



TENNESSEE CONGESTION ACTION PLANS

August 2022



Executive Summary

Contents

- 1. Background..... 1
 - Purpose and Need for Congestion Action Plans..... 1
 - Congestion Action Plan Development..... 2
- 2. Stakeholder Engagement..... 5
 - Agencies and Stakeholders Engaged 5
 - Purpose of Engagement..... 6
- 3. Data Analysis..... 7
 - Data Sources and Existing Conditions Analyses 7
 - Identifying Congested Locations..... 8
- 4. Recommendations..... 14
 - Project Recommendation Types..... 14
 - Project Selection and Screening 15
 - Policy and Programmatic Recommendations..... 17
- 5. Fiscal Analysis..... 20
 - Cost Estimation Processes..... 20
 - Summary of Capital Recommendation Costs..... 20
 - Analysis of Funding Needs..... 22
- 6. Conclusions and Next Steps..... 24

Tables

Table 5-1. Chattanooga CAP Cost Estimates	20
Table 5-2. Knoxville CAP Cost Estimates.....	21
Table 5-3. Memphis CAP Cost Estimates.....	21
Table 5-4. Middle Tennessee/Nashville CAP Cost Estimates.....	21
Table 5-5. Summary Fiscal Analysis of Funding Needs.....	23

Figures

Figure 1-1. Congestion Action Plan Study Areas.....	4
Figure 3-1. Chattanooga CAP Congested Locations	10
Figure 3-2. Knoxville CAP Congested Locations.....	11
Figure 3-3. Memphis CAP Congested Locations.....	12
Figure 3-4. Middle Tennessee/Nashville CAP Congested Locations.....	13

1. Background

The Tennessee Department of Transportation's (TDOT) 25-Year Transportation Policy Plan was adopted in 2015 and outlines a vision for addressing the state's long-term transportation needs. A key function of the plan is to document critical policy initiatives to support TDOT's transition toward performance-based, data-driven planning to maximize the efficiency of the transportation system, plan for long term needs, and improve quality of life for residents. One of these policy initiatives called for the creation of a congestion management program, which resulted in the development of Congestion Action Plans (CAPs) that build on previous planning efforts to identify and prioritize congestion reduction investments in each of the four largest cities in the state: Chattanooga, Knoxville, Memphis, and Nashville.

This document provides a high-level summary of the methodologies utilized across the four CAPs and documents the range of solutions that were explored, as well as the resulting policy and programming recommendations included in each report. Finally, this document highlights the funding deficit identified through additional comparison of CAP recommendations, previously identified congestion mitigation solutions, and ongoing TDOT projects.

Purpose and Need for Congestion Action Plans

The development of a congestion management program was a key recommendation included in TDOT's 25-Year Transportation Policy Plan. This recommendation was made in response to unprecedented growth in the state, which has resulted in worsening infrastructure and traffic conditions in west, middle, and east Tennessee, particularly in urban areas.

Rapidly deteriorating congestion negatively affects quality of life for both residents and visitors and can dampen economic development. To mitigate these impacts, TDOT chose to develop four CAPs as a coordinated, statewide response that would ultimately result in a more formal strategy to manage congestion on the freeways and major arterials.

A key objective of each CAP was to develop data-driven methodologies to quantify urban congestion in Chattanooga, Knoxville, Memphis, and Nashville, utilizing consistent data sources and analysis methods in each urban area. TDOT leadership and relevant divisions and regions were engaged in each CAP process to involve TDOT staff, build ownership, and encourage participation in the development of project and policy recommendations. Each CAP identifies a range of congestion mitigation measures, including projects and programs for freeways, arterials, intersections, and multimodal facilities, to provide an expansive toolbox of recommendations for TDOT to consider. In addition, each action plan

determined cost estimates, concept plans, and summary documents for the project recommendations included in each report.

Congestion Action Plan Development

CAP development began with the Middle Tennessee/Nashville CAP at the direction of TDOT leadership in 2019. The Middle Tennessee CAP was completed in 2020 and was intended as a pilot to be replicated in other urban areas. In 2021, companion CAP efforts were initiated for Chattanooga, Knoxville, and Memphis. Figure 1-1 illustrates the study areas that were analyzed in each CAP document, which largely correlate to urban planning boundaries. Roadways analyzed as part of these efforts include interstates and other controlled-access facilities as well as arterials on the state highway system.

A variety of previous planning studies and other resources were referenced during the development of the CAP documents, including:

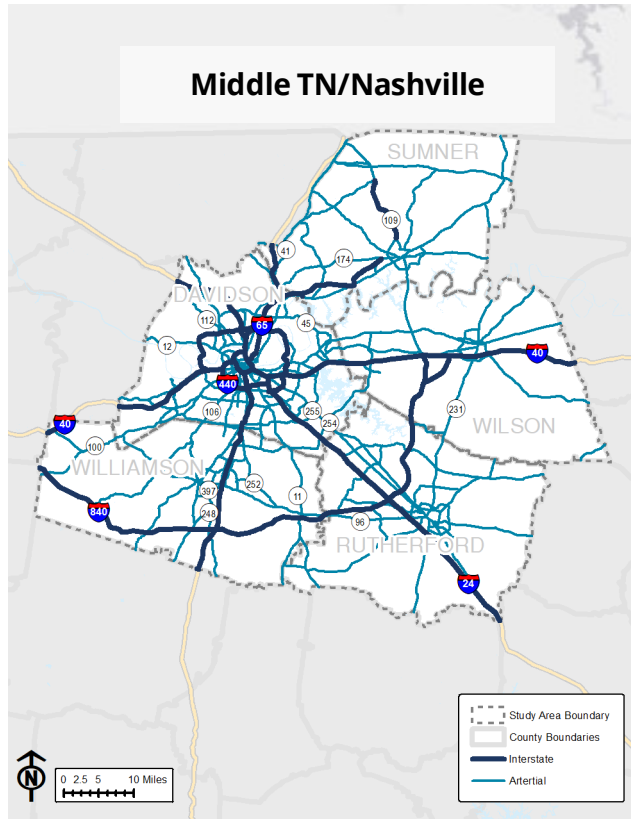
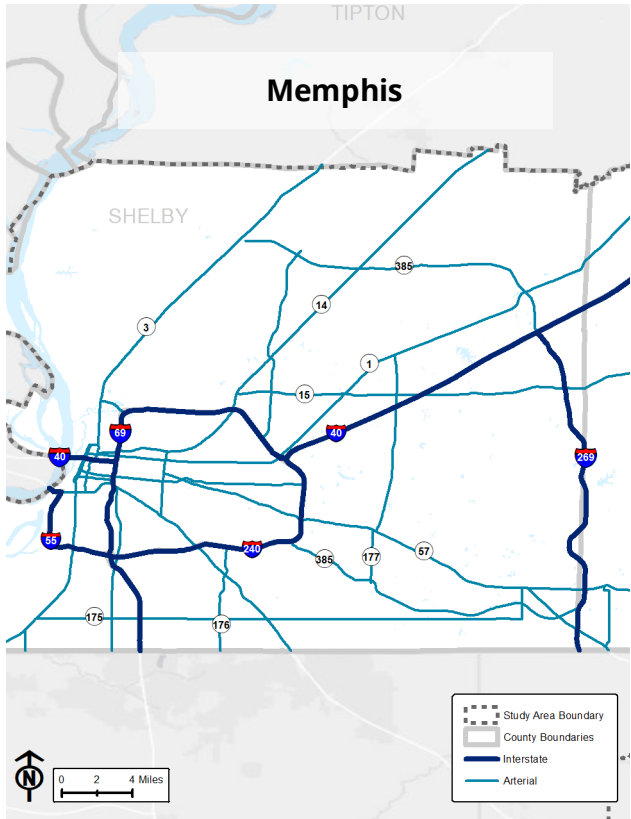
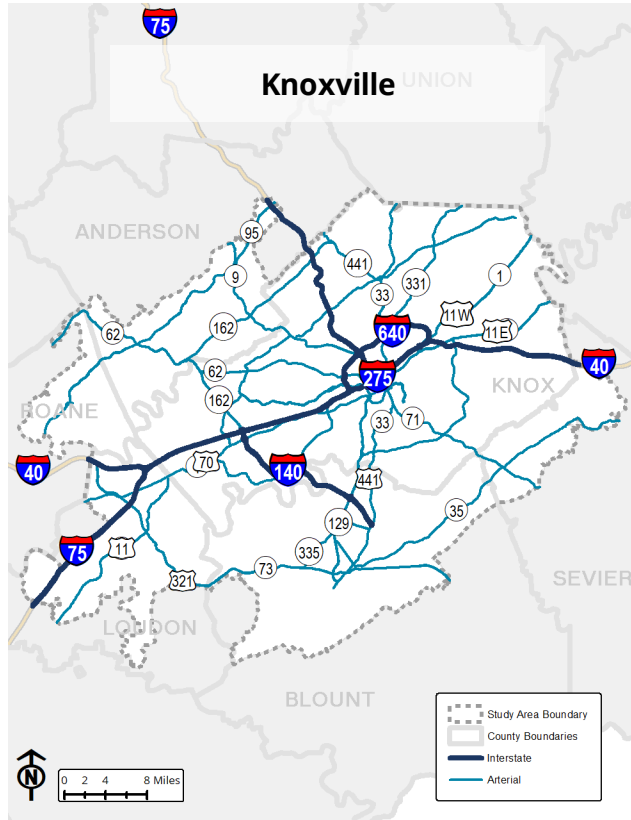
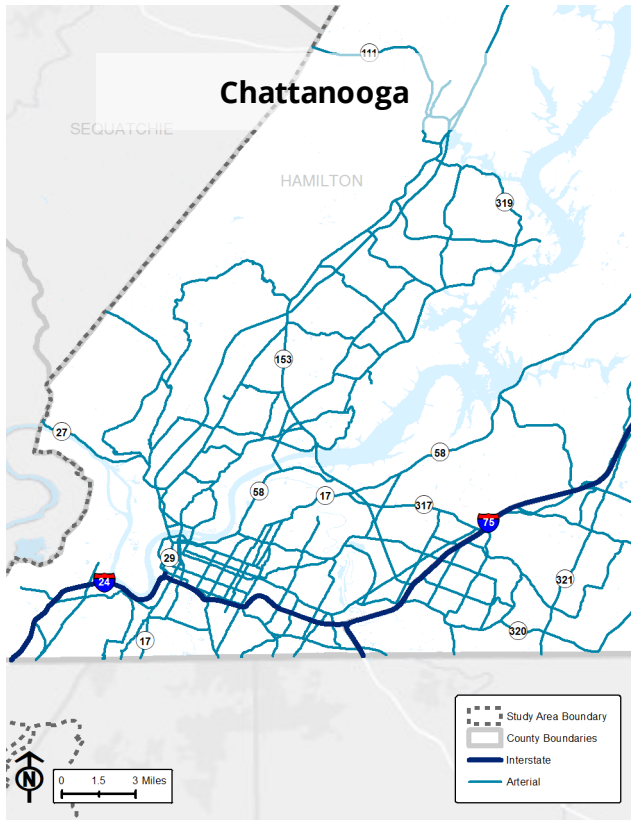
- Chattanooga-Hamilton County Regional Planning Agency (RPA) Comprehensive Plan Update 2030 (2016)
- Chattanooga Congestion Management Process Update (2018, 2022)
- Chattanooga TPO 2045 Regional Transportation Plan (2019)
- Tennessee's Improving Manufacturing, Public Roads, and Opportunities for a Vibrant Economy (IMPROVE) Act (2017)
- Knoxville Regional Transit Corridor Study (2013)
- Knoxville Regional TPO's Mobility Plan 2045 (2021)
- Memphis MPO's Livability 2050 Regional Transportation Plan (RTP) (2019)
- Memphis MPO's Fiscal Year 2020-2023 Transportation Improvement Program (TIP)
- Memphis MPO's Congestion Management Process (2020)
- Greater Memphis Regional Freight Plan (2017)
- Memphis Walk and Roll Bicycle and Pedestrian Plan (2020)
- Memphis 3.0 Transit Vision Plan (2019)
- Southern Gateway Purpose and Need Statement (2011)
- Tennessee Interstate Freight Bottleneck Analysis (2019)
- Memphis MPO's Regional ITS Architecture and Deployment Plan (2019)
- Nashville Area MPO Managed Lanes Preliminary Feasibility Assessment (2015)
- Nashville MTA/RTA nMotion Transit Plan (2016)
- Nashville Area MPO 2045 RTP (2021)
- TDOT I-40/I-81 Multimodal Corridor Study (2021)
- TDOT I-24 Corridor Study (2014)
- TDOT I-65 Multimodal Corridor Study (2018)
- TDOT I-75 Multimodal Corridor Study (2020)
- TDOT I-55 Multimodal Corridor Study (2020)

- TDOT Highway Program 2022-2024
- TDOT 2020-2023 State Transportation Improvement Program (STIP)
- TDOT 25-Year Transportation Policy Plan (2015)

Many of TDOT's previous planning efforts listed above have resulted in the identification of capital improvements needed to address congestion challenges in the four large urban areas. The five Interstate Corridor Studies represent a large share of these recommendations and include significant capital improvements that are largely unfunded. While Tennessee's IMPROVE Act of 2017 includes some projects that relate to transportation needs in these urban areas, the lion's share of needed improvements do not have identified funding to address these complex urban transportation impacts. Development of the urban CAPs was a logical next step by TDOT to help assess the constantly changing landscape of urban congestion, reaffirm the need for and further refine previously identified project concepts, and recommend additional innovative solutions for managing urban transportation demands.

Each CAP utilized a similar approach to this task of quantifying congestion and developing project recommendations, but because of the unique characteristics of each urban area, the data sources and analysis methods differ in each report. The purpose of this summary document is to highlight the general approaches used to identify congested locations and make recommendations in each CAP. In addition, this document serves as a compilation of funding needs for addressing congestion in Tennessee's major four urban areas.

Figure 1-1. Congestion Action Plan Study Areas



2. Stakeholder Engagement

Because congestion is an ongoing challenge for TDOT and its regional and local partners, a variety of agencies and stakeholders were involved in developing the CAP documents and recommendations in each of the four major urban areas. Within TDOT, various divisions as well as TDOT's regions, are responsible for monitoring and mitigating congestion on the state's highway system. External partners, including transit agencies, local jurisdictions, transportation authorities, regional planning organizations, and others provide practical knowledge of the impacts of congestion through their planning efforts, engagement with local stakeholders, and day-to-day operations.

Agencies and Stakeholders Engaged

Engagement with TDOT was critical throughout all phases of CAP development and included multiple rounds of engagement at key milestones with senior leadership, division directors, region directors, and region staff. Specifically, TDOT stakeholders included:

- Senior Leadership
- Long Range Planning Division
- Freight and Logistics Division
- Multimodal Transportation Resources Division
- Regions 1, 2, 3, and 4 Staff, including the Office of Community Transportation, Project Development, and Operations
- Strategic Transportation Investments Division
- Traffic Operations Division
- Structures Division

External stakeholder groups included the Metropolitan Planning Organizations (MPOs), local jurisdiction agency representatives, and transit agencies in each of the four urban areas. More specifically, these external stakeholder groups included representatives from the following agencies and organizations:

- Chattanooga-Hamilton County/North Georgia Transportation Planning Organization
- Chattanooga Area Regional Transportation Authority
- City of Chattanooga
- City of Eastridge
- City of Redbank
- Knoxville Area Transit
- Knoxville Regional Transportation Planning Organization
- Memphis Urban Area Metropolitan Planning Organization
- City of Memphis

- Memphis Area Transit Authority
- Metro Nashville-Davidson County Public Works Department
- WeGo/RTA Transit
- Nashville Area Metropolitan Planning Organization

Purpose of Engagement

Engagement with both internal and external stakeholders was critical throughout the development of each CAP. Meetings were held early in the planning process to review the scope of the effort and present findings of existing conditions analyses. Before project and programming recommendations were developed, stakeholders provided input on potential solutions and local project priorities.

As part of the engagement with TDOT stakeholders, specific feedback was provided on the following topics:

- Resources for data analyses,
- Criteria used to evaluate the impacts of congestion in urban areas,
- Potential congestion management solutions, including existing and future TDOT projects, and
- Cost estimates, ranking, and prioritization of recommendations.

Similar to the internal engagement with TDOT, external partners were engaged throughout the CAP planning process to ensure concurrence with existing conditions analyses, that project recommendations were consistent with local congestion mitigation efforts, and inclusion of appropriate multimodal recommendations in each CAP effort.

3. Data Analysis

Data Sources and Existing Conditions Analyses

A variety of data sources were utilized to conduct existing conditions analyses and determine the extent and impact of congestion in each of the four urban areas. A primary resource for congestion data for all four CAP documents was the University of Maryland's Regional Integrated Transportation Information System (RITIS) platform. This dataset, made available through TDOT, uses anonymized data from GPS-enabled devices to collect real-time information on traffic flow conditions. In addition to current and historical vehicular speed data, the RITIS platform allows users to identify major bottleneck locations and provides information on their relative system impact.

In addition to the RITIS data, each CAP document analyzed supplemental data to conduct a more comprehensive assessment of congestion and traffic operations in each study area. For example, the Chattanooga CAP referenced the Tennessee Radar Detection System (RDS) to examine traffic flow and considered turning movement counts, crash data, and signal timing plans to analyze existing conditions of arterials and freeway segments. The Memphis CAP existing conditions analysis included an assessment of crash data from the Tennessee Integrated Analysis Network (TITAN) database, transit ridership data from Memphis Area Transit Authority (MATA), and future traffic forecasts from the Memphis MPO's regional travel demand model. In the Middle Tennessee/Nashville CAP, Streetlight data was utilized for trip origin and destination information, and WeGo/RTA ridership and reliability data, and bicycle and pedestrian level of service (BLOS/PLOS) data were also considered. Similarly, the Knoxville CAP evaluated TDOT traffic data, Knoxville Area Transit (KAT) ridership and reliability data, bicycle and pedestrian infrastructure conditions data, and regional growth forecasts from the TPO's regional travel demand model.

In each CAP, these varied data sources were used to analyze the freeways and arterials included in each study area to create a data-driven depiction of current conditions and to prioritize the segments and intersections that were considered for project recommendations. These existing conditions analyses considered traffic operations concerns, safety issues, congestion deterioration, and multimodal conditions. Each CAP document included "cut-sheet" summaries of priority corridors that provided overviews of each roadway's existing conditions, highlighting bottleneck locations, congestion trends, multimodal overviews, and travel time reliability. These corridor summaries are included in the Appendices.

Identifying Congested Locations

While each of the CAPs used similar data sources to analyze existing conditions, each process was unique and utilized differing methodologies to identify those congested locations that received additional analysis and project recommendations.

In the Chattanooga CAP, the top five worst freeway and top 30 worst arterial bottleneck locations were identified using the RITIS “Bottleneck Ranking” tool, which considers the speed differential between free-flow and congested speeds, the severity of congestion, and total delay. Once the bottleneck locations were identified, six roadway segments were identified that overlapped with the freeway bottlenecks, while 10 intersections and five corridors were identified that overlapped with the arterial bottlenecks. These segments, corridors, and intersections were chosen in consultation with stakeholders to be analyzed further and prioritized for project recommendations.

The Memphis CAP identified the top 20 worst bottlenecks using speed and travel time data from the RITIS platform that were ranked based on how long a bottleneck takes to clear, its length, and its frequency. In addition to the bottleneck locations, the top 15 congested roadway segments were identified using the RITIS “Congestion Scan” tool, which compares the observed flow rate to the free flow rate for segments along the corridor by time intervals. These segments were then ranked using a weighted average that considered the annual daily traffic of each corridor to identify the corridors where the largest number of trips were affected by congestion. After the bottleneck locations and congested segments were identified, project recommendations were developed to address each congested location.

In both the Middle Tennessee/Nashville and Knoxville CAPs, deficiency scores were developed to rank the existing levels of congestion on arterials and freeways within both urban areas. A variety of metrics were utilized to develop the deficiency scores, including:

- Existing congestion levels, which considered congested speeds, travel time and reliability of transit service,
- Impacts of congestion, including passenger and commercial vehicle volumes, the impacts of bottlenecks, and future growth projected along regional corridors,
- Congestion deterioration during peak periods and throughout the day, and
- Multimodal impacts, including transit ridership and bicycle and pedestrian conditions.

Using each of these metrics, each roadway corridor was given a score to represent the relative deficiency of that segment compared to all others across each respective region. The metrics were also weighted according to facility type (freeway or arterial) and input

from TDOT stakeholders. Once corridors were ranked using the deficiency scores, capital project recommendations were developed for both regions.

Figure 3-1, Figure 3-2, Figure 3-3, and Figure 3-4 illustrate each urban area's congested segments and bottlenecks identified through the CAP process. In the Chattanooga area, 15 spot locations and 11 segments were identified as bottlenecks. In the Memphis area, 20 spot locations and 15 segments were identified as bottlenecks. In Knoxville, 35 spot locations and 15 segments were identified as bottlenecks. In the Nashville area, 20 spot locations and 57 segments were identified as bottlenecks.

Figure 3-1. Chattanooga CAP Congested Locations

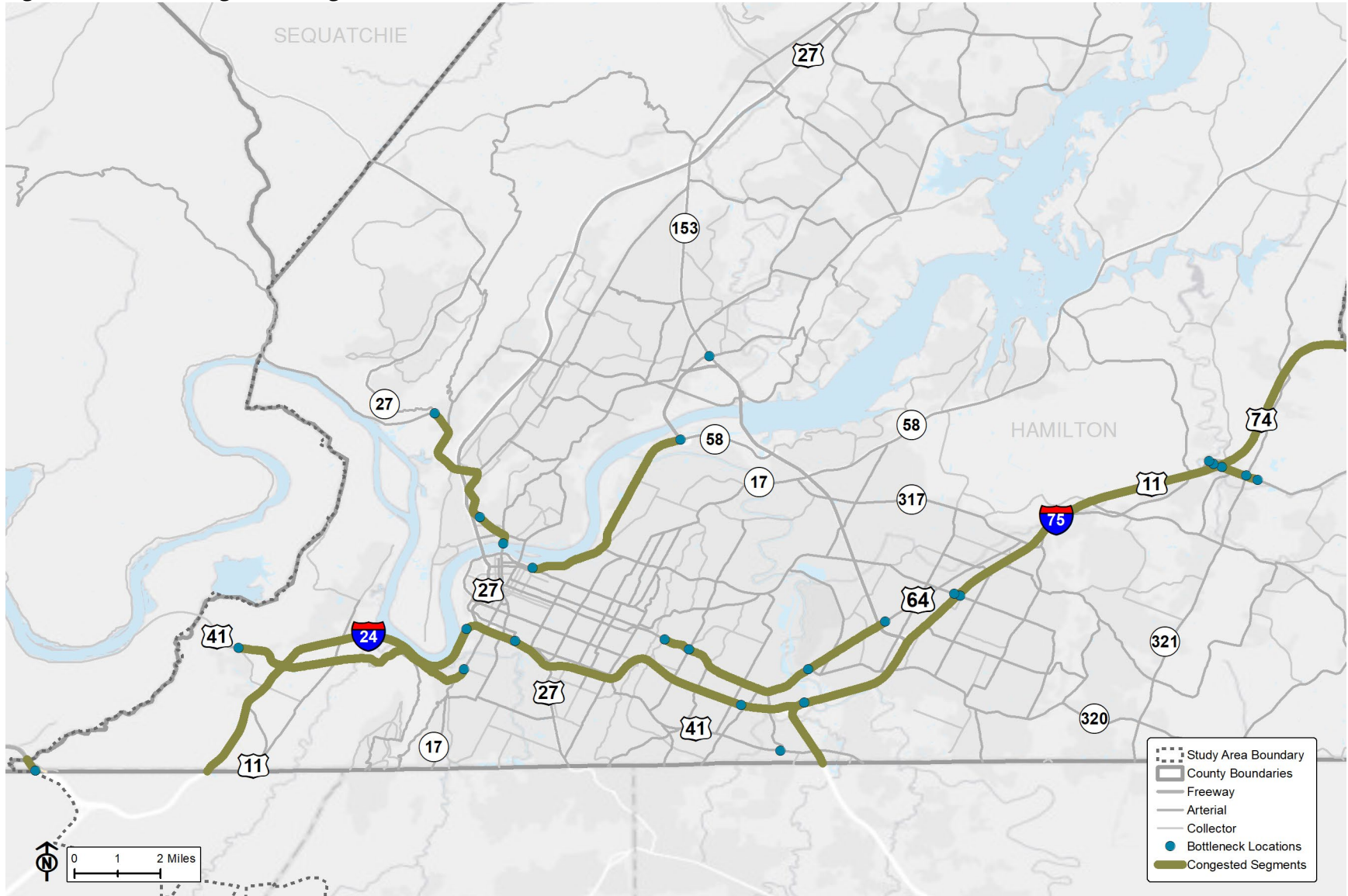


Figure 3-2. Knoxville CAP Congested Locations

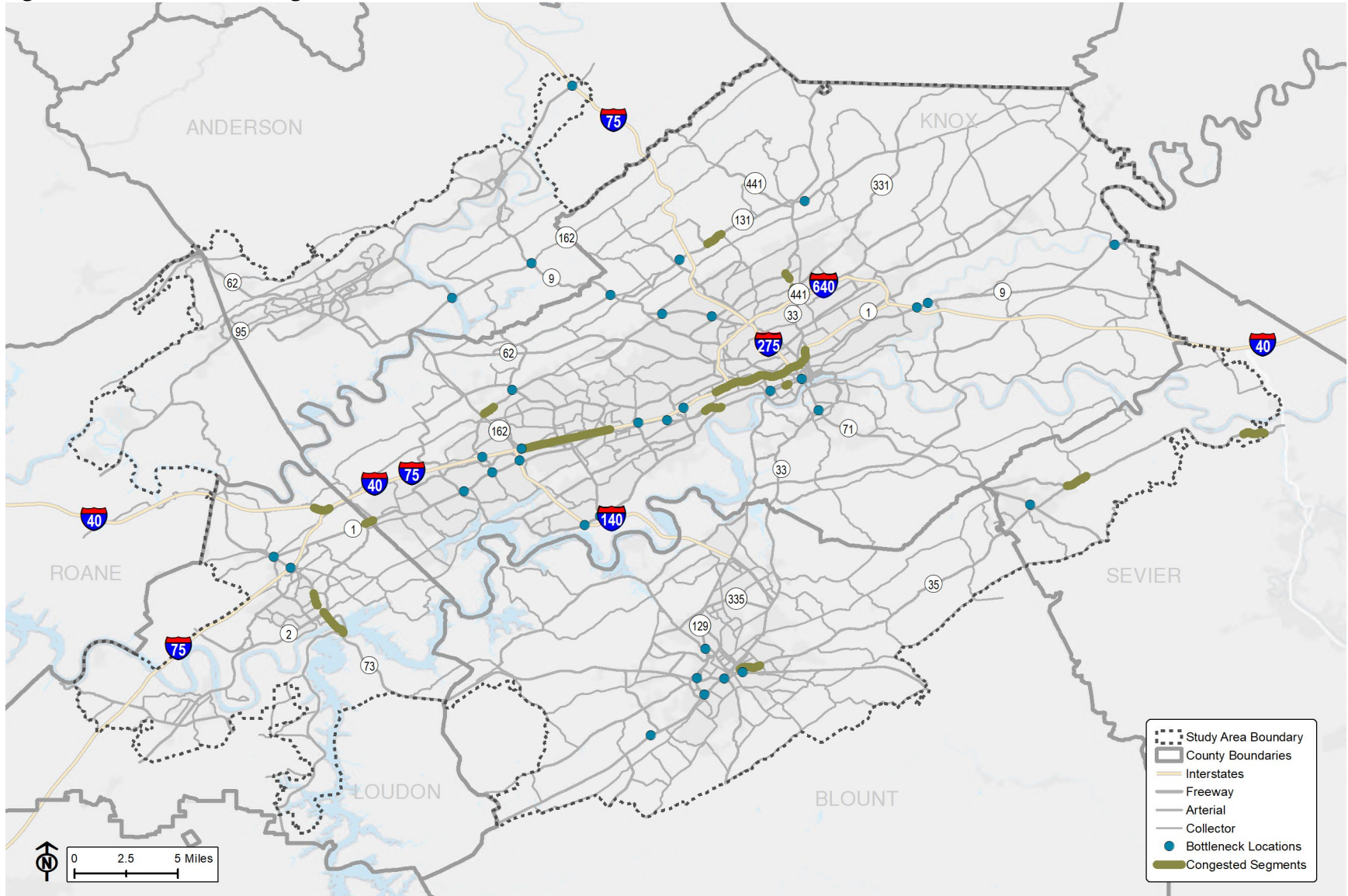


Figure 3-3. Memphis CAP Congested Locations

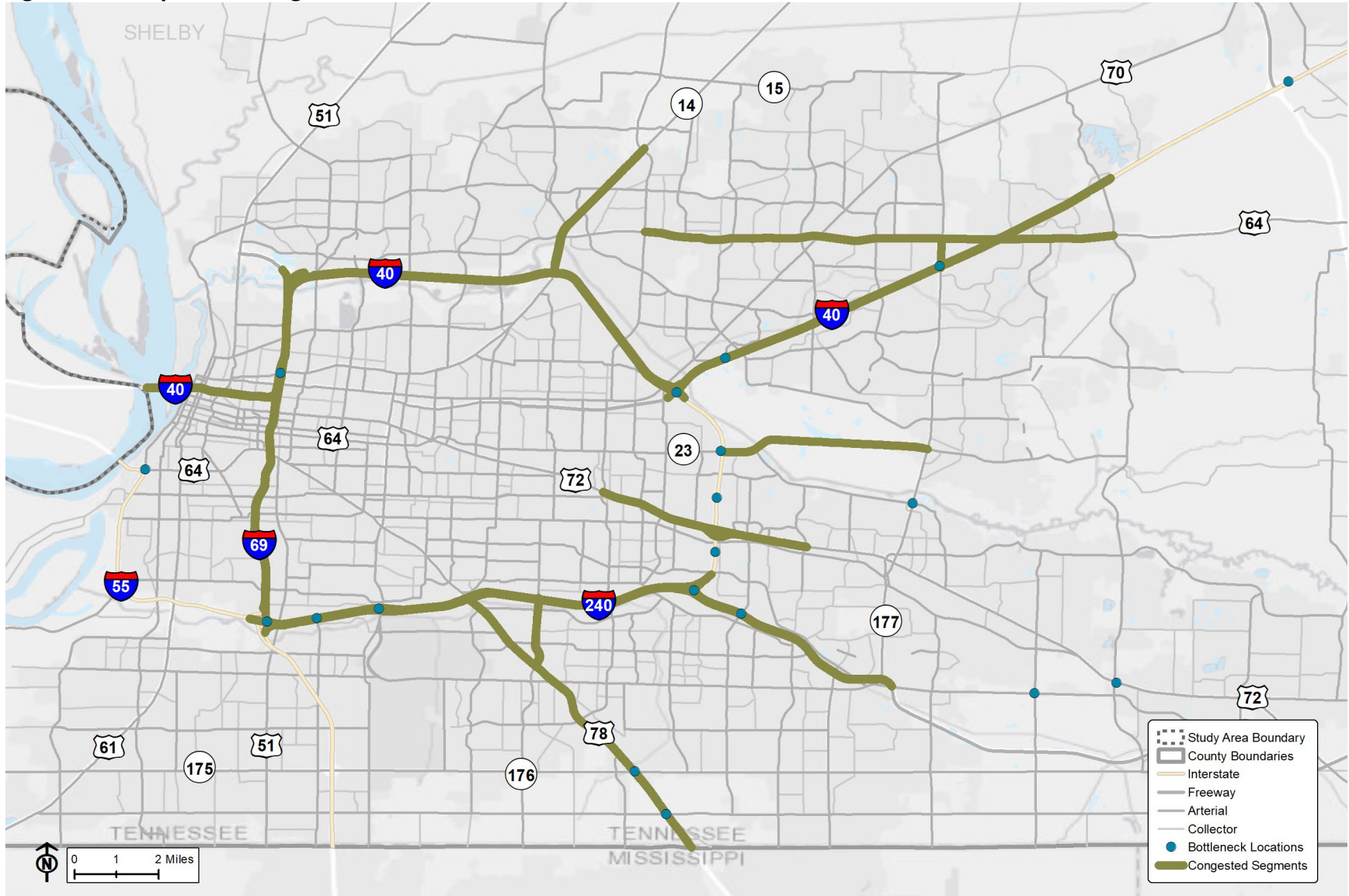
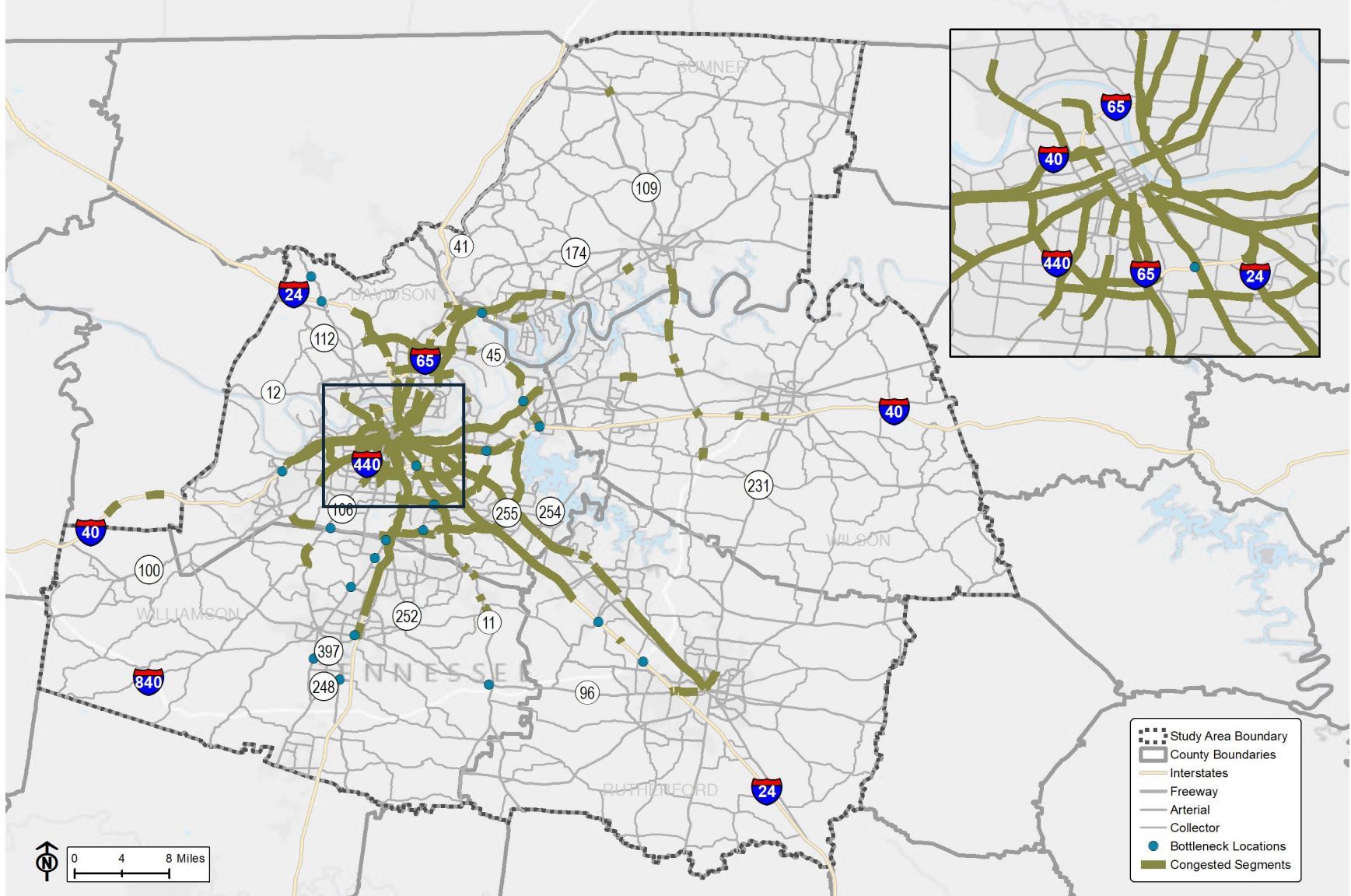


Figure 3-4. Middle Tennessee/Nashville CAP Congested Locations



4. Recommendations

Project Recommendation Types

Each CAP document organized recommended solutions into one of three strategic areas – freeways, arterials, and public transit, with various project types considered for each category.

Interstate and freeway strategies included a variety of roadway widenings and reconfigurations, demand management strategies, and transportation operations and management solutions, including:

- Safety improvements,
- Managed lanes, including HOV, HOT, and express lanes,
- Hard shoulder running lanes,
- Ramp metering, both simple and adaptive,
- New and reconstructed lanes and connectors,
- Intersection modifications, including grade-separated interchanges and center-turn overpass intersections,
- Interchange modifications and reconfigurations,
- Strategies to enable CAV and V2V technologies,
- Traffic incident management,
- Integrated corridor management solutions,
- Variable speed limits, and
- Dynamic lane assignment.

Arterial strategies included a variety of intersection-level and corridor-wide improvements, safety improvements, changes to intersection geometrics, intelligent transportation system (ITS) strategies, and others, including:

- Intersection widening and reconfigurations,
- Signal timing and operations improvements,
- Corridor improvements, including physical, technological, and/or operational improvements,
- Integrated corridor management,
- Investments in bicycle and pedestrian infrastructure,
- Access management on key routes, and
- Railroad crossing improvements.

Public transit-specific recommendations included funding increases to address increased operations and maintenance cost associated with bus rapid transit (BRT) and managed lane concepts, as well as:

- BRT routes and managed lanes for transit,
- Expanded frequency and service hours for priority bus routes,
- Improved transit amenities,
- Park-and-ride facilities,
- Transit signal coordination and priority,
- Microtransit services,
- Travel demand management strategies to support transit and ridesharing,
- Commuter rail and light rail,
- Express bus systems, and
- Transit center improvements.

All four CAP documents considered and analyzed a variety of recommendations, including those that are not currently applied in Tennessee, such as high occupancy tolling lanes and other managed lane solutions. Managed lane approaches typically fall into three categories:

- Vehicle eligibility, which includes high-occupancy vehicle (HOV) lanes, bus-only lanes, and truck-only and/or truck-restricted lanes;
- Access control, including non-toll express lanes, hard shoulder running, ramp metering, and bus on shoulder; and
- Pricing, including high-occupancy toll (HOT) lanes, express toll lanes, and fully tolled roadways.

Each CAP document explored a variety of managed lane concepts for freeway and other controlled access facilities. The success of managed lanes, regardless of the chosen approach, often relies on enforcement (making sure the right kinds of vehicles are present in lanes with occupancy and vehicle-type rules), the extent and interconnectedness of the managed lane system (so that the system takes people where they want to go with the most time savings), and political willingness to implement managed lane requirements in an equitable and effective way.

Project Selection and Screening

The project selection and screening process varied between the CAP efforts and included evaluation of existing conditions and traffic analyses, stakeholder input, review of existing and planned TDOT projects, and other criteria.

For roadways in the Knoxville region, the CAP process excluded roadway segments that already had previously identified solutions or active TDOT projects within the study area that would address congestion, leaving a small subset of interchanges and intersections to address with new project concepts. Peak hour turning movement counts were then used to analyze existing congestion issues and evaluate the relative improvement that

recommended modifications could provide. Additionally, managed lane concepts were evaluated using existing peak hour speeds from RITIS to identify locations where managed lane recommendations would be most applicable. Final project recommendations included:

- Freeway interchange and corridor strategies, including interchange modifications, managed lane solutions, ramp widenings, signal timing improvements at ramps;
- Arterial intersection improvements, including signal timing adjustments, intersection widenings and modifications to turn lanes, sight distance improvements, installation of bicycle and pedestrian facilities, a new roadway connector and overpass connection; and,
- Enhanced transit services, including amenity improvements, express bus service along key routes, improved park and ride facilities.

In the Middle Tennessee/Nashville region, opportunities for spot improvements on the freeway system and arterials were largely identified using the deficiency scoring results and local understanding of traffic patterns and operations issues. Peak hour turning movement counts were used to analyze existing congestion and the impact of recommended improvements. Managed lane recommendations were developed based on a technical warrant analysis and evaluated based on potential travel time savings, increases in person throughput, and ease of implementation. Final project recommendations included:

- Interstate and freeway improvements, including interchange modifications, ramp metering, and managed lane solutions;
- Arterial intersection improvements, including grade separation at key locations, signal timing improvements, and intersection reconfigurations; and,
- Enhanced transit service, including BRT service and express bus service with additional park and ride facilities.

The Chattanooga CAP analyzed corridors and intersections for operations and safety issues to develop project recommendations. Specifically, aerial imagery was used to assess causes of congestion such as geometric deficiencies, interchange spacing, and others, and RITIS data was used to assess the recurrence and timing of congested conditions. A review of in-place travel technologies and ongoing projects in the area also contributed to the identification of appropriate project solutions. Based on these different assessments, project recommendations were developed to address relevant issues. Final project recommendations included:

- Freeway spot and corridor improvements, including ramp metering, hard shoulder running, dynamic lane assignment, variable speed limits, high occupancy toll (HOT) lanes, roadway widening, truck-only and truck-specific lanes;

- Arterial intersection and corridor improvements, including bicycle and pedestrian enhancements, turn restrictions, railroad crossing improvements, traffic signal improvements and coordination, signage updates, access management, complete streets strategies, bridge repair and replacement, freight height and weight restrictions; and,
- Enhanced transit service, including revised and new bus routes, development of new park and ride facilities, bus on shoulder, and queue jump and transit signal priority.

Similarly, project recommendations for the Memphis CAP were developed for the ranked congested roadway segments, and short-listed solutions were screened based on the ease of implementation and potential improvements that could be expected. More specifically, managed lane solutions on the freeway system were evaluated based on traffic volumes, levels of service, cross section elements, and interchange density. Arterial strategies were developed based on feasibility for additional capacity, traffic analysis use RITIS data, evaluation of crash patterns, and assessments of alternative strategies such as travel demand management, access management, and others. Final project recommendations included:

- Freeway corridor and interchange modifications, including widening, HOT lanes, reconstruction of key interchanges, and ramp metering;
- Arterial corridor and intersection strategies, including access management, lane widening, a new collector roadway connection, intersection improvements; and,
- Enhanced transit services, including BRT service along key routes.

Policy and Programmatic Recommendations

In addition to project recommendations, each CAP document included policy and programmatic recommendations to further bolster the congestion mitigation activities in each region. These policies and programs included recommendations ranging from regional traffic operations programs and transit-supportive investments to transportation demand management and non-motorized investments.

REGIONAL TRAFFIC OPERATIONS PROGRAMS

Regional traffic operations programs are a widely used collaborative approach to managing traffic congestion using operational analysis and improvements. These programs typically involve those agencies responsible for implementing and monitoring the roadway system such as DOTs, local municipalities, and regional partners. If implemented in Tennessee, regional traffic operations programs would allow TDOT to work collaboratively with local municipalities to conduct data collection on traffic patterns and flow, provide signal coordination along corridors, and perform overall active management of the roadway system. Traffic operations programs require significant upfront capital investments to

upgrade ITS systems, update signals, and install monitoring and analysis programs. In addition, ongoing coordination between TDOT and local municipalities is critical to ensuring long-term success of such a program. Technical and financial support would be required, as would ongoing maintenance of traffic signals and accompanying intersection elements, such as detection, to ensure optimized operational capabilities for each roadway.

TRANSIT-SUPPORTIVE INVESTMENTS

Making transit a viable alternative to single occupancy vehicles requires capital improvements and operational support for transit providers to deliver service that is competitive, attractive, consistent, and widely available. The transit recommendations included in each CAP document were paired with additional recommendations for improvements at both regional and local scales to create an integrated network, such as regional bus service coupled with park-and-ride expansion. In addition, many of the transit recommendations are incorporated within and/or supported by recommendations for managed lanes given their ability to enhance the efficiency of transit service along congested corridors. Capital investment recommendations are coupled with the need for increased financial support associated with operations and maintenance that would result from expanded transit service in the urban areas.

TRANSPORTATION DEMAND MANAGEMENT

A wide variety of transportation demand management (TDM) solutions were recommended in all four CAP documents. These included proposals to support and bolster existing programs that encourage walking and biking, increase transit usage, and establish or improve existing carpool and vanpool groups for commuters. Specific suggestions for improving existing programs and increasing participation included expanding incentive offerings, intensifying existing marketing and outreach activities, and pursuing collaboration opportunities with large employers to promote alternatives to single occupancy vehicles and invest in parking management solutions.

NON-MOTORIZED INVESTMENTS

Bicycle and pedestrian investments, including specific suggestions for facility expansion, were considered as part of the congestion mitigation strategies recommended in each CAP document. Non-motorized strategies were framed as a key method to reduce vehicle trips and establish an accessible and connected multimodal system that meets the varied needs and abilities of roadway users, including those who walk, bicycle, and take transit. Recommendations included updates to TDOT multimodal policies to support the construction of bicycle and pedestrian infrastructure along the state highway system, expanded funding support for municipal investments in bicycle and pedestrian facilities, and prioritizing addressing walkway and bikeway gaps on state-managed roadways.

FREIGHT OPERATIONS

Freight-related recommendations included in the CAP documents included suggestions for implementing truck weight and height restrictions on relevant corridors, investing in partnerships and incentive programs with freight transportation providers to restrict truck movements, and roadway widening in key areas to develop truck-only lanes.

OTHER INNOVATIVE APPROACHES

Beyond recommendations for capital system expansion and lane widenings, the CAP documents suggest additional creative approaches to congestion mitigation, including innovative intersection design, such as roundabouts, grade-separated intersections, and center turn overpass intersections to address localized congestion issues. Additional recommendations include suggestions for more significant involvement from TDOT in access management decisions for new developments, bicycle, pedestrian, and transit infrastructure investments, and TDOT involvement in large local developments that could affect regional travel, particularly in urban areas. TDOT partnerships with municipalities in urban areas and early involvement in the development review process would increase the likelihood that adequate consideration is given to multimodal solutions, such as TDM programs, pedestrian and bicycle accommodations, accessibility to transit services, access management, traffic operations, and other creative transportation solutions.

5. Fiscal Analysis

A key component of the CAP process was the development of planning level cost estimates for recommended improvements. Capital costs of CAP improvements were first determined for all roadway and transit recommendations. This was followed by an assessment of fiscal commitments for other State-led projects that have potential congestion mitigation benefits.

Cost Estimation Processes

Cost estimates were generally developed for the project recommendations included in the CAP documents using the TDOT planning level cost estimating tool. Estimates were further refined using planning-level assumptions from additional sources, stakeholder feedback, and engineering judgement. All costs were developed in 2021 dollars and do not account for inflation that would inevitably occur prior to the year of expenditure. In order to compare project costs relative to their benefits and prioritize projects, cost benefit values were developed that considered project impacts to mobility, safety, economic development, ease of implementation, and system maintenance requirements.

Summary of Capital Recommendation Costs

The following tables outline the freeway, arterial, and transit recommendations and costs that were developed for each urban area as part of the CAP process. While these costs are grouped into broad project categories, more detailed project lists can be found in the Appendices.

Table 5-1. Chattanooga CAP Cost Estimates

Solution	Classification	Solution Type	Estimated Capital Cost
Roadway	Arterial	Corridor Improvements	\$56,764,000
		Intersection Improvements	\$13,179,500
	Freeway	Corridor Improvements	\$468,470,400
Transit	Arterial	Enhanced Service	\$645,000
	Arterial and Freeway	Park & Ride Lots	\$3,375,000
Total Cost			\$542,433,900

Table 5-2. Knoxville CAP Cost Estimates

Solution	Classification	Solution Type	Estimated Capital Cost
Roadway	Arterial	Intersection Improvements	\$1,359,000
		Interchange Modifications	\$88,600,000
	Freeway	Corridor Improvements	\$244,500,000
Transit	Arterial and Freeway	Enhanced Service	\$7,200,000
		Express Service/Park & Ride Lots	\$52,700,000
Total Cost			\$394,359,000

Table 5-3. Memphis CAP Cost Estimates

Solution	Classification	Solution Type	Estimated Capital Cost
Roadway	Arterial	Corridor Improvements	\$39,723,000
		Intersection Improvements	\$3,794,000
	Freeway	Corridor Improvements	\$469,498,000
		Interchange Modifications	\$571,000,000
		New Roadway	\$38,055,000
Transit	Arterial	Enhanced Service	\$185,300,000
Total Cost			\$1,307,370,000

Table 5-4. Middle Tennessee/Nashville CAP Cost Estimates

Solution	Classification	Solution Type	Estimated Capital Cost
Roadway	Arterial	Intersection Improvements	\$461,141,400
		Corridor Improvements	\$3,127,600,000
	Freeway	Interchange Modifications	\$782,900,000
Transit	Arterial and Freeway	Enhanced Service	\$2,936,400,000
Total Cost			\$7,308,041,400

Analysis of Funding Needs

The costs outlined in the previous tables reflect only those recommendations made as part of the CAP development processes, which varied in each urban area. As such, the additional analysis documented below was required to understand the full scope of funding needed to address urban congestion.

As mentioned previously, development of the CAPs built on a foundation of project needs identified in other regional, state, and local planning processes. Many of these efforts are referenced in Section 1 of this document. In some cases, a project concept has been identified for a specific location through technical analysis and outreach to the public and stakeholders, but no funding has been obligated to move the project forward. This is the case with many of the TDOT Interstate Corridor Studies, for example, which recommend significant capital projects to address congestion issues on the urban freeways but may not have any funding obligations. Across the four urban areas, these studies identify approximately \$6.9 billion for congestion mitigation projects on the urban freeway systems in bottleneck locations identified through the CAP process. In addition, there are ongoing projects on freeways and state routes that are already progressing through the project development process, have funding associated with them, and have congestion mitigation benefits. At a high level, approximately \$176 million is attributed to in-progress projects and approximately \$3.6 billion in funding for IMPROVE Act projects is attributed to bottleneck locations within the four urban areas.

It is important to note that many of the capital recommendations from the Interstate Corridor Studies relate to ongoing TDOT projects and/or CAP recommendations. After accounting for the overlap of Interstate Corridor Study recommendations with TDOT's current project commitments and the CAP recommendations, approximately \$4.1 billion in unfunded needs remains. When added to the \$9.5 billion in capital projects identified through the CAP process, this totals approximately \$13.6 billion in unfunded needs. After accounting for TDOT's existing funding commitments, which total approximately \$3.8 billion for IMPROVE Act projects and other in-progress projects, this equates to over \$17.5 billion of funding needed to address urban congestion in the State's four major urban areas. A summary of this analysis by urban area is highlighted in Table 5-5.

Table 5-5. Summary Fiscal Analysis of Funding Needs

Funding	Chattanooga	Knoxville	Memphis	Middle TN/Nashville	Total
Unfunded Interstate Corridor Study Needs	\$531,020,000	\$396,350,000	\$70,700,000	\$3,141,480,000	\$4,139,550,000
CAP Roadway Recommendations	\$538,413,900	\$334,459,000	\$1,122,070,000	\$4,371,641,400	\$6,366,584,300
CAP Transit Recommendations	\$4,020,000	\$59,900,000	\$185,300,000	\$2,936,400,000	\$3,185,620,000
				Sub-Total Unfunded Needs	\$13,691,754,300
IMPROVE Act Projects	\$368,286,939	\$775,552,887	\$498,909,960	\$2,013,188,857	\$3,655,938,643
In-Progress TDOT Projects	\$0	\$135,291,892	\$1,082,530	\$40,018,957	\$176,393,379
				Sub-Total Existing Commitments	\$3,832,332,022
				Total Congestion Funding Needs	\$17,524,086,322

Lastly, the above total congestion funding needs in Tennessee's four major urban areas does not account for all transportation needs in these regions. Regional transportation plans, led by area MPOs/TPOs, account for more than interstates and arterials on the state highway system in these urban areas as well as consider other factors such as safety, mobility, connectivity, system preservation, etc. When looking at these regional plans which cover a 25-year planning horizon, transportation needs in these four urban areas (in 2019 and 2020 dollars) exceeds over \$30 billion.

6. Conclusions and Next Steps

The CAP documents developed for Chattanooga, Knoxville, Memphis, and Middle Tennessee/Nashville utilized a data-driven approach to determine the most congested locations on the state highway system in each urban area. Based on technical analysis and coordination with regional stakeholders, each CAP recommends a list of strategic freeway, arterial, and transit improvements and provides capital cost estimates for each, in addition to policy and programmatic recommendations.

Because the project recommendations included in each CAP document are high-level, additional planning and analysis will be required before projects can be implemented. For example, future planning for managed lane recommendations will need to establish the goals and objectives for a managed lane system and include detailed traffic and operations analyses, as well as an assessment of revenue generation options, required legislative changes, enforcement, and methodologies for assessing how managed lanes are applied in various contexts. Additionally, corridor planning for transit enhancements, roadway widenings, and other design and operational recommendations will be required in advance of project implementation to guarantee that site-specific design constraints, operational parameters, financial barriers or opportunities, and public and stakeholder input are understood and accommodated. TDOT will also need continued outreach and engagement with relevant stakeholders and the public to implement these projects. These future analyses and research efforts will ensure that TDOT policies, state legislation, and project-specific objectives are aligned with the goals of any statewide congestion mitigation program.

Over the past decade, TDOT has undertaken and participated in numerous planning efforts to understand transportation needs in the state's four largest urban areas. The CAPs represent a culmination of these efforts with an ultimate goal of reaffirming the need and refining recommendations for roadway and transit improvements to address growing congestion issues. As documented in these efforts, managing current and future multimodal transportation demands will take significant investment. As such, securing supplemental federal, state, and local funding to support transit system expansion, multimodal facility development, and capital project implementation will be necessary in order to preserve the quality of life and economic vitality of Tennessee's urban areas.