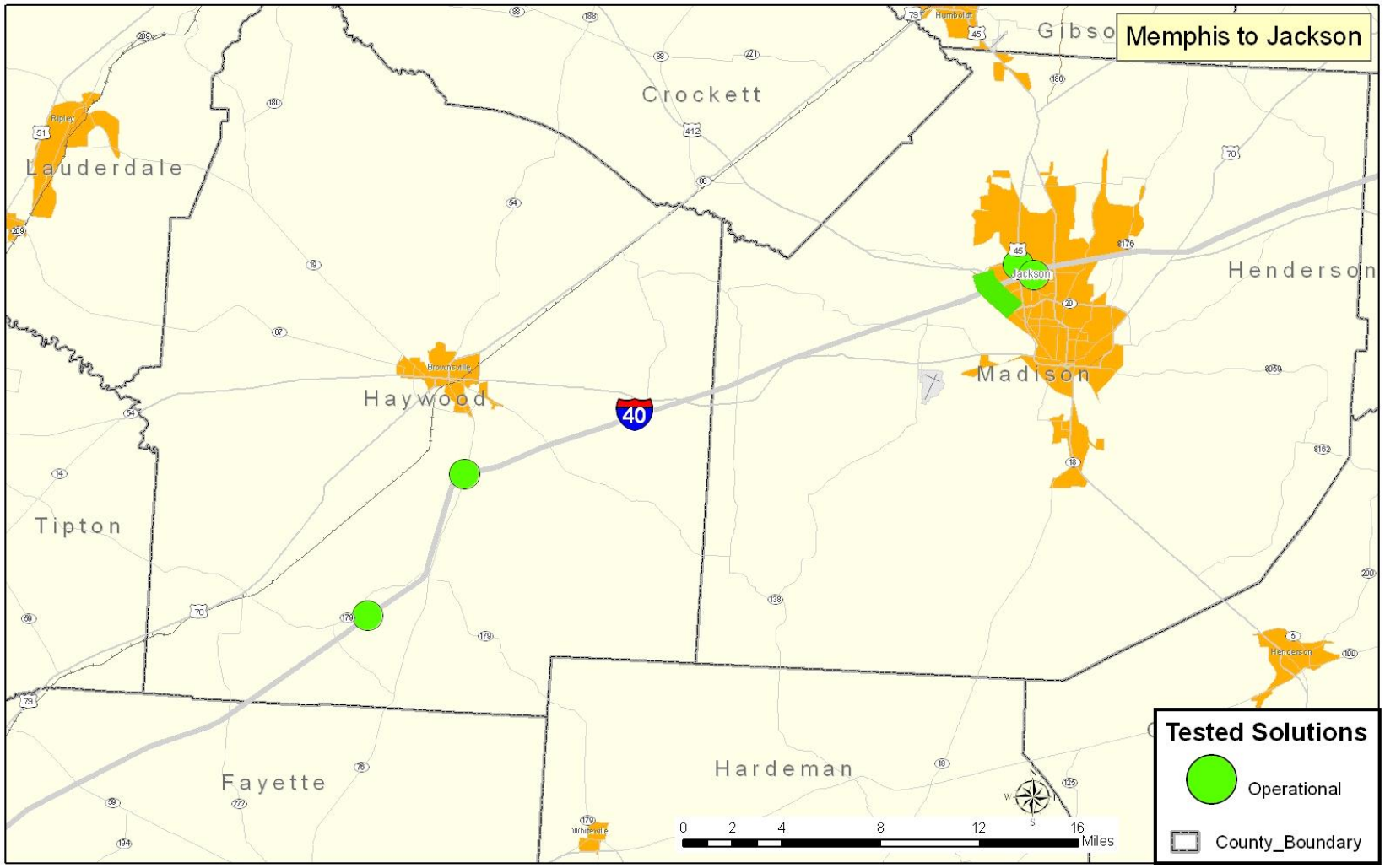


Figure 3-7: Operational Solutions (Jackson)

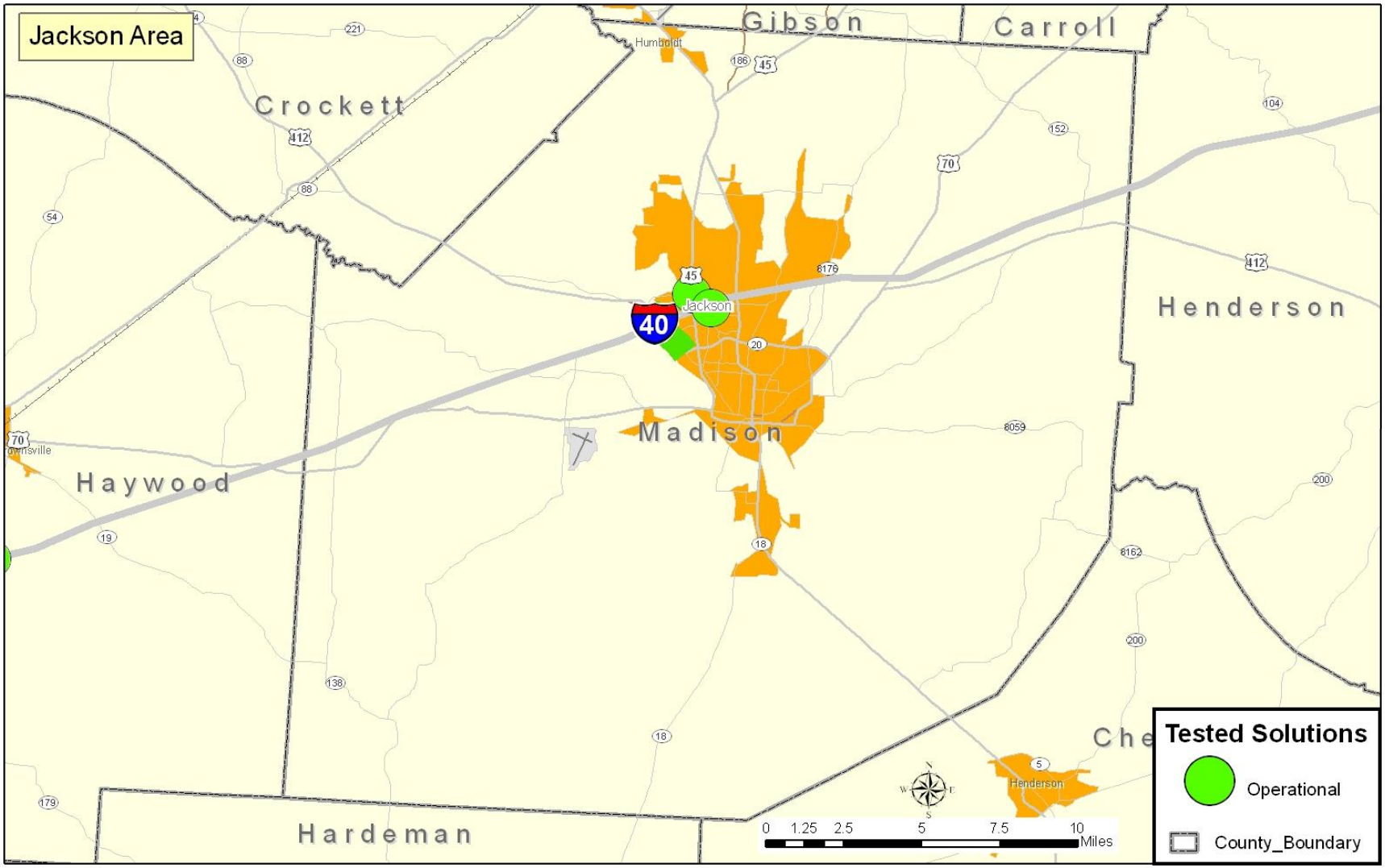


Figure 3-8: Operational Solutions (Jackson to Nashville)

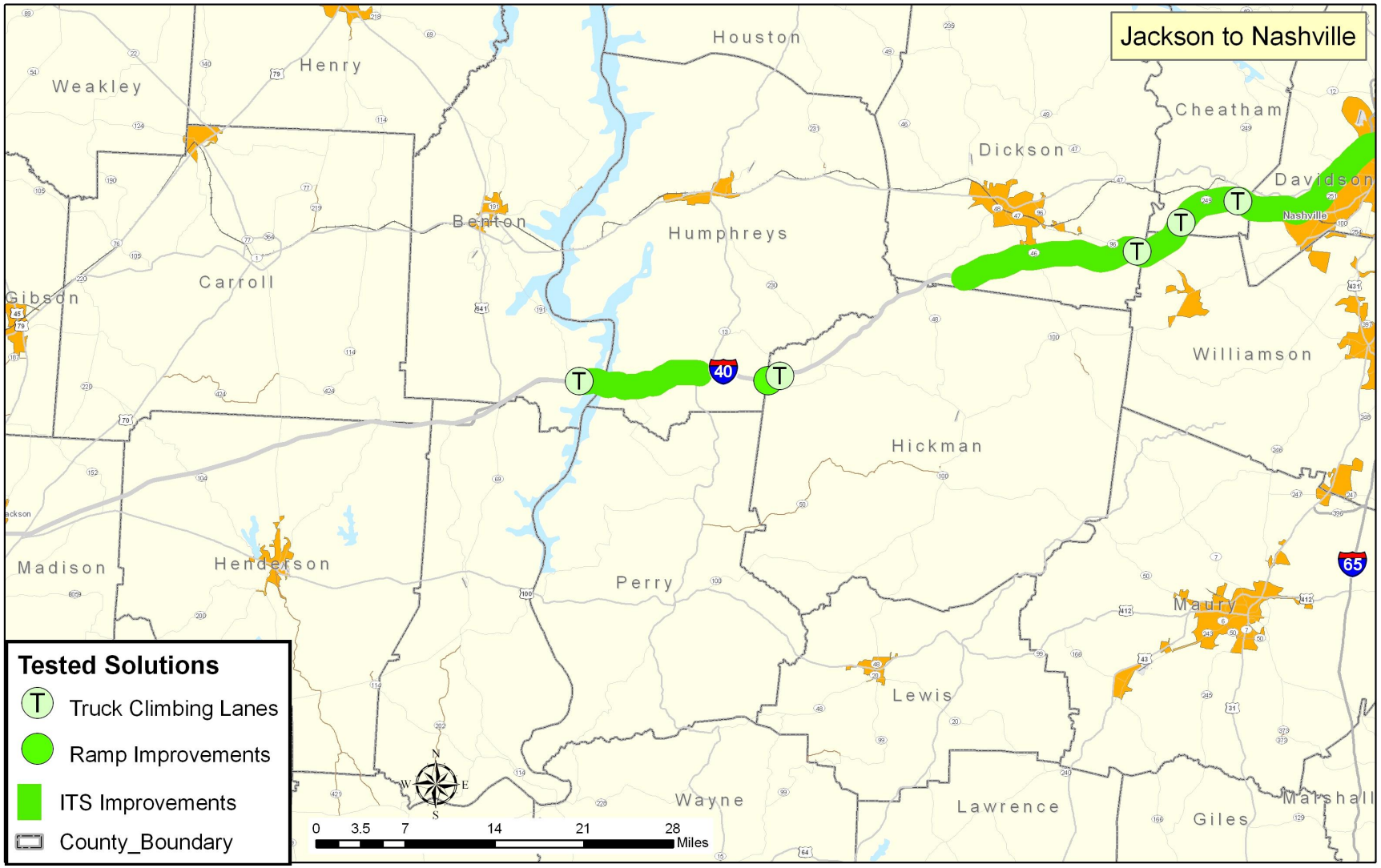


Figure 3-9: Operational Solutions (Nashville) (Dickson to Lebanon)

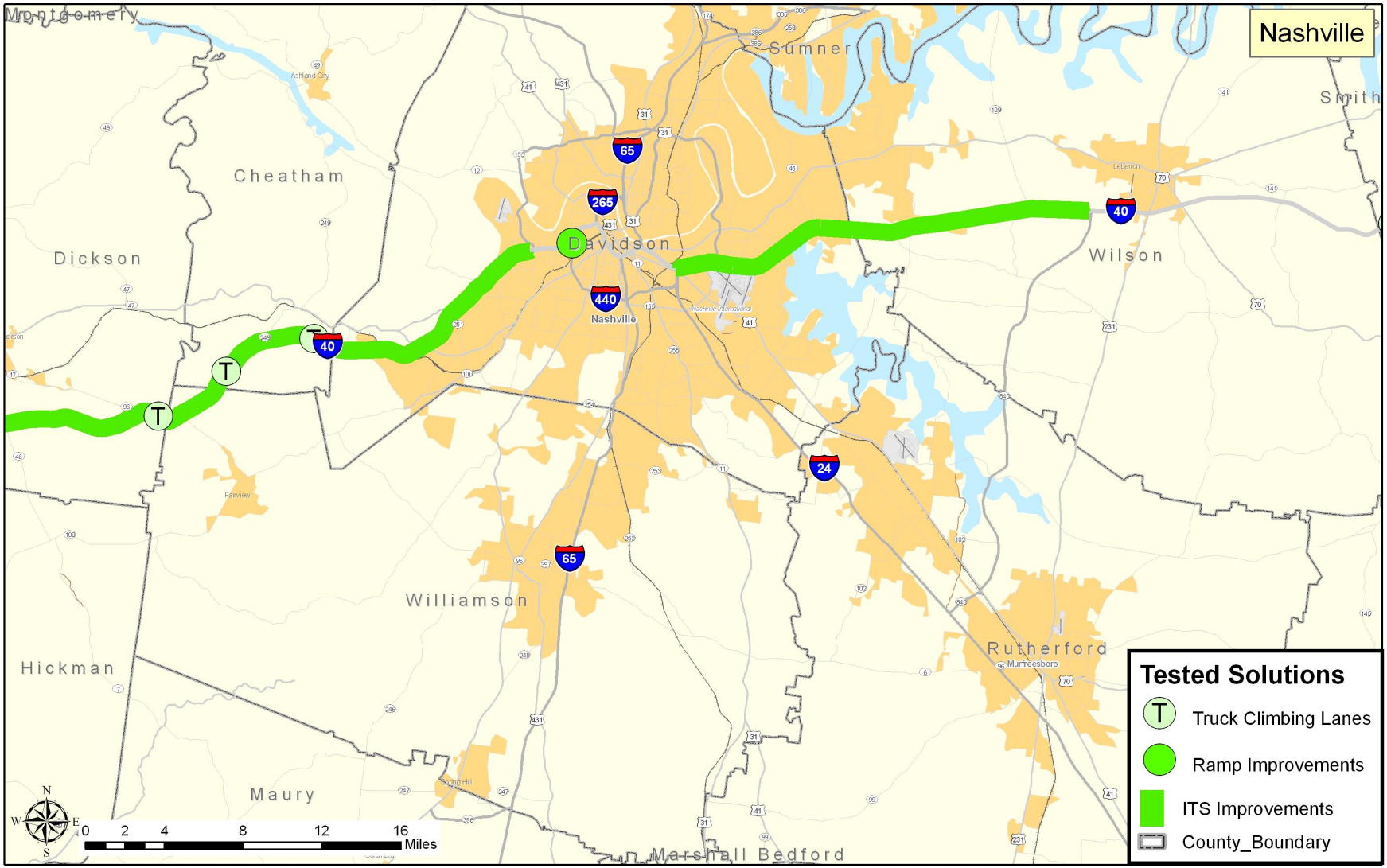


Figure 3-10: Operational Solutions (Lebanon to Knoxville)

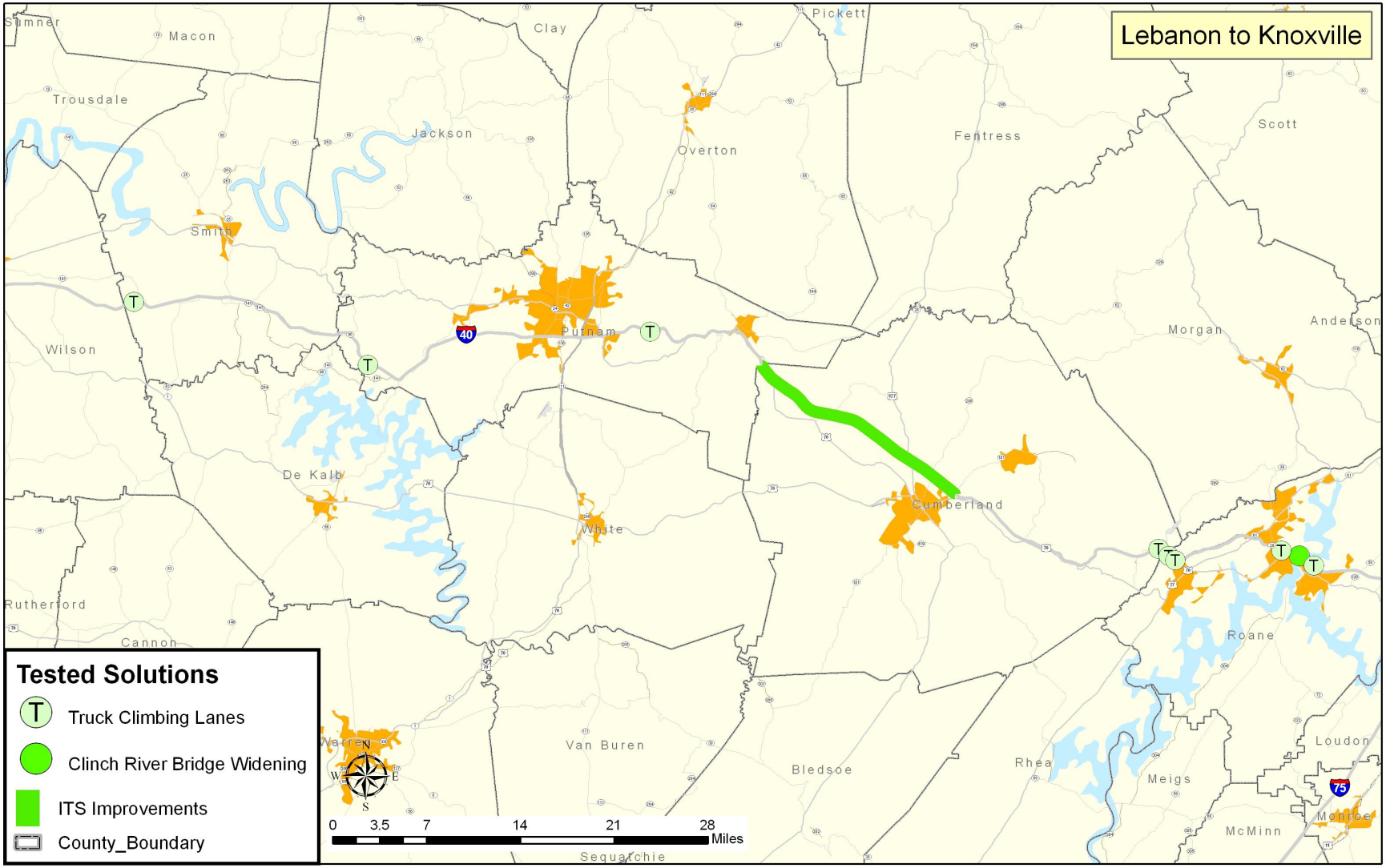


Figure 3-11: Operational Solutions (Knoxville)

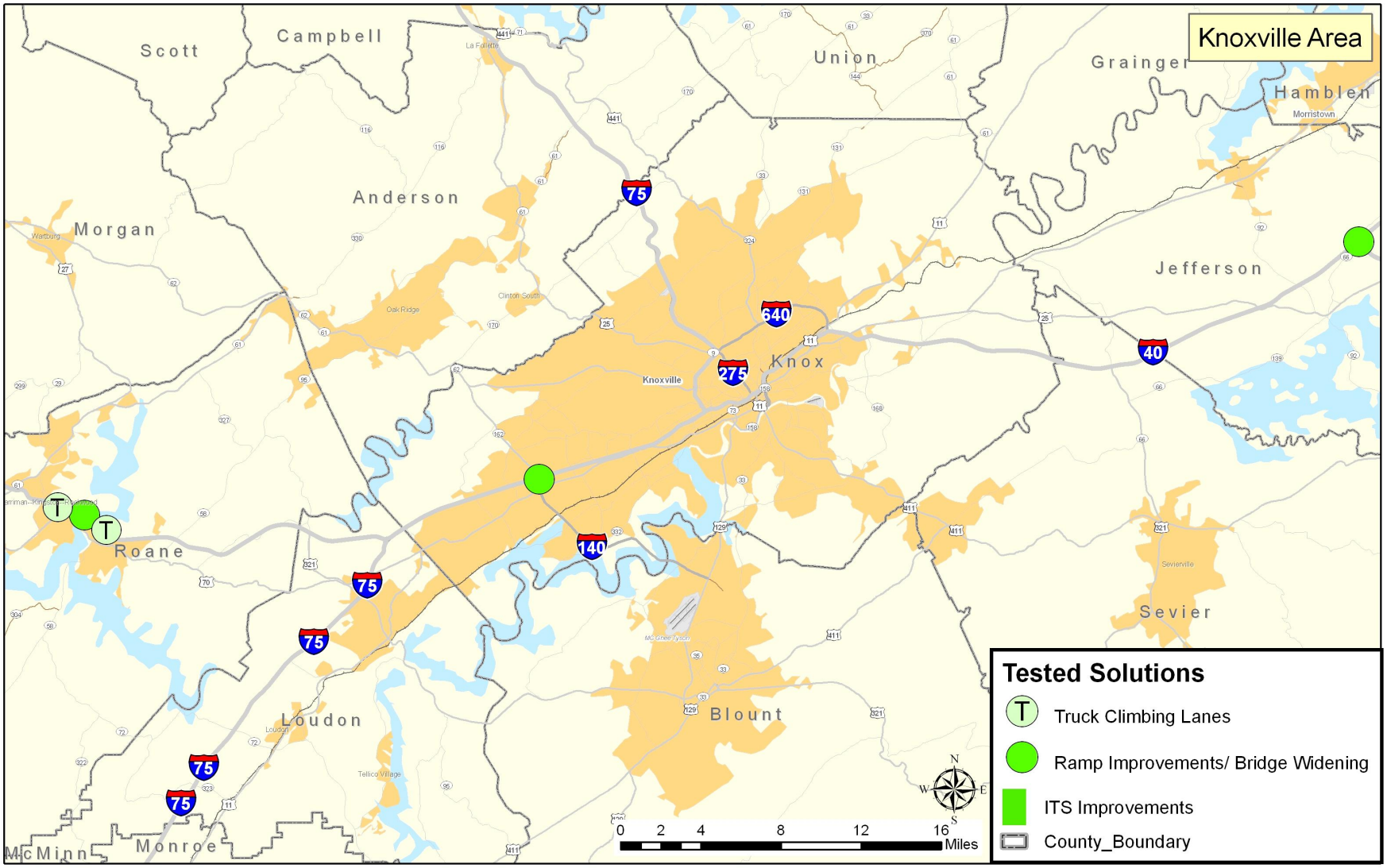
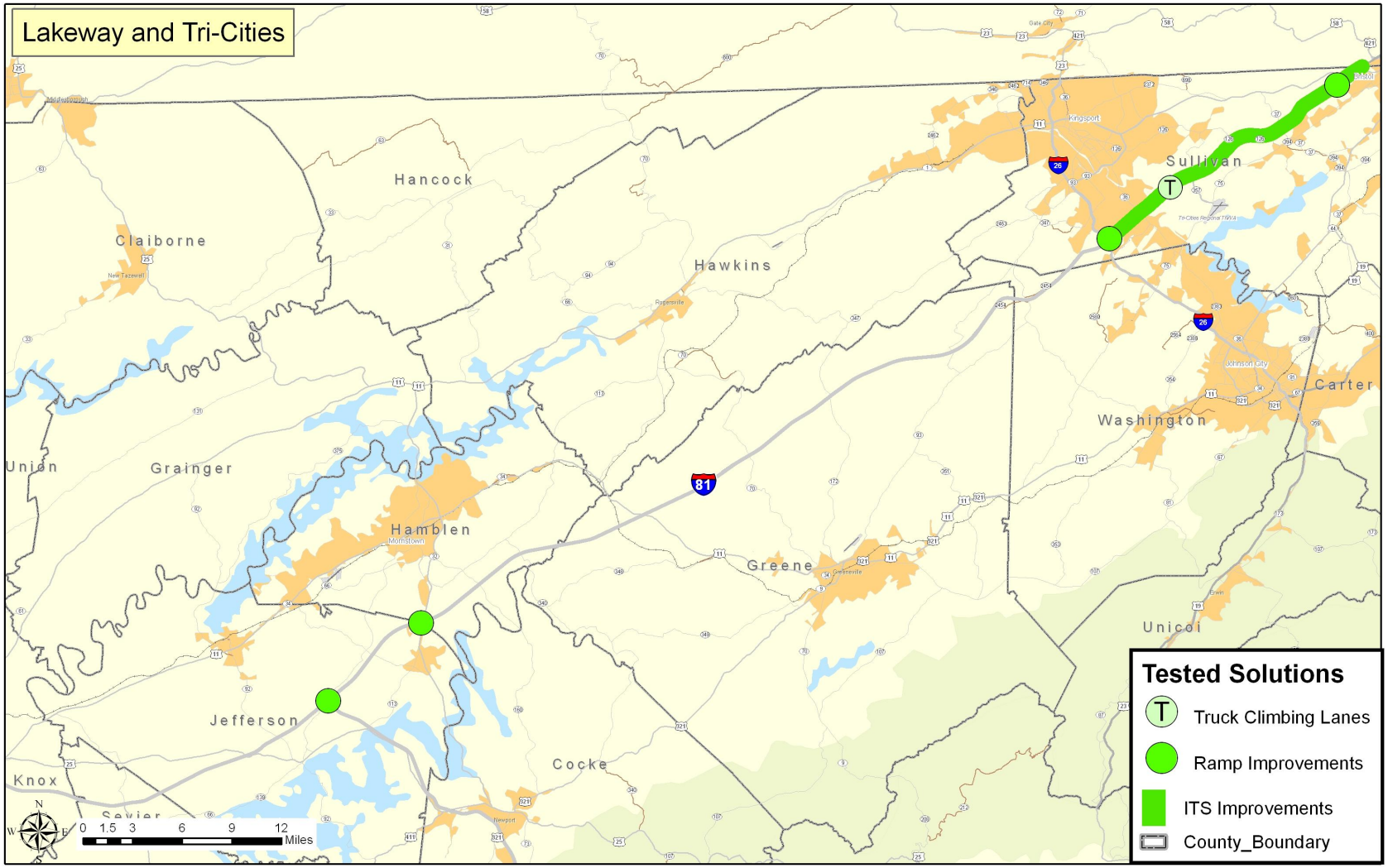


Figure 3-12: Operational Solutions (Lakeway & Tri-Cities)



4.0 FREIGHT MOVEMENT/ DIVERSION AND INTERMODAL FACILITIES

4.1 Description of Solutions

The freight movement/diversion and intermodal facilities solutions that are proposed as part of this study are:

- The Trans-Tennessee Rail Corridor
- Norfolk Southern Crescent Corridor
- New rail alignment at Mississippi River Bridge crossing
- Relocation of Nashville intermodal yard

The Trans-Tennessee Rail corridor is described in the *Tennessee Rail System Plan* as the redevelopment of a rail line connecting Crossville and Cookeville. This would enable rail to travel east to west through the state of Tennessee and provide a direct rail line from Knoxville to Nashville. The alignment is shown as a dashed red line in **Figure 4-1**.

The Crescent Corridor is a package of rail improvements planned by the Norfolk Southern Railroad on their existing rail lines spanning from New Jersey to Memphis and New Orleans. **Figure 4-2** shows the rail lines that constitute the Crescent Corridor and the locations of route improvements on the lines. The Crescent Corridor is being aggressively marketed and implemented by Norfolk Southern as a means to increase its revenue and market share in the region. It is based on the premise that long-haul intermodal services along I-20, I-40, I-75, I-85 and I-81 corridors are largely undeveloped and that many of these highways are congested. Both intermodal shippers and motor carriers have expressed interest in developing services in this corridor.

Norfolk Southern expects to deliver high quality services in the corridor that are competitive with single driver transit times. As an example, the rail travel time from Memphis, Tennessee to Harrisburg, Pennsylvania is expected to be 30 hours. The rail travel time from Memphis to Philadelphia, Pennsylvania is expected to be 43 hours. The travel time from Knoxville, Tennessee to New Jersey is expected to be 30 hours. The new service will require 28 new trains to be added to the Norfolk Southern network in the region (to be added in phases over rail lines both inside and outside of Tennessee). Access to the rail service will be available to all motor carriers, intermodal marketing companies, and private fleets with rail trailers and/or containers. Norfolk Southern's preliminary estimate is that there are over one million divertible truckloads in the Crescent Corridor.

Norfolk Southern is seeking a portion of this work to be funded by public investment based on improvements for the general public such as increased safety, reduced highway maintenance and expansion requirements, environmental benefits (emissions, land use, fuel consumption) and economic development. Investments in the corridor are scheduled to begin in 2008. The first new or improved services will be rolled out in 2009. The entire network is scheduled to be complete by 2013.

Figure 4-1: Schematic of Existing Rail Lines in Tennessee and Eastern United States

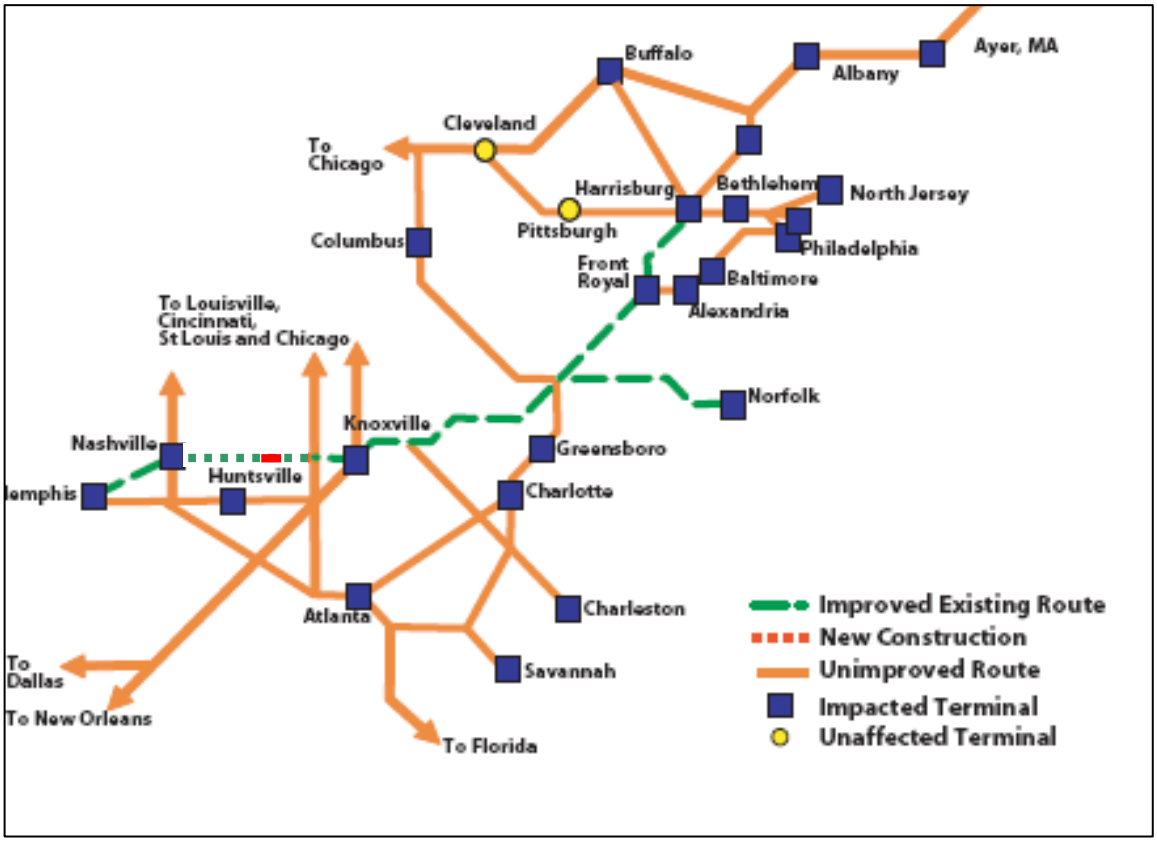
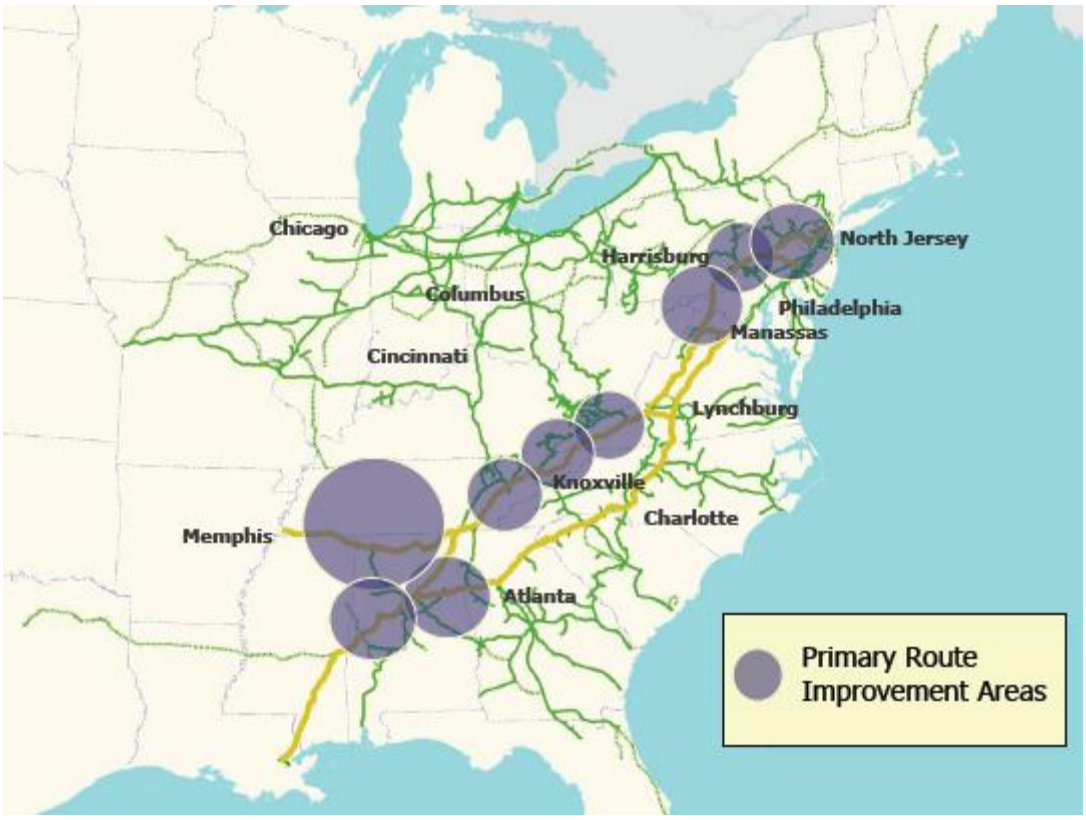


Figure 4-2: Norfolk Southern's Crescent Corridor and Proposed Rail Improvements

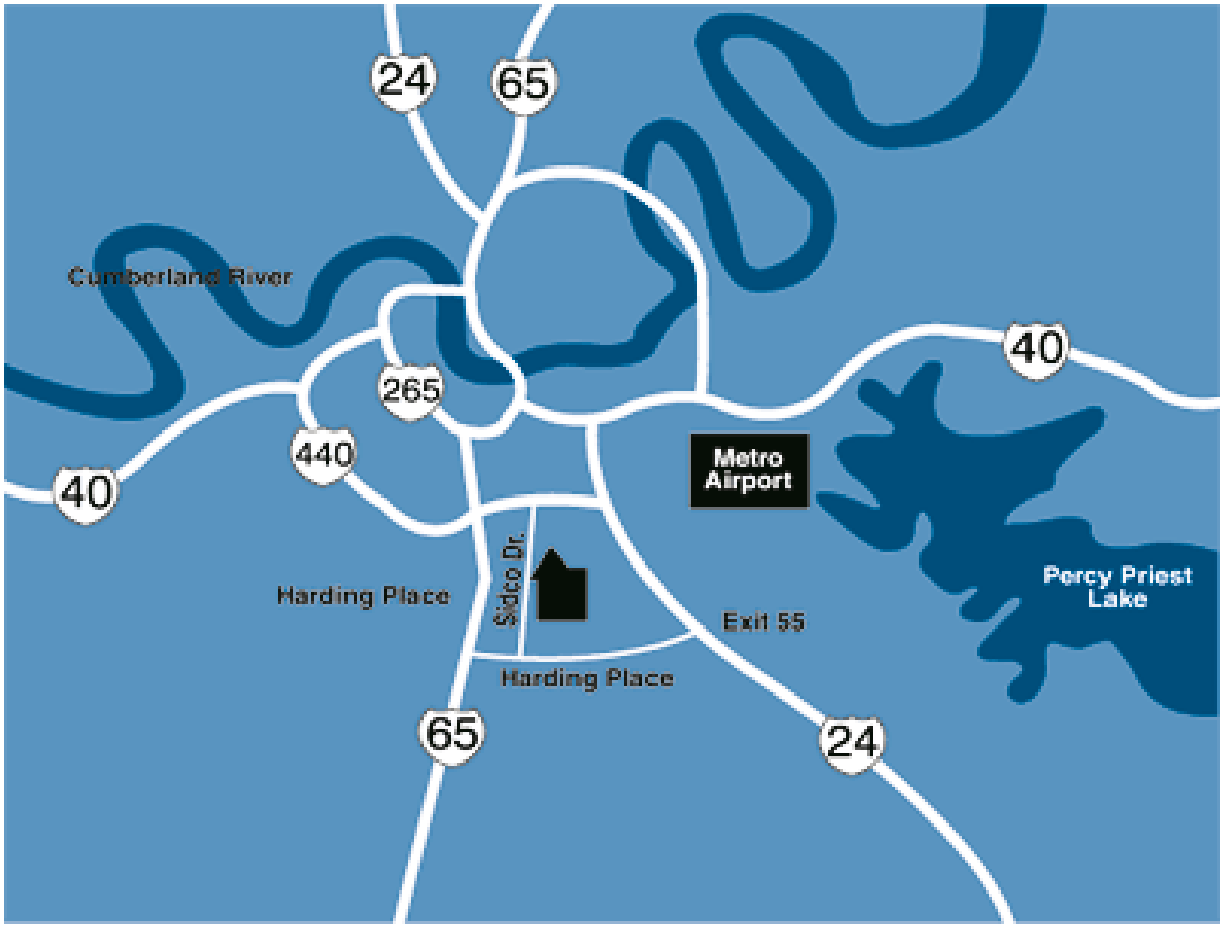


The rail solutions also include a new rail alignment for the Mississippi River Bridge just north of Memphis. The potential for this rail bridge was studied in the *Mississippi River Crossing Feasibility and Location Study* completed in June 2006. There were two potential locations for rail bridges that were recommended for further analysis. These are shown as locations "B" and "C" in **Figure 4-3**.

Figure 4-3: Location of Potential Mississippi River Rail Bridge Crossings

Another rail improvement that was considered as part of the rail-focused solution package was the relocation of the CSX intermodal rail yard to a location further away from downtown Nashville (**Figure 4-4**). The current rail yard is located roughly seven miles south of Nashville close to the I-65 and Harding Road interchange. An analysis of potential paths in and out of the rail yard indicated that moving the yard further away from the city would not have a significant impact on I-40 traffic in Nashville; therefore, this specific solution was not analyzed quantitatively as part of the solutions package described in Chapter 5.

Figure 4-4: Location of CSX Intermodal Yard in Nashville



Source: CSX website

5.0 EVALUATION

5.1 Methodology

The following four "packages" of project solutions were analyzed as part of this task:

- Roadway Capacity – additional capacity to I-40/I-81 by widening the existing interstate
- Corridor Capacity – additional capacity to parallel routes (by-passes or widening parallel arterials)
- Rail-Focused Improvements – diverting freight from truck to rail
- Operational Solutions – variable message signs, traveler information, weather management systems, interchange improvements, etc.

The analysis tools used for the Roadway Capacity and Corridor Capacity "packages" of solutions were the TDOT Statewide Travel Demand Model in conjunction with the MPO models for Memphis, Nashville, and Knoxville. The proposed solutions were coded into the model's network and the output statistics of each model run was tabulated separately across each of the following geographic regions:

- Memphis MPO area;
- Memphis to Jackson;
- Jackson MPO area;
- Jackson to Nashville;
- Nashville MPO area;
- Nashville to Knoxville; and
- Lakeway and Tri-Cities MPO areas east to the Virginia state line

For the Rail-Focused improvements scenario, the truck-rail diversion tool developed in Task 2 was used to estimate the impact of the Trans-Tennessee corridor and the new Mississippi River Bridge Crossing. Truck-rail diversion from the Crescent Corridor was estimated with a combination of tools. First, information on the proposed rail service characteristics and market size were extracted from Norfolk Southern material. The 2002 Bureau of Transportation Statistics Commodity Flow Survey was used to estimate the market share of the rail service by obtaining market share information from other corridors with a similar competitive position as the Crescent Corridor. Truck origin-destination surveys conducted in Virginia were used to estimate the routes taken by diverted trucks and therefore the amount of trucks diverted from I-40/I-81. For the Operational Solutions package, the ITS Deployment Analysis System (IDAS) software was employed to estimate the benefits of ITS solutions for both recurring and nonrecurring criteria.

To estimate safety improvements for each of the "packages", accident rates and fatality rates were extracted from TDOT's crash database. Accident rates were estimated as a function of road classification, volume and volume-to-capacity ratios. These rates were applied to each of the "packages" to estimate the change in accidents on I-40/I-81 for each scenario.

5.2 Evaluation Results

Each "package" of solutions was evaluated using throughput, congestion, and safety criteria as shown in **Table 5-1** through **Table 5-4**. This table also compares each "package" to the existing-plus-committed (E+C) highway networks for planning years 2011 and 2030. Full results of the evaluation are shown for each "package" and each geographic region in **Appendix D**. The 2030 Roadway Capacity "package" provided the most throughput for the corridor. Combined auto and truck vehicle miles of travel (VMT) were nearly 50 million per year. The other 2030 "packages" resulted in annual VMT ranges about 45 million miles of travel.

The 2030 Roadway Capacity "package" also provided the most delay reduction. It reduced recurring auto delay from approximately 300,000 hours per year in the 2030 E+C Scenario to below 100,000 hours annually. This scenario reduced recurring truck delay from roughly 150,000 hours per year to roughly 100,000 hours annually. The 2030 Corridor Capacity "package" and 2030 Rail "package" were about even in terms of delay reduction with total truck and auto delay of 408,000 hours per year. The 2030 Operational Solutions "package" provided only marginal delay reduction from the 2030 E+C Scenario with a total of approximately 450,000 hours per year of truck and auto delay. Similarly, the time to travel the entire corridor is shortest under the 2030 Roadway Capacity "package" and longest under the 2030 Operational Solutions "package" with the 2030 Rail and 2030 Corridor Capacity "packages" tied for second best travel times.

In terms of safety, the 2030 Corridor Capacity "package" was forecast to have the least number of accidents and fatalities in the horizon year. This scenario had a projected 8,500 accidents and 87 fatalities along the I-40/I-81 corridor in 2030. The 2030 Roadway Capacity "package" was found to be the second best for safety with roughly 8,700 accidents and 90 fatalities. This was just ahead of the 2030 Rail "package" with 8,800 accidents and 91 fatalities. The Operational Solutions "package" was forecast to be the least effective in terms of safety with 9,000 accidents and 94 fatalities. These projections do not incorporate the additional accidents which will be diverted to the parallel capacity that is built under the 2030 Corridor Capacity "package".

Table 5-1: Evaluation Results for Solution "Packages"

Evaluation Criteria	Baseline		Packages			
	2011 Existing + Committed Network	2030 Existing + Committed Network	2030 Roadway Package	2030 Corridor Package	2030 Rail Package	2030 Operations Package
Number of Hours of Auto Travel	412,470	613,653	574,882	562,833	613,653	613,653
Number of Hours of Recurring Auto Delay	149,281	307,783	95,232	272,948	277,526	307,783
Total Auto VMT	25,512,997	30,714,634	34,271,150	29,948,652	30,714,634	30,714,634
Number of Hours of Truck Travel	149,731	275,201	250,055	252,373	268,531	275,201
Number of Hours of Recurring Truck Delay	56,757	153,050	105,265	135,213	138,003	153,050
Total Truck VMT	9,170,315	14,396,805	14,537,649	13,673,388	13,227,005	14,396,805
Time to Travel Across Entire Corridor	634	753	649	729	735	748
Average Delay Time to Travel Across Entire Corridor	66	189	86	169	172	189
Total Number of Accidents	7,700	9,114	8,733	8,560	8,844	9,086
Total Number of Fatalities	77	94	90	87	91	94
Total Accidents at High Crash Locations	2,779	3,248	1,321	n/a	n/a	3,248

5.2.1 Highlighted Evaluation Results for Roadway Capacity "Package"

The Roadway Capacity "package", as described in Section 2.1, provides delay relief throughout the entire corridor. In the rural areas, it virtually eliminates congestion. From Memphis to Jackson, Jackson to Nashville, Nashville to Knoxville, and Knoxville to the Virginia state line, this "package" reduces auto delay by 75 percent, 92 percent, 88 percent, and 74 percent, respectively. In the urban areas of Memphis, Jackson, Nashville, and Knoxville, auto delay is reduced between 15 percent and 61 percent. Overall this "package" reduces auto delay by 69 percent and truck delay by 31 percent.

The Roadway Capacity "package" also reduces the percent of the corridor that is at level of service (LOS) D, E or F. From Memphis to Jackson, Jackson to Nashville, Nashville to Knoxville, and Knoxville to the Virginia state line, this "package" reduces the percent of the corridor at LOS D, E or F from 62 percent to 5 percent, 23 percent to 1 percent, 97 percent

to 28 percent, and 52 percent to 29 percent. There is only a slight reduction in the number of accidents in the corridor. The safety benefits of reduced volume-to-capacity (V/C) ratios in the corridor are offset by the increase in vehicle throughput so safety reductions are only 4 percent for I-40 and I-81.

The primary conclusion of this evaluation is that all of the solutions comprising the roadway alternative should be analyzed separately in Task 4, Project Prioritization, to develop project-specific, benefit/cost ratios which can be used to further refine alternatives for this study.

Table 5-2: Evaluation Results for Roadway Capacity "Package" of Solutions

Evaluation Criteria	Region								Total
	Memphis	Memphis to Jackson	Jackson	Jackson to Nashville	Nashville	Nashville to Knoxville	Knoxville	Lakeway & Tri-Cities	
Percent Reduction in Auto Delay Relative to 2030 E+C	41	75	78	92	61	88	15	74	69
Percent Reduction in Truck Delay Relative to 2030 E+C	57	25	45	31	60	30	18	15	31
Percentage of Corridor at LOS D-F (Roadway Capacity)	66	5	93	1	67	28	47	29	n/a
Percentage of Corridor at LOS D-F (2030 E+C)	100	62	87	23	99	97	92	52	n/a
Percent Reduction in Travel Time Relative to 2030 E+C	17	9	14	15	19	16	13	7	14
Percent Reduction Number of Accidents	4	2	4	2	6	2	6	1	4
Percent Reduction in Fatalities	10	0	0	0	6	5	7	0	4

5.2.2 Highlighted Evaluation Results for the Corridor Capacity "Package"

The Corridor Capacity "package" of solutions, described in Section 2.2, provides significant delay improvements in the Memphis, Nashville, and Knoxville regions. In Memphis, auto and truck delay estimates were reduced by 35 percent and 43 percent, respectively while in Nashville, forecasted auto and truck delay figures were reduced by 31 percent and 29 percent, respectively. While auto and truck delay only decreased by 9 percent in Knoxville, the percent of the I-40/I-81 corridor operating at LOS D, E or F decreased from 92 percent to 31 percent. Other areas along the corridor did not benefit as significantly from the Corridor Capacity "package". The projected number of accidents was reduced by about 6 percent for this alternative over the entire corridor. The forecasted number of fatalities for the corridor decreased by 7 percent; some areas were projected to have significant increases while others were forecast to have significant declines.

The implication of this analysis is that all of the solutions in the Memphis, Nashville, and Knoxville areas included in the Corridor Capacity "package" should be analyzed separately in the project prioritization task to develop project-specific, benefit/cost ratios which can be used to further refine alternatives for the I-40/I-81 Corridor Feasibility Study.

5.2.3 Highlighted Evaluation Results from the Rail-Focused "Package" of Solutions

All of the solutions from the Memphis, Nashville, and Knoxville areas included in the Rail-Focused "package" should be analyzed separately in Task 4, Project Prioritization, to develop project-specific, cost-benefit ratios.

5.2.4 Evaluation Highlights for the Operational "Package" of Projects

The Operational "package" described in Chapter 3 exhibits the least benefit of all of the packages in terms of throughput, delay and accidents. Although most of the benefits are found in the reliability and safety categories as shown below in **Table 5-4**, these solutions are likely to have the lowest cost, can be implemented in the shortest period of time and minimize disruption of existing traffic conditions. These projects have the greatest potential to provide some short-term improvements in vehicular flow along the corridor.

Table 5-3: Evaluation Results for Corridor Capacity "Package" of Solutions

Evaluation Criteria	Region								Total
	Memphis	Memphis to Jackson	Jackson	Jackson to Nashville	Nashville	Nashville to Knoxville	Knoxville	Lakeway & Tri-Cities	
Percent Reduction in Auto Delay Relative to 2030 E+C	35	-2	-9	5	31	3	9	3%	11
Percent Reduction in Truck Delay Relative to 2030 E+C	43	1	-2	9	29	7	9	5%	12
Percentage of Corridor at LOS D-F (Roadway Capacity)	85	78	97	23	95	94	31	51	n/a
Percentage of Corridor at LOS D-F (2030 E+C)	100	62	87	23	99	97	92	52	n/a
Percent Reduction in Travel Time Relative to 2030 E+C	17	9	14	15	19	16	13	7	14
Percent Reduction Number of Accidents	6	6	7	6	6	6	6	6	6
Percent Reduction in Fatalities	-40	43	0	50	-22	43	-43	31	7

Table 5-4: Evaluation Results for the Operational "Package" Where Applicable

Evaluation Criteria	Region								Total
	Memphis	Memphis to Jackson	Jackson	Jackson to Nashville	Nashville	Nashville to Knoxville	Knoxville	Knoxville to VA Line	
Number of Hours/Day Saved of Nonrecurring Auto Delay				53	15,862	266		2,119	18,300
Number of Hours/Day Saved of Nonrecurring Truck Delay				394	1,761	159		585	2,899
Savings in Travel Time Across Corridor (minutes)					13			3	16
Percent of Miles with Full ITS Deployment	85	0	0	0	19	0	57	19	
Percent of Miles with Partial ITS Deployment	0	0	0	12	0	41	0	3%	40
Change in Number of Accidents				5		13			18
Change in Number of Fatalities					2			2	4

5.3 Conclusions

The primary conclusions from these evaluation analyses are that each "package" has merit in addressing the deficiencies that are projected for the I-40/I-81 Corridor by 2030. For the Roadway Capacity package, significant improvement was evident in each area along the study corridor. For the Corridor Capacity package, significant improvement was evident in the Memphis, Nashville, and Knoxville areas. For the Rail Improvement package, improvements were again evident across the I-40-I-81 Corridor, but to varying degrees. For the Operational Solutions package, forecasted improvements were small. However, because these solutions have a low cost, they are included in the next round of analysis. In Task 4, each solution found to be significant along the corridor will be prioritized based on individual benefit/cost ratios.