Nashville Southeast Corridor High-Performance Transit Alternatives Study

Final Report

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NASHVILLE AREA
METROPOLITAN PLANNING ORGANIZATION

Nashville Southeast Corridor High-Capacity Transit Alternatives Analysis

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Nashville Southeast Corridor Executive Summary

I. Introduction

The southeast corridor is a 30 mile long corridor that connects downtown Nashville to downtown Murfreesboro. While the connection between these two downtowns has long been significant in the history of the region, it is the explosive outward growth in between these two bookends that has made this corridor so important.

The Nashville Area MPO initiated this study to address the existing and future transportation needs of the corridor. In the southeast corridor, residents and commuters are losing significant amounts of time due to heavy traffic congestion, and the area is in danger of losing businesses that must reduce their costs because of their loss of valuable time and money. In addition, a lack of transit options in the corridor restricts mobility for many residents and prevents businesses from accessing needed employees. A potential transit investment can benefit the corridor and the region by reducing transportation costs to citizens and businesses, giving commuters a transportation alternative to the automobile, and promoting strong and sustainable development in the corridor. This study examined potential alternatives for bringing high-capacity, high-quality transit service to the corridor and the benefits such service would have to the lives of those who live in, work in and visit the corridor.

A number of transit alternatives were considered for the southeast corridor, including bus rapid transit, commuter rail, and light rail alternatives. After an extensive evaluation, the Locally Preferred Alternative (LPA) selected was a combination of phased bus service enhancements, including development of express bus and skip stop bus services on I-24 and Murfreesboro Road (US 41/70S), and extended local bus service on Murfreesboro Road. Other improvements include bus “stations” at key locations, queue jump and signal improvements at intersections and interchanges to allow buses to bypass congested traffic conditions, and ultimately short sections of busway to further enhance the speed of bus travel in the corridor.

The foundation of the LPA recommendation is that it will build a market for transit for the southeast corridor and ensure that quality transit service is available throughout the corridor. The proposed LPA would provide basic transit service in portions of the corridor where none currently exists, ensuring that transit-dependent people have access to employment and educational opportunities in the corridor. In addition, express services will further develop the market for high quality, longer-distance travel service, which was successfully demonstrated by RTA’s “Relax-and-Ride” service that currently operates between Murfreesboro and Nashville. The proposed improvements would be phased in over a period of more than 20 years to allow corridor communities to transition development around station sites toward a more compact, transit and pedestrian-friendly pattern and secure the funding required to develop and operate the services from a variety of local, state and Federal sources. The phased approach will gradually build the public transit market in the corridor, positioning the corridor for further enhancements in transit service after 2030.

The overall benefit of the LPA for both the southeast corridor and the Nashville region can have a considerable impact. Transit can provide a viable alternative to driving the corridor’s congested roadways. By providing service where there currently is none, the

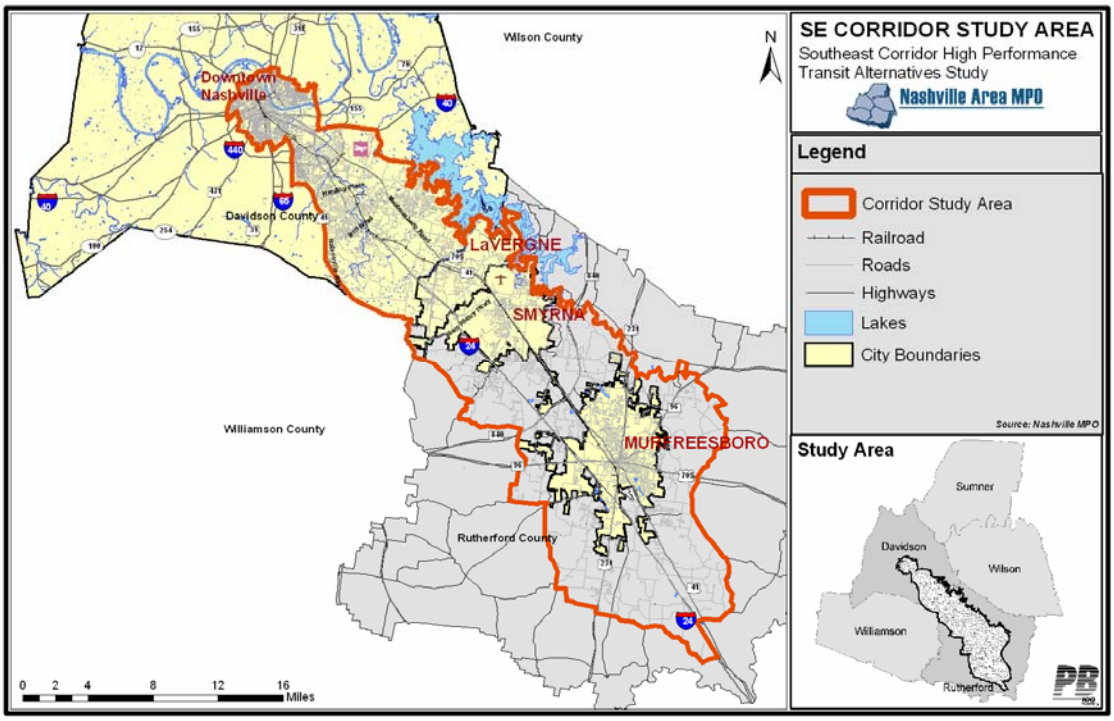
LPA can help people reach jobs, thus opening up new employment and educational opportunities in the corridor to the region's residents. Changes in land use that are expected to occur as a result of the proposed LPA would also benefit the region, providing a much needed alternative to the auto-dominated land use patterns that currently exist in the corridor.

II. Purpose, Needs and Goals of the Study

Study Area

The study corridor included the region's largest employment destinations: downtown Nashville, the Vanderbilt-West End area adjacent to downtown Nashville, and downtown Murfreesboro. Other destinations within the corridor include Nashville Airport, Dell, Interchange City, Starwood Amphitheater, Nissan plant, Treveca Nazarene University, Middle Tennessee State University, and the downtowns of LaVergne and Smyrna. Figure 1 shows the boundary of the study corridor

Figure 1 SE Corridor Study Area



A purpose and need statement was prepared by the study's steering committee in order to identify the needs of the corridor. The following needs were identified:

- **Provide Transportation Options**

Provide transportation alternatives to driving for travelers within the corridor.

- **Improve Mobility**

Allow economic growth and development in the corridor to continue without overburdening existing roadways. Reduce the negative impacts of congestion on resources, travel times, and mobility.

- **Establish Efficient Land Use Policies / Compact Development**

Provide greater emphasis on mixed-use development, traditional urban and village land use patterns, and design standards that support a diverse range of travel options. Promote land uses that are conducive to a more balanced transportation system with a focus on pedestrians and mass transit.

- **Address Environmental Concerns**

Provide transportation choices that minimize impacts to the environment and help improve air quality conditions in the region.

- **Use Limited Transportation Funding Efficiently**

Provide a cost effective investment in the transportation network that results in more transportation options and improved mobility, while supporting compact development.

Goals for the study were also identified based on the needs of the corridor.

Goal 1: Provide Longer-Distance Travelers in the Southeastern Corridor with Alternatives to Driving Private Vehicles in Heavily-Congested Traffic Conditions.
Goal 2: Promote Efficient Land Use and Development Patterns in Nashville/Davidson County and the Rutherford County Communities in the Southeast Corridor Study Area.
Goal 3: Improve and Enhance Economic Development and Employment Opportunities and Expand Access to Jobs.
Goal 4: Preserve the Natural and Social Environment.
Goal 5: Develop a Cost-Effective Transportation System Improvement Strategy that Maximizes Community Consensus and Institutional Support.
Goal 6: Develop a Strategic Part of a Multi-Modal Transportation System that would facilitate the Development of an Integrated Regional Multi-Modal System

III. Evaluation of alternatives

Alternatives were developed to address the identified needs of the corridor and goals of the study. The alternatives evaluation process was extensive, with transportation information gathered at each stage incorporated in the development of the next round of alternatives. There were three stages of evaluation: an initial screening, a detailed screening, and a final refinement of the Locally Preferred Alternative (LPA). The final LPA is the official recommendation for transit improvements in the corridor.

A pre-screening of alternatives was completed by combining potential alignments with potential transit types. The three major alignments considered for the corridor were I-24, the CSX railroad, and Murfreesboro Road (shorter portions of other alignments were considered in combination with these three major alignments). The types of transit initially considered for the corridor included bus rapid transit (BRT), light rail, heavy rail/subway, monorail, commuter rail, and high speed rail. Another choice, bus rapid transit light (BRTL), defined in the study as bus rapid transit service without a full length busway, was also included in the evaluation process.

Table 1 displays the various alignments and transit types in a matrix. The Steering Committee eliminated those combinations of transit or alignment that they thought would be inappropriate or unable to effectively serve the travel needs of the corridor. After this

analysis six viable alternatives remained to be studied in the initial round of alternatives screening.

Initial Screening
An initial screening of these six alternatives was completed by evaluating the characteristics of each alternative with regards to the goals of the project study. In this initial round of screening, many of the alternatives included sub-options in which various alignments to serve Nashville International Airport (BNA) and downtown Nashville were considered.

Table 1 Transit Choice Matrix

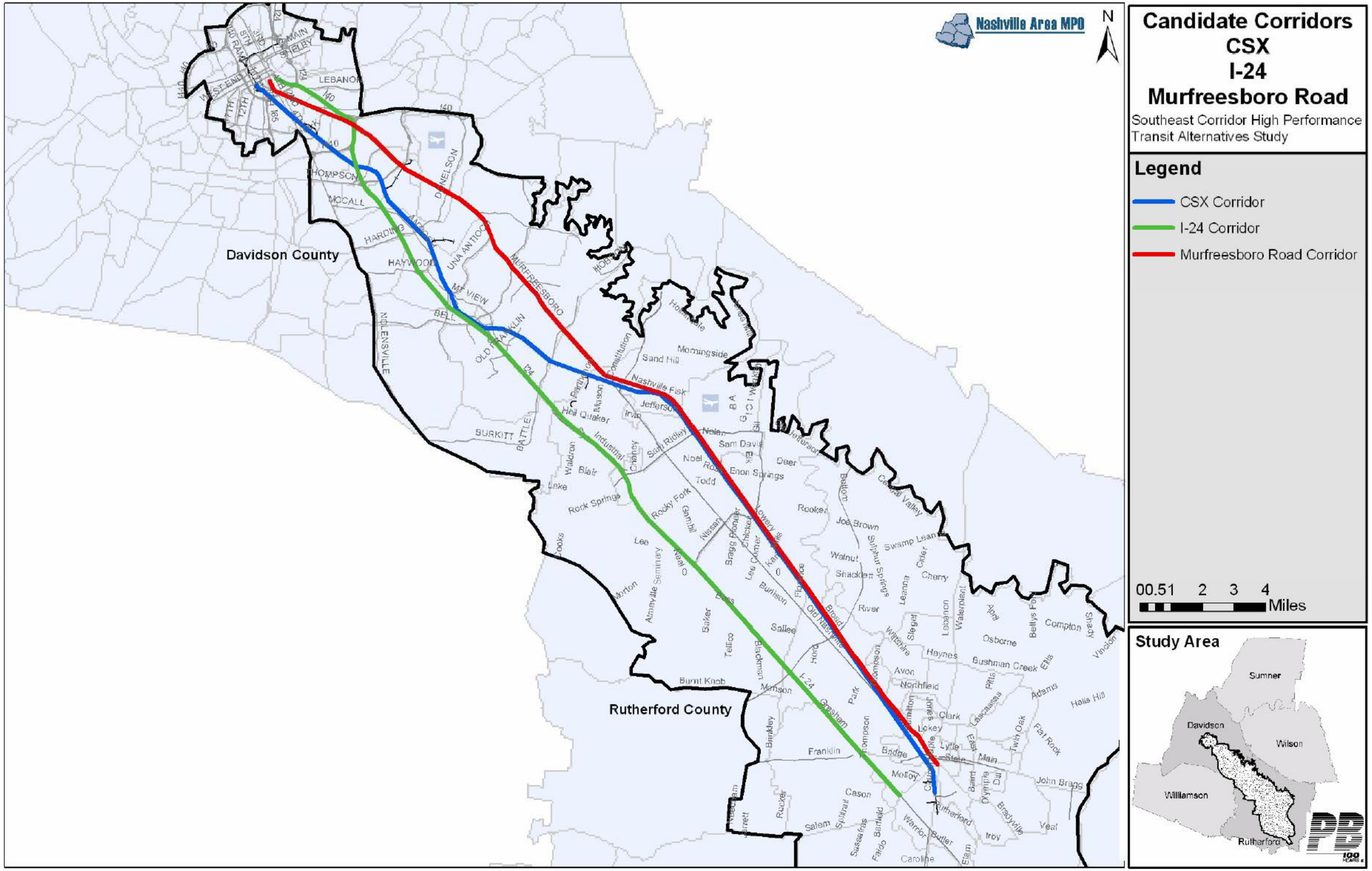
Type of Transit	**Interstate 24:**	**CSX Railroad:**	**Murfreesboro Road:**
Commuter Rail	Does not apply	**Appropriate**	Does not apply
Light Rail	**Appropriate**	**Appropriate**	**Appropriate**
BRT	**Appropriate**	Does not apply	**Appropriate**
Heavy Rail/Subway	Does not apply	Does not apply	Does not apply
Monorail	Does not apply	Does not apply	Does not apply
High Speed Rail	Does not apply	Does not apply	Does not apply

These initial alternatives selected were:
- I-24 BRT
- I-24 Light Rail
- CSX Light Rail
- CSX Commuter Rail
- Murfreesboro Road Light Rail
- Murfreesboro Road BRT

Amongst the findings from this initial screening were that light rail options would have a tremendously high capital cost—many options were well in excess of $500 million in up front capital cost. The Steering Committee determined that such a costly alternative was unlikely to be justified by ridership and other benefits, and thus, light rail was eliminated from further study. BRT, BRT light, and commuter rail were carried forward for further analysis. The screening also revealed that each alignment had its share of positive and negative aspects for a potential transit investment and all three should be moved forward in the screening process. In addition, the initial screening eliminated the Nashville International Airport from consideration in any of the alignments. The cost of a detour to the airport was considered by the Steering Committee to be far larger than the potential benefit.

Detailed screening
The Steering Committee identified five alternatives to be carried forward to the detailed screening process. Three of these alternatives were carried forward from the initial screening: a BRT alternative on I-24, commuter rail on the CSX rail line, and a BRT alternative operating on Old Nashville Pike. The other two alternatives were used as a comparison with the three build alternatives, including a No-Build Alternative, consisting of the existing system and already funded changes to the transit and roadway networks, and a Low-Cost Alternative that grew out of the bus rapid transit option on I-24.

Figure 2 Evaluation of Alternatives corridors



The detailed screening again considered the goals of the study when evaluating each of the alternatives, but each alternative was evaluated in greater detail. During this screening, costs and ridership estimates were calculated for each of the remaining build alternatives. These are detailed in the figures below.

The high capital costs and low ridership gains for all three build alternatives underscored the need for a low-cost alternative for the corridor. The low ridership also suggested that a phased approach was needed in the corridor to build a transit market over a period of time. As a result of these findings, the Steering Committee developed a low-cost enhanced bus for the Locally Preferred Alternative. This alternative best fit with the characteristics of the corridor and could be tailored to best meet the transportation needs of the corridor and the region.

Figure 3 Estimated 2030 Capital Cost

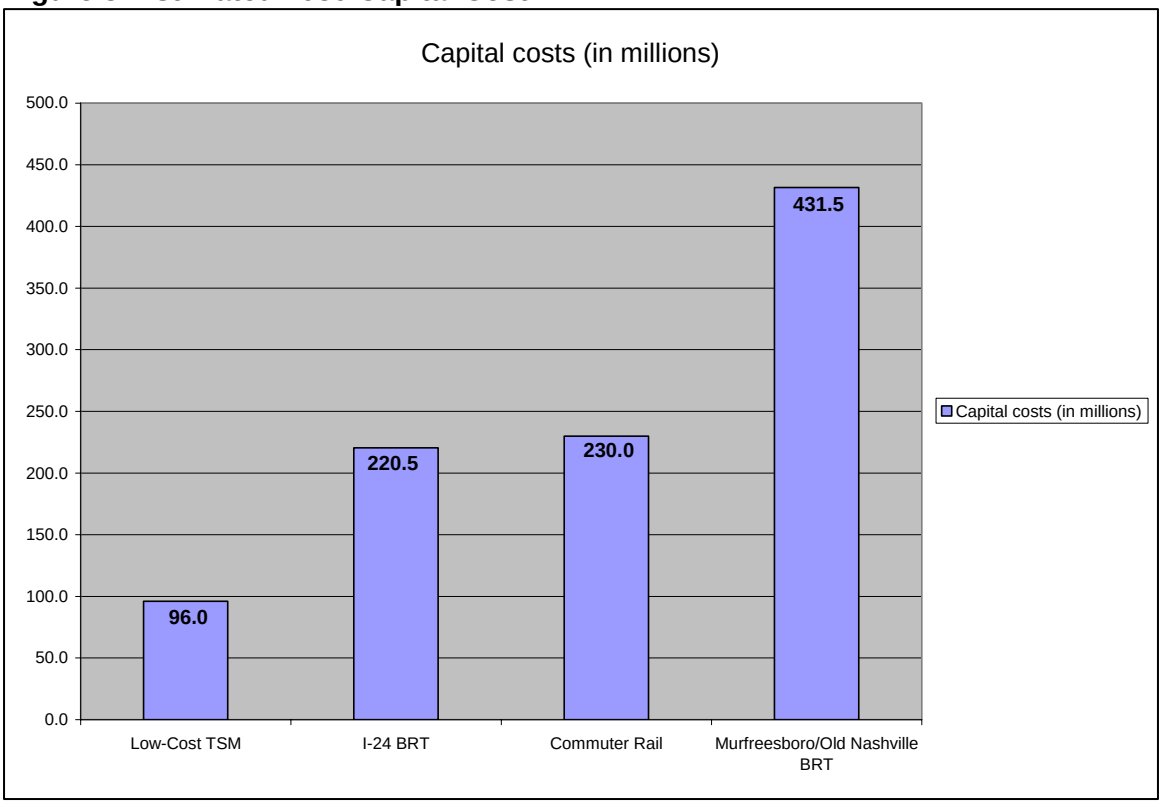


Figure 4 Estimated operating costs

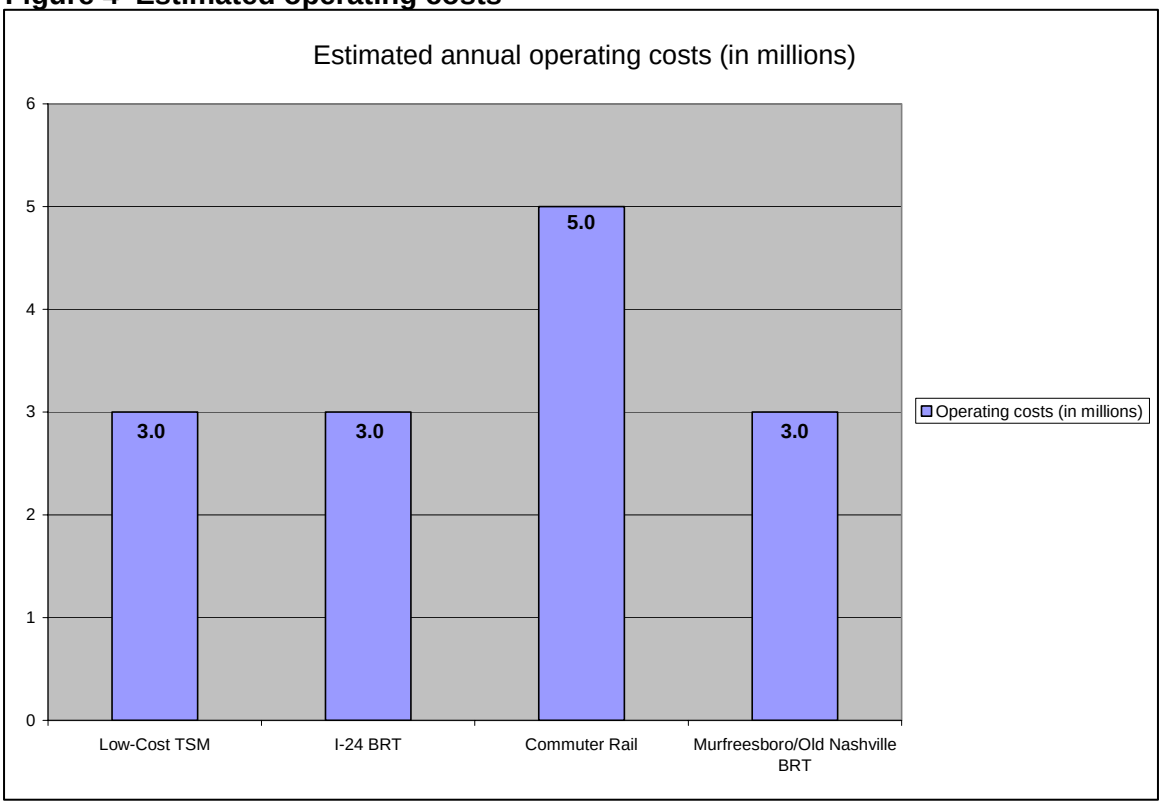


Figure 5 Estimated daily ridership

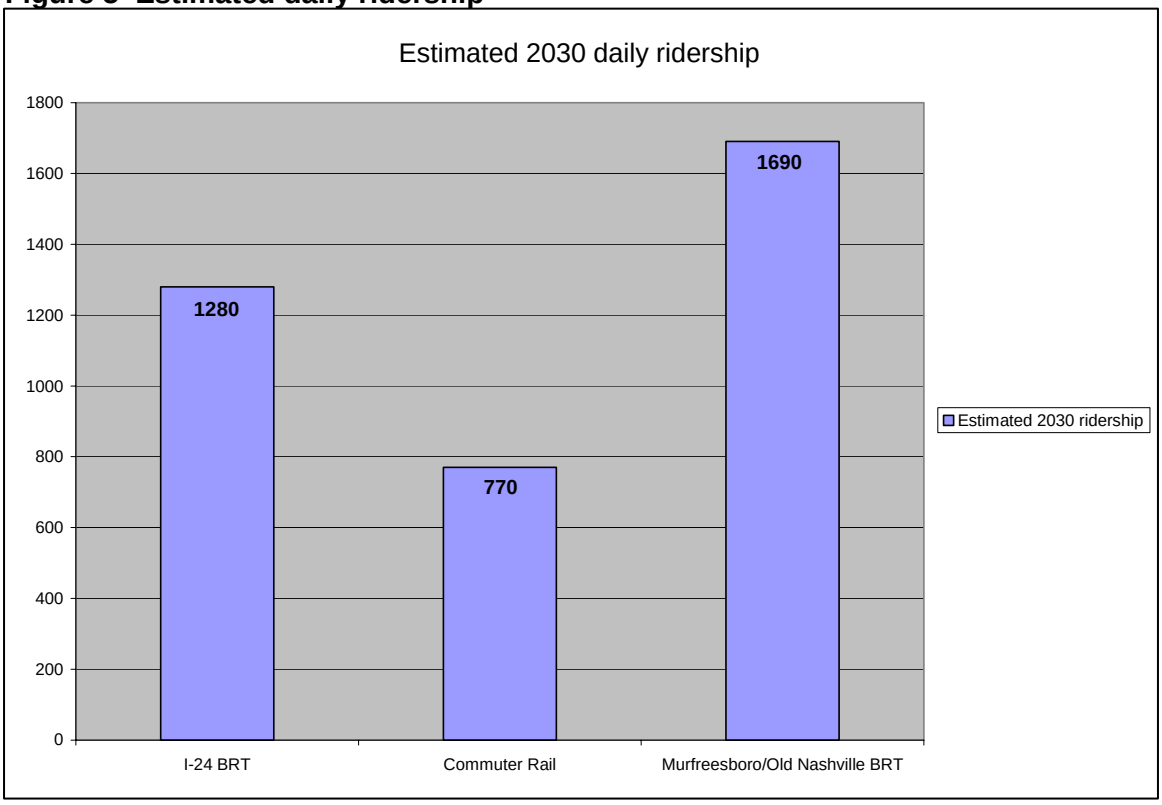
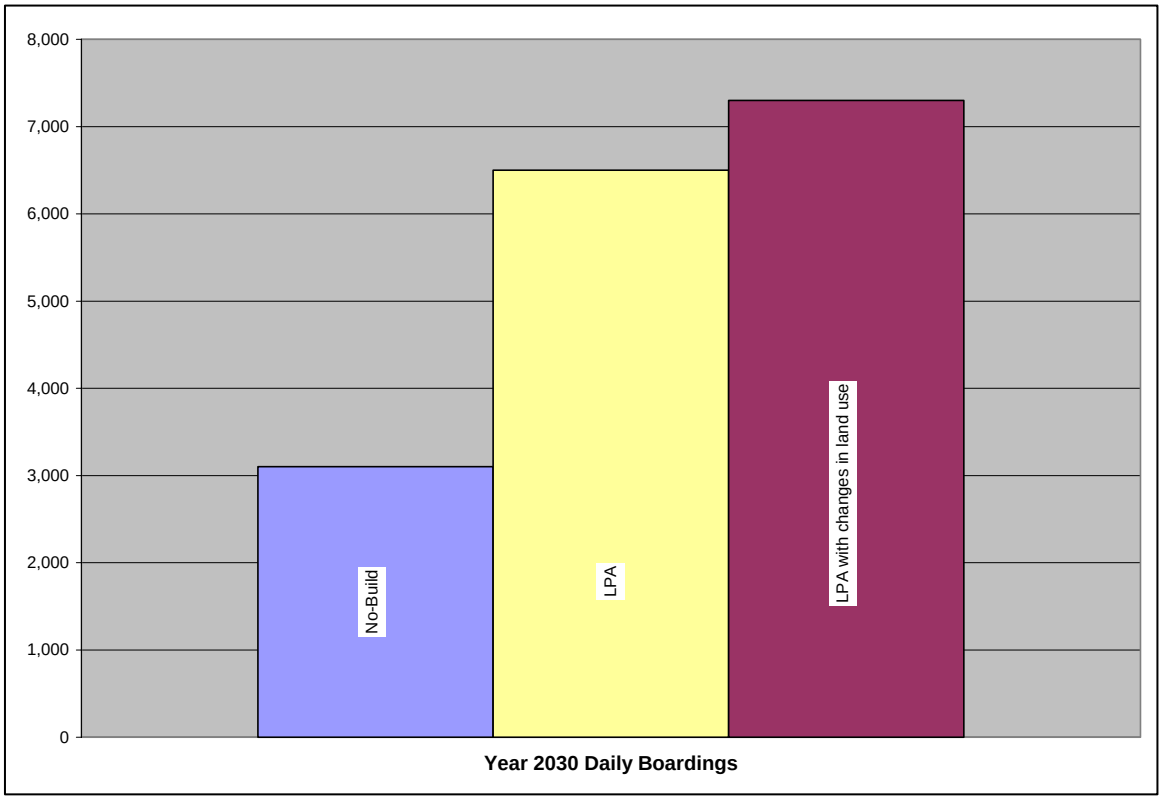


Figure 6 shows the estimated boardings of all the alternatives considered. Clearly illustrated in this chart is the fact the no-build scenario will keep transit boardings at a low level. The improvements proposed in the LPA would significantly increase transit use in the corridor.

Figure 6 Estimated corridor boardings for all transit alternatives



IV. Locally Preferred Alternative

The LPA selected for the corridor is a phased implementation of packages of relatively low-cost transit improvements. This alternative, also known as Transportation System Management (TSM) or Enhanced Bus, proposes new and expanded bus service along two of the alignments in the corridor, I-24 and Murfreesboro Road. The LPA also proposes a limited number of infrastructure improvements to increase efficiency of the system. These improvements are to be phased in three stages over a 25 year period.

Short-term improvements (1 to 5 year period)

Improvements proposed for the short-term are aimed at expanding bus service in the corridor and include new express bus service on both I-24 and Murfreesboro Road alignments serving Smyrna, LaVergne and Murfreesboro. Proposed alignments for these services are shown in Figure 7.

Mid-Term Improvements (5 to 10 years)

Improvements proposed for the mid-term include adding local circulators in LaVergne and Smyrna, introduction of local bus service between Murfreesboro and Bell Road, and construction of queue jump facilities to allow buses to bypass traffic at key I-24 interchanges. Other mid-term improvements include constructing “station” stops at key

bus stops along the corridor, to serve “skip stop” express bus service and to provide a focus for future transit oriented development and further expanded high capacity transit beyond 2030. Proposed locations of improvements are shown in Figure 8.

Long-term improvements (10-25 years)

Long term improvements in the corridor concentrate on infrastructure improvements to maintain or increase transit efficiency in the corridor. Improvements proposed include the completion of the station stop construction program, the construction of single lane busways in identified congestion areas, and the construction of more queue jump facilities at selected intersections. Locations of these improvements are illustrated in Figure 9.

Figure 7 LPA Short-Term Improvements

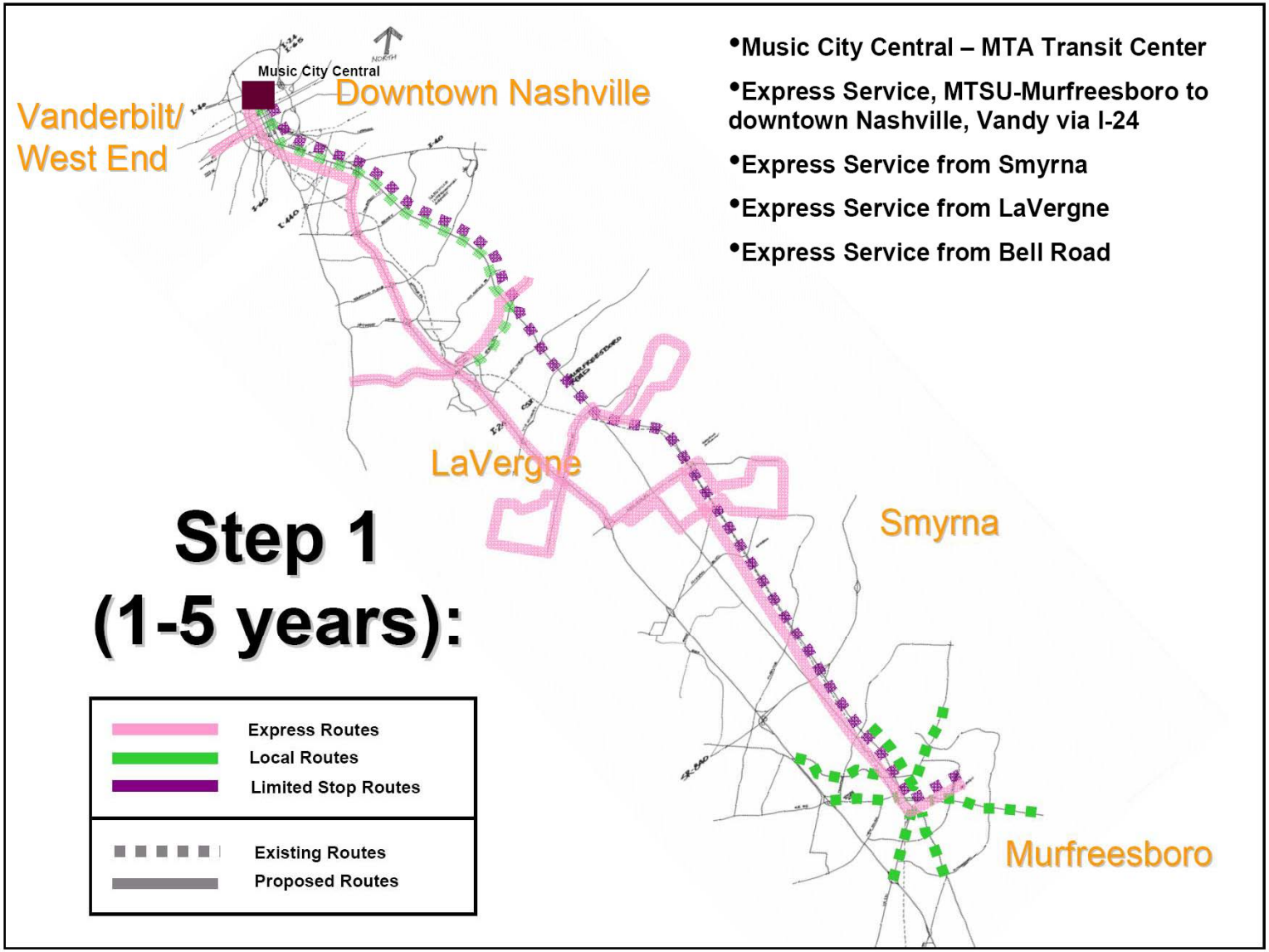


Figure 8 LPA Mid-Term Improvements

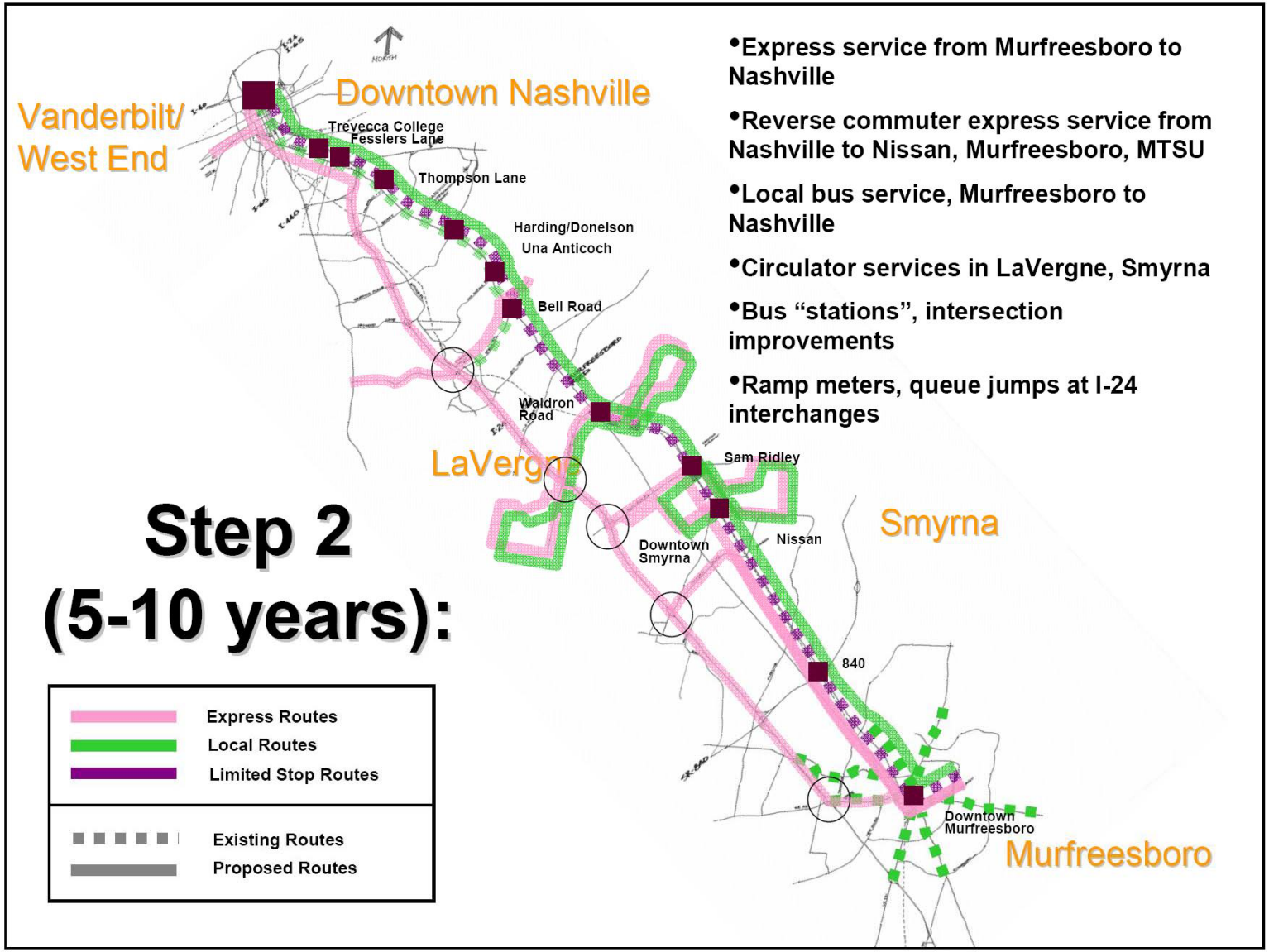


Figure 9 LPA long-Term Improvements

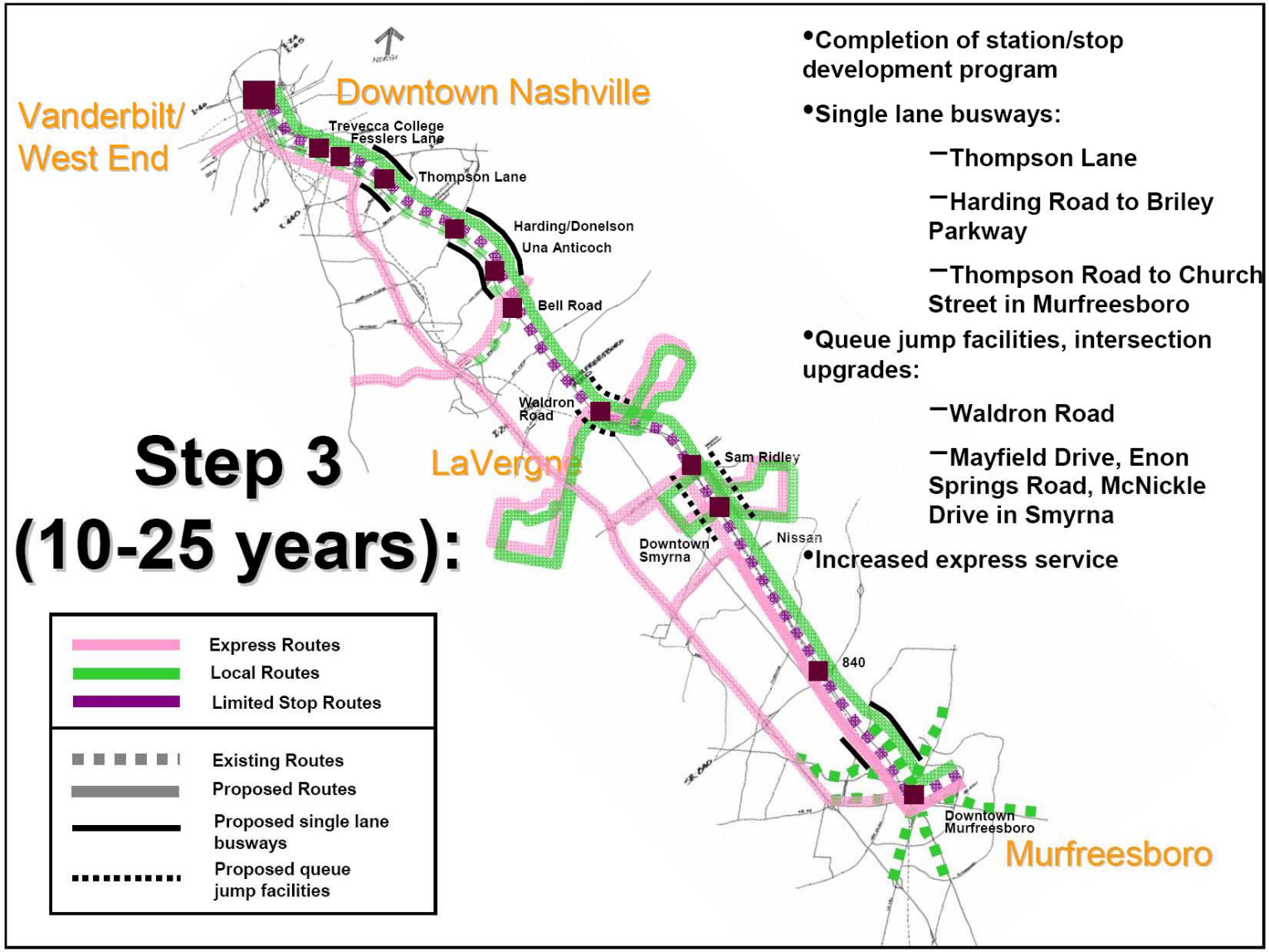


Table 2 summarizes the costs of the LPA broken down into the three phases of implementation.

Table 2 Breakdown of LPA costs by phase (in 2005 dollars)

Cost Summary	Capital					Annual Operating
	Stations	Busway/ Streetscape Miles	Infrastructure Costs	Vehicle Costs	Total Capital	Incremental Cost (over No Build) ($million)
1-5 Years	4	0	4.7	23.0	27.7	3.9
5-10 Years	12	0	22.5	17.5	40.0	11.1
10-25 Years	4	13.2	65.8	12.5	78.3	13.0
Total	20	13.2	93.0	53.0	146.0	

Two ridership estimates were prepared for the Locally Preferred Alternative at full build out, including short, medium and long-term improvements. One is for implementation of the LPA with land use patterns as they currently exist, while the other considered the benefits of compact land use development. Extrapolating current land use patterns to 2030, transit ridership in the corridor is estimated at 6,500 boardings, or 1,300 to 1,600 new boardings per day over the no-build scenario. A second scenario was developed with all expected development in the corridor up to 2030. In this scenario, development was channeled to within ½ mile of the skip/stop locations identified with the LPA, causing transit ridership in 2030 to be estimated at 7,300 boardings, or 1,600-2,200 new riders per day.

V. Land use recommendations

While the LPA concentrates on increasing transit in the corridor, land use will be important in supporting the new proposed transit service. Many studies have noted the connection between transportation choice and land use. Transportation improvements influence land development, which in turn influences future transportation development in a corridor. Public transit does well in areas with more compact, mixed use and, above all, pedestrian friendly development. This transportation and land use relationship also means that areas with good transit service have the potential for higher density, compact development close to stations.

The existence of I-24 and the land use choices by local officials in the corridor has made the automobile the dominant form of transportation in the corridor. The low-density development pattern in the corridor reflects this fact. The prevailing land use pattern represents a challenge to building cost-effective high capacity transit services in the corridor.

The strategy for implementing the proposed LPA over a 25 year period will allow local officials to prepare the ground for future high capacity transit service by making changes to zoning and land use policies. This will, in turn, allow developers to react to the new zoning and land use policies as well as the increasing availability of high quality transit service in the shaping of their developments. Such a strategy will increase the availability of transit, as well as allow for zoning changes in corridor communities, effecting and gradually shaping development in the corridor in a more transit- and pedestrian-friendly pattern.

Transit Oriented Development

Transit Oriented Development (TOD) is a form of development that is supportive of public transit service as a large-scale provider of transportation services. In TOD, development is clustered within walking distance of a transit station and buildings are

oriented to transit stops rather than to streets or parking lots. Development is mixed, usually with retail, residential, and office uses. While driving is not precluded in a TOD, the mixture of uses can reduce the amount of driving, making walking and taking public transit viable alternatives to driving for many types of trips.

TOD is a natural fit for the southeast corridor because development is occurring at a significant rate and the recommended LPA strategy includes building stations at higher use stops. The land surrounding these higher use stops could be developed (or in some cases redeveloped) to include pedestrian and transit friendly uses, which would support the ongoing development of transit through 2030 and beyond.

VI. Implementation and Conclusions

The southeast corridor has many assets that can help support transit, including walkable downtowns at each end of the corridor, colleges and universities, large retail, office and industrial developments, and a rapidly growing population and employment base. The proposed LPA seeks to build the market for public transportation in the corridor by providing service where there is none, providing improved services and facilities, and generally getting commuters used to the idea that transit is a viable transportation option in the corridor.

Implementation of the proposed LPA will be both a regional and local effort. Regional transit officials must identify a multi-faceted funding strategy for the development of facilities, purchase of vehicles and on-going operation of transit services in the corridor. Local officials must begin addressing both funding and land use issues to support the new facilities and services proposed for the corridor.

Once the LPA has been implemented gradually over the 25 year period, it is likely that further transit improvements, potentially including commuter rail or light rail transit, could be implemented in the corridor at some point after 2030. However, such improvements will depend on the identification of a funding strategy and the implementation of transit supportive land use policies to make the most efficient use of transit investments in the corridor.

Glossary of Acronyms and Terms

AA – Alternatives Analysis

Alignment – The route that an improvement, such as a bus or light rail line, could take through a corridor.

Alternative – A feasible transportation improvement that is under consideration.

At-grade – Running on street level.

Bus Rapid Transit (BRT) – A bus system operating on an exclusive bus-only lane.

Bus – Rubber-tired vehicles operating on fixed routes and schedules on roadways. Buses are powered by diesel, gasoline, battery or alternative fuel engines contained within the vehicle.

Capital costs – The expense of designing and constructing a new project.

Commuter Rail – Urban passenger train service for local short-distance travel operating between a central city and adjacent suburbs. Service must be operated on a regular basis by or under contract with a transit operator for the purpose of transporting passengers within urbanized areas, or between urbanized areas and outlying areas.

Corridor – A narrow band of land, usually surrounding a roadway or linking communities.

Environmental Assessment (EA) — An interim decision document prepared for an action where the significance of social, economic, or environmental impact is not clearly established. If the action is determined to have significant impact, an Environmental Impact Statement is then prepared. If no significant impact is determined, a finding of no significant impact (FONSI) is prepared.

Environmental Impact Statement (EIS) — Report which details any adverse economic, social, and environmental effects of a proposed transportation project for which federal funding is being sought.

Environmental Protection Agency (EPA) — Federal agency whose mission is to protect the environment by the control and abatement of pollution in the areas of air, water, solid waste, noise, radiation, and toxic substances.

Federal Highway Administration (FHWA) — Division of the U.S. Department of Transportation that specializes in highway transportation.

Federal Transit Administration (FTA) — Division of the U.S. Department of Transportation that funds transit planning and programs.

Geographic Information System (GIS) — A computer system capable of capturing, storing, analyzing, and displaying geographically referenced information; data identified according to location.

Heavy Rail – High-speed, passenger rail cars operating singly or in trains of two or more cars on fixed rails in separate rights-of-way from which all other vehicular and foot traffic are excluded.

Impact – An effect that a transportation improvement could have on the natural or manmade environment.

Land Use — Refers to the manner in which portions of land or the structures on them are used, i.e., commercial, residential, retail, industrial, etc.

Level of Service (LOS) – A qualitative measurement of the operations conditions within a traffic system and how these conditions are perceived by drivers and passengers. LOS A is free-flow, while LOS F is the worst condition.

Light Rail Transit (LRT) – Lightweight passenger rail cars operating singly (or in short, usually two-car, trains) on fixed rails in right-of-way that is not separated from other traffic for much of the way. Light rail vehicles are driven electrically with power being drawn from an overhead electric line via a trolley or a pantograph.

Locally Preferred Alternative (LPA) – The transportation improvement selected by decision-makers as the solution to the transportation needs and problems in a corridor.

Long Range — In transportation planning, refers to a time span of more than five years.

Long Range Transportation Plan (LRTP) — A document spanning a minimum of twenty years, resulting from a collaborative regional planning process.

Metropolitan Planning Organization (MPO) — The organizational entity designated by law with lead responsibility for developing transportation plans and programs for urbanized areas of 50,000 or more in population. In Tennessee, there are eleven MPOs.

Metropolitan Transit Authority (MTA) – The agency that operates and maintains the local bus system for Nashville/Davidson County.

Mixed-traffic – Automobiles and transit vehicles sharing the same roadway.

Mixed-use – A type of development where residences and businesses are located in the same area.

Mobility — The ability to move or be moved from place to place.

Mode, Intermodal, Multimodal – Form of transportation, such as automobile, transit, bicycle and walking. Intermodal refers to the connections between modes and multimodal refers to the availability of transportation options within a system or corridor.

Monorail — Guided transit vehicles operating on or suspended from a single rail, beam, or tube. Monorail vehicles usually operate in trains.

National Environmental Policy Act (NEPA) — Federal law passed in 1969 which requires an analysis of environmental impacts of federal actions (including the funding of projects).

Notice of Intent — Document prepared to inform the public of the scope of a proposed action or project.

Operations & Maintenance Costs (O & M costs) – The expense of keeping a project running once it is built.

Pedestrian Walkway — A secured path for walking.

Preliminary Engineering Phase (PE) – The project development phase that includes preparation of environmental and construction documentation, such as plans, specifications, and cost estimates. Preliminary Right-of-Way work, appraisal maps and estimates may also be reimbursed with Federal-aid funding for the preliminary engineering phase.

Project - An undertaking to develop, implement, or construct a particular transportation enhancement at a specific location or locations.

Right-of-Way (ROW) - A linear corridor of land used for transportation or other facilities such as highways, roads, streets, railroads, trails, light-rail, utilities, etc.

Regional Transportation Authority (RTA) – Agency responsible for developing a regional transit network for the nine-county Middle Tennessee region. RTA currently operates a rideshare service and will operate the regional transit system.

State Transportation Improvement Program (STIP) – A staged, multiyear, statewide, intermodal program that is consistent with the state and metropolitan transportation plans and which identifies the priority transportation projects to be undertaken over the next three years.

Surface Transportation Program (STP) – Federal-aid highway funding program that funds a broad range of surface transportation capital needs, including many roads, transit, sea and airport access, vanpool, bike, and pedestrian facilities.

Traffic Analysis Zone (TAZ) – The unit of geography most commonly used in conventional transportation planning models.

Tennessee Department of Transportation (TDOT) – State agency responsible for transportation issues and planning in Tennessee.

Transit – Public transportation such as buses or trains.

Transit Oriented Development – (TOD) Mixed-used, higher density development located within ½ mile of a transit station.

Transportation Improvement Program (TIP) — A financially constrained list of prioritized transportation projects developed by a metropolitan planning organization (MPO). The TIP covers a period of at least three years but may cover a longer period for informational purposes. The TIP must include documentation of federal and state funding sources for each project and be consistent with the Long Range Plan and adopted local comprehensive plans.

United States Department of Transportation (**USDOT)** – A federal agency that establishes the nation's overall transportation policy. Under its umbrella, there are ten administrations whose jurisdictions include highway planning, development and construction; urban mass transit; railroads; aviation; and the safety of waterways, ports, highways, and oil and gas pipelines.

Glossary Sources:

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1.0 Introduction

The Southeast Corridor High-Performance Transit Alternatives Study was conducted to answer the following questions regarding public transportation in the southeastern corridor of the Nashville Region:

- What are the transportation problems in the southeast corridor?
- What are the underlying causes of these problems?
- What are viable options (both transportation and other) to address these problems?
- What are the costs and benefits of the differing options?
- Which option is preferred as the best solution?

The need for transportation improvements in the southeast corridor has been addressed in several studies over the past decade. The region's vision for a multi-county transit system to enhance mobility and provide a safe and efficient multimodal network is illustrated in both the 2025 and 2030 Nashville Area Long Range Transportation Plans. The southeast corridor was selected to undergo the next phase of transit corridor planning because:

- The southeast corridor suffers the worst traffic congestion of the five major transportation corridors in the region.
- The corridor has experienced the highest rate of population growth of the five major corridors. (The study area accounts for 10 percent of the region's land area but contains more than 30% of the region's population.)
- The corridor contains a substantial concentration of trip origins and destinations
- The corridor includes one of the highest transit ridership routes in the region
- The corridor has a strategic position and role in the region as home to many of the areas largest employers, including Nissan and Dell Computer, which makes transportation access in the corridor vital to the region's continued economic success.

The southeast corridor is projected to be one of the strongest growing employment corridors in the region over the next twenty years. For the Nashville area to remain competitive and continue to enjoy increased development opportunities, high growth corridors such as the southeast, will need additional mobility options like high performance transit. High-performance transit provides reliable, affordable, and relatively flexible travel within and throughout a corridor.

The southeast corridor area is approximately 30 miles in length from downtown Nashville to just south of the City of Murfreesboro and encompasses an area of approximately 350 square miles. The southeast corridor has experienced tremendous population growth in recent years and is expected to continue growing at a rapid pace. The population in the study area, which includes portions of both Davidson and Rutherford Counties, was 331,000 in 2000 and is forecast to grow to more than 438,000 by the year 2025.

There are two major thoroughfares in the corridor, Interstate 24 (I-24) and Murfreesboro Road (US-41/70S), which connect Nashville with LaVergne, Smyrna and Murfreesboro. Both thoroughfares provide access to high concentrations of employment sites, including large state and federal offices in downtown Nashville, commercial/retail development in suburban areas, and single-family and multi-family housing throughout. With rapid growth in the area, congestion along these major roadways is forecast to increase. This increased congestion will make existing bus service less attractive due to longer travel times and buses that are stuck in traffic.

There are limited opportunities for roadway expansion due to topographic constraints and development adjacent to the right of way. For example, I-24 in and around downtown Nashville was constructed in the late 1950s and roadway improvements over the last several decades have expanded to the maximum amount of available right-of-way within the corridor. As a result, there is no available median right-of-way. The outside travel lanes are 20 to 30 feet below the surrounding topography and abut rock walls. The physical challenges and potential costs of expanding the right-of-way under these conditions, along with the impacts of taking the highly developed urban and industrial land which surrounds the right-of-way, limits the potential to expand the roadway. Additionally, in other parts of the I-24 corridor, major widening has occurred within the available median right-of-way to avoid affecting development alongside the edge of the roadway. Similar limitations exist along Murfreesboro Road which includes numerous commercial and retail establishments with driveways or parking facilities that directly access the roadway. At another portion along Murfreesboro Road, the Nashville International Airport has a taxiway that crosses over the road and severely limits any roadway widening. Other sections of Murfreesboro Road in the southern portion of the study area bisect the downtowns of LaVergne and Smyrna. Major roadway expansion in these areas would result in the taking of several blocks of downtown businesses. The same development characteristics and roadway expansion implications are true within the City of Murfreesboro at the southern end of the study corridor.

Currently, few options in the corridor provide alternatives to driving in heavily congested conditions. Options for longer-distance commuters are limited to: carpools and vanpools using park-and-ride lots; the Regional Transportation Authority (RTA) “Relax-and-Ride” commuter bus service which operates only during rush hour periods; local and express Metropolitan Transit Authority (MTA) routes that operate over shorter segments of the corridor; and use of the HOV lane on I-24. The HOV lane on I-24 runs between Murfreesboro and Nashville but terminates at Harding Road, several miles short of downtown Nashville. Drivers using the HOV lane must enter mixed traffic at that point creating significant congestion and limiting the utility of the HOV lane for carpools and transit. In addition, the HOV lane is not enforced, further limiting its benefit. For existing bus service there are no options that enable buses to bypass congestion. Considering this, ridership on the existing commuter services is relatively high which indicates a potential unmet demand for transit options in the corridor.

Potential commuters that do not have access to private transportation are denied access to jobs and educational opportunities throughout the corridor as a result of the lack of transit options. This lack of access reduces opportunities for all people throughout the region, hinders social and economic advancement, and reduces regional economic development. As the Southeast Corridor High-Performance Transit Alternatives Study illustrates, the lack of mobility and transportation options combined with the current and projected growth of population, employment—and traffic congestion—requires that transportation alternatives be developed to address these needs.

This report documents the analysis that was conducted on transit alternatives in the southeast corridor between April 2004 and April 2007. This study examined the existing conditions in the corridor and developed a range of transit alternatives to meet the travel needs of the corridor and the goals and objectives of the community. The MPO, a project steering committee comprised of public agencies in the corridor, and consultant staff evaluated those alternatives and developed a locally preferred alternative strategy (LPA). The Nashville MPO approved the proposed LPA in February 2007. This report describes the process by which this alternative strategy was developed and evaluated, and the public and stakeholder involvement process that ultimately led to the approval of the LPA. It describes in detail the LPA and the alternatives ultimately discarded by the Steering Committee, and documents the many technical activities

and analyses that supported and, in many ways, guided the decision-making processes in the study.

The process described in this report follows the guidelines of the Federal Transit Administration's (FTA) Section 5309 *New Starts* process and was developed with the involvement of FTA staff. This report provides information that may subsequently be used in various chapters of a NEPA document.

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2.0 Public Involvement Plan

2.1 Introduction

The Public Involvement Plan followed the MPO-approved scope of work for the Southeast Corridor Alternatives Analysis to ensure officials, agencies, local government, the public and other interested parties had an opportunity for input into the planning process for the Southeast Corridor Alternatives Analysis. The Plan included proposed strategies for outreach to disadvantaged and minority populations, non-English speaking populations within the corridor, and to persons with disabilities.

The methods used to keep officials, agencies, local government, the public and interested parties informed of the project and to allow them opportunities to provide input into the project falls into seven categories:

1. Notice of Intent
2. Meetings
3. Website Development
4. Database
5. Policy Briefings
6. Interviews
7. Media Outreach

The activities in these seven categories and the party to whom each activity was assigned are described below.

2.2 Notice of Intent

Pursuant to the National Environmental Policy Act (NEPA), the Federal Transit Administration (FTA) publishes a Notice of Intent (NOI) in the Federal Register. The NOI is required by NEPA for projects that will likely result in a NEPA Environmental Impact Statement. It informs interested parties that the study process for the Southeast Corridor has commenced and that a scoping meeting will be held. A notice of intent regarding the Southeast Corridor Study was published by RTA in 2004.

2.3 Meetings

Meetings ultimately included a Scoping Meeting round, Community Meetings, a Public Forum and Steering Committee Meetings. All meeting arrangements (locations and coordination with meeting facility manager/staff) were undertaken by the MPO with input from the consultant team.

2.3.1 Scoping Meetings

Shortly after project start-up, a round of public scoping meetings was held at three locations along the project corridor:

- Monday – July 12, 2004 – Smyrna Town Center – 3 p.m. – 7 p.m.

- Tuesday – July 13, 2004 – Rutherford County Courthouse – 3 p.m. – 8 p.m.
- Wednesday – July 14, 2004 – Downtown Nashville Library – 9 a.m. -8 p.m.

An agency scoping meeting also was held on July 14, 2004 at the Downtown Nashville Library from 1:30 p.m. to 3:30 p.m. The purpose of the round of scoping meetings was two-fold: to begin the scoping process pursuant to the National Environmental Policy Act (NEPA) and to obtain early public and agency input into the project that will assist in project planning. A summary of these three meetings can be found in Appendix 2A.

The Scoping Meetings described of the project through a presentation and through display graphics and meeting handouts. The format of the meetings loosely followed the meeting format of the Tennessee Department of Transportation. This format involves distributing a handout containing project information and providing instructions on how interested parties can comment, posting wall displays and having sufficient staff to answer questions in an open house type format. A formal presentation describing the proposed project and the Alternatives Analysis process was given and repeated at scheduled times throughout the meetings. Comments were received via comment cards turned in at the meetings or comment cards or letters mailed in after the meetings.

To build awareness about the project and generate as much public attendance as possible, a comprehensive communications and outreach program was implemented to support the scoping meetings. This strategy, with some modifications, was followed for each of the ultimately four rounds of public meetings conducted in the study. Specific communications and outreach activities included:

- **Media briefings** – During the week of June 28, 2004, a series of media briefings were conducted to background the media regarding the entire project and to generate media placements regarding the scoping meetings. Representatives from the MPO and consultant team conducted these briefings.

  Media contacted included the *Tennessean, City Paper, Scene, Tribune, Nashville Business Journal, The Daily News Journ*al (Murfreesboro), *Rutherford Courier* and the two Spanish language newspapers, *La Compana* and *El Crucero*.
- **Newspaper ads** – Newspaper ads were used to fulfill the project's legal notification requirements and to create broad awareness. Both legal and display ads were used.
- **Press release** – In addition to the press briefings, a press release detailing the scoping meeting schedule was distributed to all print, broadcast and online media in the study area.
- **Community communications** – Communications specialists for each of the cities and counties in the study area were contacted to give them a briefing on the project and to enlist their help in communicating the information. Notices and flyers regarding the meetings were furnished to each specialist.
- **Notices, flyers** – Notices and flyers representative of the newspaper display ad were reproduced and posted on bulletin boards or distributed in high traffic areas throughout the study area.
- **ADA/Disadvantaged/Minority populations** – Specific outreach efforts were made to reach these citizen groups. Direct contact was made with the public agencies and support groups that represent these populations. Their support was solicited to help communicate with the citizens they serve. Informational materials were offered for their use.

Minority media in the Nashville area were contacted and briefed, and their support was solicited to help the project reach the African-American and Non-English speaking populations in the corridor.

- **E-mail notifications** – E-mail notifications were used to reach the database of interested citizens, which was developed over the course of the study.
- **Media and community bulletin boards** – Arrangements were made to have the meetings placed on these community calendars, etc.

2.3.2 Community Meetings

Three rounds of meetings, with up to five meetings per round, were proposed for the project. The meetings occured at a variety of locations along the project corridor.

The first community meetings occurred in December 2004. The community meetings were supported with a proactive communications and outreach program similar to that of the scoping meetings. In addition to media exposure, additional outreach to the public occurred through contact with the following:

- African American Chamber of Commerce
- Greater Nashville Black Chamber of Commerce
- NAACP
- Tennessee Hispanic Chamber of Commerce
- The Native American Indian Association of Tennessee
- Urban League
- Nashville Area Chamber of Commerce
- Rutherford County Chamber of Commerce (LaVergne, Murfreesboro and Smyrna)
- Tennessee Disability Commission
- Nashville Community Centers (located within the corridor)
- Metro Nashville Swimming Centers (within the corridor)
- McFadden Community Center – Murfreesboro
- MTSU Campus and Library
- Smyrna City Hall
- LaVergne City Hall
- Murfreesboro City Hall
- Stones River Mall
- Hickory Hollow Mall
- Outlets Limited Mall
- City Park Centers – all cities
- Murfreesboro Center for the Arts
- Murfreesboro Town Centre
- Patterson Park Community Center (Murfreesboro)
- LaVergne Parks and Recreation Center
- St. Clair Senior Citizens Center (Murfreesboro)
- Smyrna Senior Citizens Center
- LaVergne Senior Center
- Murfreesboro YMCA
- Smyrna Public Library

- Nashville Public Libraries
- LaVergne Public Library
- Murfreesboro Public Libraries
- United Way of Metro Nashville (and other cities)

Over the course of the project, public meetings were conducted in December 2004, July 2006 and December 2006, coinciding with the completion of project milestones. Specific dates and locations were published in advance of the meetings, and communications and outreach activities were conducted to support these meetings as well. Summaries of these meetings can be found in Appendices 2B through 2D. Other comments submitted by citizens via postal mail and e-mail can be found in Appendix 2E and Appendix 2F respectively.

The anticipated materials that were presented at each round of meetings include:

Round 1:

- Draft definition of goals, objectives
- Preliminary definition of needs (problems/issues)
- Definition of sketch alternative system solutions, operating concepts and alternative transit modes (i.e., BRT, LRT and Commuter Rail). The consultants and MPO developed a comment form that will focus on the issues to be resolved and/or considered in the Round 1 meetings.

Round 2:

- Refined goals, objectives and community needs
- Evaluation of Detailed Alternatives. The consultants and MPO developed a comment form that to focus on the issues to be resolved and/or considered in the meetings.

Round 3:

- Review of LPA package including preferred route(s), modes, operating parameters and financial strategies. The consultants and MPO developed a comment form to focus on the issues to be resolved and/or considered in the meetings.

These meetings focused primarily on presenting the information to the public in a formal presentation, which will be followed by a question and answer session. At some meetings, the presentation was made twice within a single meeting to accommodate latecomers. Comment cards were made available for attendees to submit comments at or after the meeting. Display graphics were mounted on the walls around the room and staff were available before, after and between presentations to discuss the material one-on-one with members of the public and to answer questions. A sign in sheet was used at each meeting and members of the public who requested further information were placed on the project mailing list and were informed of future meetings and other information.

2.3.3 Public Forum

A Public Forum with speakers invited from other regions in the country to discuss major transit improvement projects was held in September 2004.

The Public Forum addressed two topics: first, how other communities have planned and implemented transit systems and second, how the transit systems' impacts on land use resulted in positive change in the community. The presenters represented communities that are at various stages in the transit planning, implementation and operation process and those that have experienced positive change in urban land use that is supported by contemporary transit systems (Charlotte, NC, and Jacksonville, FL). Two Public Forum sessions occurred on consecutive days, in Nashville and in Smyrna. Each forum included a morning session to address the "how to" topic, with the afternoon session discussing land use impacts of transit. The forums included breakout sessions to enable small group discussions and individual consideration of key issues in the different parts of the corridor. Appropriate feedback from attendees was documented at the forums.

The forum's discussion focused on the local decision-making process followed in communities where several different transit technologies have been selected to provide high capacity transit service. Other participants described land use changes in communities such as Portland, Oregon and other cities where significant changes in land use have created opportunities for public transit.

2.3.4 Steering Committee Meetings

The schedule anticipated 12 meetings of the Steering Committee will be held, on average once every month during the study process. Given the delays created by the on-board bus survey and other factors, ultimately 15 meetings were conducted. The Steering Committee served three essential purposes in the planning process: first, to act as a sounding board to measure the clarity of the project's message; second, to provide policy guidance at key decision points in the process and; third, to communicate the study progress to their agency and community constituents. The Steering Committee selected by the MPO includes representatives of the following agencies:

Federal Transit Administration
Nashville Metro Planning
Nashville MPO
Nashville MTA
Nashville Metro Traffic Engineering
Nashville International Airport
Rutherford County Planning
City of LaVergne
City of Murfreesboro
City of Smyrna
Regional Transit Authority

Given the three year duration of the project, the individual personnel representing many of the agencies changed over the course of the study. However, all of the agencies provided valuable input to the process while responding to the needs and desires of their agencies and the greater Nashville community.

2.4 Website Development and Operation

A public information website was developed by the MPO, with assistance from the consultant team, to support the communications and outreach needs of the study. The MPO hosted the website and arranged for the URL. The website is partially interactive, supporting submittal of

comments from the public via e-mail, and a number of comments were received from this source. The consultants assisted the MPO in developing the information architecture and navigation menu, and in updating the web site as appropriate.

2.5 Project Public Involvement Database

A database of members of the public interested in the project was developed and updated on an ongoing basis throughout the life of the project. The database was used to communicate with those who have requested to be placed on the project's contact list. Individuals included on the list received periodic messages regarding the project, such as updates and meeting notices.

At public meetings and other forums, members of the public were asked whether they would like to be included on the mailing list as a part of comment forms dispensed and collected at public meetings and on the interactive website. The database was supplemented by the names of residents and businesses in the corridor, which were provided by the MPO through available data sources and the regional Geographic Information System (GIS). The list also included the names of civic groups, churches and agencies in the affected areas of the corridor. Names of individuals and groups representing the transit-dependent populations and disabled populations were obtained through the Regional Transportation Authority and the Metropolitan Transit Authority, and other sources, and were added to the database.

2.6 Policy Briefings

At key decision points in the planning process, consultants and MPO staff held policy briefings. These were held to coincide with the public meetings. The intent of these briefings is to ensure that interested officials are given an opportunity to be informed of the project status. The meetings were by invitation only and were attended by public officials and agency representatives, who used the forums to ask questions prior to release of the information to the public and the media.

2.7 Stakeholder Interviews

Face to face interviews were conducted with 20 key stakeholders, officials and decision makers in the region to determine their perception of community needs, the role of transit service and the threshold level of information required for them to make decisions. Individuals to be interviewed were identified in consultation with the MPO staff and members of the project steering committee, and included elected officials and community leaders in the corridor's communities. Many valuable insights were gleaned from these interviews, which also promoted the study to these community decision makers.

2.8 Media Outreach

Subsequent to the initial media briefings that preceeded the scoping meetings, the study team maintained ongoing contact with key media throughout the project. Specific activities included:

- Press releases – Preparation and distribution of press releases to update the project or communicate project milestones.
- Meeting announcements – All print, broadcast and internet media serving the study area utilized to announce public meetings, locations, dates and times.
- Talk shows – members of the MPO and consultant staff were booked on radio and television shows to discuss and promote the project. The purpose for these

appearances was public education, to report on project programs, and to make the public aware of scheduled public meetings.

A media activity schedule for each round of meetings was prepared and modified over the course of the study, to outline the activities to be conducted leading up to each set of public meetings and forums. The media activity schedule presented prior to the September 8-9 public forums is shown in the table on the next page. A similar format was used for the other public meetings and forums.

Table 2-1 September 8-9, 2004 Public Involvement Activity Schedule for Public Forums

2004 Date	Days Prior to Meeting	Activity
August 4	35 days	• Submit legal and retail ads and public forum flyers for MPO approval
August 9	30 days	• MPO approval of legal and retail ads and flyers
August 11	28 days (4 weeks)	• Final ad production completed for newspaper placement • Press release draft completed for approval by MPO • Public forum handout and comment sheet draft to MPO for approval
August 13	26 days	• Print media deadline for MPO • Legal and retail ad insertion orders to newspaper
August 14	25 days (3.5 weeks)	• Information "sign-up" day at public areas (e.g., shopping malls, community centers)
August 18	21 days (3 weeks)	• Legal ad appears in newspaper • Press release draft approved for release • Coordination of public forum announcement with city/county communicators • Public forum announcement advisories to ADA/minority/disadvantaged groups • Public forum announcement submitted to community bulletin boards
August 25	14 days (2 weeks)	• Public forum media briefing, reporter contact • Distribution of public forum flyers in study area • Meeting handout and comment sheet approval by MPO
August 30	9 days	• E-mail and mail notifications to study mailing list • Press release distributed to media
September 1	7 days (1 week)	• Retail ad appears in newspapers
September 3	5 days	• Final production of meeting materials
September 6	2 days	• Follow-up public forum advisories to media • Radio and television talk shows during week of September 6-10
APPENDIX A September 8-9	—	• Public forum meetings

Source: Ackermann Public Relations, July 2004

The following key messages, as well as the goals for the project, were developed for use by the MPO and consultants who communicated with the public and media. This message was modified as the purpose of the meeting changed over the course of the study, and was summarized in the handouts, press releases and other materials produced for each round of public meetings.

The Study's Purpose:

- The Southeast Corridor High Capacity Transit Study will consider all high capacity transit alternatives and determine the locally preferred alternative.
- This study is needed because there are few options in the corridor to driving in heavily congested conditions on the major roadways, including I-24 from Murfreesboro to downtown Nashville.
- There is no public transit service within Murfreesboro with a population of 75,000 and home to a university of 21,000, where some 18,000 of those are commuters. The traffic count on I-24 west from Murfreesboro nearly doubles, from approximately 64,000 to 120,000 cars per day as the interstate enters Nashville. Traffic congestion causes a waste of resources, stress on commuters and may reduce economic growth and limit economic development opportunities.
- High capacity transit options for the long-distance commuter are limited to the RTA "Relax and Ride" express service between Murfreesboro and Nashville, which operates only during rush hour periods.
- Economic development may be hampered by the lack of access to jobs by transit dependent employees. Because the corridor's land use patterns were developed primarily for auto use, land development has occurred without evident forethought on potential high capacity transit options that may serve the needs of the corridor more efficiently.
- The study also will address environmental concerns such as air, water and noise pollution associated with existing auto traffic as well as other alternatives such as new roadways, rail or bus.
- The study also will identify transit improvements that achieve local consensus, meet state and federal funding guidelines and are cost effective.

The Study's Goals:

- The study will provide long distance travelers with alternatives to driving private vehicles in heavily congested traffic conditions. The transit options for work or non-work related commutes would provide greater benefits to driving private vehicles such as trip time, convenience, safety, cost and comfort. The study will also provide a wider array of transportation options to and from homes, jobs and services, and will increase high capacity transit options outside of Nashville.
- The study's recommendations will promote efficient land use and development patterns throughout the region, such as concentrating employment and other activity centers along existing and planned transit corridors. The study also will maintain and promote downtown Nashville, downtown Murfreesboro and other established areas as the region's main employment and activity centers. It will promote the reuse of existing

vacant buildings and sites in the high traffic areas as well as encourage multi-use developments that include commercial, retail, recreation and housing.

- The study will suggest ways to improve and enhance economic development and job opportunities by improving access and new transportation options to employment centers, housing and education. The study will also recommend options to enhance reverse commuting for Nashville residents to jobs in other areas of the corridor. It will also identify high quality transit access to the Nashville International Airport from downtown Nashville, Murfreesboro and other corridor communities.
- The study will demonstrate how to enhance the natural and social environment by improving air quality, reducing commuter stress, minimizing transportation-related noise impacts, protecting – and when possible, enhancing environmentally sensitive areas – and minimizing community disruption, as well as creating transportation investments that don't negatively impact the aesthetic environment.
- The study will develop a cost-effective transportation system improvement strategy that maximizes community consensus and institutional support.

A series of frequently asked questions (FAQ)s and the answers to these questions was also developed for use by the MPO and consultants in public involvement and media activities.

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3.0 Needs Assessment and Evaluation Methodology

3.1 Introduction

The Needs Assessment and Evaluation Methodology identifies the problems and opportunities in the Southeast Corridor, verifies the perceived issues through a thorough examination of the existing conditions, and explains how those problems and the community's goals for the study will shape the ways in which alternatives will be evaluated.

3.2 Study Area

This section describes the corridor and affected jurisdictions within the study area. Overall, the southeast corridor is a subset of the Nashville region that offers a diverse mix of land uses that include office parks, suburban and urban neighborhoods, light industrial, strip commercial, airports and large industry.

3.2.1 Study Area Description

The study area known as the Southeast Corridor links the City of Nashville, Davidson County and the cities of LaVergne, Smyrna and Murfreesboro in Rutherford County. Nashville is the second largest city in Tennessee, with a population of approximately 570,000[1]. The central business district houses the highest concentration of office employment in the region, which includes State offices and the Capital, as well as Federal and Metropolitan Government offices. Nashville draws approximately 132,000 daily commuters from surrounding counties, about 25,000 of which come from Rutherford County. The Nashville downtown area is also a prominent music and cultural center with venues and activities at the Ryman Auditorium, Frist Art Center, Schermerhorn Symphony Center, Country Music Hall of Fame, the Tennessee Performing Arts Center, the Nashville Convention Center, and the Municipal Auditorium.

In recent years, downtown Nashville has also emerged as a place of sports: the Nashville Predators, an NHL team, play at the Gaylord Entertainment Center; the Nashville Sounds, a minor league baseball team, play at Greer Stadium; and the Tennessee Titans, an NFL team, play at the Coliseum, bringing visitors and fans from across the state and the region.

Murfreesboro is the southernmost terminus of the study corridor and lies about 30 miles southeast of Nashville. It has a population of approximately 75,000 and is home to Middle Tennessee State University (MTSU). MTSU is primarily a commuter-oriented institution that draws students from throughout the region. MTSU has an estimated enrollment of 21,000, of whom about 17,500 live off campus. Between Nashville and Murfreesboro are the City of LaVergne with an approximate population of 22,000, and the Town of Smyrna, with a population of approximately 26,000. LaVergne and Smyrna form a major employment area which is home to a Nissan automobile manufacturing plant, Bridgestone/Firestone, Ingram, and other major employers.

Figure 3-1 shows the general corridor study area. The corridor comprises 357 square miles, representing about 10 percent of the land area of the five county MPO region and containing 30 percent of the region's population. The study area is approximately 30 miles in length from downtown Nashville to just south of Murfreesboro. In downtown Nashville, a three mile radius from the center of downtown has been established as the northern terminus of the study area.

[1] Population data throughout this document is from the 2000 US Census, unless otherwise noted.

This area includes West End Avenue and the Church Street district to the west of downtown which includes Vanderbilt University and Medical Center, Baptist Hospital, and HCA Healthcare. These employers account for nearly 20,000 jobs.

The western border of the study area includes Nolensville Pike and extends southeasterly toward the Davidson County line. In Rutherford County, the western border is approximately three miles west of Interstate 24 (I-24). The southern terminus is approximately six miles south of the city limits of Murfreesboro, capturing the complete corporate and urbanized area of Murfreesboro. The eastern boundary of the study area extends from the three-mile radius of the downtown study area termini and follows I-40 (to the east) toward Nashville International Airport. Just east of the Nashville International Airport, the eastern border of the study area is roughly three miles east of Murfreesboro Road (US-41/70S), traverses Percy Priest Lake to the east and includes the complete corporate and urbanized boundaries of the cities of LaVergne, Smyrna, and Murfreesboro.

The precise study area boundary coincides directly with the boundaries of traffic analysis zones (TAZs) that are used by the MPO to organize population, employment and demographic data for analysis in their regional transportation model. Making the study area boundaries contiguous with TAZ boundaries allows the study area to be defined as an aggregation of TAZs, which facilitates data analysis. The study area boundary may be refined or redefined if transportation needs are identified that would require analysis or solutions outside the present boundary.

The two primary north-south thoroughfares within the corridor are Murfreesboro Road (US-41/70S), and I-24. This corridor experiences significant levels of traffic congestion. The 30-mile segment of I-24 between Nashville and Murfreesboro handles between 64,000 and 176,000 average daily trips. Murfreesboro Road has between 21,000 and 40,000 average daily trips. The estimated corridor population is approximately 331,000. Some of the significant trip attractors/generators along the corridor include Nashville International Airport, MTSU, major employers such as Nissan and Dell Computer and the regional shopping malls, commercial services, office parks, hospitals and downtown Nashville.

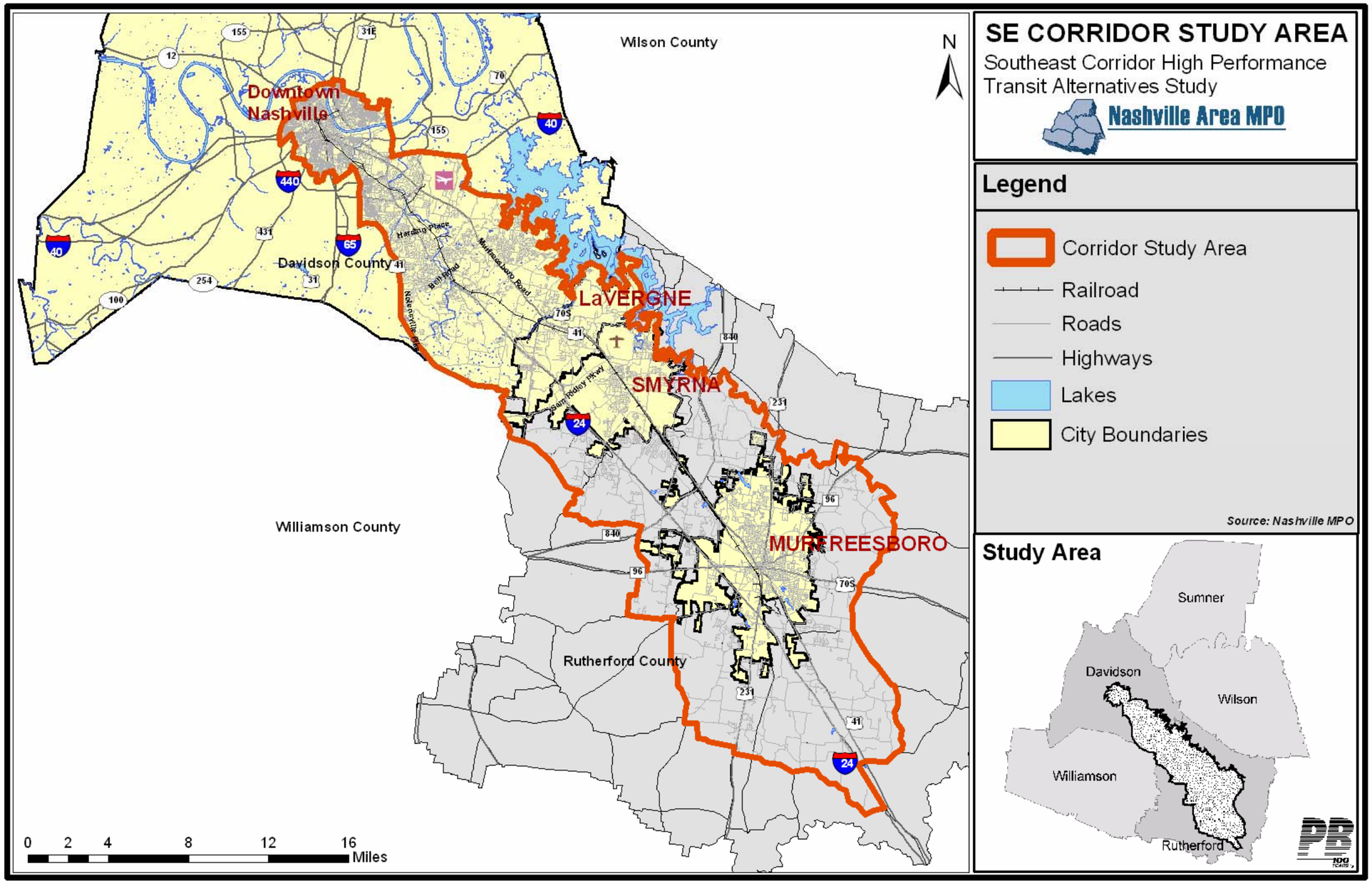
3.2.2 Jurisdictions Affected

The study area includes portions of two counties and three municipalities: Metropolitan Nashville-Davidson County, Rutherford County, and the cities of LaVergne, Smyrna, and Murfreesboro, which are located within Rutherford County.

Nashville and Davidson County is a single form government with its authority encompassing more than a half-million people and 533 square miles. Metropolitan Nashville-Davidson County has operated under its present Metropolitan Charter since 1963. A component of Metropolitan Nashville-Davidson County government is the Metropolitan Transit Authority (MTA), created in 1953 to supervise, regulate, and maintain jurisdiction over public transit in the City of Nashville. With the creation of Metropolitan Government, the service area of MTA was expanded to include all of Davidson County.

Southeast of Nashville-Davidson County, Rutherford County lies at the geographic center of Tennessee and encompasses approximately 612 square miles. The cities of LaVergne, Smyrna, and Murfreesboro are three of four municipalities located in Rutherford County. These cities account for approximately 63 percent of the county's population. Currently, neither Rutherford County nor its municipalities operate, or are served by, local fixed-route transit services.

Figure 3-1
Southeast Corridor Study Area



3.3 Summary of Need and Purpose

The Nashville Area MPO has initiated the Southeast Corridor High Performance Transit Alternatives Study to develop and analyze transit options that address both present and future transportation needs within the corridor. The purpose of the study is to analyze the transportation problems of the corridor and to consider potential transit solutions.

The need for transportation improvements within the study area is based on a number of interacting transportation problems. These include the lack of transit options in the corridor, heavy and worsening traffic congestion on major roadways, land use and development trends that contribute to worsening congestion and make it more difficult to serve the corridor with transit, and environmental concerns associated with increased auto use. If plans are not made now to develop alternative approaches for these transportation problems, they will compound and worsen in the future, threatening the corridor's continued growth and the quality of life of those who live, work, and visit in the corridor.

3.3.1 Transportation Options

Currently, there are few alternatives in the corridor to driving in heavily congested conditions. Options for longer-distance commuters are limited to driving alone; car or vanpools that can use the I-24 HOV lanes; the Regional Transportation Authority (RTA) "Relax-and-Ride" express service that operates during rush hour periods; and MTA routes that operate over shorter segments of the corridor. Ridership on these services is relatively high. None of these transit options operate on facilities that allow them to bypass the heavily congested roadway conditions and there are no other transit services outside Nashville-Davidson County. This includes the City of Murfreesboro, a city of significant size and the site of Middle Tennessee State University.

This lack of mobility options affects many travel markets. Potential commuters that do not have access to private transportation, including reverse commuters, are effectively denied access to jobs in the corridor due to the lack of transit options. In addition, those who depend on public transit for their transportation face limited housing options. Continued economic development could be limited by the lack of access to jobs for transit dependent employees. Students traveling to Nashville from southern areas of the corridor, and students traveling to Murfreesboro from Nashville and areas in the north of the corridor, are also limited in their travel options. Those who are unable or unwilling to drive, or simply prefer to use transit are negatively affected by this lack of transportation options in the corridor. The lack of access to non-drivers of the employment and educational opportunities in much of the corridor is both a social equity and economic development issue. Many disadvantaged persons lack access to jobs and educational opportunities that would allow them to improve their lives. In addition, many employers lack access to workers as a result of this vacuum of transit options.

Identified Transportation Need: Provide transportation alternatives for travelers within the corridor.

3.3.2 Mobility and Traffic Congestion

Growth in traffic volumes is indicative of both population growth and economic vitality. However, growth in travel without growth in the capacity of the transportation system results in traffic congestion. The southeast corridor suffers the worst traffic congestion of the five major transportation corridors in the region. Limited opportunities for roadway expansion exist due to topographic constraints and development adjacent to the right of way. With the rapid growth in the area, congestion along the major roadways is forecast to increase. Traffic volumes rise

annually, with congestion in the corridor showing a consistent increase each year. Traffic congestion wastes resources as well as the time of travelers, and has the potential to reduce economic growth and limit economic development opportunities in the corridor and the region. I-24 and I-40, which converge south of the downtown, is the primary transportation spine of Middle Tennessee, with nearly 176,000 vehicles a day passing to and through the area. I-24, US 41 (Murfreesboro Road) and the CSX rail corridor are the only continuous southeast-to northwest corridors connecting this part of the region to downtown Nashville. I-24 is the only one of these facilities that is a limited-access highway. The terrain and existing development in most of the corridor, especially in areas adjacent to downtown Nashville, constrain adding further capacity or the development of new rights of way. Motorists are beginning to recognize the significance of this congestion with travel speeds nearly 75 percent less than that of the posted speed limit during the morning commute (12 to 13 miles per hour compared to a posted speed of 55 mph).

Identified Transportation Need: Allow economic growth and development in the corridor to continue without overburdening existing roadways. Reduce the negative impacts of congestion on resources, travel times, and mobility.

3.3.3 Land Use Policies / Compact Development

The Nashville region is working to avoid the fate of many other urban areas that are experiencing the negative impacts of sprawl and the deterioration of compact urban centers. Transit can influence, support, and promote more compact land use and development patterns within the corridor. This will allow the corridor to be served by a more efficient mix of transportation options that include walking, cycling, and mass transit. Section 3.4.3 describes land use and development patterns within the corridor in detail. Land use patterns in the area tend to be low-density and pedestrian unfriendly, with uses widely and strictly separated. Existing development is oriented for the convenience of auto travel, as opposed to pedestrians or users of mass transit. Over time, development has occurred with little, if any, consideration for the ways in which public transportation infrastructure and services might serve the travel needs of those who live, work, or travel within the corridor. This has resulted in a development pattern and transportation system that does not meet all the needs of the various users such as pedestrians, cyclists, and transit riders. The current auto-centric transportation network increasingly suffers from traffic congestion, which indicates that the capacity of the system does not meet the demands of drivers. The result is a transportation system, in terms of its capacity and composition of services that lags behind the demand for transportation services. The auto-centric development pattern also represents a significant threat to farmland and open space and has the potential to significantly diminish the quality of life for Nashville area residents by reducing access to a variety of housing, retail and commercial development types, reducing access to open space, and promoting traffic congestion. Over time, this auto-centric focus toward development increases travel times for all users of the transportation system including drivers and bus riders.

Identified Transportation Need: Provide greater emphasis on mixed-use development, traditional urban and village land use patterns, and design standards that support a diverse range of travel options. Promote land uses that are conducive to a more balanced transportation system with key roles for pedestrian and mass transit.

3.3.4 Environmental Concerns

By reducing or stabilizing the rate of auto use in the corridor, transit improvements help alleviate a number of environmental problems, including air, water, and noise pollution. Automobile use

raises a number of environmental concerns ranging from air, noise and visual pollution to depletion of fixed-supply resources to the pollution generated by leaking fuel storage tanks and the decomposition of scrapped vehicles. Traffic congestion adds to a host of environmental problems ranging from lost time to travelers to air quality "hot spots" caused by idling vehicles. Transit can reduce the impacts of these issues, but the development of such a facility should minimize the impacts on property and avoid creating environmental justice impacts on affected populations.

Identified Transportation Need: Transportation alternatives that minimize impacts to the environment and help to improve air quality conditions in the region.

3.4 Planning Context

This section describes the planning context of the study area and provides an overview of previous transportation studies performed in the corridor. These studies have identified assorted transportation problems in the southeast corridor and have recommended various solutions or improvements. Although no one study has recommended a comprehensive program to address all of the transportation needs, the needs identified in these studies offer a starting point for the Southeast Corridor Alternatives Analysis.

The planning context also includes a review of the demographic, socio-economic, land use and natural environments in the corridor. These factors ultimately will drive existing and future demand for transportation services and directly impact the mix of roadway and transit improvements that might address the specific needs of the corridor.

Significant findings of the assessment of the planning context revealed:

- The southeast corridor represents 30 percent of the region's population while accounting for only 10 percent of the land area in the region.

- Rutherford County is the second fastest growing county in the region with a near 54 percent increase in population since 1990. This trend is projected to continue as Rutherford County is expected to experience a 75 percent increase in population growth by the year 2025.

- Population density within the corridor represents 927 persons per square mile, which is denser than the third largest city in Tennessee – the City of Knoxville, with a population density of 751 persons per square mile.

- Population diversity in the corridor is comparable with that of Davidson County as a whole; however, nearly 68 percent of both Davidson and Rutherford County's Hispanic population reside within the study area.

- Between 2000 and 2003, nearly 23,000 new residential units were constructed in Davidson and Rutherford Counties. Of the 23,000 units, 60 percent were in Rutherford County.

- Davidson County has the largest employment base in the region with 51 percent of the employment (or 303,000 jobs). Rutherford County has the second largest employment base in the region with just over 100,000 (or 17 percent of the jobs).

- The top 20 largest employers (in terms of number of employees) in the corridor account for over 50,000 jobs and 13 percent of all jobs in Davidson and Rutherford Counties.

- According to the US Census roughly 27 percent (or 25,297) of the residents of Rutherford County traveled to Davidson County in 2000 for employment. This is a 77 percent increase over 1990 commuting trends, which is greater than the 54 percent increase in population that occurred in Rutherford County during the same period.

- Existing local land use policies in the corridor provide limited, if any, compact or transit oriented development (TOD) regulations. Current land use policies throughout the corridor do not significantly promote compressed development, limit suburban sprawl, or encourage walking and mass transit as the primary transportation mode.

For more details of the planning context, including discussion of the transportation and planning studies relevant to the corridor, as well as a detailed analysis of the demographic, socioeconomic, and development context of the corridor, see Appendices 3A through 3C.

3.4.1 Previous Studies

Over the past decade, many regional and sub-regional studies have been conducted in the Nashville MPO area. Several of these studies have focused on the entire region while others have been specific to a particular study area. Most of the studies identify specific transportation problems and needs that include the southeast corridor in some fashion. Studies previously conducted in the corridor include:

Nashville MPO Area High Occupancy Vehicle (HOV) Study – The study was commissioned in 1996 by the Tennessee Department of Transportation (TDOT) to develop a concept for incorporating HOV lanes as a transportation strategy for the regional transportation network. The stated goals of the study included: improving air quality, reducing energy consumption, improving regional mobility, improving the overall efficiency of the highway system, and providing a publicly acceptable HOV system.

The HOV Study recommended HOV lanes for I-24 from downtown Nashville to US-231 in Rutherford County (which is approximately 3 miles north of the southern terminus of the Southeast Corridor study area). To date, a large portion of the study recommendations have been implemented within the Southeast Corridor, including the HOV lanes on I-24 from Harding Place in Davidson County to State Route 840 (SR-840) in Rutherford County. There are, however, critical segments of the I-24 HOV lane system in the Southeast Corridor that are called for in the plan but have yet to be constructed. These include the segments from downtown Nashville to Harding Place (approximately 7 miles) and from SR-840 in Rutherford County to US-231.

Nashville MPO Area Central Business District (CBD) Access Study – This study was commissioned in 1996 by TDOT to investigate improved access into the southern portions of the Nashville Central Business District (CBD) between the Broadway exit on I-40 and the Fesslers Lane exit on I-40. The study identified three sets of distinct transportation problems in the area, each impacting motorists from the southeast portion of the region traveling into and out of the downtown. First, limited access is caused by prohibited movements from 2nd/4th Avenue interchange with I-40. Second, route continuity is affected where three interstate routes

converge (I-24, I-40, and I-65) near the CBD. The third and final problem identified is the weaving of local access and longer-distance traffic on I-40. Each of these problems reduce capacity and cause traffic congestion and other transportation problems on I-24, which is the sole north-south limited access facility in the southeast corridor.

A series of recommendations for this location were proposed, each consisting of significant costs and impacts to motorists, businesses, and surrounding properties. In general, recommended improvements included reconstructing three interchanges, replacing five existing structures that flyover five local roads and two interstates, and doubling existing lanes via ramps and through lanes. To date, none of the study recommendations have been advanced.

Nashville Regional Commuter Rail Evaluation Study – This study was commissioned in 1996 by RTA, the MPO, and MTA to explore the feasibility of commuter rail in the Middle Tennessee region. Five corridors were identified for development of commuter rail service in the 20-year planning horizon. One of these was the southeast corridor, which extended from the Landport in downtown Nashville to SR-96 in Murfreesboro. The southeast corridor was identified as one of two standout corridors in terms of high ridership, low operating deficit per passenger, and favorable emission reductions. The study concluded that commuter rail is a feasible future transportation option in the Nashville region, and warrants incorporation in regional transportation and development planning. To date, the east line, from downtown Nashville to the City of Lebanon, is the only rail line of the five under development, and is scheduled to be operational by 2006.

Nashville Regional Commuter Rail Evaluation: Potential Start-up Segments Study - Commissioned in 1998 by the MTA to explore how to begin implementing the original (1996) study findings of the potential start-up segments. The east line, which began operation in 2006, was selected as the region's initial start-up line due to the amount of available track capacity along the line. For the southeast corridor, the study concluded that double track existed on the current CSX Transportation track from the downtown toward Thompson Lane (just north of the Hickory Hollow Mall) and could be used as part of an initial start-up commuter rail line. The study noted that consideration should be given to extending beyond this initial location to at least the Hickory Hollow Mall area if not all the way to the cities of LaVergne and Smyrna as an initial start up phase. Analysis of a third corridor identified in the study, the northeast corridor from Nashville to Gallatin, began in 2007.

Park-and-Ride Lot Study – A Middle Tennessee Park-and-Ride Lot Study for the region was first conducted in 1993 by RTA and later updated in 1999. The study resulted in an inventory of existing park-and-ride lots, recommendations for improvements to current locations, and a listing of future park-and-ride lots. The vast majority of the recommendations to existing lots included better signage, lighting, and/or creating formal agreements with lots that are currently used under arrangements that are informal in nature. Four future park-and-ride lot locations were identified in the Southeast Corridor study area. The locations included Harding Road in Davidson County (adjacent to the CSX Railroad), the Hickory Hollow area in Davidson County (near the Crossings), the Town of Smyrna (either at the abandoned CSX Depot or near Sam Ridley Parkway), and the City of LaVergne (near Waldron Road). These sites were identified with the notion that three of the four could be used as future commuter rail stations once service was established in the corridor. To date, many of the short-term strategies have been undertaken, and numerous park-and ride lot improvements, particularly signage improvements, have been made throughout the region.

Nashville Urban Core Light Rail Analysis – Commissioned by MTA in 1999 to explore the feasibility of a phased development of light rail transit (LRT) from downtown Nashville to the

West End corridor. The study identified a 4.2 mile system connecting the east bank of the Cumberland River (which is the location of the Tennessee Titans Stadium) via the current downtown transit center (Petway), the Clement Landport (which is the stated location for a future downtown commuter rail station) and eventually down the West End corridor. In addition to pedestrian and bicycle traffic as the primary access to the LRT, the study calls for feeder bus and park-and-ride facilities to support the system. The study documents the importance of the concentration of activities and employment in the downtown to West End corridor and the ability to interconnect potential commuter rail (via the Landport), providing seamless travel from suburban communities, such as those in the Southeast Corridor, to and through the downtown and West End area. To date, no study recommendations have been advanced.

Beating Gridlock Study – Commissioned by the Nashville Area Chamber of Commerce in 1999 as part of a nine-month effort of the Transportation Division of the Chamber. The study in large part relied on the findings of the various plans mentioned in this section articulating the impact of congestion on the region's infrastructure and the lack of rail transit in the region. The study offers support for rail transit in Middle Tennessee and describes the challenge to the region and the role of the Chamber of Commerce in advancing rail transportation in Davidson and surrounding counties.

Nashville Downtown Transportation Plan – This plan was commissioned by Nashville-Davidson County Metropolitan Government in 2000 and outlines policy options and directions in the downtown relative to transportation, land use, and development. The primary focus of the plan is the creation of a regional multimodal transportation system focused on downtown Nashville. Key points of the plan draw on expanding the base bus system for the region along with the trolley system in the downtown, aggressive steps toward greater transportation demand management (TDM) in the downtown, and support for commuter rail, HOV lanes, and intelligent transportation systems (ITS) in the region to improve mobility to and from the downtown area. Several of the plan's recommendations have been implemented in some form or are under various stages of development.

Regional Transit Development Study – This study was commissioned by the MPO in 2003 to identify areas of the region – today and in the future – where transit services would be a reasonable part of the mobility system. Within the southeast corridor study area, recommendations in the short-term included local transit service in the City of Murfreesboro and further expansion of the existing express transit service from Nashville to Murfreesboro as well as to the cities of LaVergne and Smyrna. The study notes that development of the express service is a logical progression to the long term solution of some sort of fixed-guideway transit. Additionally, in the long term, local circulator systems are recommended for the City of LaVergne and the Town of Smyrna.

Five Year Service Improvement Plan – Completed by MTA in March 2004 to provide a detailed outline of how MTA plans to move from its current form of transportation for those without other transportation options, to a network that attracts riders that normally would not have seen transit as a viable option for their travel needs. This plan outlines recommendations for service improvements over the next five years, commencing August of 2004. There are recommendations made for every route that currently operates as well as suggested new routes. Five routes in the southeast corridor study area are slated for increased transit service operations as a result of planned improvements. These routes include Route 11 - Southeast Connector, Route 12 – Nolensville, Route 15 – Murfreesboro, Route 18 - Elm Hill Pike/ Airport, and Route 25 - Midtown.

City of Murfreesboro Transit Feasibility Study – This study was commissioned by the City of Murfreesboro and TDOT in 2001 to evaluate the feasibility of providing local transit service within the city. The study found that the City of Murfreesboro has sufficient population and other characteristics that warrant the development of public transit service with the potential of an annual ridership of 331,000 fixed route trips and 12,000 demand response trips. The city began operating transit service in 2006.

Town of Smyrna Intermodal Transportation Center Study – This study was commissioned by the Town of Smyrna in 2002 to advance the development of an intermodal transportation station that would offer the greatest options for long term transit needs for the area. Key components of the assessment included identifying a facility and site capable of serving park-and-ride lot needs, potential express bus and commuter rail service, and other intermodal functions such as local bus service, and bicycle and pedestrian travel. Seven locations were evaluated with the preferred location being a site located on the northwest portion of Sam Ridley Parkway bordering on the CSX railroad. The study concluded with a master plan for the development of the transit center.

Nashville Area Long Range Transportation Plans – The Nashville Area MPO completes a Long Range Transportation Plan every three years and adopted the 2030 Long Range Transportation Plan in November of 2005. These plans provide a comprehensive assessment of the region's transportation infrastructure and needed improvements to remain competitive in a regional and global market.

Since 1999, the long range plan has identified the southeast corridor as the most congested corridor in the region. One reason for the significant increase in congestion levels is the limited number of north-south roadways serving the communities of LaVergne, Smyrna, Murfreesboro, and Rutherford County and the tremendous amount of development projected within the corridor area. Even with planned roadway improvements in the southeast corridor area over the next twenty years, levels of service on the two major north-south roadways, I-24 and Murfreesboro Road (US-41/70S), are at best likely to achieve a level of service “E”.

The plan states that the region must develop a multimodal transportation system to maintain a relative level of mobility and accessibility in the region. The plan calls for the completion of the HOV lanes along I-24 from US-231 in Murfreesboro to downtown Nashville and the development of a high capacity transit system serving the same geography.

Major Thoroughfare Plans for the Cities of LaVergne, Smyrna, Murfreesboro, and Rutherford County – These plans were commissioned in 2003 by each of the respective jurisdictions in cooperation with the Nashville Area MPO. These plans identify existing and future needs along major roadways throughout their communities. Each plan serves as a comprehensive assessment of transportation needs in the respective community and documents local and regional transportation demands within their geography.

Numerous roadways in these communities are currently classified as congested and are projected to worsen in the future. Important north-south roadways such as I-24 and Murfreesboro Road (US-41/70S) are among some of the most traveled facilities in these communities. Additionally, there are several east-west corridors that are gateways to these communities from I-24 such as Waldron Road, Sam Ridley Parkway, Nissan Drive, SR-96, and US-231 all of which function at levels of service “D” or worse. Each of the studies indicate significant existing and projected future traffic growth along these roadways and indicate that little, if any, congestion relief will be achieved through roadway widening.

3.5 Community Structure

Middle Tennessee and the Nashville Area (which includes Davidson and Rutherford Counties) have experienced significant population and employment growth in the past two decades and forecasts project similar robust growth in the coming decades. The southeast portion of the region from the downtown core of Nashville toward the Cities of LaVergne, Smyrna, and Murfreesboro is the fastest growing area of the region. The southeast corridor has experienced population and employment growth rates that have exceeded those of the region as a whole. This fast rate of growth has brought with it needs for transportation improvements to address traffic congestion, to offer additional transportation options, and to address environmental concerns.

This section discusses population, employment, and land use characteristics of the region and the study area.

3.5.1 Demographics

The Nashville MPO service area, including Nashville-Davidson, Rutherford, Sumner, Williamson and Wilson counties, has a population of over 1.1 million. Population in the region increased 25% between 1990 and 2000, and projects to increase 47% between 2000 and 2025. The region is experiencing a pattern of internal migration, in which new residents are moving to Nashville-Davidson County from other regions, while established Nashville-Davidson County residents are migrating to surrounding counties. Population in the portions of Nashville-Davidson and Rutherford Counties that lie in the project study area with projections to increase by nearly one-third, from 331,000 to 438,000, between 2000 and 2025. The corridor is significantly more densely populated than the rest of the region or the State of Tennessee.

Median household income in Nashville-Davidson County ($39,800 in 2000) is slightly higher than the median for the state ($36,400), while the median for Rutherford County ($46,300) is considerably higher than that of the state or Nashville-Davidson County. The corridor contains pockets of very high income population as well as some high concentrations of poverty, particularly near downtown Nashville and eastern Murfreesboro. The corridor study area contains a higher percentage of minorities, children and young adults than the State of Tennesee or the region as a whole.

3.5.2 Employment and Economic Outcomes

The southeast corridor is, in many ways, the economic engine of the region. Large employers located in the corridor outside downtown Nashville and the Vanderbilt-West End area include Nissan, Dell, Ingram, Bridgestone/Firestone, and Whirlpool, among dozens of others employing significant numbers. Large institutions such as Middle Tennessee State University, Nashville International Airport, the Veterans Administration and other regional medical facilities also employ thousands of residents from throughout the region. Employment has steadily grown and diversified over the past twenty years, with the greatest growth in Rutherford County, and this growth is expected to continue at a rate as great or greater than the rate of population growth in the corridor.

3.5.3 Land Development Patterns and Plans

Land use in the corridor is characterized by older, higher density areas, particularly near the central areas of Nashville and Murfreesboro, and newer, lower density areas in the central and southern areas of the corridor. Much of the new development in the past 30 years has been auto-oriented residential, commercial and industrial developments. A number of higher density

mixed use developments are in various stages of planning or construction. These developments will promote a more balanced transportation system and the use of walking, bicycling and transit as alternatives to driving. However, such developments must become more prominent in the mix of future land use if a more balanced transportation system is to support the future growth of the corridor.

Population and employment growth in the region and in the corridor will place increased pressure on the transportation facilities in the region. The large population and relatively high density in the corridor, and the concentration of younger and lower income residents indicate a future need for improvements to the transit system. It also indicates an approach to addressing the region's transportation needs to include provisions for walking, bicycling, and transit, as well as improvements to the roadway system.

3.5.4 Major Activity Centers

The study area has a large and diverse array of major activity centers almost all of which continually struggle to remain accessible for patrons and employees due to traffic congestion, auto-dependency and limited transportation options. A significant element of this accessibility concerns the ability to satisfy parking needs associated with an overwhelming dependence on automobile access. Satisfying parking demands competes with facility expansion desires and/or leads to development of costly parking structures. Traffic generation and localized congestion tends to be a major source of conflict with neighboring residents and businesses. Improved transit could help address access and parking problems of these major traffic generators and could provide an alternative choice of travel for patrons and staff.

The major activity centers within the study area include:

- Malls - Hickory Hollow Mall and Stones River Mall
- Colleges and Universities - Tennessee State University (downtown campus), Vanderbilt University, Belmont University, Trevecca Nazarene University, Middle Tennessee State University
- Medical Centers – Vanderbilt Hospital, Baptist Hospital, Centennial Hospital, Stonecrest, Alvin C York VA Medical Center, Middle Tennessee Medical Center
- Entertainment Centers - Nashville Convention Center, Gaylord Entertainment Center, Tennessee Titans Stadium, Ryman Auditorium, Country Music Hall of Fame, Schermerhorn Symphony Hall, Starwoood Amphitheater
- Other Activities - Downtown Nashville, Music Row, Nashville International Airport, and Smyrna Airport

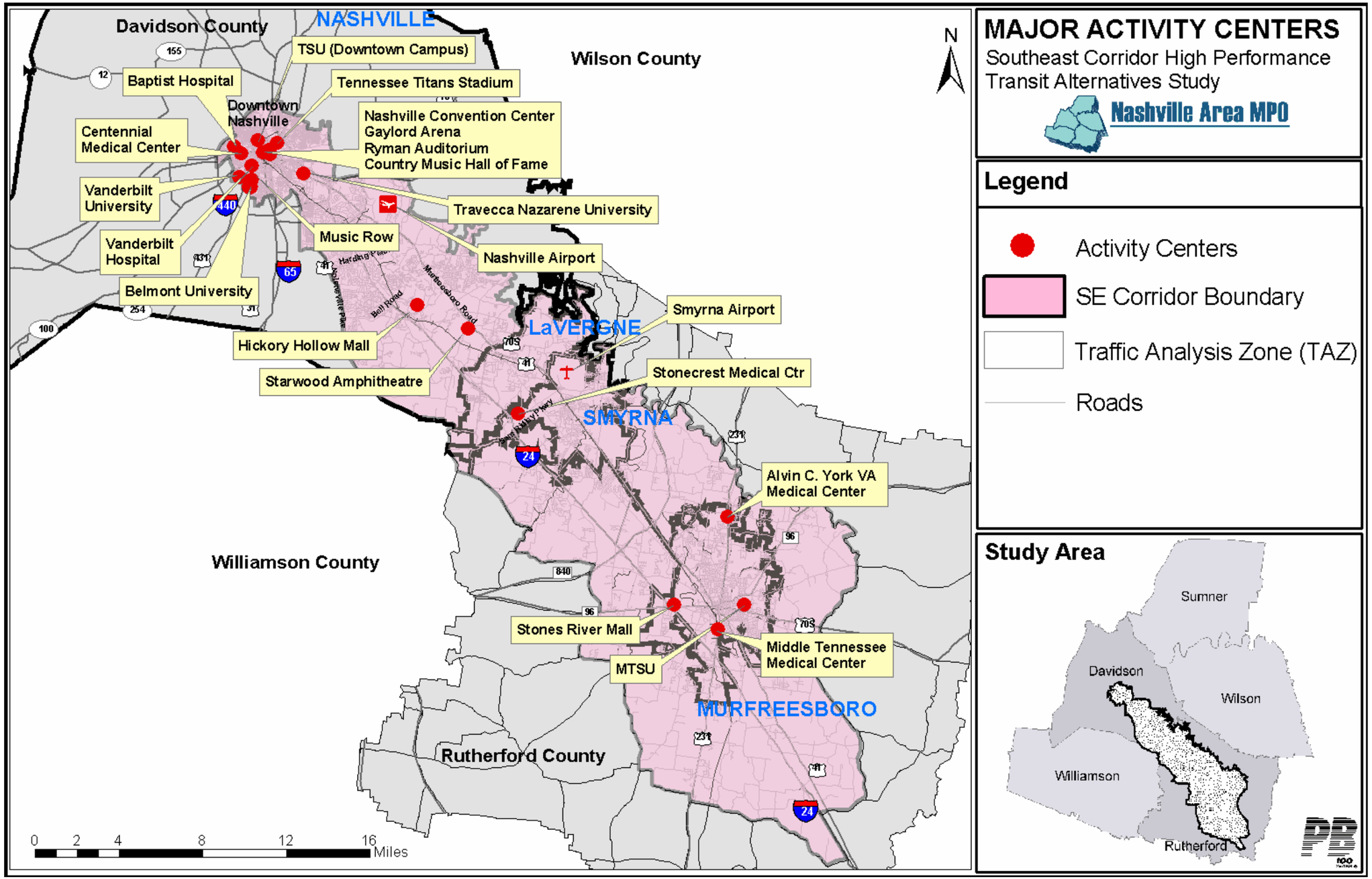
Table 3-1 shows the number of employees and additional information about each of the activity Centers. Figure 3-2 illustrates the location of these major activity centers within the study area.

Table 3-1 Number of Jobs and Other Trip Generating Factors for Activity Centers in the Southeast Corridor Study Area

Activity Center	No. Jobs (2002)	Beds	Seating Capacity	Students	Sq. Feet	Acres
Baptist Hospital	3,100	685				38
Centennial Medical Center	4,500	615				40
Vanderbilt University / Football Stadium	6,400		41,000	11,000		323
Vanderbilt Hospital	7,200	874				
Belmont University	820			4,300		
TSU (Downtown Campus)	200					
Tennessee Titans Stadium	276		68,798			105
Nashville Convention Center	850				118,675	
Gaylord Entertainment Center			20,000		43,000	
Ryman Auditorium			1,300			
County Music Hall of Fame						
Trevecca Nazarene University	330			2,000		
Nashville Airport	3,100					
Music Row	It is an area with many locations not one location.					
Hickory Hollow Mall	3,600					
Starwood Amphitheatre	200		17,000			
Smyrna Airport	200					
Stonecrest Medical Center	400	75			13,526	
Alvin C York VA Medical Center	1,260	491				
Stones River Mall	1,367					
MTSU / Football Stadium	1,670		15,000	23,000		466
Middle Tennessee Medical Center	1,200	286				
Total	36,673	3,026	163,098	40,300		

Source: Nashville MPO Travel Demand Model

Figure 3-2 Major Activity Centers



3.5.5 Natural Environment

The natural environment of Middle Tennessee is beginning to experience the effects of decades of automobile dominated development patterns and single mode transportation decisions. Land use and development patterns have created communities and neighborhoods that are isolated and dependent upon the automobile for nearly all basic trips (e.g. to work, shop, and for pleasure). In addition, auto dependency in the corridor has generated various types of region-wide, corridor-wide and localized pollution. Tremendous growth in vehicle miles traveled, population growth, and other non-transportation related factors have put the region and its residents at risk. Controlling air pollution in the region is a driving factor in Middle Tennessee's economic prosperity and over all quality of life. The region will begin to see reduced economic growth, increased potential health risks, and less federal funding for roadway projects that improve access to employment centers in the region without a viable solution to automobile dependence. The southeast corridor stands to see the greatest impact from this auto dominated development effect given the projected employment growth of the corridor and the amount of available land for future residential and commercial development.

On April 15, 2004, the Nashville region, which includes the counties of Davidson and Rutherford, was designated non-attainment for 8-hour ozone standards violations. In addition to air quality, within the study area there are several large land areas of key importance to the natural environment. These areas include:

- Cumberland River
- Percy Priest Lake
- Stones River
- Stones River National Battlefield

Development pressures have begun to jeopardize these natural features within the study area. Land availability and the demand from developers for roadway access has created an environment whereby quality of life features such as these are becoming adversely impacted. Any transportation solution must balance travel demands while protecting the natural environment.

3.6 Transportation Infrastructure and Function

This section describes the existing transportation facilities, which includes highways, public transit, freight railroads, and other transportation services. The demographic changes and growth in the corridor have outpaced the capacity and function of the transportation system. Further expected growth will overtax the existing infrastructure and transportation systems, creating demand for new approaches and new types of infrastructure in the future.

3.6.1 Regional Travel Patterns

For the past 50 years, Middle Tennessee, like most portions of the state and nation, has devoted most of its transportation dollars to roads, bridges, and interstate highways. Today, Nashville is one of only six cities in the United States located at the intersection of three interstate highways: I-40, I-24, and I-65.

Over this same time period, the web of interstate highways has helped to fuel the rapid growth of the region's economy. While the region is well served by a complex system of roads ranging from interstates and other freeways to city streets and rural local roads, travel on these roadways has been steadily increasing as the region has grown, causing congestion levels to rise.

The interstate system, which comprises I-24, I-40, and I-65, completely encircles downtown Nashville. There are eight (8) interstate access points into and out of the downtown area from the interstate system. There are three interchange access points to the west of the downtown area via I-40/I-65. These interchanges also provide access to the West End, Church Street, and Charlotte Avenue corridors, which serve the Vanderbilt and medical center area. There is one interchange access point to the south of the downtown area via I-40 providing access into the downtown area from 2nd Avenue and access out of the downtown area from 4th Avenue. Each of these roadways is a one-way facility and the two roads function as a one-way pair. There are three interstate interchanges east of the downtown area providing access points into and out of the downtown to the east. These interchanges also serve the Tennessee Titan Football Stadium (known as The Coliseum) which seats 68,000 people, and one interchange north of the downtown area (8th Avenue North), which provides access to the downtown area and Metro Center office and industrial park.

From southeast of downtown Nashville toward the City of Murfreesboro, along I-24, there are 10 interchanges located in Davidson County providing access to numerous residential, industrial, commercial, and retail concentrations throughout the study area. From the Davidson County line into Rutherford County along I-24 to Epps Mill Road, which is south of US-231 in the City of Murfreesboro, there are seven interchanges providing access to the communities of LaVergne, Smyrna, and Murfreesboro. Several of the interchanges along this section of the study area have high levels of commercial and industrial activity while others are largely undeveloped. These undeveloped portions are slated for future industrial and/or residential development.

Several of the roadways with interchanges on I-24 experience extremely high volumes of traffic which contribute considerably to backups along I-24 and corresponding roadways during peak hours. The most heavily traveled connecting roadways on I-24 in Davidson County are I-40, I-440, and Bell Road (SR-254) with 120,000, 100,000, and 41,000 vehicles respectively interchanging to and from I-24. Within Rutherford County, Sam Ridley Parkway, SR-840, SR-96, and US-231 are the most heavily traveled connecting roadways to I-24, with traffic volumes of 31,000, 35,000, 41,000 and 49,000 respectively. The volumes of these interchanging roadways to and from I-24 contribute to the increased delays and congestion levels experienced along I-24 between downtown Nashville and the City of Murfreesboro.

Table 3-2 Traffic Volumes at I-24 Interchanges, 2004

Interchanges (North to South)	Traffic Volume (2004)
I-65 north of Cumberland River	136,513
I-65 south of 2nd/4th Avenue	114,963
Fesslers Lane	27,366
I-40	120,133
I-440	99,681
Briley Parkway	32,133
Harding Place (SR-255)	37,431
Haywood Lane	25,689
Bell Road (SR-254)	40,722
SR-171	14,650
Waldron Road	19,303
Sam Ridley Parkway	30,655
SR-102	15,622
SR-840	35,143
SR-96	40,806
US-231	49,287

Source: TDOT 2004 ADT Counts

High Occupancy Vehicle (HOV) lanes are currently designated on I-24 North and South between the Harding Road Interchange, several miles south of Downtown Nashville, and SR-840 north of Murfreesboro. These lanes are restricted during high traffic hours inbound (7-9 AM) and outbound (4-6 PM) and are reserved for the exclusive use of vehicles with two or more people, buses, motorcycles, and emergency vehicles. Penalties for single-occupant vehicle drivers abusing the HOV lanes are not severe (the penalty is statutorily limited to $25) and violations are considered non-moving offenses, like parking violations. Evidence indicates that the HOV lanes are not rigorously enforced.

Data provided by TDOT confirm the lack of enforcement for HOV lanes. While legitimate use of the HOV lanes on I-24 has increased by more than 50% over the past five years, the number of violators has nearly doubled, making it likely that the number of violators—in addition to the lack of through HOV service to downtown Nashville—has suppressed the number of potential legitimate users of the HOV facility.

Congestion on I-24 at the point where the HOV lane ends, south of the Harding Road interchange, is among the most severe of any location in the corridor. Morning peak period congestion at this location is much worse than the general congestion in the area between Bell Road and Briley Parkway where I-24 operates at LOS “D”. The reason for this intense congestion is the introduction of vehicles from the HOV lanes—both those using the HOV lanes legally and illegally—into the reduced number of available travel lanes between Harding Road and the merge with I-40. The congestion generated by the merging of the HOV into the general purpose lanes combined with the HOV lane stopping short of the downtown destinations of most commuters, wipes out much of the travel time savings from which HOVs benefit and greatly reduces the utility of the HOV lanes for transit or carpool use.

Table 3-3 Daily Average HOV Usage on I-24 between Old Hickory Blvd. and Waldron Road, 1999-2005

	1999 AM	1999 PM	2002 AM	2002 PM	2005 AM	2005 PM
Legal HOV Users	475	601	403	535	680	653
HOV Violators	485	575	927	1,059	1,265	914
Total Users	960	1,176	1,330	1,594	1,945	1,567

In addition to the interstate system, there are ten major arterial roadways that serve downtown Nashville. Of these arterial roadways, only one, Murfreesboro Road (US-41/70S), serves the complete southeast corridor area. Congestion occurs regularly on this corridor as well as on I-24 as traffic approaches and exceeds the roadway's operating capacity, and it occurs sporadically on other roads in response to temporary lane blockages. Historically, congestion in the region has been associated with radial commuting patterns leading in and out of the Davidson County and the central business district from surrounding suburban counties.

Along Murfreesboro Road there are numerous crossing streets both signalized and unsignalized. Additionally, there are several grade-separated roadways due to the high volume of traffic along certain cross streets. Focusing on the higher volume crossing streets, there are fourteen signalized intersections with crossing traffic of greater then ten thousand vehicles. At these locations, through traffic along Murfreesboro Road suffers delay due to competing time for green time. The most heavily traveled crossing streets along the corridor in Davidson County are Fesslers Lane, Donelson Pike, and Old Hickory Boulevard, with 27,000, 37,000, and 33,000 vehicles respectively crossing Murfreesboro Road. Within Rutherford County, Thompson Lane, SR-96, and US-231 are the most heavily traveled crossing streets with traffic volumes of 12,000, 42,000, and 26,000 respectively crossing Murfreesboro Road. The volumes of the crossing streets throughout the corridor and at these locations contribute to the increased delays and congestion levels experienced along Murfreesboro Road between downtown Nashville and the City of Murfreesboro.

Table 3-4 Traffic Volumes on Roads Crossing Murfreesboro Road, 2004

Crossing Street (North to South)	Traffic Volume (2004)
Fesslers Lane	27,366
Fosters Avenue	10,562
Thompson Place	12,625
Donelson Pike (SR-255)	37,200
Old Hickory Boulevard (SR-254)	32,800
SR171	15,090
Waldron Road	13,730
Stones River Road	12,210
Enon Springs Road	13,640
Thompson Lane	19,190
North Field Road	17,790
SR-96	42,220
US-231	25,870
Tennessee Boulevard	20,841

Source: TDOT 2004 ADT Counts

Figure 3-3 illustrates commuting patterns between Rutherford and Davidson Counties and other counties within the region. Based on recent U.S. Census data, roughly 27 percent (or 25,000) of the commuters in Rutherford County traveled to Davidson County for work in 2000. In comparison, only 24 percent (or 14,271) of Rutherford County commuters traveled to Davidson County in 1990. While the increase in the proportion of commuters traveling from Rutherford County to Davidson increased by only 3 percent between 1990 and 2000, the actual number of commuters increased by roughly 77 percent due to the 54% increase in population that occurred in Rutherford County during the same period.

Travel data from the MPO's regional model indicate that an estimated 108,000 home based work (HBW) trips come into downtown Nashville and the West End/Church Street area during the weekday from residents of Davidson and Rutherford Counties. In 2025, forecasts indicate the number of HBW trips to these areas to increase to more than 134,000 trips daily. Rutherford County commuters account for nearly 6 percent of these trips today and are projected to account for nearly 12 percent in 2025. This is because the rate of growth in Rutherford County is projected to exceed that of other suburban counties and Nashville-Davidson County.

Other major destinations in the study area include the corridors of Briley Parkway, Harding Road, Bell Road, Interchange City, Sam Ridley, and the City of Murfreesboro, which add to congestion on I-24 and Murfreesboro Road. Figure 3-4 illustrates 2002 and 2025 travel and commuting trends of Davidson and Rutherford County residents to major destinations along the corridor.

Looking more closely at all HBW trips originating from within the study area (with a destination within the study area – not just downtown), significant commuting and travel trends exist between several of the major destinations within the study area corridor. Over 110,000 home-based work trips originate during the weekday within the study area corridor, and over 56,000 (or 51 percent) of those trips are destined for one of nine major destinations within the study area, as depicted in Figure 3-2.

These 56,000 home based work trips are longer distance trips, which traverse one of the two major north-south roadways (I-24 or Murfreesboro Road) within the study area corridor. The remaining 54,000 trips are shorter distance trips, and tend to remain within the area of origination.

The zone areas designated as the City of Murfreesboro and the Bell Road area have the largest concentration of shorter distance trips. The high level of mixed-use development (employment and residential activity) within those zones compared to the other zone areas along the corridor relates to the relatively high number of shorter distance trips (intrazonal trips) within these areas.

Figure 3-3
Commuting Patterns in the Region

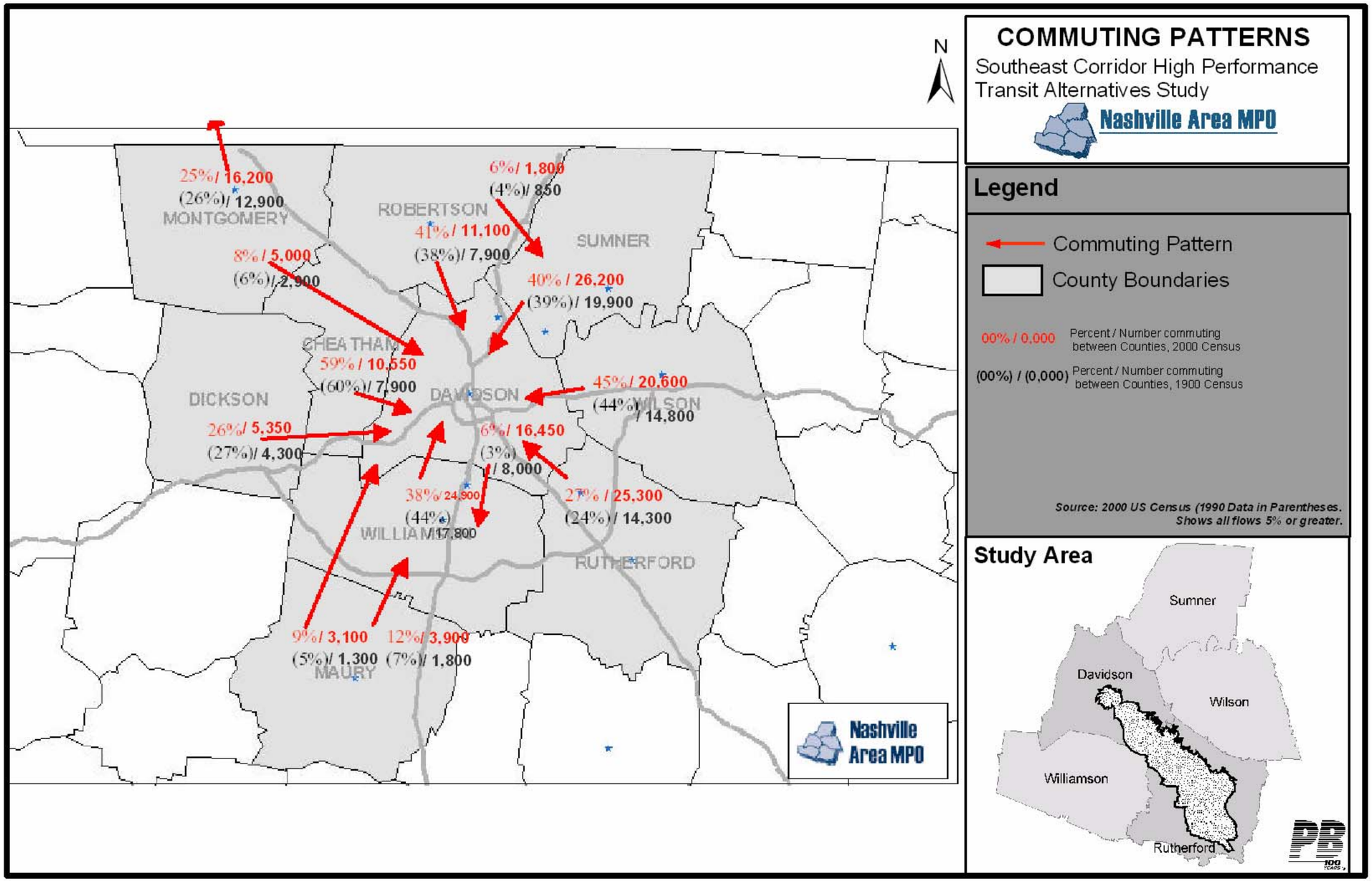
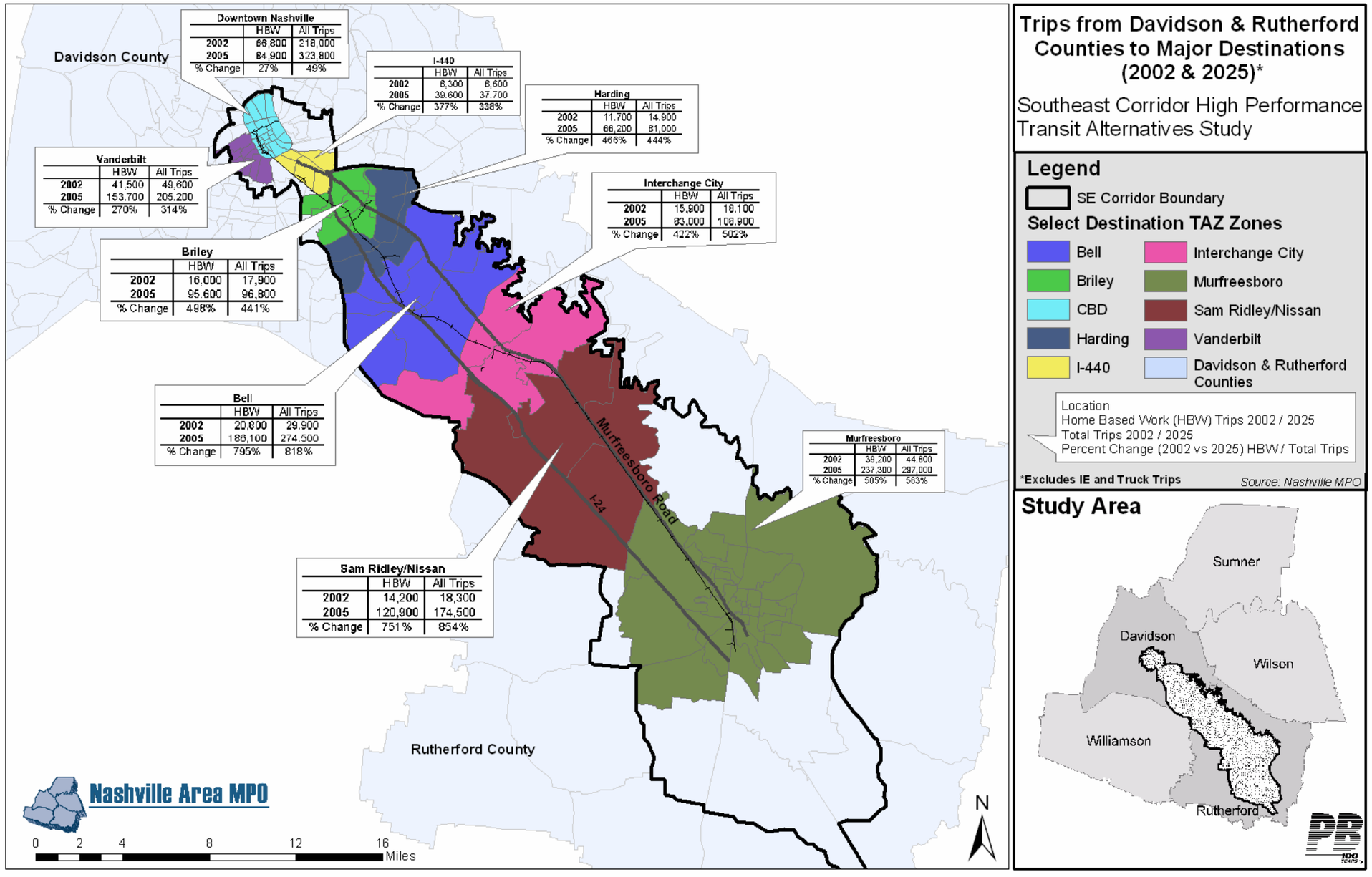


Figure 3-4
Trips from Davidson and Rutherford Counties to Major Destinations within the Study Area (2002 & 2025)



Figures 3-5 through 3-12 and Tables 3-5 through 3-9 depict 2002 and 2025 travel trends for both home based work trips and all trip purposes within the corridor - illustrating both the flows of trips from various concentrations within the study area (such as residential housing) to specific activities destinations within the corridor (such as employment and shopping). The initial graphs in each group compare the interzonal (between zones) and intrazonal (within zones) trips for each type trip destination. The second set shows a breakdown of interzonal trips in each destination zone. Comparing the two sets of graphs allows us to compare all types of trips with home-based work trips (trips between home and work).

Figure 3-5
SE Corridor Interzonal and Intrazonal Trips, All Trip Purposes, 2002

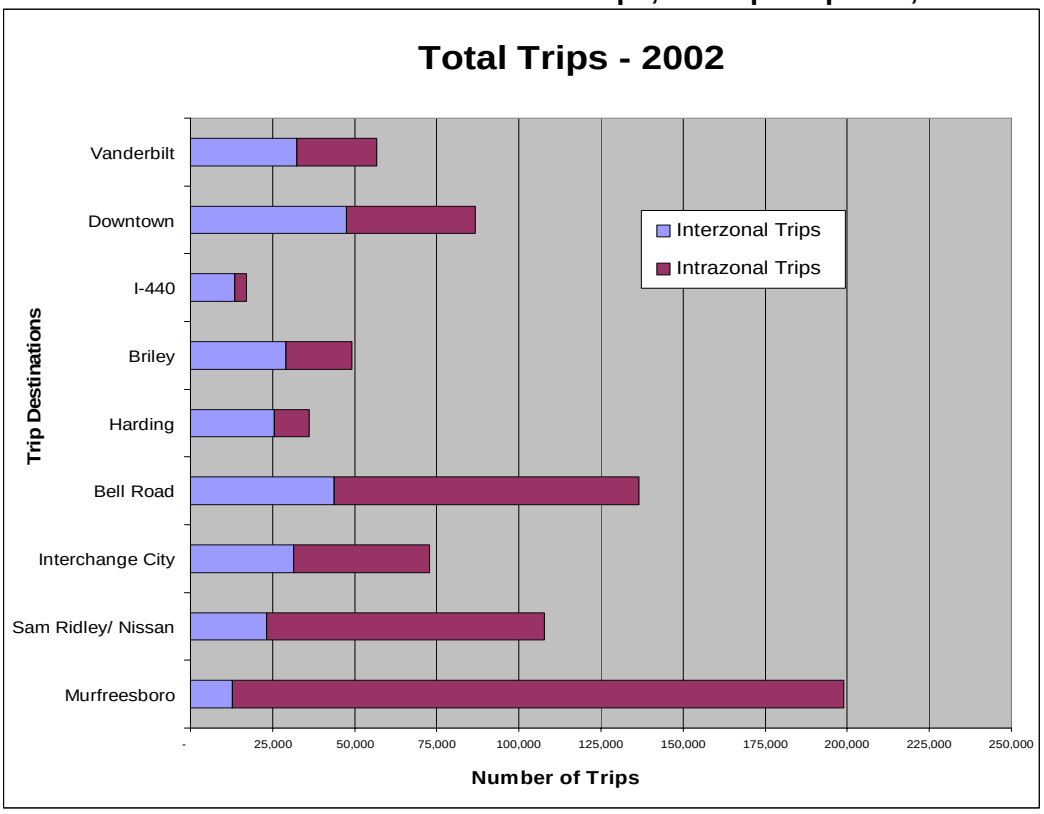
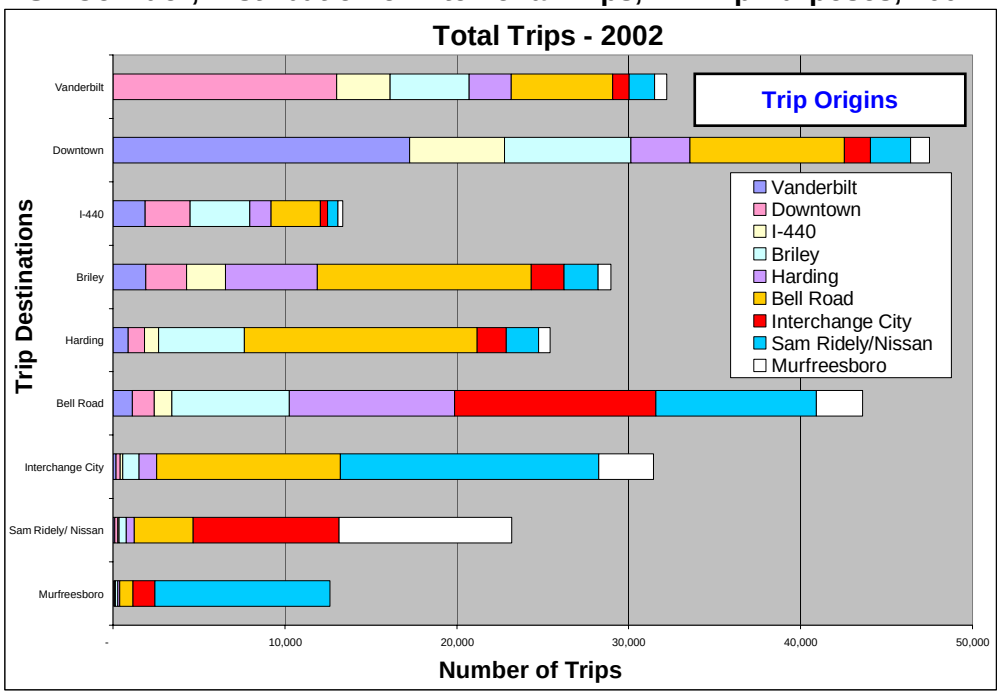


Table 3-5
SE Corridor Distribution of Interzonal Trips, All Trip Purposes, 2002

2002	TO	Vander-bilt	Down-town	I-440	Briley	Harding	Bell Road	Inter-change City	Sam Ridley/ Nissan	Murfrees-boro	Total 2002 Trips
FROM	Vanderbilt	24,300	17,300	1,900	1,900	900	1,200	200	100	50	47,850
	Downtown	13,000	39,100	2,600	2,400	1,000	1,300	200	150	100	59,850
	I-440	3,100	5,500	3,600	2,300	800	1,000	150	100	50	16,600
	Briley	4,600	7,400	3,500	20,000	5,000	6,800	950	400	150	48,800
	Harding	2,500	3,400	1,300	5,300	10,700	9,600	1,000	500	150	34,450
	Bell Road	5,900	9,000	2,800	12,500	13,600	93,000	10,700	3,400	800	151,700
	Interchange City	1,000	1,500	500	1,900	1,700	11,700	41,400	8,500	1,250	69,450
	Sam Ridley/Nissan	1,500	2,400	600	2,000	1,900	9,300	15,000	84,600	10,200	127,500
	Murfreesboro	700	1,100	250	750	650	2,700	3,200	10,100	186,200	205,650
	Destine Trips	**32,300**	**47,600**	**13,450**	**29,050**	**25,550**	**43,600**	**31,400**	**23,250**	**12,750**	**258,950**
	Intrazonal Trips	**24,300**	**39,100**	**3,600**	**20,000**	**10,700**	**93,000**	**41,400**	**84,600**	**186,200**	**502,900**
	Total Trips	**56,600**	**86,700**	**17,050**	**49,050**	**36,250**	**136,600**	**72,800**	**107,850**	**198,950**	**761,850**

Intrazonal Trips are shorter distance trips within a given zone

Figure 3-6
SE Corridor, Distribution of Interzonal Trips, All Trip Purposes, 2002



Note: Intrazonal trips, which tend to be shorter distance trips, are not included in the above figure

Table 3-6
SE Corridor All Trip Purposes – 2002

2002	TO	Vander-bilt	Down-town	I-440	Briley	Harding	Bell Road	Inter-change City	Sam Ridley/ Nissan	Murfrees-boro	Total 2002 Trips
FROM	Vanderbilt	24,243	17,249	1,861	1,927	882	1,149	190	121	49	47,671
	Downtown	13,000	39,095	2,614	2,342	970	1,273	224	153	65	59,736
	I-440	3,118	5,512	3,597	2,272	812	1,015	150	88	29	16,593
	Briley	4,594	7,376	3,469	19,946	4,960	6,819	945	411	125	48,645
	Harding	2,444	3,409	1,259	5,328	10,715	9,601	1,040	480	131	34,407
	Bell Road	5,915	9,005	2,842	12,460	13,551	93,260	10,684	3,397	782	151,896
	Interchange City	960	1,492	438	1,906	1,715	11,727	41,362	8,504	1,249	69,353
	Sam Ridley/Nissan	1,489	2,356	615	1,989	1,872	9,317	15,016	84,568	10,202	127,424
	Murfreesboro	692	1,083	254	743	645	2,714	3,185	10,057	186,177	205,550
	Destine Trips	**32,212**	**47,482**	**13,352**	**28,967**	**25,407**	**43,615**	**31,434**	**23,211**	**12,632**	**258,312**
	Intrazonal Trips	**24,243**	**39,095**	**3,597**	**19,946**	**10,715**	**93,260**	**41,362**	**84,568**	**186,177**	**502,963**
	Total Trips	**56,455**	**86,577**	**16,949**	**48,913**	**36,122**	**136,875**	**72,796**	**107,779**	**198,809**	**761,275**

Intrazonal Trips are shorter distance trips within a given zone

Figure 3-7
SE Corridor Interzonal and Intrazonal Trips, All Trip Purposes, 2025

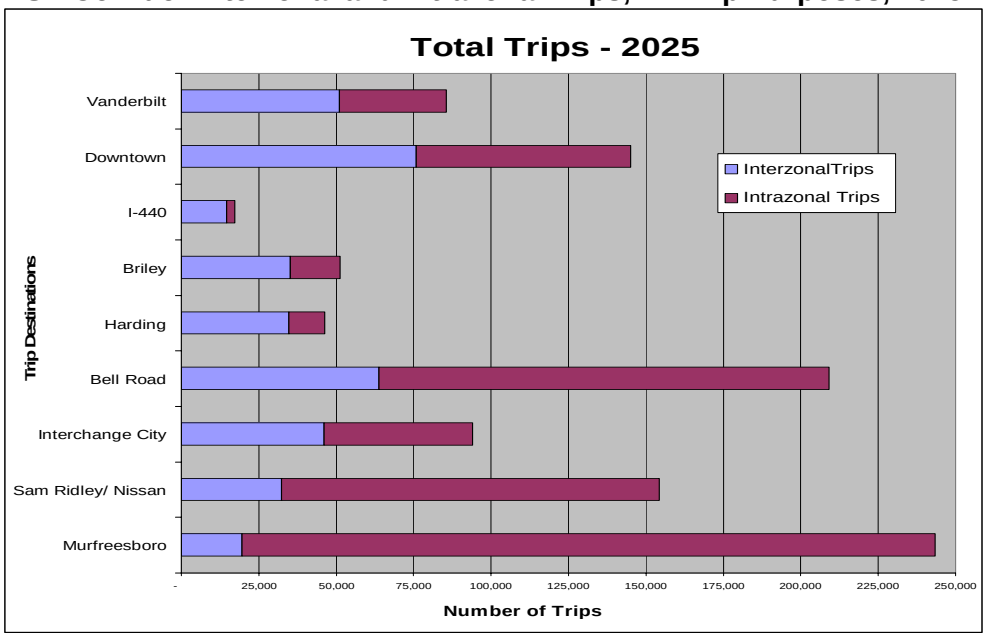
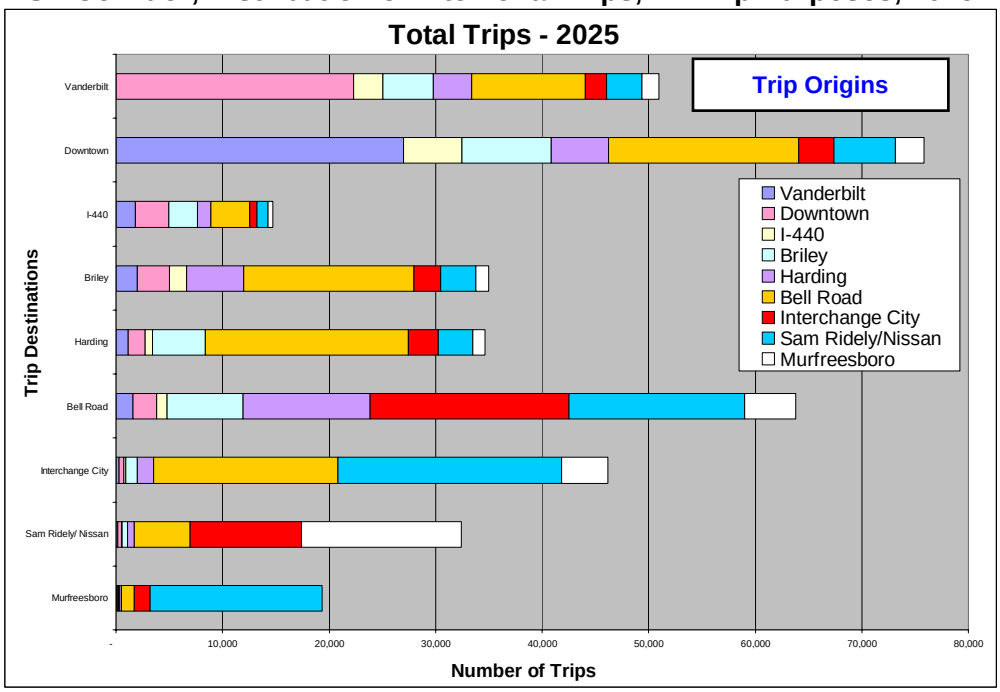


Table 3-7
SE Corridor All Trip Purposes, 2025

2025	TO	Vander-bilt	Down-town	I-440	Briley	Harding	Bell Road	Inter-change City	Sam Ridley/ Nissan	Murfrees-boro	Total 2025 Trips
FROM	Vanderbilt	34,400	27,000	1,800	2,000	1,200	1,600	300	200	100	68,600
	Downtown	22,300	69,200	3,150	3,000	1,550	2,200	450	300	100	102,250
	I-440	2,750	5,500	2,600	1,650	700	1,000	200	100	50	14,550
	Briley	4,800	8,450	2,700	16,250	4,950	7,200	1,100	500	150	46,100
	Harding	3,600	5,300	1,250	5,350	11,700	11,900	1,500	650	200	41,450
	Bell Road	10,700	17,850	3,700	16,000	19,100	145,300	17,300	5,250	1,200	236,400
	Interchange City	2,000	3,350	700	2,550	2,800	18,700	47,900	10,450	1,500	89,950
	Sam Ridley/Nissan	3,400	5,700	1,000	3,300	3,250	16,500	21,000	121,900	16,200	192,250
	Murfreesboro	1,600	2,700	450	1,250	1,150	4,800	4,300	15,000	224,000	255,250
	Destine Trips	**51,150**	**75,850**	**14,750**	**35,100**	**34,700**	**63,900**	**46,150**	**32,450**	**19,500**	**373,550**
	Intrazonal Trips	**34,400**	**69,200**	**2,600**	**16,250**	**11,700**	**145,300**	**47,900**	**121,900**	**224,000**	**673,250**
	Total Trips	**85,550**	**145,050**	**17,350**	**51,350**	**46,400**	**209,200**	**94,050**	**154,350**	**243,500**	**1,046,800**

Intrazonal Trips are shorter distance trips within a given zone

Figure 3-8
SE Corridor, Distribution of Interzonal Trips, All Trip Purposes, 2025



Note: Intrazonal trips, which tend to be shorter distance trips, are not included in the above figure

Figure 3-9
SE Corridor Interzonal and Intrazonal Home Based Work Trips – 2002

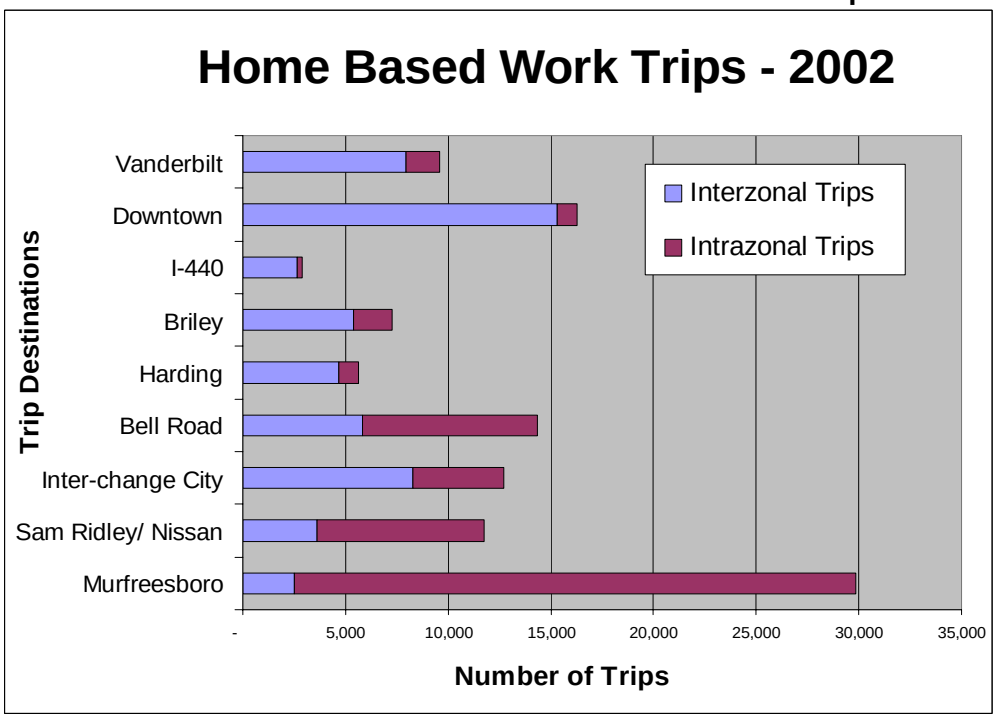
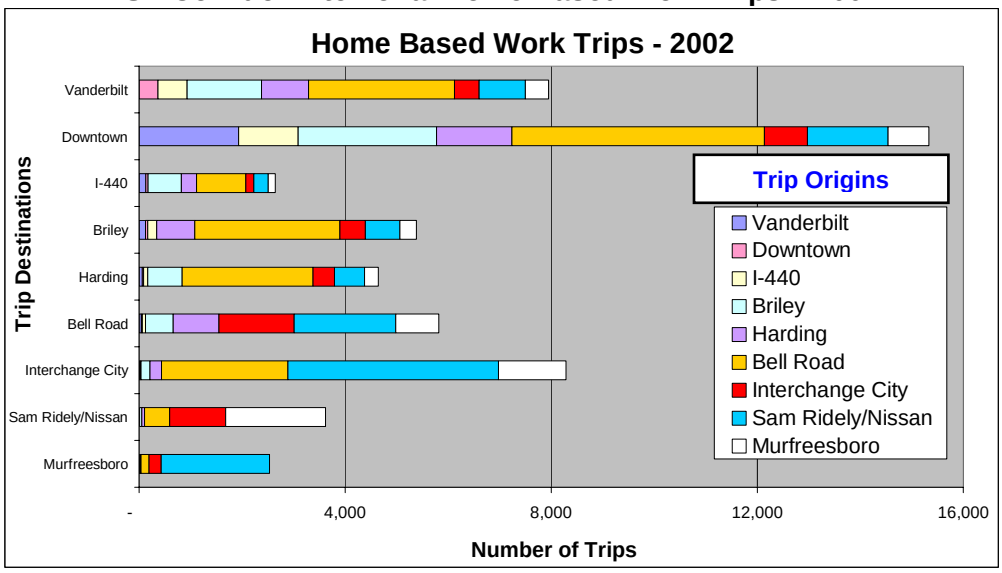


Figure 3-10
SE Corridor Interzonal Home Based Work Trips – 2002



Note: Intrazonal trips, which tend to be shorter distance trips, are not included in the above figure

Table 3-8
SE Corridor Home Based Work Trips – 2002

2002	TO	Vander-bilt	Down-town	I-440	Briley	Harding	Bell Road	Inter-change City	Sam Ridley/ Nissan	Murfrees-boro	Total 2002 Trips
FROM	**Vanderbilt**	1,650	1,900	150	100	100	50	20	10	-	3,980
	Downtown	400	950	50	50	20	20	10	-	-	1,500
	I-440	600	1,150	250	200	100	50	20	10	10	2,390
	Briley	1,450	2,700	650	1,900	700	550	200	40	20	8,210
	Harding	900	1,500	300	750	1,000	900	200	50	20	5,620
	Bell Road	2,800	4,900	950	2,800	2,550	8,500	2,500	500	150	25,650
	Interchange City	500	850	150	500	400	1,500	4,400	1,100	250	9,650
	Sam Ridley/Nissan	900	1,550	300	700	600	2,000	4,100	8,150	2,100	20,400
	Murfreesboro	450	800	150	300	300	800	1,300	1,900	27,300	33,300
	Destine Trips	**8,000**	**15,350**	**2,700**	**5,400**	**4,770**	**5,870**	**8,350**	**3,610**	**2,550**	**56,600**
	Intrazonal Trips	**1,650**	**950**	**250**	**1,900**	**1,000**	**8,500**	**4,400**	**8,150**	**27,300**	**54,100**
	Total Trips	**9,650**	**16,300**	**2,950**	**7,300**	**5,770**	**14,370**	**12,750**	**11,760**	**29,850**	**110,700**

Intrazonal Trips are shorter distance trips within a given zone

Figure 3-11
SE Corridor Interzonal and Intrazonal Home Based Work Trips – 2025

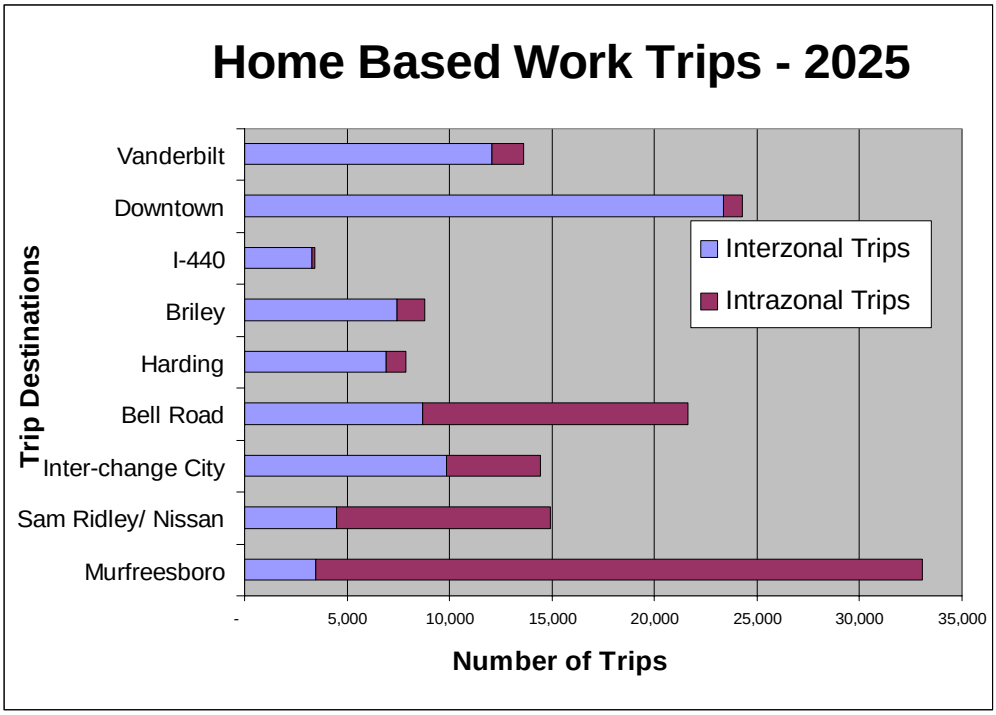
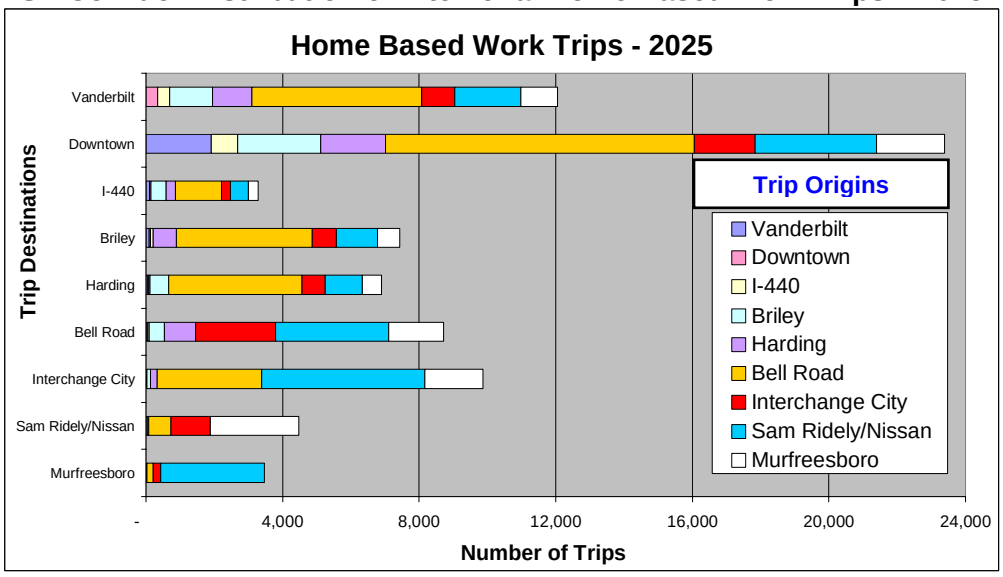


Figure 3-12
SE Corridor Distribution of Interzonal Home Based Work Trips – 2025



Note: Intrazonal trips, which tend to be shorter distance trips, are not included in the above figure

Table 3-9
SE Corridor Home Based Work Trips – 2025

2025	TO	Vander-bilt	Down-town	I-440	Briley	Harding	Bell Road	Inter-change City	Sam Ridley/ Nissan	Murfrees-boro	Total 2025 Trips
FROM	Vanderbilt	1,600	1,900	100	100	50	50	10	10	-	3,820
	Downtown	350	900	50	50	20	20	10	-	-	1,400
	I-440	350	800	150	100	50	20	10	10	-	1,490
	Briley	1,250	2,400	450	1,350	550	450	100	50	10	6,610
	Harding	1,200	1,900	300	700	1,000	900	200	50	20	6,270
	Bell Road	5,000	9,000	1,350	3,950	3,900	12,900	3,050	650	200	40,000
	Interchange City	1,000	1,800	250	700	700	2,300	4,600	1,150	200	12,700
	Sam Ridley/Nissan	1,900	3,600	500	1,200	1,100	3,300	4,800	10,500	3,000	29,900
	Murfreesboro	1,100	2,000	300	650	600	1,600	1,700	2,600	29,600	40,150
	Destine Trips	**12,150**	**23,400**	**3,300**	**7,450**	**6,970**	**8,640**	**9,880**	**4,520**	**3,430**	**79,740**
	Intrazonal Trips	**1,600**	**900**	**150**	**1,350**	**1,000**	**12,900**	**4,600**	**10,500**	**29,600**	**62,600**
	Total Trips	**13,750**	**24,300**	**3,450**	**8,800**	**7,970**	**21,540**	**14,480**	**15,020**	**33,030**	**142,340**

Intrazonal Trips are shorter distance trips within a given zone

Travel forecasts for the year 2025 indicate a 42 percent increase in home based work trips (those considered longer distance trips) along the corridor over 2002 travel conditions. Additionally, the longer distance work trips increase from 51 percent to 56 percent of the total HBW trips generated within the study area corridor. Analysis of the interzonal and intrazonal data indicates the need for transportation improvements that will provide improved service for the growing commuter market to downtown Nashville and the Vanderbilt-West End area. The number of intrazonal trips generally exceeds the number of interzonal, even in the case of the home-based work trips, which tend to be longer than average trips. The data for shorter distance trips in the Bell Road area along with Interchange City, Sam Ridley/Nissan Boulevard, and the City of Murfreesboro, rival that of the areas of downtown Nashville and the Vanderbilt area. Downtown Nashville and the growing employment center surrounding Vanderbilt, West End and Music Row will remain the primary destination for transit improvements in the corridor. However, and just as importantly, the data indicates that improvements are needed to facilitate a growing volume of shorter trips, including intrazonal trips and trips between adjacent zones, in the corridor. The conclusion is that transit improvements considered in the corridor must not only provide improved access for commuters to downtown Nashville, but must also be capable of providing viable alternatives for these shorter trips, and trips to strong secondary markets in the corridor including Murfreesboro, LaVergne, Smyrna and Interchange City. This suggests that, in addition to line haul rail or bus improvements, increased feeder bus service and local bus services outside Nashville-Davidson County will be required to meet the future transit needs in the corridor.

3.6.1.1 Level of Service

Consistent with industry standards, traffic operations have been categorized into one of six level of service (LOS) conditions. The volume to capacity ratios used for each LOS are:

A: 60% of capacity or less
B: 61 to 70% percent of capacity
C: 71 to 80% percent of capacity
D: 81 to 90% percent of capacity
E: 91 to 100% percent of capacity
F: Over 100% percent of capacity

The scale sets LOS A as a free-flow traffic condition where motorists experience virtually no obstacles to their movement. Level of service B through E represents gradually declining traffic

operation. LOS F designates a breakdown in traffic flow characterized by bumper to bumper traffic.

In the Nashville area, LOS D is the service level accepted by the MPO as the minimum desired standard. Figure 3-13 illustrates the current and future level of service of I-24 and Murfreesboro Road within the study area.

Tables 3-10 and 3-11 identify the overall travel conditions of I-24 and Murfreesboro Road including the number of lanes, existing traffic counts, and forecasted travel demand. These facilities are the only two radial routes serving the complete length of the southeast area from downtown Nashville to the City of Murfreesboro.

Table 3-10
I-24 from Downtown to Rutherford/Coffee County Line

I-24	**2003**					**2025**		
From I-40 Downtown Nashville to:	**Average Daily Traffic (ADT)**	**Level of Service (LOS)**	**Average AM Peak Speed (MPH)**	**Average PM Peak Speed (MPH)**	**Existing Number of Lanes**	**Traffic Forecasts**	**Level of Service (LOS)**	**Future Number of Lanes***
Fesslers Lane	176,000	**F**	25	31	8	217,000	**F**	8
Briley Parkway (SR 155)	121,000	**D**	17	46	8	134,000	**E**	8
Bell Road	101,000	**D**	52	60	8	140,000	**E**	8
Old Hickory Blvd (SR 171)	102,000	**D**	54	62	8	132,000	**E**	8
Sam Ridley Pkwy (SR 266)	85,000	C	63	66	8	124,000	**E**	8
Nissan Drive (SR 102)	84,000	C	67	68	8	104,000	**D**	8
SR 840	81,000	**E**	69	67	8	89,000	C	8
SR 96	64,000	**E**	65	53	4	93,000	C	8
US 231	53,000	**D**	69	68	4	89,000	C	8
Rutherford/Coffee Co. Line	39,000	C	70	69	4	63,000	**E**	4

* Based on Nashville Area MPO 2025 Long Range Transportation Plan
Bold reflects roadways with a LOS of D or worse. Pink reflects a change of one category in LOS and red reflects a change of two categories in LOS (between 2003 and 2025)
Source: Nashville Area MPO and TDOT

Table 3-11
Murfreesboro Road from Downtown Nashville to US-231 in Murfreesboro

Murfreesboro Road	2003					2025		
From 8th Avenue to:	Average Daily Traffic (ADT)	Level of Service (LOS)	Average AM Peak Speed (MPH)	Average PM Peak Speed (MPH)	Existing Number of Lanes	Traffic Forecasts	Level of Service (LOS)	Future Number of Lanes*
Fesslers Lane	29,000	B	21	28	5	27,000	B	5
Thompson Lane	24,000	B	24	28	5	32,000	**D**	5
Briley Pkwy (SR155)	28,000	A	32	24	7	39,000	B	7
Bell Road	38,000	**F**	28	31	4	36,000	**F**	4
OHB/Hobson Pike (SR 171)	22,000	B	32	36	4	65,000	**F**	4
Sam Ridley Pkwy	23,000	B	37	35	4	51,000	**F**	4
Nissan Pkwy	22,000	B	36	37	4	30,000	C	4
SR-840	41,000	**F**	52	53	4	57,000	**F**	6
SR 96	32,000	**D**	35	41	4	32,000	A	6
S Church Street (SR 231)	33,000	B	18	22	6	28,000	A	6

* Based on Nashville Area MPO 2025 Long Range Transportation Plan
Bold reflects roadways with a LOS of D or worse. Pink reflects a change of one category in LOS and red reflects a change of two categories in LOS (between 2003 and 2025)
Source: Nashville Area MPO and TDOT

Table 3-12 identifies current roadway improvements under construction or planned for I-24 and Murfreesboro Road.

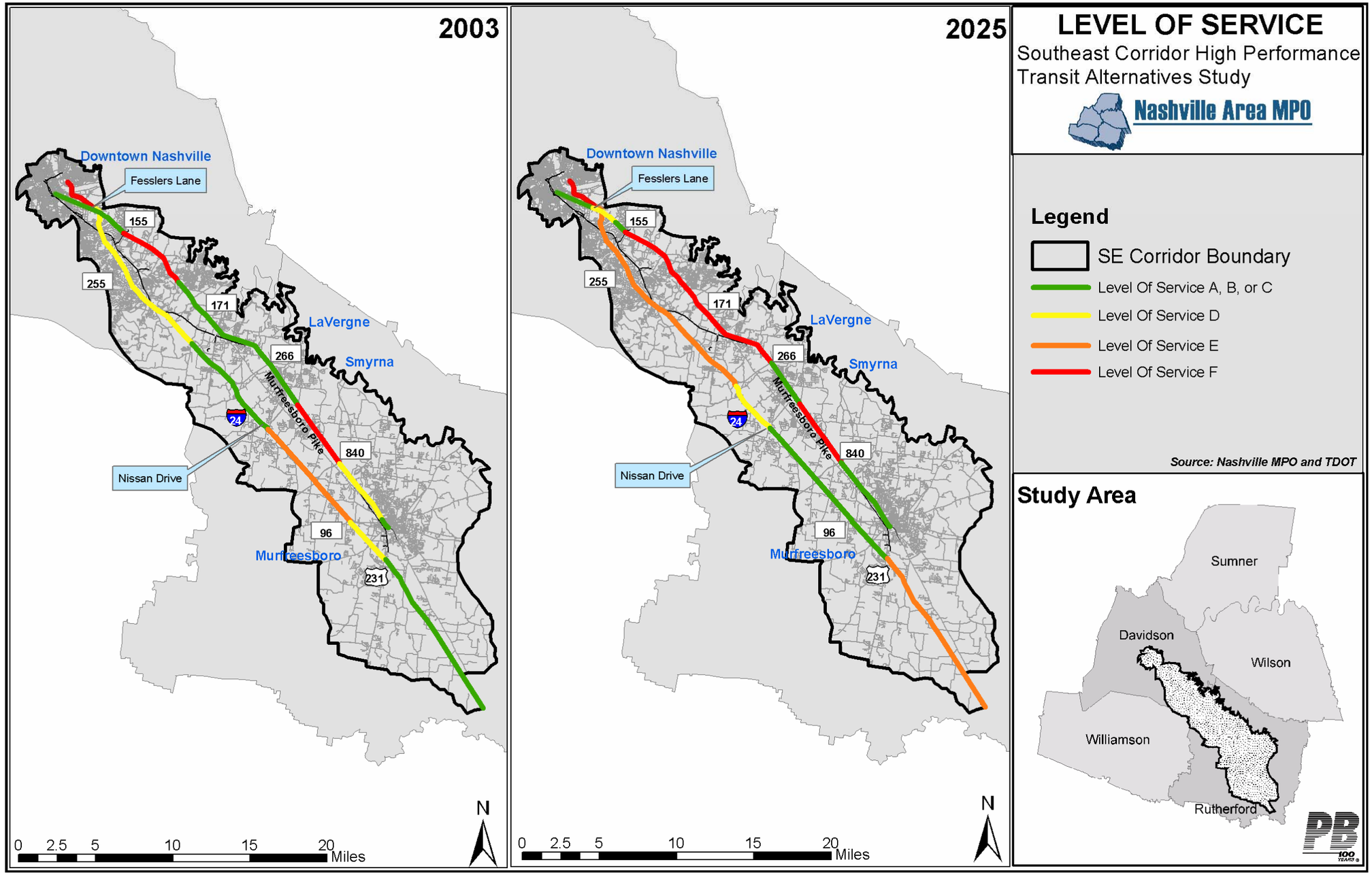
Table 3-12
Current Planned Roadway Improvements

Location	Type Improvement	Schedule/Activity
I-24 at Manson Pike	New Interchange	Completed July 2005
I-24 from SR-840 to east of SR-96	Widening from 4 to 8 lanes/2 of which are HOV	Completed September 2005
I-24 from SR-96 to east of US231	Widening from 4 to 8 lanes/2 of which are HOV	Projected Completion June 2008
I-24 at SR-99	New Interchange	Projected Completion June 2008
US-41/70S @ Memorial Ave. (SR-10) & Old Fort Parkway (SR-96)	New Interchange	Under Development

Source: TDOT

The southeast corridor continues to experience tremendous increases in both traffic volumes and congestion. This primarily results from the growing population and employment base of the corridor as well as the overall growth in the public's propensity to travel. Even with currently planned roadway improvements, travel demand will continue to exceed the available capacity of the roadway network. Additional improvements will be required to address these problems.

Figure 3-13
Highway Level of Service (2003 & 2025)



3.6.2 Public Transportation

The study area for the Southeast Corridor Alternatives Analysis includes several local, express and commuter bus routes, however, there are a number of gaps in the public transit offerings throughout the corridor. Particularly, there are limitations in terms of geographic coverage, service availability by time of day and day of week, and other issues that affect access to transit. Because of these gaps, many of the transportation markets identified earlier in this report are not served with the existing transit system. Ridership increases on the services that do exist in the corridor indicate an interest and demonstrate a need for improved transit services in the corridor.

MTA

The Metropolitan Transit Authority (MTA) has a charter to provide bus service within Nashville-Davidson County. The network of transit service operated by MTA is illustrated in Figure 3-14. The Regional Transportation Authority (RTA) contracts with MTA to operate a commuter bus service ("Relax-and-Ride") to the communities of LaVergne, Smyrna, and Murfreesboro. The study area currently supports parts of five local bus routes, parts of four express bus routes and a commuter bus route. In Table 3-13, the MTA bus routes serving the study area are listed by route number and name and includes the hours and headways for each route.

MTA is a component unit of the Metropolitan Government and was created in 1953 to supervise, regulate and maintain jurisdiction over public transit in the City of Nashville. MTA is governed by a five-member board appointed by the Mayor and approved by the Council. The Metropolitan Government partially funds MTA's annual operating and capital budgets. MTA currently employs an active fleet of approximately 140 buses, vans and trolleys serving approximately seven million riders annually.

In July 2004, MTA and Vanderbilt University implemented a new ridership program for the university's faculty and staff. Under the program, a Vanderbilt employee can use his or her university identification card in the bus farebox for free fare; for which MTA then invoices the university. In the first month, the program generated nearly 15,000 boardings, with primary ridership generated from routes within the southeast corridor and the West End Boulevard and Hillsboro Road corridors. In January 2006 ridership on this program had reached approximately 35,000 per month.

The MTA also operates Access Ride, which is a paratransit service for those with mobility impairments who cannot use fixed-route service. Access Ride provides curb-to-curb service in lift equipped vehicles. The service is required to be equivalent to non-commuter, fixed-route service and is offered within 1 1/2 miles on either side of every fixed-route during the same service hours. Customers beyond this service area are provided trips based on availability. The service is provided from origin to destination on a curb-to-curb basis. Customers are able to make reservations up to the day before their trip, but no more than 7 days in advance.

RTA

Created by state statute in 1990, the Regional Transportation Authority (RTA) is a nine-county regional agency in the Nashville metropolitan area whose mission is to plan and develop a regional transit system including developing a region-wide commuter rail system.

RTA also administers the region's carpool and vanpool program. This program is described further in Section 3.5.7. RTA collaborates with MTA to deliver a number of other commuter and employment related transportation services. MTA operates three regional commuter bus routes

Figure 3-14
Transit Routes

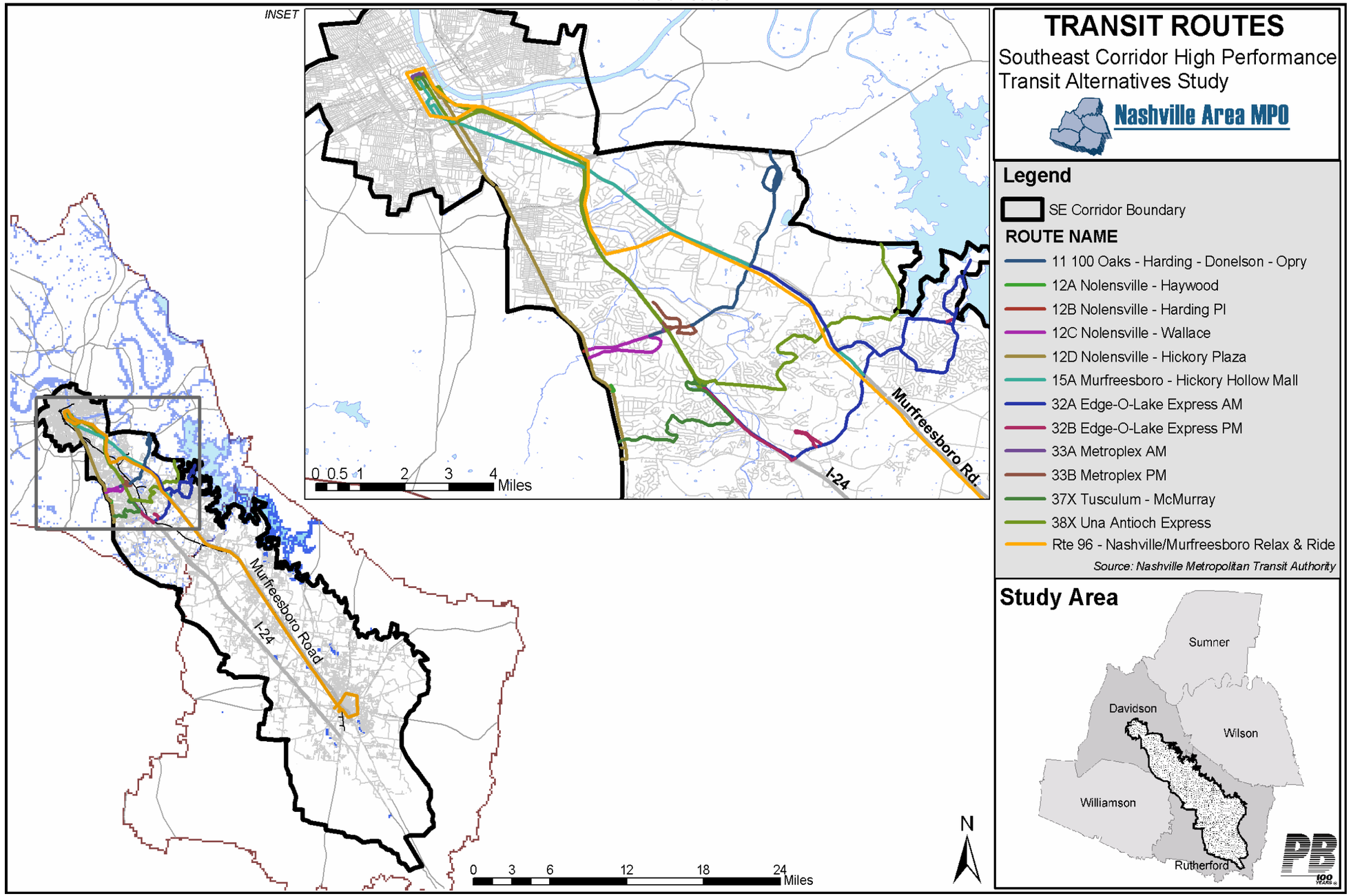


Table 3-13
Study Area Transit Routes & Service

Route No.	Route Name	Area Served	Days of Service	Service Headways (min.) or No. of Express Trips		
				Peak	Off-Peak	Weekend
Local Routes						
11	Southeast Connector	Crosstown Route connecting 100 Oaks Mall, International Airport and Opry Mills Shopping Center	Weekday	40 min.	40 min.	N/A
12	Nolensville	Along Nolensville Road to Old Hickory Road	Weekday, Saturday and Sunday	15 min.	20/30 min.	40/60 min. (40 typ.)
15	Murfreesboro	Murfreesboro Road to Hickory Hollow Mall	Weekday, Saturday and Sunday	17/20 min.	20 min.	30/60 min. (60 typ.)
18	Elm Hill Pike/ Airport	Elm Hill Pike, Donelson Pike and Airport	Weekday, Saturday and Sunday	60/70 min.	65/75 min.	60 min.
25	Midtown	Loop service along Deaderick St., Charlotte Ave., Patterson St., 20/21 Sts., Edgehill Ave., Ch.Davis Blvd., Hermitage Ave., and 4/5 Sts.	Weekday, Saturday and Sunday	30 min.	60 min.	60 min.
Express and Commuter Routes						
32X	Edge-O-Lake Express	I-40 and Bell Road to Edge-O-Lake neighborhood.	Weekday	8 am/pm peak trips	3 off-peak trips	N/A
33X	Hickory Hollow Mall/ Old Hickory Express	I-24 and Bell Road to Hickory Hollow Mall and Hickory Plaza.	Weekday	6 am/pm peak trips	2 off-peak trips	N/A
37X	Tusculum/ McMurray Express	I-24 or I-40 depending on am or pm trip. Service along Old Hickory Blvd., Edmonson Pike, McMurray Rd., Ocala Ave., and Apache Trl.	Weekday	7 am/pm trips	2 off-peak trips	N/A
38X	Una Antioch Express	I-24 or I-40 depending on am or pm trip. Service along Richards Blvd., Una-Antioch Pike and Bell Rd.	Weekday	6 am/pm trips	2 off-peak trips	N/A
96	Nashville/ Murfreesboro Relax and Ride	Murfreesboro Road to Murfreesboro and Middle TN State University	Weekday	9 am/pm trips	None	N/A

Source: MTA

under contract with RTA that deliver commuter services between downtown Nashville and Murfreesboro, Hendersonville, and Mount Juliet. These routes serve various park and ride locations in outlying counties and are supported by a guaranteed ride home program. Recent ridership on these routes is more than 50,000 rides annually.

The collaboration of the two agencies extends to the delivery of several services funded by RTA's Job Access grant. These services include extension of regular bus routes to employment sites to meet specific work shift needs during the day. It also includes RTA funding the weekend operation of MTA's night owl service. This is an after midnight service offered on a demand response basis that provides riders a trip from the downtown transit center to bus stop locations within a limited area of central Nashville. These services have been valuable in solving the transportation issues many employees face in reaching employment opportunities. The Job Access funding has provided an estimated 46,000 rides annually the past few years.

3.6.2.1 Operating Characteristics

The MTA transit system operates regular weekday service, Monday through Friday, and weekend service, with different Saturday and Sunday schedules. Hours of service and headways vary among the routes depending on service periods and weekday and weekends. On a typical day most local routes operate with 15 to 30 minute peak-period headways, 20 to 45 minute mid-day headways, and late evening hourly service. A summary of the days of operation and typical headways for the routes throughout the study area is in Table 3-13 above.

In the MTA system, the express and commuter bus routes share many common characteristics with regard to their schedules and service. They both provide a limited, primarily peak hour service during weekdays; no weekend service; faster service at higher travel speeds to outlying neighborhoods and communities; and have less frequent stops than local bus service. The express bus routes make more frequent stops in the outlying neighborhoods and stay within Davidson County. Many of the passengers on these routes are public school students attending various magnet schools within the county. The commuter bus routes provide more limited stop service, focusing on picking up commuters at park and ride lots in larger communities and cities outside of Davidson County.

3.6.2.2 Level of Service

Transit level of service (LOS) is a qualitative assessment of transit service from the user's point of view. The Transit Capacity and Quality of Service Manual (TCQSM) provides six designated ranges of values for a particular service measure, graded from "A" (best) to "F" (worst) based on a transit passenger's perception of a particular aspect of transit service. The LOS of existing public transportation services within the study area can be based on a number of service measures as defined by the TCQSM. These are:

- Service frequency
- Hours of service
- Service coverage
- Passenger loads
- Reliability
- Transit/auto travel time difference

Focusing on the main travel route along Murfreesboro Road in the study area, the LOS of existing service can be quantified using the transit routes that serve these streets. The area is served primarily by bus routes 15 and 96. Route 96 is a commuter express route, which provides limited peak-period service on weekdays to the city of Murfreesboro, while route 15 is a local route that travels along Murfreesboro Road as far south as Bell Road and Hickory Hollow Mall.

For the section of Murfreesboro Road served by route 15, the service frequency LOS (based on headway only) would range between LOS C during peak periods and LOS B to E during off-peak periods. This is based on the route's operating headway which ranges from 17 to 60 minutes during peak and off-peak hours. The LOS is B based on the hours of service criteria. This is a result of the route providing a minimum of hourly service until midnight. The TCQSM identifies LOS B as service being available from 17-18 hours per day.

For the sections of Murfreesboro Road south of Bell Road that are served only by limited, peak-hour route 96, the LOS measures are lower. Based on the operating headways, which range from 57 to 105 minutes, the existing LOS for service for the city of Murfreesboro ranges

between E and F. Service to the town of Smyrna is more frequent, ranging from 26 to 95 minutes, which establishes existing LOS ranges between D and F.

Travel times on route 15 along Murfreesboro Road vary between the peak, mid-day and evening periods. Based on the schedule, the peak period travel times vary between 48 and 62 minutes from Hickory Hollow Mall to the Deaderick Street Mall in downtown Nashville. During mid-day, the same route is scheduled to take 50 minutes and the evening service is scheduled to take 39 minutes. Travel times on route 96, from the Smyrna K-Mart park and ride lot to the Deaderick Street Mall, vary from 50 to 61 minutes according to the schedule during the am and pm peak period service. From Murfreesboro to the Deaderick Street Mall, the scheduled travel times vary between 82 and 88 minutes during the peak period.

Service reliability is another measure of service for public transit. Existing transit service reliability, in terms of on-time performance and headway adherence, can be negatively affected by several variables. These variables include school zones along the roadway, accidents, and traffic flow delays. As the previous discussions of traffic congestion indicate, there are a number of locations along Murfreesboro Road where drivers experience congested conditions on a daily basis, exacerbated by accidents and other temporary disruptions. These conditions negatively impact bus schedule adherence and service reliability on the bus system. Service reliability in congested conditions can only be achieved by using bus priority treatments such as dedicated lanes or signals, or by providing additional right of way for transit vehicles over some or all of the right of way. These will be key considerations in developing transit alternatives along both Murfreesboro Road and I-24.

Passenger loadings—the peak number of people on board the bus at a given time period—are another indicator of transit system performance. Information provided by MTA suggests that portions of route 15 (Murfreesboro Road), route 12 (Nolensville Road) and route 18 (Elm Hill Pike/Airport) experience standing loads (more passengers on board than there are seats) during the morning and evening peak periods. This is further indication that additional transit capacity, in the form of more frequent transit service, is required in the corridor to meet existing demand. Travel demand analysis to be performed in the development of alternatives will be used to estimate future demand for transit and recommend an optimum level of transit service to meet this demand in the corridor.

3.6.2.3 Fare Structure

The MTA has a number of fare options associated with use of the current transit system. Their fare options include the following:

- Local Service $1.45
- Transfer $0.10
- Elderly and Disabled $0.70
- Youth $0.90
- Express Service $1.75 to $2.25

An extensive set of fare pass options are available including:

- 20 Ride Local $24.85
- 7 Day Pass $14.70
- 31 Day Pass $48.00
- 20 Ride express $30.90 to $40.50

The fare structure for the Access Ride service is $1.75 for eligible customers with attendants riding for free.

3.6.2.4 Ridership

Average monthly ridership, during the period from September 2003 through May 2004, for the existing transit routes within the study area is summarized in Table 3-14. As identified in the table, average monthly ridership on the local routes is highest on route 15 Murfreesboro, at 43,154 trips. For Relax and Ride route 96, which provides service to the communities of LaVergne, Smyrna, and Murfreesboro, the average monthly ridership for this period was 2,247 trips. Ridership spiked approximately 20 percent on route 96 during June and July 2004; and has the potential for further increases with the re-location of two park and ride lots to more accessible locations in LaVergne and Smyrna.

3.6.2.5 Revenues and Costs

In 2002, the MTA operated a total of 8,878,818 annual vehicle revenue miles of service and 629,327 annual vehicle revenue hours. Operating service costs for the year were $54 million. The operating expense per bus revenue hour was $66.26 and per bus passenger trip was $2.60.

Table 3-14
Average Monthly Ridership (September 2003 through May 2004)

Route No.	Route Name	Average Monthly Ridership	Passengers per Revenue Hour	Passengers per Revenue Mile
Local Routes				
11	Southeast Connector	1,071	3.1	0.2
12	Nolensville	23,937	24.3	1.8
15	Murfreesboro	43,154	27.3	1.8
18	Elm Hill Pike/ Airport	8,433	20.5	1.3
25	Midtown	11,722	13.2	1.0
Express and Commuter Routes				
32X	Edge-O-Lake Express	4,785	16.0	0.8
33X	Hickory Hollow Mall/ Old Hickory Express	2,593	20.0	1.1
37X	Tusculum/ McMurray Express	3,121	19.8	1.1
38X	Una Antioch Express	3,192	20.6	1.1
96	Nashville/ Murfreesboro Relax and Ride	2,247	11.1	0.4

Source: MTA

3.6.2.6 Planned Service Improvements

The current Five Year Service Improvement Plan for MTA, adopted in March of 2004, calls for service improvements for nearly all MTA routes over the next five years. Table 3-15 illustrates the various service improvements for the transit routes serving the southeast corridor area.

Table 3-15
Current Planned Transit Service Route Improvements

Route No.	Route Name	5-Year Plan Recommendations
11	Southeast Connector	• Years 1-3 - No changes • Year 4 - 60 minute service during mid-day • Year 5 - Same as Year 4 but adds 60 minute service on Saturday till 6:15pm
12	Nolensville	• Year 1 - Addition of 11:15 am weekday trip • Year 2 - 20 minute midday headway • Year 3 - Route operates to Hickory Plaza every trip; Service to Wallace & Harding Loops reallocated; 10 minute peak service; and 20 minute midday service • Year 4 - 30 minute weekday service until 8:15 pm; 20 minute Saturday service until 6:15 pm; 30 minute Sunday service until 6:15 pm • Year 5 – No Changes
15	Murfreesboro	• Year 1 - Create a split headway on this route, Alternating service between Hickory Hollow Mall and the Wal-Mart Supercenter on Murfreesboro, past Bell Road; 10 minute headway during peak periods • Year 2 - Reallocation of Vultee deviation to new Route 5 • Year 3 - 20 minute service from 6:15 pm to 8:15 pm; 30 minute service from 8:15 pm • Year 4 - 20 minute service until 6:15 pm on Saturday; 30 minute service until 6:15 pm on Sunday • Year 5 - No changes
18	Elm Hill Pike/ Airport	• Year 1 - No changes • Year 2 - Split current routing into two routes: one that operates local to and from the airport via Elm Hill Pike, and one that operates express from the Airport to Downtown via I-40; 20 minute peak service; 30 minute off peak service until 8:15 pm; 60 minute Saturday service until 8:15 pm; 60 minute Sunday service until 6:15 pm • Years 3 through 5 - No changes
25	Midtown	• Year 1 - 30 minute service all day until 6:15 pm; All trips to MTA from 8:15 am until 3:45 pm • Year 2 - 20 minute peak service • Year 3 - 20 minute service via Jo Johnson until 8:15 pm ;40 minute service to Hart until 8:15 pm • Years 4 through 5 - No change
32X	Edge-O-Lake Express	• Years 1 through 4 - No change • Year 5 - 1 extra am and pm trip
33X	Hickory Hollow Mall/ Old Hickory Express	• Years 1 through 4 - No change • Year 5 - 1 extra am and pm trip
37X	Tusculum/ McMurray Express	• Years 1 through 4 - No change • Year 5 - 1 extra am and pm trip
38X	Una Antioch Express	• Years 1-4 - No changes • Year - 5 - 1 extra am and pm trip
96	Nashville/ Murfreesboro Relax and Ride	• Years 1 through 5 – No Changes

Source: MTA 2004

Despite service improvements within Davidson County, there are currently no additional transit service improvements planned within LaVergne, Smyrna or Rutherford County over the next five years. Murfreesboro however began operating local service in 2006.

3.6.3 Park and Ride Lots

Within the study area, there are 16 existing park-and-ride lots, of which six are formal lots and ten are considered informal lots. Of the 16 park-and-ride lots in this corridor, 14 of them are

located outside of Davidson County in the communities of LaVergne, Smyrna, Murfreesboro, and Rutherford County.

It is the goal of the RTA and MTA to improve the condition and accessibility of the park and ride lots throughout the system. Many of the lots have poor pedestrian access and limited or no amenities, such as bus shelters or benches. At many park and ride lots, there is an absence of sidewalks within the facility leading to nearby neighborhoods or alongside the road. The Nashville Area MPO has set aside funds to assist with improvements to these facilities.

Table 3-16 identifies the location and capacity of the existing park-and-ride locations within the corridor.

Table 3-16
Existing Park and Ride Lots

	Location	County	Formal-Informal	Spaces	Shared-Separate
1	Edge-O-Lake Dr/US-41 (Plaza)	Davidson	Informal	24	Shared
2	Hickory Hollow Cinemas	Davidson	Formal	267	Shared
3	Stones River/Murfreesboro Rd	Rutherford	Informal	20	Shared
4	I-24E at Waldron Road	Rutherford	Formal	36	Separate
5	I-24 at Sam Ridley Blvd	Rutherford	Formal	31	Separate
6	US-41 near Sam Ridley Blvd	Rutherford	Formal	17	Shared
7	I-24 at SR-102 Lee Victory Pkwy	Rutherford	Informal	12	Separate
8	SR-840 at US-41	Rutherford	Formal	215	Separate
9	US-41 at Georgetown Square	Rutherford	Informal	20	Shared
10	SR-96 Agricultural Center	Rutherford	Formal	129	Shared
11	US-41 at Jackson Heights Shop-Center	Rutherford	Informal	30	Shared
12	I-24E at SR-96 (Chevron)	Rutherford	Informal	10	Shared
13	US-41/Cannonsburgh	Rutherford	Informal	20	Shared
14	I-24 at US-231	Rutherford	Informal	20	Shared
15	Mercury Plaza (Murfreesboro)	Rutherford	Informal	25	Shared
16	I-24 and Buchanan Road	Rutherford	Informal	10	Shared

Source: Regional Transportation Authority

The Nashville Regional Commuter Rail Evaluation, conducted in April of 1996, recommended seven commuter rail stations in the Southeast Corridor (see section 3.3.2). The Park-and-Ride Study reassessed the potential locations for functionality and viability as a potential park-and-ride lot, which later could be converted to a commuter rail station. Of the seven locations only three were recommended:

- Crossings/Hickory Hollow Area – Nashville-Davidson County
- US-41/70S and Front Street – Smyrna
- Waldon Road/Murfreesboro Road – LaVergne

Considerable investment has gone into development of the existing park-and-ride share program. This system of facilities provides an excellent opportunity for consideration of various transit alternatives within the study area.

3.6.4 Railroads

This section describes the rail transportation system within the Nashville area and the study area. Rail transport is predominately freight for the region with passenger rail service planned by 2006 for populations east of downtown Nashville (known as the east line to the cities of Mount Juliet and Lebanon).

The Surface Transportation Board (STB) separates railroad companies into three classes based on revenues for each of the railroads. The largest railroad systems are classified as Class I railroads, followed by Class II railroads, which are mid-to-small sized companies (also known as short-line railroads), and Class III railroads, which are small sized companies. In the study area there is one Class I Railroad, one Short-line Railroad, and one planned commuter passenger rail service.

Class I Railroad – CSX Transportation The freight rail network serving Nashville is an important rail hub for the region; at least one hundred trains per day are handled through the main lines and yard facilities in Nashville where extensive swapping of blocks (multi-car segments of freight trains) are accomplished. All of the main lines, which are currently owned by CSX Transportation (CSX) and feed this hub, are single track and already have capacity constraints.

CSX operates 23,357 miles of track in 23 states in the eastern United States. In Tennessee, CSX operates 1,137 miles of track. CSX operates lines from Nashville southward to Birmingham, Alabama, and from Nashville westward to Jackson and on to Memphis. CSX also operates a north-south line from Jellico, Tennessee, at the Kentucky border, southerly to Knoxville and on to Ocoee, Tennessee, near the Georgia border. CSX has approximately 35,000 employees nationwide and 2,600 employees in Tennessee.

Within the study area, the CSX rail line from Nashville to Chattanooga traverses the entire length of the corridor connecting downtown Nashville to LaVergne, Smyrna, and Murfreesboro. This rail line sustains a relatively high level of freight traffic with 30 to 35 trains per day.

CSX is capable of running full double stack clearances through all of Tennessee and the company does not currently have any bridge clearance problems in the state. Along this rail line, CSX routes trains from Cincinnati to Atlanta through Louisville and Nashville. CSX also routes trains from Atlanta to Chattanooga and then to Nashville.

Short-Line Railroads - Nashville and Eastern Railroad

The Nashville and Eastern Railroad is classified as a short-line and operates 95 miles of main line and 15 miles of branch line in Davidson, Wilson, Smith, and Putnam counties. The railroad's principal connection is to CSX Transportation in Nashville. The line runs from Nashville eastward to Monterey, Tennessee. The Nashville and Eastern Railroad employs 27 full-time staff members and has an annual payroll of $1.3 million. The railroad provides service to 35 shippers.

Within the study area, the Nashville and Eastern Railroad serves downtown Nashville but leaves the study area just east of I-24/I-40 and extends easterly toward Wilson County.

Passenger Rail – East Commuter Rail

In 1996, the MTA and RTA initiated a study to explore the potential of commuter rail in the Nashville region. From this study, six corridors were considered for further evaluation. A 1998 study analyzed the capital costs for the three most promising corridors. This analysis is discussed in Section 3.3.2. Based on the results of these studies and efforts of the Nashville Area Commuter Rail Task Force—which included the Nashville Chamber of Commerce, area business leaders, the MPO, MTA, RTA, TDOT, CSX, the Nashville and Eastern Rail Authority, and a Nashville Congressional delegation—the East Corridor was selected as the first corridor to be implemented in the Nashville Area Commuter Rail System.

The Nashville MPO included the East Corridor commuter rail project in its fiscally constrained long range transportation plan in 1999. FTA approved the project to advance into preliminary

engineering (during which time an environmental assessment was undertaken) in late 1999. The East Line became operational in 2006 with service from downtown Nashville at the Cumberland River, to the City of Lebanon, which is approximately 35 miles from downtown Nashville.

3.6.5 Aviation

Within the study area, there are three airports, one commercial and two General Aviation (GA) airports. The large amount of employment, commercial, and manufacturing within this area of the region has benefited from relatively convenient access to airport facilities, be it for business travel, product or supply shipping, or pleasure.

Commercial Air Service

The southeast corridor is the focus of commercial air service in the region. Nashville International Airport (NIA), which lies at the northeastern edge of the corridor, is a major regional and corridor traffic generator. Travelers and airport employees, as well as the employees of business located near the airport for various reasons, make the airport area a major employment center and major transportation destination. Smyrna Airport and its surrounding area also is developing as a major regional employment destination.

Nashville International Airport is one of six commercial airports in Tennessee and is located southeast of downtown with direct access to I-40, serving as an important asset to the regional business community. Non-stop jet service to forty-five markets is provided to mid-state businesses and travelers by eleven air carriers, making the airport a major traffic generator.

Nashville International has the highest origination numbers compared to any other airport in Tennessee. (Origination numbers are the number of passengers originating their flight from the Nashville airport.) One of the reasons for this is the low-fare carrier, Southwest Airlines, which makes it attractive for passengers to drive to Nashville from all parts of the State and even from the State of Kentucky. Nashville International is also the second busiest airport in Tennessee in terms of enplanements, or departing passengers, just behind the Memphis Airport. NIA has an average of 4 million enplanements per year.

The Nashville International Airport provides commercial air service to the metropolitan area and all of Middle Tennessee through major commercial carriers. The airport is served by Air Canada, American, American Eagle, Comair, Continental, Corporate Express, Delta, Delta Express, Mesa, Northwest, Skyway, Southwest, Trans States, TWA, United, United Express, US Airways, and US Airways Express. With 400 arrivals and departures daily, the Nashville International Airport serves 96 major markets throughout the country. The airport is nearly adjacent to Rutherford County, just eight miles from LaVergne.

Surface transportation to the airport includes private automobiles and rental cars, taxis and shuttle buses, limousines, charter buses, and MTA transit.

General Aviation (GA) Airports

There are 32 GA airports in Middle Tennessee, two of which are in the study area - the Smyrna Airport and the Murfreesboro Municipal Airport. The Tennessee Statewide Aviation System adopted in 2001 ranked the Smyrna Airport third and the Murfreesboro Municipal Airport fourth in Middle Tennessee relative to business development opportunities. These airports are premier business airports and are anticipated to continue to play a major role in the commercial growth of its market. In addition, they generate business activity in surrounding areas due to their desirability to businesses, such as air freight, that require proximity to a large general aviation airport.

The Murfreesboro Municipal Airport serves both public and private clients, and has one 3,900-foot runway that can be used for smaller jet aircraft. The airport benefits from its location in Murfreesboro but is constrained in its growth by its residential access and surroundings. However, the proximity to Nashville and I-24 are positive factors that are expected to exert continued pressure on the airport's capacity. Taxi and rental car transportation are available.

The Smyrna Airport serves both public and private clients, and has one 5,500-foot runway and one 8,037-foot runway. The geographic location of the Smyrna Airport with direct access to I-24 via Sam Ridely Parkway and relative proximity to Nashville International make it among the top ranked GA airports in Middle Tennessee. Smyrna Airport also has the majority of the design features that are required for a regional service airport and is in the midst of a major expansion to carry international freight and passengers. Courtesy car and rental car services are available.

There are five industrial parks in Rutherford County fostering positive development opportunity for both the Murfreesboro Municipal Airport and the Smyrna Airport. These industrial parks are:

- South Park Distribution Center - a 160 acre industrial park with roughly 70 acres available for future development
- Smyrna Industrial Airpark - a 180 acre industrial park with roughly 140 acres available for future development
- Interchange City - a 50 acre industrial park which is fully developed
- Stevenson Property - a 50 acre industrial park with nearly 50 acres available for future development
- Murfreesboro property - a 430 acre municipal park located off Murfreesboro Road south of SR-840 which has availability for future development

The success of these airport facilities is relative to their geographic location and proximity to numerous employment and residential communities. Any transit alternative within the study area must consider these trip generators and the economic benefits from continued intermodal connectivity and access.

3.6.6 Transportation System Management

In the Nashville area, the Tennessee Department of Transportation (TDOT) has recently installed an intelligent transportation system (ITS) to assist motorist and emergency and law enforcement officials in responding to highway incidences. Dozens of dynamic message signs, as well as radar detectors and video cameras, are being installed on the interstates in Nashville-Davidson County. Within the study area, I-24/I-40 has two dynamic message signs, radar detectors, and video cameras. This initial system is part of a larger regional ITS program that is to be developed in the region over the next 20 years.

Local jurisdictions are using ITS technology to achieve better signal coordination along important arterial routes, and to establish traffic management centers where data is collected and analyzed. Over the long term, the local and state efforts are coordinated through a plan known as the ITS Regional Architecture. This plan spells out what types of data are being collected by each agency, what will be shared, and the compatibility needs for equipment.

Davidson County has operated a combination of direct connect and closed loop traffic signal systems since the 1980s. These systems directly manage approximately 65% of the traffic

signals in the county. The direct connect traffic control and monitoring system was upgraded in 2005 using federal funds. Major signal retiming began in 2005, using CMAQ funds and continued in 2006 using local funds. An ITS master plan is currently being developed, and will use federal funding sources for both its planning and for implementation, with additional funding required to complete implementation. There are also major efforts underway in the areas of wayfinding, bus priority systems (which allow buses to bypass congested intersections), emergency vehicle preemption, and signal equipment upgrades using a combination of federal and local funding. Additional funding sources will be required to facilitate full implementation of these programs.

In addition to the ITS system being deployed by TDOT, the State of Tennessee also operates a freeway service patrol which covers all of the interstates within Davidson County. Interstate 24 is patrolled by the local service patrol, which provides assistance to stranded motorists and also playing a major role in mitigating congestion as a result of incidents (a stalled vehicle blocking the travel lane, wrecks, etc.).

While these services have reduced non-reoccurring traffic congestion (collisions, etc.) within the study area, the services are at present limited to Nashville-Davidson County. As the program grows, motorists traveling within Rutherford County will also see the benefit of these services.

3.6.7 Travel Demand Management

Two programs, while not exclusive to the southeast corridor, offer travel demand management options for travelers within the study area. These programs include:

Carpool and Vanpool RideShare Matching Program - In partnership with the RTA, MTA provides assistance with starting a commuter benefits or ridesharing program. RTA maintains a regional database of active carpools and vanpools where individuals can find suitable matches for commuting, including bus routes. Corporations can have a database developed just for their employees. Currently, with 100 vanpools in operation, the program is one of the largest in the southeastern United States. Drawing from a customer base primarily from the outlying counties surrounding Davidson County, downtown Nashville is the destination of a majority of vanpool customers, although many other destinations are served including the hospitals and Vanderbilt University in West End, and the Opryland Hotel and Convention Center. The agency administers a carpool database to complement the vanpool program. Carpools and vanpools are particularly well suited to longer distance travel, such as many of the home based work trips being made in this corridor, and as such will be a key component of providing future services in this corridor.

Guaranteed Ride Home Program - The Guaranteed Ride Home service is intended to provide free emergency rides home for regular commuters who travel in Davidson, Rutherford, Sumner, Williamson or Wilson counties, who cannot ride home with their normal carpool, vanpool or express bus. Commuters must be pre-registered in the program and will receive a voucher for a taxi or rental car to take you home. Guaranteed ride home programs are an important complement to vanpool, carpool, and commuter transit services, providing users of those services with an emergency trip home in the midday in the event of a family emergency, or in the evenings for people who miss the last available bus or train to their destination.

The largest number of vanpools are destined for downtown Nashville. Participation in these programs is voluntary and range in participation from corridor to corridor and year to year, fluctuating in response to changes in employment levels, fuel prices and other variables.

3.6.8 Transportation Funding Overview

Taxpayer funding for transportation projects at the Federal, state and local levels is limited and must be expended prudently. The Southeast Corridor High-Performance Transit Alternatives Study must identify improvements that can achieve local consensus, meet state and Federal funding guidelines and demonstrate that they are an efficient use of taxpayer funds. The FTA Section 5309 New Starts Program Funding Process or other Federal Programs could provide up to 80% of the capital funding for design and construction of a qualified major transit project -- though funding at this level is unusual under current Federal Funding conditions. In most cases, Federal funds will not provide more than 50% of the capital and construction costs. The remainder of capital funds for a major transit investment, and all of the operating funding, must generate at the local or state levels.

FTA must approve the project at various points through the planning process. The key to this approval is the development of a locally-preferred alternative (LPA) that represents the region's consensus on a project that best meets the transportation needs in a given corridor. The LPA must represent a local consensus and be capable of gaining support for the level of local funding required to build and maintain the project over the long term. For FTA to approve the project beyond the alternatives analysis level the project must demonstrably meet a significant transportation need as identified by the alternatives analysis study and meet various external measures of efficiency compared to other projects of its type from around the country. FTA is also increasingly requiring projects to demonstrate that they will be, or are already, supported by changes in regional land use patterns that help to ensure the long-term success of the transit investment.

3.7 Project Statement of Purpose and Need, Goals and Objectives

The statement of purpose and need is one of the most important outcomes of this analysis and has been derived from:

- input from the public
- discussions with public officials throughout the corridor
- an analysis of the data as provided in this report

The statement of purpose and need defines the transportation problems and issues within a corridor. These problems are complex and involve facets beyond transportation such as land-use and development patterns. The problem must first be stated so that analysis of all reasonable information can take place and all transportation issues can be successfully addressed. In addition, information from local elected officials, transportation professionals, and the public is vital in determining what types of needs exist and what should be considered for a solution. This statement of purpose and need, including the goals and objectives, will guide the development and assessment of alternative approaches for best meeting the needs of the corridor. It is important to consider that as additional information and public input accumulates over the course of the study, elements of the statement and/or goals and objectives may be modified to meet other identified needs or goals.

The steering committee of the Nashville Southeast Corridor High-Performance Transit Alternatives Study developed the following statement of purpose and need:

- **Provide Transportation Options**
  Provide transportation alternatives for travelers within the corridor.

- **Improve Mobility**
  Allow economic growth and development in the corridor to continue without overburdening existing roadways. Reduce the negative impacts of congestion on resources, travel times, and mobility.

- **Establish Efficient Land Use Policies / Compact Development**
  Provide greater emphasis on mixed-use development, traditional urban and village land use patterns, and design standards that support a diverse range of travel options. Promote land uses that are conducive to a more balanced transportation system with key roles for pedestrian and mass transit.

- **Address Environmental Concerns**
  Provide transportation choices that minimize impacts to the environment and help to improve air quality conditions in the region.

- **Use Limited Transportation Funding Efficiently**
  Provide a cost effective investment in the transportation network that results in more transportation options, improved mobility, and supports compact development.

The following goals and objectives have been identified to fulfill the purpose and address the needs of the corridor:

Goal 1: Provide longer-distance travelers in the southeastern corridor with alternatives to driving private vehicles in heavily-congested traffic conditions.

Objectives:

1. Provide transit options serving longer-distance trips (primarily more than 3 miles in length) in the corridor that are competitive with, or ideally superior to, driving a private automobile, in terms of trip time, convenience (in the context of specific time-of-day and day-of week trips), safety, cost (to the individual user) and comfort.
2. Provide enhanced multi-modal access to home, jobs, services and other activity centers for corridor residents, workers, and visitors.
3. Increase utilization of public transit in the corridor for all trip purposes.
4. Provide transportation options that serve both work and non-work trips.
5. Provide improved transit opportunities for reverse-commuters traveling from the northern areas of the corridor and other parts of the Nashville region to workplaces in suburban areas of the corridor.
6. Improve access to mass transit in areas of the corridor outside central Nashville.
7. Provide greater diversity of transportation options in the corridor by providing improved conditions for pedestrians, bicyclists, and other non-automotive users.

Goal 2: Promote efficient land use and development patterns in Nashville/Davidson County and the Rutherford County communities in the southeast corridor study area.

Objectives:

1. Promote compact transit-accessible land development in Nashville, Murfreesboro, LaVergne, Smyrna and other communities in the southeast corridor study area.
2. Concentrate employment and other activity centers within existing and planned transit corridors (fully considering the relationship of transit and parking availability, as associated with such activity centers).
3. Maintain and promote downtown Nashville, other existing established activity centers, including Interchange City, and downtown Murfreesboro as the main employment and activity centers in the corridor.

4. Preserve farmland and open space in existing rural areas of the corridor.
5. Promote development that re-uses existing sites and buildings, and that efficiently uses existing infrastructure and public services.
6. Promote multi-use development combining many activities including commercial, retail, education, recreation, and housing.

Goal 3: Improve and enhance economic development and employment opportunities and expand access to jobs.

Objectives:

1. Promote sustainable economic growth throughout the corridor by providing improved access and optional transportation modes.
2. Provide improved access to housing opportunities throughout the corridor by providing improved transportation access and options.
3. Provide improved access to employment centers throughout the corridor by providing improved transportation access and options.
4. Provide high quality transit access to Nashville International Airport from downtown Nashville, Murfreesboro and other areas within the corridor.
5. Enhance reverse commute options providing access for Nashville residents to job opportunities in other areas of the corridor.
6. Provide improved access to special events and other destinations in the study corridor.

Goal 4: Preserve the natural and social environment.

Objectives:

1. Improve air quality.
2. Minimize transportation-related noise impacts.
3. Protect and, where possible, enhance environmentally sensitive areas.
4. Minimize community and neighborhood disruption.
5. Minimize negative aesthetic impacts of transportation investments and, where possible, design systems that add to the aesthetic environment.
6. Address environmental justice concerns by carefully assessing disproportionate impacts and providing improvements that benefit members of socially disadvantaged groups.
7. Promote land use and development policies, and transportation strategies that are consistent and mutually supportive.

Goal 5: Develop a cost-effective transportation system improvement strategy that maximizes community consensus and institutional support.

Objectives:

1. Assure that total benefits of the preferred transportation investment strategy recommended by the study warrant their total costs.
2. Achieve public consensus and institutional support, including the support of public agencies, local governmental entities and public officials, for the preferred transportation investment strategy recommended by the study.
3. Ensure that the costs and benefits are shared equitably among citizens and governmental entities throughout the region.
4. Maximize the leverage of local funds in obtaining State and Federal funds to support transportation investments in the corridor.

Goal 6: Develop a strategic part of a multi-modal transportation system that would facilitate the development of an integrated regional multi-modal system

Objectives:

1. Develop alternatives and strategies that complement, rather than conflict with, regional plans for development of a multi-modal system.
2. Develop alternatives that are consistent with the transportation and development goals of the region as identified in the Nashville Area MPO's Long Range Transportation Plan and other regional planning documents.
3. Avoid alternatives that might have the affect of precluding the development of other transportation modes or options to serve other corridors of the region.

3.7.1 Performance Criteria and Evaluation Measures

A series of detailed performance criteria and evaluation measures were developed based on the above listed transportation goals and objectives to effectively evaluate potential alternatives that meet the need and purpose for high-performance transit service within the southeast corridor study area. For each goal and objective, a measure or series of measures has been identified by which the alternatives can be compared. These evaluation measures are discussed in Section 3.9.

3.8 Needs Assessment Conclusions

The southeast corridor has experienced tremendous population growth in recent years and is expected to continue growing at a rapid pace. This increase in population and employment has generated traffic growth that exceeds the growth in capacity of the transportation system. This traffic is expected to increase in the future, generating additional congestion and delays for travelers, as well as other socio-economic and environmental impacts related to congestion.

- Significant congestion occurs within the corridor in both the AM and PM peak hours as commuters traverse from the outer areas of Davidson County and the communities of Rutherford County into downtown Nashville.

- Of the 32 miles of I-24 between downtown Nashville and Murfreesboro, currently 24 miles (or 75% percent) operate at levels of service (LOS) D or worse during peak periods. By 2025, nearly 80 percent of the corridor will operate at LOS D or worse, even after significant road widening of I-24 during this period.

- Portions of Murfreesboro Road are forecast to increase in traffic by 30,000 vehicles per day, with nearly 80 percent of the corridor (or 25 miles) operating at levels of service D or worse during peak periods.

- Limited transit services exist within the corridor leaving vast areas and populations un-served by public transportation. Within the corridor there are 10 bus routes providing service. Of these routes only two serve north-south movements and of these two routes, only one provides service over the complete length of the corridor.

The data presented in this study indicate a steady worsening of congestion. If present trends continue, traffic congestion and the lack of mobility options will threaten the long-term growth of the southeast corridor. The southeast corridor is effectively the engine of economic growth in the Nashville region, therefore the costs of not planning today will be more than just higher financial costs for solving these problems tomorrow; they will include costs to the quality of life

of all who live, work and visit in the corridor. As this report illustrates, the lack of mobility and transportation options, combined with the current and projected growth of population, employment—and traffic congestion—requires that transportation alternatives be developed now to address these needs.

The Nashville region is working to avoid the fate of many other urban areas that are experiencing the negative impacts of sprawl and the deterioration of compact urban centers. Transit can influence, support, and promote more compact land use and development patterns within the corridor. This will allow the corridor to be served by a more efficient mix of transportation options that include walking, cycling, and mass transit. Land use patterns in the area tend to be low-density and pedestrian unfriendly with various uses strictly separated. Existing development is oriented for the convenience of auto travel, as opposed to pedestrians or users of mass transit. Over time, development has occurred with little, if any, consideration for the ways in which public transportation infrastructure and services might serve the travel needs of those who live, work, or travel within the corridor. This has resulted in a development pattern and transportation system that does not meet all the needs of the various users such as pedestrians, cyclists, and transit riders. The current auto-centric transportation network increasingly suffers from traffic congestion, which indicates that the capacity of the system does not meet the demands of drivers. The result is a transportation system, in terms of its capacity and composition of services that lags behind the demand for transportation services.

This development pattern represents a significant threat to farmland and open space and has the potential to significantly diminish the quality of life for Nashville area residents by reducing access to a variety of housing, retail and commercial development types, reducing access to open space, and promoting traffic congestion. Over time, this auto-centric focus toward development increases travel times for all users of the transportation system including drivers and bus riders.

For the region to remain competitive and continue to enjoy increased development opportunities, additional mobility options such as high performance transit are warranted. High performance transit is capable of providing reliable, affordable, and relatively flexible travel within the corridor. Findings of this needs assessment demonstrate a viable role for public transportation in the corridor as a means for

- addressing existing and forecasted congestions levels
- accommodating significant projected increases in population and employment growth over the next twenty years
- and influencing land use and development decisions

Cost effective transportation solutions such as mass transit are capable of facilitating continued economic growth in the corridor while balancing desired mobility needs with that of an ever-fragile physical and social environment. Given the current lack of public transportation in the corridor, the projected increase in population and employment, and the likely benefits from increased mobility options, further development of transit alternatives is warranted.

3.9 Evaluation Methodology

3.9.1 Introduction

The intention of this planning process is to methodically evaluate the alternatives against the purpose, need, goals and objectives, and to use that analysis to identify the transit solution that best satisfies the needs of the region. The results of each stage of screening will be

documented in future reports/chapters dedicated to describing the development and analysis of each round of alternatives. At each stage of the screening process, results of analysis will be presented by the consultants to the Steering Committee, which will develop the alternatives to be carried forward to the next stage of analysis and screening. The results of each stage will be presented to stakeholders and to the general public to solicit their input, and this public and stakeholder input will be considered by the Steering Committee before the analysis moves forward to the next stage.

3.9.2 Evaluation Methodology

The evaluation methodology consists of multiple goals and objectives; performance measures associated with those goals; and a mechanism to apply the performance measures to the alternatives. This section provides an overview of each of these elements.

3.9.2.1 Goals

The following goals have been established to guide the evaluation and development of a preferred transportation alternative as part of this analysis. The goals reflect coordination, cooperation, and participation among members of the Steering Committee, stakeholders and citizens within the study area. The stated goals of this effort are:

Goal 1: Provide longer-distance travelers (those making trips three miles or longer) in the southeastern corridor with alternatives to driving private vehicles in heavily congested traffic conditions.

Goal 2: Promote efficient land use and development patterns in Nashville/Davidson County and the Rutherford County communities in the Southeast Corridor Study Area.

Goal 3: Improve and Enhance Economic Development and Employment Opportunities and Expand Access to Jobs.

Goal 4: Preserve the natural and social environment.

Goal 5: Develop a cost-effective transportation system improvement strategy that maximizes community consensus and institutional support.

Goal 6: Develop a strategic part of a multi-modal transportation system that would facilitate the development of an integrated regional multi-modal system.

The goals and objectives in part reflect the evaluation criteria established by the FTA for potential projects eligible for funding under the Section 5309 New Starts process. This is a competitive process whereby communities across the country compete for federal assistance in starting a new transit project. The Federal criteria and measures related to justifying the project are listed below:

Table 3.17 FTA Project Justification Criteria and Measures

New Starts Criteria	Measures
Mobility Improvements	• Travel Time Saving • Low Income Households Served
Environmental Benefits	• Change in Regional Pollutant Emissions • Change in Regional Energy Consumption • EPA Air Quality Designation
Operating Efficiencies	• Operating Cost per Passenger Mile
Cost Effectiveness	• Incremental Cost per New Rider
Transit-Supportive Land Use and Future Patterns	• Existing Land Use • Containment of Sprawl • Transit-Supportive Corridor Policies • Supportive Zoning Regulations • Tools to Implement Land Use Policies • Performance of Land Use Policies • Other Land Use Factors
Other Factors	• Technical Capacity • Project benefits not reflected by other New Starts Criteria

Source: *New Starts: An Introduction to FTA's Capital Investment Program.* US Department of Transportation, Federal Transit Administration.

In addition to the criteria above, the FTA considers the community's capacity to finance the proposed project. FTA has established a number of measures that help them to assess financial capacity, including:

- Stability and Reliability of Capital Financing Plan
- Stability and Reliability of Operating Financing Plan
- Local Share of Proposed Costs

The issue of financial capacity is not directly applicable to the evaluation of specific alternatives and ranking one alternative above another. However, it underscores the importance, as expressed in the project justification criteria related to operating efficiency and cost effectiveness, to minimize the costs of the alternatives relative to the transportation benefits they provide to the region.

For each of the goals established for this project, there are a series of corresponding objectives, which are intended to address the purpose and need and goals of the project. A listing of each objective and the respective goal is provided in Section 3.9.3 of this report.

3.9.2.2 Process of Evaluation

The alternatives proposed for the Southeast Corridor High-Performance Transit Alternatives Study will be evaluated in three stages that lead to selection of a Locally Preferred Alternative (LPA). The evaluation measures are designed to apply various criteria in a cost-effective manner to identify the option that best meets the goals.

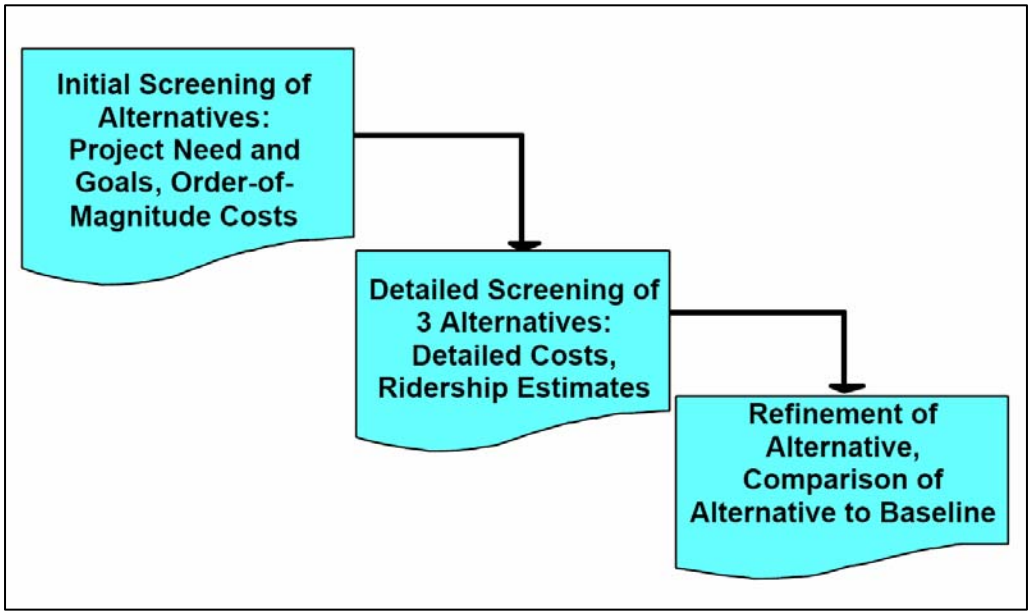
Each phase of the evaluation process is summarized below and illustrated in Figure 3-15.

Stage 1 - the **Initial Screening** process evaluates each of the transit types and alignments suggested during the Scoping process. The initial screening will eliminate the least-promising alternatives from further consideration and thereby develop three alternatives with the most potential for meeting the goals and objectives. These three alternatives will be moved into a second and more detailed screening. The evaluation measures used as part of the initial screening are generally more qualitative than quantitative. The initial screening will also include a comparison of capital costs between transit alternatives and the completion of the HOV lanes on I-24 from Briley Parkway to downtown Nashville. The screening will be performed in a charette in which consultants facilitate discussion and decision-making by members of the Steering Committee. The screening will develop three alternatives to be carried forward into Stage 2 Detailed Screening. These alternatives will be based upon the outcome of the scoring related to the Stage 1 Screening related to the goals and objectives, as well as the desires of the Steering Committee to test a range of alternate alignments, transit modes, and operational options in the Detailed Screening.

Stage 2 - the **Detailed Screening** evaluates the refined list of three alternatives as well as a no-build alternative (consisting of the existing-plus-committed system) and a No-Build or TSM ("Low Cost") alternative using more in-depth analysis. This includes quantitative measures where possible, including the first ridership estimates and detailed operating cost estimates. The transit-based alternatives will also be compared in terms of relative cost to an alternative extending the I-24 HOV lanes from their terminus near Harding Road to downtown Nashville. The Detailed Screening step will further narrow the alignment and design options to a single alternative that best meets the project goals and objectives and best satisfies the purpose and need for the project. The Steering Committee will develop a single final alternative as an outcome to the detailed screening.

Stage 3 - the **Final Screening** evaluates a single alternative that emerges from the Detailed Screening as it compares to both the No-Build and TSM scenarios. This alternative could include portions of one or more of the three alternatives identified in the second phase, or could include phased, "implementable" shorter operative segments of fixed-guideway (rail or busway) from one or more of the alternatives. This final screening process will provide the basis for selecting a locally preferred alternative (LPA).

Figure 3-15
Three Step Evaluation Process



3.9.2.3 Objectives and Measures of Effectiveness

The transportation goals for the study were translated into objectives and measures of effectiveness in order to evaluate the performance of each of the proposed alternatives. Many of the goals and objectives are related to the New Starts criteria and measures. For each goal, a measure (or series of measures) is used to compare the alternatives against each other. These measures may be qualitative (yes-no, or descriptive) or quantitative (expressed numerically, such as estimates of transit ridership or costs). These goals and objectives may be modified as the alternatives analysis proceeds, based on the availability of data, the concerns of the Steering Committee, and comments from Stakeholders, members of the public, and regulatory agencies.

<u>Goal 1:</u> Provide longer-distance travelers in the southeastern corridor with alternatives to driving private vehicles in heavily-congested traffic conditions.

This goal relates to several of the measures under the New Starts Criteria "Mobility Improvements," including Time Savings and Low Income Households Served.

Objectives:

1. Provide transit options serving longer-distance trips (primarily more than 3 miles in length) in the corridor that are competitive with, or ideally superior to, driving a private automobile, in terms of trip time, convenience (in the context of specific time-of-day and day-of week trips), safety, cost (to the individual user) and comfort.

   In the initial screening, the analysis of this objective will focus on the mode, with alternatives that are transit based and serving longer trips being favored over roadway-based or shorter distance alternatives. For the detailed and final screening of alternatives, the alternatives will be compared to one another according to the actual transit ridership for longer-distance trips and the overall travel time savings as compared to no-build on the transit network as predicted by the regional transportation model. This objective relates to Time Savings, a New Starts Measure.

2. Provide enhanced multi-modal access to home, jobs, services and other activity centers for corridor residents, workers, and visitors.

   The objective is analyzed similarly to the first objective, through comparison of ridership and travel time savings as predicted by the regional transportation model. This is based on the assumption that alternatives that provide the greatest multi-modal access for those traveling in the corridor will increase transit use and reduce overall travel time on the transportation network. This objective relates to several New Starts Measures including Time Savings and Low Income Households Served.

3. Increase utilization of public transit in the corridor for all trip purposes.

   The alternatives will be compared in terms of system-wide transit ridership, and ridership on the corridor-specific major improvements (such as a rail or bus line) that are the primary transit services in the alternative. This comparison will be based on the ridership estimates developed using the regional transportation model.

4. Provide transportation options that serve both work and non-work trips.

   The members of the project Steering Committee will initially compare the likely relative performance of each of the alternatives in terms of their ability to provide for both work and non-work trips according to their collective professional judgment. For example, an alternative that provides service only or primarily during peak travel periods might be judged to provide poor service to non-work trips. In the more detailed phases of the screening, the ridership estimates for each alternative will be disaggregated into home based work, home based other and non home based trips. Alternatives that offer the most balanced performance between these three categories of trips will rate higher on this objective.

5. Provide improved transit opportunities for reverse-commuters traveling from the northern areas of the corridor and other parts of the Nashville region to workplaces in suburban areas of the corridor.

   Initially, the Steering Committee will judge the prospects for each alternative to provide improved transit service for reverse commuters based on their collective professional judgment. For example, alternatives that provide less service in a reverse-commute direction would be judged as less effective for serving reverse commuters than alternatives offering a more balanced schedule of services in the peak and off-peak directions. Detailed analysis will focus on the actual number of reverse commute trips (trips opposite the prevailing direction of peak period travel) for each alternative, as predicted by the regional transportation model. This objective relates to the New Starts Measure Low Income Households Served.

6. Improve access to mass transit in areas of the corridor outside central Nashville.

   This objective will be measured using ridership estimates provided by the regional transportation model.

7. Provide greater diversity of transportation options in the corridor by providing improved conditions for pedestrians, bicyclists, and other non-automotive users.

Alternatives will be compared under this objective by comparing the number of residents who live within ½ mile of transit stations or stops under each alternative. This is based on the assumption that transit improvements are more conducive to favorable pedestrian and bicycling conditions than highway or roadway improvements, and that the greater the number of residents who reside within areas served by transit stations, the greater the number who will benefit from the pedestrian and bicycle improvements that should follow these transit improvements.

Goal 2: Promote efficient land use and development patterns in Nashville/Davidson County and the Rutherford County communities in the southeast corridor study area.

This goal and the objectives related to it applies to measures under the New Starts Criteria "Transit Supportive Land Use and Future Patterns"

Objectives:

1. Promote compact transit-accessible land development in Nashville, Murfreesboro, LaVergne, Smyrna and other communities in the southeastern corridor study area.

   The initial screening based on this objective will simply favor transit alternatives over non-transit alternatives. The detailed screening will measure the absolute distance of transit stops to a select list of employment and activity centers in the corridor. Alternatives where existing activity centers are located a short distance from transit stations are seen as being more promising in terms of promoting transit-accessible future land development, and would be seen more favorably than those where activity centers are further away from stations.

2. Concentrate employment and other activity centers within existing and planned transit corridors (fully considering the relationship of transit and parking availability, as associated with such activity centers).

   Scoring on this objective is based on the number of major employment and activity centers within 5 miles of a transit station and is based on the same reasoning as the analysis under objective 1, alternatives that place stations closer to existing centers would be more successful at concentrating future development.

3. Maintain and promote downtown Nashville, other existing established activity centers, including Interchange City, and downtown Murfreesboro as the main employment and activity centers in the corridor.

   The alternatives would be compared on this objective based on the Steering Committee's qualitative assessment of the ability of the alternative to provide access to employment and activity centers in the corridor. For example, the Steering Committee might consider the proximity of stations to the activity centers, the track record of the transit mode for supporting development, and other characteristics of the alternative.

4. Preserve farmland and open space in existing rural areas of the corridor.

   The analysis of the alternatives based on this objective will be based on the Steering Committee's qualitative assessment of the alternative's capacity to support farmland and open space preservation. Alternatives that avoid rural land, that tend to concentrate development around stations, or that bypass agricultural land would be considered positively under this objective.

5. Promote development that re-uses existing sites and buildings, and that efficiently uses existing infrastructure and public services.

   Initial screening based on this objective will consist of the Steering Committee's qualitative assessment of the relative capacity of each alternative to promote re use of existing sites and buildings, particularly the corridor's existing core areas. For example, alternatives that use existing rights of way or makes use of existing buildings as transit stations would be preferred over those that would require significant new right-of-way or infrastructure, or would threaten existing buildings. The number of acres of land within 5 miles of transit stations under each alternative will be used as a qualitative measure of this objective under the detailed alternatives, based on the assumption that this land would increase in value were the alternative to be built.

6. Promote multi-use development combining many activities including commercial, retail, education, recreation, and housing.

   The Steering Committee will consider qualitatively the potential for each alternative to promote multi-use development.

<u>Goal 3:</u> Improve and enhance economic development and employment opportunities and expand access to jobs.

Objectives:

1. Promote sustainable economic growth throughout the corridor by providing improved access and optional transportation modes.

   This objective will be measured in the initial screening qualitatively, with the Steering Committee comparing the relative development potential for each mode and alignment. For example, alternatives that provide a higher level of service, particularly in both the peak and reverse-commute directions, would be seen as preferable to those that provide a lower frequency of service or operate only in the peak direction. The detailed screening will calculate the total population residing within 5 miles of the station sites, and the number of jobs within ½ mile of station sites. Increased population and employment within close proximity to stations correlates with improved sustainable access for employees, which in turn helps sustain economic growth in the corridor.

2. Provide improved access to housing opportunities throughout the corridor by providing improved transportation access and options.

   Under this objective, the initial screening will be qualitative, based on the Steering Committee's professional judgment as to the quality of access to housing under each alternative. The Steering Committee would consider their knowledge of the location of housing developments, access to the developments by roadway and transit connections, and other aspects of the alternatives and the development surrounding the alignments. In the detailed screening, the assessment will analyze the population within 5 miles of the station sites, since access to housing depends on the distance of housing to the station sites. A distance of five miles is a standard distance for the service area of a park-and-ride lot.

3. Provide improved access to employment centers throughout the corridor by providing improved transportation access and options.

In the initial screening, the Steering Committee will make a qualitative comparison between the alternatives in terms of their ability to improve access to a number of key employment centers, including downtown Nashville, Vanderbilt/West End, Interchange City, Nissan, Dell, downtown Murfreesboro, and MTSU. This initial screening analysis will take into account the proximity of the stations and alignments to the activity centers, the character of the access to the sites by roadway and pedestrian connections, and other factors. The detailed screening will compare the combined distance of these sites from transit stations under each alternative.

4. Provide high quality transit access to Nashville International Airport from downtown Nashville, Murfreesboro and other areas within the corridor.

   The comparison between alternatives under this objective will calculate the travel time to the airport from downtown Nashville and downtown Murfreesboro under each alternative.

5. Enhance reverse commute options providing access for Nashville residents to job opportunities in other areas of the corridor.

   Detailed analysis will calculate the actual number of reverse commute trips (trips opposite the prevailing direction of peak period travel) for each alternative, as predicted by the regional transportation model. This measure is the same as used under Goal 1, Objective 5. This objective relates to the New Starts Measure Low Income Households Served.

6. Provide improved access to special events and other destinations in the study corridor.

   For the initial screening the Steering Committee will qualitatively assess how the alternatives improve access to special events and other destinations. The Steering Committee will consider the distance of stations and alignments to the special event sites, characterize the auto and pedestrian access to the sites, and will consider other factors. The detailed screening will be based on the distance of stations to special travel generators (major employment centers, shopping and entertainment centers, sports arenas, colleges, etc.)

<u>Goal 4:</u> Preserve the natural and social environment.

Objectives under this goal relate to measures under the New Starts Criteria Environmental Benefits.

Objectives:

1. Improve air quality.

   Detailed screening will calculate the change in vehicle miles traveled (VMT) and vehicle hours traveled (VHT) on the entire travel network under each alternative, as predicted by the regional transportation model. VMT and VHT are inputs to air quality models and are a standard surrogate for measuring the relative air quality impact of changes to the transportation system.

2. Minimize transportation-related noise impacts.

   Noise measurement estimates will be conducted for each alignment and mode and will be compared as part of the project environmental analysis.

3. Protect and, where possible, enhance environmentally sensitive areas.

   In the initial screening, the alternatives will be assessed based on this objective by comparing the number of parks, schools, bodies of water, and other sensitive sites and areas are within ¼ miles of the proposed alignment. Alternatives that affect more of these sensitive sites will be scored lover in terms of this objective. For the detailed screening, a literature search of State and Federal databases of environmentally sensitive areas will be consulted, and the number of sensitive sites affected by each alternative will be documented.

4. Minimize community and neighborhood disruption.

   The initial screening related to this objective will identify the number of sensitive community and neighborhood sites, such as schools, libraries, churches, community centers, and parks or playgrounds, within ¼ mile of the alignment (as in the previous objective). A second tier initial screening will be based on whether the improvements proposed in the alternative cross or lie adjacent to any part of the Stones River National Battle Field. In the detailed screening, environmental specialists from the consultant team will conduct and document a windshield survey of the alignments and will use this information to supplement that collected in the initial screening.

5. Minimize negative aesthetic impacts of transportation investments and, where possible, design systems that add to the aesthetic environment.

   The performance of the alternatives on this objective will not be addressed in the alternatives analysis, and will be addressed at later stages in the project development process. The alternatives are assumed to be designed to function efficiently while fitting in well with the character of the neighborhood.

6. Address environmental justice concerns by carefully assessing disproportionate impacts and providing improvements that benefit members of socially disadvantaged groups.

   The alternatives will be analyzed according to this objective by comparing the number of low income and minority households within a five mile radius of each station and within ¼ mile of the right of way. The five mile radius identifies minority and low income populations served by the alternative, while the number within ¼ miles of the right of way identifies the number impacted by the alternative. This objective is related to both the Environmental Benefits and Mobility Improvements criteria under New Starts.

7. Promote land use and development policies, and transportation strategies that are consistent and mutually supportive.

   To address this objective, the consultants will analyze existing land use in the corridor and compare the proposed alignment and station locations for each alternative and characterize the compatibility of the existing or proposed land use with the proposed transit improvements.

<u>Goal 5:</u> Develop a cost-effective transportation system improvement strategy that maximizes community consensus and institutional support.

Objectives under this goal are related to the Operating Efficiencies, Cost Effectiveness, and Local Financial Commitment criteria under New Starts.

Objectives:

1. Assure that total benefits of the preferred transportation investment strategy recommended by the study warrant their total costs.

   For the initial screening, capital and operating costs will be developed at a unit-cost level of detail. In the detailed screening, alternatives will be compared using capital costs developed at a higher level of detail, based on engineering quantities, and operating costs will be developed based on transportation model outputs. These costs will be converted to annualized costs according to FTA guidelines.

2. Achieve public consensus and institutional support, including the support of public agencies, local governmental entities and public officials, for the preferred transportation investment strategy recommended by the study.

   Public consensus on a locally-preferred alternative will be based on the outcome of public and stakeholder meetings and the decision-making processes of the Steering Committee, the MPO Transportation and Policy Boards and TDOT.

3. Ensure that the costs and benefits are shared equitably among citizens and governmental entities throughout the region.

4. Maximize the leverage of local funds in obtaining State and Federal funds to support transportation investments in the corridor.

   These two objectives will not be considered as part of screening, but rather are objectives that a locally preferred alternative are meant to achieve.

<u>Goal 6:</u> Develop a strategic part of a multi-modal transportation system that would facilitate the development of an integrated regional multi-modal system

Objectives:

1. Develop alternatives and strategies that complement, rather than conflict with, regional plans for development of a multi-modal system.

   The alternatives will be compared according to their consistency with the regional transportation plan and other applicable transportation planning documents. The locally preferred alternative may be adopted as part of an update or amendment to the regional long range transportation plan. In the final screening, the potential amount of investment in the locally preferred alternative that might be applicable to other transit lines will be documented.

2. Develop alternatives that are consistent with the transportation and development goals of the region as identified in the Nashville Area MPO's Long Range Transportation Plan and other regional planning documents.

   The alternatives will be compared in terms of their consistency with existing or proposed local land use plans.

3. Avoid alternatives that might negatively affect the development of other transportation modes or options to serve other corridors of the region.

   This objective will be analyzed qualitatively based on a consensus of the professional opinion of the Steering Committee. Those alternatives that would hinder or preclude potential development of other transit lines serving the region will rate lower. For example, an alternative that recommended a downtown terminal or alignment that would make it more difficult for an alternative in another corridor to use a different transit mode would perform poorly on this objective.

4.0 Phase I Screening of Alternatives

4.1 Introduction

The region's vision for a multi-county transit system to enhance mobility and provide a safe and efficient multimodal network is illustrated in both the 2025 and 2030 Nashville Area Long Range Transportation Plans. The assessment of existing conditions in Chapter 3 indicated a need to develop transportation strategies that would provide transportation alternatives to driving in the increasingly congested corridor conditions; provide transit options to travel in the corridor; and provide for a range of environmental improvements and social benefits.

This chapter describes the development and assessment of a broad range of alternatives that could potentially meet the transportation needs identified in Chapter 3. The process is guided by the project goals and the empirical analysis that is contained in that chapter, and provides the initial assessment of the potential costs and benefits of improvements in the corridor. The outcome provides a strong basis for developing a more detailed and more viable set of alternatives in a second round, that more closely meet the transportation needs and goals of the project.

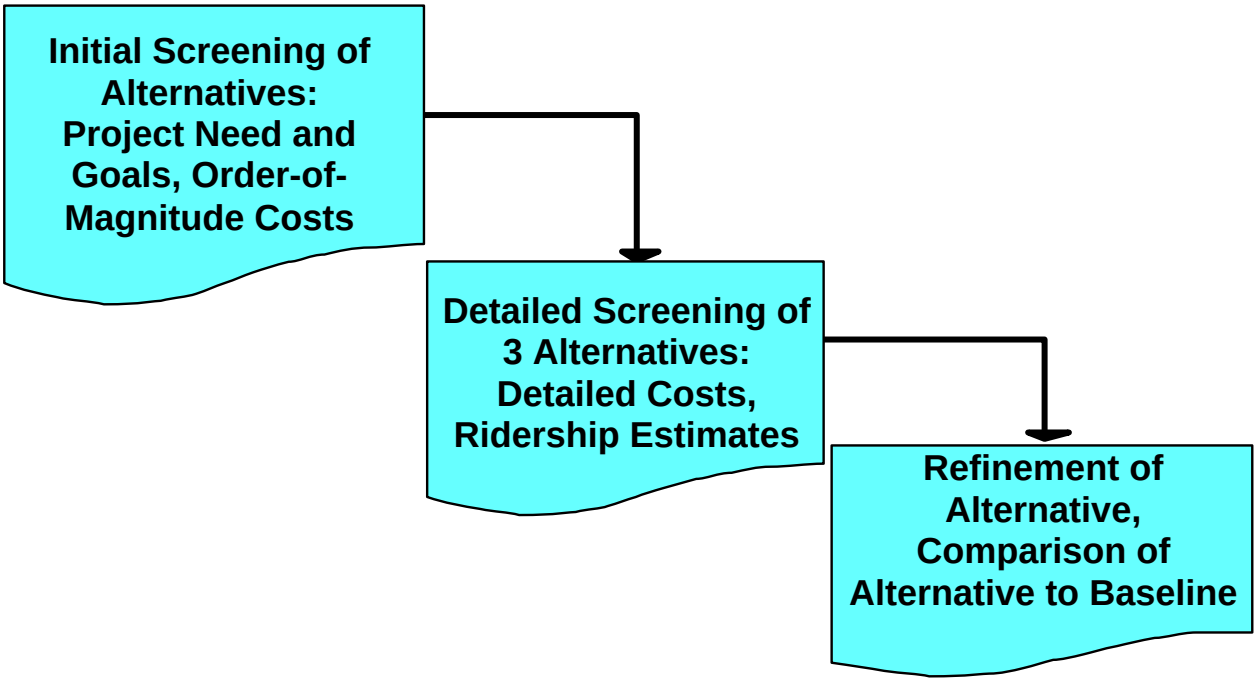
4.2 Alternatives Development and Evaluation Process

This task report describes alternatives that could potentially meet the transportation needs identified in Chapter 3, the Needs Assessment. The need for transportation improvements in the southeast corridor has been addressed in several studies over the past decade. The southeast corridor was selected to undergo the next phase of transit corridor planning because:

- The southeast corridor suffers the worst traffic congestion of the five major transportation corridors in the region.
- The corridor has experienced the highest rate of population growth of the five major corridors. (The study area accounts for 10 percent of the region's land area but contains more than 30 percent of the region's population.)
- The corridor contains a substantial concentration of trip origins and destinations
- The corridor includes one of the highest transit ridership routes in the region
- The corridor has a strategic position and role in the region as home to many of the areas largest employers, including Nissan and Dell Computer, which makes transportation access in the corridor vital to the region's continued economic success.

The evaluation methodology for the study is outlined in Section 3.9. In that section of the report, the purpose and need and goals and objectives described in Chapter 3 are used to develop screening criteria, and an initial range of options is identified. This chapter documents the development and screening of these initial alternatives. Subsequent chapters will document the development and screening of detailed alternatives together with the Baseline (Transportation System Management (TSM) or "No-Build" alternatives) and the development and refinement of a Locally Preferred Alternative (LPA). The evaluation process is shown in the following diagram.

Figure 4-1 Three Step Evaluation Process



In the initial screening, various transit types (such as Bus, Bus Rapid Transit, Light Rail and Commuter Rail) are combined with approximate potential alignments to form a long list of alternatives for comparison in terms of each alternative's feasibility, potential to meet the project purpose and need and study goals, order of magnitude costs and impacts. In this phase, the precise alignment and station location is less important than the general perception of the alternative's ability to serve the transportation need at a reasonable financial and environmental cost.

The detailed screening takes the most promising elements of the Phase I alternatives and combines them to form a short list of alternatives (3-5) and performs a detailed analysis, including detailed estimates of ridership, capital and operating costs, and compares the alternatives to one another and to the No-Build and TSM alternatives. The best-performing alternative in the detailed screening phase is then further refined and compared once again to the No-Build and TSM alternatives before one is selected as the Locally Preferred Alternative strategy to meet the transportation needs of the corridor.

4.3 Initial Range of Alternatives

The following section details the potential route alternatives and the transit modes, or types of transit service, that were considered.

4.3.1 Transportation Markets

The southeast corridor connects downtown Nashville at the northwest end of the corridor with Murfreesboro and Rutherford County at the southeast end. Between the end points are numerous major regional trip generators including the Nashville International Airport and surrounding area, Hickory Hollow regional mall, the cities of LaVergne and Smyrna, and major

employers (Dell, Bridgestone/Firestone and Nissan). The study area includes many commercial centers and residential areas, ranging from low to high density. The study area is intersected by a number of major highway routes, including US-231, SR-840, Sam Ridley Parkway, Waldron Road, Bell Road, Harding Place, Briley Parkway, and I-440.

The southeast corridor supports a mix of north-south travel markets. The needs assessment in Chapter 3 indicated a wide variety of short-and long-distance travel patterns in the corridor. Commuters to downtown Nashville and the Vanderbilt-West End area are a key travel market, but do not represent the majority of trips in the corridor. Other important travel markets include:

- Work and non-work-based travelers within Nashville-Davidson County, Smyrna, LaVergne, Rutherford County, and Murfreesboro.
- Travelers between Smyrna, LaVergne, Rutherford County, and Murfreesboro, and within those communities.
- Travelers from throughout the corridor who do not drive or lack access to a vehicle, including many younger, older and disabled people who live, work, shop or study in the corridor.
- Reverse-commuters to the many regional employment sites outside downtown Nashville, such as Dell and Nissan.
- Travelers to Nashville International Airport, including those working at the airport and those using it for air travel.
- Students traveling north to Vanderbilt, TSU, Treveca Nazarene and other educational opportunities in Nashville-Davidson County, and south to MTSU in Murfreesboro.
- Travelers to sporting and entertainment events in downtown Nashville, the Vanderbilt-West End area, and at Starwood Ampitheater.
- Shoppers from throughout the region traveling to retail areas such as Hickory Hollow Mall and other shopping areas in the corridor.

Other travel markets exist in the corridor. Transit alternatives are best suited to accommodating commuter markets to downtown Nashville and the West End area. These trips are concentrated by destination and time, with many people traveling to a single dense area (downtown Nashville and the adjacent Vanderbilt-West End area) during a relatively short period of time (the morning and evening rush hour periods). Commuter trips are the most likely to be delayed by congested traffic conditions and to contribute to traffic congestion. Offering a more convenient or faster alternative that attracts commuters to transit is perhaps the most effective use of transit to reduce traffic congestion and increase transportation system capacity. Commuter trips into the downtown area are also the most likely to be affected by parking costs.

However, while commuter trips are an important market for transit, they represent only a minority of trips in the corridor. An effective transportation strategy for the corridor must provide for a variety of travel markets, including shorter trips within the corridor, reverse-commute trips, connections for students to educational opportunities, and trips to special events like Titans and Predators games. The development of alternatives was guided by the need to provide fast and convenient service to commuters while also providing service for the range of travel markets in the corridor.

4.3.2 Potential Alignments

The initial examination of the corridor focused on three parallel existing rights-of-way as possible locations for improved transit service:

1. Interstate 24,
2. CSX Railroad
3. Murfreesboro Road (US-41 and 70 S).

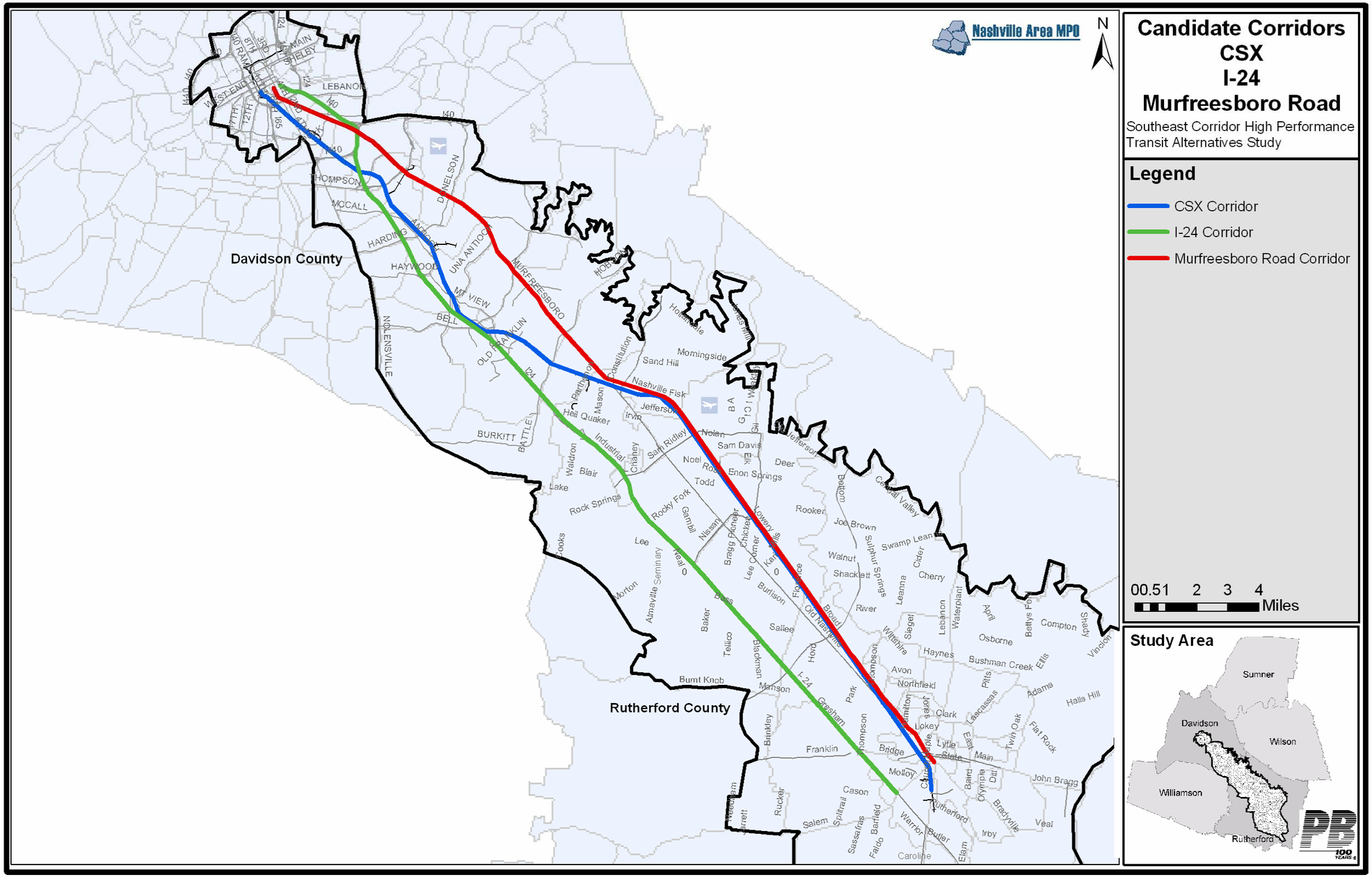
Figure 4-2 shows the location of the three major alignments.

Interstate 24 (I-24) connects major urban areas from St. Louis to Atlanta. Within Tennessee, the highway connects Nashville to Chattanooga and locally the highway forms the transportation spine in the southeast segment of the Middle Tennessee region. Eight lanes (four in each direction) have been built from downtown Nashville to State Route 840 (SR-840) in Rutherford County, approximately 27 miles. Beginning at the Harding Place interchange southeast to SR-840, the far left lanes in each direction are designated as High Occupancy Vehicle (HOV) lanes. These lanes are restricted to use by vehicles carrying two or more persons, or transit vehicles, during the two hour peak period, in the peak direction, on weekdays. South of the SR-840 interchange, I-24 is being widened to provide two additional lanes, for a total of six lanes to continue the HOV lanes to the approximate south end of the corridor. The current program also includes building two new interchanges in the Murfreesboro area, at Manson Pike and at SR-99.

I-24 often experiences heavy congestion in the peak direction and ruing the peak period. HOV lanes now are available throughout the corridor south of Harding Road. The sudden withdrawal of the HOV lane at Harding Road results in traffic backups as HOVs merge with other traffic. The region's long range transportation plan includes the eventual widening of the northern segment to provide HOV lanes—which also could be used by transit services. However, the improvements have not been programmed or funded and remain a long range improvement.

The CSX rail line operating through the corridor is part of the Chattanooga Subdivision of the railroad. The rail line operates through downtown Nashville via a double-track mainline and side tracks in the 11th Avenue "gulch area." The Landport structure, planned as a downtown commuter rail station and MTA bus transfer center, the former primary intercity train station (Union Station) and the Kayne yards and a small train storage area all are located in the gulch area south of Broadway. The CSX rail line continues south and east from downtown through LaVergne, Smyrna, Murfreesboro, and south to Chattanooga and Atlanta.

Figure 4-2
Candidate Alignments



Key operating characteristics of the CSX facilities in the southeast corridor include active use of the Kayne Street storage yard, very heavy freight traffic (more than 100 trains per day) from downtown to Chestnut Street where some trains turn south to Radnor Yards, heavy freight traffic (up to 35 trains per day) throughout the remainder of the southeast corridor and heavy freight traffic into and out of the Nissan plant in Smyrna. Right-of-way restrictions (narrow width and extensive cut and fill track sections) are more prevalent in the north segment of the corridor while periodic industrial sidings are scattered along the length of the corridor. The most restrictive conditions are in the Polk Avenue area, where two CSX tracks are at the bottom of a cut section approximately 20 feet deep. South of Polk Avenue the track cross sections are less restrictive. In this area, some sections are in cut and fill conditions while others are adjacent to level ground. In the Smyrna portion of the corridor the CSX tracks run parallel to Murfreesboro Road at approximately the same level. In some areas in the south of the corridor the CSX right of way is immediately adjacent to Murfreesboro Road.

Murfreesboro Road (US-41/70S) is a typical federal highway that formed the backbone of the pre-interstate highway system across the nation. Since the construction of I-24, it has become a regional arterial linking downtown Nashville with the developing suburbs in Davidson and Rutherford counties. A variety of improvements exist along its course: four and six lane urban sections lined with businesses, urban sections with a grass median, semi-rural settings with faster posted speed limits and separate urbanized suburban enclaves with commercial buildings in proximity to the roadway pavement. A limited number of intersections with major arterials and highways have been grade separated, but the predominate conditions in the corridor are represented by signalized grade intersections with primary streets and more numerous minor street intersections with traffic controls on the side streets.

Key operating characteristics of Murfreesboro Road include periodic roadway segments susceptible to heavy peak-hour traffic congestion, numerous traffic signals, periodic school zones and speed restrictions in urbanized areas.

4.3.3 Potential Types of Transit

The project Steering Committee initially considered a broad range of transit types. Some transit types clearly oriented to longer distance inter-city travel such as magnetic levitation rail (Maglev), and types oriented to very short trips such as automated guideway transit (AGT) also known as “people movers”, and personal rapid transit (PRT), were not considered. Additional information about the types of transit considered can be found in Chapter 6, the Technology Assessment.

Roadway widening to provide additional general purpose lanes also was not considered. Providing additional general purpose lanes to the existing facilities or on new right of way was thought by some members of the project Steering Committee to be inconsistent with the project’s purpose, to provide alternatives to driving in congested conditions. Additional general purpose lanes also would not support project goals related to preserving the natural and social environment, supporting existing development and compact land use, and other project goals that are advanced primarily by the provision of transit services and improvements.

The types of transit considered for the corridor follows.

Commuter Rail (CR) Commuter rail operations are typically in the morning and evening peak periods with a possible small amount of reverse commute and mid-day service. Commuter rail

uses two types of equipment: 1) conventional diesel railroad engines and passenger cars running in a “push-pull” configuration; or 2) diesel multiple units (DMUs) or self-propelled diesel passenger cars that comply with Federal Railroad Administration (FRA) safety standards for operating in freight rail environments. Passenger rail service in the CSX right-of-way will be subject to a negotiated agreement with the railroad, and high platform stations may be prohibited in the freight railroad environment.

Light Rail Transit (LRT) vehicles are modernized descendants of the early twentieth century street cars. Modern LRT vehicles can operate rapidly in exclusive rights-of-way or can operate on city streets in mixed urban traffic. They typically are powered by an overhead electric feed and have a passenger capacity several times that of buses. Non-FRA compatible DMU vehicles can operate similarly to LRTs and are sometimes referred to as Diesel LRTs. Diesel LRTs starting and stopping characteristics result in a somewhat slower travel time than the electric powered vehicles. LRT systems typically operate at high frequencies all-day rather than only during the peak-period.

Bus Rapid Transit (BRT) is a bus based system that uses infrastructure and technological improvements to significantly speed up the operating environment for the bus units compared to local bus operations. Top-of-the-line BRT systems employ separate pavements dedicated to bus-only use to allow buses to bypass auto traffic and travel undisturbed between stations or in an express mode to major destinations such as downtown Nashville. Many BRT systems use special bus fleets to provide higher capacity and a higher level of amenities than typical buses, and to help differentiate the BRT service from standard bus service. Electrically powered, hybrid or alternative fuel vehicles can be used. BRT systems provide considerable operational flexibility by allowing buses to circulate as local service in neighborhoods, for example, and then enter the busway as an express route directly to its destination or to multiple destinations within a small area. During such a trip, the passenger saves time by avoiding transfers between buses. Other buses operate from station to station on the BRT alignment in the same manner as an LRT system. BRT, like LRT, can provide all-day transit service as well as express or commuter service. BRT systems typically cost much less to implement than LRT systems and can more easily be implemented in multiple stages as funding and right of way become available. In areas where projected passenger loads are very high, LRT may be more efficient in terms of operating costs per passenger carried, because a light rail train with a single operator can carry many times the number of passengers as a single bus. However, if anticipated passenger loads are light, BRT can be an efficient option.

Bus Rapid Transit Light (BRTL) employs some of the same operating concepts as BRT, but does not include long sections of exclusive busway. Instead, BRTL uses existing HOV lanes and employs low-cost traffic engineering based solutions to bypass congested areas, such as queue jump lanes or signal priority systems. BRTL will not operate as fast and efficiently as BRT but can provide an improvement in terms of travel time and speed as compared to standard buses operating on city streets. Because BRTL does not include high cost dedicated busways, it is a low cost alternative to conventional BRT.

Heavy Rail/Subway is a very high capacity transit system featuring exclusive operating environments and is found in many large U.S. cities. For example, in Atlanta, the MARTA system utilizes underground alignments (subway), at grade alignments along highways and freight tracks and aerial guideway to achieve its separate operating path. Heavy rail delivers electric power to the train by a “hot” third rail. This requires that the tracks be completely isolated from the adjoining community. Because heavy rail is suited for large cities with heavy

transit ridership, it is not applicable to communities in the size category of Nashville, Charlotte, Memphis, Raleigh, and Louisville.

Monorail is a unique variation of aerial mass transit that has been present in the U.S. for thirty or more years. The system employs an elevated guideway beam supported by a row of columns. The train cars straddle the beam and carry passengers from station to station. In the U.S. it is primarily used in amusement resort parks where large volumes of passengers are moved through a controlled environment that requires minimum operating procedures such as switching trains between alternative tracks. Monorail is undergoing its initial urban application in Las Vegas where it is expected to carry large volumes of visitor traffic between the major hotel attractions and the nearby airport. Monorail is not applicable to the 30-mile Southeast Corridor for the following reasons: its aerial structural system and aerial stations are expensive on a per mile basis compared to at-grade transit service, its track record in providing urban/suburban transit service has not been demonstrated, and monorail is not applicable for express service when compared to proven bus and commuter rail modes.

High Speed Rail is an inter-city rail system that has been the subject of numerous studies throughout the US and abroad over the past 30 years. To date, none of the feasibility studies of high speed rail conducted in the US have proceeded into engineering design or construction. Most have been stopped or significantly delayed due to financial reasons or conflicts with scheduled airline service. Passenger rail service in the nation's northeast corridor has been incrementally improved over the years, but still lacks the operating features of a high speed system. The primary goal of high speed rail is to move passengers between major destinations at speeds comparable to airline trips between the same destinations. Within a major urban area it is possible that a high speed rail line may provide service to two or more stations in a corridor as part of larger intercity service patterns. It is unlikely, however, to have frequently spaced stations and to provide anything beyond express service from a central city stop to one or two suburban stations. This type of configuration would be unlikely to satisfy the transportation needs of the southeast corridor.

4.3.4 Pre-Screening of Combined Alignments and Transit Types

Table 4-1 shows the potential combination of transit types and alignments that were initially identified to serve the corridor. The Steering Committee performed a pre-screening of these corridors and transit types as the initial step in the screening of alternatives, and based on this pre-screening identified the six alternatives considered in the Phase I Initial Screening. The purpose of this pre-screening was to remove potential alignments or transit types that were clearly infeasible or not applicable to the transit needs of the corridor, so that study time and resources could be applied to alternatives with better prospects for implementation.

For the purposes of this pre-screening, which did not emphasize differences in operating characteristics, LRT and BRT were considered to be equivalent and indistinguishable modes. Both LRT and BRT require a similar footprint; both would occupy a linear corridor of 40 to 52 feet in width when in an exclusive operating alignment and would require similarly sized and functioning stations. Similarly, because commuter rail, which must operate on an exclusive rail right of way, and BRTL, which operates primarily in mixed traffic on public roads, are so different from each other and from LRT/BRT systems in space and operating characteristics that they are treated as distinct alternatives. Transit types and alignments that have been judged to be inappropriate for any alignment or application in the southeast corridor are described as "does not apply" in Table 4-1.

Table 4-1 Transit Type/Corridor Matrix

Type of Transit	Interstate 24:	CSX Railroad:	Murfreesboro Road:
Commuter Rail: Railroad Equipment or DMUs	Does not apply	**Appropriate**	Does not apply
Light Rail/DMU or BRT	**Appropriate**	**Appropriate**	**Appropriate**
BRTL	**Appropriate**	Does not apply	**Appropriate**
Heavy Rail/Subway	Does not apply	Does not apply	Does not apply
Monorail	Does not apply	Does not apply	Does not apply
High Speed Rail	Does not apply	Does not apply	Does not apply

This pre-screening of mode and alignment combinations left the following alternatives to be considered in the next step of screening. These alternatives were analyzed in the Phase I screening of alternatives:

Alternative 1: I-24 Alignment, LRT/DMU or BRT

Alternative 2: I-24 Alignment, BRTL

Alternative 3: CSX Alignment, Commuter Rail, Conventional Railroad Equipment or FRA-Compatible DMU

Alternative 4: CSX Alignment, LRT/DMU or BRT

Alternative 5: Murfreesboro Road Alignment, LRT/DMU or BRT

Alternative 6: Murfreesboro Road Alignment, BRTL

4.3.5 Description of Phase I Screening Alternatives

The alternatives identified in this phase of analysis describe transit types (Commuter Rail, LRT, BRT, or BRTL) operating on the three available alignments in the corridor. Each alternative operates primarily on one of the three corridors (I-24, the CSX rail line and Murfreesboro Road) but each alternative has differing end points in downtown Nashville and Murfreesboro. The alternatives are described below.

The six alternatives developed for this initial phase of analysis are all “build” alternatives, consisting of significant LRT, Commuter Rail or BRT services. Several of the alternative include options referred to as “BRT Light,” which consist of expanded bus service supported by only minor physical improvements. These “BRT light” options might be considered versions of a transportation management systems (TSM) alternative. However, this phase of analysis did not include a formal comparison of the alternatives with either a TSM or No-Build baseline alternative. The alternatives developed in the next, detailed phase of analysis and in subsequent phases will be compared to the No-Build and to a TSM alternative. See Chapter 5 for more information.

Operational details such as service frequencies or fare policies were not considered in this initial phase of development and are assumed to be equivalent across alternatives. A number of alignments for operating LRT/DMU or BRT service into downtown Nashville north of Gateway Boulevard have been identified by the study team and are depicted in the maps describing the alternatives. However, in this initial phase of screening, the precise alignment of BRT or LRT service downtown is irrelevant in differentiating between the alternatives. Downtown alignment options and station locations are described in these alternatives for illustrative purposes and for

the purposes of analysis, but will be analyzed in greater detail in the second, detailed phase of analysis in this study. Further, issues such as the availability of right of way, impacts on downtown traffic, engineering and environmental challenges and other factors that will not be analyzed in detail in the study could result in the relocation of downtown alignment and station locations during phases of the project development process after the completion of the study.

Alternative 1: I-24 Alignment, LRT/DMU or BRT

This alternative consists of an all-day LRT/DMU or BRT service in the alignment of I-24. The alternatives would operate in exclusive guideways from downtown Nashville to Murfreesboro and MTSU. As noted earlier, LRT can be either electrically-powered by overhead wires, or could use DMU technologies. The basic alignment for the alternative begins at the MTA Central Station (Music City Central) in downtown Nashville. This facility will be located on the north side of Charlotte Street between Fourth and Fifth Avenues, and is not part of the Southeast Corridor project. Various combinations of north and south one-way street pairs could be considered as possible north south routes for the alignment within the downtown area. These will be determined further in the detailed phase of analysis. For the purposes of the initial screening the alignment for this alternative was assumed to be southbound on Fourth Street and northbound on Fifth Street.

The alignment options under Alternative 1 are shown in the map in Figure 4-3. Under Alternative 1, from Gateway Boulevard, the BRT or LRT alternative could proceed east to First Avenue and south on Hermitage to the vicinity of Fairfield where transit would transition to the west side of I-24 by using an aerial structure. Following the western edge of the I-24 right-of-way, the transit guideway would fly over major cross streets. At the southern end of the corridor, the guideway would exit I-24 north of SR-96 and then travel south and east following Tennessee Boulevard to the end of the corridor at the MTSU Station. However, the alternative could follow multiple alignments in the Murfreesboro area and could terminate at various points in the corridor.

The LRT/DMU alignment would require exclusive tracks in the curb lane of city streets or along the outer edge of the interstate right-of-way. The north and southbound tracks would be located on opposite sides of city streets but on the same side of the interstate to minimize construction costs and facilitate operation of stations. On the interstate, a right-of-way width for the rail cars (LRT or DMU) between stations is assumed to be 40 feet (24 feet for the dynamic envelope surrounding the two tracks and eight feet outside the tracks on both sides to accommodate track drainage and emergency evacuation routes). At the stations a center platform between the tracks is assumed with a desired width of 24 feet and a minimum width of 18 feet. Depending on the availability of equipment, an LRT platform would likely be designed to accommodate a low-floor vehicle (approximately 14 inches in height), whereas the DMU platform may have to accommodate a high-floor vehicle with a high platform (approximately 36 to 40 inches above track height).

The BRT alignment would follow the same routing as the LRT/DMU option described above. The minimum right-of-way for the BRT guideway between stations along the interstate is assumed to be 52 feet (two lanes at 12 feet each, a center shoulder/buffer lane of 14 feet and eight feet for roadway drainage on each side of the busway). Stations with center platforms and the same minimum widths as the rail platforms would likely be designed to accommodate low-floor vehicles (approximately 14 inches above grade).

Station Locations*:* Assuming street running operation on the outside (curb) lanes of Fourth and Fifth Avenues downtown (northbound on Fifth and southbound on Fourth), street-running stations/stops in the downtown area could be located as follows:

1. MTA Music City Central, located in downtown Nashville on Charlotte Street between Fourth and Fifth Avenues.
2. Church Street, sidewalk station/stops would be on northbound Fifth at Church and southbound Fourth one block to the east on Church.
3. Broadway, a split station is assumed with the northbound station on Fifth Avenue and the southbound station on Fourth Avenue, both in the curb lanes on the south side of Broadway.

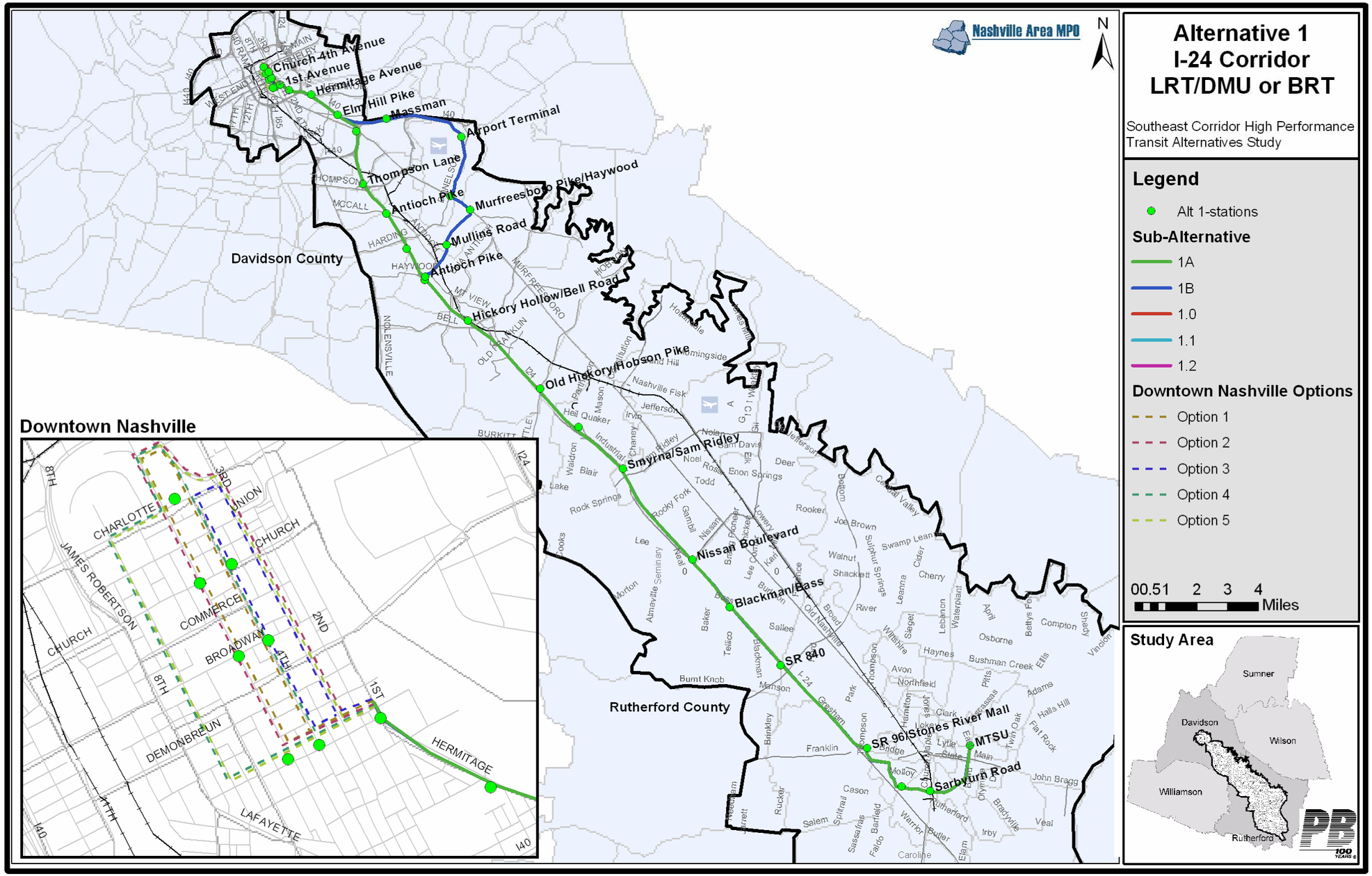
The outside-lane running configuration would continue on Gateway, First and Hermitage Avenues.

1. Gateway Boulevard, like Broadway, split stations on both Fourth and Fifth Avenues north of Gateway Boulevard, or on Gateway Boulevard in the vicinity of Fourth and Fifth Avenues.
2. First Avenue, a split station on Gateway Boulevard at First Avenue or on First near Gateway Boulevard.
3. Rolling Mill Hill, a station located to serve the proposed residential redevelopment project and to provide access to nearby destinations including the Metro offices at Lindsley Avenue.
4. Hermitage Avenue, this station would be located near the intersection of Fairfield Avenue.

The alignment previously described is the alternative 1A alignment between Murfreesboro Road and Haywood Lane. An alternate alignment through this area, Alternative 1B, is described below. Both alternative alignments are shown on the map in Figure 4-2.

1. Elm Hill Pike, the initial interstate station would be an aerial station spanning Elm Hill Pike adjacent to the I-24 ROW.
2. Murfreesboro Road, an aerial station on the west side of the interstate.
3. Thompson Lane, an aerial station on the west side of the interstate.
4. Antioch Pike, an aerial or at grade station on the west side of the interstate.
5. Harding Place, this aerial or at-grade station would be accessed from Apache Drive immediately south of the Harding Place/I-24 interchange on the west side of the highway.
6. Haywood Lane, this aerial or at-grade station would be accessed from Apache Drive immediately south of the Haywood Lane/I-24 interchange on the west side of the highway.
7. Hickory Hollow/Bell Road, this station would be located on Antioch Pike/Hickory Hollow Parkway on the east side of the interstate and north of the Bell Road.
8. Southeast Arterial or Old Hickory/Hobson Pike, a station would be at the new planned southeast arterial interchange or at the existing Old Hickory/Hobson Pike interchange with I-24.

Figure 4-3
Alternative 1: I-24 Alignment, LRT/DMU or BRT



9. LaVergne/Waldron Road, this first station in Rutherford County would be accessed from Industrial/Enterprise Boulevard on the east side of the interstate.
10. Smyrna/Sam Ridley, an at-grade station would be accessed from Industrial Boulevard.
11. Nissan Boulevard, this station at the Nissan Boulevard interchange would be on the east side of the interstate.
12. Blackman/Bass, a station on the west side of the interstate served by Blackman Road.
13. SR-840, a station would be located on Florence Road in the west quadrant of the interchange between the I-24 and SR-840. Provisions for direct access from the interchange ramps to park-and-ride facilities at the station would be developed, if possible.
14. SR-96/Stones River Mall, this station would be accessed from either Old Ford Road or Thompson Road on the east side of the interchange.

Street running stations in Murfreesboro would begin immediately south of the SR-96/Stones River Mall station and would utilize an alignment on Tennessee Boulevard. Each of these stations could function as a terminus of the system if engineering, right-of-way, or other issues prevent development of the system further south and west.

1. SR-99/New Salem Road, an at-grade station on Tennessee Boulevard with parking facilities intended to serve I-24 patrons living south of Murfreesboro.
2. Church Street, an at-grade station on Tennessee at Church Street (US-231).
3. MTSU, an at-grade station on the east side of the university on Tennessee Boulevard.

Station/stops in the downtown could be in the curb lanes or as part of an improved sidewalk. Stations in the I-24 right-of-way would be fully developed, as needed, with a platform, parking, feeder bus, and pedestrian sidewalk connections to the adjoining community.

Sub Alternative 1B – This sub-alternative at the north end of the corridor would be arranged to serve the Nashville International Airport by exiting the I-24 guideway south of the Haywood Lane Station to follow an alternate path to downtown Nashville via the airport. The Haywood Lane Station would be relocated to a point near the intersection of Haywood and Antioch Pike. From that point the guideway would follow the planned Haywood Lane extension to the north to a station at Mullins Road and a second new station at Murfreesboro Road. The guideway would turn west on Murfreesboro Road, north on Donelson Pike and enter an elevated airport station in the vicinity of the east end of the existing parking garage. Exiting the terminal area, the guideway would follow an elevated path across the long term parking and vehicular circulation roadways to follow a path along the south limits of I-40 to the west. A station would be located at Massman Drive adjacent to the I-40 right-of-way before the guideway reentered the I-24 right-of-way at the Elm Hill Pike Station. North of Elm Hill Pike, the guideway would follow the previously defined base alignment for Alternative 1.

The Sub-Alternative 1B alignment would substitute stations at Mullins Drive, Murfreesboro Road (near Donelson Pike), The Nashville Airport, and Massman Drive for stations on Alternative 1

where the following roads cross the path of the interstate: Harding Place (Apache Drive), Antioch Pike, Thompson Lane and Murfreesboro Road.

Alternative 2 – I-24 Alignment, BRTL

Alternative 2 also focuses on transit opportunities associated with I-24. The alignment for Alternative 2 (2A) proposes BRTL using the I-24 HOV lanes from near the south end of the corridor (SR-96) to Donelson Pike. At this point the interstate would be widened to permit buses to enter a bus-only aerial structure that would shift the BRTL to a busway on the east side of the CSX where the BRTL would run for a distance of about one and three quarters miles to the vicinity of Haywood Lane and Antioch Pike. At this point the busway would follow the planned route of the Haywood Lane extension northeast to Murfreesboro Road and proceed into downtown Nashville. BRTL units operating on Murfreesboro Road would receive preferential treatment to speed their travel time. A variety of traffic engineering techniques would be utilized to favor the bus operations, but no dedicated lanes would be constructed. This alignment is shown in the map in Figure 4-4.

At SR-96, the south end of the corridor in Murfreesboro, the guideway would exit I-24 to follow a new guideway alignment to SR-99 and then use Tennessee Boulevard to the end station at the MTSU campus.

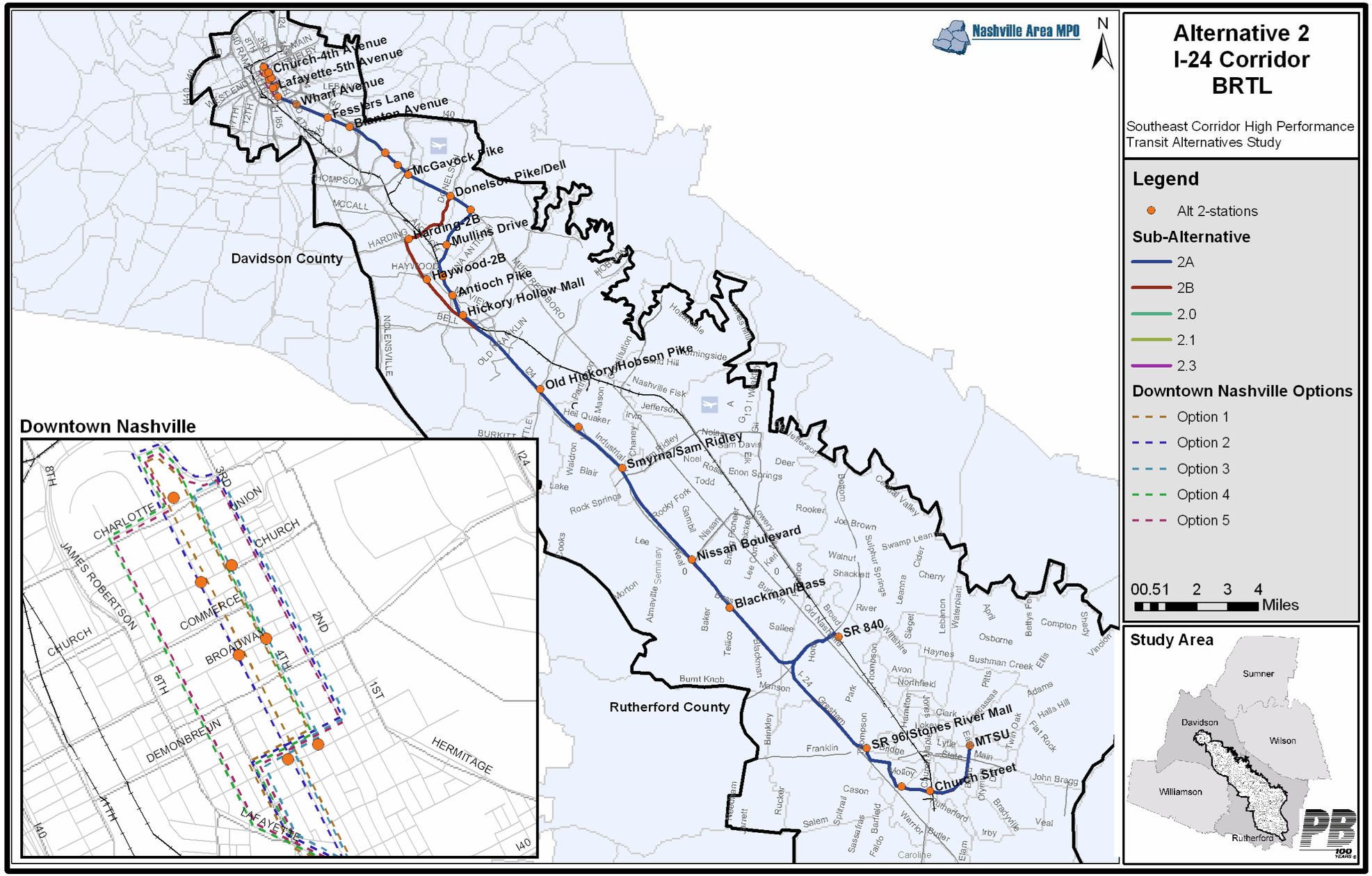
Operating plans for the BRTL would call for some through buses to exit the interstate to serve the station, or the station would be served by local buses that would then enter the HOV lanes as express service. Once in the HOV lane, express buses would not exit to serve additional line stations, but would continue non-stop to their planned destination.

Station Locations: Station/stops for the BRTL option would use improved sidewalks with pedestrian street-crossing signals, as needed. On the short busway segment along the CSX, the stations would resemble those in Alternative 1 with a platform, parking and pedestrian walk connections to the adjoining community. In the I-24 segment of the corridor, the BRTL bus units would operate in the center HOV lanes and gain access to and exit the HOV lanes by crossing the general purpose lanes to the existing interchanges. At the interchanges designated for stations, improvements would consist of station platforms, local/feeder bus facilities and park-and-ride facilities in the vicinity of the interchanges.

Assuming a Fourth-Fifth Avenue alignment downtown and the location of the MTA Transfer Center on the north side of Charlotte Street, street-running stations in the downtown area would be located along Fourth and Fifth Avenues from the MTA Transfer Center to Lafayette.

1. MTA Music City Central, located in downtown Nashville between Fourth and Fifth Avenues.
2. Church Street, sidewalk station/stops would be on northbound Fifth at Church and southbound Fourth one block to the east on Church.
3. Broadway, a split station is assumed with the northbound station on Fifth Avenue and the southbound station on Fourth Avenue, both in the curb lanes on the south side of Broadway.
4. Gateway Boulevard, like Broadway, split stations on both Fourth and Fifth Avenues north of Gateway Boulevard, or on Gateway Boulevard in the vicinity of Fourth and Fifth Avenues.
5. Lafayette Street, this station would have station/stops on both sides of Lafayette at Fourth Avenue.

Figure 4-4
Alternative 2 – I-24 Alignment, BRTL



6. Wharf Avenue, this split station would place platforms in the curb lanes on opposite sides of Lafayette Street/Murfreesboro Road.
7. Fesslers Lane, a split platform station at Fesslers Lane.
8. Blanton Avenue, a split station would be located immediately north of the I-24 interchange at Blanton Avenue.
9. Thompson Lane, this split station would serve residential areas on both sides of Murfreesboro Road.
10. Glengarry Drive, a split station would serve residential areas on both sides of Murfreesboro Road.
11. McGavock Pike, a split platform station would be built at this location.
12. Donelson Pike/Dell, a split platform station would be built at this location.
13. Haywood Lane Extended, a split platform station would be built at this location on Murfreesboro Road.
14. Mullins Drive, a split platform station would be built at this location along the extension of Haywood Lane.

South of the Mullins Drive station the BRTL would enter a short busway section on the east side of the CSX the right-of-way

1. Richards Road, a two-platform station would serve area residents and park-and-ride customers.
2. Antioch Pike, a two-platform station would serve area residents and park-and-ride customers.
3. Hickory Hollow Mall, a two-platform station would serve employers, area residents and park-and-ride customers. Feeder/shuttle bus connections would play an important role in this station's function.

Immediately south of the Hickory Hollow Mall Station an aerial flyover structure would carry buses into the center HOV lanes.

1. Southeast Arterial or Old Hickory/Hobson Pike, a station would be at the new planned southeast arterial interchange or at the existing Old Hickory/Hobson Pike interchange with I-24.
2. LaVergne/Waldron Road, the first station in Rutherford County would be accessed from Industrial/Enterprise Boulevard on the east side of the interstate.
3. Smyrna/Sam Ridley, an at-grade station would be accessed from Industrial Boulevard.
4. Nissan Boulevard, this station at the Nissan Boulevard interchange would be on the east side of the interstate.
5. Blackman/Bass, on the west side of the interstate served by Blackman Road.
6. SR-840, located on Florence Road in the west quadrant of the interchange between I-24 and SR-840. Provisions to provide direct access from the interchange ramps to park-and-ride facilities at the station would be developed, if possible.

7. SR-96/Stones River Mall, accessed from either Old Ford Road or Thompson Road on the east side of the interchange.

Street running stations in the Murfreesboro area would begin immediately south of the SR-96/Stones River Mall station and likely would utilize a curbside alignment on Tennessee Boulevard. As in Alternative 1, any of these stations might serve as a terminal station depending on availability of right of way, costs and other factors.

1. SR-99/New Salem Road, an at-grade station on Tennessee Boulevard with parking facilities intended to serve I-24 patrons living south of Murfreesboro.
2. Church Street, an at-grade station on Tennessee Boulevard at Church Street.
3. MTSU, an at-grade station on the east side of the university on Tennessee Boulevard.

Sub Alternative 2B – BRT Light via I-24 and Murfreesboro Road

An alternate alignment, designated 2B on the map, would operate in mixed traffic along Donelson Pike between I-24 and Murfreesboro Road. A truly "light" BRT option, this option would eliminate the likely flyover ramps, highway widening along I-24 and the development of a new alignment alongside the CSX rail line. These improvements would most likely generate high capital costs and would create significant impacts. However, without these improvements the service would operate at slower speeds, increasing the running time of bus services operating in the corridor.

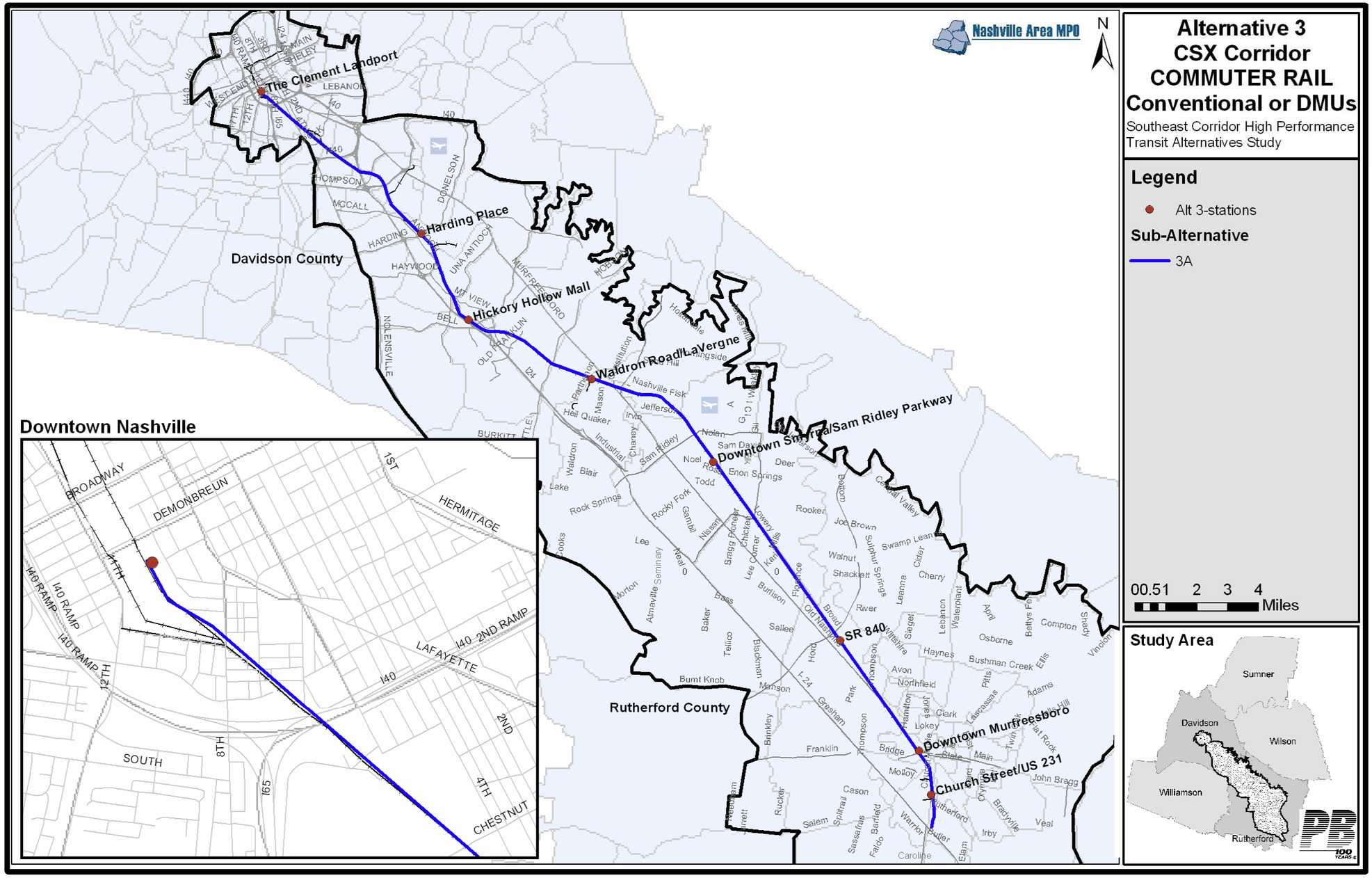
The 2B alignment introduces a station at Harding Road, relocates the stations at Haywood Lane Extended and Mullins Drive to along the I-24 alignment, and eliminates the stations at Richards Road and Antioch Pike.

Alternative 3 – CSX Alignment, Commuter Rail, Conventional Railroad Equipment or FRA-Compatible DMU

This alternative explores various options for developing commuter rail service on the CSX rail line. Transit modes to be tested in guideways along the railroad corridor in this alternative include commuter rail service using conventional railroad equipment, or using DMU vehicles that meet the crash-worthiness and other safety standards set by the Federal Railroad Administration (FRA) for operation in mixed traffic with freight rail equipment. This differs from the DMU technology described in Alternative 1 and employed as an option in Alternatives 4 and 5, which are not FRA-compliant and could not be safely or legally operated on an active freight rail alignment. It is assumed the volume of freight traffic would not allow for a transit operator to secure a dedicated time-of-day window of operation, or separation with freight rail operations, using the CSX rail line as it is now configured, but rather that the transit operator may be able to negotiate the purchase of access rights to the outer-edge portions of the right-of-way to develop additional rail line capacity. As with Alternative 1, there may be locations where additional right of way will be required alongside the CSX property to provide a path for transit. However, there may also be segments where the existing rail right-of-way is wide enough to accommodate both freight and passenger operations. The alternative is shown on the map in Figure 4-5.

The base alignment for Alternative 3 would use the CSX right-of-way, or land adjacent to it, for most of the 32 mile route. Passenger service would be operated on passenger tracks beginning at its southern terminus from a station near the intersection of the CSX right-of-way and Church Street (US-231) in Murfreesboro. This station is intended to provide sufficient park-and-ride facilities to meet the demand for a typical end-of-the-line station, and in this instance, the station

Figure 4-5
Alternative 3 – CSX Alignment, Commuter Rail, Conventional Railroad Equipment or FRA-Compatible DMU



is well served by proximity to I-24, thus increasing its usefulness in intercepting Nashville-bound motorists. From the southern terminus the passenger service would continue north to downtown Murfreesboro, the communities of Smyrna and LaVergne and continue into Davidson County. Passenger trains would continue north on the edge of the CSX right-of-way to a terminal platform at Landport served by the rebuilt Demonbreun Street Bridge and MTA shuttle buses.

Stations: Beginning in downtown Nashville, the commuter rail stations for the base alignment for Alternative 3 have been identified as follows. Park-and-ride facilities would be essential station components at all stations except for stations in the downtown areas of Nashville and Murfreesboro.

1. The Clement Landport, the north terminal station would complete the initial construction of the facility with the addition of a passenger platform, parallel to the CSX tracks and on the Landport property.
2. Harding Place, the first station south of downtown Nashville would have access from Harding Place and provide sufficient parking space and feeder bus connections for the mid-Davidson County commuter.
3. Hickory Hollow Mall, this station would be accessed from Antioch Pike/Hickory Hollow Parkway, north of Bell Road.
4. Waldron Road/LaVergne, primary access to the station from LaVergne and Interchange City would be from Waldron Road; parking would be provided.
5. Downtown Smyrna or Sam Ridley Parkway, this station would be located in downtown Smyrna at the former train station unless traffic handling/safety issues on Murfreesboro Road/Lowery Street and the proximate CSX tracks dictate otherwise. The Sam Ridley Parkway location would be a backup site.
6. SR-840, this station would be accessed from Murfreesboro Road/Broad Street and represent an expansion of the existing park-and-ride lot.
7. Downtown Murfreesboro, the station with minimum, if any, parking facilities would be located near Main Street and emphasize pedestrian and feeder bus access.
8. Church Street/US-231, this end-of-the-line station would emphasize parking with direct access from Church Street and nearby access to I-24 via the Church Street interchange.

Alternative 4 – CSX Alignment, LRT/DMU or BRT

This alternative provides transit service to the corridor using either LRT/DMU or BRT vehicles on an alignment that would parallel the CSX rail right of way along most of its alignment. The majority of the alternative's length would use the edge of the CSX right-of-way to provide an exclusive path for the transit system. Additional right of way would have to be added to the CSX property at certain locations to complete the path for transit. As with commuter rail, negotiations with the railroad would determine the extent of right-of-way available for use by transit. The LRT/DMU modes would be expected to occupy a path of at least 40 feet in width. Like Alternative 1, this width would include the space in which two transit vehicles would operate and sufficient adjacent space on each side to provide for drainage and track evacuation routes. The distance separating the centerlines of the transit tracks from the CSX freight tracks would have to be determined, but most likely would be required to maintain at least 26 feet of separation from the edge of the CSX freight tracks.

The BRT route would mimic the path described for LRT/DMU vehicles along the outer edge of the CSX right-of-way. On city streets, BRT units would operate in curb lanes with sidewalk stations/stops. Within and adjacent to the CSX right-of-way, the two lane busway with shoulder space and areas to resolve drainage problems would occupy a path of about 52 feet. Passengers accessing the stations would be channeled to separate their path from crossing the active busway pavement. Similar to rail stations, special provisions would have to be taken to channel pedestrians away from the freight tracks except at established public crossings.

The base routing for Alternative 4 would follow the CSX right-of-way north from SR-96 in Murfreesboro. South of downtown Nashville, the guideway would leave the CSX alignment and proceed into the city along various alignments. One option (4A) would route trains from the CSX right-of-way onto northbound Second, Third or Fourth Avenues, west on Oak Street and north on Sixth Avenue before crossing over to Fourth and Fifth (or other streets as selected to serve downtown Nashville) via Gateway Boulevard. Other options (4B, 4C, and 4D) would approach downtown via Lafayette Street, from various alignments that connect the CSX rail line to Murfreesboro Road.

At the south end of the corridor, the guideway would exit the CSX right-of-way at the Church Street/US-231 Station and operate on street via Tennessee Boulevard to the end-of-the-line at the MTSU campus. The alignments are shown on the Map in Figure 4-6.

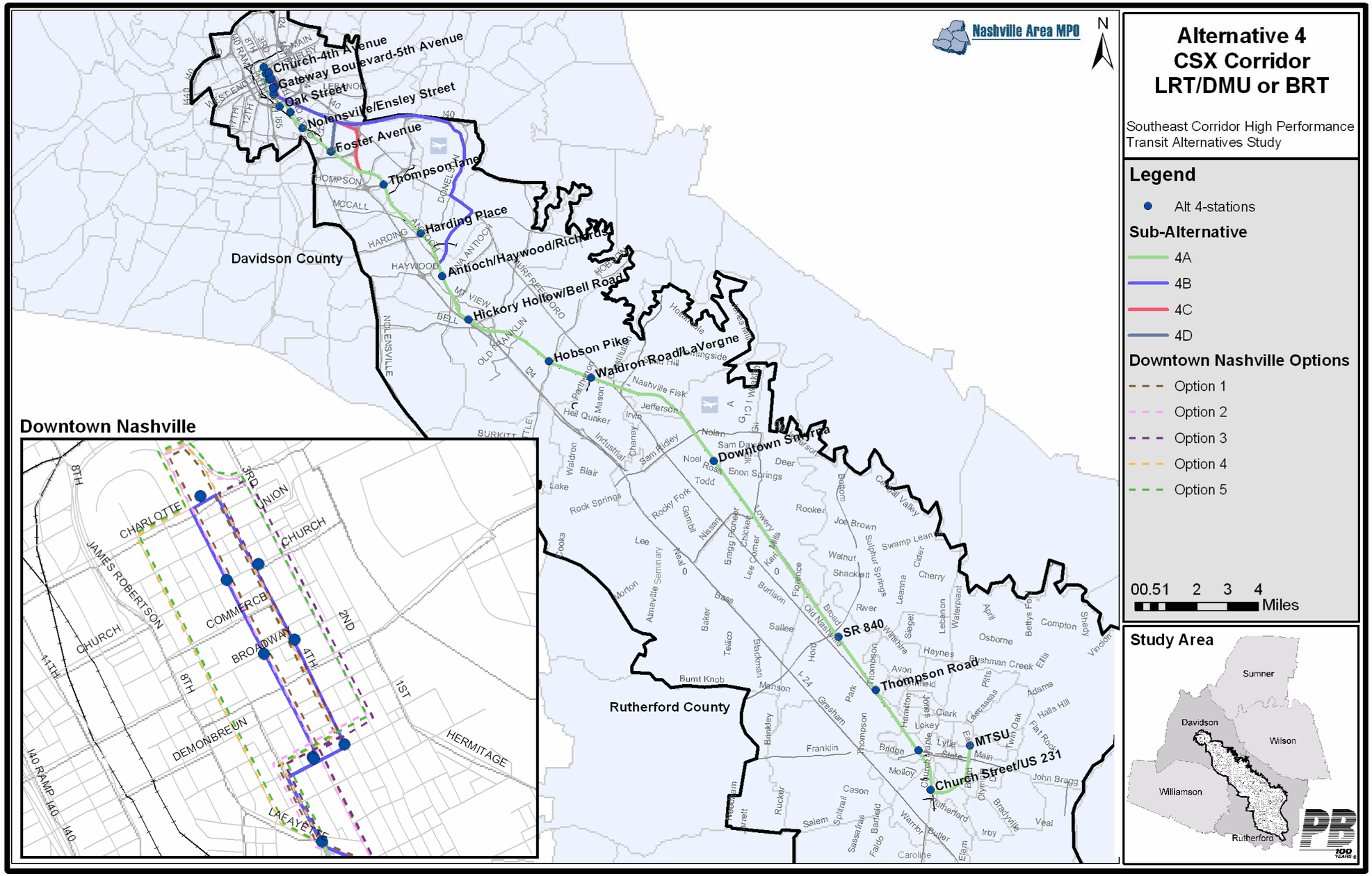
In Nashville-Davidson County, additional sub-alternative routing options for the corridor include leaving the exclusive guideway along the CSX and following the route of Alternative 2B north along the planned extension of Haywood Lane to the terminal of the Nashville International Airport, then along the southern side of I-40 to a point where the guideway transitions to Lafayette Street/Murfreesboro Road in the vicinity of Blanton Street, then into the downtown on Lafayette Street (4B); between the CSX rail line and Murfreesboro Road via Foster Avenue (4C) or via a rail line that parallels Creek Street and runs alongside the north-western side of Treveca Nazarene University (4D).

Stations: Beginning in downtown Nashville, the following transit stations have been identified for the base route.

Street running service in downtown Nashville would position transit in the curb lanes through the following seven stations.

1. MTA Music City Central in downtown Nashville between Fourth and Fifth Avenues.
2. Church Street, sidewalk station/stops would be on northbound Fifth at Church and southbound Fourth one block to the east on Church.
3. Broadway, a split station with the northbound station on Fifth Avenue and the southbound station on Fourth Avenue, both in curb lanes on the south side of Broadway.
4. Gateway Boulevard, This would be a split station with sidewalk station/stops on both sides of Gateway Boulevard at Fifth Avenue.
5. Lafayette Street, the station would be on 6th Avenue on the north or south side of Lafayette.Oak Street, this station would be near the intersection of 6th Avenue and Oak Street south of I-40.

Figure 4-6
Alternative 4 – CSX Alignment, LRT/DMU or BRT



6. Chestnut Street, depending on the routing, a station would be on Second, Third or Fourth Avenues at Chestnut Street.

South of the Chestnut Station the guideway for LRT or BRT would enter the edge of the CSX right-of-way.

1. Nolensville/Ensley Street, the first station on the CSX guideway, would serve the north end of Nolensville Road and the State Fairgrounds.
2. Foster Avenue.
3. Thompson Lane, the at-grade crossing of Thompson Lane at the CSX.
4. Harding Place, an aerial station that would span Harding Place to maximize pedestrian access and provide park-and-ride facilities.
5. Antioch/Haywood/Richards, accessed from Richards Road.
6. Hickory Hollow/Bell Road, located on Antioch Pike/Hickory Hollow Parkway on the east side of the CSX and north of the Bell Road. Feeder/shuttle bus connections would play an important role in this stations' functioning.
7. Hobson Pike
8. Waldron Road/LaVergne, primary access to the station from LaVergne and Interchange City would be from Waldron Road; parking would be provided.
9. Downtown Smyrna or Sam Ridley Parkway, this station would be located in downtown Smyrna at the former train station unless traffic handling/safety issues on Murfreesboro Road/Lowery Street and the proximate CSX tracks dictate otherwise. The Sam Ridley Parkway location would be a backup site.
10. SR-840, this station would be accessed from Murfreesboro Road/Broad Street and represent an expansion of the existing park-and-ride lot.
11. Thompson Road, this station would serve the northeast side of Murfreesboro.
12. Downtown Murfreesboro, located near Main Street, the station would emphasize pedestrian and feeder bus access.
13. Church Street/US-231, this end-of-the-line station would emphasize parking with direct access from Church Street and nearby access to I-24 via the Church Street interchange.

At Church Street in the south end of the corridor, transit would enter a street-running service along Tennessee Boulevard to the MTSU campus.

1. MTSU, an at-grade station on the east side of the MTSU campus on Tennessee Boulevard.

Stations/stops for the street-running portions of Alternative 4 in downtown Nashville and Murfreesboro would utilize sidewalk stations for the curb lane operating transit vehicles. Stations within or adjacent to the CSX right-of-way would be developed with a platform and, as needed, parking, feeder bus and pedestrian sidewalk connections to the adjoining community.

Alternative 5 – Murfreesboro Road Alignment, LRT/DMU or BRT

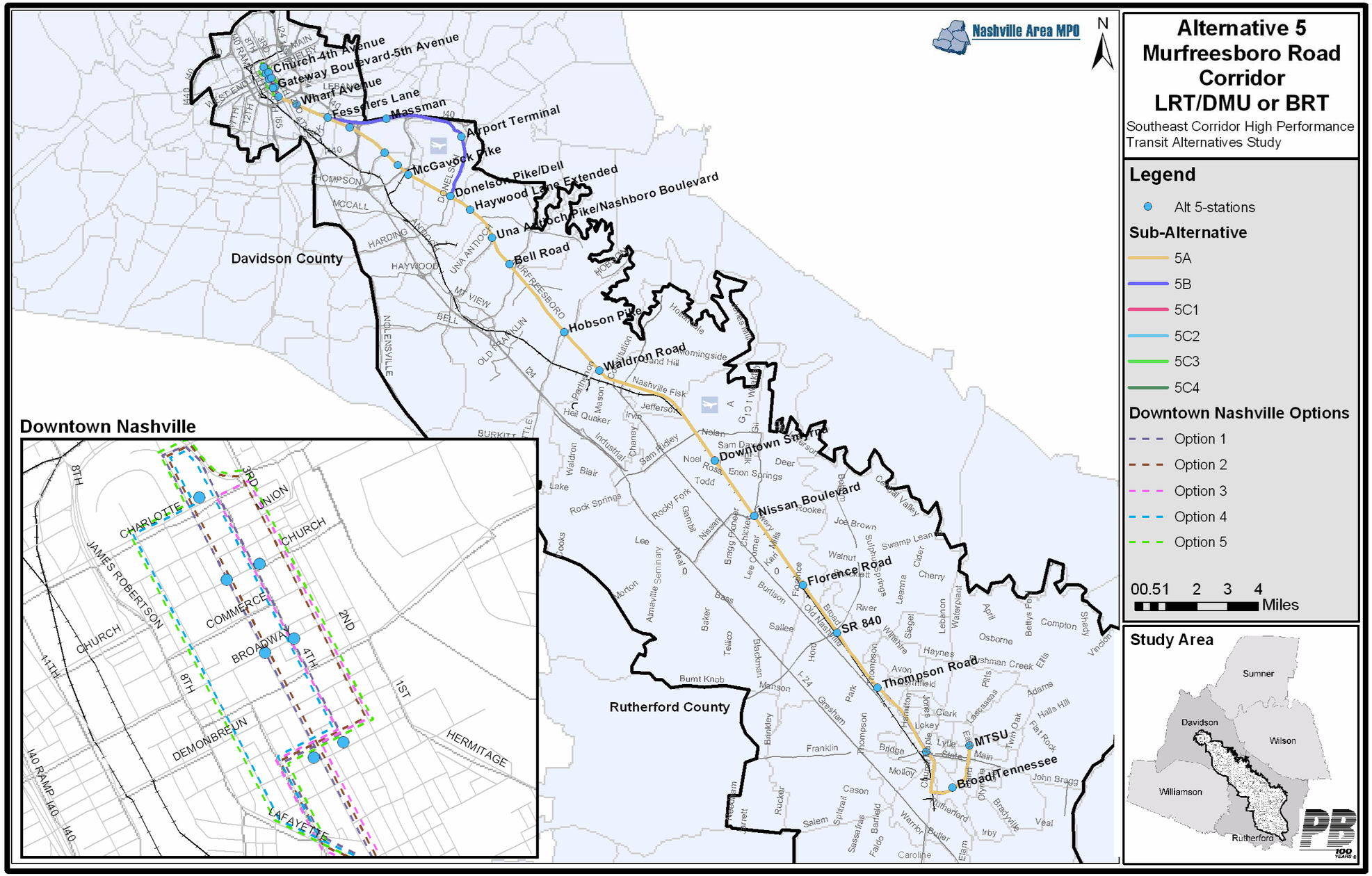
In Alternative 5 LRT, DMU or BRT service would operate on an alignment following Murfreesboro Road (US-41). Transit guideways for rail or bus would be located primarily in the center of the roadway, with the general purpose roadway lanes rebuilt to the outside on both

sides of the road (relocation of the roadway center line could allow for all of the reconstruction to occur on one side or the other of the existing roadway right-of-way). The rebuilding of the highway would require additional right-of-way and result in restrictions on vehicular turning movements that cross the center of the highway. At stations, the highway right-of-way would be widened to accommodate the center or outside platforms. Feeder/shuttle buses would use bus stops located in the curb lanes served by the signalized crosswalks. The alignment of the route (5A) is shown on the map in Figure 4-7.

Stations*:* Street-running stations would be typical throughout this alternative. Stations between the downtown Nashville MTA transfer center and the intersection of Murfreesboro Road and Haywood Lane extended would be the same as in Alternative 2. South of Haywood Lane, the additional stations would be along Murfreesboro Road. The stations are:

1. The MTA Music City Transit Center, this station is located in the downtown area of Charlotte Street between Fourth and Fifth Avenues.
2. Church Street, sidewalk station/stops would be on northbound Fifth at Church and southbound on Fourth one block to the east on Church.
3. Broadway, a split station is assumed with the northbound station on Fifth Avenue and the southbound station on Fourth Avenue, both in the curb lanes on the south side of Broadway.Gateway Boulevard, like Broadway, split stations on both Fourth and Fifth Avenues north of Gateway Boulevard, or on Gateway Boulevard in the vicinity of Fourth and Fifth Avenues.
4. Lafayette Street, this station would have station/stops on both sides of Lafayette at Fourth Avenue.
5. Wharf Avenue, this station would be located in the center of Lafayette Street/Murfreesboro Road.
6. Fesslers Lane, a station located on Murfreesboro Road at Fesslers Lane.
7. Blanton Avenue, a station located immediately north of the I-24 interchange at Blanton Avenue.
8. Thompson Lane, this station would serve residential areas on both sides of Murfreesboro Road.
9. Glengarry Drive, a station would serve residential areas on both sides of Murfreesboro Road.
10. McGavock Pike,
11. Donelson Pike/Dell,
12. Haywood Lane Extended,
13. Una Antioch Pike/Nashboro Boulevard,
14. Bell Road,
15. Hobson Pike,
16. Waldron Road,
17. Downtown Smyrna or Sam Ridley Parkway,

Figure 4-7
Alternative 5 – Murfreesboro Road Alignment, LRT/DMU or BRT



18. Nissan Boulevard,
19. Florence Road,
20. SR-840,
21. Thompson Road,
22. Downtown Murfreesboro, the station would be located on Broad Street near Memorial Drive and Main Street.
23. Broad/Tennessee, this station would emphasize parking with indirect access from I-24 via the Church Street interchange.
24. MTSU, an at-grade station on the east side of the MTSU campus on Tennessee Boulevard.

As on Alternatives 1, 2, 4, and 6, the airport alignment could serve the City of Murfreesboro via a number of alignments, and each station in the Murfreesboro area could serve as the terminal station if necessary.

Alternative 5B – International Airport Option

An optional route at the north end of the corridor, designated 5B, follows a route to the Nashville International Airport by turning north at Donelson Pike to a station at the airport terminal, turning west along the south side of I-40 to a station at Massman Drive and reentering Murfreesboro Road at the station at Blanton Avenue. Under this sub alternative, these stations would replace the stations under Alternative 5A at McGavock Pike, Glengarry Drive and Thompson Lane.

Alternative 6 – Murfreesboro Road Alignment, BRTL

This alternative places BRTL on Murfreesboro Road, running in the curb lanes of the highway. At major bottlenecks, the alternative could employ stretches of exclusive busway in the outside (right) lanes to avoid congested traffic and thus improving average operating speed. Other traffic devices used to maintain operating speeds could be queue-jump lanes at signalized intersections and preferential phasing at traffic signals. However, no full-length dedicated right of way would be implemented.

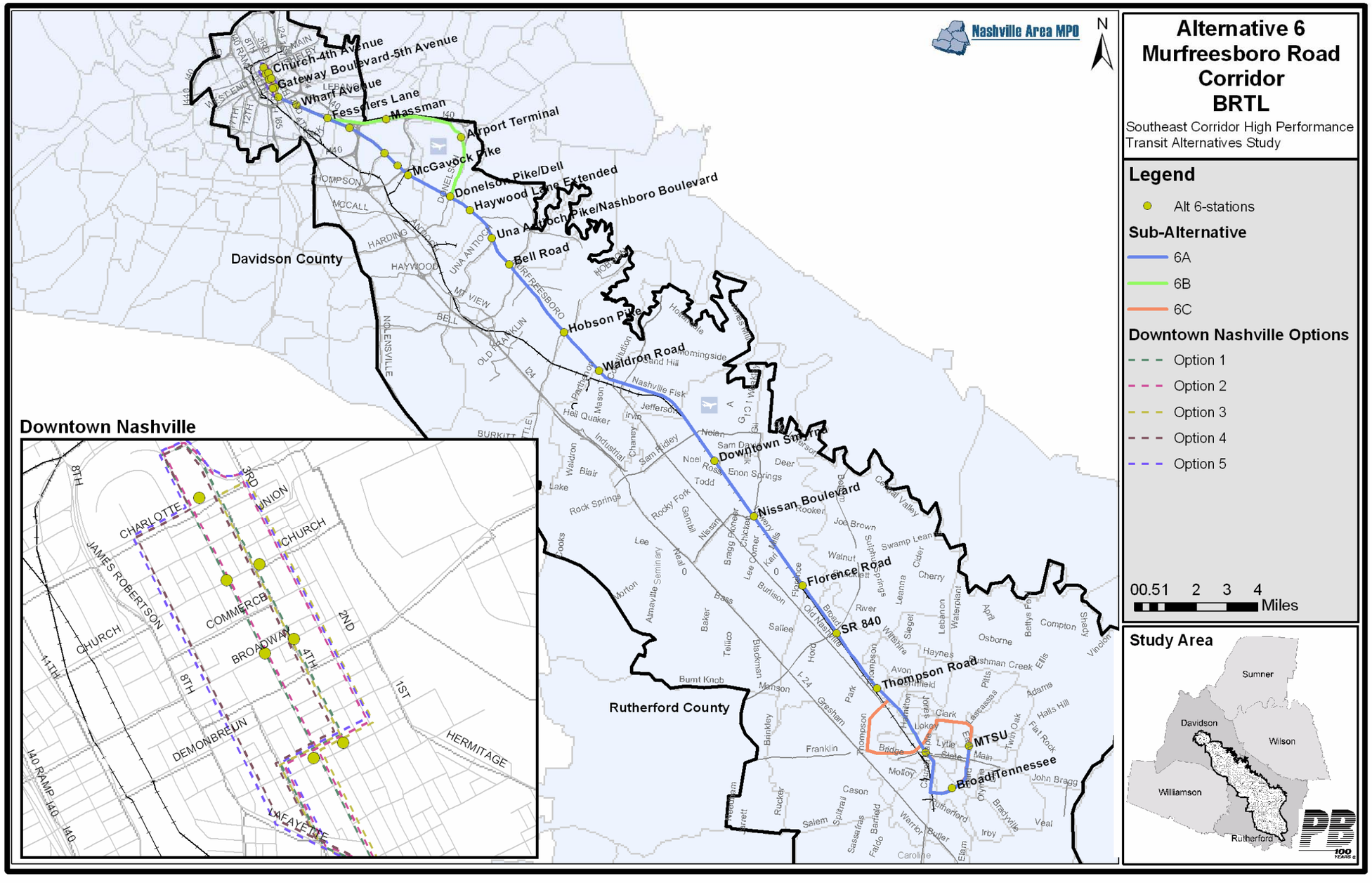
Unlike in Alternative 5, where left-turning traffic experiences major adjustments to its travel path, in Alternative 6 right turning traffic from and across the path of transit vehicles would present both safety and transit speed issues. Accordingly, steps to reduce right turns would be taken including the closing or consolidating drives to private property and closing some minor street intersections.

Station/stops would be located in the outside lanes of the highway and incorporated into sidewalks, as appropriate. Additional sidewalk and pedestrian improvements may be required to tie the stations to the adjoining walk-shed. Parking would be in facilities outside the highway right-of-way near the station/stops, and signalized pedestrian crosswalks would tie together the platforms on opposite sides of the highway. The alignment options are shown in the map in Figure 4-8.

Stations: Station/stops would be the same as those cited in Alternative 5.

1. MTA Music City Central in downtown Nashville between Fourth and Fifth Avenues.
2. Church Street, sidewalk station/stops would be on northbound Fifth at Church and southbound Fourth one block to the east on Church.

Figure 4-8
Alternative 6 – Murfreesboro Road Alignment, BRTL



3. Broadway, a split station is assumed with the northbound station on Fifth Avenue and the southbound station on Fourth Avenue, both in the curb lanes on the south side of Broadway.
4. Gateway Boulevard, like Broadway, split stations on both Fourth and Fifth Avenues north of Gateway Boulevard, or on Gateway Boulevard in the vicinity of Fourth and Fifth Avenues.
5. Lafayette Street, this station would have station/stops on both sides of Lafayette at Fourth Avenue.
6. Wharf Avenue, this station would be located in the center of Lafayette Street/Murfreesboro Road.
7. Fesslers Lane, a station on Murfreesboro Road at Fesslers Lane.
8. Blanton Avenue, located immediately north of the Blanton Avenue interchange with I-24.
9. Thompson Lane, this station would serve residential areas on both sides of Murfreesboro Road.
10. McGavock Pike,
11. Donelson Pike/Dell,
12. Haywood Lane Extended,
13. Una Antioch Pike/Nashboro Boulevard,
14. Bell Road,
15. Hobson Pike,
16. Waldron Road,
17. Downtown Smyrna or Sam Ridley Parkway,
18. Nissan Boulevard,
19. Florence Road,
20. SR-840,
21. Thompson Road,
22. Downtown Murfreesboro, the station would be located on Broad Street near Memorial Drive and Main Street.
23. Broad/Tennessee, this station would emphasize parking with indirect access from I-24 via the Church Street interchange.
24. MTSU, an at-grade station on the east side of the MTSU campus on Tennessee Boulevard.

Alternative 6B – International Airport Option

An optional route, 6B at the north end of the corridor follows the same route to the Nashville International Airport as defined in Sub-Alternative 5B including turning north at Donelson Pike to the Airport terminal station, turning west along the south side of I-40 to a station at Massman Drive and reentering Murfreesboro Road at the Blanton Avenue station. This sub-alternative

would substitute these two stations for three Alternative 6A stations: McGavock Pike, Glengarry Drive and Thompson Lane.

4.4 Screening of Phase I Alternatives

The screening of the 13 alternatives and sub-alternatives identified for the first phase of screening was based largely on qualitative assessments reached by the members of the project Steering Committee, MPO and consultant staff. These assessments were made in a series of meetings and workshops in which the alternatives were rated and a short list of alternatives was developed for assessment in the second phase of screening. The alternatives were compared to the initial phase screening criteria described in Section 3.8. These criteria, in turn, were based on the project goals and objectives identified in 3.0 Needs Assessment and Evaluation Methodology. The assessment is organized in the Phase I Evaluation Matrix that are shown in the tables included in this section of the report.

The Phase I assessment relies heavily on qualitative assessments of the relative advantages and disadvantages of each of the alternatives across the many evaluation criteria, and relatively few quantitatively-based assessments. On each of the qualitative assessments, the Steering Committee came to agreement, after much discussion, on an ordinal scoring of "+", "=" or "-" for each alternative, in which "+" is a positive score and "-" is a negative one, with "=" indicating that the factor is neither positive or negative for this alternative. This approach avoided excessive precision in what is obviously a rough estimate of the relative merits of each alternative across a wide range of criteria. Qualitative assessments such as these are based largely on the informed, but necessarily subjective, judgments of the Steering Committee members and staff participating in the discussions. Moreover, the various goals, objectives and criteria have not been "weighted" in terms of their relative importance by the Steering Committee. For these reasons, it is important not to consider this evaluation matrix as a mechanism for selecting a preferred alternative from among those examined in Phase I. It is better seen as a tool for organizing much of the information necessary for creating the smaller number of alternatives that will be examined in detail in the Phase II screening.

Goal 1: Provide Longer Distance Travelers in the Southeastern Corridor with alternatives to driving private vehicles in heavily-congested traffic conditions.

The initial screening of alternatives considered evaluation criteria based on several of the objectives included under goal 1. The analysis results are summarized in Table 4-2. The following discussion explains the results of the analysis for each of the objectives considered in the initial analysis under goal 1.

1. Provide transit options serving longer-distance trips (primarily more than 3 miles in length) in the corridor that are competitive with, or ideally superior to, driving a private automobile, in terms of travel time, convenience (in the context of specific time-of-day and day-of-week trips), safety, cost (to the individual user) and comfort.

The Steering Committee found that full LRT or BRT options along I-24, or CR, LRT or full BRT options using the CSX rail alignment, would be better suited to providing longer-distance trips serving standard commute travel markets and meeting the various requirements of this objective than the other options. BRTL in the I-24 and Murfreesboro Road corridors would be subject to delays due to congested traffic conditions and would cause delays, which would diminish the value of transit so commuters. The Steering Committee did not believe that BRTL options could provide travel speeds, comfort or convenience that could compete with driving

Table 4-2
Initial Alternatives Screening-Goal 1 Criteria

		Alternative 1: I-24 Alignment LRT/DMU or BRT		Alternative 2: I-24 Alignment BRT Light		Alternative 3: CSX Alignment Commuter Rail	Alternative 4: CSX Alignment, LRT/DMU or BRT				Alternative 5: Murfreesboro Road Alignment, LRT, DMU, BRT		Alternative 6: Murfreesboro Road Alignment, BRT Light	
Goals and Objectives	Initial Screening Criteria	1A via I-24	1B via Airport	2A via CSX-Haywood Extended	2B via Harding/ Donelson Pike		4A via CSX	4B via Airport	4C	4D	5A via Murfreesboro Road	5B via Airport	6A via Murfreesboro Road	6B via Airport
Goal 1: Provide longer-distance travelers in the southeastern corridor with alternatives to driving private vehicles in heavily-congested traffic conditions.														
1. Provide transit options serving longer-distance trips (primarily more than 3 miles in length) in the corridor that are competitive with, or ideally superior to, driving a private automobile, in terms of trip time, convenience (in the context of specific time-of-day and day-of week trips), safety, cost (to the individual user) and comfort.	Does the proposed strategy provide an alternative to automobile use for longer-distance travelers in the corridor (qualitative)	+	+	=	=	+	+	+	+	+	=	=	-	-
2. Provide enhanced multi-modal access to home, jobs, services, and other activity centers for corridor residents, workers, and visitors.	Will not be considered in initial screening.													
3. Provide transportation options that serve both work and non-work trips.	Does the proposed strategy provide transportation options that serve both work and non-work trips (qualitative)	+	+	+	+	-	+	+	+	+	+	+	+	+
4. Provide improved transit opportunities for reverse-commuters.	Does the proposed strategy provide for use by reverse-commuters (qualitative)	+	+	+	+	=	=	=	=	=	+	+	=	=
5. Improve access to mass transit in areas of the corridor outside central Nashville.	Number of residents within 1 mile of stations/stops (quantitative measure)	**89,000**	**90,000**	**91,000**	**86,000**	**34,000**	**81,000**	**83,000**	**82,000**	**78,000**	**86,000**	**86,000**	**82,000**	**82,000**
	Number of jobs within 1 mile of stations/stops (quantitative measure)	**178,000**	**186,000**	**192,000**	**199,000**	**144,000**	**172,000**	**183,000**	**177,000**	**174,000**	**189,000**	**189,000**	**190,000**	**190,000**
6. Increase utilization of public transit in the corridor for all trip purposes.	Will not be considered in initial screening.													
7. Provide greater diversity of transportation options in the corridor by providing improved conditions for pedestrians, bicyclists, and other non-automotive users.	Will not be considered in initial screening.													

"+" Positive or Better "-" Negative or Worse "=" Average or Little Change

and encourage significant numbers of commuters to switch to transit. LRT or BRT options using Murfreesboro Road would be delayed by frequent cross streets and frequent station spacing compared to the I-24 and CSX corridor options, causing travel time delays that would reduce the attractiveness of these options to commuters. The Steering Committee rated options operating on Murfreesboro Road lower on this objective, regardless of transit type, due to the large number of cross streets that could not be avoided under these options and the associated travel time delays.

2. Provide enhanced multi-modal access to home, jobs, services, and other activity centers for corridor residents, workers, and visitors. (not considered in initial screening)

3. Provide transportation options that serve both work and non-work trips

The Steering Committee interpreted this objective as the ability of each alternative to provide for non-work travel markets (such as shopping and entertainment trips), which were identified as important travel markets in Chapter 3. Non-work trips tend to be shorter, to not be oriented to downtown Nashville, and many are made during the off-peak travel periods (midday, evening and weekend) and in the reverse-commute direction. All of the proposed alternatives were rated well by the committee on this objective except the CR option on the CSX alignment. Commuter rail service on the CSX line would be limited by capacity and budget constraints to operating primarily, if not exclusively, in the peak direction and during the weekday peak travel periods, thus providing less service for reverse-commute direction travelers and little or no service during the midday, evening and weekend time periods. The wider stop spacing typical of commuter rail would limit the facility of the service for shorter trips. For these reasons, CR was perceived as serving non-work trip travel markets less well than the other options considered.

4 Provide transit opportunities for reverse commuters.

Under this objective, bus-based alternatives were generally rated more highly than rail-based ones for serving the reverse commute market. Bus-based alternatives would provide more opportunities for one-seat rides for reverse-commuters, while rail based options likely would require transfers.

5. Improve access to mass transit in areas of the corridor outside central Nashville.

This objective was evaluated based on the number of residents and the number of jobs located within one mile of stations located outside downtown Nashville. The alignments differed little in the number of people living and working near them; the numbers varied mainly based on the number of stations. All of the BRT and LRT alternatives ranged from 180,000 to 190,000 residents and 80,000 to 90,000 employees, regardless of whether they were in the I-24, CSX or Murfreesboro Road alignments, because these alternatives had about the same large numbers of stations throughout the corridor. CR alternatives had fewer stations and thus fewer people living or working near them. The CSX alignment had slightly fewer residents and employees than either Murfreesboro Road or I-24. Alternatives along I-24 had the most employees near their stations, while alternatives along Murfreesboro Road had the most residents.

6. Increase utilization of public transit in the corridor for all trip purposes. (not considered in initial screening)

7. Provide greater diversity of transportation options in the corridor by providing improved conditions for pedestrians, bicyclists, and other non-automotive users. (not considered in initial screening)

Goal 2: Promote efficient land use and development patterns in Nashville-Davidson County and the Rutherford County communities in the southeast corridor study area

The scoring of alternatives under the criteria applicable to Goal 2 is shown in Table 4-3. The evaluation of Goal 2, in this initial screening, was highly qualitative in nature, based primarily on the professional judgments and opinions of the members of the Steering Committee, the consultant team, and others who participated in the screening process. More detailed analysis of land use in the corridor is part of the detailed phase of alternatives screening.

1. Promote compact transit-accessible land development in Nashville, Murfreesboro, LaVergne, Smyrna and other communities in the southeastern corridor study area.

This objective was evaluated based on the transit type. Experience in other cities has shown that rail-based improvements (heavy rail, LRT or CR) have been successful in attracting and concentrating development around stations. Bus-based alternatives have not been proven to be as successful, or are too new to have a well-documented track record. BRT and BRT light alternatives were thus rated negatively on this objective, while CR and LRT alternatives were rated more favorably.

2. Concentrate employment and other activity centers within existing and planned transit corridors (fully considering the relationship of transit and parking availability, as associated with such activity centers).

This objective was measured according to the number of centers near (within 1 mile of) non-downtown based employment and activity centers, as identified in 3.0 Needs Assessment and Evaluation Methodology. Alternatives in the I-24 alignment were rated highest in this regard, with 8-9 major employment and activity centers lying within close proximity of its stations. Alternatives in the CSX alignment rated second, with 7-8 centers, and Murfreesboro Road was rated lowest, with only 5-6 centers. The commuter rail alternative along the CSX alignment had only five centers within close proximity, owing again to the wider station spacing and lower number of stations under that alternative.

3. Maintain and promote downtown Nashville, other existing established activity centers, including Interchange City and downtown Murfreesboro, as the main employment and activity centers in the corridor.

All alternatives are well connected and oriented to downtown Nashville and other employment and activity centers, although the activity centers that are well served vary between the three alignments (I-24, CSX and Murfreesboro Road). Alternatives using Murfreesboro Road were rated lower than the other alignments, largely because it would require crossing many intersections, which may make it slower than the other alternatives, and thus would provide a less convenient connection to Downtown Nashville and to the other activity and employment centers than the other alternatives.

Table 4-3
Initial Alternatives Screening-Goal 2 Criteria

		Alternative 1: I-24 Alignment LRT/DMU or BRT		Alternative 2: I-24 Alignment BRT Light		Alternative 3: CSX Alignment Commuter Rail	Alternative 4: CSX Alignment, LRT/DMU or BRT				Alternative 5: Murfreesboro Road Alignment, LRT, DMU, BRT		Alternative 6: Murfreesboro Road Alignment, BRT Light	
Goals and Objectives	Initial Screening Criteria	1A via I-24	1B via Airport	2A via CSX-Haywood Extended	2B via Harding/ Donelson Pike		4A via CSX	4B via Airport	4C	4D	5A via Murfreesboro Road	5B via Airport	6A via Murfreesboro Road	6B via Airport
Goal 2: Promote efficient land use and development patterns in Nashville/Davidson County and the Rutherford County communities in the Southeast Corridor Study Area.														
1. Promote compact transit-accessible land development in Nashville, Murfreesboro, LaVergne, Smyrna and other communities in the southeastern corridor study area.	Is the technology/alignment primarily transit-based (which tends to concentrate development)? (qualitative measure)	=	=	-	-	=	+	=	+	+	+	=	-	-
2. Concentrate employment and other activity centers within existing and planned transit corridors (fully considering the relationship of transit and parking availability, as associated with such activity centers).	Proximity of alternative and stations to existing employment and activity centers (Quantitative - Number of Centers)	**8**	**9**	**8**	**8**	**5**	**7**	**8**	**7**	**7**	**5**	**6**	**5**	**6**
3. Maintain and promote downtown Nashville, other existing established activity centers, including Interchange City, and downtown Murfreesboro as the main employment and activity centers in the corridor.	How well does the alternative strategy serve downtown Nashville, Interchange City, and downtown Murfreesboro (qualitative measure)	=	=	=	=	=	=	=	=	=	-	-	-	-
4. Promote development that re-uses existing sites and buildings, and that efficiently uses existing public infrastructure and public services.	Qualitative assessment of the use of existing public infrastructure	=	=	-	+	=	=	=	-	-	=	=	+	+
5. Promote multi-use development combining many activities including commercial, retail, education, recreation, and housing.	Will not be considered in initial screening.													

"+" Positive or Better "-" Negative or Worse "=" Average or Little Change

4. Promote development that re-uses existing sites and buildings, and that effectively uses existing public infrastructure and public services.

This criterion primarily examined the degree to which the alternatives used existing facilities rather than requiring additional right of way or construction of new facilities. The alternatives that scored most highly on this alternative were those did not require new facilities or right of way, primarily BRTL alternatives on using the I-24 and Murfreesboro Road alignments. Alternatives that required new right of way scored negatively.

5. Promote multi-use development combining many activities including commercial, retail, education, recreation, and housing. (not considered in initial screening)

Goal 3: Improve economic development and employment opportunities and expand access to jobs.

Table 4-4 lists the scoring of the criteria under Goal 3.

1. Promote sustainable economic growth throughout the corridor by providing improved access and optional transportation modes.

Options that offered strong potential for promoting new development and redevelopment were rated positively under this alternative. Thus, rail-based alternatives were rated positively, as were alternatives that would provide new access and open up new areas for development or redevelopment (Alternative 3, which used the CSX alignment, and 4C-Foster Avenue, and 4D-rail line paralleling Clark Street). Alternatives that offered little new infrastructure (especially BRT light alternatives) or served highly developed or undevelopable areas (such as the perimeter of the airport in alternatives 1B, 4B, 5B and 6B) were rated negatively.

2. Provide improved access to housing opportunities throughout the corridor by providing improved transit access and options.

Alternatives that met this objective were those whose stations were located nearer to, or were more accessible to, existing housing developments, which would benefit the alternative's capacity to serve many transit markets but particularly transit dependent populations. Areas surrounding I-24 and CSX contain more housing development than those surrounding Murfreesboro Road, which is predominately commercial or industrial. Thus, the I-24 and CSX corridors were ranked better than the Murfreesboro Road corridor on this criterion. Options that contained an airport alignment, which bypassed residential development as a result of the airport detour, scored negatively on this criterion.

3. Provide improved access to employment centers throughout the corridor by providing improved transportation access and options.

This objective was stratified by considering separately the performance of each alternative in serving a short list of the corridor's most important employment centers. By analyzing the service to employment centers, each alternative can be rated on the potential capacity to serve a variety of transportation markets, including commuters to downtown Nashville, commuters to locations south of downtown Nashville, and reverse commuters. Employment centers considered in the analysis included:

Table 4-4
Initial Alternatives Screening-Goal 3 Criteria

		Alternative 1: I-24 Alignment LRT/DMU or BRT		Alternative 2: I-24 Alignment BRT Light		Alternative 3: CSX Alignment Commuter Rail	Alternative 4: CSX Alignment, LRT/DMU or BRT				Alternative 5: Murfreesboro Road Alignment, LRT, DMU, BRT		Alternative 6: Murfreesboro Road Alignment, BRT Light	
Goals and Objectives	Initial Screening Criteria	1A via I-24	1B via Airport	2A via CSX-Haywood Extended	2B via Harding/ Donelson Pike		4A via CSX	4B via Airport	4C	4D	5A via Murfreesboro Road	5B via Airport	6A via Murfreesboro Road	6B via Airport
Goal 3: Improve economic development and employment opportunities and expand access to jobs.														
1. Promote sustainable economic growth throughout the corridor by providing improved access and optional transportation modes.	Qualitative assessment of development potential by modes	=	=	-	-	=	+	=	+	+	+	=	-	-
2. Provide improved access to housing opportunities throughout the corridor by providing improved transportation access and options.	Qualitative assessment of access to housing opportunities throughout the corridor	+	-	=	=	+	+	-	+	+	=	-	=	-
3. Provide improved access to employment centers throughout the corridor by providing improved transportation access and options.	Does the alternative improve access to (qualitative measure):													
	Downtown Nashville	+	+	+	+	+	+	+	+	+	+	+	+	+
	Vanderbilt/West End Area	+	+	+	+	-	+	+	+	+	+	-	+	+
	Interchange City	+	+	+	+	+	+	+	+	+	-	-	-	-
	Dell	-	+	+	+	-	-	+	-	-	+	+	+	+
	Nissan	-	-	-	-	+	+	+	+	+	+	+	+	+
	Downtown Murfreesboro/MTSU	+	+	+	+	+	+	+	+	+	+	+	+	+
4. Provide high quality transit access to Nashville International Airport from downtown Nashville, Murfreesboro and other areas within the corridor.	Will not be considered in initial screening.													
5. Enhance reverse commute options providing access for Nashville residents to job opportunities in other areas of the corridor.	Will not be considered in initial screening.													
6. Provide improved access to special events and other destinations in the study corridor.	Does the alternative enhance access to special events and special event destinations in the corridor (qualitative measure)	=	=	=	=	-	=	=	=	=	=	=	=	=

"+" Positive or Better "-" Negative or Worse "=" Average or Little Change

- Downtown Nashville
- Vanderbilt/West End Area
- Interchange City
- Dell
- Nissan
- Downtown Murfreesboro/MTSU

Alternatives were scored relative to their ability to provide connections for commuters to each of these sites. All of the alternatives were rated highly in their ability to serve downtown Nashville, but alternatives that bypassed other employment centers or had fewer stations were rated lower based on their inability to serve those sites. For example, alternatives in the I-24 alignment were rated low in their ability to serve Nissan, which is located in the Murfreesboro Road area; options operated on Murfreesboro Road were similarly rated low in their ability to serve Interchange City. The CSX rail alternative was rated lower than other alternatives in its ability to serve the Vanderbilt/West End area, Dell and MTSU, which can only be operated by shuttle buses under that alternative.

4. Provide high quality transit access to Nashville International Airport from downtown Nashville, Murfreesboro and other areas within the corridor. (not considered in initial screening)

5. Enhance reverse commute options providing access for Nashville residents to job opportunities in other areas of the corridor. (not considered in initial screening)

6. Provide improved access to special events and other destinations in the study corridor.

Most of the alternatives were ranked as equal in terms of serving special event markets and other short trip markets. The CSX commuter rail alternative was identified negatively, because the commuter rail service would provide little or no evening or weekend service, which would preclude special events service, because the CSX rail alternative is not located adjacent to some of the special events locations such as the Starwood Amphitheater or the locations of games of area sports teams such as the Tennessee Titans football team, Nashville Sounds baseball team, and the football teams of Vanderbilt, TSU and MTSU, and because the commuter rail option would have fewer and more widely-spaced stations, which would further limit the number of locations within walking distance of stations.

Goal 4: Preserve the Natural and Social Environment

Table 4-5 shows the scoring for criteria under Goal 4. A number of the more critical evaluations of environmental impacts were not considered at this stage of the analysis. These include direct comparison between the alternatives in terms of their impact on air quality, noise and vibration, aesthetic considerations, and land use. The more detailed evaluation of criteria will be made in the detailed evaluation of alternatives.

1. Improve air quality. (not considered in initial screening)

2. Minimize transportation-related noise impacts. (not considered in initial screening)

3. Protect and, where possible, enhance environmentally sensitive areas.

Table 4-5
Initial Alternatives Screening-Goal 4 Criteria

		Alternative 1: I-24 Alignment LRT/DMU or BRT		Alternative 2: I-24 Alignment BRT Light		Alternative 3: CSX Alignment Commuter Rail	Alternative 4: CSX Alignment, LRT/DMU or BRT				Alternative 5: Murfreesboro Road Alignment, LRT, DMU, BRT		Alternative 6: Murfreesboro Road Alignment, BRT Light	
Goals and Objectives	Initial Screening Criteria	1A via I-24	1B via Airport	2A via CSX-Haywood Extended	2B via Harding/ Donelson Pike		4A via CSX	4B via Airport	4C	4D	5A via Murfreesboro Road	5B via Airport	6A via Murfreesboro Road	6B via Airport
Goal 4: Preserve the natural and social environment.														
1. Improve air quality.	Will not be considered in initial screening.													
2. Minimize transportation-related noise impacts.	Will not be considered in initial screening.													
3. Protect and, where possible, enhance environmentally sensitive areas.	Proximity to or impacts on parks, schools and other institutions; impacts on bodies of water; number of private properties impacted; aesthetic considerations (within 500 ft - quantitative measure).	**800**		**1,200**		**800**	**1,600**				**1,800**		**1,900**	
4. Minimize community and neighborhood disruption.	Proximity of alternatives to parks, schools, hospitals, and other institutions/community services (within 500 ft - quantitative measure)	**9 Parks, 3 Schools, 1 Hospitals**		**8 Parks, 2 Schools, 1 Hospitals**		**7 Parks, 2 Schools, 0 Hospitals**	**12 Parks, 7 Schools, 0 Hospitals**				**2 Parks, 5 Schools, 0 Hospitals**		**5 Parks, 6 Schools, 0 Hospitals**	
	Does the alternative cross or touch the Stones River National Battle Field (Yes/No)	**No**	**No**	**No**	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**No**	**No**	**No**
5. Minimize negative aesthetic impacts of transportation investments and, where possible, design systems that add to the aesthetic environment.	Will not be considered in initial screening.													
6. Address environmental justice concerns by carefully assessing disproportionate impacts and providing improvements that benefit members of socially disadvantaged groups.	Locations of concentrations of low income and minority communities within 1/4 mile of alignment (quantitative measures):													
	Stations	**8,000 Minority 16,000 Low-Income**		**10,000 Minority 13,000 Low-Income**		**2,000 Minority 5,000 Low-Income**	**3,200 Minority 10,000 Low-Income**				**10,000 Minority 15,000 Low-Income**		**10,000 Minority 15,000 Low-Income**	
	Alignment	**21,000 Minority 22,000 Low-Income**		**22,000 Minority 20,000 Low-Income**		**9,000 Minority 13,000 Low-Income**	**20,000 Minority 20,000 Low-Income**				**23,000 Minority 19,000 Low-Income**		**24,000 Minority 21,000 Low-Income**	
7. Promote land use and development policies, and transportation strategies that are consistent and mutually supportive.	Will not be considered in initial screening.													
8. Provide transportation options that reduce stress.	Will not be considered in initial screening.													
9. Minimize impacts to farmland and open space in existing rural areas of the corridor.	Number of acres of rural land within 100 feet of alternative alignment and stations (quantitative measure)	**1,700**		**2,700**		**1,200**	**1,200**				**1,900**		**1,600**	

"+" Positive or Better "-" Negative or Worse "=" Average or Little Change

This criterion measures the potential impacts of the alternatives on parks, schools and other institutions, impacts on bodies of water, the number of private properties impacted within 500 feet of the alignments of the alternatives. In this phase, the analysis was limited to the number of private properties impacted by the various alternatives, because many of the other elements of this criteria (such as proximity to parks, schools and bodies of water) were considered under other criteria and will be reported as such.

The GIS analysis of the alternatives found that the Murfreesboro Road alignments would have the greatest impacts on private property, impacting 1,800-1,900 private parcels. The alternatives in the I-24 alignment that remained almost wholly within the I-24 right of way over their entire alignment (1A, 1B) and the CSX Commuter rail alternatives (Alternative 3) impacted the fewest parcels (800). Alternatives that diverged from the highway or rail alignments in the area just south of downtown Nashville quickly increased the number of properties they affected by passing through residential and industrial areas south of the city.

4. Minimize community and neighborhood disruption.

This criterion in this phase of the analysis considered the number of parks, schools and hospitals that would lie within 500 feet of the alternative rights of way and thus might be adversely affected by the alternatives. The results vary greatly between the alternatives. The greatest number of impacts were created by the combination of on and off railroad alignments in Alternative 4, the LRT/DMU or BRT on the CSX alignment. This set of alternatives potentially would impact 12 parks and 7 schools. The I-24 alignments also affected a large number of sites, primarily parks. The Murfreesboro Road alignments affected the fewest sites overall and affected fewer parks but larger numbers of schools than the other alternatives. The CSX commuter rail alternative, whose right of way is almost exclusively in a long-time rail right of way, also had relatively few impacts of this type.

Affects on the Stones River National Battlefield, a historic site in the southern portion of the alignment of the corridor north of Murfreesboro, are a key piece of the environmental analysis. In this initial phase of analysis, the evaluation notes that the CSX alignment and alternatives that use that alignment would pass through the battlefield. This is particularly an issue for alignments under Alternative 4, which necessarily would require additional right of way in this area. Alternatives operating in the Murfreesboro Road and I-24 alignments would not directly affect the battlefield site.

5. Minimize negative aesthetic impacts of transportation investments and, where possible, design systems that add to the aesthetic environment. (not considered in initial screening)

6. Address environmental justice concerns by carefully addressing disproportionate impacts and providing improvements that benefit members of socially disadvantaged groups.

The issue of environmental justice impacts is a complicated one of balancing the need to provide access for minority and low-income people to use a proposed transit improvement, while ensuring that they do not disproportionately suffer negative impacts of building and operating the improvement—issues such as noise, vibration, property acquisitions and other dislocations. The detailed analysis will take a more in-depth look at environmental questions. In this phase, the analysis considered the number of minority and low income persons located within 500 feet of stations and alignments. The proximity to stations considers the positive aspect of the improvement for minority and low-income communities, since proximity to stations

equates to access to the proposed improvements. Proximity to the alignment equates to the potential negative aspects.

In all cases, more minority and low income persons live near the alignment than they do the stations. Alternatives in the CSX alignment provide relatively less access to minority and low income populations than the other alternatives, and fewer minority and low income people would be negatively impacted by the alternatives in that alignment. The alternatives serving Murfreesboro Road and I-24 were relatively the same, each serving around 10,000 minority and 10,000-15,000 low income persons living within the station areas, while impacting around 20,000-25,000 minority and low income persons.

7. Promote land use and development policies, and transportation strategies that are consistent and mutually supportive. (not considered in initial evaluation)

8. Provide transportation options that reduce stress. (not considered in initial evaluation)

9. Impacts to farmland and open space in existing rural areas of the corridor.

This criterion measured the acres of rural land (zoned agricultural or public open space) located within 100 feet of the alignment and stations. The CSX alignment alternatives ranked best in this regard, with most of its alignment located in older, built-up areas. The I-24 BRT light alignment (Alternative 2), which veers off existing I-24 alignment, performed worst, affecting some 2,700 feet of agricultural and open space land.

Goal 5: Develop a cost-effective transportation system improvement strategy that maximizes community consensus and institutional support.

Table 4-6 shows the scoring of criteria under Goal 5. Costs and benefits, as well as the institutional and funding structure necessary to build and operate major transit improvements, are major challenges facing any significant expansion of a transit system. Preliminary capital cost estimates, made at a conceptual, unit cost level, were used to compare the alternatives in this phase of analysis. Operating cost estimates and more detailed capital cost estimates will be made for the detailed screening of alternatives. The Steering Committee also rated the alternatives in terms of their potential for community support.

1. Assure that total benefits of the preferred alternative investment strategy warrant their total costs.

This key evaluation criteria under the FTA's New Starts program is made by comparing the benefits to the transportation system (estimated by the travel demand model) to the net annual operating cost and annualized capital cost of developing, building and operating the proposed system. Since model runs were not performed for this initial analysis, a full estimate of the costs and benefits are not possible. Capital cost estimates were made for each of the alternatives and sub-alternatives and offered a first comparison between them. Since all of the alternatives are roughly the same length (30-40 miles) and face many of the same issues in terms of property acquisition and terrain, the costs tended to vary more by transit type than by alignment. BRT light alternatives offered the lowest potential costs, under fifty million dollars for alternatives in both the I-24 and Murfreesboro Road alignments. BRT was next lowest. Of the rail modes, traditional commuter rail was least expensive. DMU was higher and LRT which includes overhead structures and wires and other infrastructure related to electrification, was the most

Table 4-6
Initial Alternatives Screening-Goal 5 Criteria

		Alternative 1: I-24 Alignment LRT/DMU or BRT		Alternative 2: I-24 Alignment BRT Light		Alternative 3: CSX Alignment Commuter Rail	Alternative 4: CSX Alignment, LRT/DMU or BRT				Alternative 5: Murfreesboro Road Alignment, LRT, DMU, BRT		Alternative 6: Murfreesboro Road Alignment, BRT Light	
Goals and Objectives	Initial Screening Criteria	1A via I-24	1B via Airport	2A via CSX-Haywood Extended	2B via Harding/ Donelson Pike		4A via CSX	4B via Airport	4C	4D	5A via Murfreesboro Road	5B via Airport	6A via Murfreesboro Road	6B via Airport
Goal 5: Develop a cost-effective transportation system improvement strategy that maximizes community consensus and institutional support.														
1. Assure that total benefits of the preferred transportation investment strategy recommended by the study warrant their total costs.	Capital cost estimates for right-of-way based costs (excluding vehicles and maintenance facilities), developed at a unit-cost level of detail (quantitative measure, millions of 2004 Dollars)	**BRT: $290-$370 LRT: $670-$830 DMU: $480-$600**	**BRT: $350-$440 LRT: $740-$920 DMU:$530-$660**	**BRTL: $110-$140**	**BRTL: $30-$40**	**COM: $460-$580**	**BRT: $340-$420 LRT: $620-$770 DMU: $450-$560**	**BRT: $390-$480 LRT: $700-$860 DMU: $510-$640**	**BRT: $350-$430 LRT: $630-$780 DMU: $460-$580**	**BRT: $350-$430 LRT: $630-$780 DMU: $460-$580**	**BRT: $260-$320 LRT: $530-$660 DMU: $390-$490**	**BRT: $270-$340 LRT: $560-$700 DMU: $410-$520**	**BRTL: $40-$50**	**BRTL: $40-$50**
2. Achieve public consensus and institutional support, including the support of public agencies, local governmental entities, and public officials, for the preferred transportation investment strategy recommended by the study.	Order of magnitude capital costs by mode:													
	BRTL			=	+								+	+
	BRT	=	-				-	-	-	-	+	+		
	LRT	-	-				-	-	-	-	=	=		
	DMU	-	-				-	-	-	-	-	-		
	COM					-								
3. Ensure that the costs and benefits are shared equitably among citizens and governmental entities throughout the region.	Will not be considered in initial screening.													
4. Maximize the leverage of local funds in obtaining State and Federal funds to support transportation investments in the corridor.	Will not be considered in initial screening.													

"+" Positive or Better "-" Negative or Worse "=" Average or Little Change

costly mode. The need to build costly flyovers and other improvements to integrate the alternatives in the existing highway operations made the I-24 alternatives slightly more expensive than the CSX or Murfreesboro Road alternatives. The Murfreesboro Road alternatives were the least expensive by a slight margin. However, the differences in costs between modes far exceeded the differences between alignments.

2. Achieve public consensus and institutional support, including the support of public agencies, local government entitites, and public officials, for the preferred transportation investment strategy recommended by the study.

The members of the Steering Committee, based on their knowledge and opinion of the perception of transit improvements and funding strategies among representatives of local and regional transportation agencies, public officials, and members of the public. The Steering Committee focused their rankings on this measure on the overall cost. Alternatives with high estimated capital cost were perceived as being more difficult to develop and were ranked negatively; alternatives that were less expensive or had less impact were ranked positively.

As with the capital costs, the alternative varied more on this criteria according to the transit type than the alignment. Light rail and DMU alternatives tended to be rated more negatively than BRT alternatives, primarily because of cost. Alternatives in or alongside the CSX alignment, other than commuter rail, were also all ranked negatively due to possible issues with negotiating right of way use with the private rail operator in the corridor, CSX Transportation, Inc.

3. Ensure that the costs and benefits are shared equitably among citizens and governmental entities throughout the region. (not considered in initial evaluation)

4. Maximize the leverage of local funds in obtaining State and Federal funds to support transportation investments in the corridor. (not considered in initial evaluation)

Goal 6: Develop a strategic part of a multi-model transportation system that would facilitate the development of an integrated regional multi-modal system.

The committee considered the three objectives under this alternative and determined to not employ criteria under this goal in the initial screening, but to consider it in the detailed and final screening of alternatives.

4.5 Summary and Conclusions of Initial Screening Findings

The initial evaluation of alternatives did not provide conclusive evidence either to reject or endorse any of the 13 sub-alternatives examined. However, it did provide a number of indicators to direct the development of a short list of alternatives on which to provide detailed evaluation:

- Preliminary estimates indicated that the capital costs of a light rail alternative serving the full length of the corridor (Nashville to Murfreesboro) would cost more than $500 million, while DMU-based alternatives would cost more than $400 million. Given that BRT alternatives could provide similar service at a lesser cost of capital investment, it was determined that the alternatives tested in the Detailed Evaluation would not include a light rail or DMU alternative. BRT, commuter rail and BRT Light were retained as modes to be tested in the Detailed Evaluation.
  Result: LRT is not carried forward to detailed screening

- The evaluation did not provide sufficient information to allow the elimination of any of the three major existing alignments under consideration. Each of the alignments (I-24, CSX rail line and Murfreesboro Road) has unique characteristics, based on the prevailing transportation mode in the corridor (interstate highway, pre-automobile era rail line, and arterial highway) and the resulting development patterns are typical of those types of transportation modes. Each alignment tended to have distinct advantages and disadvantages in cost effectively serving the various transportation markets in the corridor while avoiding impacts and achieving the other goals of the project. However, no alignment clearly emerged as superior and none had any fatal flaws identified at this level of evaluation. The CSX alignment appeared to be inferior to the other alignments, in that it is somewhat more isolated than the two roadway alignments from surrounding residential and commercial development in some segments of the corridor. The corridor had clear (and related) advantages in the lesser level of environmental impacts its use would generate. The disadvantages of this alignment were not clear enough at this point to suggest its elimination as a viable option, and the desire to maintain an option using the commuter rail mode further supported its being carried forward for further analysis.
  Result: Carry forward one option using each alignment

- All of the alternatives, except for the "bus rapid transit light" alternatives, had high estimated capital costs, ranging from $300 million to more than $700 million. Many members of the public, commenting at public meetings and through other channels, as well as members of the steering committee, made note of the high costs. Some on the Steering Committee as well as some members of the public expressed skepticism at the Nashville region's ability to support such costs, particularly in the context of proposed high capacity transit improvements in other corridors.
  Result: Develop options with awareness of the need to minimize capital costs.

- The airport alignments included in a number of options (1B, 4B, 5B and 6B) were eliminated from consideration for a number of stated reasons. The airport alignments tended to be longer than the direct alignments that served Murfreesboro Road, the CSX rail alignment and I-24. These longer alignments increase capital costs. The longer alignments also increase travel time, which degrades the alternatives' ability to serve longer distance trips and provide travel times that are competitive with driving. The market of airport users and employees, though important, was not thought to be large enough to warrant the high costs, both financial and in terms of travel time and convenience, associated with serving it. The Steering Committee considered serving the airport using a "spur" or alternate alignment, direct service to downtown via one of the primary alignments and a secondary alignment serving the airport. However, this was thought to be too costly to consider in an initial phase of system development, although it could be considered later as an add-on once the system is developed and proves successful. Finally, routing the alignment around the airport, which is constrained from further development of much of its land, would divert the alignment from existing development while offering few opportunities for shaping new development into more transit-supportive patterns. Other options, including development of a bus circulator to connect the airport and satellite parking to BRT or rail stations in the corridor, could provide service to the airport while avoiding routing of the main north-south service through the airport property.
  Result: remove airport alignments from consideration in detailed screening.

- As a result of public input, Old Nashville Pike, a highway extending south from Murfreesboro Road in LaVerne to downtown Murfreesboro, was identified as a fourth viable alignment for the southern portion of the corridor. The Steering Committee accepted this suggestion, and Old Nashville Pike was considered for inclusion in one of the detailed alternatives that emerged from the initial evaluation.
  Result: Alternatives using Murfreesboro Road alignment will use Old Nashville Pike for southern portion of alignment during the detailed screening of alternatives.

Based on this analysis, the Steering Committee determined to carry forward the following alternatives for the detailed screening:

- A No-Build option consisting of the existing network with planned and programmed improvements.
- BRT or BRTL on I-24
- A Low Cost, or TSM Alternative based on the BRT service on I-24
- Commuter rail service on the CSX rail alignment
- BRT or BRTL on Murfreesboro Road and Old Nashville Pike

These alternatives and their evaluation are described in Chapter 5 – Phase II Screening of Alternatives.

5.0 Phase II Screening of Alternatives

5.1 Introduction

Typically an Alternatives Analysis has two phases: a general Phase I screening and a more detailed Phase II screening. Chapter 4 described the Phase I screening of alternatives, including key information on the transportation markets and destinations, the types of transit available and potential alignments in the southeast corridor. Based on this analysis the Steering Committee developed three alternatives for further analysis. The development and evaluation of those initial alternatives produced an improved understanding of the costs, benefits and potential impacts of major transit options in the southeast corridor and helped in the Phase II screening process. This chapter documents the Phase II screening using the three detailed alternatives developed in Chapter 4. The information gained and decisions made from the Phase II screening were then used to develop a Locally Preferred Alternative (LPA) for the corridor.

5.2 Detailed Alternatives Development and Evaluation Process

This chapter documents the decision-making process used by the project Steering Committee to select the modes and infrastructure elements identified in the initial screening with the most potential for addressing the transportation needs of the corridor. The selected alternatives were developed at a higher level of geographic and operational detail than those from the initial evaluation. Capital and operating costs, along with transit ridership, were estimated for these alternatives. Subsequent chapters will focus on various detailed analyses of the methodologies used to evaluate the potential costs and performance of the various alternatives and will describe in detail the development of the preferred alternative and its evaluation and comparison with the baseline alternative.

5.3 Range of Alternatives

As mentioned in Chapter 4, there is a wide variety of existing regional trip generators, destinations and potential travel markets within the corridor (see Section 4.3.1). With an eye towards serving these markets, the following section details the potential route alternatives and mode alternatives considered.

5.3.1 Phase II Alternatives

The alternatives identified in the second, detailed phase of analysis describe a No-Build alternative, a Low-Cost TSM alternative, and three alternatives carried from the initial Phase I screening. The alternatives from the Phase I screening are labeled Alternative A (I-24 BRT), Alternative B (CSX Commuter Rail) and Alternative C (Murfreesboro Road BRT).

The development of the Alternatives A, B, and C was guided by the outcome of the initial Phase I screening. This screening compared six major build alternatives (with some sub-alternative alignments within each corridor) on a number of criteria related to the project goals and objectives and the measures of effectiveness evaluated by the FTA's New Starts process. The screening process and its results are described and documented in Chapter 4, with FTA New Starts criteria mentioned in section 4.4.

The Steering Committee made a number of observations about the alternatives evaluated in the Phase I analysis:

- The initial evaluation did not provide sufficient information to allow for the elimination of any of the three major existing alignments under consideration. The three major alignments considered (I-24, the CSX rail line, and Murfreesboro Road) had offsetting advantages and disadvantages. Each of the alignments has unique characteristics, based on the prevailing transportation mode in the corridor (interstate highway, pre-automobile era rail line, and arterial highway), and the resulting development patterns are typical of those types of transportation modes. Murfreesboro Road was closest to the major activity, population and employment centers and existing development, and it also caused the most impact to persons living and working in the corridor and to cultural and historic resources and sensitive uses in the corridor (schools, churches, cemeteries, parks, etc.). The CSX rail and I-24 corridors tended to cause fewer impacts but were more distant from existing development. Fewer routes crossing these alignments also allowed for higher speed operation compared to the Murfreesboro Road corridor. The CSX alignment appeared to be inferior to the other alignments, in that it is somewhat more isolated from surrounding residential and commercial development in some segments of the corridor than the two roadway alignments. However, these disadvantages were not clear enough for the alignment to be eliminated from consideration at an early stage.
- The committee determined that direct fixed guideway service to Nashville International Airport (BNA) would most likely be too expensive and would extend the service through areas on or near the airport property that could not be redeveloped in a transit-friendly manner, thus adding too much travel time for those traveling between downtown Nashville and areas south of the airport. The Steering Committee concluded that service between the airport, downtown Nashville, and other areas of the southeast corridor could be provided more cost-effectively using other means (such as on-street bus services). Segments of fixed-guideway services directly connecting to BNA were not carried forward into the alternatives developed for the Phase II detailed analysis.
- All of the alternatives, except for the “bus rapid transit light” alternative, had high estimated capital costs, ranging from $300 million to more than $700 million. Many members of the public, local officials and members of the project Steering Committee made note of the high costs and recommended considering lower cost options. Some expressed skepticism at the Nashville region’s ability to support such costs, particularly in the context of proposed high capacity transit improvements in other corridors.
- Light rail was eliminated as a transit mode option, primarily due to the high cost of rail construction and electrification and limited flexibility of service compared to bus rapid transit.
- As a result of public input, Old Nashville Pike, a highway extending south from Murfreesboro Road in LaVerne to downtown Murfreesboro, was identified as a fourth viable alignment for the southern portion of the corridor. The Steering Committee accepted this suggestion, and Old Nashville Pike was considered for inclusion in one of the detailed alternatives that emerged from the initial evaluation.

Potential Baseline Alternatives

The Baseline Alternative represents the transit system as it will exist in the future if no major transit improvements, such as Commuter Rail or BRT, are constructed as a result of the project. The Baseline Alternative offers a basis for comparison to assess the potential benefits of the proposed major investment alternatives. Two potential Baseline Alternatives were prepared for the southeast corridor project. The no-build alternative consists of improvements planned and

programmed by the transit agency and the MPO. The Low Cost Alternative, sometimes referred to as the transportation system management (TSM) or enhanced bus alternative, represents the best level of service that can be provided to serve the corridor's needs without constructing dedicated guideway or other high cost improvements. The Federal Transit Administration ultimately will determine which of these alternatives will serve as the baseline for purposes of evaluating the proposed alternatives under the Section 5309 New Starts program.

No-Build Alternative

The No-Build Alternative typically includes the existing transit system and any changes or additions to the transit system that have funding through the region's transportation improvement program (TIP) or the financially-constrained portion of the region's Long-Range Transportation Plan (LRTP). Operational improvements included in the transit system's short-range plans for which no outside funding are required also are included in the No-Build Alternative. The startup in October 2006 of RTA's East Commuter Rail line connecting Lebanon to downtown Nashville is the largest change to Nashville's transit system in decades, and additionally it is the region's sole rail-based transit operation. This change to the transit system was incorporated in the Baseline and Build alternatives during the course of the southeast corridor study. Other improvements recommended in MTA's 5-Year Plan affecting transit service in the corridor are listed in Table 5-1:

Table 5-1:
Current Planned Transit Service Route Improvements

Route No.	Route Name	5-Year Plan Recommendations
11	Southeast Connector	• Years 1-3 - No changes • Year 4 - 60 minute service during mid-day • Year 5 - Same as Year 4 but adds 60 minute service on Saturday till 6:15pm
12	Nolensville	• Year 1 - Addition of 11:15 am weekday trip • Year 2 - 20 minute midday headway • Year 3 - Route operates to Hickory Plaza every trip; Service to Wallace & Harding Loops reallocated; 10 minute peak service; and 20 minute midday service • Year 4 - 30 minute weekday service until 8:15 pm; 20 minute Saturday service until 6:15 pm; 30 minute Sunday service until 6:15 pm • Year 5 – No Changes
15	Murfreesboro	• Year 1 - Create a split headway on this route, Alternating service between Hickory Hollow Mall and the Wal-Mart Supercenter on Murfreesboro, past Bell Road; 10 minute headway during peak periods • Year 2 - Reallocation of Vultee deviation to new Route 5 • Year 3 - 20 minute service from 6:15 pm to 8:15 pm; 30 minute service from 8:15 pm • Year 4 - 20 minute service until 6:15 pm on Saturday; 30 minute service until 6:15 pm on Sunday • Year 5 - No changes
18	Elm Hill Pike/ Airport	• Year 1 - No changes • Year 2 - Split current routing into two routes: one that operates local to and from the airport via Elm Hill Pike, and one that operates express from the Airport to Downtown via I-40; 20 minute peak service; 30 minute off peak service until 8:15 pm; 60 minute Saturday service until 8:15 pm; 60 minute Sunday service until 6:15 pm • Years 3 through 5 - No changes
25	Midtown	• Year 1 - 30 minute service all day until 6:15 pm; All trips to MTA from 8:15 am until 3:45 pm • Year 2 - 20 minute peak service • Year 3 - 20 minute service via Jo Johnson until 8:15 pm ;40 minute service to Hart until 8:15 pm • Years 4 through 5 - No change

Table 5-1:
Current Planned Transit Service Route Improvements (continued)

32X	Edge-O-Lake Express	• Years 1 through 4 - No change • Year 5 - 1 extra am and pm trip
33X	Hickory Hollow Mall/ Old Hickory Express	• Years 1 through 4 - No change • Year 5 - 1 extra am and pm trip
37X	Tusculum/ McMurray Express	• Years 1 through 4 - No change • Year 5 - 1 extra am and pm trip
38X	Una Antioch Express	• Years 1-4 - No changes • Year - 5 - 1 extra am and pm trip
96	Nashville/ Murfreesboro Relax and Ride	• Years 1 through 5 – No Changes

These changes to the underlying transit network were also included in the Low Cost alternative and in each of the three build alternatives discussed below (Alternatives A, B and C).

Low Cost (TSM or Enhanced Bus) Alternative

The Low Cost alternative tested in this round of alternatives evaluation consisted of the proposed transit routes and station park-and-ride improvements proposed in alternative A, the I-24 BRT alternative. All services identified under Task A, including circulator, express and local pattern bus routes would be operated under the Low Cost alternative under nearly the same alignments. Under the Low Cost alternative, no significant guideway (busway or bus lane) or new roadway improvements would be implemented. The elimination of the busway is the primary difference between Alternative A and the Low Cost alternative, and all other differences between the two alternatives stem from this single change. Eliminating these guideway improvements, including the costly development of the busway in the area north of Harding Road, would eliminate most of the capital costs associated with Alternative A. Park-and-ride lots would remain available at all identified station locations from Bell Road/Hickory Hollow Mall south. Stations would remain in place in locations similar to those identified in Alternative A, but they would not be located adjacent to the roadway right of way. The elimination of the roadway and the location of stations off the I-24 roadway right of way would increase travel time and off highway running time compared to Alternative A.

Alternative A: I-24 Alignment, BRT

Alternative A (similar to and based on alternatives 1 and 2 in the initial alternative screening, described in Chapter 4) consists of an all-day bus service operating mainly in the I-24 alignment. The alternative includes a two lane busway connecting downtown Nashville to the Bell Road/Hickory Hollow Mall area, with a single-lane reversible busway continuing south from Bell Road to Murfreesboro. The reversible busway south of Bell Road would operate north during the morning peak travel period and south during the afternoon peak period. During other periods the busway would be unused. The alternative presumably would use upgraded commuter buses powered by on-board energy (diesel or diesel-electric hybrid). These buses would have a capacity of approximately 45 (seated with no standees permitted) and would include amenities such as padded seats, reading lights, and tray tables. The alternatives' alignment, station and park-and-ride locations, and circulator route alignments are shown in the map in Figure 5-1. The alignment begins in the north at the MTA Central Station in downtown

Nashville (assumed to be located on the north side of Charlotte Street between Fourth and Fifth Avenues). The alignment in downtown Nashville will be re-examined in further development; however, for the purposes of ridership, buses would operate southbound on Fourth Street and northbound on Third Avenue. Buses would operate in downtown streets in existing lanes shared with local traffic.

From Gateway Boulevard, the BRT alignment proceeds east to First Avenue, south on Hermitage to the vicinity of Fairfield (south of I-40), where it would enter a barrier separated dedicated busway with two twelve foot lanes. The busway would transition to the west side of I-24 on an aerial structure. Following the western edge of the I-24 right-of-way, the transit guideway would flyover major cross streets, crossing to the opposite side of the interstate where necessary to avoid engineering and right-of-way impacts. To the extent possible, at-grade alignments of the guideway would be utilized to reduce costs. Right-of-way width, topography and manmade features would affect the ability of the guideway to remain entirely within the interstate property. It is likely that additional right of way would be required in some areas, and allowance has been made in cost estimates to acquire additional property. For the purposes of developing cost estimates, it was assumed that the busway would operate on the northern/eastern edge of I-24 from Fairfield south to between Fessler's Lane and Elm Hill, where it would cross over I-24 on an aerial structure to operate on the southern/western side.

The proposed busway would continue south along I-24 and would cross back over to the eastern side between Haywood and Bell using a second aerial structure. South of the Bell Road station the alignment would continue south as a single lane reversible busway. The 12 foot busway would operate alongside the I-24 alignment, northbound during the AM peak and southbound during the PM peak. The reversible busway would be closed to all traffic during the off-peak periods, during which buses would operate on the HOV lane south of Bell Road. Stations would be configured with platforms on both sides to allow buses with right hand door configurations to serve the station in both directions. Stations would consist of platforms and shelters oriented to the northbound direction, with lighting and paved paths. Stations would be configured to allow buses to pass in the single lane section of the busway.

The proposed service includes stations/stops at the locations listed below. Precise station locations have not been identified, but stations would be located to achieve a balance between cost and availability of property already owned by governmental or transportation entities; minimizing environmental, socio-cultural and aesthetic impacts; providing park-ride space where applicable and access for pedestrians and cyclists; and minimizing cost and time delay by locating as near as possible to the BRT alignment.

In downtown Nashville, the buses would operate in a skip stop pattern along their alignment, stopping where the alignment crosses the following streets:

- Charlotte Avenue (MTA Music City Central Station)
- Union Street
- Church Street
- Commerce Street
- Broadway Avenue
- GEC (Gaylord Entertainment Center) on Broadway
- Demonbreun Street
- Malloy Avenue
- Franklin Street

Outside downtown Nashville, station stops would be located at the following locations in Nashville-Davidson County. Stations from Harding Place north would be at grade or aerial and located adjacent to the right of way, so that buses could access them without leaving the busway right of way. The precise locations of the stations would be determined at a later stage of analysis.

- Rolling Mill Hill
- Hermitage Avenue
- Elm Hill Pike
- Murfreesboro Road
- Thompson Lane
- Antioch Pike
- Harding Place
- Haywood Lane
- Hickory Hollow/Bell Road

A park-and-ride lot would be included in the station at Hickory Hollow Mall-Bell Road, and at all stations south of Bell Road.

Stations in Rutherford County are located at the following locations:

- Old Hickory/Hobson Pike
- Waldron Road
- San Ridley Parkway
- Nissan Boulevard
- SR 840
- Manson Pike
- SR 99

When using city streets in downtown Nashville and Murfreesboro, the transit system would operate in existing lanes shared with local traffic. At the south end of the corridor the guideway would exit I-24 north of SR 96 and then travel south and east following Tennessee Boulevard to the end of the corridor at the MTSU Station. However, the alternative could follow multiple alignments in the Murfreesboro area and could terminate at various points in the corridor.

The operating plans for Alternative A are shown in Figures 5-2 and 5-3. Figure 5-2 shows the stopping pattern and number of buses serving each pattern during the AM peak period (the PM peak period service plan mirrors the AM service plan), while Figure 5-3 provides this same information for the off-peak (midday) period. As the figure shows, the plan combines long distance service to downtown Nashville from Murfreesboro, LaVergne, Smyrna, and other areas of Rutherford and southern Nashville-Davidson County with services oriented to shorter-distance trips within the corridor and services for reverse commuters to Murfreesboro and MTSU, Interchange City, Nissan, and other attractions in the corridor. The proposed new services all use the portion of the guideway that passes the congested point on I-24 between Fairfield and Harding Road that currently delays travelers in that area of the corridor. A series of shuttle routes in the southern areas of the corridor would begin their morning service circulating as local bus services through neighborhoods in communities in the south of the corridor. These same buses would then serve park-and-ride lot stations at the nearest major interchange along I-24 before entering the busway to complete their trips to downtown Nashville. In the Nashville-Davidson County portion of the corridor, intersecting bus routes

would allow passengers to transfer to the BRT at stations located along the busway. Some trips would continue through downtown Nashville beyond the Charlotte Street terminal and continue to the West End and Vanderbilt University areas, providing a one-seat ride from southern portions of the corridor to the West End/Vanderbilt areas.

Fares for the proposed Alternative A were assumed to be the same (adjusted for inflation to 2030) as existing fares for the RTA and MTA services in the corridor. At the time of the Phase I analysis, MTA regular local bus fare was $1.45, while express fares ranged from $1.75 to $2.25. RTA Relax and Ride fare, which would apply to the routes using the proposed busway was $2.25. The full fare schedule for MTA and RTA services is included in Chapter 3. Fares would be collected on board the buses.

Alternative B: CSX Alignment, Commuter Rail

This alternative, which is similar to and based on Alternative 3 from the initial alternatives discussed in Chapter 4, consists of commuter rail service in the rail corridor extending south from downtown Nashville through LaVergne and Smyrna to Murfreesboro. This line is owned by CSX Transportation, Inc. (CSX), which uses it extensively in their freight operations. The line extends southward beyond Murfreesboro to Chattanooga and Atlanta. The alternative presumably would use conventional railroad equipment or DMU vehicles that meet crash-worthiness and other safety standards set by the Federal Railroad Administration (FRA). This would make it permissible for the commuter rail trains to operate in mixed traffic with freight rail equipment such as that operated by CSX on the existing tracks in this alignment. The commuter service would not replace all radial bus service in the corridor.

The existing rail infrastructure in the corridor may not have sufficient capacity to allow CSX's existing rail operation and commuter rail service to operate simultaneously. Presuming this to be the case, construction of additional rail infrastructure would be required before the commuter rail service could begin operation. In some areas this could be accomplished within the available adjacent right of way; in other areas, additional strips of adjacent land could be required to develop the additional infrastructure required. Moreover, the railroad's active approval and participation is paramount in the project development process if commuter service is to be operated on CSX rail lines or property. Discussions with CSX, the owner of the existing alignment and rail infrastructure in this corridor, would not begin until a later phase of project development and would not begin at all unless the results of this study indicate that the alignment ranks highly among the available alternatives and bears further study. The precise alignment, station locations, frequency of service, and other characteristics of a commuter rail service in this alignment will be determined largely through discussions with the railroad over such issues as access to the tracks and right of way, addition of rail capacity improvements, operation of service (operation of trains by CSX or another private operator under contract with a local public transit agency like MTA or RTA, or direct operation of service by a local transit agency), location of a train storage and maintenance facility, and scheduling of service. Should the commuter rail option in this alignment be selected as the study's preferred alternative, a range of outcomes are possible. These include:

- Commuter rail operating on CSX's existing rail infrastructure under an agreement with CSX, with minimal rail infrastructure improvements and the addition of stations, park and ride lots and a train storage and maintenance facility owned, operated by or on behalf of a public entity. This essentially describes the development and operation of RTA's existing East Line commuter rail operation.

Figure 5-1 Alignment and Station Location for Alternative A, BRT on I-24

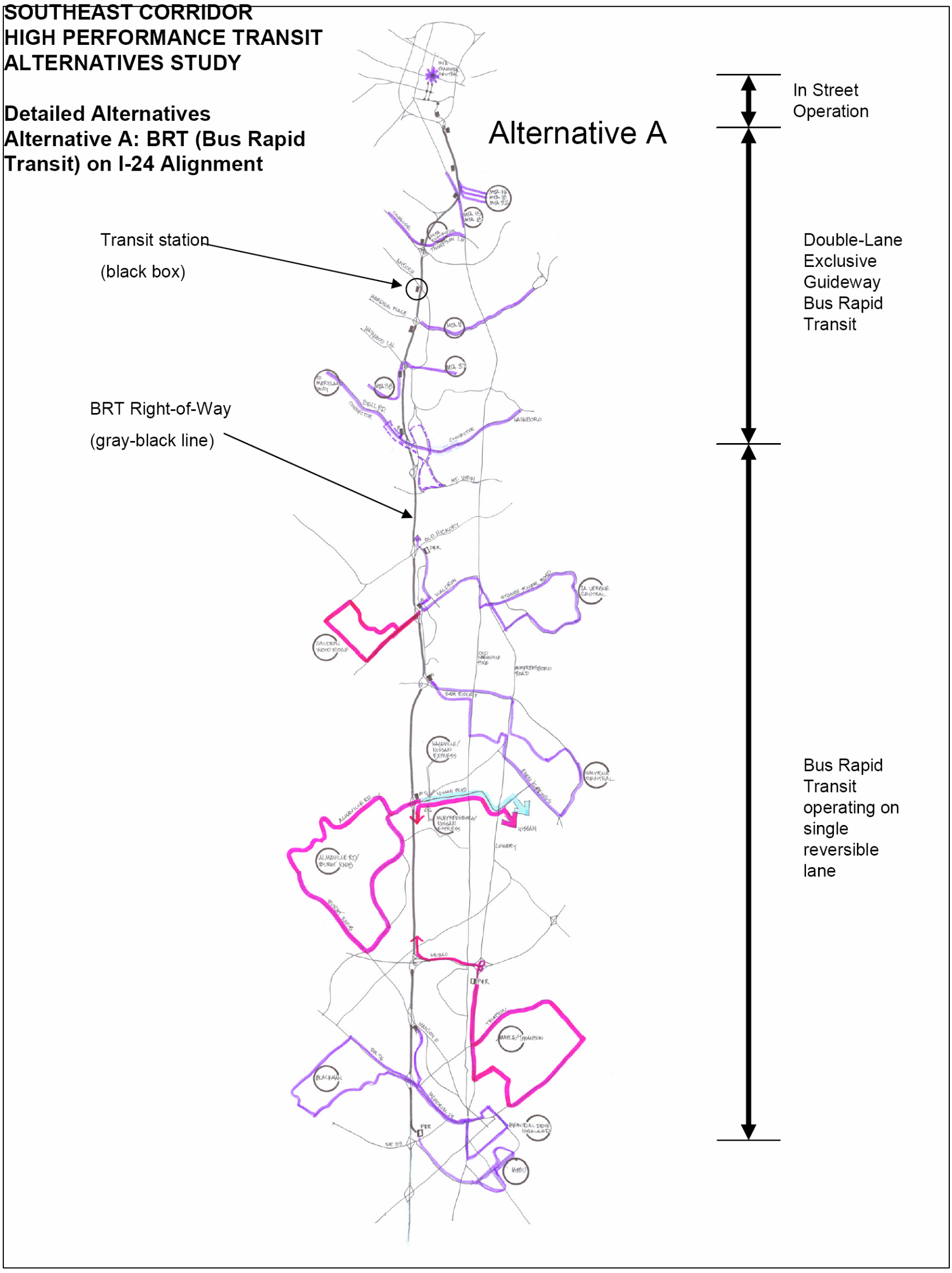


Figure 5-2 Alternative A Operating Concept – AM Peak Period

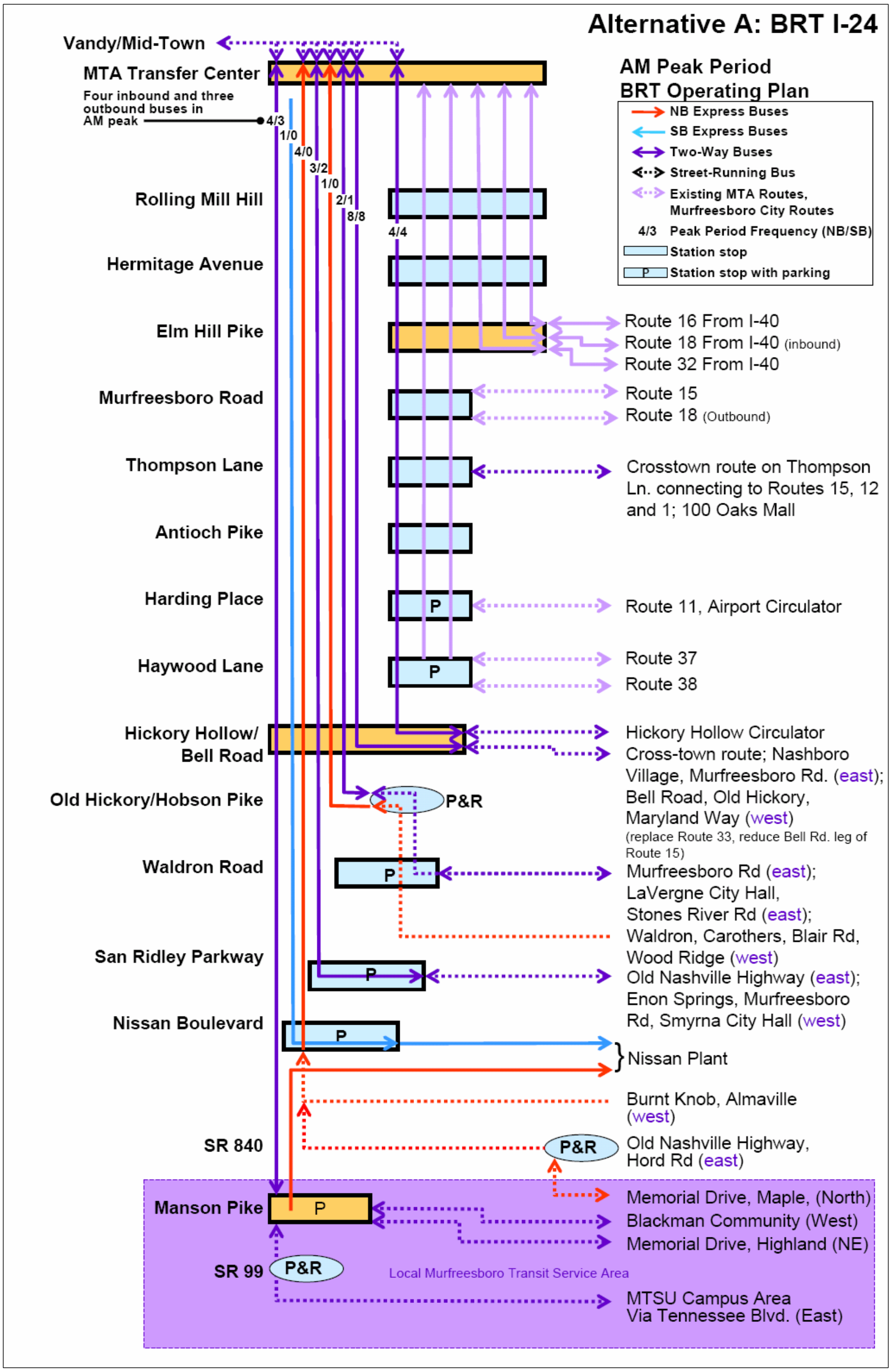
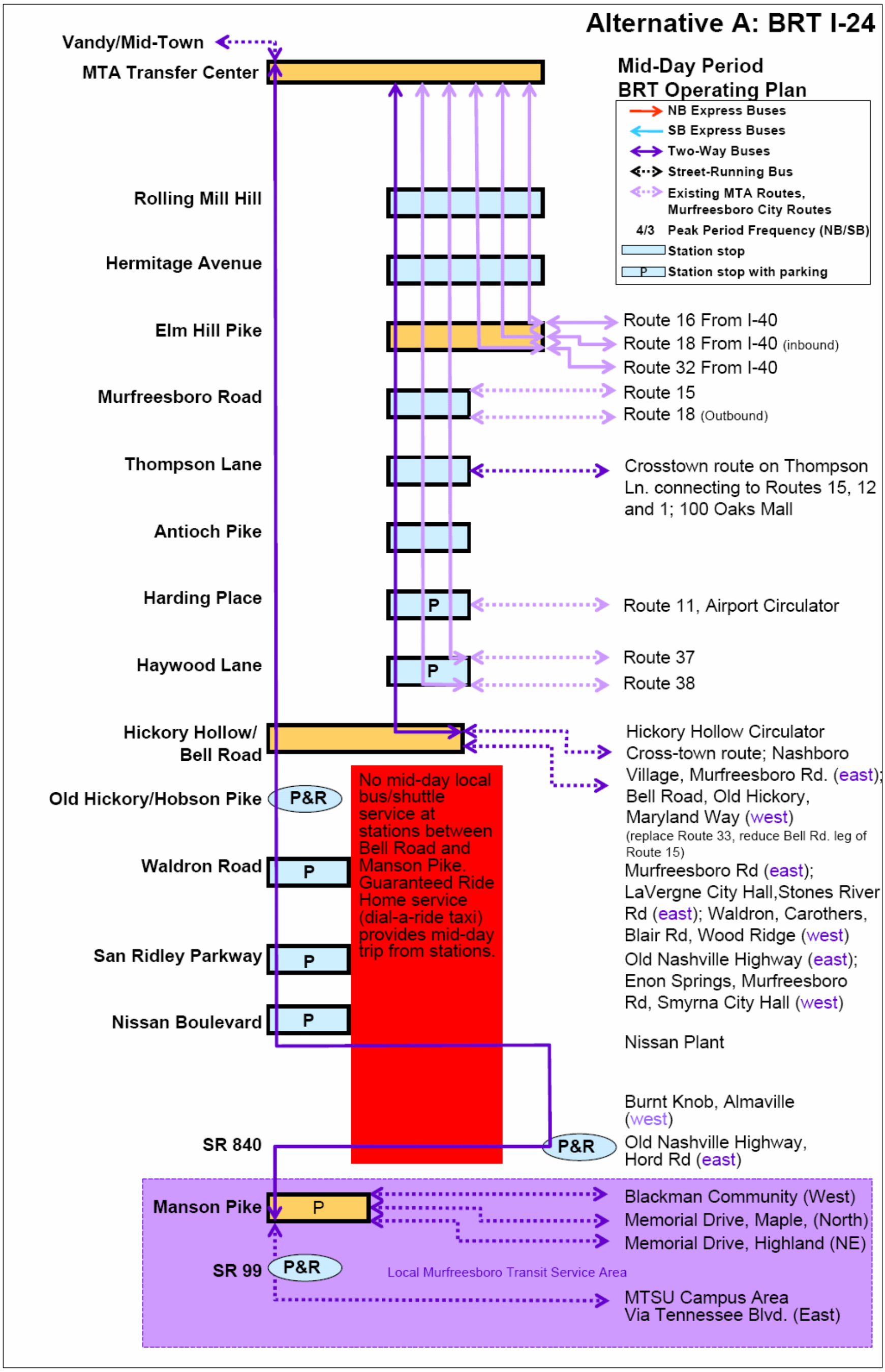


Figure 5-3 Alternative A Operating Concept – Mid-Day Period



- Commuter rail operating on CSX's existing rail infrastructure with the addition of significant new track, right of way, signal, structures or other improvements—in addition to stations and a train storage and maintenance facility—funded and/or developed by a public transportation entity. This would provide CSX with additional freight rail infrastructure in exchange for allowing the commuter rail service to operate on their alignment and right of way. The precise amount and nature of the new infrastructure or right of way required would depend on the operating characteristics of the freight service, commuter rail operations and negotiations between the railroad and the public entities developing the commuter service. The improvements could range from new crossovers and passing sidings to construction of one or more additional tracks over some or all of the right of way.
- Development of a parallel commuter rail system on new right of way and track adjacent to or near the CSX rail line, operating commuter rail service in parallel with the existing CSX operation but with little or no connection or inter-operation between the commuter rail system and CSX's rail system.

The costs and difficulty of developing a commuter rail option in this alignment increase dramatically from the first to the last of these options, requiring further discussion and analysis should commuter rail service be considered beyond this round of evaluation.

To account for this uncertainty, a range of assumptions have been considered by the study team and Steering Committee members concerning the level of infrastructure required to support commuter rail operations on this alignment, the capital cost of these improvements, and the potential frequency of commuter rail operations in this corridor.

Options considered include:
- Construction of a single additional track of new rail alignment and infrastructure between downtown Nashville (Clement Landport) and Murfreesboro
- Construction of two additional tracks of new rail alignment and infrastructure from downtown Nashville to Bell Road, and one additional track from Bell Road south to Murfreesboro.
- Construction of two additional tracks from downtown Nashville to Murfreesboro.

Preliminary capital costs have been prepared for the infrastructure required to develop each of these three options. These are presented in a later section of this chapter.

The proposed alignment of the commuter rail line, the locations of commuter rail stations, and the approximate alignments of feeder and circulator bus routes are shown in Figure 5-4. The CSX rail right of way in the corridor, mainly constructed in the 19th century, is a relatively straight and flat alignment with modest curves and grades. Portions of the CSX alignment and relatively flat grades have been made possible in the rolling topography of the corridor by cutting and filling the land in the rail right-of-way. Should additional right of way or track development be required, it may need to follow the same cut and fill pattern. In some cases, development of commuter rail may require the construction of aerial flyover structures to avoid conflicts with freight operations, the location of stations on the side of the track that are best suited for and avoidance of natural obstacles or environmentally sensitive sites.

The basic alignment for Alternative B would use the CSX right-of-way, or land adjacent to it, for most of the route. Commuter rail service would operate on passenger tracks beginning at its southern terminus from a rail station at the intersection of the CSX right of way and Church Street (US 231) in Murfreesboro. This location is adjacent to an I-24 interchange and thus

would be convenient for intercepting Nashville-bound motorists. The station would provide sufficient park-and-ride facilities to meet the potentially high demand of an end-of-the-line station. The service would continue north, making stops in downtown Murfreesboro, Smyrna, LaVergne, and Davidson County. The service would terminate at a downtown station located along the existing rail line at or near the Clement Landport. The single downtown station, which is located some distance from the core of downtown Nashville, would be served by a circulator bus that would distribute transferring passengers through downtown Nashville, connecting the commuter rail station with the Central Station transit center off of Charlotte Avenue and the Vanderbilt/West End area.

The following station locations were identified for this alternative:

- Clement Landport
- Harding Place
- Hickory Hollow Mall, accessed from Antioch Pike/Hickory Hollow Parkway, north of Bell Road
- Waldron Road/LaVergne
- Downtown Smyrna (Murfreesboro Road at Lowery Street)
- SR-840, expanding on the existing park-and-ride lot at Murfreesboro Pike/Broad Street, Downtown Murfreesboro
- Church Street/US 231, near the I-24 interchange

Stations would include platforms, shelters, and associated lighting and security amenities. Proof of payment fare media would also be sold at ticket vending machines at each station. The downtown station was assumed to be a more significant facility that would include a climate-controlled passenger waiting area and staffed ticket booths. Park-and-ride spaces would be provided at the Hickory Hollow Mall, Waldron Road, Smyrna, SR 840 and Church Street/US 231 stations. At Harding Place and in downtown Murfreesboro, a park-and-ride lot would not be consistent with the area's development pattern, and access to the station would be limited to walk-up, bus transfer and passenger drop offs ("kiss-and-ride").

The operating plans for Alternative B are shown in Figures 5-5 and 5-6. Figure 5-5 shows the rail and bus services proposed to operate during the AM peak period (the PM peak period service plan mirrors the AM service plan), while Figure 5-6 provides this information for the off-peak (midday) period. Seven trains would operate during each two hour peak period, with four traveling in the peak and three in the off-peak direction. Five of the seven trains would operate in a skip stop station stopping pattern in which alternating stations would be bypassed on alternating trips, to reduce the number of stops on each train and thereby increase travel speed and reduce travel time. During the mid day period, a single train would operate once in each direction, essentially to provide emergency service for travelers to downtown Nashville who need to return home mid day. Trains were assumed to be standard single-level commuter rail cars pulled by a locomotive seating in 2-car consists. Single car commuter rail cars have a maximum seated capacity of about 110 persons per car.

Fares for the commuter rail service were assumed to be $2.25, the fare for the existing RTA Relax and Ride bus service in the corridor. The $2.25 fare was maintained to avoid biasing the comparison between commuter rail and the bus-based options tested in Alternatives A and C. Fares for shuttle buses were assumed to be $1.45, with credit given for this fare towards commuter rail fare for passengers transferring between the two services.

Shuttle bus routes would operate in neighborhoods around the stations from Bell Road south. Corridor communities including Smyrna, LaVergne and Murfreesboro would be served by circulator routes, and these routes would connect transferring passengers at the commuter rail stations to destinations including Interchange City, Nissan and MTSU. These circulator routes would operate in the peak periods only and would be timed to connect to the commuter rail trips arriving and departing at each station. They would use standard transit buses similar to the standard MTA fleet. Existing MTA bus services would connect to the Bell Road and Harding Road stations. As noted above, a circulator route would distribute transferring rail passengers through downtown Nashville and connect them to the MTA's transfer center at Charlotte Street and to the West End area and Vanderbilt Campus.

Alternative C: Murfreesboro Road/Old Nashville Pike Alignment, BRT

In Alternative C BRT service would operate on an alignment along Murfreesboro Road (US 41) and Old Nashville Pike. Alternative C (similar to and based on alternatives 5 and 6 in the initial alternative screening, described in Chapter 4) consists of an all-day bus service operating on a two lane busway along Lafayette Street from downtown south to Oak Street and then along Murfreesboro Road south to Bell Road. A single lane busway would continue south along Murfressboro from the Bell Road area to Old Nashville Pike, and then along Old Nashville Pike south to Murfreesboro. The reversible busway south of Bell Road would operate in the prevailing commuter traffic directions, north during the morning peak travel period and south during the afternoon peak period. During other periods the busway would be unused.

Upgraded commuter buses powered by on-board energy (diesel or diesel-electric hybrid) would be used for the primary busway services (other buses using conventional equipment may use the busway for portions of their trips). The busway could be located in the center or on one or the other of the sides of the roadway with relocation of the existing roadway center line.

The proposed alignment and station locations for Alternative C are shown in Figure 5-7. The precise location of the alignment would depend on the availability of median and adjacent property and would be positioned to minimize costs or to avoid engineering, environmental or property impacts. However, the study assumes that significant additional right of way would be required in both the Murfreesboro Road and Old Nashville Pike sections of the alignment.

The typical cross-section across the roadway would place the 12 foot busway lanes in the center or on the side of the roadway. Barriers would be placed on the outside of the transit guideway to separate and protect general-purpose traffic from the transit vehicles and to prevent general purpose traffic from entering the busway, which could reduce bus movement and potentially risk collision. Queue jump facilities and the installation of signal priority or pre-emption systems at major intersections would be required to facilitate the progression of buses on the busway through the many at-grade intersections along Murfreesboro Road and Old Nashville Pike.

Figure 5-4 Alignment and Station Location for Alternate B, Commuter Rail on CSX Alignment

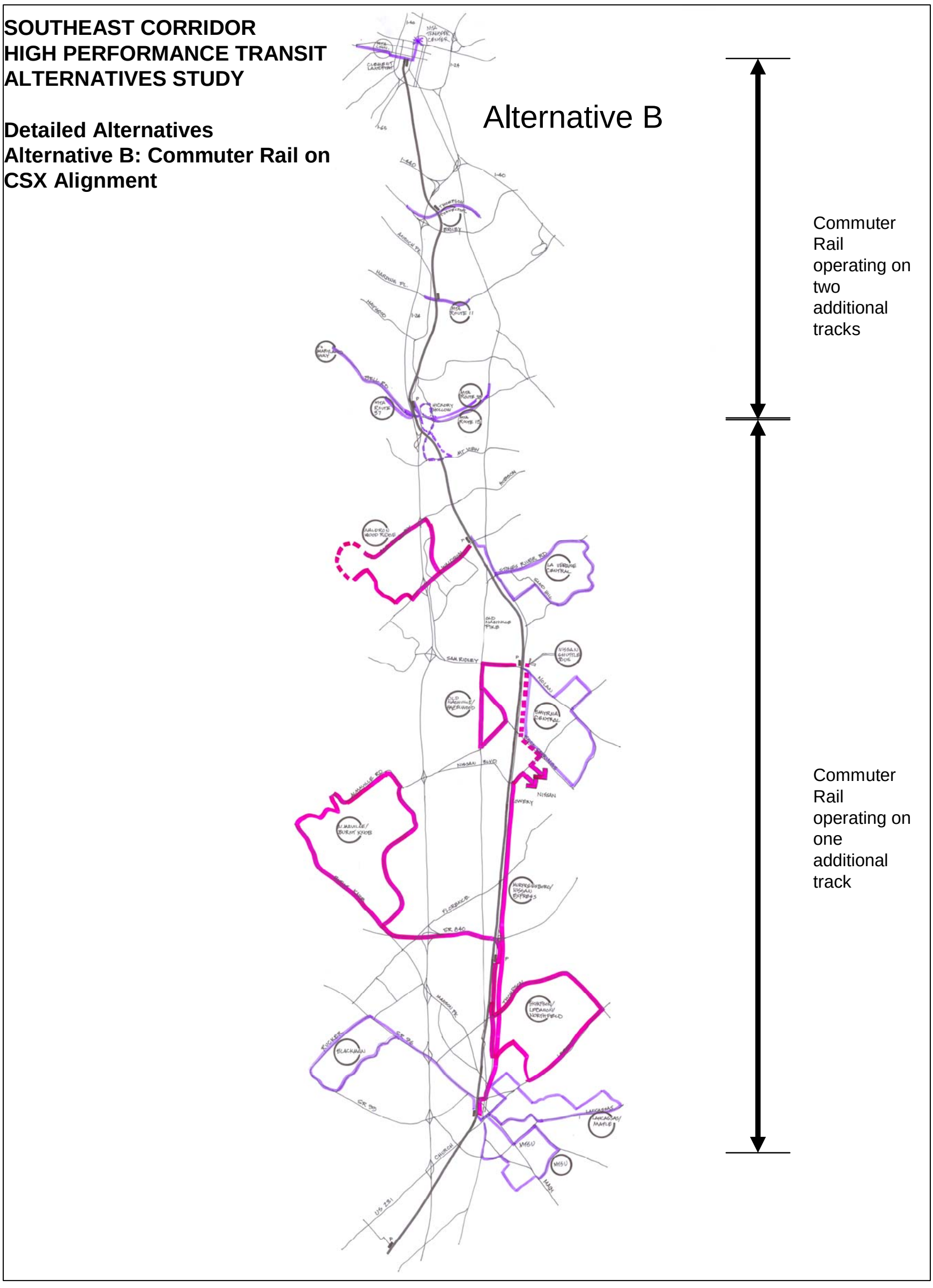


Figure 5-5 Alternate B Operating Concept – AM Peak

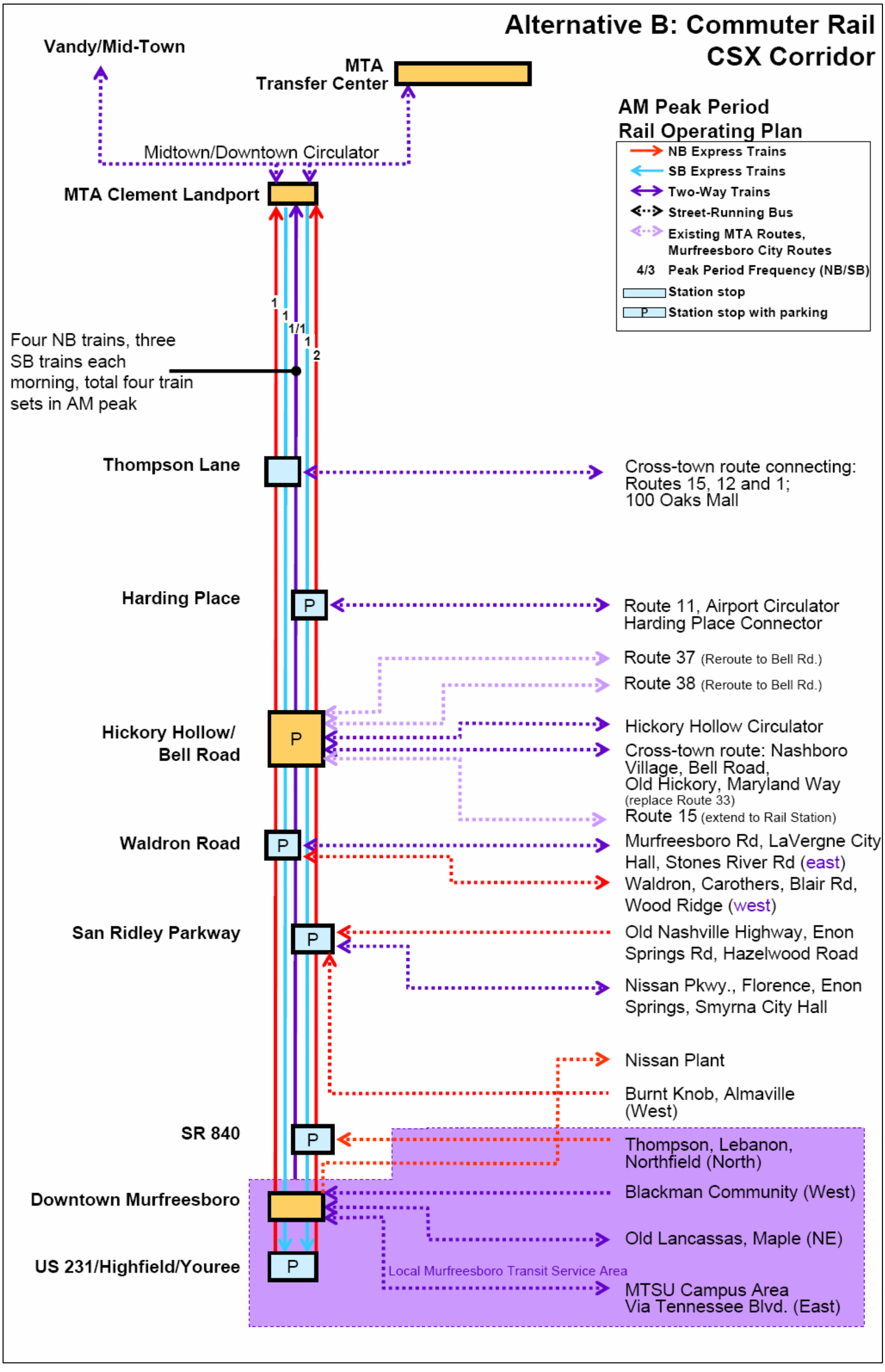
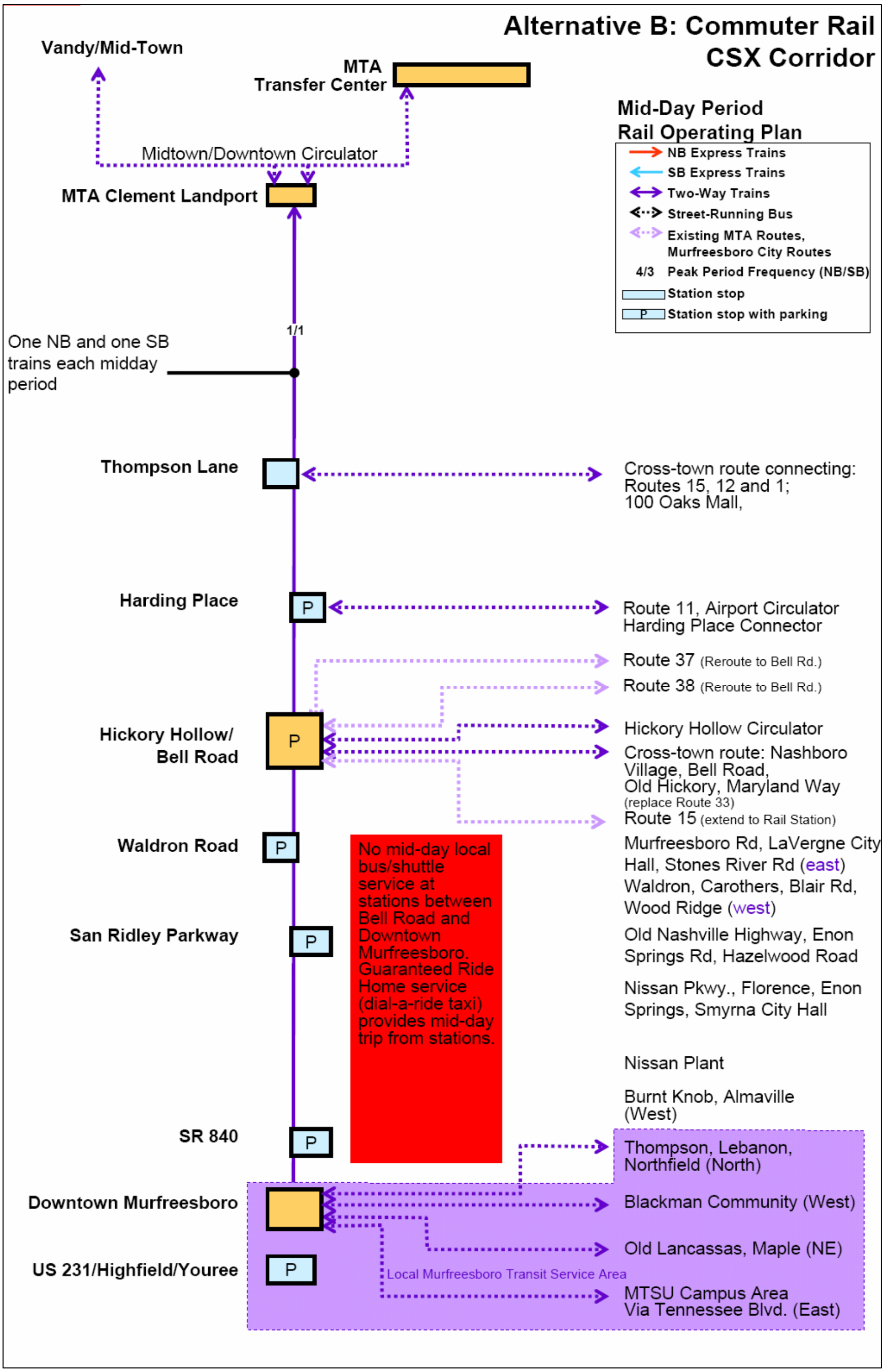


Figure 5-6 Alternate B Operating Concept – Mid-Day Period



Traffic signals and lane configuration could permit traffic to cross the guideway's path at some locations, but many streets crossing Murfreesboro Road and Old Nashville Pike in the busway area would be closed to through traffic. With this arrangement, transit could travel along a safe path at the maximum posted speed on the adjoining highway. The coordination of transit and traffic signal systems would permit operation of the roadway crossings on the guideway's path to both maintain the transit vehicles' speed and the safe crossing of traffic. Traffic on Murfreesboro Road and Old Nashville Pike would likely maintain faster average speeds with the elimination of numerous left turning vehicles into cross streets and private property adjoining the right-of-way. Depending on whether the guideway was positioned in the center or curb lanes, either left or right turns would be restricted in most of the alignment. The development of the busway could also result in restrictions of access to driveways along sections of Murfreesboro Road and Old Nashville Pike.

The roadway right-of-way along Murfreesboro Road and Old Nashville Pike would be widened to accommodate the center or curbside station platforms. Stations from Bell Road south to Murfreesboro would include park-and-ride lots. These lots would be located on property adjacent to highway right-of-way near the stations. Signalized pedestrian crosswalks would allow passengers to access the platform across the north or southbound traffic lanes. Pedestrian and streetscape improvements would complement the stations and busway and would encourage pedestrian access to development along the busway. Stations would consist of a shelter and associated pedestrian path improvements, lighting, and passenger safety and security improvements.

Street running stations or major stops in downtown Nashville (along 4th and 5th Avenues) would be at the following locations:

- Charlotte MTA Central Station
- Union Street
- Church Street
- Commerce Avenue
- Broadway Avenue
- Demonbreun Street
- Franklin Street

Busway stations along Murfreesboro Road in Nashville-Davidson County would be at the following locations:

- Oak Street
- Wharf Avenue
- Lester Avenue
- Fesslers Lane
- Thompson Lane
- McGavock Pike
- Donelson Pike
- UNA-Antioch Pike
- Bell Road

Stations in LaVergne, Smyrna, Murfreesboro and unincorporated Rutherford County would be located as follows:

- Mount View Road
- Waldron Road
- Sam Ridley Parkway
- Nissan Boulevard /Almaville Road
- SR 840
- Downtown Murfreesboro
- I-24 at South Church Street

Stations from Bell Road south (except the station in downtown Murfreesboro) would have parking available for park-and-ride activity and would provide for bus transfer and walk up. The downtown Murfreesboro station would be served by connecting bus service and walk-up traffic, but it would not be an appropriate location for a park-and-ride facility due to the development pattern in downtown Murfreesboro.

The operating plans for Alternative C are shown in Figures 5-8 and 5-9. Figure 5-8 shows the stopping plan for the AM peak period (the PM peak period service plan mirrors the AM service plan), while Figure 5-9 describes off-peak (midday) period operation. The operating plan, similar to that operated in Alternative A, combines longer distance express services oriented to commuters to downtown Nashville with services oriented to shorter distance trips within the corridor. As in Alternative A, circulator routes would circulate through neighborhoods in the south of the corridor (LaVergne, Smyrna and Murfreesboro) before entering the busway along Nashville Pike or Murfreesboro Road to complete a high speed express trip to downtown Nashville. In the Nashville-Davidson County portion of the corridor, intersecting bus routes would permit passengers to transfer to the BRT at stations along the busway. As shown in the diagram, some trips operate continuously from the Charlotte Street transit center to the West End and Vanderbilt University areas, providing passengers bound to those areas with a one seat ride from areas in the south of the corridor.

Express bus routes operating on the busway would use special suburban coaches with higher level amenities such as padded seats and reading lamps. These vehicles have a seated capacity of 45 and do not allow standing passengers. Local bus routes would use standard transit buses similar to those used by MTA. Fare policy, correcting for inflation, was assumed to be the same as MTA and RTA in 2004-2005, with local bus routes costing $1.45 and $2.25 for express routes. A full discussion of the fare policy is included in section 3.6.

Figure 5-7 Alignment and Station Location for Alternative C, BRT on Murfreesboro Road/Old Nashville Pike

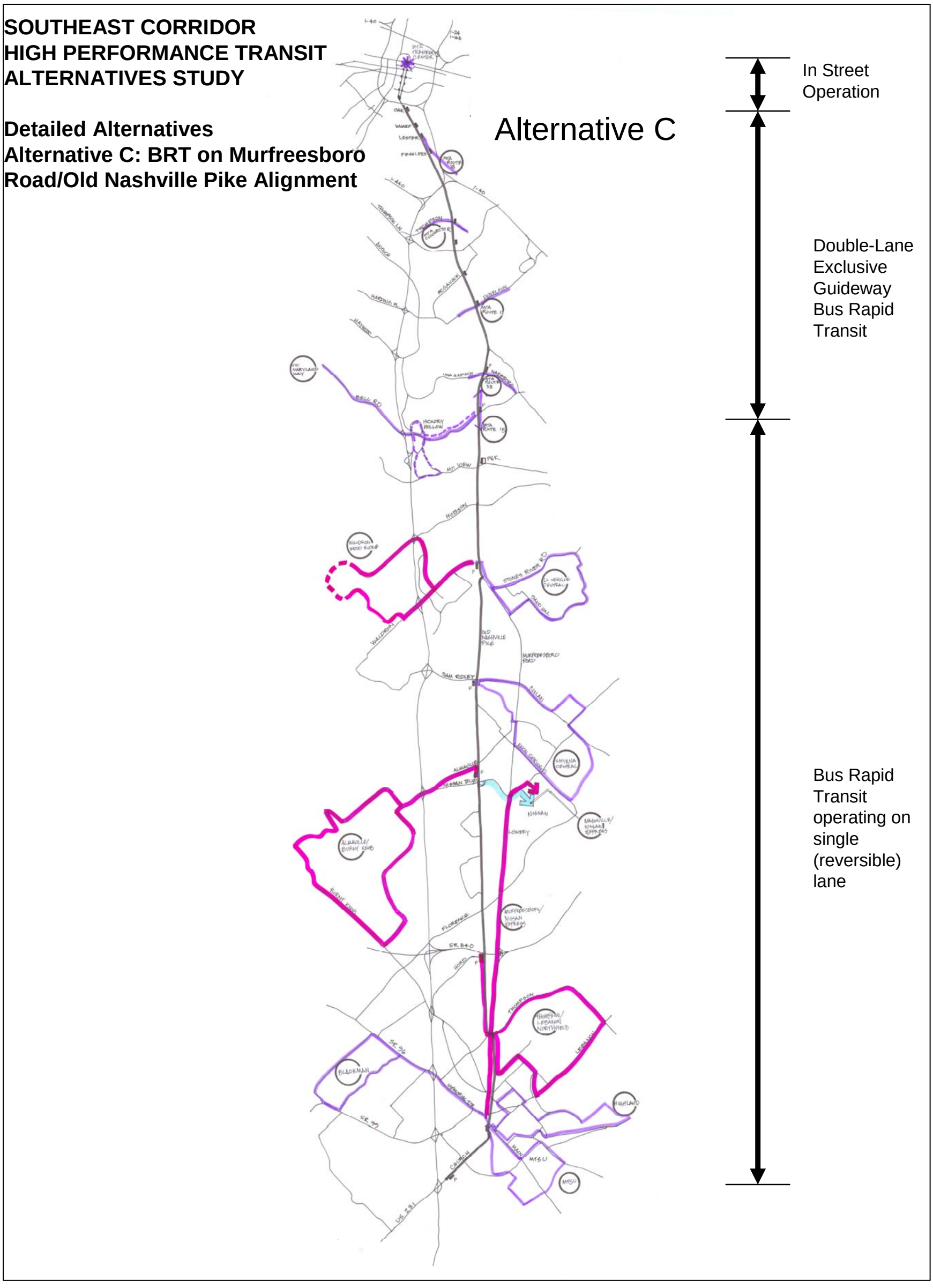


Figure 5-8 Alternative C Operating Concept – AM Peak

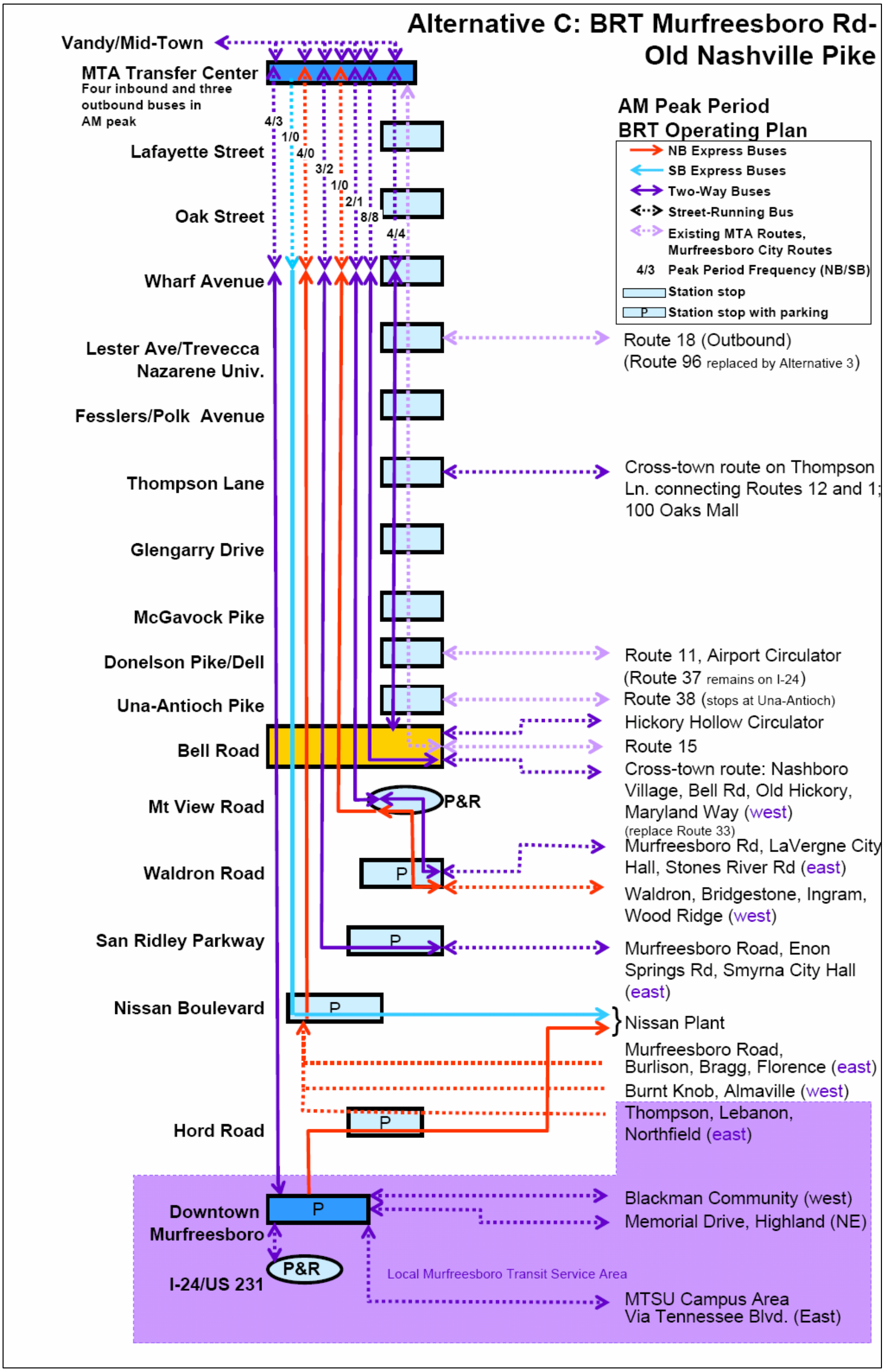
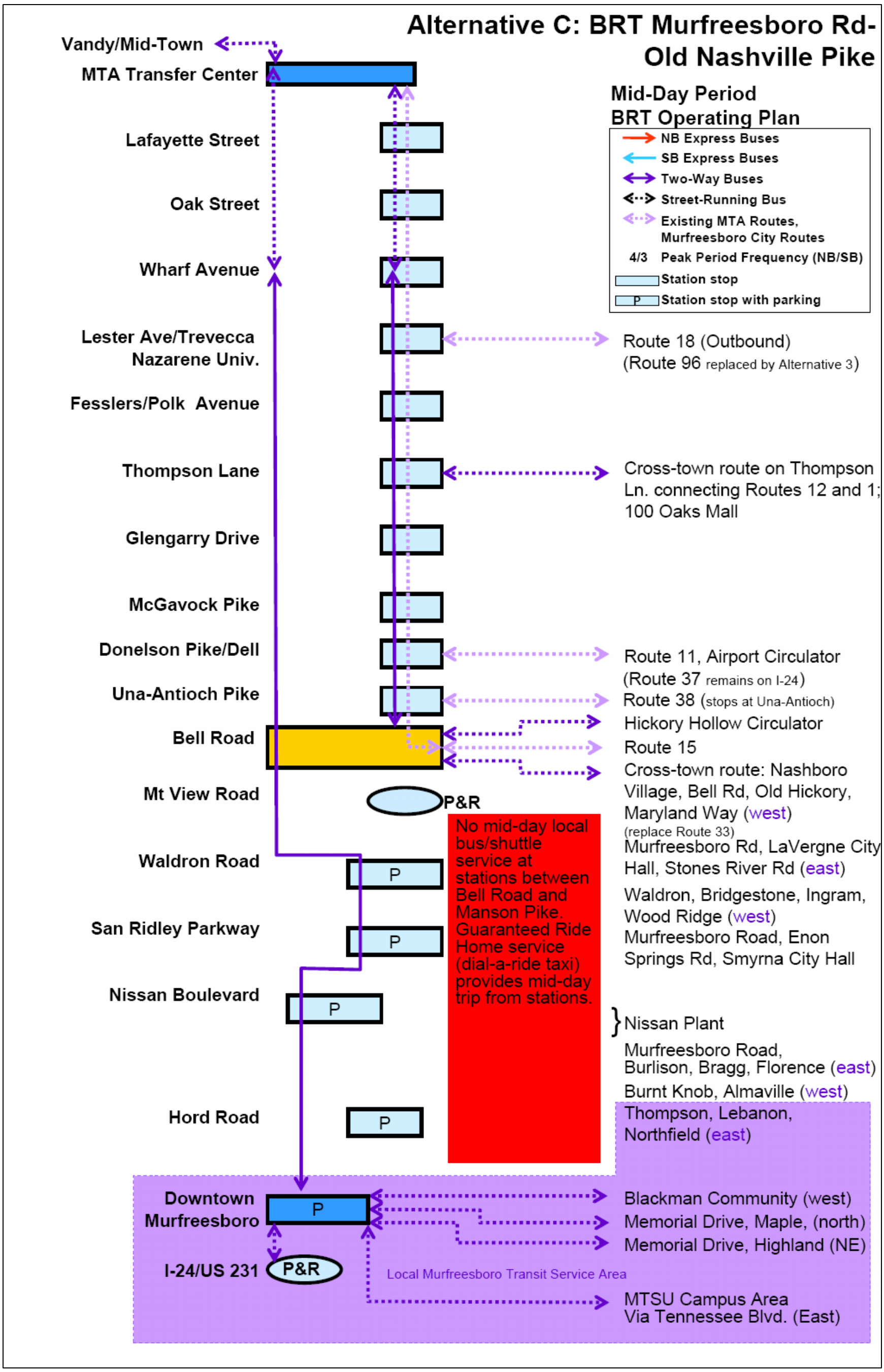


Figure 5-9 Alternative C Operating Concept – Mid-Day Period



5.3.2 Screening of Phase II Alternatives

The comparison of the Phase II detailed alternatives was based on both qualitative judgments and quantitative analysis of the three alternatives, comparing them to the Detailed Screening Criteria identified in Section 3.9, the Evaluation Methodology. These measures in turn are based on the goals and objectives described in Chapter 3, the Needs Assessment. The purpose of the screening is to identify the alternative, or elements of each of the alternatives, that might be carried forward as a potential preferred alternative for the study or to support the rejection of the alternatives in favor of the no-build option. The assessment included estimates of capital and operating costs and transit ridership and a preliminary environmental screening. Qualitative assessments were made through discussions between members of the project Steering Committee, MPO and consultant staff in a series of meetings and workshops held to discuss the alternatives. The assessment is organized in the Phase II Evaluation Matrix, which is shown in the tables included in this section of the report.

Wherever possible, the Phase II analysis relies on quantitative assessments that facilitate comparison between the alternatives. Precise numbers often are rounded, so that they do not imply a level of precision in the estimates that could not be supported by estimating techniques that are not, at this point, based on a high level of engineering or environmental research. Where qualitative assessments are used, the ordinal numeric scoring used in the Phase I assessment was carried forward. In this system, 1 is the highest or “best” score and 3 is the lowest, or “worst”. Generally, decimal qualitative scores were avoided, again to avoid the impression of high precision on estimates that are based solely on subjective judgment.

The assessments under each of the project’s goals are summarized below. More detailed information can be found in the accompanying evaluation matrices.

Goal 1: Provide longer distance travelers in the southeastern corridor with alternatives to driving private vehicles in heavily-congested traffic conditions.

The Phase II screening of alternatives considered evaluation criteria based on several of the objectives included under Goal 1. The analysis results are summarized in Table 5-2. The following discussion explains the results of the analysis for each of the objectives considered in the initial analysis under Goal 1.

1. Provide transit options serving longer-distance trips (primarily more than 3 miles in length) in the corridor that are competitive with, or ideally superior to, driving a private automobile, in terms of travel time, convenience (in the context of specific time-of-day and day-of-week trips), safety, cost (to the individual user) and comfort.

2. Provide enhanced multi-modal access to residences, jobs, services, and other activity centers for corridor residents, workers and visitors.

For the detailed evaluation these objectives were evaluated based on transit ridership. The travel demand forecasting model was used to provide a range of estimates to improve specific ridership (ridership on the specific new bus or rail services that are the focus of the alternatives) and system-wide ridership (increased ridership on the entire Nashville regional transit network, including the corridor, compared to the no-build scenario), under the assumption that higher transit ridership will equate to greater travel time savings in the corridor. All ridership estimates

were developed using Nashville MPO's travel demand forecasting model, which used the highway and transit systems and demographic projected data for the year 2030. The sensitivity tests accounted for the potential of increased transit use generated by Nashville travelers as they become more accustomed to new transit modes that are superior to standard local bus service (bus rapid transit and commuter rail) and to using park-and-ride lots. The estimates also tested for higher than average increases in gasoline prices due to the rapid increases in those prices during 2005 and 2006. The ridership estimates and their underlying assumptions are described in detail in Chapter 8.

Alternative C, the BRT in the Murfreesboro Road-Old Nashville Pike corridor, produced the best improvement in specific and system-wide ridership results. Alternative B, the commuter rail along the CSX right of way, carried the fewest riders on the improvement itself (on the commuter rail line) but carried the second highest number of new riders, adding up to 2,100 new transit riders to the Nashville system but only 900 of those passengers were projected to use the commuter rail service itself. This lower ridership is likely due to the lower frequency of service on the commuter rail alternative and the greater distance between stations. Alternative A added the least system-wide ridership (up to 1,600) but carried more of those new riders on the service itself than did the commuter rail system under Alternative B. Only Alternative C produced significantly more riders than the Low Cost, or TSM alternative, which is the non-busway version of Alternative A. Alternative A likely showed lower ridership than Alternative C due to the greater distance from corridor attractions and residential concentrations, many of which are much closer to the alignment of Alternative C.

Table 5-3 shows ridership by station for Alternative A. As the table indicates, ridership is heavily skewed to longer-distance trips from the southern areas of the corridor to downtown Nashville. Interim stations between Bell Road and downtown Nashville, most of which do not provide park-and-ride access and produce a negligible number of riders. This indicates that the alternative provided little advantage to using existing MTA and RTA bus services, such as MTA's Route 15 local bus and RTA's Route 96 Relax-and-Ride service. The results for all alternatives show the existence of a pronounced, though not large, market for reverse commute services and a significant market for transit service to the Bell Road-Hickory Hollow Mall area from both the Nashville and Murfreesboro directions. The results also indicate that some station locations along major intersecting highway corridors (Sam Ridley, Harding Place) likely would not produce significant transit ridership and should be reworked or eliminated from further consideration as potential station sites.

Station ridership for Alternative B (Table 5-4) shows a similar pattern, though less pronounced than in Alternative A. Longer distance trips (between Murfreesboro and downtown Nashville, and to a lesser extent to Bell Road) are the majority of trips. Closer stations that are in the MTA's existing service area (Harding, Thompson) show little or no ridership, except as destination stations.

Station ridership for Alternative C (Table 5-5) shows the same pattern of boardings and alightings as in A, perhaps more pronounced due to the larger number of stations under this alternative.

Charts of 2030 ridership for each alternative are shown in Figure 5-10.

Table 5-2
Detailed Alternatives Screening – Goal 1 Criteria

Goals and Objectives	Detailed Screening	TSM (Low-Cost)	Alternative A: BRT I-24	Alternative B: CR CSX Alignment	Alternative C: BRT M'Boro Rd./Old N'Ville Pike
Goal 1: Provide longer-distance travelers in the southeastern corridor with alternatives to driving private vehicles in heavily-congested traffic conditions. (Goal relates to travel time savings and low-income households served, measures under New Starts Criteria Mobility Improvements)					
1. Provide transit options serving longer-distance trips (primarily more than 3 miles in length) in the corridor that are competitive with, or ideally superior to, driving a private automobile, in terms of trip time, convenience (in the context of specific time-of-day and day-of week trips), safety, cost (to the individual user) and comfort. (New Starts Measures: Time Savings, Low Income Households Served)	System-wide and improvement specific (i.e., the specific bus or rail line that is the focus of the alternative) that is the focus of the alternative, and travel time savings on transportation networks (quantitative measures). These measures are used based on the assumption that higher transit ridership and travel time savings across the regional transportation network (provided by the travel demand forecasting model) will indicate those alternatives that compete best with the private automobile.	Improvement Specific:1,200-1,500 Daily Riders System Wide new daily riders: To be determined	Improvement Specific:1,300-1,600 daily riders System-Wide new daily riders: 500-1,600	Improvement-Specific: 500-900 daily riders System-wide new daily riders: 800-2,100	Improvement-Specific: 1,500-1,900 System-Wide new daily riders: 1,400-2,500
2. Provide enhanced multi-modal access to residences, jobs, services, and other activity centers for corridor residents, workers, and visitors. (New Starts Measures: Time Savings, Low Income Households Served)					
3. Provide transportation options that serve both work and non-work trips. (New Starts Measure: Low Income Households Served)	Transit trips by purpose (HBW, NHB, HBO) for each alternative (quantitative) and employment within ½ mile radius of stations. Alternatives that have higher ridership specifically in non-work related travel, and have stations within a short distance of many jobs, will be assumed to provide a better balance between work and non-work travel and thus will score higher on this alternative.	Jobs within ½ mile: 33,000	HBW: 1,000-1,270 HBO: 150-190 NHB: 90-100 Jobs within ½ mile: 33,000	HBW: 440-780 HBO: 40-60 NHB: 50-70 Jobs within ½ mile: 21,000	HBW: 970-1,250 HBO: 250-310 NHB: 280-300 Jobs within ½ mile: 40,500
4. Provide improved transit opportunities for reverse-commuters. (New Starts Measure: Low Income Households Served)	Number of reverse commute transit trips, low income and minority households within 5 mile radius of station stops; zero car households within ½ mile of stations stops (quantitative), generated by the travel demand forecasting model. Higher numbers of reverse commuters indicate improved transit opportunities for reverse commuters.	Minority households within 5 miles: 64,000 Low income households within 5 miles: 87,500 Zero Car Households within ½ mile: 3,350	Minority households within 5 miles: 64,000 Low income households within 5 miles: 87,500 Zero Car Households within ½ mile: 3,350	Minority households within 5 miles: 40,000 Low income households within 5 miles: 62,500 Zero Car Households within ½ mile: 1,550	Minority households within 5 miles: 64,500 Low income households within 5 miles: 90,000 Zero Car Households within ½ mile: 4,000
5. Improve access to mass transit in areas of the corridor outside central Nashville. (New Starts Measure: Low Income Households Served)	Number of residents within 5 mile radius of stations/stops (quantitative), based on the assumption that greater numbers of residents in proximity to major transit stations or stops equates to improved access.	Population within 5 miles: 491,000 Households within 5 miles: 196,000	Population within 5 miles: 491,000 Households within 5 miles: 196,000	Population within 5 miles: 219,000 Households within 5 miles: 149,500	Population within 5 miles: 335,500 Households within 5 miles: 196,000
	Number of jobs within ½ mile radius of stations/stops (quantitative) based on the assumption that greater numbers of jobs in proximity to major transit stations or stops equates to improved access.	33,000	33,000	21,000	40,500
	A distance of ½ mile to jobs is based on the maximum distance most people are willing to walk to their destination (roughly 10 minutes). A distance of 5 miles is based on a reasonable distance for a commuter to drive to a park and ride lot to access the transit alternative.				
6. Increase utilization of public transit in the corridor for all trip purposes.	System-wide and improvement-specific transit ridership (quantitative), transit ridership being the key indicator of increased utilization.	Improvement Specific:1,200-1,500 Daily Riders System Wide new daily riders: To be determined	Improvement Specific:1,300-1,600 daily riders System-Wide new daily riders: 500-1,600	Improvement-Specific: 500-900 daily riders System-wide new daily riders: 800-2,100	Improvement-Specific: 1,500-1,900 System-Wide new daily riders: 1,400-2,500
7. Provide greater diversity of transportation options in the corridor by providing improved conditions for pedestrians, bicyclists, and other non-automotive users.	Number of residents within ½ mile radius of transit stations/stops (quantitative), based on the assumption that transit improvements are more conducive to favorable conditions for pedestrian, bicycle and other non-auto users than highway improvements and that improved access to transit improvements primarily benefit non-auto users. A distance of ½ mile to jobs is based on the maximum distance most people are willing to walk to their destination (roughly 10 minutes).	16,000	16,000	5,400	15,500

3. Provide transportation options that serve both work and non-work trips

The criteria used to evaluate the alternatives against this objective were the ridership by trip purpose and the number of jobs located near the stations. As noted in the previous discussion of ridership, there was a small but significant market for reverse commute travel on all of the alternatives. Analysis by trip purpose (Table 5-6) shows that while Alternative B has lower ridership than the BRT alternatives, the primary ridership difference between Alternatives A and C is in non-work related travel. The two alternatives are equal in terms of Home-Based Work trips, but Alternative C carries more Home-Based Other and Non-Home Based trips. This probably is because the Murfreesboro Road and Old Nashville Pike alignment brings travelers closer to shopping and other non-work locations than the other two alignments.

The number of workers adjacent to stations was estimated for 2030 using GIS analysis of population and employment data from Nashville MPO's travel demand model. The number of workers was highest for Alternative C, which, with more than 40,000 jobs located within ½ mile of stations, had nearly twice as many jobs in the area as the area studied for Alternative B—primarily because there are more stations in Alternative C, and the stations are closer in proximity to major employment centers at Murfreesboro Road.

Table 5-3
Estimated 2030 Total Daily Station Ridership for Alternative A (I-24 BRT)

Alternative A (I-24 BRT)	From	To	Station Boardings
SR 99	310	10	160
Manson Pike	250	30	140
SR 840/Murfreesboro Road PNR	40	-	20
Nissan Blvd	200	30	110
Sam Ridley	-	-	-
Waldron Rd.	90	10	50
Old Hickory/Hobson Pike	30	10	20
Hickory Hollow/Bell Road	300	110	210
Haywood Lane	-	10	-
Harding Place	-	-	-
Thompson Lane	-	-	-
Murfreesboro Road	-	-	-
Elm Hill Pike	-	-	-
Hermitage Avenue	30	100	60
Peabody	10	170	90
Franklin	-	60	30
Malloy	-	-	-
Demonbreun	-	10	-
GEC	-	-	-
Broadway	10	50	30
Commerce	-	80	40
Church	-	20	10
Union	10	330	170
Charlotte/Downtown Transit Center	20	270	150
TOTAL			**1,280**

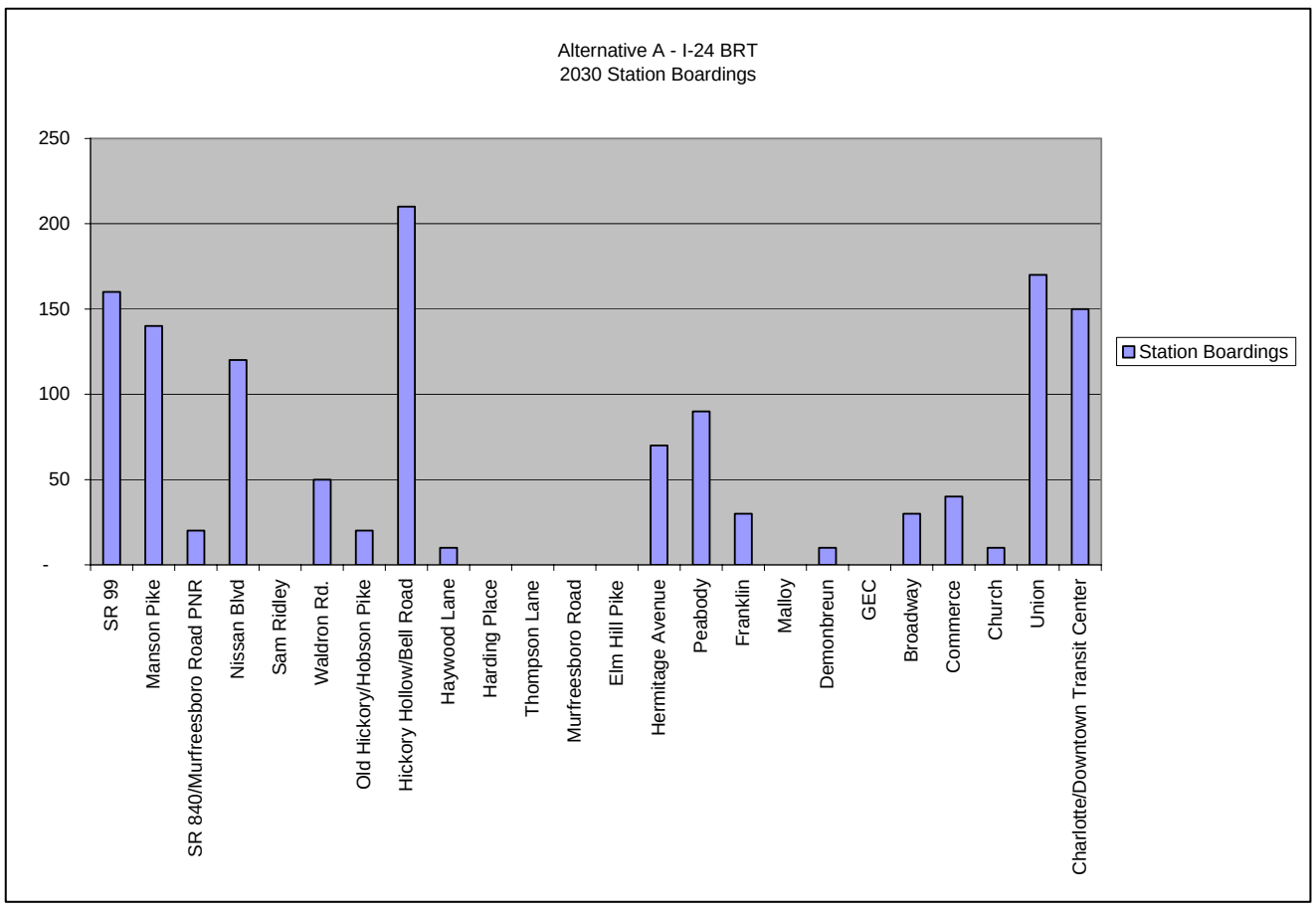
Table 5-4
Estimated 2030 Total Daily Station Ridership for Alternative B (CSX Commuter Rail)

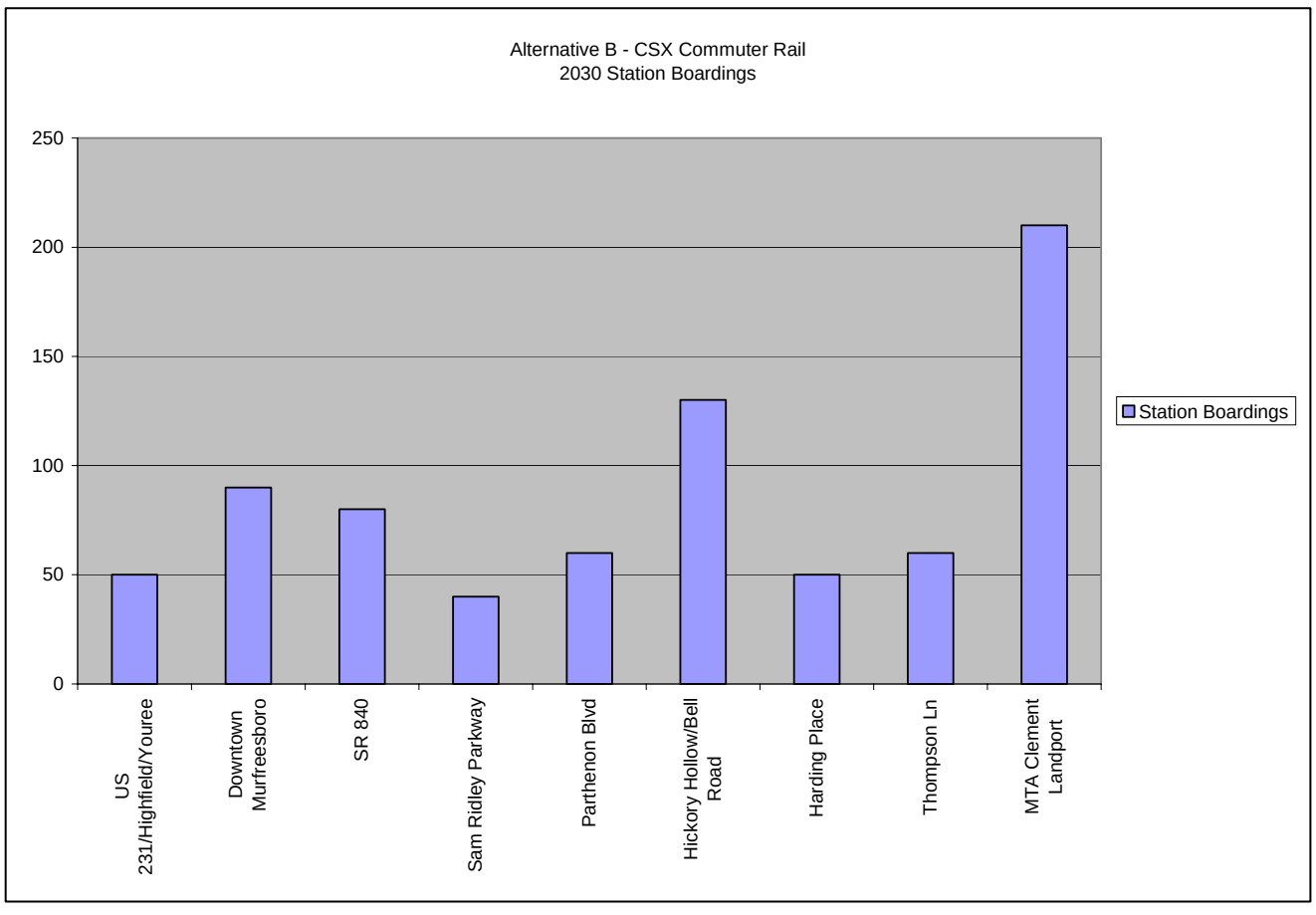
Alternative B (CSX Commuter Rail)	On	Off	Station Boardings
US 231/Highfield/Youree	110	-	50
Downtown Murfreesboro	150	40	90
SR 840	160	-	80
Sam Ridley Parkway	70	10	40
Parthenon Blvd	120	-	60
Hickory Hollow/Bell Road	130	130	130
Harding Place	30	70	50
Thompson Ln	10	120	60
MTA Clement Landport	10	420	210
TOTAL			**770**

Table 5-5
Estimated 2030 Total Daily Station Ridership for Alternative C (Murfreesboro/Old Nashville BRT)

Alternative C Murfreesboro Rd./Old Nashville BRT	On	Off	Station Boardings
I-24 at S. Church	400	30	220
Downtown Murfreesboro	410	110	260
SH 840	260	10	130
Nissan/Almaville	30	40	30
Sam Ridley Pkwy	40	20	30
Waldron	70	40	50
Mount View Rd	-	-	0
Bell Rd	440	330	390
UNA Antioch Pk	-	-	0
Donelson Pike	-	-	0
McGavock Pike	-	-	0
Thompson Ln	-	-	0
Fesslers Ln	-	-	0
Lester Avenue	-	-	0
Wharf Avenue	-	-	0
Oak St.	-	-	0
Franklin	20	190	110
Demonbreun	-	20	10
Broadway	-	80	40
Commerce	-	110	50
Church	-	20	10
Union	-	560	280
Charlotte MTA Transit Center	20	140	80
TOTAL			**1690**

Figure 5-10 2030 Ridership for each alternative





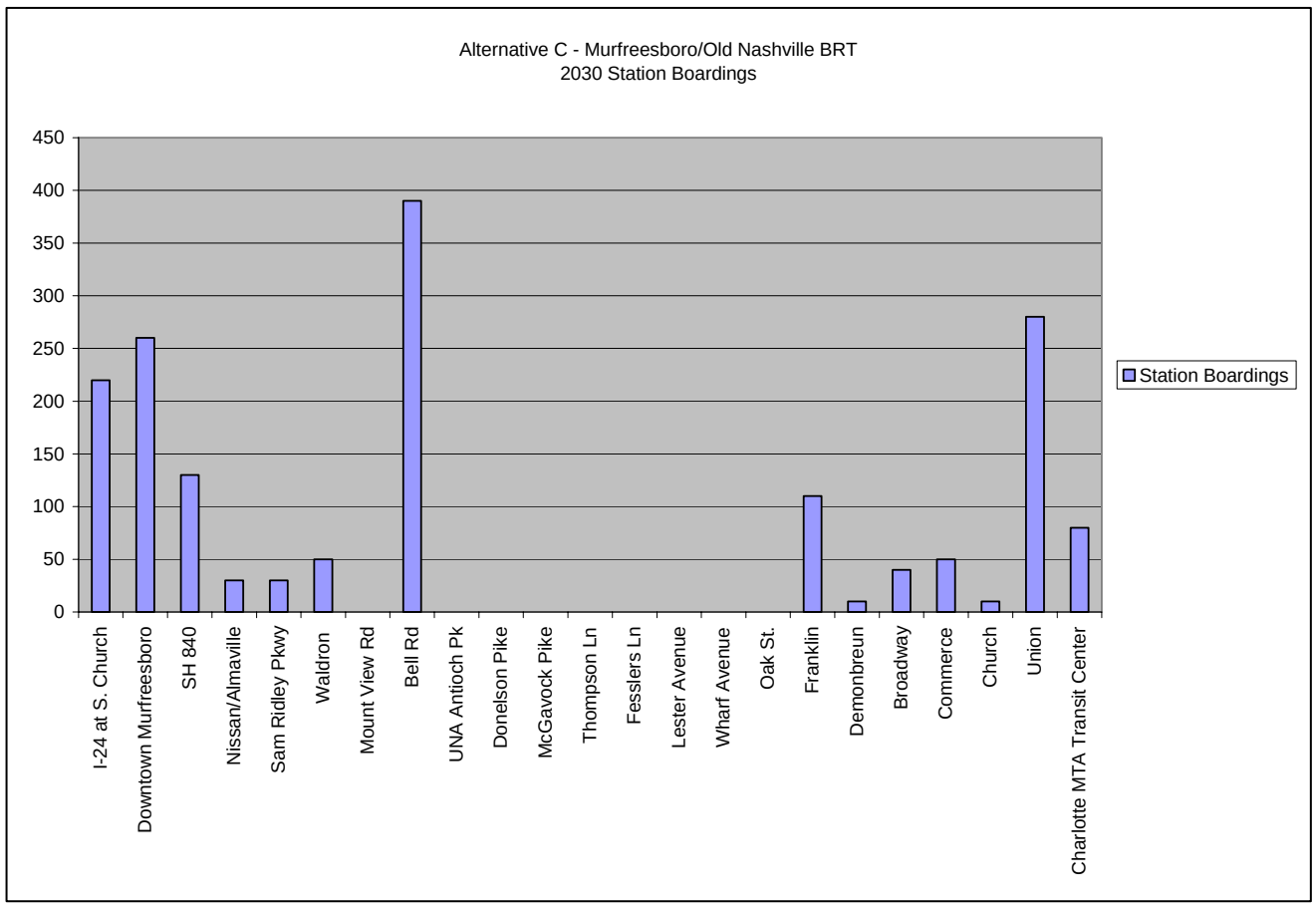


Table 5-6
Estimated Ridership by Trip Purpose for Detailed Alternatives

	Riders by Trip Purpose			
Alternative	Home-Based Work	Home-Based Other	Non Home-Based	Total
1. I-24 BRT	1,000-1,270	150-190	90-100	1,250-1,560
2. CSX Commuter Rail	440-780	40-60	50-70	530-900
3. M'boro/Old Nashville BRT	970-1,250	250-310	280-300	1,500-1860

Table 5-7
Change in Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT) for Detailed Alternatives

Alternative	**VMT**	**VHT**	**VMT Change (from No-Build)**	**VMT % Change (from No-Build)**	**VHT Change (from No-Build)**	**VHT % change (from No-Build)**
No-Build	30,160,420	1,052,491	0	0.00%	0	0.00%
TSM	30,149,191	1,052,128	-11,229	-0.04%	-363	-0.03%
1. I-24 BRT	30,144,716	1,052,050	-15,704	-0.05%	-441	-0.04%
2. CSX Commuter Rail	30,145,286	1,052,044	-15,134	-0.05%	-447	-0.04%
3. M'Boro/Old Nashville BR	30,139,361	1,051,874	-21,059	-0.07%	-617	-0.06%

4. Provide transit opportunities for reverse commuters.

This objective was evaluated based on the number of minority, low income, and zero car households located near stations. Alternatives A and C, as well as the Low Cost-TSM alternative, had roughly equal numbers of these groups. Ridership results confirm that these two alternatives have essentially equal numbers of reverse commute trips (trips oriented to Bell Road or LaVergne, Smyrna or Murfreesboro—see tables 5-3 through 5-5). Alternative B had fewer members of these groups near the stations, primarily because of the smaller number of stations in the commuter rail alternative.

5. Improve access to mass transit in areas of the corridor outside central Nashville.

Evaluation was based on the number of jobs located near stations (excluding jobs in downtown Nashville or the Vanderbilt-West End area). This criteria also was a measure under Objective 3, described above. Alternative C had 40,000 jobs within ½ mile, more than Alternative A (33,000) and nearly twice as many as Alternative B, the commuter rail alternative.

6. Increase utilization of public transit in the corridor for all trip purposes.

This measure also is a component of the analysis under Objective 3, above. Alternative C, the BRT on Murfreesboro Road and Old Nashville Pike, carried the highest overall ridership. While about equal to Alternative A in terms of work trip ridership, as Table 5-6 shows, non-work related ridership also was highest under Alternative C. Alternative B provided few non Home-Based Work related trips.

7. Provide greater diversity of transportation options in the corridor by providing improved conditions for pedestrians, bicyclists and other non-automotive users.

The number of residents located within ½ mile of stations was selected as a surrogate measure for this objective. This is because stations located within walking distance of residents would spur development of improved pedestrian and bicycle facilities. Alternatives A and C, the BRT options, and the Low Cost-TSM Alternative, each had around 16,000 residents located near stations. Alternative B, the commuter rail option, had around 5,400 similarly located. This difference, again, is largely due to the greater number of stations/stops available under the BRT options.

Goal 2: Promote efficient land use and development patterns in Nashville-Davidson County and the Rutherford County Communities in the Southeast Corridor Study Area

The relationship between transportation and land use is well documented; transportation affects potential land use, and choices in land use affect the type of transportation that can be supported. This is an important concept for the southeast corridor since the transit choice can ultimately affect future development. Typically, if frequent high-quality transit service is provided in a corridor, the potential for higher-density land use increases. Thus, if only automobiles can access an area, the resulting land use will be low density sprawl with large amounts of parking. If local or express bus service is provided then there may be a modest increase in the density of the land use. Finally, if bus rapid transit, light rail, or commuter rail are provided in a corridor then the potential for high density land use increases greatly. It should be noted that most land use decisions rest with local government, and it would be up to them to encourage higher density development at stations as part of new transit service in the southeast corridor.

The scoring of alternatives under the criteria applicable to Goal 2 is shown in Table 5-7. The measures used to evaluate the alternatives under this goal were primarily quantitative.

1. Promote compact transit-accessible land development in Nashville, Murfreesboro, LaVergne, Smyrna and other communities in the southeastern corridor study area.

To support this objective, the study team measured the distance of station stops to selected high density employment centers and regional activity centers. Alternatives in which activity centers are located near stations support and promote high density development. Table 5-8 shows the results of this analysis. Stations under Alternative C (BRT on Murfreesboro Road-Old Nashville Pike) were located slightly nearer to employment centers than stations under Alternatives A and B, thought the difference was not great. Alternative A stations were located more distant from regional activity centers than were stations under Alternatives B or C. The analysis overall indicates a slight edge for Alternative C. The employment and activity centers were not “weighted” to account for the relative number of employees and visitors they represent. Further analysis of this type would be required for this measure to serve as a true differentiator.

An analysis of land use surrounding potential station sites was conducted in this phase of screening, and the study team discussed the potential for transit oriented development in station areas along the corridor and provided the local communities with samples of zoning codes that incorporate aspects of transit oriented development. This process is documented in Appendix 5A – Land Use Summary.

2. Concentrate employment and other activity centers within existing and planned transit corridors (fully considering the relationship of transit and parking availability, as associated with such activity centers).

This criteria uses data from the analysis that supported Objective 1. Alternative A and C station stops were located near 22 identified major employment centers. Alternative B stations were located near 12. As noted under other measures, Alternative C has fewer stations, and this, rather than the alignment location, probably explains much of the difference between the alternatives on this measure.

3. Maintain and promote downtown Nashville, other existing established activity centers, including Interchange City and downtown Murfreesboro, as the main employment and activity centers in the corridor.

All of the alternatives provide good service to downtown Nashville (meaning can provide service on 30 minute headways and within ¼ mile of most of downtown). Alternatives A and C (and the Low Cost-TSM alternative) have multiple stations/stops in the downtown area and thus provide better service on this measure than Alternative C, which has only one station in the downtown area.

4. Promote development that re-uses existing sites and buildings and effectively uses existing public infrastructure and public services.

To support this objective, the study team estimated the number of unused or underused land within close proximity (1/2 mile) of the stations. The number of acres (about 12-13) available under Alternatives A and C were effectively the same, indicating that there is relatively little such land available, at least within close proximity of the selected station sites. Alternative B had less underused acreage adjacent to stations, owing again to the fewer number of stations on this alternative .However, on a per station basis, Alternative B had more potentially re-developable land than the other two alternatives.

Goal 3: Improve economic development and employment opportunities, and expand access to jobs.

Table 5-9 shows the results of the detailed analysis under Goal 3. The analysis is primarily quantitative and references much of the same data as employed under Goals 1 and 2.

1. Promote sustainable economic growth throughout the corridor by providing improved access and optional transportation modes.
2. Provide improved access to housing opportunities throughout the corridor by providing improved transit access and options.

These objectives were measured by estimating the population located within 5 miles of the corridor's station stops and also the number of jobs located within ½ mile, using GIS analysis. These two measures indicated the number of persons who could potentially use the proposed system to get to work, including those who would use park-and-ride services to get to workplaces (including downtown Nashville) and the number of jobs outside downtown Nashville that are located near the stations. Alternative A has the largest population living near stations (490,000, or nearly half the population of the Nashville region), primarily because its station areas include both the entire southeast corridor area and a large proportion of the large

Table 5-8
Detailed Alternatives Screening – Goal 2 Criteria

Goals and Objectives	Detailed Screening	TSM (Low-Cost)	Alternative A: BRT I-24	Alternative B: CR CSX Alignment	Alternative C: BRT M'Boro Rd./Old N'Ville Pike
Goal 2: Promote efficient land use and development patterns in Nashville/Davidson County and the Rutherford County communities in the Southeast Corridor Study Area. (Goal relates to measures under New Starts Criteria Transit Supportive Land Use and Future Patterns)					
1. Promote compact transit-accessible land development in Nashville, Murfreesboro, LaVergne, Smyrna and other communities in the southeastern corridor study area. (relates to measures under New Starts Criteria Transit Supportive Land Use and Future Patterns)	Proximity in terms of absolute distance of station stops to selected high density employment and activity centers. Alternatives in which more activity centers are located a short distance from stations are most likely to promote further development in close proximity to stations.	See Table 5-9			
2. Concentrate employment and other activity centers within existing and planned transit corridors (fully considering the relationship of transit and parking availability, as associated with such activity centers). (relates to measures under New Starts Criteria Transit Supportive Land Use and Future Patterns)	Number of major new or existing employment or activity centers located within close proximity of transit stations or major stops (quantitative - absolute number of centers served). The number of major activity centers within a short distance of stations is an indication of how concentrated development is within a short distance of the stations. Scoring will be based on the absolute number of activity centers within 5 miles of the station.	22	22	12	22
3. Maintain and promote downtown Nashville, other existing established activity centers, including Interchange City, and downtown Murfreesboro as the main employment and activity centers in the corridor. (relates to measures under New Starts Criteria Transit Supportive Land Use and Future Patterns)	How well does the alternative strategy serve downtown Nashville, Interchange City, and downtown Murfreesboro (qualitative measure, absolute number of activity centers served) Alternatives that provide direct service to each of the largest activity centers are identified, and the number of major centers counted, by members of the consultant team and verified by members of the Steering Committee.	Multiple stops in downtown Nashville, centrally located stops in Interchange City area and Murfreesboro	Multiple stops in downtown Nashville, centrally located stops in Interchange City area and Murfreesboro	Single, peripherally located station in downtown Nashville. Distant station to interchange City. Centrally located station in Murfreesboro	Multiple stops in downtown Nashville, centrally located stops in Interchange City area and Murfreesboro
4. Promote development that re-uses existing sites and buildings, and that efficiently uses existing public infrastructure and public services. (relates to measures under New Starts Criteria Transit Supportive Land Use and Future Patterns)	Potential acres with increased value of developable land to be as a result of alternatives (quantitative measures). Increased value of land and improvements is an indication of efficient use of infrastructure, since more valuable land tends to be used more intensively and, therefore, uses infrastructure more intensively and over a smaller area.	12.5 sq. mi.	12.5 sq. mi	7.1 sq. mi.	12.6 sq. Mi.
5. Promote multi-use development combining many activities including commercial, retail, education, recreation, and housing. (relates to measures under New Starts Criteria Transit Supportive Land Use and Future Patterns)	How well does the proposed strategy serve existing residential and employment centers in the corridor; How well does it serve proposed developments with TOD elements in the corridor (qualitative measure), based on discussion between members of the consultant team and members of the Steering Committee.	Based on discussion with Steering Committee			

Table 5-9
Linear Distance from Stations to Major Employers and Activity Centers

Major Employers (500+ employees)	Alternative A*/Low Cost TSM *I-24 Corridor*		Alternative B *CSX Railroad Corridor*		Alternative C* *Murfreesboro Road Corridor*	
BellSouth Telecommunications	MTA Transit Center	0.2 miles	Land Port	0.6 miles	MTA Transit Center	0.2 miles
Nortel Networks	MTA Transit Center	2.3 miles	Land Port	2.6 miles	MTA Transit Center	2.3 miles
Peterbilt Motors Co	MTA Transit Center	9.2 miles	Land Port	9.7 miles	MTA Transit Center	9.2 miles
Reemay Inc	MTA Transit Center	10.1 miles	Land Port	10.6 miles	MTA Transit Center	10.1 miles
Robert Orr Sysco Food Services	MTA Transit Center	5.5 miles	Land Port	5.4 miles	MTA Transit Center	5.5 miles
Tennessean	MTA Transit Center	0.5 miles	Land Port	0.1 miles	MTA Transit Center	0.5 miles
United Methodist Publishing	MTA Transit Center	0.4 miles	Land Port	0.2 miles	MTA Transit Center	0.4 miles
Visteon	MTA Transit Center	5.3 miles	Land Port	5.1 miles	MTA Transit Center	5.3 miles
Aladdin Industries LLC	Murfreesboro Rd	0.4 miles	Harding	2.3 miles	Fesslers Lane	0.7 miles
CNA Insurance	Murfreesboro Rd	5.3 miles	Harding	5.2 miles	Donelson Pk/Dell	3.9 miles
RTS Wright Industries LLC	Murfreesboro Rd	0.3 miles	Harding	2.0 miles	Thompson Lane	1.1 miles
Thomas Nelson Inc	Murfreesboro Rd	3.4 miles	Harding	3.6 miles	Glengarry Drive	2.8 miles
Aerostructures Corp	Thompson Lane	1.8 miles	Harding	1.3 miles	Glengarry Drive	0.5 miles
BetterBilt Doors & Windows	Smyrna/Sam Ridley	4.1 miles	Downtown Smyrna	1.6 miles	Smyrna/Sam Ridley	2.7 miles
Bridgestone/Firestone Inc	Old Hickory	0.6 miles	Waldron Road	1.2 miles	Waldron Road	1.6 miles
Cumberland Swan	Smyrna/Sam Ridley	4.8 miles	Downtown Smyrna	2.4 miles	Smyrna/Sam Ridley	3.4 miles
General Mills	SR 99	1.8 miles	Downtown M'boro	2.9 miles	I-24/US231	0.7 miles
Ingram Book Co	Waldron Road	0.6 miles	Waldron Road	1.6 miles	Waldron Road	1.8 miles
Metalworking Products	Old Hickory	1.1 miles	Waldron Road	0.9 miles	Waldron Road	1.2 miles
Nissan North America Inc	Nissan Blvd	2.9 miles	Downtown Smyrna	3.1 miles	Nissan Blvd	1.3 miles
Square D	Smyrna/Sam Ridley	4.8 miles	Downtown Smyrna	2.2 miles	Smyrna/Sam Ridley	3.3 miles
Stratos & Javelin Boats	SR 99	2.6 miles	US 231	3.4 miles	I-24/US231	1.3 miles
Whirlpool Corp	Old Hickory	0.9 miles	Waldron Road	0.9 miles	Waldron Road	1.2 miles
Average Distance to a Station	**3.0 miles**		**3.0 miles**		**2.7 miles**	

Activity Centers	Alternative A* *I-24 Corridor*		Alternative B *CSX Railroad Corridor*		Alternative C* *Murfreesboro Road Corridor*	
Centennial Hospital	MTA Transit Center	1.8 miles	Land Port	1.5 miles	MTA Transit Center	1.8 miles
Vanderbilt University	MTA Transit Center	1.5 miles	Land Port	1.1 miles	MTA Transit Center	1.5 miles
Baptist Hospital	MTA Transit Center	1.4 miles	Land Port	1.0 miles	MTA Transit Center	1.4 miles
Vanderbilt Hospital (VA)	MTA Transit Center	1.8 miles	Land Port	1.4 miles	MTA Transit Center	1.8 miles
Vanderbilt Childrens' Hospital	MTA Transit Center	1.8 miles	Land Port	1.4 miles	MTA Transit Center	1.8 miles
Vanderbilt University Hospital	MTA Transit Center	1.8 miles	Land Port	1.4 miles	MTA Transit Center	1.8 miles
Belmont University	MTA Transit Center	2.0 miles	Land Port	1.6 miles	MTA Transit Center	2.0 miles
Music Row	MTA Transit Center	0.9 miles	Land Port	0.5 miles	MTA Transit Center	0.9 miles
TBoR/TSU downtown campus	MTA Transit Center	0.4 miles	Land Port	0.5 miles	MTA Transit Center	0.4 miles
Tennessee Titans Stadium	MTA Transit Center	0.6 miles	Land Port	1.0 miles	MTA Transit Center	0.6 miles
Nashville Convention Center	MTA Transit Center	0.1 miles	Land Port	0.6 miles	MTA Transit Center	0.1 miles
Gaylord Entertainment Center	MTA Transit Center	0.1 miles	Land Port	0.4 miles	MTA Transit Center	0.1 miles
Ryman Auditorium	MTA Transit Center	0.2 miles	Land Port	0.5 miles	MTA Transit Center	0.2 miles
Country Music Hall of Fame	MTA Transit Center	0.2 miles	Land Port	0.5 miles	MTA Transit Center	0.2 miles
Travecca Nazarene University	Elm Hill	0.9 miles	Land Port	1.9 miles	Lester Ave	0.2 miles
BNA (Nashville Airport)	Thompson	3.3 miles	Harding	3.2 miles	Donelson	1.8 miles
Hickory Hollow Mall	Hickory Hollow	0.4 miles	Hickory Hollow	0.5 miles	Mt. View Road	2.0 miles
Starwood Amphitheatre	Waldron Road	2.0 miles	Waldron	1.5 miles	Mt. View Road	1.4 miles
Smyrna Airport	Sam Ridley	0.4 miles	Sam Ridley	0.5 miles	Sam Ridley	1.7 miles
Stonecrest Medical Center	Sam Ridley	3.2 miles	Sam Ridley	2.4 miles	Sam Ridley	1.2 miles
Middle Tennessee State University	SR96	3.0 miles	Downtown Murfreesboro	1.9 miles	Downtown Murfreesboro	1.6 miles
Alvin C. York VA Medical Center	SR840	3.9 miles	SR840	3.9 miles	Hord Road	4.3 miles
Stones River Mall	SR96	1.5 miles	Downtown Murfreesboro	1.0 miles	Downtown Murfreesboro	1.3 miles
Middle Tennessee Medical Center	SR96	2.2 miles	Downtown Murfreesboro	1.0 miles	Downtown Murfreesboro	0.8 miles

*Note: Alternatives A and C have a number of minor stations/stops in the downtown area, some of which may be closer to major destinations than the MTA Music Central City Station at Charlotte Avenue

southeastern corridor. Alternative B has the fewest, owing again to the larger station spacing on that alternative. Alternative C has the largest number of jobs, and Alternative B has the fewest, as discussed under Goal 1, Objective 3, above.

3. Provide improved access to employment centers throughout the corridor by providing improved transportation access and options.

This objective was measured using the same analysis as was used for Goal 2, Objective 1. Data supporting this analysis can be found in Table 5-8.

4. Provide high quality transit access to Nashville International Airport from downtown Nashville, Mufreesboro and other areas within the corridor.

Nashville International Airport (BNA) was eliminated as a possible destination for a guideway station after the initial round of screening, which determined that it was too far from the various alignment options and would introduce too much delay to through service if the alignment was routed through the terminal. However, there remains strong interest in serving BNA with improved transit service. The analysis under this objective focused on the driving distance from the airport to the nearest station stop identified under each alternative. Not surprisingly, given the location of the airport to the northeast of Murfreesboro Road, analysis found that the nearest station to BNA was the Bell Road station under Alternative C, the BRT service on Murfreesboro Road. This station is less than 2.5 miles from the airport. The nearest stations under the other alternatives would be more than four miles from BNA.

5. Enhance reverse commute options providing access for Nashville residents to job opportunities in other areas of the corridor.

This objective is the same as Goal 1, Objective 4. The results of Goal 1, Objective 5 also pertain to this objective.

6. Provide improved access to special events and other destinations in the study corridor.

Special event trip generators are included in the activity centers examined in Table 5-8. Alternatives A and C are essentially equal to each other, but superior to Alternative B, in serving activity centers in and near downtown Nashville, due to the flexibility of downtown BRT service and the single station under Alternative B. Activity centers in the corridor outside downtown tend to be nearest to Murfreesboro Road or Old Nashville Pike of the three alignments under consideration, giving a slight edge to Alternative C under this objective. Special event trips have not been examined as part of the ridership estimation for this project and are not proposed to provide a significant source of ridership or revenue. An analysis of the relative importance of these activity centers in terms of trip generation would be necessary if this criteria were to be used as a significant factor for differentiating between the alternatives.

Table 5-10
Detailed Alternatives Screening – Goal 3 Criteria

Goals and Objectives	Detailed Screening	TSM (Low-Cost)	Alternative A: BRT I-24	Alternative B: CR CSX Alignment	Alternative C: BRT M'Boro Rd./Old N'Ville Pike
Goal 3: Improve economic development and employment opportunities and expand access to jobs.					
1. Promote sustainable economic growth throughout the corridor by providing improved access and optional transportation modes.	Total population within a five mile radius and number of jobs within ½ mile radius of each station or stop, based on the assumption that improved access and increased diversity of transportation modes will promote economic growth and increase sustainability of that growth. Measurement will be essentially the same as for Goal 1, Objective 5.	Population within 5 mile radius of station stops: 491,000 Jobs within ½ mile of station stops: 33,000	Population within 5 mile radius of station stops: 491,000 Jobs within ½ mile of station stops: 33,000	Jobs within 5 mile radius of station stops: 219,000 Jobs within ½ mile of station stops: 21,400	Population within 5 mile radius of Station Stops: 335,500 Jobs within ½ mile of station stops: 40,500
2. Provide improved access to housing opportunities throughout the corridor by providing improved transportation access and options.	Total population within a five mile radius of each station or stop, based on the idea that access to housing is improved by increasing access to transit to a higher proportion of the regional population. A distance of 5 miles is based on a reasonable distance for a commuter to drive to a park and ride lot to access the transit alternative.	491,000	491,000	219,000	335,500
3. Provide improved access to employment centers throughout the corridor by providing improved transportation access and options.	Distance of alternative stations/stops from major employment centers, based on the idea that alternatives with stations and stops located closer to the activity centers would provide better access to employment. Quantitative measure based on aggregate absolute distance of stations or major stops from major employment and activity centers.	See Table 5-8			
4. Provide high quality transit access to Nashville International Airport (BNA) from downtown Nashville, Murfreesboro and other areas within the corridor.	Proximity of stations to BNA in terms of absolute distance (quantitative measure)	Nearest Station: Harding Place Distance to BNA: 4.8 miles	Nearest Station: Harding Place Distance to BNA: 4.8 miles	Nearest Station to BNA: Harding Place Distance to BNA: 4.2 miles	Nearest Station to BNA: Donelson Pike/Dell Distance to BNA: 2.4 miles
5. Enhance reverse commute options providing access for Nashville residents to job opportunities in other areas of the corridor.	Number of reverse commute transit trips (quantitative measure) Same as Goal 1, Objective 4.	See Tables 5-3 to 5-5			
6. Provide improved access to special events and other destinations in the study corridor.	Proximity to key special generator locations. (quantitative measure), with greater proximity representing improved access. Based on aggregate absolute distance of stations or major stops from major activity centers.	See Table 5-8			

Goal 4: Preserve the Natural and Social Environment

Table 5-10 shows the scoring for criteria under Goal 4. Most of these objectives are supported by quantifiable data or will be when analysis is complete. An inventory of environmental concerns was taken for the corridor, and the information from this inventory can be found in Appendix 5B – Environmental Inventory Technical Memo.

1. Improve Air Quality

The analysis will provide the number of auto vehicle miles and vehicle hours traveled (VMT and VHT) in 2030 for each alternative from output produced by the travel demand model. This data has not yet been developed. VMT and VHT are the inputs used to generate air quality emissions estimates and serve as a surrogate for such an analysis. Experience in other cities suggests that the VMT and VHT vary little between transit alternatives, and transit alternatives usually do not greatly reduce emissions.

2. Avoid interference with sensitive soils, groundwater sources, and hazardous materials sites.

3. Minimize transportation-related noise impacts.

4. Protect and, where possible, enhance environmentally sensitive areas.

5. Minimize community and neighborhood disruption.

These criteria measure the potential impacts on various types of sensitive sites in the corridor. All of the alternatives would likely create significant impacts to sensitive sites of various types. The alternatives located in the I-24 corridor (Alternative A and the Low Cost-TSM Alternative) would have the fewest impacts, which is logical given that it is a relatively recently developed right of way dominated by transportation uses. Alternative C, operating in Murfreesboro Road and Old Nashville Pike, operates in long-established rights of way on which adjacent land has long been developed. This corridor has the highest number of potential environmental impacts of the three alternatives.

6. Minimize negative aesthetic impacts of transportation investments, and, where possible, design systems that add to the aesthetic environment.

This highly subjective criterion will be examined in later stages beyond this Alternatives Analysis.

7. Address environmental justice concerns by carefully addressing disproportionate impacts and providing improvements that benefit members of socially disadvantaged groups.

The measure for this objective focused on the number of minority and low income households located within 5 miles of the stations or stops. The analysis found the numbers about equal between Alternatives A and C, each with about 64,000 minority households and about 90,000 low-income households. Alternative B, the commuter rail alternative, had fewer, around 40,000 minority and 63,000 low-income households. Again, the difference between the alternatives was primarily based on the fewer stations included under Alternative B.

8. Promote land use and development policies and transportation strategies that are consistent and mutually supportive.

A major analysis and outreach effort regarding the corridor's land use and development patterns was conducted as part of this study and will be documented in later drafts of this report. The study found that the land adjacent to Alternative A (I-24) would be the most consistent with development of additional transportation right of way, and that transportation development would cause the least disruption of the three corridors under consideration. The study also found that the I-24 corridor is the least transit oriented area and would most benefit from transit-supportive land use policies. Alternative C (Murfreesboro Road, Old Nashville Pike) represented the opposite situation—this area had the most transit supportive development of the three alternatives, but transit improvements in this corridor would be the most disruptive and the least consistent with adjacent land uses. Further transit supportive development in the Murfreesboro Road and Old Nashville Pike alignments would have a large impact on land use in those areas but would have less than in the I-24 corridor. In all analyzed corridors and jurisdictions, transit oriented development policies are not in place to support future land use. All of the communities in the corridor were provided with sample land use zoning codes, and their planning directors are aware of the importance of implementing transit supportive land use around major transit corridors and stations.

9. Provide transportation options that reduce stress caused by congestion-induced delay.

The assumption underlying this criterion is that transit improvements will reduce the need for driving (and may marginally or temporarily reduce traffic congestion), and thus will reduce stress because of the increased transit ridership. Transit ridership estimates are provided under Goal 1, Objective 2.

10. Impacts to farmland and open space in existing rural areas of the corridor.

Alternative C had the highest total impacts to rural land and Alternative A had the least, though there were wide differences between types of impacts. Alternative C had the least impact on agriculturally zoned land, impacting only about 800 acres compared to over 1,200 for Alternatives A and B. However, acres of actual working farm land were highest under Alternative C and lowest under alternative A. Alternative C impacted the largest amount of Federal Land (the alternative passes through the middle of Stones River National Battlefield), religious institutions and schools. Alternative A impacted those uses the least. Alternative B was worst for impacts to parkland at 25 acres, compared to 12 acres for Alternative A and 7 acres for alternative C.

Table 5-11
Initial Alternatives Screening – Goal 4 Criteria

Goals and Objectives	Detailed Screening	TSM (Low-Cost)	Alternative A: BRT I-24	Alternative B: CR CSX Alignment	Alternative C: BRT M'Boro Rd./Old N'Ville Pike
Goal 4: Preserve the natural and social environment. (Goal relates to measures under New Starts Criteria Environmental Benefits)					
1. Improve air quality. (New Starts Measures: Change in Regional Pollutant Emmissions, EPA Air Quality Designation)	Vehicle hours and miles traveled under each alternative. VHT and VMT are the primary inputs in regional air quality modeling and thus are a surrogate for measuring the relative pollution benefits of alternatives—higher VHT and VMT translate to higher volumes of pollution	VMT: 30,149,199 VHT: 1,052,128	VMT: 30,144,716 VHT: 1,052,050	VMT: 30,146,286 VHT: 1,052, 044	VMT: 30,139,361 VHT: 1,051,944
2. Avoid interference with sensitive soils, groundwater sources, and hazardous materials sites.	Analysis of impacts to sensitive receptors including sensitive soils and, groundwater. Conduct hazardous material literature search screening (quantitative and qualitative measures). Conducted as part of environmental analysis.	All alternatives would potentially impact sensitive soils and water resources. See environmental analysis and maps for details. Further delineation is required to determine degree of impact and potential mitigation strategies. See Objectives 3-5 for impacts on other sensitive resources.			
3. Minimize transportation-related noise impacts.	Number of sensitive receptors within 1,000 feet (for noise and vibration) (quantitative), conducted as part of environmental analysis.	Improvements limited to station areas and streetscape in downtown Nashville and Murfreesboro	59 Sites See Objectives 4 and 5	Same as Alt A	Same as Alt A
4. Protect and, where possible, enhance environmentally sensitive areas.	Literature search to identify ecologically sensitive areas, sensitive noise receptors, superfund sites and other hazardous materials sites, and landfills within ¼ mile, and historic resources. Conducted as part of environmental analysis.		CERCLIS Facilities: 1 RCRIS Facilities: 9 RTE Species: 8	CERCLIS Facilities: 1 RCRIS Facilities: 12 RTE Species: 18	CERCLIS Facilities: 1 RCRIS Facilities: 8 RTE Species: 18
5. Minimize community and neighborhood disruption.	Conduct windshield survey to identify parks, schools, hospitals, and other institutions/community services that were not identified in the GIS mapping/data that was available in initial screening. Conducted as part of environmental analysis (2,000 foot buffer around alignment)		NRHP Listed: 5 NRHP Eligible: 5 Archaeological: 5 Cemetaries:11 Schools: 7 Churches: 9 Parks/Rec: 4 Hospitals: 2 Points of Interest: 14	NRHP Listed: 9 NRHP Eligible: 2 Archaeological: 10Cemetaries:7 Schools: 5 Churches: 29 Parks/Rec: 5 Hospitals: 4 Points of Interest: 14	NRHP Listed: 11 NRHP Eligible: 3 Archaeological: 12Cemetaries: 7 Schools: 6 Churches: 41 Parks/Rec: 3 Hospitals: 0 Points of Interest: 10
6. Minimize negative aesthetic impacts of transportation investments and, where possible, design systems that add to the aesthetic environment.	Will be assessed in subsequent stages of development.				
7. Address environmental justice concerns by carefully assessing disproportionate impacts and providing improvements that benefit members of socially disadvantaged groups. (Related to both New Starts Criteria Environmental Benefits and Mobility Improvements, measure Low Income Households Served.	Absolute number of low income and minority households within a five mile radius of each station (quantitative measure).	Minority Households: 64,000 Low-income Households: 87,500	Minority Households: 64,000 Low-income Households: 87,500	Minority Households: 40,000 Low-income Households: 62,500	Minority Households: 64,500 Low-income Households: 90,000
8. Promote land use and development policies, and transportation strategies that are consistent and mutually supportive. (related to both Environmental Benefits and Transit Supportive Land Use and Future Patterns in New Starts Criteria).	Consistency with adopted/proposed land use plans and policies. Consultant and MPO staff will examine existing land use plans and characterize consistency with each alternative.	Improvements limited to station areas and streetscape in downtown Nashville and Murfreesboro	Right of way improvements limited to along I-24 and I-40, consistent with existing use. Station areas not zoned for TOD. Least disruption of existing development of build alternatives.	Improvements primarily through existing town centers and industrial areas. Station areas not zoned for TOD. Moderate disruption of existing development.	Improvemednts primarily through commercial-retail areas. Station areas not zoned for TOD. Most disruption of existing development.
9. Provide transportation options that reduce stress caused by congestion-induced delay.	Transit ridership and travel time savings on transportation network (quantitative measures) (Same as Goal 1, Objective 2)				
10. Minimize impacts to farmland and open space in existing rural areas of the corridor.	Acres of rural land and public open space within 1000 feet of right of way.		Agricultural: 1,275 Acres Farm: 285 Federal: 0 Park: 12 Religious: 33 School: 20	Agricultural: 1,249 Acres Farm: 443 Federal: 103 Park: 25 Religious: 92 School: 37	Agricultural: 798 Acres Farm: 473 Federal: 147 Park: 7 Religious: 186 School: 57

Goal 5: Develop a cost-effective transportation system improvement strategy that maximizes community consensus and institutional support.

Table 5-11 shows the scoring of criteria under Goal 5. Capital and operating-maintenance costs were developed for the alternatives at a relatively detailed level. These costs and the methodologies used to develop them will be described and documented in greater detail in Chapter 9. A cost benefit analysis comparing travel time savings for transit riders to estimated annualized costs will be developed for the preferred and baseline alternatives in the final stages of this project.

1. Assure that total benefits of the preferred alternative investment strategy warrant their total costs.

Capital cost estimates for the infrastructure were made for each of the alternatives. A range of cost estimates were developed for Alternative B, the commuter rail alternative, to account for uncertainty of what might be developed in the corridor. These range from costs of developing a single additional track and sidings from Murfreesboro to Nashville ($230 million); a double track north of Bell Road to downtown Nashville and a single track and sidings from Bell Road south to Murfreesboro ($245 million); and full double track development from downtown Nashville to Murfreesboro ($330 million).

Alternative C, the BRT alternative on Murfreesboro Road consisting of a double lane busway north of Bell Road and a single lane south of Bell, would entail significant right of way costs and many conflicting cross streets. This alternative had the highest estimated improvements cost at about $430 million. Alternative A, consisting of a double lane busway north of Bell Road and a single lane south of Murfreesboro Road, had the lowest overall cost of the major build alternatives at about $220 million. Development of the stations and park-ride lots in the I-24 corridor that would be associated with the Low Cost-TSM alternative would cost $90 - $100 million in infrastructure costs. Estimates of vehicle costs are about $75 million over a thirty year time period for each of the alternatives.

Operating costs generally constitute a small part of the overall cost of a transit alternative, though in absolute costs they can be significant. The operation of the BRT alternatives (Alternatives A and C) was estimated to add an additional $3 million per year to the annual operating cost of MTA-RTA's transit services. The commuter rail alternative (Alternative B) was estimated to add about $5 million to the annual operating costs.

Goal 6: Develop a strategic part of a multi-modal transportation system that would facilitate the development of an integrated regional multi-modal system.

The results of the analysis under these criteria are shown in Table 5-12. Figure 5-11 charts the costs of each of the four considered alternatives. These criteria were analyzed in a more qualitative way than most of the other goals, befitting to the more subjective nature of the measures.

1. Develop alternatives and strategies that complement, rather than conflict with, regional plans for the development of a multi-modal system.

The development of the alternatives took into account regional plans, including the region's long range transportation plan (LRTP), and the Needs Assessment, documented in Chapter 3. Recommendations coming out of the study will require amendment of the regional LRTP and Transportation Improvement Program (TIP) prior to implementation.

2. Develop alternatives that are consistent with the transportation and development goals of the region as identified in the Nashville Area MPO's Long Range Transportation Plans and other regional planning documents.

Consistency with MPO planning documents is addressed in Objective 1, above. Regional land use planning issues are covered in Goal 4, Objective 8.

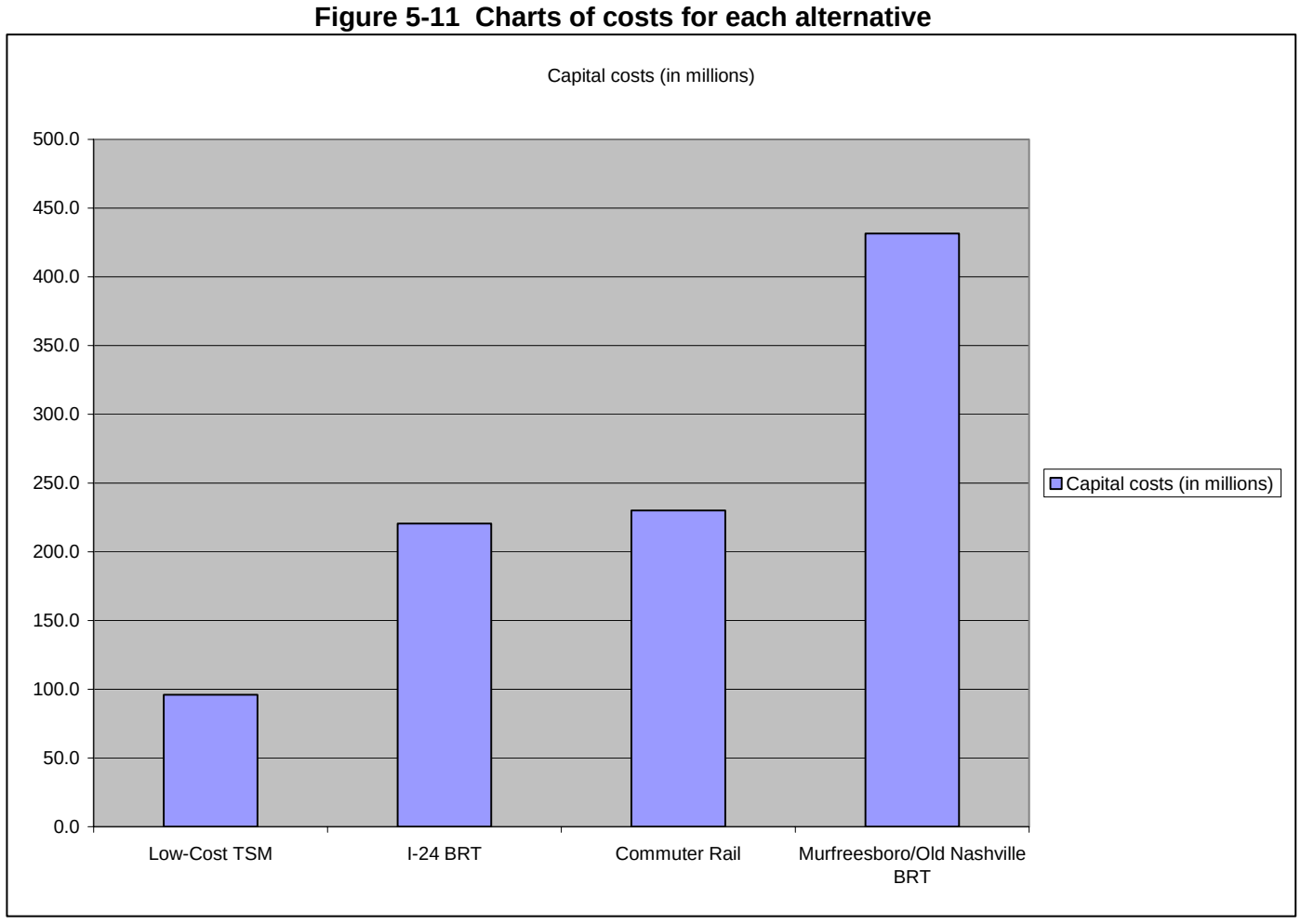
3. Avoid alternatives that might have the effect of precluding the development of other transportation modes or options to serve other corridors in the region.

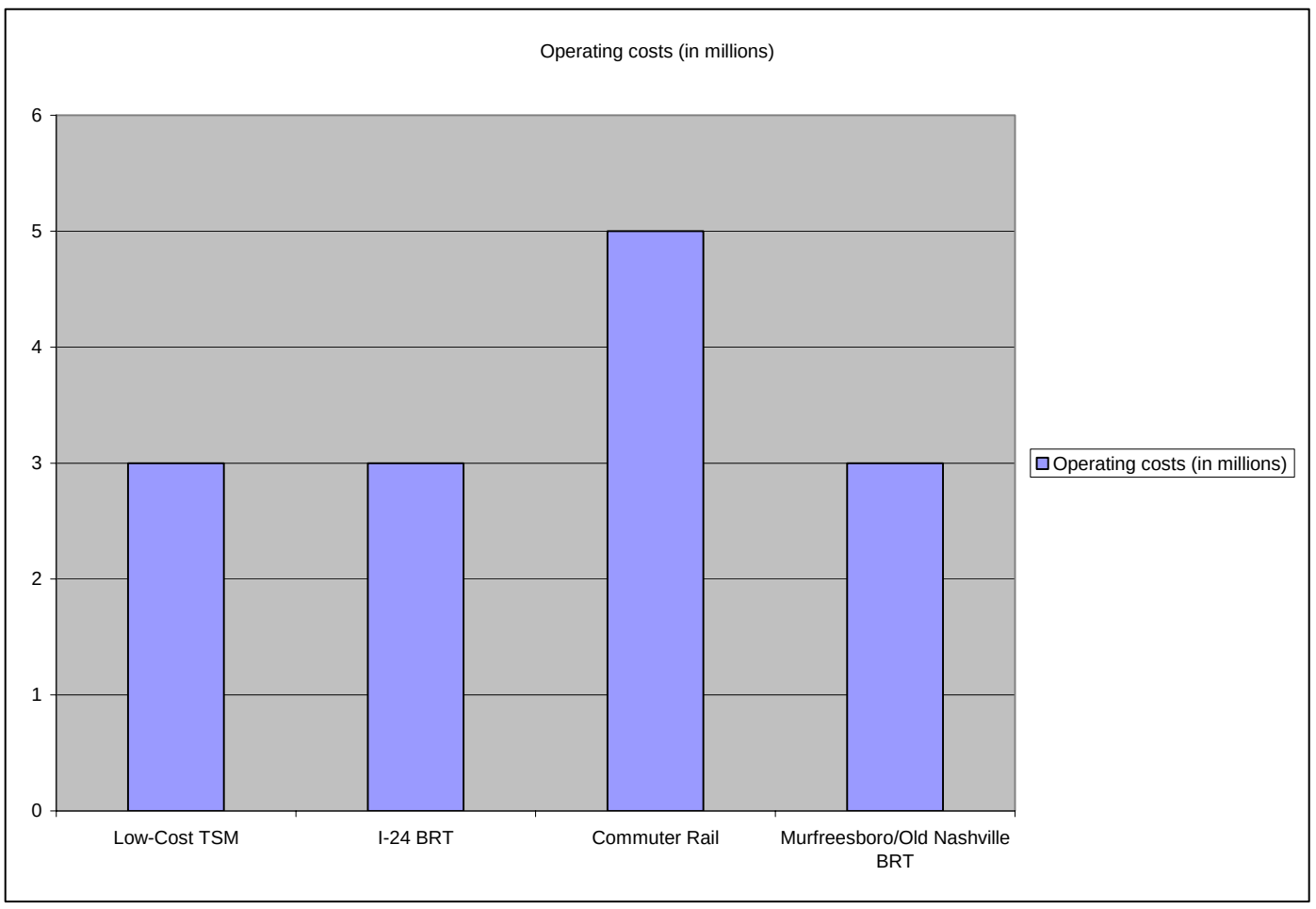
Alternative 2, the CSX commuter rail option, has some potential for connectivity to the East Line Commuter Rail line. Moreover, development of that service could potentially facilitate development of commuter rail services on other corridors. The BRT and Low Cost-TSM alternatives have no potential for interoperating with the East commuter rail line. Because the BRT guideway would not enter downtown Nashville, the development of BRT in the southeast corridor would do little to directly influence or support the development of BRT in other corridors. The development of none of the alternatives would preclude the development of other modal options in other Nashville regional corridors.

Table 5-12
Detailed Alternatives Screening – Goal 5 Criteria

Goals and Objectives	Detailed Screening	TSM (Low-Cost)	Alternative A: BRT I-24	Alternative B: CR CSX Alignment	Alternative C: BRT M'Boro Rd./Old N'Ville Pike
Goal 5: Develop a cost-effective transportation system improvement strategy that maximizes community consensus and institutional support. (related to New Starts Criteria Operating Efficiencies, Cost Effectiveness, and Local Financial Commitment)					
1. Assure that total benefits of the preferred transportation investment strategy recommended by the study warrant their total costs. (New Starts Measures: Operating Efficiencies, Cost Effectiveness).	Detailed cost estimates based on engineering quantities and detailed operating cost estimates; cost effectiveness measure comparing cost to regional user benefit; winners/losers analysis to identify location of benefits (quantitative measures) **All costs are preliminary and exclude bus rolling stock. 2004 Dollars and Unit Costs, 25% contingency**	Capital cost of infrastructure, traffic and station improvements: $96.0 m Vehicles: $74.8 m (30 year cost) Operating Cost: Approx. $3 m	Capital Cost of infrastructure, traffic and station improvements: $220.5 m Vehicles: $74.8 m (30 year cost) Operating Cost: Approx. $3 m	Capital Cost of infrastructure, traffic and station improvements: $230 m (Single Track with Sidings) $245m (Double Track north of Bell) $330 m (Double Track full length) Vehicles: $76.4 m (30 year cost) Bus: Operating Cost: Approx. $5 m	Capital Cost of infrastructure, traffic and station improvements: $431.5 m Vehicles: $79.8 m Operating Cost: Approx. $3 m
2. Achieve public consensus and institutional support, including the support of public agencies, local governmental entities, and public officials, for the preferred transportation investment strategy recommended by the study. (New Starts Criteria: Local Financial Commitment)	Objective achieved through Steering Committee and MPO deliberation, not an evaluation measure.				
3. Ensure that the costs and benefits are shared equitably among citizens and governmental entities throughout the region.	Objective of implementation strategy, not an evaluation measure.				
4. Maximize the leverage of local funds in obtaining State and Federal funds to support transportation investments in the corridor.	Objective of implementation strategy, not an evaluation measure.				

Figure 5-11 Charts of costs for each alternative





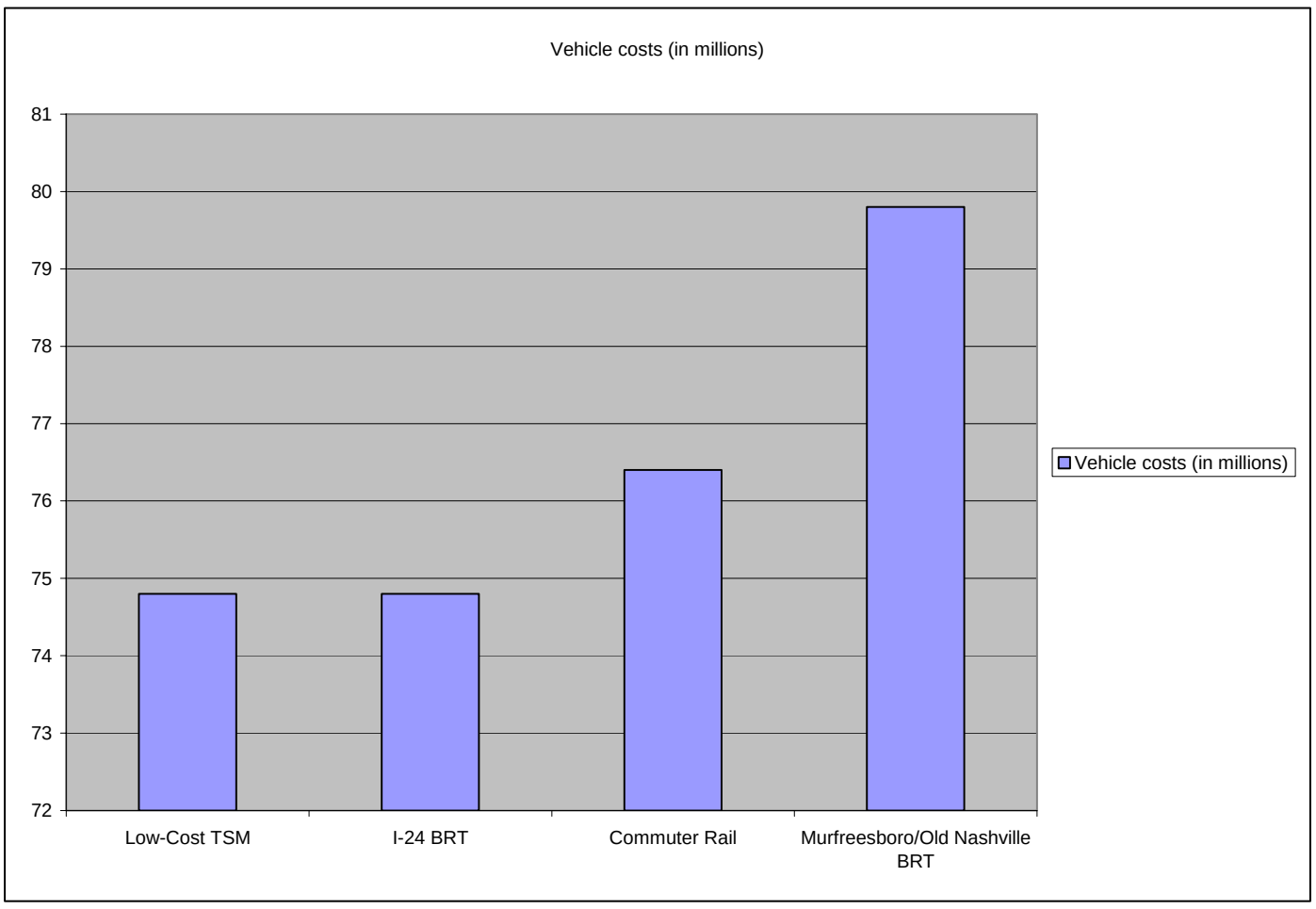


Table 5-13
Detailed Alternatives Screening – Goal 6 Criteria

Goals and Objectives	Detailed Screening	TSM (Low-Cost)	Alternative A: BRT I-24	Alternative B: CR CSX Alignment	Alternative C: BRT M'Boro Rd./Old N'Ville Pike
Goal 6: Develop a strategic part of a multi-modal transportation system that would facilitate the development of an integrated regional multi-modal system.					
1. Develop alternatives and strategies that complement, rather than conflict with, regional plans for development of a multi-modal system.	Is the alternative consistent with the regional transportation plan and other applicable transportation planning documents? (qualitative measure) Based on discussion and consensus of steering committee members.	Regional transportation plan will require amendment to include recommendations of any alternative.			
2. Develop alternatives that are consistent with the transportation and development goals of the region as identified in the Nashville Area MPO's Long Range Transportation Plan and other regional planning documents.	Consistency with adopted/proposed land use plans and policies. (qualitative measure) Same as Goal 4, Objective 8	Improvements limited to station areas and streetscape in downtown Nashville and Murfreesboro	Right of way improvements limited to along I-24 and I-40, consistent with existing use. Station areas not zoned for TOD. Lowest disruption of existing development.	Improvements primarily through existing town centers and industrial areas. Station areas not zoned for TOD. Moderate disruption of existing development.	Improvements primarily through commercial-retail areas. Station areas not zoned for TOD. Highest disruption of existing development.
3. Avoid alternatives that might have the affect of precluding the development of other transportation modes or options to serve other corridors of the region.	Does the alternative facilitate or preclude potential development of other potential transit lines serving the region? (qualitative measures) Based on discussion and consensus of steering committee members.	Little connectivity or potential benefit to other corridors	Little connectivity or potential benefit to other corridors.	Has some connectivity with existing East Commuter Rail Line. Development of downtown station and other improvements would facilitate CR development in other corridors	Little potential benefit to other corridors.

Summary of Detailed Screening Findings

Extensive information from the detailed evaluation of alternatives allowed the Steering Committee to make important decisions regarding the project and to begin developing their preferred alternative. The committee's recommended Locally Preferred Alternative was a phased implementation of the low-cost enhanced bus alternative, consisting of expanded bus service and infrastructure improvements on Murfreesboro Road and I-24. This alternative is described in detail in Chapter 10. This recommendation seeks to build ridership in some of the potential transit markets identified in the southeast corridor, targeting long distance commuters via express buses and shorter distance captive riders on new local service. Once these transit travel markets are developed, a future increase in service or a change to a higher capacity service could potentially result.

The most significant findings of the Phase II analysis were as follows:

- Alternatives A (I-24 alignment), B (CSX Alignment), and C (M'Boro/Old Nashville alignments) do not appear to be justified based on the capital costs of the alternatives under consideration ($200-$500 million range) and the relatively low ridership gains (fewer than 3,000 new riders per day). This disparity between costs and ridership underscored a need to consider lower cost and phased approaches to development.
- Current regional land use policies are insufficient in generating the ridership needed to support major transit investment as indicated by the relatively low ridership predictions for the corridor. Activity nodes and corridors of transit oriented development are needed to adequately support major investments in mass transit and as alternatives to further roadway development.
- The relatively low ridership in the corridor further suggests that a phased approach should be considered. In such an approach additional transit services and facilities such as stations, streetscape and intersection improvements, and park-and-ride lots are introduced gradually over time. This will allow services to grow in parallel with gradually increasing demand and allow transit supportive land use policies to gradually grow the market for transit service.
- The evaluation made it clear that Murfreesboro Road is a stronger alignment than the I-24 or CSX alignments. Murfreesboro Road is closer than other alignments to existing development and population and employment nodes, and it has more existing transit supportive development in areas adjacent to stations than do the other alignments. In addition, it supports more non-work related and shorter distance trip-making than either the I-24 and CSX alignments. For this reason, the Murfreesboro Road alignment had significantly higher ridership than the other alignments. The committee recommended focusing transit service and infrastructure improvements on the Murfreesboro Road corridor in a potential Locally Preferred Alternative for the study.
- The evaluation further suggests that Murfreesboro Road is superior to Old Nashville Pike as an alignment in the southern portion of the corridor. Old Nashville Pike appears to provide no advantage over Murfreesboro Road in terms of ridership, costs, or accessibility, but it does bring additional environmental concerns, such as passage through the Stones River National Battlefield, that are more challenging than those in the Murfreesboro Road alignment.
- The costs of developing a busway over most of the Murfreesboro Road alignment are likely to be prohibitive and not supportable given the potential ridership by 2030. Development of such a busway would have higher environmental costs in this corridor than in others due to

the highly developed nature of the corridor and the large number of environmentally sensitive sites along the Murfreesboro Road alignment.

- The development of major park-and-ride stations in the Murfreesboro Road corridor will be difficult and expensive and will not be conducive to promoting transit oriented development in station areas.
- The committee recommended that a potential LPA for the study should include longer-distance service and the development of additional park-and-ride facilities in the I-24 corridor to complement the services under development on Murfreesboro Road. Both Alternative A and the TSM alternative, operating in the I-24 alignment, are projected to carry about the same number (or slightly more) of longer-distance work trips as Alternative C.

6.0 Transit Technology Assessment

6.1 Introduction

One of the first steps in the Southeast Corridor High Performance Transit Alternatives Study was to create a summary of the many different types of transit that could be used in the southeast corridor. This chapter provides a thorough listing of the various types of transit technology and their descriptions and operating characteristics. The intent of this chapter is to provide a general understanding of the various transit technologies, including some of the more recently developed technologies, and to provide a very broad overview of some of the costs associated with each technology. Transit technologies can be placed into several categories with each category serving different types of communities or providing different levels of service. For example, the local bus category is generally considered to be best suited for short distance travel in compact developments. Automated guideway transit (AGT), also called "people movers", is best suited for short-distance travel in areas like airports that handle large numbers of people and require lots of walking. For medium and long distance travel, express buses, busways, light rail transit (LRT), and heavy rail can be solutions depending on the character of the corridor. For longer distances, commuter rail or high-speed rail may work best.

Some of these technologies and applications will not be appropriate for providing efficient and convenient high performance transit throughout the southeast corridor. A potential transit system for the corridor should provide the capacity and flexibility required to connect activity centers, penetrate and serve the core of community centers, and circulate passengers to and from multiple urban cores. The technology must present a sense of permanence in order to encourage developers and local governments to invest in an efficient and sustainable growth pattern. The balance of this chapter examines the broad range of system technology categories, their general operating characteristics, and applications.

Pedestrian and Transit Oriented Development

Transit plays an important role in the types of development that can or will occur at existing and planned transit routes and stations. Transit-oriented development (TOD) is specifically designed to support both pedestrian and transit activities. Generally, it consists of moderate to highly compact development located within an easy walk of a major transit stop. TOD contains a mix of residential, employment and shopping opportunities designed primarily for use by pedestrians while still providing limited access by car. TOD is not just development located next to transit lines; it is development designed and constructed to facilitate and promote transit ridership through a number of specific design elements:

- Compact: moderate to highly compact development is constructed to ensure that a large number of people work, live and shop within a short walk of the transit line. Also, parking requirements are reduced or directed into multi-story parking structures.
- Mixed-use: development includes a variety of land uses (i.e., residential, commercial, retail, etc.) within easy walking distance of the transit line and of each other.
- Pedestrian-friendliness: all elements of the development are designed to promote active living, walking and transit use. This also includes details like the

orientation of buildings, the placement of doors, the design of landscaping, sidewalks and crosswalks, and the positioning and size of parking facilities. Although the development of many cities and suburbs up to the 1940's was shaped, in part, by the existence of transit service, the term TOD is generally applied only to new development or redevelopment. With TOD development, the primary means of transportation is by walking. All of the retail shops, grocery stores, and homes are placed within a very short walk of each other. The result increases transit ridership and reduces people's dependence on the automobile. This in turn improves air quality, saves tax dollars and improves the quality of life for everyone who uses the transportation system. A number of U.S. cities, most notably Portland, Oregon; San Diego and San Jose, California; and the communities served by the Hudson-Bergen Waterfront Line in northern New Jersey, have been the sites of a significant number of TODs. As an example of a city closer to Nashville, Atlanta's MARTA has also begun to support TODs around its stations. The types of public policies needed to encourage TODs include:

- Changes to planning and zoning ordinances to allow mixed use, compact development, smaller land setbacks and lower parking requirements that require pedestrian improvements with access for transit.
- Funding for infrastructure improvements by local and state governments can require transit oriented-development policies and improvements through regulations. Some local programs have provided direct subsidies, preferred financing or tax abatements for TODs. Federal transportation funding, such as the Federal Transit Administration (FTA) Section 5309 New Starts program, supports the planning, design and construction of major fixed-guideway transit projects with a requirement of transit-oriented improvements to support new transit stations and services.
- Joint development of property owned by transit providers or governmental units can encourage the location of development near transit stations, help support that development and take advantage of the opportunity to shape the land-use development.
- Direct development of land around stations, by the transit provider or other governmental entity, has been employed in a few locations to provide an anchor around which other development can grow nearby.

6.2 Bus Transit

Bus transit is the dominant mode of public transportation throughout the world. This mode is typified by large, multi-passenger, rubber-tired vehicles capable of operating in an exclusive or mixed traffic travel lane with other vehicles. Buses are typically powered by diesel engines, which have been proven effective and inexpensive to operate and maintain. In addition, over the past several years, the advancement of alternative fuels has resulted in more options for powering vehicles. There are also many vehicle models available, each with its own specific passenger capacities, travel speeds, style and level of comfort. Buses vary dramatically in terms of size and capacity, from small vans to large articulated vehicles 70 feet in length. Types of fuel and power sources include diesel-powered vehicles to experimental models using hydrogen fuels. Finally, amenities range from sturdy basic models to luxury motor coaches.

Buses are usually operated according to fixed schedules and generally provide local (including shuttle services such as community bus and downtown shuttles), express

service, or bus rapid transit (BRT) applications. Station areas may be simple bus stops or more elaborate stations that include amenities such as sheltered areas, passenger benches, fare vending machines, vehicle location signs ("next bus" technology), etc. Most buses generally require passengers to board the vehicle using steps from a curb or low-level platform, although transit agencies have been increasing the use of buses with partial or full-length low floors to minimize the number of steps a passenger must climb.

6.2.1 Vehicle Technologies

The common bus technologies include conventional, articulated, electric trolley, dual-power (diesel/electric), or guided buses. All of these are described in more detail in the sections that follow. For each of these technologies there are a number of manufacturers that produce vehicle models with various engineering designs.

Conventional Bus

The vast majority of buses are powered by diesel engines. Conventional diesel-powered buses vary in length from approximately 30 to 40-feet, seat approximately 45 passengers, and are capable of highway speeds (Figure 6-1). The cost of these types of vehicles is approximately $280,000 (35 ft.) or $300,000 (40 ft.). This type of bus is typically used in urban and suburban environments to provide line-haul fixed route service as well as express service. A number of bus fleets are currently being converted to clean diesel or cleaner burning compressed natural gas and other alternative fuels. Section 6.2.2 discusses the various alternative fuel options for buses.

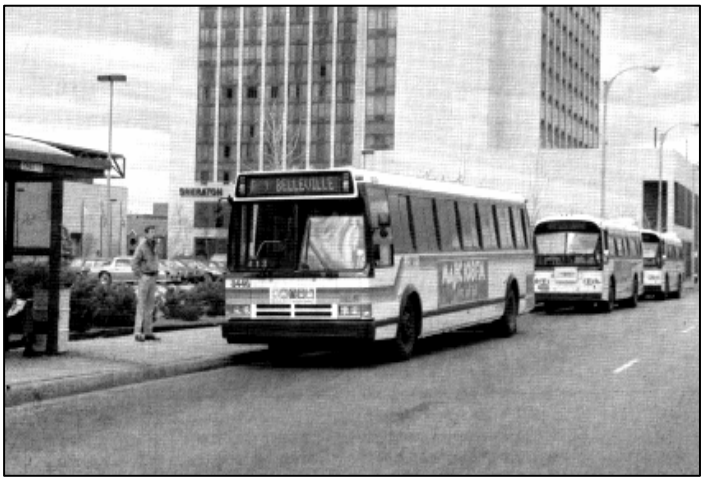


Figure 6-1 Conventional Bus

Articulated Diesel Bus

Articulated buses are approximately 60 feet in length and are capable of highway speeds. The articulation separates the bus into two sections - a forward section where the driver sits and a rear or trailer section. The two sections join at an articulation joint. Riders can walk freely between the sections. Articulated buses can negotiate smaller radius horizontal curves than conventional buses because they can bend at the mid-point of the vehicle body (Figure 6-2). The long length of these vehicles can create a disadvantage in terms of vehicle storage and maneuverability in some situations. However, these vehicles have a higher passenger capacity than shorter conventional vehicles. These buses can operate in mixed traffic on city streets, in HOV lanes, bus only lanes or busways. Their passenger capacity is approximately 110, with 60 seated. Cost is approximately $400,000.

Figure 6-2 Articulated Diesel Bus

Electric Trolley Bus

Electric trolley buses are similar in passenger capacity to both conventional and articulated diesel powered buses, except that they are propelled by electric motors and obtain power from overhead wires along the route. They are available as either standard trolleys approximately 40-feet in length (Figure 6-3) or articulated trolleys approximately 60-feet in length. They are limited to approximately 40 miles per hour top speed. The trolley bus can be steered and does not need a guideway, although the reach of its trolley poles limits its movement. Some trolley buses are equipped with battery power to allow them to travel short distances when disconnected from the overhead wire. Trolley buses offer excellent traction and power at low speeds, making them very effective on steep grades. The electric propulsion option also allows these buses to operate inside tunnels without a build up of exhaust fumes. Trolley buses cost approximately twice as much as a diesel powered bus but have a longer useful life. Trolley buses are currently in operation in Boston, Seattle, San Francisco, Dayton, Ohio and Philadelphia.

Figure 6-3 E-800 Trolley Bus

Dual-Power (Diesel/Electric Trolley) Bus

Sometimes referred to as dual-mode buses, dual-power buses are similar to other buses in size and seating capacity. However, they differ in that they have both electric and diesel propulsion units. This dual-power feature enables them to operate as an electric trolley bus along sections with overhead power distribution wires and as a conventional diesel bus on other streets. Dual-power bus performance is similar to a diesel-powered bus when operating under diesel power and similar to a trolley bus when operating under electric power. Dual-power buses have been developed in both standard and articulated vehicles. Dual-power buses are currently in use in the Seattle bus tunnel (Figure 6-4).

Figure 6-4 Dual Mode Bus, Seattle, Washington

6.2.2 Alternative Fuels

Bus technologies that are powered by alternative fuels such as clean diesel, natural gas, battery and electric power have been a popular trend for transit agencies worldwide. Additional technologies include hydrogen fuel cell technology, which is not yet available but is under development and testing. The first operational hydrogen fuel-cell bus was delivered to Madrid, Spain, in the summer of 2003. One goal of the Madrid test project was to demonstrate an effective and emission-free public transportation system, as well as prove the reliability of the hydrogen fuel technology. Many of these alternative fuels are compatible with the various types of common bus applications such as local bus, shuttle, express, and BRT.

Clean Diesel and Biodiesel

Clean diesel technology is a recently developed form of a standard diesel internal combustion engine. Clean diesel uses a number of new technological innovations to adapt the traditional diesel engine to reduce the volume of pollutants, especially particulate matter that a bus produces in operation. Clean diesel technology is mainly based on existing diesel technology. As such it does not require a special fuel or fueling facility, and engines closely resemble traditional diesel engines, reducing the need for retrained mechanics. Clean diesel is a relatively new technology and has yet to be proven to perform reliably over a long period. In addition, buses equipped with clean diesel technology are generally more costly to purchase and maintain than standard diesel buses.

Biodiesel is another type of clean burning or low emission alternative fuel. It is made from renewable resources and contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines and requires very little or no engine modifications. Blended biodiesel is somewhat more expensive than regular diesel but much less costly than other forms of clean fuel technologies. The Nashville MTA has been testing a biodiesel blend in approximately 18 of their buses. MTA has recently applied for a grant through TDOT to cover the additional cost of the fuel to switch the entire fleet to the biodiesel blend.

Natural Gas

Natural gas technologies including compressed natural gas (CNG), liquid natural gas (LNG) and propane have been used to power transit buses. Natural gas-powered vehicles have the appeal of producing less pollution than standard diesel buses and

have the added benefit of using a domestically produced fuel that is usually less expensive than diesel. However, natural gas buses have a lower travel speed, lower acceleration and can travel fewer miles between refueling stops than standard diesel buses. They are usually smaller than standard diesel buses for this reason. They are also more expensive to buy, operate and maintain, and their engines tend to wear out more quickly than standard diesel buses. As with any innovative technology other than standard diesel, natural gas vehicles require separate maintenance facilities, a separate set of spare parts, and specially trained maintenance staff. Natural gas has proven a volatile and potentially dangerous motor fuel, particularly at the point of refueling. Natural gas fueling facilities are separate from diesel facilities and are more expensive to build, operate and maintain, and they have different and more stringent safety and environmental requirements than diesel fueling facilities.

Battery Powered Electric

Battery-powered electric buses also have been implemented in several cities. Battery-powered vehicles are quieter and smoother running than diesel buses and produce no pollution at the location of the vehicle. However, because of the current limitations of battery power storage technology, battery-powered vehicles are generally smaller and slower than standard transit buses and are primarily applicable only for shorter trips. Vehicle batteries must be recharged after only a few hours service, and to provide continuous service with a single vehicle, batteries must be "swapped out" several times over the course of a service day. This requires a staffed maintenance facility located at a bus layover point. Battery powered buses use proven electric vehicle technology, but are more expensive to buy and maintain than standard diesel buses.

Hybrid Electric

Hybrid electric buses, related to dual-powered buses, are powered by a combination of diesel and natural gas or electrical power that reduces or eliminates air pollution and noise from the bus. In some configurations, a diesel or natural gas-powered engine is used to generate electricity that is stored to power an electric motor. Hybrid electric buses have the advantages of quieter and more environmentally friendly operations which produce less pollution. These types of vehicles also obtain greater fuel economy than conventional diesel engines. However, hybrid electric is not yet a proven technology for large transit vehicle power. Other factors associated with hybrid electric buses are that the vehicles are more costly to purchase and maintain, and they have a lower top speed and less acceleration power than standard diesel buses. In some cases, the electrical system must be recharged using an off-board electrical power source.

6.2.3 Bus Transit Operating Applications

The following sections provide a summary of the typical operating modes for bus service.

Local On-Street Bus

Local on-street bus service is the most prevalent form of transit in urban areas throughout the United States, including the southeast corridor. This type of transit operates in existing public rights-of-way (in mixed traffic), making frequent stops and traveling at low speeds. It should therefore be used only for short to medium length trips that are contained within a single urban area. Local bus systems typically provide an essential grid or radial service from residential areas to various activity centers throughout a local community. They also serve major activity centers (e.g., hospitals,

regional attractions and large shopping centers). Some community-to-community service and cross-town connecting service are provided. Depending on the frequency of service, the density of corridors and other factors, local bus systems can serve light to heavy passenger volumes. These vehicles enable flexible routing and scheduling since they operate over the existing street network. However, since buses operate in mixed traffic, an increase in traffic volume and congestion requires more equipment and longer service hours to maintain scheduled headways and balances passenger loads.

Local bus service is ideally suited to provide feeder service to a higher-speed, higher capacity line-haul, fixed guideway system (including BRT or busways) that operates over a long distance corridor. In this respect, local service can function as a collector system at the residential end of the trip and as a distribution system at the employment end of the trip. Local on-street bus service is particularly effective at serving the low-density development typically found throughout the Nashville area. Because local bus systems operate on existing streets, the only direct capital costs are the vehicles, passenger amenities and maintenance facilities.

Express Bus

Express bus service is geared primarily to peak travel periods over longer distances and at higher average speeds. Express buses usually collect passengers on local streets or at a park-and-ride facility at one end of a route, making few or no intermediate stops until reaching the other end of the route. In many locations, express service operates from the outer suburbs to the central business district, with stops at several locations at each end of the route. Express service can also be considered as a way to connect various cities and towns or provide a high-speed service from park-and-ride facilities to major activity centers. Express bus routes may use buses from the same vehicle fleet used by local bus services, or they could use special buses that provide amenities such as cushioned seats, reading lights, and tray tables. These amenities provide a higher level of comfort to better accommodate passengers during the longer express bus trips. In many cases, express buses operate on major roads and highways rather than local streets. Express buses can use priority technology, High Occupancy Vehicle (HOV) lanes or a busway for the express portion of the trip (Figure 6-5).

Figure 6-5 Los Angeles Express Bus/HOV Lane

Buses used for express service are sometimes larger than buses used for local service and can include over-the-road coaches or articulated buses. Capital and operating costs can be similar to local buses or more than twice as much. Costs for physical improvements such as special bus stops or bus lanes and park-and-ride lots must also be included in the total cost of the express bus services.

Urban Arterial Service
In an urban setting, express bus service may be limited stop or skip stop service running in urban arterial corridors alongside local bus service. Where local bus service in these corridors may stop at nearly every crossing street, with stop spacing of three, four or more stops per mile, express bus stops may be limited to major crossing arterials, with only one or two stops per mile. The purpose of express bus service is to provide passengers with a faster ride, one with fewer stops or detours off the direct route, and to benefit customers making longer trips or those transferring between bus routes at major transfer points. Typically express bus service in an urban setting is provided using the same fleet of buses used for local bus service.

Express bus service in an urban setting can be enhanced through the development of queue jump lanes to allow buses to bypass congested intersections and remove buses from the congestion of the general traffic flow during peak-period or all day using HOV, Bus-Taxi, or exclusive bus lanes. In addition, signal priority or signal pre-emption systems, in which traffic signals are advanced or pre-empted by the approach of a bus, can also enhance express bus service. Without such improvements, express buses must operate in the same congested traffic conditions as auto traffic and local bus routes, and thus, time savings may not be significant when compared to local service.

Limited Access Highway Service
Many express bus routes operate from more distant suburban locations and use a freeway or highway alignment for part of their trip. Freeway operations provide a faster travel time that result from higher posted speed limits, a more linear alignment, and uninterrupted traffic flow. Buses typically operate in mixed highway traffic and serve limited stops between an origin and destination.

HOV lanes enhance express transit service. These non-separated lanes on a freeway or highway are typically located on the inside lanes which have pavement markings and signs to indicate that use is restricted to HOVs such as buses, taxis, vanpools and carpools (Figure 6-6). HOV lanes provide buses with a speed advantage when compared to single-occupant cars operating in congested highway conditions. This tends to make bus service's travel time competitive with driving; however, additional traffic from carpools and vanpools using the HOV lane can restrict its effectiveness for buses. Some examples of operating HOV facilities include an extensive network in Orange County, California; and I-95 through South Florida.

Figure 6-6 HOV Lane – I-495 Long Island Expressway, New York

Bus Rapid Transit

Bus rapid transit (BRT) is a system of improvements to make bus service more attractive when compared to auto travel. The primary goals of BRT are to reduce transit travel time and increase service reliability. This application concept is a flexible one that encompasses physical, technological, operational and marketing improvements in response to congestion, operational needs, opportunities and market demand.

The implementation of BRT service within a transportation corridor can be an evolutionary process in which transit amenities and infrastructure improvements are phased in over time as conditions and demand warrant them, and as funding becomes available. For example, an urban corridor supporting a high volume of bus service and ridership may designate the outside lanes as bus lanes during peak periods to increase travel speeds. In addition, station area enhancements and vehicle aesthetics can be implemented to identify a distinguishable transit mode. Later, as the corridor develops over time, a traffic signal priority system and queue jumps at congested intersections can further improve the bus system throughout, resulting in additional ridership gains. As ridership increases, a full-time curb-separated right-of-way and improved streetscape treatments on the BRT system could be implemented throughout the travel corridor.

BRT systems provide communities with an excellent opportunity to upgrade service to transit users and thereby increase transit use. They also offer an opportunity to invest in streetscape and facility improvements that beautify and enhance the corridor. Developers and potential residential and commercial investors perceive these investments as a strong indication of the community's commitment to an area. This perception of commitment can promote redevelopment opportunities and improved development in the corridor.

BRT systems provide greater operational flexibility when compared to a system with a fixed alignment such as LRT or heavy rail. For example, BRT systems usually allow buses to leave their dedicated alignment at the beginning and end of the trip to provide their own collector and distributor services, potentially offering more passengers a one seat ride. This is accomplished by providing connections to major intersecting roads, thereby reducing the inconvenience associated with transfers from one mode or one vehicle to another. This feature is well suited to the residential end of the trip where densities are too low to provide transfer stations within convenient walking distance, as well as distribution systems to established employment centers such as central business districts, where the construction and operation of any form of fixed guideway transit may be difficult. Other bus routes operating partially over a common section can benefit from operation in the bus lanes over part of their trip.

BRT service is presented according to levels of service implementation (initial, intermediate and full) as defined by the Federal Transit Administration (FTA). Each level of BRT service includes various technological, operational, and structural elements according to the specific implementation level. Initial BRT is a basic set of amenities for BRT service. Intermediate provides a more comprehensive application of transit infrastructure and technology. Full BRT is a developed system that applies the transit elements of initial and intermediate BRT service. Each level of BRT service benefits from upgraded marketing and the installation of service enhancements to provide passenger safety, comfort, and convenience, thereby upgrading a system's image and increasing customer attractiveness.

Initial BRT Service
Initial BRT service prescribes minimal improvements to existing bus services that include an increase in service frequency, a decrease in transit travel time and the implementation of passenger amenities for the purposes of developing a distinct mode of transportation.

Initial BRT service is typically distinguishable from conventional bus service through vehicle aesthetic improvements and the installation of passenger station amenities. Vehicle improvements range from a color scheme different from existing conventional buses to purchasing new buses that are equipped to provide a more comfortable ride. Passenger stations are typically upgraded to include curbside concrete hard stands with covered seating areas, adequate lighting, highly visible signage and route information.

This type of BRT service shares a travel lane to operate in mixed traffic on urban or suburban streets with some level of preferential treatment. The type of preferential treatment for initial BRT service is achieved through a deployment of Intelligent Transportation Systems (ITS) technology such as signal prioritization. A signal prioritization system improves transit travel times by allowing buses to advance, prioritize, or pre-empt traffic lights when approaching a signalized intersection. The components of the system involve a bus-mounted transponder that utilizes an electronic signal to correspond with an intersection's traffic signalization system. A signal priority system allows an approaching bus and traffic to pass through an intersection without interruption by a stop signal. This improvement minimizes transit travel delays, improves reliability and allows buses to maintain schedule adherence. The installation of an enhanced signalization network may even reduce the number of buses required to operate on a route to meet existing schedules, and thus reduce operating costs.

Intermediate BRT Service
Intermediate BRT service utilizes a designated right-of-way that applies various types of infrastructure and technology to reduce dwell time and accelerate transit travel time within a transportation corridor. Intermediate BRT may utilize a designated lane during peak travel times, a fully dedicated lane or an HOV travel lane that may or may not be barrier separated from other vehicular traffic.

This type of BRT service includes advanced upgrades to transit vehicles, bus stop amenities, and creation of bus "stations" at key locations in a corridor. Various improvements along a BRT service corridor are applied to speed up passenger boarding and reduce overall travel time. This is achieved using transit vehicles that are designed with low-floors and multiple, wider doors for faster passenger boardings and alightings.

Signage and information system upgrades at bus stops typically utilize the deployment of ITS infrastructure such as passenger information systems to provide riders at bus stops with real-time route and schedule information. Improved fare collection systems include off-board fare collection and ticketing systems for this level of BRT. These types of service elements and information improvements increase passenger confidence in using the system, resulting in increased transit ridership. Intermediate BRT service also involves measures to improve pedestrian conditions through streetscape and landscaping improvements which facilitate connections to properties and land uses adjacent to stops.

Non-Barrier Separated Bus Lane
A basic type of transit priority improvement is the designation of a specific bus lane for bus-only traffic. This type of bus lane designation restricts traffic from the use of that lane by separating traffic lanes through pavement markings and signs. The restriction may be limited to the peak direction and to peak periods, or it may be in both directions and at all times of day.

The most common type of bus lane is the curbside bus lane, in which the right (outer) lane in each direction is designated for bus only use (Figure 6-7). Rarely, curbside bus lanes operate in the contra-flow direction. Curbside bus lanes allow bus stops to be easily accessible. Stopping buses do not block auto traffic, and auto traffic does not prevent buses from re-entering traffic after a stop. However, curbside bus lanes can rarely be separated from traffic lanes because access to driveways and deliveries must be maintained along the urban and suburban street front. Usually, curbside bus lanes allow taxis, bicyclists, and right-turning traffic to use the designated bus lane, which can cause delays to bus traffic. In addition, auto breakdowns and illegal parking can block the bus lane, and violations of the bus lane are frequent, particularly under congested conditions. The Forbes-Fifth one way bus lanes between the Squirrel Hill area and downtown Pittsburgh, the downtown bus loop in Toledo, Ohio and the Madison Avenue bus lanes in New York City are examples of systems using curbside bus lanes in U.S. cities.

Figure 6-7 Silver Line, Boston

Non-barrier separated BRT bus lanes have also been developed in several cities in the right (outer) lanes of expressways that are designated as HOV lanes. These lanes also serve car pooling auto drivers in many cities. The restrictive use of HOV lanes and non separated bus lanes is violated by single-occupant drivers, breakdowns of vehicles and congestion from excessive numbers of high occupancy vehicles and buses. In addition, merging to and from median and inside-lane HOV facilities into the regular traffic stream can create delays for vehicles entering and exiting the expressway.

Another component of intermediate BRT is the installation of dedicated segments of right-of-way in urban and/or suburban settings that increase travel time and allow BRT to receive priority over auto traffic. These are installed as a non-barrier BRT bus lane. One example of this is a queue jumping lane, which can be installed at major intersections to allow buses to bypass congested traffic conditions (Figure 6-8). A queue jumper provides transit vehicles with a segment of exclusive right-of-way using a programmed traffic signal that turns green ahead of the other signals. This enables a bus to “jump” ahead of the rest of the traffic, providing transit vehicles with a speed and time advantage over the normal traffic flow. These bypass lanes can speed up bus

service between 30 to 60 seconds at a typical signalized intersection. Bus stops at times are integrated into the design of queue jumps to create mini “stations” at major interchanges. This type of facility also helps to speed buses on expressways where full HOV or bus lanes have not been implemented. For example, queue jump lanes for buses (and HOVs) have been implemented in conjunction with ramp metering systems, allowing buses to bypass the ramp metering before cars may enter the entrance ramp. Queue jumps also have been installed at exit ramps. Many toll roads also have special bus lanes allowing them to bypass toll queues.

Typically, construction costs for this type of facility ranges from $200,000 to $500,000 per intersection. Queue jumpers are particularly useful along major roadways where lower-passenger volumes, a lack of financial resources, or available right-of-way prevent the installation of a continuous exclusive right-of-way for buses. Queue jumpers have been implemented in Charlotte, North Carolina, Montgomery County, Maryland and Santa Clara County, California.

Figure 6-8 Queue Jump Lane

Barrier Separated Bus Lane

Intermediate BRT also includes barrier separated or limited–access roadways for buses. An example is an at-grade separated median bus lane that operates in the center of an arterial roadway, with two bus lanes or occasionally a single bi-directional lane. Median bus lanes do not potentially block curbside access or remove curbside parking. They are often barrier separated from auto traffic, which makes them less subject to delays from drivers violating the bus lane restrictions, breakdowns or other mishaps. Median bus lanes, however, must accommodate bus stops or stations in each direction. Offsetting the stations can minimize the space they consume, but fitting the bus lanes, stations, and vehicle travel lanes into the roadway section can be challenging and costly, particularly because it often requires reconstruction of the entire roadway and/or adjacent sidewalks. In median bus lane applications, bus passengers must cross auto travel lanes to reach stations, requiring improvements to crosswalks and the implementation of fences and streetscape treatments to control pedestrian movements. Signage and signal systems must discourage motorists from accidentally entering the median bus lane during left turning movements from crossing streets.

Through-bus movements on the alignment may require a separate traffic signal phase to prevent left-turning motorists on the roadway adjacent to the alignment from crossing the path of oncoming buses. The Canal Street bus lane in New Orleans, the Market Street bus lane in San Francisco, the busway on Number 3 Road in Richmond (Figure 6-9), the Euclid Corridor project in Cleveland, and the CATS busway on Independence Boulevard in Charlotte are examples of BRT systems employing median bus lanes in arterial corridors.

Intermediate BRT service that operates on a separated individual right-of-way may employ bus technology that steers or guides buses over portions of their routes. This is accomplished by use of wayside-located guidance curbs or optical guidance systems that utilize a camera to follow painted tracks on the road. This technology relieves the driver of the responsibility of steering the bus when in the guideway. Optically-guided

technologies also provide precise docking at stops or whenever a vehicle may need to negotiate tight rights-of-way. However, optically guided technologies can be affected by rain and are subject to tampering by vandals.

A primary benefit of this technology is that it enables a bus to operate on a narrower guideway. On new installations, the required roadway width (approximately 9 to 10 feet) is about 20 percent less than conventional bus lane requirements (approximately 11 to 12 feet), and no shoulders are required (Figure 6-10). Buses can leave the track at stations and/or at other locations and operate on streets as regular vehicles.

Figure 6-9 Median Busway, Richmond, Virginia

Figure 6-10 Guided Bus, Essen, Germany

Fully Developed BRT

Fully developed BRT service consists of all the amenities and attributes of both initial and intermediate BRT. Full BRT service is defined as a fully separated bus facility, often running alongside or in the median of expressways, or in disused rail corridors. This type of BRT system allows unimpeded travel flow at the legal speed limit, and when combined with on-line stations and park-and-ride lots, it can carry volumes and produce travel speeds comparable with light rail transit at a fraction of the initial capital cost.

Full BRT may also include travel lanes typically built in a highway or roadway right-of way, but the buses are physically separated from the other traffic lanes and intersections and may have exclusive flyover access ramps. The Shirley Highway in Washington D.C., the Seattle Bus Tunnel (Figure 6-11), the East and West Busways in Pittsburgh, several of the regional busways in Ottawa, and the priority lanes on major freeways in Houston, Texas are examples of this type of BRT facility.

Figure 6-11 Seattle Busway Tunnel

Buses using this type of BRT facility normally collect passengers on local streets or at park-and-ride facilities and then enter the exclusive busway and operate much like a rail vehicle on a fixed guideway system. Busways permit the location of stations along the busway at major community origins and destinations. However, compared to HOV lanes, which are generally considered highway facilities, busways are exclusively transit facilities and often must be financed exclusively using local, state and Federal transit funding. On-line stations, particularly in the medians of expressways, may be less convenient for passengers. However, the characteristics of BRT allow passengers to board in their neighborhoods and alight near their destinations at off-line locations by buses that can then enter the bus lane for the express portion of the trip.

A summary matrix that provides a comparison of each bus application is presented in Table 6-1. A summary matrix that presents key characteristics of each level of BRT service is presented in Table 6-2.

Table 6-1 Bus Service Summary

	Local on-Street Bus	Express Bus	BRT
Passenger Volumes	Serves light to heavy passenger volumes	Serves medium to high passenger volumes	Serves medium to high passenger volumes
Passenger Capacity	Up to 2,000 to 4,000 passengers per hour per lane one-way	4,000 to 6,000 passengers per hour per lane one-way	6,000 to 12,000 passengers per hour per lane one-way
Speed	Slow speed - 12 to 20 mph average with stops and peak hour traffic	Medium to high speed - up to the legal speed limit depending on traffic conditions	High speed - up to legal speed limit on the use of exclusive lanes
Type of Trips	Dense area-wide network useful for short-to-medium length trips	Serves medium to long trips (depending on operating speed and bus stop spacing)	Primarily serves long distance commuter trips
Stop Frequency	Stops spaced 0.2 to 0.5 miles apart	Typically less frequent stops or point-to-point service; often uses limited access highways, HOV lanes	Typically infrequent stops; point-to-point service
Capital Costs	Low capital cost	Relatively low capital cost unless HOV or park-and-ride facilities are included	Relatively low vehicle cost, but medium to high cost for exclusive busway lanes
Operations and Maintenance Costs	Moderate operating costs per vehicle mile or passenger mile basis. High vehicle maintenance costs.	Moderate operating costs on a vehicle mile or passenger mile basis Average vehicle maintenance costs	Moderate operating costs per vehicle mile or passenger mile basis. High vehicle maintenance cost -- exclusive guideway system is an additional maintenance cost
Right-of-Way Requirements	Uses existing rights-of-way	Uses existing rights-of-way, with the exception of new park-and-ride lots	May require additional rights-of-way for new park-and-ride lots and lane expansions. Operates in mixed traffic HOV lanes or exclusive travel lanes

Table 6-2 Levels of BRT Summary

	Initial BRT	Intermediate BRT	Full BRT
Right-of-way	Shared lanes in Mixed Traffic	Designated lanes/HOV lanes Barrier separated dedicated lanes	Exclusive alignment with full grade separation
Stations	Improved passenger amenities – lighting, shelter, signage etc.	Enhanced passenger information and fare collection	Enhanced loading and land use features
Service	Improved service frequency	Skip stop service and express services High frequency and reliability	Convenient transfer options
Route Structure	Single route with transfers, connections and color coding	Multiple route operations with transfer facilities Integration with regional transit services	One seat rides Transfer reduction
Intelligent Transportation Systems	Signal priority	Automated passenger information	Vehicle location and system surveillance

Source: Federal Transit Administration

6.3 Rail Transit

Rail transit is the term used to describe conventional fixed guideway transit systems that use a dual rail track, as historically used by railroads, for both support and guidance. Rail transit categories include light rail transit (LRT), heavy (or rapid) rail transit, commuter rail transit and high speed rail.

6.3.1 Light Rail Transit

LRT is a flexible transportation mode that can operate in a variety of physical settings. As the modern technological descendent of the streetcar, a distinctive feature of LRT is that vehicles draw power from an overhead wire. This is in contrast to heavy rail vehicles that are usually powered by a track-level third rail. This overhead power collection feature allows LRT systems to integrate with other at-grade transportation modes and pedestrian areas. LRT (like streetcars) can operate in mixed traffic on tracks embedded at-grade with street and pedestrian crossings, or on a fully-segregated guideway.

Figure 6-12 Los Angeles Blue Line LRT

LRT Operational Characteristics:

- Serves moderate to high passenger volume
- Typically 3,600 to 22,000 per hour one-way
- Low to medium speed – 30 to 65 mph (depending on degree of separation of right-of-way and distance between stops)
- May serve short to long distance trips
- Stations spaced 0.5 to 1 miles apart
- Normally uses overhead power collection
- May operate in traffic, with cross-traffic, or on exclusive right-of-way
- Can negotiate steep grades and small radius curves
- Stations may be elaborate or simple. May use low platforms, high platforms, or both
- Vehicles may operate alone or in trains of up to four vehicles
- Numerous vehicle suppliers
- Cannot operate jointly with freight trains or other railroad equipment

- Moderate to high capital cost (more than commuter rail/less than heavy rail)
- Moderate O&M cost on a vehicle mile or passenger mile basis

The most recent light rail systems in the U.S. operate vehicles that are 90 to 95 feet long and up to 9 feet 6 inches wide. Operator cabs at both ends of the vehicle (articulated and non-articulated) allow bi-directional operation. LRT systems can operate either as a single car or in multi-car trains. The capacity of a typical LRT vehicle ranges between 120 and 170 passengers. A three-unit train can carry up to 510 passengers, and the single direction, hourly capacity of a line can be up to 16,000 persons per hour per direction (pphpd). Figures 6-13 and 6-14 illustrate LRT systems in operation in Cleveland and Portland, respectively.

The maximum operating speed of modern LRT systems generally ranges from 55 to 65 miles per hour, making it suitable for medium distance trips in suburbs or between central business districts. However, average operating speeds can be reduced to 10 to 25 miles per hour if operating in mixed traffic with frequent stops.

Depending on the surrounding environment, LRT station design may incorporate high or low platforms. Generally, transit systems with on-street operations, where passengers can walk across tracks, use simple stations with low platforms, while systems with reserved right-of-way use high platforms.

Figures 6-13 (Cleveland; left) and 6-14 (Portland; right)

Entry into light rail vehicles (LRVs) has traditionally been provided in one of two ways: step entry or level boarding. Low-floor LRVs provide level boarding, which has become quite common, operating in Portland, OR and Hudson-Bergen County, NJ. With the passage of the Americans with Disabilities Act of 1990 (ADA), all new rapid transit stations must provide access for the disabled to every car unit. This means that all LRT systems opened after January 1993 must provide level boarding.

Diesel light rail vehicles such as the Siemens “RegioSprinter” operate like light rail vehicles but are self-powered and thus do not require overhead catenary power. This reduces the initial capital cost of developing a light rail line but eliminates some of the noise reduction and pollution control benefits of electric light rail. Diesel light rail vehicles have been used successfully in Europe and are being considered for implementation in Santa Cruz, California, Harrisburg, Pennsylvania, and some other cities.

6.3.2 Heavy (or Rapid) Rail Transit

Heavy rail transit (HRT) systems are at the upper end of the urban transit spectrum in terms of speed, capacity and reliability. Also referred to as rapid rail, metro, or subway, HRT operates in an exclusive, grade-separated right-of-way. Power is collected from a third-rail located adjacent to and parallel with the running rail. No at grade crossings of the right-of-way are permitted. HRT is characterized by a high capacity to carry passengers, which can range up to 60,000 pphpd with a maximum speed of 70 miles per hour. Average trip length is from 5 to 15 miles. Individual cars are typically 75 feet in length and can carry up to 170 passengers in normal loading situations; full load capacity is about 300 passengers. HRT vehicles are normally operated in married pairs (one unit of two cars) and multiple-unit trains of 4 up to 10 units which are coupled or uncoupled to meet varying travel demand conditions.

Heavy rail is best suited for service in high density corridors that connect low-density suburbs to the central city area of large metropolitan areas. Station spacing typically ranges from 1 to 2 miles. Examples of HRT systems in the U.S. include:

- Atlanta-MARTA
- Miami-MDT (Figure 6-15)
- San Francisco - BART
- Washington D.C. - WMATA

Figure 6-15 Miami Metro HRT system

The capital cost for HRT systems range between $95 to $140 million per mile. With the possible exception of higher capacity people mover systems and high speed rail, HRT is at the upper end of the cost range for rail urban transport systems. This is largely the result of the exclusive and grade-separated right-of-way infrastructure requirements. Operation and maintenance cost for HRT systems on a per passenger or a passenger mile basis may be lower than those for bus or LRT alternatives.

Heavy Rail Transit Operational Characteristics:

- Serves high passenger volume
- Typically 42,000 to 60,000 per hour one-way
- High speed - up to 70 mph
- Serves medium to long trips

- Stations spaced 1 to 2 miles apart
- Requires exclusive right-of-way
- Must use high platforms
- Power collection from “third rail”
- Numerous vehicle suppliers
- Can have long trains (usually 4 to 10 cars)
- Moderate to low O&M cost on a vehicle mile or passenger mile basis
- Very high capital cost

6.3.3 Commuter Rail

Commuter rail is generally used for longer distance regional rail trips. For conventional commuter rail operations, single or bi-level passenger cars are pushed or pulled by diesel or electrically-powered locomotives. Typically these systems are operated by railroads under agreement with a transit agency on their own tracks or through a leased track usage agreement. A major advantage of commuter rail is its ability to use existing freight trackage in joint use with freight trains or Amtrak service. Generally, commuter rail operates to provide peak period and peak direction service.

Due to federal regulations that require an automatic train control system for speeds in excess of 79 miles per hour, commuter rail generally operates at this maximum speed. The slower acceleration and longer braking distances of commuter rail when compared to the other rail technologies make it best suited to longer distance trips. Commuter rail vehicles can use high or low platform boarding. Individual cars can carry up to 160 seated passengers with a nominal standing load capacity of 300 passengers. Trains with 10 to 12 cars are not uncommon. Therefore, individual trains have a high capacity, but because headways are longer, the total line capacity is typically less than heavy rail (7,500 to 25,000 passengers per hour in a single direction).

Capital costs range from $7 million to $25 million per mile. The operating cost, primarily due to union labor costs, can be relatively high. Due to the high passenger capacity potential and the long distances traveled, the cost per passenger mile for commuter rail is in the middle range for rail transit alternatives. Representative examples of U.S. commuter rail systems include:

- Cal Trans in San Francisco, California
- Tri-Rail, Florida
- MARC in Baltimore, Maryland
- Metra in Chicago, Illinois

Commuter Rail Operational Characteristics:

- Serves moderate to high passenger volume
- Non-powered passenger cars pulled by locomotives; or diesel multiple units (self propelled)
- Can use existing tracks jointly with other railroad equipment
- Serves long distance trips
- Typically 8,000 to 25,000 per hour one-way
- High speed - up to 79 mph (without cab signals)
- Stations spaced 5 to 7 miles apart

- Stations may be elaborate or simple, and use low platforms, high platforms or both.
- Can have long trains (usually 4 to 12 cars)
- Diesel locomotives have air and noise quality impacts, and are maintenance-intensive
- Relatively low capital cost (when using existing tracks)
- Moderate to low O&M cost on a vehicle mile or on a passenger mile basis

Diesel-Electric and Electric Locomotives
Diesel-electric locomotives are the most common railroad locomotive in use in North America. They are used for both freight and passenger service. Traction power for these systems is either diesel or electric. Electric locomotives operate from electric power drawn from an overhead contact system. When a diesel locomotive is used, the locomotive is capable of pushing or pulling from one to eight cars (push-pull operation). Figure 6-17 depicts a locomotive-hauled commuter rail of double-decked passenger cars operating on Chicago's Metra system.

Figure 6-16 Chicago Metra Locomotive-Hauled Commuter Rail

Multiple Unit Cars (Diesel and Electric)
Diesel and electric multiple unit cars are self-propelled commuter rail cars that do not require a locomotive to push or pull them. Multiple unit cars can operate as single cars or as trains of up to 10 cars. These cars are typically 85 feet in length and provide seating for 60 to 100 passengers. They are capable of speeds from 80 to 120 miles per hour. Figure 6-17 depicts an electric multiple unit vehicle in New York. Figure 6-18 illustrates the latest diesel multiple unit (DMU) prototype to meet the Federal Railroad Administration's approval. The South Florida Regional Transportation Authority (Tri-Rail) is using this prototype as part of a demonstration project.

Figure 6-17 New York Commuter Rail EMU

Figure 6-18 Diesel Multiple Unit

6.3.4 High Speed Rail

High speed rail is generally used for longer distance intra-urban travel in a region and serves to connect cities 100 to 500 miles apart. The trains are usually powered by one or more electric engine receiving power from an overhead catenary system. High speed rail requires an exclusive right-of-way in the form of separate tracks or on shared tracks with a temporal separation. Shared rights-of-way are becoming less practical due to the speed and construction of the rail, tolerances required and shared maintenance cost issues.

This type of service addresses the need of moderate to high passenger volumes over long distances. Passenger volumes are generally in the range of 3,000 to 22,000 per hour. As passenger demand increases, the need for exclusive rights-of-way also increases. High speed trains are capable of cruising in excess of 200 miles per hour. Station spacing is generally 25 to 50 miles on average and train lengths vary from 8 to 14 cars. The seated capacity of a car ranges from 68 to 88 passengers. All passengers are typically seated for high speed rail service.

Capital costs range between $60 and $100 million per mile. The cost of right-of-way, communications, control and rolling stock are the primary items of cost. In addition, the

operating cost, due to labor costs, can be relatively high. The cost per passenger mile is in the middle of the range for rail transit alternatives because of the speed and distances traveled,.

Representative examples include the ICF in Germany; the TGV in France (Figure 6-19) and the SKS in Japan. While some limited 125 to 140 miles per hour service exists, there are no true high speed trains currently in operation in the U.S.

Figure 6-19 TGV High Speed Rail System, France

6.4 Other Fixed Guideway Transit

This section describes other fixed guideway transit technologies not included in the rail transit categories previously discussed. Included in this section are automated guided transit systems (personal rapid transit, group rapid transit, and people movers) and monorail technologies.

6.4.1 Automated Guideway Transit

Automated Guideway Transit (AGT) refers to a broad range of fixed guideway technology in which the most prominent feature is automatic train operation. AGT technology includes a wide range of service levels – from proven "people mover" systems such as the downtown Miami Metromover and numerous airport circulators – to experimental systems such as the personal rapid transit (PRT) system planned for a suburban commercial area near Chicago's O'Hare Airport. Currently, the majority of AGT systems operate as local distribution systems in areas where many trips are concentrated over short distances. They typically are found at airports (e.g., Atlanta and Miami), zoos, amusement parks, and in major commercial centers or downtowns (e.g., Harbour Island in Tampa and the People Mover in downtown Detroit). However, AGT systems have been successfully used in urban line-haul applications in Vancouver, B.C. and Lille, France. AGT is increasingly being used in urban environments in line-haul applications.

The service characteristics of AGT vary considerably. Urban, medium capacity systems can reach speeds of 50 to 55 miles per hour. People movers are generally operated at 35 miles per hour. Airport and local circulators typically operate at speeds of 25 miles per hour or less. Passenger capacities are less than light or heavy rail systems. This lower passenger capacity is due to AGT's tighter geometric tolerances and shorter station spacing. All AGT systems are proprietary and generally can be distinguished by their suspension devices or propulsion mechanisms. While some systems are suspended from an overhead "track" (somewhat similar to a cable car), most systems run on top of a track or multiple tracks. Vehicles can be rubber tired or steel wheeled. Power is supplied by a high voltage contact (third) rail located in the trackbed. AGT systems therefore require full grade separated rights-of-way from other traffic and pedestrians. The steel wheeled version requires conventional railroad-type steel rails to be affixed to the guideway, while the rubber-tired version have a concrete or steel running surface and a concrete and steel center or side rails for lateral guidance.

AGT vehicles range between 20 and 55 feet in length, operate singly or in combination with other vehicles, and can accommodate 150 or more passengers. AGT systems have capacities of between 5,000 and 15,000 passengers per hour. One advantage of people movers is the typically narrow envelope requirement allows the system to be used in tight rights-of-ways (including through the interior of buildings), and negotiate small radius curves and relatively steep grades.

Because most systems are fully automated (i.e., driverless), techniques must be employed to ensure that accidental intrusion or entry by pedestrians onto the right-of-way is prevented. These protection systems, in conjunction with the exclusive guideway and automated technology, can result in costs significantly higher than heavy rail on a per mile basis.

Typical subclassifications of the AGT system technologies include people mover and personal rapid transit systems.

Automated Guideway Transit Operational Characteristics:

- Serves medium to high passenger volumes
- Typically 5,000 to 15,000 per hour one-way
- Medium speed - up to 55 mph
- Serves short to medium length trips
- Stations spaced 0.25 to 0.5 miles apart
- Automated train system with control/supervision from central control center
- Complex guidance / switching systems
- Right-of-way must be grade separated
- Cars may operate alone or as trains
- Proprietary vehicle and guideway designs with turnkey procurement
- Varying levels of maturity, depending on individual system manufacturer
- Highest capital cost
- Highest O&M cost

Automated People Movers
Automated People Movers (APMs) are a class of transport in which fully automated, medium sized vehicles operate on fixed guideways along an exclusive, grade-separated right-of-way. Vehicles may operate in single married-pair units or trains.

Airport applications usually include barrier doors between the platform and track. Urban applications such as Downtown People Movers (DPMs) typically do not.

The majority of APM systems usually operate as a local distribution system in an environment where there are many trips concentrated over short distances. They typically are found at airports such as Atlanta, Orlando and Dallas, zoos, and in the major commercial centers or downtown areas, like the Skyway in Jacksonville. Service may be provided according to a fixed schedule or on demand with stations configured for vehicles/trains stopping on-line.

Automation and grade separation allow for higher service frequency and capacities for larger APMs range from 5,000 to 15,000 passengers per hour per direction (pphpd). Train envelope dimensions are about 10 to 12 feet in height, 8 to 10 feet in width and 40 to 240 feet in length for a single to six-car system.

Representative examples of APM technology include:

Bombardier/UTDC Advanced Light Rail System (ALRT) – Fully automated, electrically powered vehicles operated as a 2.9-mile loop system in downtown Detroit, and as a line-haul system in both Toronto and Vancouver, BC (Figure 6-20).

Figure 6-20 Vancouver BC SkyTrain

Matra VAL (France) – Fully automated, rubber-tired guideway system at airports in Paris, France and Chicago O'Hare. Urban transit applications include Lille (Figure 6-21) and Toulouse, France, and Taipei, China.

Figure 6-21 VAL People Mover System, Lille, France

Personal Rapid Transit

Personal Rapid Transit (PRT) systems are small, low speed systems that require an exclusive right of way and are designed to provide personalized service such as traveling to the desired stop without intermediate stops at other stations. The guideway is typically more expensive than those of conventional systems. The term “rapid’ in PRT is to enhance its image, but technically it is not justified because this mode does not perform at a level characteristic of rapid transit. The capacity of PRT systems is approximately 5,000 pphpd or less, and their speed is generally 25 miles per hour or less.

6.4.2 Monorail

Monorail is a fixed guideway transit mode in which a series of electrically propelled vehicles straddle atop or suspend from a single guideway beam, rail, or tube. If fully automated, they are similar in operation to AGT systems but are classified separately due to their unique guideway configuration (Figure 6-22).

The trains generally consist of permanently coupled cars having suspension, propulsion, and control equipment in common. Electric power is generally picked up by carbon collectors on the bottom of the vehicle in contact with a bus bar mounted on the side of the guideway beam. They can be operated either manually with fail-safe anti-collision systems or in a totally automated mode. Operating and maintenance costs vary according to the level of automation and the required capacity, but can be comparable to conventional grade-separated systems.

The guideway for monorail systems is typically elevated since it must be totally grade separated from all other traffic. Emergency egress from vehicles on this elevated guideway has historically been a problem with monorail systems. Potential solutions have included the addition of emergency walkways to the guideway and on-board inflatable slides and emergency hatches to the vehicles to permit passenger movement from a disabled vehicle to adjacent vehicles and/or ground level.

The main disadvantage with monorail systems is their inability to switch tracks efficiently. Whole sections of the guideway support beam must be physically moved from one guideway to another during switching – a slow and maintenance intensive operation.

Consequently, the applicability of monorail systems has usually been limited to simple loop and shuttle systems.

Depending on the size of the vehicles and operating speed, monorail systems are defined as either small capacity or large capacity.

Figure 6-22 Walt Disney World Monorail

Monorail Operational Characteristics:

- Serves medium to moderate passenger volumes
- Electric powered, rubber-tired propulsion system
- Typically 5,000 to 10,000 passengers per hour one-way
- Medium speed- up to 45 mph
- Serves short to medium length trips
- Stations spaced 0.5 to 1 mile apart
- Stations must have high-level platforms
- Automated train control system with supervision from central control center
- Complex guidance / switching systems
- Right-of-way must be grade separated
- Vehicles can be combined to form trains of up to 6 cars
- Proprietary vehicle and guideway designs with turnkey procurement
- Little experience in urban applications
- High capital cost
- Very high O&M cost on a vehicle mile or passenger mile basis

Small Size Monorail

Small size monorails are the types of systems that are primarily found in airports, amusement parks, zoos, fairs, etc. They operate at low speeds and have simple suspension systems (no secondary suspension). Some small monorails have been provided with full automation. Passenger capacity is usually 100 or less, generally all seated. System line capacities for small-size monorails generally range from 500 to 5,000 pphpd. This technology includes the ADtranz (manufactured by ABB Daimler-Benz Transportation, Germany). An example of the straddle-beam, separate-car, medium vehicle system from Sydney, Australia can be seen in Figure 6-23.

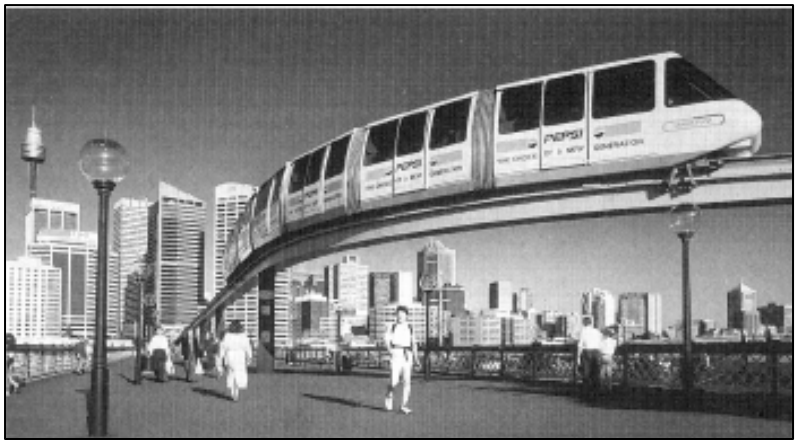


Figure 6-23 ADtranz Monorail in Sydney, Australia

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Large Size Monorail

In large-sized monorail systems, the vehicles generally operate as trains under the control of an operator. The vehicles sit astride a heavy beam structure, riding on rubber tires, with additional stabilizing rubber tires providing guidance laterally. The power is taken from a collector system beneath the cars. System line capacities for large-size monorails generally range from 5,000 to 10,000 pphpd. One example of this technology includes the Hitachi Series 1000 (Japan) – a straddle-beam, large vehicle monorail. Figure 6-24 depicts the 10.5 mile system in operation between Hamamatsu-cho in Tokyo and the Haneda airport.

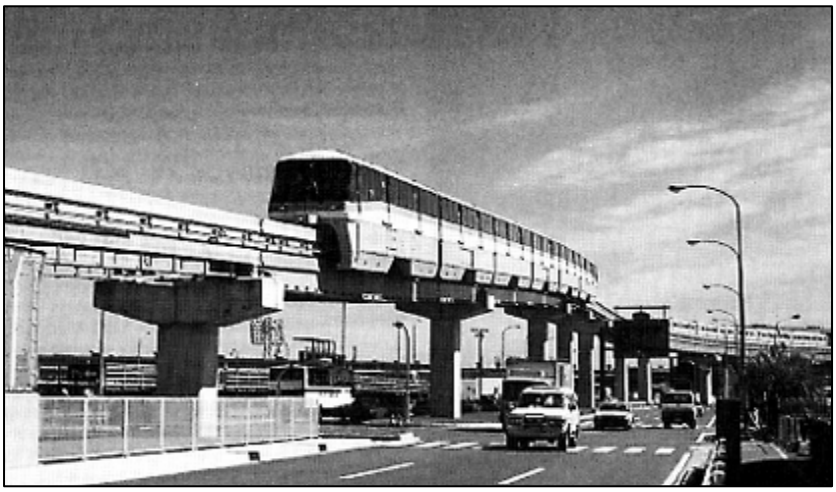

Figure 6-24 Hitachi Series 1000 Straddle Monorail Cars at the Tokyo Airport

6.4.3 Magnetic Levitation (Mag-Lev)

Magnetic Levitation (Maglev) is a research and development stage technology that uses no wheels or rails for guidance or support. Instead, a concrete or steel guideway is used and the vehicle is magnetically levitated above the guideway, guided, and propelled by a wave of magnetic energy. During movement there is no contact between the vehicle and guideway. Levitating the train above the guideway eliminates most of the frictional drag inherent with other technologies, thus reducing the power required at high speeds and creating the opportunity for operating speeds at the high end of operations of up to 250 to 300 miles per hour.

Two basic types of Maglev technology exist: the electrodynamic suspension (repulsive forces) or EDS and electromagnetic suspension (attractive forces) or EMS. The German Trans-Rapid system shown in Figure 6-25 and the South Korean HML system shown in Figure 6-26 are examples of the EMS (attractive force) technology.

Figure 6-25 German Trans-Rapid Maglev System

Figure 6-26 South Korean HML03 Maglev System at the Taejon Expo

Maglev systems offer the latest evolution in high speed ground transportation, offering speeds that can exceed 300 miles per hour with the potential of low operating and maintenance costs, and minimum environmental intrusions. Although Maglev systems may prove to be promising in the future, they remain unproven technology and have technical obstacles to overcome such as train control and guideway switching design. There are no Maglev systems currently in revenue operation in the U.S. in a public transit application.

6.5 Other Technologies

There is a new “Tram-On-Tires” (Figure 6-27) technology manufactured by Bombardier. This trolley bus concept features an electrically powered, modern and attractive vehicle. It is in use in Nancy, France, and looks like a modern light rail vehicle. It is a double articulated vehicle, with four trucks, rubber tires (i.e., no tracks), 100 percent low floor, 40-foot radius turning capability, 13 percent grade climbing capability and draws power from a dual wire overhead system. This electric bus may offer low-cost advantages not available with even at-grade LRT. It eliminates tearing up streets to move utilities and install rails; however it may require the installation of a centerline guide rail and traffic sensing loops. It precludes the concern with stray-current control and related corrosion, a design issue that must be addressed with LRT rail as a return path, especially with embedded rail. The dual-wire overhead power distribution system is more visually obvious than the single wire per track LRT system. It is smaller than an LRV at 80.3 feet long and 8.2 feet wide and seats 48 persons (including fold-down seats), with 50 standees (at 2.0 per square meter). It should be pointed out that design information is not definitive enough to be sure of its application—a single- sided configuration is shown.

That means all loading in either direction must be from the right side, unless a two-sided version is made available. The system that was installed in Nancy, France had capital costs of approximately $16 million per mile excluding vehicles. Recently, this system has experienced incidents regarding operational safety and is undergoing further examination to determine the appropriate corrective action. There are no tram-on-tires systems in operation within the U.S.

Figure 6-27 Tram-On-Tires

6.6 Summary of Modal Characteristics

A comparative summary of the modal characteristics for each of the transit technologies previously discussed is presented in Table 6-3. This table provides an overview of infrastructure requirements as well as approximate projections of capital and operating costs according to the technology. These estimates are meant for sketch level planning purposes only and could be significantly higher or lower depending on a number of factors.

Table 6-3 reflects a summary of the candidate technologies' operating characteristics. It generally addresses vehicle capacity, train capacity, one-way hourly capacity, minimum station spacing, maximum speed, desirable average operating speed, right-of-way requirements and capital and operating cost. Figure 6-28 illustrates the different types of technologies and associated passenger capacities.

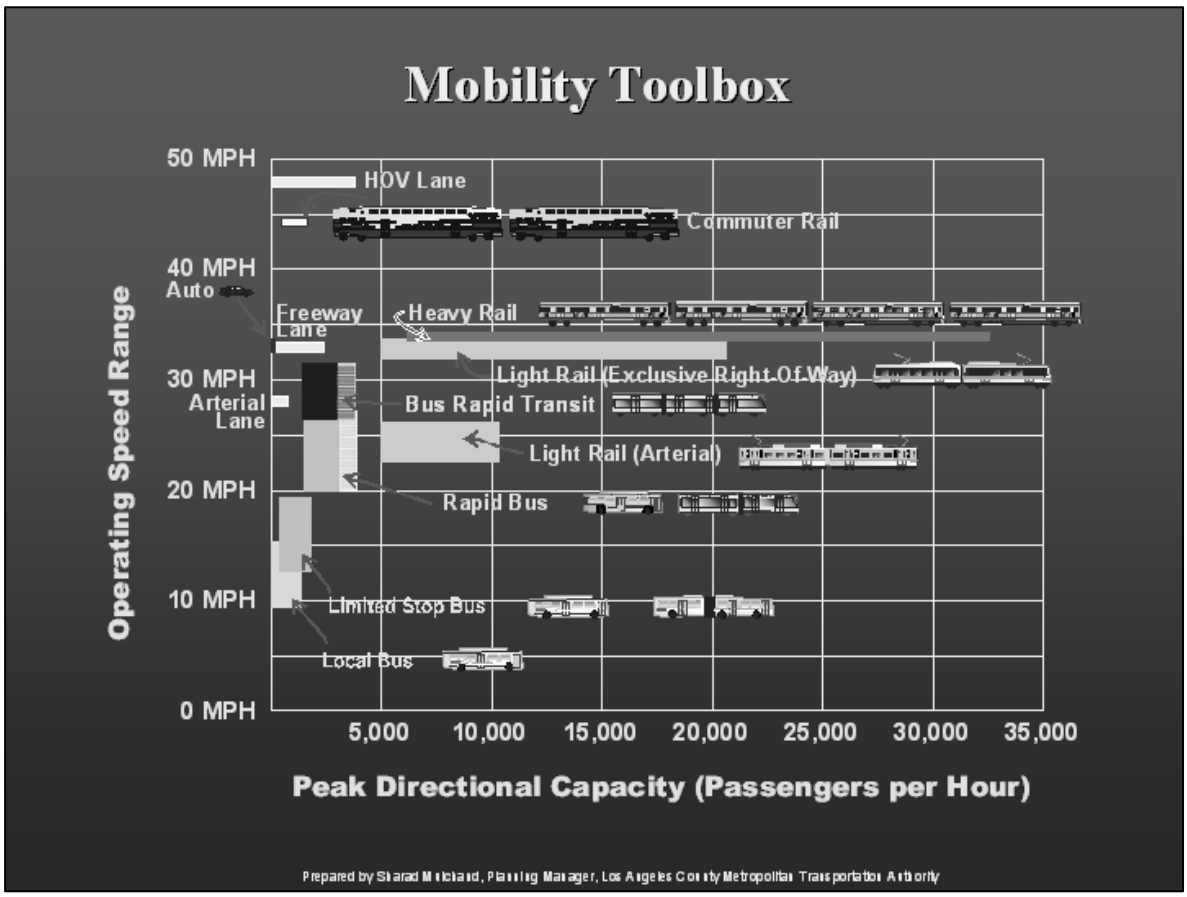

Figure 6-28 Mobility Toolbox

Table 6-3 Summary of Available System Technology Operating Characteristics

	Local Bus	Express Bus	Busway/ Priority Bus Lane	Light Rail transit	Heavy Rail Transit	Commuter Rail	Diesel Multiple Unit (DMU)	Automated Guideway Transit	Monorail
Vehicle Capacity (1) (passengers/vehicle	45-60	60-110	60-110	120-170	120-170	120-180	60-100	20-150	30-40
Vehicle Cost ($ millions)	0.31	0.39	0.39	1.5-3.2	2.0-2.9	1.0-1.7	2.5	1.5	6.0
Vehicle Life (years)	10 to 15	10 to 15	NA	30	30	30	Not Available	10 to 15	10 to 15
Train Capacity (maximum passengers/train)	N/A	N/A	N/A	680 (4-car unit)	1700 (10-car unit)	1800 (10-car unit)	400 (4-car unit)	600 (6-car unit)	240 (6-car unit)
One Way Hourly Passenger Capacity	2,000-4,000 (per lane)	4,000-6,000 (per lane)	6,000-12,000 (per lane)	3,600-22,000	42,000-60,000	7,500-25,000	2,400-4,000	5,000-15,000	5,000-10,000
Minimum Station Spacing (miles)	.25 – .50	3 – 5	3 – 5	.50 – 1	1 – 2	5 – 7	.50 – 1	.25 – .50	.50– 1
Maximum Speed (mph)	45	65	65	65	70	79 **(6)** (w/o cab signals)	62	55	45
Average Operating Speed (mph)	10-30	30-50	50-65 (on busway)	20-35	35-50	40-60	25-40	25-40	25-35
Right-of-Way issues	Operates on city streets or busway	Operates on city streets or busway	Operated on city streets or in exclusive right-of-way	Operates on city streets	Full Grade Separation	Operates on existing Railroad Tracks	Operates on Existing Railroad Tracks	Full Grade Separation	Full Grade Separation

Integration	**Easy due to street level boarding and ability to operate in mixed traffic.**		**Relatively easy due to street level boarding and ability to operate in mixed traffic.**		**Relatively difficult due to elevated boarding platforms on separated rights of way.**				
Capital Cost (2) per mile of dual track) (millions $)	N/A	N/A	$26 – $33	$30 – $40	$95 – $140	$7 – $25 **(5)**	Not Avail. $5 – $15 (est.)	$70 – $100	$60 – $90
Operating Costs: **- per vehicle mile -** **per passenger mile (4)**	$4.10-$5.60 $0.35-$0.50	$3.50-$4.90 $0.45-$0.65	$4.80-$7.00**(3)** $0.55-$0.90**(3)**	$6.75-$9.60 $0.45-$0.55	$8.90-$9.40 $0.25-$0.35	$6.50-$14.00 $0.25-$0.30	Not Available	$18.70 $21.00 $2.25-$2.40	Not Available

Source: Parsons Brinckerhoff and Carter Burgess

1. All capacities include standing passengers (at 4 passengers per square meter), except for commuter rail and monorail technologies.
2. Costs are indicative only, and include total system costs with the exception of vehicles or right-of-way.
3. Includes maintenance costs for busway.
4. Operating cost per passenger mile assumes ridership levels justify type and capacity of system.
5. Commuter rail system capital costs assume at-grade operation with grade crossings.
6. With cab signals, speeds up to 120 miles per hour are obtainable with appropriate equipment and proper ROW permit.

Note: Only typical system ranges are illustrated. Some existing systems have values outside the ranges shown.

6.7 Local and Regional Transit Agencies

Nashville Area Metropolitan Transit Authority (MTA)

MTA is a component unit of the Nashville-Davidison Metropolitan Government and was created in 1953 to supervise, regulate and maintain jurisdiction over public transit in the City of Nashville. MTA is governed by a five-member board appointed by the Mayor and approved by the Council. The Metropolitan Government partially funds MTA's annual operating and capital budgets. MTA currently employs an active fleet of approximately 140 buses, vans and trolleys serving approximately seven million riders annually. MTA is the largest transit service provider in the Nashville region and also provides regional service through contract with the Regional Transit Authority (RTA).

Over the past several years MTA has begun to systematically update their infrastructure and capital assets by installing advanced fareboxes, overhauling their planning and operations software, and modernizing an aging fleet with new 40 foot buses. MTA has recently completed a 5 year operational plan which outlines their strategies to improve and increase bus services within Davidson county.

Regional Transit Authority (RTA)

Created by state statute in 1990, the RTA is a nine-county regional agency in the Nashville metropolitan area whose mission is to plan and develop a regional transit system including a region-wide commuter rail system.

RTA also administers a traditional vanpool program to area commuters as a viable option to driving their own cars. Currently, with 100 vanpools in operation, the program is one of the largest in the southeast. Drawing from a customer base primarily from the outlying counties surrounding Davidson County, downtown Nashville is the destination of a majority of vanpool customers, although many other destinations are also served. The agency administers a carpool database to complement the vanpool program.

RTA collaborates with MTA to deliver a number of commuter and employment related transportation services. MTA operates three regional bus routes under contract with RTA that deliver commuter services between downtown Nashville and Murfreesboro, Hendersonville, and Mount Juliet. These routes serve various park and ride locations in outlying counties and are supported by a guaranteed ride home program.

RTA has implemented the first segment of the planned regional rail transit sytem. The first spur a commuter rail alignment to connect Nashville and Lebanon and began operations in September 2006.

6.8 Conclusion

As is evidenced by the multitude of transit options discussed in this chapter, there are many technologies and transit alternatives that could be used to satisfy the transportation needs of the southeast corridor. These various types of technologies are designed to serve various transportation needs, and each has its own costs and benefits. The Southeast Corridor High-Performance Transit Alternatives Study compared the transit needs of the corridor with the available transit technologies to determine, with input from the public and local officials, which systems would best serve the community.

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8.0 Travel Demand Forecasting

8.1 Introduction

This chapter documents the process by which the Nashville MPO's regional transportation model was modified and employed to develop ridership estimates and other information to support the analysis of alternatives and selection of a preferred alternative. Further documentation of these modifications and copies of the new model developed as part of the study have been provided to the MPO outside the context of this report. Results of the ridership testing and other information provided as outputs of the model are discussed in Chapters 5, 9 and 10 of this report.

8.2 Modeling Methodology

8.2.1 Model Development

The Nashville regional model has recently been updated based on a TransCAD software platform[1]. However, the model did not include a formal mode choice step. Therefore, as a part of this study, PB developed a mode choice model and transit assignment procedures to allow the model to forecast specific transit demand by zone, route and transit stop. This also required the development of a transit network, and transit level of service matrices.

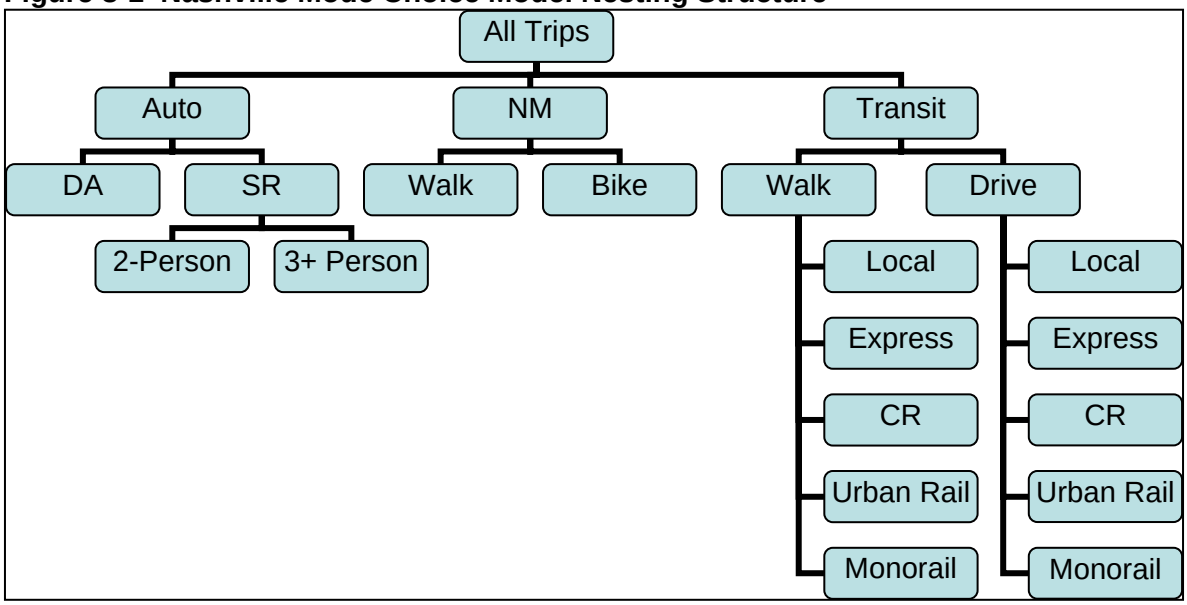
Fortunately, the current model's trip generation and distribution steps were developed to include all person-trips, and not just auto vehicle-trips. Therefore, no change was required in the trip generation or distribution steps of the current model. The mode choice model was inserted after trip distribution, and was used to calculate not only transit trips, but auto trips (by occupancy) and non-motorized trips as well. The factors that are used to adjust person trips to vehicle trips are effectively removed, in place of the modal trip tables produced by the new mode choice model.

The mode choice model is designed as a stand-alone program (coded in Fortran) that reads and writes fixed-format binary (noted by a "bin" extension) file, which, along with an associated dictionary file is compatible with TransCAD input and output formats. The program was based on the Memphis mode choice model, and borrows the same behavioral coefficients (in-vehicle time, out-of-vehicle time, cost) as are used in the Memphis model. The latter has been used for multi-modal corridor analyses, and uses coefficients that are within generally-accepted ranges. Mode and market-specific constants were modified to match target totals for modal travel, based on the 1997 home interview survey and the 2006 transit on-board survey.

Figure 8-1 shows the nesting structure. The model is a nested logit model, and estimates shares for auto, non-motorized and transit modes and sub-modes.

[1] "Nashville MPO Travel Demand Model" 2005. Prepared by PBS&J for the Nashville MPO.

Figure 8-1 Nashville Mode Choice Model Nesting Structure



Specific travel markets that are considered in the model include purpose-markets, access markets, and auto ownership markets. Purposes include Home-Based Work (HBW), Home-Based Other (HBO), and Non-Home Based. Transit access markets divide each origin/destination pair into short, long and no walk access combinations at the production and attraction ends. A "short" access/egress walk is defined as less than 0.25 miles; a "long" access/egress walk is defined as between 0.25 and 0.50 miles. Any market with more than a 0.5 mile walk distance is available to drive access only. Short walk times are constrained to a maximum of 5 minutes, and long walk times are constrained to a maximum of 10 minutes. Auto ownership markets divide trips by 0, 1 and 2+ households at the production end for HBW and HBO trip purposes. Auto ownership markets are determined based on a simple logit model that uses average zonal autos per household. Figure 8-2 shows how household market segments are determined based on the average household size value.

The household shares are then multiplied by average total trip rates by household size and normalized to determine the trip share markets. The household trip factors are shown in Table 8-1.

Figure 8-2 Nashville Auto Ownership Submodel

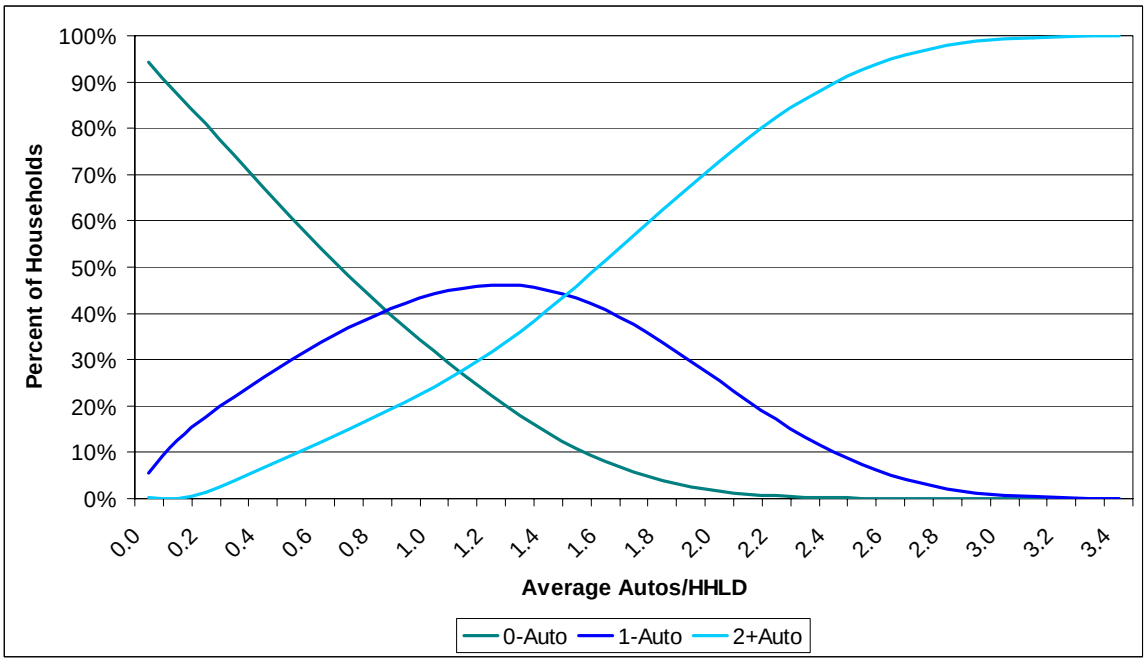


Table 8-1 Trip Rates for HBW and HBO Auto Ownership Markets

Auto Markets	HBW Trip Rate	HBO Trip Rate
0-Auto	0.26619	1.4509
1-Auto	1.24823	3.9936
2+ Auto	2.21788	6.0160

Constants for auto ownership are applied at the top and mid level, as well as at the lower level for the 2 and 3+ auto occupancy choice. There is no auto ownership stratification specific to the transit line-haul choices, however.

Tables 8-2 and 8-3 show the coefficients and constants used in the model

Table 8-2 Coefficients for the Nashville Mode Choice Model

Coefficients	Description	Purposes		
		HBW	HBO	NHB
CIVT	In-Vehicle Time (min)	-0.0250	-0.0125	-0.0200
CWAIT1S	Short Initial Wait (<5 min)	-0.0500	-0.0250	-0.0400
CWAIT1L	Long Initial Wait (>5 min)	-0.0500	-0.0250	-0.0400
CWAIT2	Transfer Wait (min)	-0.0500	-0.0250	-0.0400
CWALK	Walk Time (Walk mode)	-0.0375	-0.01875	-0.0400
CTWALK	Walk Time (Transit access/egress)	-0.0375	-0.01875	-0.0300
CDRIVE	Drive In-Vehicle Time	-0.0500	-0.0250	-0.0400
CCOST	Cost (parking, Op & fare)	-0.0046	-0.00809	-0.0046
ACPM	Auto Cost per Mile (cents)	12.0	12.0	12.0
OCC3P	Average 3+ Occupancy	3.5	3.5	3.5
INTDA	Intra-Zonal Drive-Alone share	0.73	0.73	0.73
INT2P	Intra-Zonal 2-Person Auto share	0.21	0.21	0.21
INT3P	Intra-Zonal 3+ Person Auto Share	0.06	0.06	0.06
CLSPRM	Logsum coefficient, Primary modes	0.75	0.75	0.75
CLSSUB	Logsum coefficient, SR & DA	0.75	0.75	0.75
CLSPTH	Logsum coefficient, transit line-haul	0.65	0.65	0.65
Coefficient Statistics				
	Wait/IVT Ratio	2.0	2.0	2.0
	Walk/IVT Ratio	1.5	1.5	2.0
	Walk access/IVT Ratio	1.5	1.5	1.5
	Drive IVT/IVT Ratio	2.0	2.0	2.0
	Cost/Hr	$3.26	$0.93	$2.61

Table 8-3 Constants for the Nashville Mode Choice Model

Coefficients	Description	Purposes		
		HBW	HBO	NHB[1]
KTRN -0	Transit – 0 auto	3.6995	-0.1230	-2.6223
KTRN -1	Transit – 1 auto	-1.1268	-2.7151	
KTRN -2	Transit – 2+ auto	-3.2622	-3.8965	
KNMOT-0	Non-Motorized – 0 auto	6.7695	0.9500	1.3517
KNMOT-1	Non-Motorized – 1 auto	0.3629	-0.8202	
KNMOT-2	Non-Motorized – 2+ auto	0.3102	-0.8138	
KSR – 0	Shared Ride – 0 auto	0.0000	0.0000	-0.1121
KSR – 1	Shared Ride – 1 auto	-1.0401	-0.0382	
KSR – 2	Shared Ride – 2+ auto	-1.7375	0.1638	
K3P – 0	3+p occupant auto – 0 auto	-0.5356	-0.8307	0.2042
K3P – 1	3+p occupant auto – 1 auto	-0.4552	0.3066	
K3P – 2	3+p occupant auto – 2+ auto	-0.9668	0.3066	
KBIKE – 0	Bike – 0 auto	-11.5566	-4.6412	-8.5362
KBIKE – 1	Bike – 1 auto	-6.3393	-6.1293	
KBIKE – 2	Bike – 2+ auto	-6.3392	-8.3327	
KDTRN - 0	Drive-Transit – 0 auto	-5.2934	-3.5595	-2.9819
KDTRN - 1	Drive-Transit – 1 auto	-3.0133	-2.6546	
KDTRN - 2	Drive-Transit – 2+ auto	-2.7462	-2.6546	

Notes:
[1] NHB trip purpose is not stratified by auto ownership

8.2.2 Use of Survey Data

Both the 1997 home interview survey and the 2006 on-board survey were used to generate the observed target values for the mode choice model calibration. A 2002 base year was used for the calibration. Table 8-4 shows the target shares used to calibrate the mode choice model. They are stratified by auto ownership and trip purpose. AM peak congested times were used for the HBW trip purpose, and off-peak times were used for the HBO and NHB trip purposes.

8.2.3 Model Calibration

The mode choice model calibration utilized a built-in “self-calibration” routine, which systematically adjusts each constant to match the observed transit shares. Shares were matched to (at most, in one instance) within 0.5% and virtually all calibration comparisons matched to well within 0.1%. The calibration also included the inclusion of a transit distance-specific term, which adjusts the transit mode attractiveness by distance. The distance-specific constants shown in Table 8-5 were developed based on transit on-board data.

Table 8-4 Regional Daily Mode Choice Target Totals

						Local			Express					
	DA	SR2	SR3+	Walk	Bike	walk	pnr	knr	walk	pnr	knr	Transit	Non-Transit	Total
HBW 0 Auto	0	2,707	1,034	1,906	100	2,389	0	64	55	0	10	2,518	5,747	8,265
HBW 1 Auto	130,830	29,949	13,224	2,068	3,659	1,556	166	194	15	42	28	2,001	179,729	181,730
HBW 2+ Auto	560,651	54,714	10,075	5,198	3,938	370	170	9	98	153	4	804	634,577	635,381
Total HBW	691,480	87,370	24,333	9,171	7,698	4,315	336	267	168	195	42	5,323	820,053	825,376
HBO 0 Auto	0	20,426	4,755	5,084	1,222	2,012	0	92	73	0	0	2,177	31,486	33,663
HBO 1 Auto	158,780	106,336	168,114	5,182	344	994	38	69	42	13	0	1,156	438,756	439,912
HBO 2+ Auto	428,781	342,538	551,255	17,856	197	273	47	130	50	17	23	540	1,340,626	1,341,166
Total HBO	587,561	469,300	724,125	28,121	1,762	3,279	85	291	165	30	23	3,873	1,810,869	1,814,742
NHB	489,843	317,971	441,038	21,526	1,234	1,377	161	287	30	39	46	1,940	1,271,612	1,273,552
Total	1,768,885	874,640	1,189,496	58,818	10,694	8,971	582	845	363	264	111	11,136	3,902,534	3,913,670

Table 8-5 Transit Distance Coefficient

Distance Range	HBW			HBO			NHB
	0 Auto	1 Auto	2+ Auto	0 Auto	1 Auto	2+ Auto	
0-5 miles	0.4770	-0.2917	-0.4411	-0.2623	-0.2656	-0.8020	-0.5186
5-10 miles	0.2386	0.3339	0.1848	0.4378	0.3939	0.5498	0.6448
10-15 miles	-1.0009	0.1124	0.5149	0.6144	0.4047	0.4701	0.5166
15-20 miles	-1.2000	0.0000	0.3000	0.7000	0.4500	0.6000	0.5000
20-25 miles	-1.1000	0.3000	0.5000	0.7000	0.5000	0.7000	0.5000
25-30 miles	-1.0000	0.7000	0.9000	0.7000	0.5500	0.7500	0.5000
30-35 miles	-0.9000	0.9000	1.1000	0.7000	0.6000	0.9000	0.5000
35-40 miles	-0.8000	1.1000	1.3000	0.7000	0.6500	1.0000	0.5000
40-45 miles	-0.8000	1.2000	1.5000	0.7000	0.7000	1.2000	0.5000
45-50 miles	-0.8000	1.3000	1.6000	0.7000	0.7500	1.3000	0.5000
50-55 miles	-0.8000	1.3000	1.6000	0.7000	0.8000	1.3500	0.5000
55-60 miles	-0.8000	1.3000	1.6000	0.7000	0.8500	1.4000	0.5000
60-65 miles	-0.8000	1.3000	1.6000	0.7000	0.9000	1.4500	0.5000
65-70 miles	-0.8000	1.3000	1.6000	0.7000	0.9500	1.5000	0.5000

There were sufficient observations only for up to 15 miles from the observed data, so above this limit, the constants were extrapolated, based on patterns in previous experience from the Los Angeles area. The data did, however generally indicate a rising transit mode share with distance.

Appendix A contains the user's guide for the mode choice model.

8.2.4 Network Development

Figure 8-3 shows the year 2030 No-Build transit network. Since the Nashville model did not previously have a transit network, the existing network was coded from the current schedule information. In addition, both walk and drive access links were added, as appropriate. The maximum drive access connector distance is 10 miles, and is limited within the pathbuilder to 30 minutes. The maximum walk time is limited by the pathbuilder to 20 minutes. The pathbuilder method is TransCAD's "Pathfinder" method.

Other pathbuilding parameters include:

Transfer time weight = 2.0
Transfer penalty = 7.5 min (5 min penalty x 1.5 weight)
Initial wait time weight = 2.0
Transit stop dwell time = 15 seconds
Maximum number of transfers = 3
Walk time weight = 1.5
Walk speed = 3 mph
Maximum initial wait time = 30 min
Maximum transfer wait time = 60 min
Minimum wait time = 2 min
Wait time = ½ headway
Maximum overall impedance = 240 min
Non-favored modes weighted by 10% during path-building

Bus speed model:

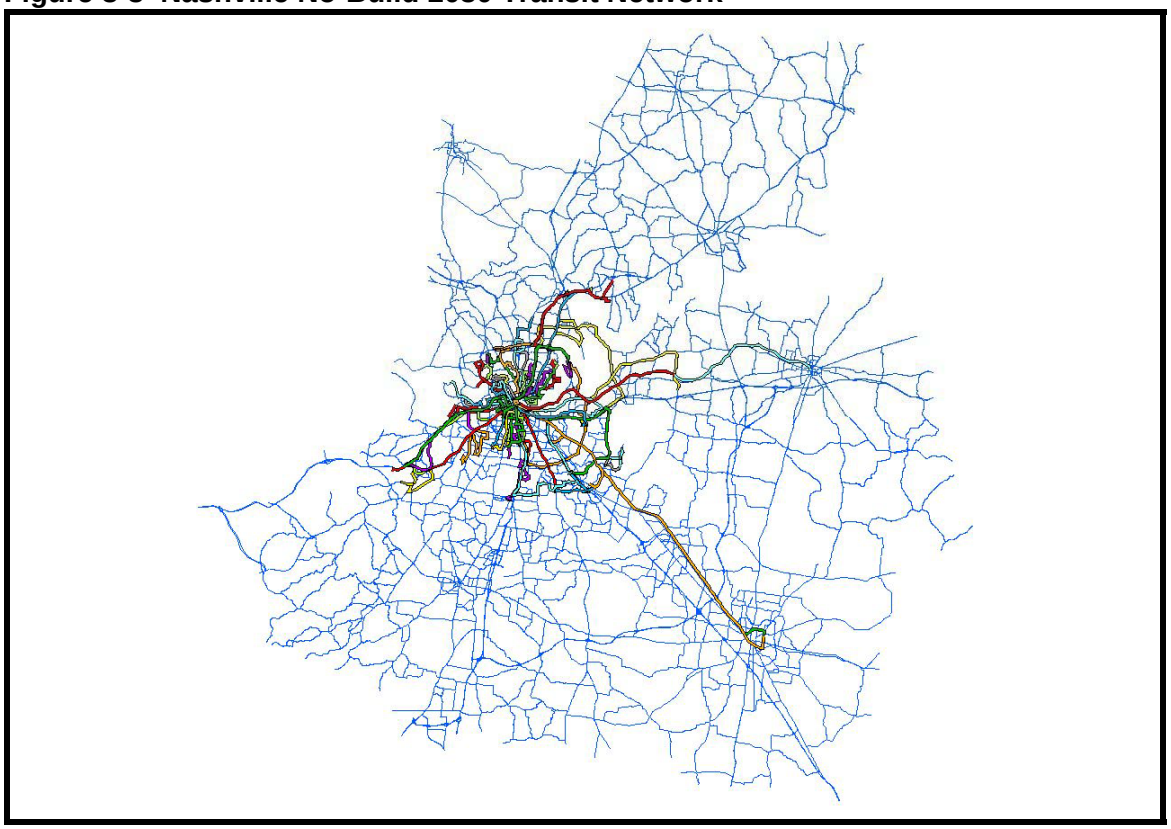
15 seconds/stop dwell time
Transit speed, area type 1 (High Density Urban) – congested speed reduced by 45%
Transit speed, area type 2 (Dense Urban) – congested speed reduced by 40%
Transit speed, area type 3 (Urban) – congested speed reduced by 35%
Transit speed, area type 4 (Suburban Business) – congested speed reduced by 30%
Transit speed, area types 5-7 (suburban, exurban, rural) – congested speed reduced by 25%

Overall correlation to schedule speeds is 85.2%

Note that weights and penalties are used only to determine path choices. Transit LOS variables, such as access/egress, wait and in-vehicle time reflect the actual time spent in these activities.

The on-board survey was assigned to the current network, and total boardings agreed with observed boardings to within 0.5% or about 50 boardings.

Figure 8-3 Nashville No-Build 2030 Transit Network



8.3 Detailed Screening Alternatives

The following section briefly describes the modeled alternatives. For a complete description of the alternatives, refer to Chapter 5, the Phase II Screening of Alternatives.

8.3.1 No-Build

The No-Build alternative includes those changes to the transit system that are described in the region's Transportation Improvement Program (TIP) or the financially-constrained portion of the region's Long Range Transportation Plan (LRTP). These include changes that have been planned and programmed, and for which there is a reasonable expectation for funding. The largest single change is the inclusion of the RTA's East Commuter Rail line connecting Lebanon to the Nashville CBD, which began in October 2006. Other transit improvements involved primarily service duration and frequency changes for routes 11, 12, 15, 18, 25, 32x, 33x, 37x, and 38x. Notably, no changes are programmed for the Route 96 "Relax and Ride" service to Murfreesboro. These changes, along with the 2030 highway network, were incorporated in the TSM and build alternatives.

8.3.2 Low Cost (TSM or Enhanced Bus)

The Low Cost alternative consisted of the proposed transit routes and Station/Park-and-Ride improvements proposed in Alternative A, the I-24 BRT alternative. All services

identified under Alternative A, including circulator routes, express and local pattern bus routes would be operated under the Low Cost alternative under nearly the same alignments. Under the Low Cost alternative, no significant guideway (busway or bus lane) or new roadway improvements would be implemented. This elimination of the busway is the primary difference between Alternative A and the Low Cost alternative and all other differences between the two alternatives stem from this single change. Park-and-ride lots would remain available at all identified station locations from Bell Road/Hickory Hollow Mall south. Stations would remain in place in locations similar to those identified in Alternative A, but would not be located adjacent to the roadway right of way.

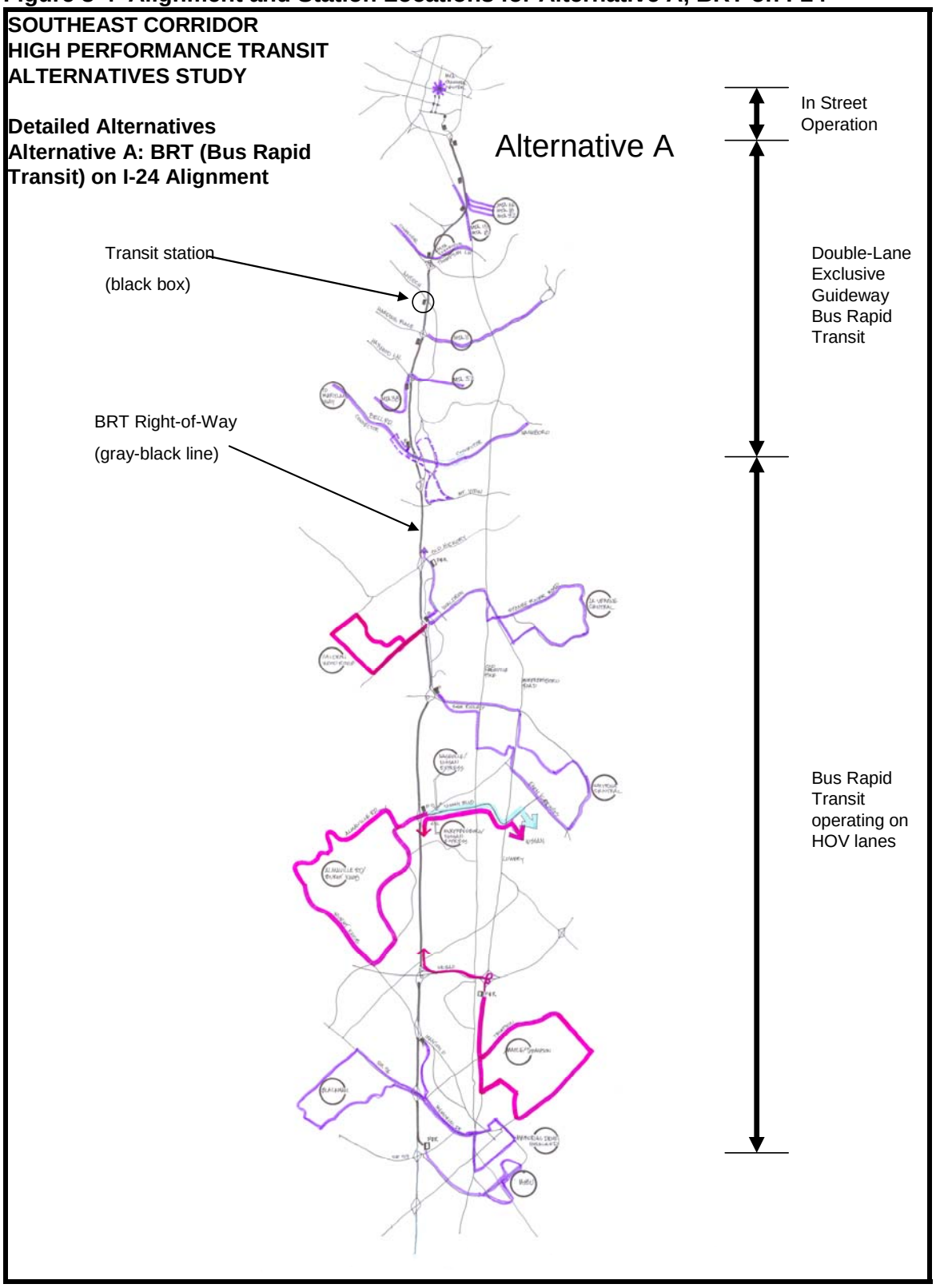
A variant of the low-cost alterative was also tested with the assumption of more concentrated land use around stations. This was done by assuming than all new growth to 2030 would be placed within 0.25 miles of a transit stop within the corridor.

8.3.3 Alternative A: I-24 Alignment, BRT

Alternative A consists of an all-day bus service operating mainly in the I-24 alignment. The alternative includes a two lane busway connecting downtown Nashville to the Bell Road/Hickory Hollow Mall area, with a single-lane reversible busway continuing south to Murfreesboro. The reversible busway south of Bell Road would operate north during the morning peak travel period and south during the afternoon peak period. During other periods the busway would be unused. The alternatives' alignment, station and park-and-ride locations, and circulator route alignments are shown in the map in Figure 8-4. The alignment begins in the north at the MTA Transit Center in downtown Nashville (assumed to be located on the north side of Charlotte Street between Fourth and Fifth Avenues). The alignment in downtown Nashville will be re-examined in further development; however, for the purposes of ridership buses would operate southbound on Fourth Avenue and northbound on Third Avenue. Buses would operate in downtown streets in existing lanes shared with local traffic and would stop at local bus stops along their alignment.

The operating plan combines long distance service to downtown Nashville from Murfreesboro, LaVergne, Smyrna, and other areas of Rutherford and southern Nashville-Davidson County with services oriented to shorter-distance trips within the corridor and services for reverse commuters to Murfreesboro and MTSU, Interchange City, Nissan, and other attractions in the corridor. The proposed new services all use the portion of the guideway that passes the congested point on I-24 between Fairfield and Harding Road that currently delays travelers in that area of the corridor. A series of shuttle routes in the southern areas of the corridor would begin their morning service circulating as local bus services through neighborhoods in communities in the south of the corridor. These same buses would then serve park-and-ride lot stations at the nearest major interchange along I-24 before entering the busway to complete their trip to downtown Nashville. In the Nashville-Davidson County portion of the corridor, intersecting bus routes would allow passengers to transfer to the BRT at stations located along the busway. Some trips would continue through downtown Nashville beyond the

Figure 8-4 Alignment and Station Locations for Alternative A, BRT on I-24



Charlotte Street terminal and continue to the West End and Vanderbilt University areas, providing on those trips a one-seat ride from southern portions of the corridor to the West End/Vanderbilt areas.

8.3.4 Alternative B: Commuter Rail CSX Alignment

This alternative consists of commuter rail service in the rail corridor extending south from downtown Nashville through LaVergne and Smyrna to Murfreesboro. This line is owned by CSX Transportation, Inc. (CSX), which uses it extensively in their freight operations. The alternative presumably would use conventional railroad equipment or DMU vehicles that meet the crash-worthiness and other safety standards set by the Federal Railroad Administration (FRA). This would make it permissible for the commuter rail trains to operate in mixed traffic with freight rail equipment such as that operated by CSX on the existing tracks in this alignment. The proposed alignment of the commuter rail line, the locations of commuter rail stations, and the approximate alignments of feeder and circulator bus routes are shown in Figure 8-5.

Seven trains would operate during each two hour peak period, with four traveling in the peak and three in the off-peak direction. Five of the seven trains would operate in a skip stop station stopping pattern in which alternating stations would be bypassed on alternating trips, to reduce the number of stops on each train and thereby increase travel speed and reduce travel time. During the mid day period, a single train would operate once in each direction, essentially to provide emergency service for travelers who need to return home mid day from downtown Nashville.

Shuttle bus routes would operate in neighborhoods around the stations from Bell Road south. Corridor communities including Smyrna, LaVergne and Murfreesboro would be served by circulator routes, and these routes would connect transferring passengers at the commuter rail stations to destinations including Interchange City, Nissan and MTSU. These circulator routes would operate in the peak periods only and would be timed to connect to the commuter rail trips arriving and departing at each station. Existing MTA bus services would connect to the Bell Road and Harding Road stations. As noted above, a circulator route would distribute transferring rail passengers through downtown Nashville and connect them to the MTA's transfer center at Charlotte Street and to the West End area and Vanderbilt Campus.

8.3.5 Alternative C: BRT Murfreesboro Road/Old Nashville Pike Alignment

In Alternative C BRT service would operate on an alignment along Murfreesboro Road (US 41) and Old Nashville Pike. This alternative consists of an all-day bus service operating on a two lane busway from downtown Nashville on Lafayette Street to Oak Street and then south along Murfreesboro Road to Bell Road. A single lane busway would continue south from the Bell Road area to Old Nashville Pike along Murfreesboro Road, and along Old Nashville Pike to Murfreesboro. The reversible busway south of Bell Road would operate in the prevailing commuter traffic directions, north during the morning peak travel period and south during the afternoon peak period. During other periods the busway would be unused. The proposed alignment and station locations for Alternative C are shown in Figure 8-6.

Figure 8-5 Alignment and Station Locations for Alternative B: Commuter Rail

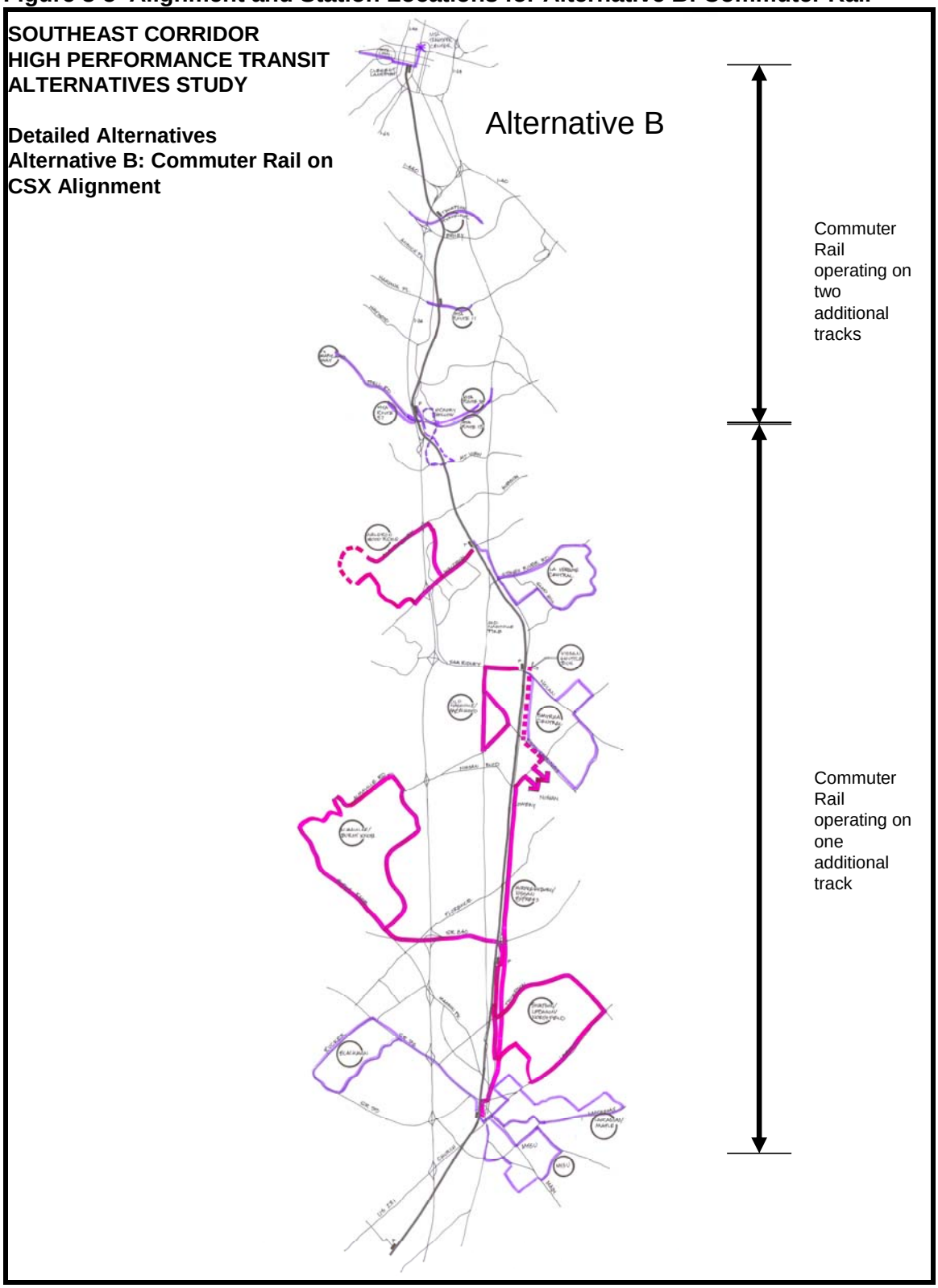
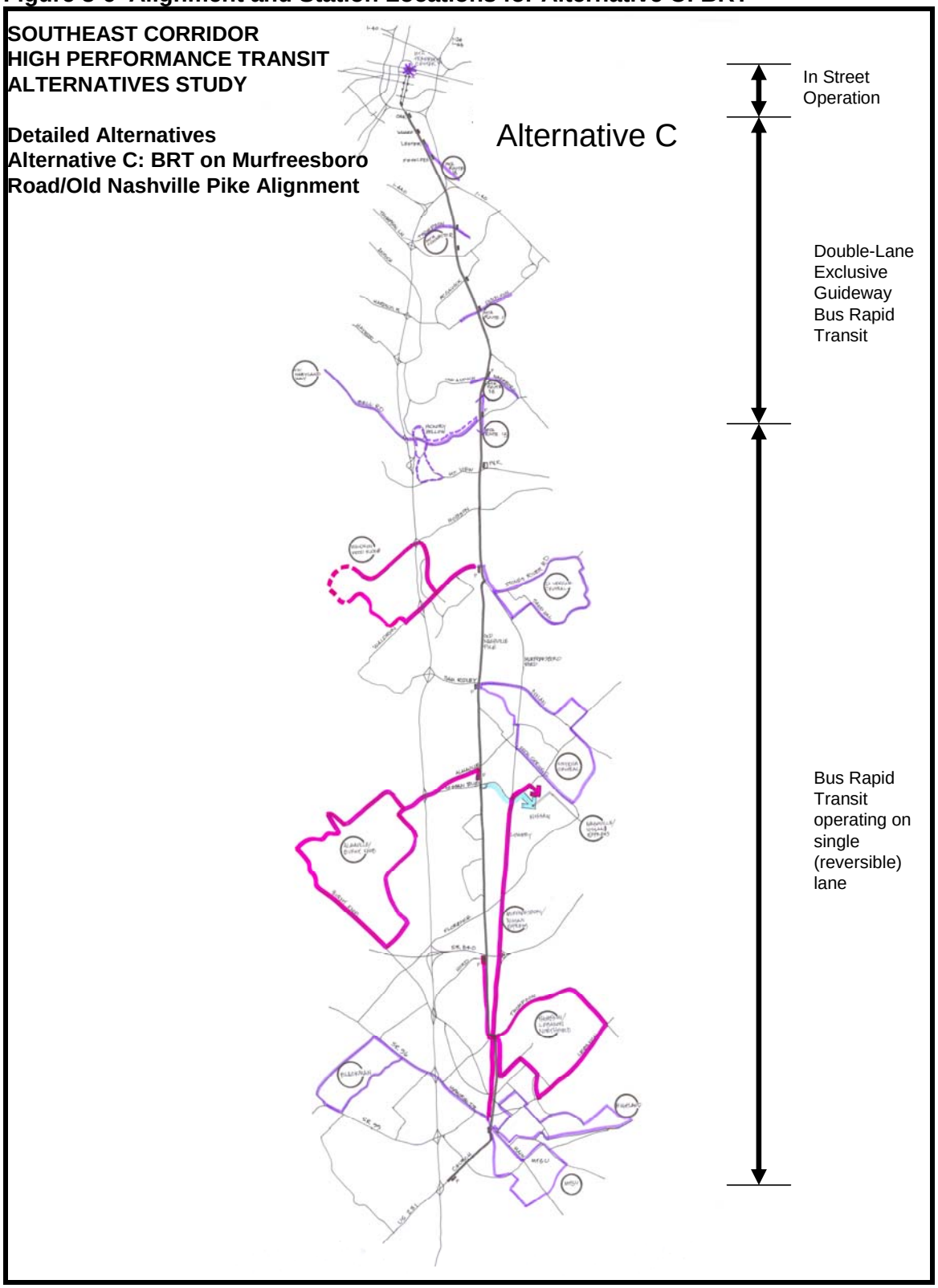


Figure 8-6 Alignment and Station Locations for Alternative C: BRT



The operating plan for Alternative C combines longer distance express services oriented to commuters to downtown Nashville with services oriented to shorter distance trips within the corridor. As in Alternative A, circulator routes would circulate through neighborhoods in the south of the corridor (LaVergne, Smyrna and Murfreesboro) before entering the busway along Nashville Pike or Murfreesboro Road to complete a high speed express trip to downtown Nashville. In the Nashville-Davidson County portion of the corridor, intersecting bus routes would permit passengers to transfer to the BRT at stations along the busway. Some trips operate continuously from the Charlotte Street transit center to the West End and Vanderbilt University areas, providing passengers bound to those areas with a one seat ride from areas in the south of the corridor.

8.4 Transportation Model Results

8.4.1 Transit Ridership

Table 8-6 shows the results of the mode choice model, applied to the alternatives. The ranges represent the difference between a base model run and the cumulative application of five mode choice adjustments. These adjustments include:

1. A commuter rail mode-specific constant equal to 18 minutes of equivalent In-Vehicle Time and a BRT mode-specific constant equal to 6 minutes of equivalent In-Vehicle time.
2. A 25% discount on commuter rail In-Vehicle time
3. The application of a calibrated distance-based coefficient for all transit (discussed earlier)
4. An adjustment of one cent (from $0.12 to $0.13) in the auto operating cost, based on historical gas prices
5. An adjusted drive-access coefficient for one- and two-auto households, based on experience in Los Angeles. The adjustment consisted of an equivalent 15 minutes for one-auto households and 25 minutes for two-auto households.

Table 8-6 Year 2030 Transit Linked-Trip Summary

Alternative	System Total	Corridor Guideway	Change from NB	Change from TSM
No-Build	15,500-16,800	-NA-		-900 - -1,100
TSM	16,400-17,900	-NA-	1,100	
Alt A (BRT on I-24)	15,600-17,200	800-1,600	100-400	-700 - -800
Alt B (CR)	16,000-17,600	200-900	500-800	-300 - -400
Alt C (BRT on MBR Rd)	16,300-18,100	900-1,900	800-1,300	-100 – 200
Enhanced Bus	16,800-18,300	-NA-	1,300-1,500	400
Enhanced Bus, Modified Land Use	17,300-18,900	-NA-	1,800-2,100	900 – 1,000

Ranges represent assumptions regarding
- use of a CR mode-specific constant,
- a 25% discount on CR IVT,
- use of transit distance-based coefficients,
- auto operating cost adjustment and
- a drive-access coefficient adjustment.

The TSM alternative and alternative C show a similar improvement over the no-build alternative, while the Enhanced Bus further improves on ridership performance. With a more concentrated land use, the Enhanced Bus improves by about 500 transit trips per day.

8.4.2 Boardings and Alightings

Table 8-7 shows the total boardings for corridor routes, by alternative. Alternative A and the Enhanced Bus alternatives show the greatest change from the TSM or no-build alternatives. With a more concentrated land use, the Enhanced Bus shows a significant increase in boardings.

Table 8-7 Year 2030 Transit Boardings in the Corridor

Alternative	Total Boardings	Change from NB	Change from TSM
No-Build	3,100		-1,900
TSM	5,200	2,200	
Alt A (BRT on I-24)	6,300	3,200	1,100
Alt B (CR)	5,200	2,200	0
Alt C (BRT on MBR Rd)	6,100	3,000	900
Enhanced Bus	6,500	3,400	1,300
Enhanced Bus with Modified Land Use	7,300	4,200	2,100
Corridor Routes include: 15, 32, 96(relax & ride), All corridor Guideway routes, all Corridor feeder routes			

8.4.3 VMT and VHT change

Table 8-8 shows a summary of the vehicle-miles and vehicle-hours of travel for each of the alternatives. This was a matrix-based calculation, using a fixed highway time and distance matrix, multiplied by the vehicle-trip table for each alternative.

There is very little difference between the alternatives in terms of overall VMT and VHT. The build alternatives show from -0.03% to -0.07% change from the no-build alternative.

Table 8-8 VMT and VHT for Alternatives, Region-Wide

Alternative	VMT	VHT	Avg. Speed
No-Build	30,160,420	1,052,491	28.66
TSM	30,149,191	1,052,128	28.66
Alt A (BRT on I-24)	30,144,716	1,052,050	28.65
Alt B (CR)	30,145,286	1,052,044	28.65
Alt C (BRT on MBR Rd)	30,139,361	1,051,874	28.65
Enhanced Bus	30,142,546	1,051,944	28.65
Enhanced Bus with Modified Land Use	30,138,541	1,051,796	28.65

9.0 Capital and Operating/Maintenance Cost Estimates

The project team developed estimates of capital costs (costs associated with fixed infrastructure or real property, such as new rail lines, busways or stations) and operating and maintenance costs (costs associated with the ongoing operation and maintenance of the services) for each of the significant alternatives developed in the Phase I and Phase II screening of alternatives and for the proposed Locally Preferred Alternative (LPA). The cost estimating methodologies employed in each round of analysis and the results of the estimates are described in detail in this chapter. The cost estimating techniques employed in the Phase II screening of alternatives and to estimate the costs associated with the proposed LPA use built-up cost methodologies as required by the FTA in their guidance for Section 5309 New Starts projects.

9.1 Cost Estimating in the Initial Screening of Alternatives

Cost estimates were developed for the initial round of alternatives in order to provide a basis for differentiating between the various alignments (various permutations of alignments concentrated on I-24, the CSX rail alignment, and Murfreesboro Road) and the modes under consideration (bus rapid transit and BRT light, commuter rail, and light rail, both electrically powered and operated using diesel multiple units).

9.1.1 Capital Costs

Fully built-up capital cost models based on unit costs were developed for the initial round of screening and were used, with some modifications and updating, throughout the remainder of the study. These models used industry-standard and TDOT unit cost information for various elements of construction of the various transit types and developed per-mile and per station unit costs. Separate models were developed for BRT/Roadway and LRT alternatives and for commuter rail alternatives, which were thought to be sufficiently different to warrant a separate model. In the initial phase, these costs were based on 2003 cost histories from TDOT and other sources.

Worksheets were created with the cost elements of each of the various construction types (normal right of way, in rock cuts, and on bridge), and developed unit costs per mile and per station for these construction types for the model used for roadway and BRT alternatives. Costs of design, engineering, construction management and contingencies were included in the per mile and per station unit costs as percentage markups. Right of way acquisition was not explicitly considered in this initial stage of development. The purchase of vehicles also was not included in this estimate, which assumed that vehicle purchase costs would be less significant than right of way and station based improvements.

The worksheets for developing these unit costs for the various construction types are included in Appendix 9A. Estimates were prepared for each alternative by estimating costs for individual stations and for right of way improvements of various types over segments of each alignment. Spreadsheets showing these calculations are included in Appendix 9B. The cost estimates for these alternatives are shown in Table 9-1. Note that the estimates were presented for decision-making purposes as a range of 90% to 110% of the actual estimate and generally rounded to the nearest $10 million.

Table 9-1 Phase I Screening Alternative Capital Cost Estimates (2003 Dollars)

ALTERNATIVE	Estimated Cost	COST RANGE (in Millions)	
		FROM	TO
Alternate 1A-BRT	$331.4	$290	$370
Alternate 1A-LRT	$746.2	$670	$830
Alternate 1A-DMU	$537.7	$480	$600
Alternate 1B-BRT	$394.2	$350	$440
Alternate 1B-LRT	$828.5	$740	$920
Alternate 1B-DMU	$596.6	$530	$660
Alternate 2A-BRTL	$127.2	$110	$140
Alternate 2B-BRTL	$35.1	$30	$40
Alternate 3-Commuter Rail	$520.8	$460	$580
Atlernate 4A-BRT	$377.9	$340	$420
Alternate 4A-LRT	$691.0	$620	$770
Alternate 4A-DMU	$508.6	$450	$560
Atlernate 4B-BRT	$435.3	$390	$480
Alternate 4B-LRT	$781.3	$700	$860
Alternate 4B-DMU	$573.0	$510	$640
Atlernate 4C-BRT	$389.7	$350	$430
Alternate 4C-LRT	$706.9	$630	$780
Alternate 4C-DMU	$519.8	$460	$580
Alternate 4D-BRT	$389.7	$350	$430
Alternate 4D-LRT	$706.9	$630	$780
Alternate 4D-DMU	$519.8	$460	$580
Alternate 5A-BRT	$329.8	$290	$370
Alternate 5A-LRT	$713.5	$640	$790
Alternate 5A-DMU	$533.9	$480	$590
Alternate 5B-BRT	$305.2	$270	$340
Alternate 5B-LRT	$628.8	$560	$700
Alternate 5B-DMU*	$460.0	$410	$510
Alternate 6A-BRTL	$44.9	$40	$50
Alternate 6B-BRTL	$43.4	$30	$50

*Pivot estimate based on 5A DMU estimate and 5B LRT estimate

9.1.2 Operating/Maintenance Costs

Estimates of operating and maintenance costs were not developed in the initial screening of alternatives. No specific operating strategy, including estimates of running time, hours and days of service and other operating plan elements necessary to develop operating costs was developed for this set of alternatives, making estimation of operating and maintenance costs challenging and potentially inaccurate. Further, the project Steering Committee assumed that operating costs would be similar between alternatives of similar modes given the similar length of the alignment and other factors, and that the differences between the alternatives in terms of operating costs would be minor compared to other areas of the evaluation.

9.2 Cost Estimating in the Detailed Analysis of Alternatives

9.2.1 Capital Costs

The capital cost estimating methodology used for the initial alternatives was also used in estimating capital costs for the two BRT alternatives developed for detailed analysis: alternatives A (BRT on I-24) and C (BRT on Murfreesboro Road). Cost estimates in this detailed analysis also included estimates of vehicle costs. Capital cost estimates for Alternative B, the Commuter Rail service on the CSX Rail line, were made using a separate methodology prepared specifically for estimating rail infrastructure based on experience in other cities.

Infrastructure on BRT Alternatives

Capital cost estimates for the infrastructure supporting the BRT alternatives (alternatives A and C) and for the proposed TSM alternative (a lower cost variant of alternative A) were made using the capital cost estimating models prepared for the initial round of alternatives analysis, with new inputs based on the new configurations and alignments of the alternatives. Because more than one year passed between the estimation of costs for the initial alternatives and the detailed alternatives, the cost estimating models were updated to include more recent TDOT cost inputs, where applicable or available. A revised set of worksheets for development of unit costs for the various construction types are included in Appendix 9C. Estimates for alternatives A and C are shown in tables 9-2 through 9-4.

Rolling Stock Estimates for the Detailed Phase Alternatives

Rolling stock capital cost estimates were based on operating statistics for each of the BRT alternatives and the no-build network based on output from the travel demand model, which generated running time estimates and service frequency for each direction on bus routes included in the transportation system for each alternative. The one way running time for each bus route was multiplied by two to generate a round trip running time, and a recovery time factor of 15% was added to each round trip running time. The round trip running time was then divided by the AM peak period headway to derive the number of buses required to operate the route. A key input to the model used to estimate operating cost (described below) was the sum of buses required to operate each route in the system or the number of buses required in maximum service. A 15% spare ratio was then added to the number of buses required in

Table 9-2: TSM Alternative (Enhanced Bus on I-24) Infrastructure Capital Cost Estimate (2005 Dollars)

Description	From	To	Miles	Const Type	BRT Cost PerMile	BRT Cost Per Segment
Lump Sum-CBD Areas						**9,150,000**
Nashville Downtown Area			2	Lump	500,000	1,000,000
Murfreesboro Downtown Area			5.3	Lump	Blended	8,150,000
Stations						**55,500,000**
MTA Transfer Center Station				STA. 1	150,000	150,000
Church St. Station				STA. 1	150,000	150,000
Broadway Station				STA. 1	150,000	150,000
Gateway Blvd. Station				STA. 1	150,000	150,000
1st Ave. Station				STA. 1	150,000	150,000
Rolling Mill Hill Station				STA. 1	150,000	150,000
Hermitage Ave Station				STA. 1	150,000	150,000
Elm Hill Pike Station				STA. 2	10,000,000	10,000,000
Elm Pedestrian Structure Spanning I-24					2,000,000	2,000,000
Murfreesboro Rd. Station				STA. 2	10,000,000	10,000,000
Thompson Lane Station				STA. 2	10,000,000	10,000,000
Antioch Pike Station				STA. 2	10,000,000	10,000,000
Harding Place Station				STA. 3	1,200,000	1,200,000
Haywood Station				STA. 3	1,200,000	1,200,000
Hickory Hollow/Bell Rd. Station				STA. 3	1,200,000	1,200,000
OHB/Hobson Pike Station				STA. 3	1,200,000	1,200,000
Lavergne/Waldron Rd. Station				STA. 3	1,200,000	1,200,000
Sam Ridley				STA. 3	1,200,000	1,200,000
Nissan Blvd Station				STA. 3	1,200,000	1,200,000
Blackman Station				STA. 3	1,200,000	1,200,000
840 Station				STA. 3	1,200,000	1,200,000
SR 96/Stone River Mall Station				STA. 3	1,200,000	1,200,000
SR 99/New Salem Rd. Station				STA. 1	150,000	150,000
Church St. Station				STA. 1	150,000	150,000
MTSU Station				STA. 1	150,000	150,000
Mainline Construction (I-24)						**76,602,542**
I-24 over Hermitage to Harding Place Area	15	18.596	3.596	BRIDGE	13,160,928	47,326,697
Rock Construction	18.596	18.859	0.263	RC	12,432,550	3,269,761
Mainline Roadway Construction	18.859	19.163	0.304	I-24	6,903,576	2,098,687
Bridge	19.163	19.667	0.504	BRIDGE	13,160,928	6,633,108
Rock Construction	19.667	20.238	0.571	RC	12,432,550	7,098,986
Structure over Harding Place Interchange	20.238	20.538	0.3	BRIDGE	13,160,928	3,948,278
Mainline Roadway Construction	20.538	21.44	0.902	I-24	6,903,576	6,227,025
OTHER CONSRUCTION ITEMS						**2,000,000**
Facility						-
Traffic Engineering Improvements						2,000,000
RIGHT-OF-WAY						**9,746,000**
Station Land					125,000	4,250,000
Mainline ROW					2,000,000	5,496,000
SOFT COSTS						**29,069,723**
Preliminary Engineering (2% of above costs)						3,059,971
Final Design (4%)						6,119,942
Project Management for Design and Construction						
Construction Administration & Management (6%)						9,179,913
Insurance, Legal, Permits, Review Fees (7%)						10,709,898
Surveys, Testing, Investigation, Inspection						
Agency Force Account Work						
FINANCE CHARGES						
CONTINGENCY (25% of Construction, ROW, Vehicles)						**38,249,635**
TOTAL						**220,317,900**

Table 9-3: Alternative A (BRT on I-24) Infrastructure Capital Cost Estimate (2005 Dollars)

Description	From	To	Miles	Const Type	BRT Cost PerMile	BRT Cost Per Segment
Lump Sum-CBD Areas						**9,150,000**
Nashville Downtown Area			2	Lump	500,000	1,000,000
Murfreesboro Downtown Area			5.3	Lump	Blended	8,150,000
Stations						**55,500,000**
MTA Transfer Center Station				STA. 1	150,000	150,000
Church St. Station				STA. 1	150,000	150,000
Broadway Station				STA. 1	150,000	150,000
Gateway Blvd. Station				STA. 1	150,000	150,000
1st Ave. Station				STA. 1	150,000	150,000
Rolling Mill Hill Station				STA. 1	150,000	150,000
Hermitage Ave Station				STA. 1	150,000	150,000
Elm Hill Pike Station				STA. 2	10,000,000	10,000,000
Elm Pedestrian Structure Spanning I-24					2,000,000	2,000,000
Murfreesboro Rd. Station				STA. 2	10,000,000	10,000,000
Thompson Lane Station				STA. 2	10,000,000	10,000,000
Antioch Pike Station				STA. 2	10,000,000	10,000,000
Harding Place Station				STA. 3	1,200,000	1,200,000
Haywood Station				STA. 3	1,200,000	1,200,000
Hickory Hollow/Bell Rd. Station				STA. 3	1,200,000	1,200,000
OHB/Hobson Pike Station				STA. 3	1,200,000	1,200,000
Lavergne/Waldron Rd. Station				STA. 3	1,200,000	1,200,000
Sam Ridley				STA. 3	1,200,000	1,200,000
Nissan Blvd Station				STA. 3	1,200,000	1,200,000
Blackman Station				STA. 3	1,200,000	1,200,000
840 Station				STA. 3	1,200,000	1,200,000
SR 96/Stone River Mall Station				STA. 3	1,200,000	1,200,000
SR 99/New Salem Rd. Station				STA. 1	150,000	150,000
Church St. Station				STA. 1	150,000	150,000
MTSU Station				STA. 1	150,000	150,000
Mainline Construction (I-24)						**-**
I-24 over Hermitage to Harding Place Area	15	18.596	3.596	BRIDGE		
Rock Construction	18.596	18.859	0.263	RC		
Mainline Roadway Construction	18.859	19.163	0.304	I-24		
Bridge	19.163	19.667	0.504	BRIDGE		
Rock Construction	19.667	20.238	0.571	RC		
Structure over Harding Place Interchange	20.238	20.538	0.3	BRIDGE		
Mainline Roadway Construction	20.538	21.44	0.902	I-24		
OTHER CONSRUCTION ITEMS						**2,000,000**
Facility						-
Traffic Engineering Improvements						2,000,000
RIGHT-OF-WAY						**-**
Station Land						
Mainline ROW						
VEHICLES (number)						**-**
Light Rail						
Heavy Rail						
Commuter Rail Cars						
Bus						
Other (Locomotives)						
Non-revenue vehicles						
Spare parts						
SOFT COSTS						**12,663,500**
Preliminary Engineering (2% of above costs)						1,333,000
Final Design (4%)						2,666,000
Project Management for Design and Construction						
Construction Administration & Management (6%)						3,999,000
Insurance, Legal, Permits, Review Fees (7%)						4,665,500
Surveys, Testing, Investigation, Inspection						
Agency Force Account Work						
FINANCE CHARGES						
CONTINGENCY (25% of Construction, ROW, Vehicles)						**16,662,500**
TOTAL						**95,976,000**

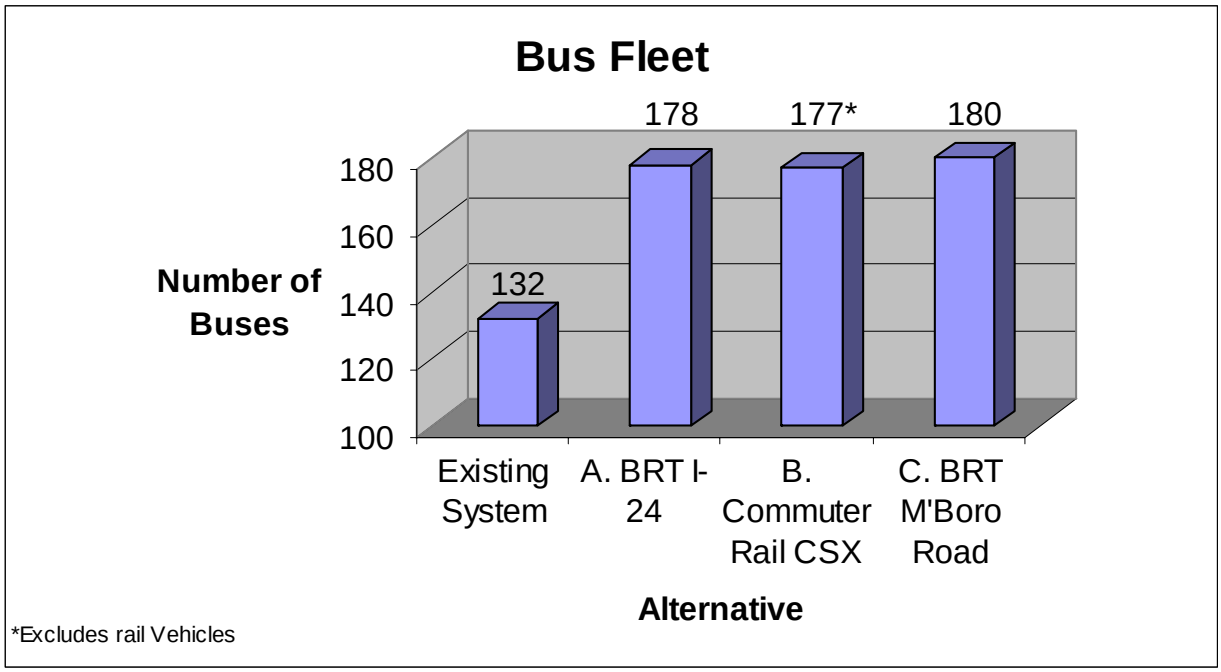
Table 9-4: Alternative C (BRT on I-24) Infrastructure Capital Cost Estimate (2005 Dollars)

Description	From	To	Miles	Const Type	BRT Cost PerMile	BRT Cost Per Segment
Lump Sum-CBD Areas						**2,100,000**
Nashville Downtown Area			2.7	Lump	500,000	1,350,000
Murfreesboro Downtown Area			3	Lump	250,000	750,000
Stations						**19,500,000**
MTA Transfer Center Station				STA. 1	150,000	150,000
Church St. Station				STA. 1	150,000	150,000
Broadway Station				STA. 1	150,000	150,000
Gateway Blvd. Station				STA. 1	150,000	150,000
Lafayette Street				STA. 1	150,000	150,000
Wharf Avenue				STA. 1	150,000	150,000
Fesslers Lane				STA. 1	150,000	150,000
Blanton Avenue				STA. 2	1,200,000	1,200,000
Thompson Lane				STA. 2	1,200,000	1,200,000
Glengarry Drive				STA. 2	1,200,000	1,200,000
McGavock Pike				STA. 2	1,200,000	1,200,000
Donelson Pike/Dell				STA. 2	1,200,000	1,200,000
Haywood Lane Extended				STA. 2	1,200,000	1,200,000
Una Antioch Pike/Nashboro Village				STA. 2	1,200,000	1,200,000
Bell Road				STA. 2	1,200,000	1,200,000
Hobson Pike				STA. 2	1,200,000	1,200,000
Waldron Road				STA. 2	1,200,000	1,200,000
Downtown Smyrna or Sam Ridley Pkwy				STA. 2	1,200,000	1,200,000
Nissan Blvd				STA. 2	1,200,000	1,200,000
Florence Road				STA. 2	1,200,000	1,200,000
SR 840				STA. 2	1,200,000	1,200,000
Thompson Road				STA. 2	1,200,000	1,200,000
Downtown Murphreesboro				STA. 1	150,000	150,000
Broad/Tennessee				STA. 1	150,000	150,000
MTSU				STA. 1	150,000	150,000
Mainline Construction (Murfreesboro Road)						**218,187,597**
Lafayette Street to 2nd Avenue	18	18.573	0.573	NC-6	6,689,257	3,832,944
2nd Avenue to Menzler Road	18.573	20.505	1.932	NC-5	6,689,257	12,923,645
Menzler Road to Glengarry Drive	20.505	22.778	2.273	NC-4	6,689,257	15,204,682
Replace RR bridge so transit can fit (low clearance, no lateral clearance)	20.505		0.1	RR Bridge	10,560,000	1,056,000
Replace bridge to eliminate pier in median	22.478		0.1	Bridge	13,160,928	1,316,093
Glengarry Drive to Briley Pkwy	22.778	23.169	0.391	NC-5	6,689,257	2,615,500
Briley Pkwy to Donelson Pike	23.169	24	0.831	NC-7	6,689,257	5,558,773
Tunnel under airport. Assume no Reconstruction	24	24.18	0.18	Tunnel		-
Briley Pkwy to Donelson Pike	24.18	24.791	0.611	NC-7	6,689,257	4,087,136
Donelson Pike to Old Murfreesboro Pike	24.791	25.191	0.4	NC-4	6,689,257	2,675,703
Old Murfreesboro Pike to Rural Hill	25.191	27.775	2.584	NC-5	6,689,257	17,285,041
Rural hill to Forest View	27.775	28.36	0.585	NC-7	6,689,257	3,913,215
Forest view to Rutheford County line	28.36	32.24	3.88	NC-5	6,689,257	25,954,318
Rutherford County Line to Morgen Ave	0	4.675	4.675	NC-4	6,689,257	31,272,277
Pier in Median - Sam Ridley	3.876					
Morgen Ave to Mayfield Dr	4.675	5.484	0.809	NC-5	6,689,257	5,411,609
Mayfield Dr to Hoover Dr	5.484	6.164	0.68	NC-4	6,689,257	4,548,695
Hoover Dr to Ken Pilkerton Dr	6.164	6.384	0.22	NC-5	6,689,257	1,471,637
Ken Pilkerton Dr to Medical Center Pky	6.384	15.784	9.4	NC-4	6,689,257	62,879,017
Medical Center Pky to Old Fort Pky	15.784	16.453	0.669	NC-7	6,689,257	4,475,113
Old Fort Pky to Church St P&R	16.453		1.75	NC-5	6,689,257	11,706,200
OTHER CONSRUCTION ITEMS						**10,000,000**
Facility						-
Traffic Engineering Improvements						10,000,000
RIGHT-OF-WAY						**49,761,600**
Station Land					125,000	3,750,000
Mainline ROW					2,000,000	46,011,600
SOFT COSTS						**56,914,347**
Preliminary Engineering (2% of above costs)						5,990,984
Final Design (4%)						11,981,968
Project Management for Design and Construction						
Construction Administration & Management (6%)						17,972,952
Insurance, Legal, Permits, Review Fees (7%)						20,968,444
Surveys, Testing, Investigation, Inspection						
Agency Force Account Work						
FINANCE CHARGES						
CONTINGENCY (25% of Construction, ROW, Vehicles)						**74,887,299**
TOTAL						**431,350,843**

maximum service to generate the required fleet size for each alternative. Subtracting the fleet size for the no-build alternative from the fleet size generated for the build alternatives results in the estimate of additional buses required to operate the service. This number was then multiplied by a cost factor for each type of required bus to generate the vehicle capital costs.

The fleet size estimates for the three alternatives in the detailed phase (including the bus fleet required for the commuter rail alternative) are shown in Figure 9-1. The model estimated that about 132 vehicles would be required to operate the no-build system, while nearly 180 would be required to operate the various build alternatives. In the case of the commuter rail alternatives, these additional vehicles are in addition to a number of commuter rail vehicles that would be necessary to operate the service.

Figure 9-1: Bus Fleet Estimates for Detailed Alternatives



The cost estimates for the bus fleet assumed that BRT vehicles would cost an average of $1 million per vehicle and that more common transit buses would cost an average of $300,000. The estimates for alternatives A and C are shown in the table below. No estimate was prepared for the TSM alternative; however, due to the slightly slower operating speed under that alternative, it is assumed that the vehicle cost for the TSM alternative would be slightly more than Alternative A, on which it is based. The 30 year cost is a life cycle cost, a method for equalizing the cost of buses (which have an expected useful life of 12 years) and commuter rail vehicles (which have an expected useful life of 30 years). The costs of the bus fleet for the three detailed phase alternatives are shown in Table 9-5.

Under Alternative B, the commuter rail option on the CSX rail line, rail vehicles (either self propelled DMUs or cars pulled by rail engines) would be required in addition to buses. The committee and consultants ultimately determined that the option as tested in the travel demand model could be operated with as few as three trains. The trains currently operating on the Nashville Star East corridor were provided for a nominal fee from the old stock of another operator, and such a scenario would remain possible for other operations in the Nashville area.

The purchase of new rail rolling stock was estimated at approximately $42 million, for 3 locomotives at a cost of $4.9 million each and cars at a cost of about $2.3 million.

Table 9-5: Bus Capital Costs for the Detailed Phase Alternatives (2005 Dollars)

	Number of Additional Veh.	Initial Vehicle Cost	30 year Veh. Cost
A. BRT I-24			
Bus	BRT: 23	$23.0 m	$57.5 m
	Bus: 23	$6.9 m	$17.3 m
	Total: 46	$29.9 m	$74.8 m
B. Commuter Rail CSX			
Bus	45	$13.5 m	$33.8 m
Rail	3	$42.6 m	$42.6 m
Total:		$56.1 m	$76.4 m
C. BRT Murfreesboro Road			
Bus	BRT: 25	$25.0 m	$62.5 m
	Bus: 23	$6.9 m	$17.3 m
	Total: 48	$31.9 m	$79.8 m

Capital Cost Estimates for Alternative B (Commuter Rail on CSX Rail Line)

Capital cost estimates for the proposed commuter rail alternative on the CSX alignment were made using a more detailed, rail oriented cost estimating model developed based on experience at other freight and commuter rail properties across the country. The worksheet, including proposed units and unit costs, is shown in Table 9-6.

The assumptions underlying Alternative B were complicated by uncertainty regarding the potential for a commuter rail in the corridor to use CSX right of way or tracks. CSX did not participate in the study and the potential level of operation on CSX right of way or the level of improvements that CSX would require to allow inter-operation, if they would allow it at all, is not known. As a result, a variety of levels of improvement, ranging from the development of a parallel track and sidings the entire distance between Murfreesboro and Nashville, to the minimal development of sidings along CSX's existing tracks, were considered for cost analysis. Ultimately, several levels of improvements, ranging in cost from around $220 million to more than $340 million, were considered based on whether a full additional track, partial additional track or sidings would be required to operate the commuter rail service.

Table 9-6: Infrastructure Capital Costs for Alternative C (CSX Commuter Rail) (2005 Dollars)

Description	Quantity	Base Year Dollars Unit Cost (X$000)	Base Yr Dollars Total (X$000)
GUIDEWAY & TRACK ELEMENTS (route miles)	**39.2**	**929**	**36,425**
Guideway: At-grade exclusive right-of-way		-	
Guideway: At-grade semi-exclusive (allows cross-traffic)			
Guideway: At-grade in mixed traffic			
Guideway: Aerial structure			
Guideway: Built-up fill			
Guideway: Underground cut & cover			
Guideway: Underground tunnel			
Guideway: Retained cut or fill			
Track: Direct fixation			
Track: Embedded			
Track: Ballasted			31,046
Track: Special (switches, turnouts)			5,379
Track: Vibration and noise dampening			
STATIONS, STOPS, TERMINALS, INTERMODAL (number)	**9.0**	**3,400**	**30,600**
At-grade station, stop, shelter, mall, terminal, platform	5.0	1,360	6,800
Aerial station, stop, shelter, mall, terminal, platform	4.0	3,825	15,300
Underground station, stop, shelter, mall, terminal, platform			
Other stations, landings, terminals: Intermodal, ferry, trolley, etc.			
Joint development			
Automobile parking multi-story structure			
Elevators, escalators			8,500
SUPPORT FACILITIES: YARDS, SHOPS, ADMINISTRATION	**39.2**	**-**	**-**
Administration Building: Office, sales, storage, revenue counting			
Light Maintenance Facility			
Heavy Maintenance Facility			
Storage or Maintenance of Way Building			
Yard and Yard Track			
SITEWORK & SPECIAL CONDITIONS	**39.2**	**867**	**33,975**
Demolition, Clearing, Earthwork			11,474
Site Utilities, Utility Relocation			
Haz. mat'l, contam'd soil removal/mitigation, ground water treatments			
Environmental mitigation, e.g. wetlands, historic/archeologic, parks			597
Site structures including retaining walls, sound walls			4,405
Walks, plazas, landscape, furniture, lighting, bike fac., signage, fencing			
Automobile, bus, van accessways including roads, parking lots			17,500
Temporary facilities and other indirect costs during construction			
Public Art			
SYSTEMS	**39.2**	**912**	**35,745**
Train control and signals			29,070
Traffic signals and crossing protection			2,275
Traction power supply: substations			
Traction power distribution: catenary and third rail			
Communications			800
Fare collection system and equipment			1,600
Central Control			2,000
Construction Subtotal (1-5)	**39.2**	**3,488**	**136,745**
ROW, LAND, EXISTING IMPROVEMENTS (acres)	**31.9**	**203**	**6,490**
Purchase or lease of real estate	31.9		6,490
Relocation of existing households and businesses			
VEHICLES (number)	**15.0**		
Light Rail			
Heavy Rail			
Commuter Rail Cars	12.0		
Bus			
Other (Locomotives)	3.0		
Non-revenue vehicles			
Spare parts			
SOFT COSTS	**39.2**	**876**	**34,340**
Preliminary Engineering (2% of above costs)			3,615
Final Design (4%)			7,229
Project Management for Design and Construction			
Construction Administration & Management (6%)			10,844
Insurance, Legal, Permits, Review Fees (7%)			12,651
Surveys, Testing, Investigation, Inspection			
Agency Force Account Work			
FINANCE CHARGES			
CONTINGENCY (25% of Construction, ROW, Vehicles)			45,184
TOTAL			**222,758**

9.2.2 Operating/Maintenance Costs

Annual operating and maintenance (O&M) costs consist of the ongoing costs of operating, maintaining, and managing the transit system.

These costs typically include:

- Labor costs (wages, fringe benefits, and other costs) for bus and rail operators, vehicle and facility maintainers, and other personnel directly engaged in providing transit service
- Fuel and electricity for motive power
- Parts, fluids and materials for maintaining the vehicles
- The non-labor operating costs of operating facilities (such as rail stations or bus park-and-ride lots) or maintenance facilities (such as bus and rail storage and maintenance facilities. These include utilities and materials for cleaning and maintaining the facilities.
- Administrative costs—labor and other costs associated with the management and direction of the transit agency.
- Insurance

Annual operating and maintenance costs for the alternatives were estimated using a multi-factor cost model. The cost model disaggregates actual O&M costs for recent years as reported by Metro Transit to the National Transit Database (NTDB), a database maintained by the Federal Transit Administration (FTA) to monitor and report the performance of US mass transit agencies. The costs are disaggregated into cost categories that can be reasonably assumed to vary with quantities of service provided. The differences in quantities of service provided under each alternative are expressed in differences in operating statistics that serve as cost drivers. These cost drivers include:

- Vehicle revenue hours of service
- Vehicle revenue miles of service
- Number of vehicles required in maximum service
- Number of fixed guideway miles

Some of the operating statistics relevant to operations and maintenance costing come from the travel demand model used to estimate the ridership for the various alternatives. The basis for the FTA preferred process for operations and maintenance costing is based on existing local agency bus (and rail, if available) service characteristics factored for the cost categories that vary by the amount of each type of service characteristic. For example, some categories of operating costs tend to vary by miles of service (such as fuel costs), while others vary by hours of service (such as driver labor and fringe benefits), still others vary by the number of required peak vehicles (such as vehicle cleaning). These cost drivers were generated based on outputs from the ridership estimation tasks performed for each of the alternatives (the enhanced bus, BRT and LRT alternatives) using the regional model. Administrative costs are assumed to increase proportionally in response to changes in the volume of service based on their current proportion in the cost of operating the transit system. The model allows some cost items to remain “fixed” and invariable regardless of the volume of service operated. A full breakdown of the cost items and their assignment by cost categories is shown for bus operations in Table 9-7.

Table 9-7: Cost Model for Nashville Regional Transit Services (2005 Dollars)

Nashville MTA: Motor Bus O&M Unit Cost Model

Based on 2004 Sumbittals to National Transit Database NTD ID: 4004 Mode: MB Service: DO Report: RY 2004 Close-Out 7-25-2005
Year 2005 Dollars

Conversion from June 2004 to April 2005 Dollars: 1.0241

1. Cost Allocation Model (2004 Dollars)

2004 Actual Expenses

	Annual Cost	Annual Cost & Attribution: Revenue-Vehicle-Hours	Scheduled Revenue-Vehicle-Miles	Peak Vehicles	Exclusive Access Right-of-Way Miles	Fixed (not in model)	Gen Admin. Percentage Add-On	% of Total
Vehicle Operations Labor								
Operator Salaries and Wages	$ 6,929,111	$ 6,929,111						28%
Other Salaries and Wages	$ 1,164,098	$ 1,164,098						5%
Fringe Benefits	$ 5,435,292	$ 5,435,292						22%
Services	$ 52,593			$ 52,593				0%
Sub-Total	**$ 13,581,094**	**$ 13,528,501**	**$ -**	**$ 52,593**	**$ -**	**$ -**		**56%**
Vehicle Operations Materials and Supplies								
Fuel and Lubricants	$ 1,165,301		$ 1,165,301					5%
Tires and Tubes	$ 173,391		$ 173,391					1%
Other Materials/Supplies	$ 29,390		$ 29,390					0%
Utilities	$ -		$ -					0%
Casualty and Liability	$ -			$ -				0%
Taxes	$ -			$ -				0%
Miscellaneous	$ 17,078			$ 17,078				0%
Expense Transfers	$ -					$ -		0%
Sub-Total	**$ 1,385,160**	**$ -**	**$ 1,368,082**	**$ 17,078**	**$ -**	**$ -**		**6%**
Vehicle Maintenance Labor								
Other Salaries and Wages	$ 1,938,724		$ 969,362	$ 969,362				8%
Fringe Benefits	$ 1,302,022		$ 651,011	$ 651,011				5%
Services	$ 105,818		$ 52,909	$ 52,909				0%
Sub-Total	**$ 3,346,564**	**$ -**	**$ 1,673,282**	**$ 1,673,282**	**$ -**	**$ -**		**14%**
Vehicle Maintenance Materials and Supplies								
Fuel and Lubricants	$ 17,007		$ 17,007					0%
Tires and Tubes	$ 993		$ 993					0%
Other Materials and Supplies	$ 1,853,252		$ 1,853,252					8%
Utilities	$ -			$ -				0%
Casualty & Liability	$ -			$ -				0%
Taxes	$ -			$ -				0%
Miscellaneous	$ 44,378		$ 44,378					0%
Expense Transfer	$ -					$ -		0%
Sub-Total	**$ 1,915,630**	**$ -**	**$ 1,915,630**	**$ -**	**$ -**	**$ -**		**8%**
Non-Vehicle Maintenance Labor								
Other Salaries and Wages	$ 732,067			$ 732,067				3%
Fringe Benefits	$ 491,647			$ 491,647				2%
Services	$ 84,331			$ 84,331				0%
Sub-Total	**$ 1,308,045**	**$ -**	**$ -**	**$ 1,308,045**	**$ -**	**$ -**		**5%**
Non-Vehicle Maintenance Materials and Supplies								
Fuel and Lubricants	$ -			$ -				0%
Tires and Tubes	$ -			$ -				0%
Other Materials and Supplies	$ 120,738			$ 120,738				0%
Utilities	$ -			$ -				0%
Casualty & Liability	$ -			$ -				0%
Taxes	$ -			$ -				0%
Miscellaneous	$ -			$ -				0%
Expense Transfer	$ -					$ -		0%
Sub-Total	**$ 120,738**	**$ -**	**$ -**	**$ 120,738**	**$ -**	**$ -**		**0%**
General Administration								
Other Salaries and Wages	$ 711,992						$ 711,992	3%
Fringe Benefits	$ 478,165						$ 478,165	2%
Services	$ 522,735						$ 522,735	2%
Fuel and Lubricants	$ -						$ -	0%
Tires and Tubes	$ -						$ -	0%
Other Materials and Supplies	$ 200,165						$ 200,165	1%
Utilities	$ 364,255						$ 364,255	1%
Casualty and Liability	$ 402,422						$ 402,422	2%
Taxes	$ -						$ -	0%
Miscellaneous Expense	$ 116,786						$ 116,786	0%
Expense Transfers	$ -					$ -	$ -	0%
Sub-Total	**$ 2,796,520**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 2,796,520**	**11%**
TOTAL	**$ 24,453,751**	**$ 13,528,501**	**$ 4,956,994**	**$ 3,171,736**	**$ -**	**$ -**	**$ 2,796,520**	**100%**
Percent								
Units Per Year		**305,800**	**4,287,207**	**113**		**1**	**$ 21,657,231**	
UNIT COST (June 2004 Dollars)		**$ 44.24**	**$ 1.16**	**$ 28,068**		**$ -**	**12.9% add-on**	
UNIT COST (April 2005 Dollars)		**$ 45.30**	**$ 1.18**	**$ 28,744**		**$ -**	**12.9% add-on**	

The data source for bus operating costs was Metro Transit's 2004 submission to the NTD, which was the most recent available at the time of the analysis. The costs for 2004 were inflated to 2005 dollars at an annual inflation rate of 2.41%, based on Consumer Price Index (CPI) data for Southern Cities from the Department of Labor. The MTA has added vehicles during the early part of this decade, and the consultants thought that this growth would distort the costs if earlier years were averaged in, so only 2004 costs were used for developing the cost factors. The totals under each cost driver were then divided by the average value for each cost driver for the year 2004 to derive a cost factor for each cost driver.

The annual operating and maintenance cost estimates for the bus components of the No Build and the three build alternatives were derived by multiplying the annual revenue vehicle hours of service, the annual revenue vehicle miles of service, and the number of vehicles required during the peak period by their respective cost factors. In addition, administrative costs were calculated by multiplying the total costs associated with these three cost drivers by the administrative cost factor (12.9%).

The operating statistics for the BRT alternatives were developed through use of output for each of the alternatives generated by the Regional Ridership Model. The model generates an estimate of the directional revenue hours and miles of service, and the number of buses or trains required to operate the service, for each direction of each bus route or rail line in the network; this was completed for one hour of peak and one hour of off-peak period of operation (the same data was employed to estimate the number of buses or trains required and to generate the capital cost of rolling stock). Worksheets showing the calculation of these statistics are included in Appendix 9D.

The estimates of revenue travel time and distance are used to generate an estimate of the number of vehicles required to operate the service during the peak hour, and also are built up through factoring to create the annual estimates of revenue vehicle hours and miles of service for each alternative, with separate estimates developed for rail and bus services.

Revenue travel time is converted to revenue vehicle hours for bus and rail by adding a 15% layover factor to each single direction trip, to account for required operator rest and schedule recovery time. Revenue vehicle miles, which do not include deadhead miles, are taken directly from the travel distance estimates provided by the model. The revenue vehicle hours and miles are multiplied by the number of trips operated during each peak and off peak hour to estimate the number of revenue vehicle hours and miles that each line will generate during each peak and off-peak hour. The revenue vehicle hours and miles for the peak period are multiplied by 2, for the number of peak hours of operation in each weekday, and by 10 for the number of midday and evening hours on the average route.

The final step in developing annual revenue vehicle hours and miles of service is the application of the annualization factor. This factor converts the estimates of weekday vehicle revenue hours and miles of service to an annual estimate, taking into account the lower levels of service provided on Saturdays, Sundays and Holidays. For bus services, this factor was developed by comparing the average number of buses in operation by hour on weekdays to the number in operation on Saturdays and Sundays-Holidays. Using this methodology, the study team estimated the annualization factor for bus service to be 308 equivalent weekdays of service per year.

The number of buses required under each alternative was estimated by dividing the travel and layover time for each direction of each bus route by the peak period headway of the route as

provided under each alternative in the travel demand model. The number of buses required for each route were added together to make up a system-wide estimate.

Table 9-8 through 9-10 illustrates the operating and maintenance cost calculation for the bus portion of Alternatives A through C. Commuter rail operations in Alternative B were estimated at approximately $1 m per operating train, or about $3 million per year, in addition to the $26.5 million in estimated bus cost, making the total operating cost for that alternative the highest of the three at about $29 million per year. The operating cost of the existing MTA system in 2004 is about $24.5 million per year. No operating cost estimate was made separately for the TSM alternative, which was essentially the same operation as Alternative A.

Table 9-8: Operating Cost Estimate for Alternative A (BRT on I-24)

	Revenue Hours	Revenue Miles	Vehicles
Daily Stats	1,056	21,739	
Annualization Factor	308	308	
Annual Stats	325,316	6,695,730	156
Cost Factors	45.30	1.18	28,743.70
Annual Cost	14,738,125.55	7,928,041.80	4,484,017
Total Annual Cost	27,150,184		

Table 9-9: Operating Cost Estimate for Alternative B (Commuter Rail on CSX Alignment)

	Revenue Hours	Revenue Miles	Vehicles
Daily Stats	1,039	20,323	
Annualization Factor	308	308	
Annual Stats	319,997	6,259,495	161
Cost Factors	45.30	1.18	28,743.70
Annual Cost	14,497,121	7,411,520	4,627,736
Total Annual Cost	26,536,377	+commuter rail	

Table 9-10: Operating Cost Estimate for Alternative C (BRT on Murfreesboro Road)

	Revenue Hours	Revenue Miles	Vehicles
Daily Stats	1,080	21,222	
Annualization Factor	308	308	
Annual Stats	332,605	6,536,468	161
Cost Factors	45.30	1.18	28,743.70
Annual Cost	15,068,304.67	7,739,468.55	4,627,736
Total Annual Cost	27,435,509		

9.3 Cost Estimates for the Proposed LPA

For the proposed LPA, which consists of proposed bus improvements, stations, and short sections of busway, the capital cost estimates were updated to 2005 dollars. New operating costs were developed for both the no-build network and the extensive bus network that comprised the LPA. Because the LPA is proposed to be implemented in three phases (0-5 years, 5-10 years, and 0 -25 years), estimates for each period were prepared.

9.3.1 LPA Capital Costs

The new capital cost rates that were used for the LPA are shown in Appendix 9C, and are based on TDOT cost histories. This modification captured the large increase in fuel, steel and concrete costs between 2003 and 2005.

Table 9-11 shows the cost breakdown for the infrastructure elements included in the LPA. Since the purpose of the LPA was to get the maximum benefit at minimum cost from the proposed improvements, a rigorous process of eliminating unnecessary elements was pursued by the consultants and Steering Committee. At the same time, the purpose of the estimates at this point was not to compare alternatives but to achieve a reasonably accurate estimate of improvements that were expected to be built, and thus included in future planning reports. The estimates include allocations for the potential cost of right of way and for traffic engineering improvements at effected intersections and interchanges along the corridor.

9.3.2 LPA Rolling Stock and Operating Costs

The methodology, used for developing an operating contest for the LPA and No-Build was based on the 2004 cost factors (inflated to 2005) and the cost drivers used for developing the operating costs for Alternatives A, B and C. The methodology was refined to provide a more accurate count of future fleet sizes, and the annualization factor was adjusted to more closely reflect MTA and RTA's actual operation (which operate less service than was initially assumed during weekends and holidays).

Table 9-12 shows the calculation of the annualization factor used in the development of operating cost estimates for the proposed LPA. The travel demand model estimates the number of hours and miles of service required to operate on a single peak and single off-peak hour of an average weekday. Factors were then used to convert these two daily estimates, in this case by multiplying the off-peak hour by 10 and the peak hour by two, to denote the hours of each day during which these levels of service are operated. To convert to annual costs, a factor was developed to multiply the daily estimates to annual estimates. This involved multiplying by the annual number of weekdays (252, assuming 52 five-day weeks, less eight public holidays) and converting the lower level of service operated on the other 113 days a year to "equivalent weekdays". In the earlier estimates, the costs were developed assuming 308 equivalent weekdays, based on factors that the consultant team has used in other cities. Discussions with RTA and MTA led to a reduction of that factor to 298, based on the calculations shown in Table 9-12.

Table 9-11: Annualization Factor for LPA Operating and Maintenance Cost Estimates

Annualization	Number/Year	Weekday Equivalency Factor	Equivalent Weekdays	
Weekdays	252	1	252	
Saturdays	52	0.5	26	
Sundays	52	0.333	17.33	
Holidays	9	0.333	3	
	365		298	Equivalent Days/Year

Table 9-12: Capital Costs of Locally Preferred Alternative Infrastructure

PREFERRED ALTERNATIVE: Partial Busway and Stations on Murfreesboro Road				
Description	**Miles**	**Const Type**	**BRT Cost PerMile**	**BRT Cost Per Segment**
Streetscape-Stop Improvements, downtown areas (Lump Sum)				
Nashville Downtown Area	2.70	Lump	$ 500,000	$ 1,350,000
Murfreesboro Downtown Area	3.00	Lump	$ 250,000	$ 750,000
Stations				
MTA Transfer Center Station (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Church St. Station (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Broadway Station (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Gateway Blvd. Station (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Lafayette Street (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Trevecca College (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Fesslers Lane (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Thompson Lane (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Donelson Pike/Dell (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Una Antioch Pike (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Bell Road (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Waldron Road (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Sam Ridley Parkway (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Downtown Smyrna (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Nissan Boulevard (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
SR 840 (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Thompson Road (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Downtown Murfreesboro (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Broad/Tennessee (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
MTSU (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Subtotal				$ 3,650,000
Mainline Construction (Single Lane Reversible Busway, Murfreesboro Road)				
North of Thompson Lane to Briley Parkway	0.90	NC-5	$ 6,223,109	$ 5,600,798
Reedwood (south of Harding/Donelson) to Rural Hill	2.90	NC-4	$ 6,223,109	$ 18,047,016
Queue Jump, Enon Springs, McNickle Drive	0.70	NC-5	$ 6,223,109	$ 4,356,176
Thompson Lane to Church Street (Murfreesboro)	3.00	NC-7	$ 6,223,109	$ 18,669,327
Mainline Construction (Queue Jump Facilities at I-24 Interchanges)				
Bell Road	0.25	NC-4	$ 6,223,109	$ 1,555,777
Waldron Road	0.25	NC-4	$ 6,223,109	$ 1,555,777
Sam Ridley Parkway	0.25	NC-4	$ 6,223,109	$ 1,555,777
Nissan Boulevard (Limited Stop Route Station)	0.25	NC-4	$ 6,223,109	$ 1,555,777
SR 96	0.25	NC-4	$ 6,223,109	$ 1,555,777
Subtotal				*$ 54,452,204*
OTHER CONSRUCTION ITEMS				
Facility				$ -
Traffic Engineering Improvements				$ 10,500,000
RIGHT-OF-WAY				
Station Land			$ 125,000	$ 5,000,000
Mainline ROW			$ 2,000,000	$ 17,340,000
TOTALS FOR ALTERNATIVE	**14.45**		**---**	**$ 93,042,204**

In addition to $93 million in capital costs for infrastructure under the LPA, the operating cost model estimated that about 106 buses over and above the no-build network fleet size would be required to operate the more extensive service provided by the LPA. Rather than attempt to predict operational details such as bus types and sizes (as was done in the previous estimates, which estimated the cost of regular buses at $300,000 and BRT buses at $1 million per unit), an average cost comparable to that of a "suburban" layout bus would be used for all new vehicles, at an average cost of $500,000. At this rate, the estimated cost of vehicles for the LPA was estimated at $53 million, which increased the total cost of the alternative to about $146 million.

The operating cost for the LPA developed a cost for operating the entire MTA/RTA bus system with the LPA in place (about $40.6 million per year) and subtracted from it the operation of the No-Build system (about $27.6 million per year) to yield an operating cost at full build out at about $13 million per year. The calculations supporting these assumptions are shown in Tables 9-13 and 9-14. Further supporting calculations are found in Appendix 9E.

Table 9-13: Estimated Operating Cost of No-Build Scenario (2005 Dollars)

	Revenue-Vehicle-Hours	Scheduled Revenue-Vehicle-Miles	Peak Vehicles	Exclusive Access Right-of-Way Miles	Fixed (not in model)	Gen Admin. Percentage Add-On
Cost Factors	**$ 45.30**	**$ 1.18**	**$ 28,744**	**$ -**	**$ -**	**12.9% add-on**
Annual Stats	**294,639**	**5,691,614**	**151**			
Total per Statistic	13,348,332	6,739,124	4,340,299			3,154,268
Total Annual Cost	27,582,023	Total				

Table 9-14: Estimated Operating Cost of Proposed LPA at Full Build Out (2005 Dollars)

	Revenue-Vehicle-Hours	Scheduled Revenue-Vehicle-Miles	Peak Vehicles	Exclusive Access Right-of-Way Miles	Fixed (not in model)	Gen Admin. Percentage Add-On
Cost Factors	**$ 45.30**	**$ 1.18**	**$ 28,744**	**$ -**	**$ -**	**12.9% add-on**
Annual Stats	**410,286**	**8,432,456**	**257**			
Total per Statistic	18,587,593	9,984,402	7,387,131			4,643,272
Total Annual Cost	40,602,398					
	27,582,023	No-Build				
	13,020,375	Net Annual Operating Cost				

9.3.2 LPA Phasing

The proposed LPA is a phased alternative, to be implemented in three broad phases over a 25 year period. An initial phase in the first five years includes minimal improvements in service and infrastructure, with more significant and costly improvements in the outer years. Table 9-14 summarizes the costs of infrastructure, vehicles, and annual operating costs for each phase of LPA implementation.

Table 9-14: Costs by Implementation Phase for Infrastructure, Vehicles, and Incremental Annual Operating Costs (2005 Dollars)

Cost Summary	Capital					Annual Operating
	Stations	Busway/ Streetscape Miles	Infrastructure Costs	Vehicle Costs	Total Capital	Incremental Cost (over No Build) ($million)
1-5 Years	4	0	4.7	23.0	27.7	3.9
5-10 Years	12	0	22.5	17.5	40.0	11.1
10-25 Years	4	13.2	65.8	12.5	78.3	13.0
Total	20	13.2	93.0	53.0	146.0	

Tables 9-15 and 9-16 show the breakdown of infrastructure cost elements for the two interim phases of development of the LPA. As the tables show, the improvements are limited to development of a handful of stations and intersection improvements in the short (0-5 Year) term, amounting to no more than $4.7 million. The 5-10 year period has a larger capital infrastructure investment level at $22 million, primarily due to the investment of $15 million in queue jump improvements at interchanges along I-24. The bulk of the investment is pushed out to the later stages, with more than half of the $93 million slated for the last period of implementation, in which the short sections of busway on Murfreesboro Road, among other improvements, would be developed. The total expenditure through the 10-25 year phase is shown in Table 9-11.

Vehicle purchases were phased based on the proposed implementation of service improvements, which is described in Chapter 10. Up to 46 vehicles (including spares) were estimated to be required to implement the new services identified in the plan for the first five years, at an estimated capital cost of $23 million. An additional 35 vehicles would be required in the second phase, at a cost of $17.5 million. In the third phase an additional 25 vehicles would be required, at a cost of $12.5 million. These calculations are shown in Table 9-17, below, while the backup is included in the operating cost breakouts in Appendix 9F.

Operating costs for the initial period (0-5 years) were estimated at $3.9 million per year, while costs are estimated to escalate to about $11.1 million a year in additional costs during the 5 to 10 year period, before reaching about $13 million per year during the 10-25 year period when full implementation is reached. Tables 9-17 and 9-18 show the operating costs for the interim periods.

Table 9-16: Breakdown of Infrastructure Costs, 0-5 years

Revenue-Vehicle-Hours	Scheduled Revenue-Vehicle-Miles	Peak Vehicles	Exclusive Access Right-of-Way Miles	Fixed (not in model)	Gen. Admin. Percentage Add-On
$45.30	$1.18	$28,744	$ -	$ -	12.9% add-on
323,631	6,367,692	197			
$14,661,780	$7,539,630	$5,662,509			$3,597,967.00
$31,461,886	Total				
$27,582,023	No-Build		Number of Buses - No-Build	46	$23,000,000.00
$3,879,863	Net Annual Operating Cost		Phase II	35	$17,500,000.00
			Phase III	25	$12,500,000.00
			Total		$53,000,000.00

Table 9-17: Breakdown of Infrastructure Costs, 5-10 years

Revenue-Vehicle-Hours	Scheduled Revenue-Vehicle-Miles	Peak Vehicles	Exclusive Access Right-of-Way Miles	Fixed (not in model)	Gen. Admin. Percentage Add-On
$45.30	$1.18	$28,744	$ -	$ -	12.9% add-on
397,203	8,103,086	232			
$17,994,886	$9,594,414	$6,668,538			$4,423,591
$38,681,429	Total				
$27,582,023	No-Build				
$11,099,406	Net Annual Operating Cost				

9E-Operating Route Detail, full build out of LPA and No-Build
9F-Operating Route Detail, phases of LPA

Table 9-18: Cost Detail for LPA Capital Infrastructure Investments, Initial Phase (Years 0-5) (2005 Dollars)

PREFERRED ALTERNATIVE DRAFT 2: Partial Busway and Stations on Murfreesboro Road				
Description	**Miles**	**Const Type**	**BRT Cost PerMile**	**BRT Cost Per Segment**
Streetscape-Stop Improvements, downtown areas (Lump Sum)				
Nashville Downtown Area		Lump	$ 500,000	
Murfreesboro Downtown Area		Lump	$ 250,000	
Stations				
MTA Transfer Center Station (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Church St. Station (Downtown Station Stop)		STA. 1	$ 150,000	
Broadway Station (Downtown Station Stop)		STA. 1	$ 150,000	
Gateway Blvd. Station (Downtown Station Stop)		STA. 1	$ 150,000	
Lafayette Street (Downtown Station Stop)		STA. 1	$ 150,000	
Trevecca College (Limited Stop Route Station)		STA. 2	$ 200,000	
Fesslers Lane (Limited Stop Route Station)		STA. 2	$ 200,000	
Thompson Lane (Limited Stop Route Station)		STA. 2	$ 200,000	
Donelson Pike/Dell (Limited Stop Route Station)		STA. 2	$ 200,000	
Una Antioch Pike (Limited Stop Route Station)		STA. 2	$ 200,000	
Bell Road (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Waldron Road (Limited Stop Route Station)		STA. 2	$ 200,000	
Sam Ridley Parkway (Limited Stop Route Station)		STA. 2	$ 200,000	
Downtown Smyrna (Limited Stop Route Station)		STA. 2	$ 200,000	
Nissan Boulevard (Limited Stop Route Station)		STA. 2	$ 200,000	
SR 840 (Limited Stop Route Station)		STA. 2	$ 200,000	
Thompson Road (Limited Stop Route Station)		STA. 2	$ 200,000	
Downtown Murfreesboro (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Broad/Tennessee (Downtown Station Stop)		STA. 1	$ 150,000	
MTSU (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Subtotal				$ 700,000
Mainline Construction (Single Lane Reversible Busway, Murfreesboro Road)				
North of Thompson Lane to Briley Parkway		NC-5	$ 6,223,109	
Reedwood (south of Harding/Donelson) to Rural Hill		NC-4	$ 6,223,109	
Queue Jump, Enon Springs, McNickle Drive		NC-5	$ 6,223,109	
Thompson Lane to Church Street (Murfreesboro)		NC-7	$ 6,223,109	
Subtotal				*$ -*
OTHER CONSRUCTION ITEMS				
Facility				$ -
Traffic Engineering Improvements				$ 3,000,000
RIGHT-OF-WAY				
Station Land			$ 125,000	$ 1,000,000
Mainline ROW			$ 2,000,000	$ -
TOTALS FOR ALTERNATIVE	**0.00**		**---**	**$ 4,700,000**

Table 9-19: Cost Detail for LPA Capital Infrastructure Investments, Second Phase (Years 5-10) (2005 Dollars)

PREFERRED ALTERNATIVE DRAFT 2: Partial Busway and Stations on Murfreesboro Road				
Description	**Miles**	**Const Type**	**BRT Cost PerMile**	**BRT Cost Per Segment**
Streetscape-Stop Improvements, downtown areas (Lump Sum)				
Nashville Downtown Area	1.35	Lump	$ 500,000	$ 675,000
Murfreesboro Downtown Area	1.50	Lump	$ 250,000	$ 375,000
Stations				
MTA Transfer Center Station (Downtown Station Stop)		STA. 1	$ 150,000	
Church St. Station (Downtown Station Stop)		STA. 1	$ 150,000	
Broadway Station (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Gateway Blvd. Station (Downtown Station Stop)		STA. 1	$ 150,000	
Lafayette Street (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Trevecca College (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Fesslers Lane (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Thompson Lane (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Donelson Pike/Dell (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Una Antioch Pike (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Bell Road (Limited Stop Route Station)		STA. 2	$ 200,000	
Waldron Road (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Sam Ridley Parkway (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Downtown Smyrna (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Nissan Boulevard (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
SR 840 (Limited Stop Route Station)		STA. 2	$ 200,000	
Thompson Road (Limited Stop Route Station)		STA. 2	$ 200,000	
Downtown Murfreesboro (Downtown Station Stop)		STA. 1	$ 150,000	
Broad/Tennessee (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
MTSU (Limited Stop Route Station)		STA. 2	$ 200,000	
Subtotal				$ 2,250,000
Mainline Construction (Single Lane Reversible Busway, Murfreesboro Road)				
North of Thompson Lane to Briley Parkway		NC-5	$ 6,223,109	
Reedwood (south of Harding/Donelson) to Rural Hill		NC-4	$ 6,223,109	
Queue Jump, Enon Springs, McNickle Drive		NC-5	$ 6,223,109	
Thompson Lane to Church Street (Murfreesboro)		NC-7	$ 6,223,109	
Mainline Construction (Queue Jump Facilities at I-24 Interchanges)				
Bell Road	0.25	NC-4	$ 6,223,109	$ 1,555,777
Waldron Road	0.25	NC-4	$ 6,223,109	$ 1,555,777
Sam Ridley Parkway	0.25	NC-4	$ 6,223,109	$ 1,555,777
Nissan Boulevard (Limited Stop Route Station)	0.25	NC-4	$ 6,223,109	$ 1,555,777
SR 96	0.25	NC-4	$ 6,223,109	$ 1,555,777
Subtotal				*$ 7,778,886*
OTHER CONSRUCTION ITEMS				
Facility				$ -
Traffic Engineering Improvements				$ 3,500,000
RIGHT-OF-WAY				
Station Land			$ 125,000	$ 3,000,000
Mainline ROW			$ 2,000,000	$ 4,920,000
TOTALS FOR ALTERNATIVE	**4.10**		**---**	**$ 22,498,886**

Evaluation and Selection of the Locally Preferred Alternative Strategy

10.1 Introduction

This report documents the development and identification of a proposed locally preferred alternative strategy (LPA) for addressing the transit needs of the southeast corridor. The alternative, a lower-cost, bus based strategy, was developed largely based on the results of the performance of the alternatives analyzed during the Phase I and II screening of alternatives. This analysis led the Steering Committee to combine the better performing elements of those alternatives to create a lower cost and more effective program. Implementation of the proposed LPA will allow for a transit travel market to be developed in the corridor via local and express bus service. The ultimate goal over a 25 year implementation period is for the region to build support and patronage for transit and for the region to develop strategies to pay for the capital investments and on-going operating costs. Ultimately the enhanced bus service proposed by the LPA could serve as a stepping stone to higher capacity service in the corridor like higher capacity Bus Rapid Transit, Light Rail, or Commuter Rail. However, the implementation of these higher capacity rail options is not a part of the LPA and most likely would occur beyond the 2030 time period.

10.2 Alternatives Evaluation Process

The evaluation process began with the development of six initial alternatives consisting of Commuter Rail, Light Rail, and Bus Rapid Transit (BRT) service options on the three main north-south corridors connecting Murfreesboro to Nashville via Smyrna and LaVergne: I-24, the CSX rail alignment, and Murfreesboro Road (US 41). These six alternatives were evaluated using both qualitative and quantitative measures related to the study's statement of purpose and need and project goals and objectives. The evaluation included identification of environmental red flags, comparison of station area population and employment, and concept-level estimates of capital or infrastructure costs. This analysis is documented in full detail in the Southeast Corridor Alternatives Analysis Final Report.

Based on the results of the initial screening, the Steering Committee determined that none of the proposed alignments (I-24, Murfreesboro Road and the CSX rail line) were clearly superior to the others. The initial screening indicated an alignment directly serving Nashville International Airport would add travel time and costs that far outweigh the potential benefits of the airport connection for users. Based on this finding, the options for alignments serving the airport that were considered as part of several alternatives were eliminated from consideration. Likewise, the committee found that the cost of developing a light rail system to operate the length of the corridor would be highly costly, and light rail was dropped from consideration as an alternative mode. However, while commuter rail clearly performed less well than BRT in the initial screening, the Steering Committee determined that it potentially provided sufficient benefits for it to be carried forward into the next round of alternatives screening. Based on public input, a fourth alignment option for providing service to the southern half of the corridor, Old Nashville Pike, was incorporated into one of the alternatives developed for detailed testing.

Based on the results of this initial screening and by incorporating the most promising elements of the six initial alternatives, the project's Steering Committee developed three alternatives, together with an enhanced bus or TSM alternative and a No-Build alternative to be carried

forward into detailed screening. Figure 10-1 illustrates this selection process. These alternatives were:

- Alternative A: BRT "Light" on I-24
- Alternative B: Commuter Rail on the CSX rail alignment
- Alternative C: BRT on Murfreesboro Road

The No-Build alternative consisted of the existing regional transit system together with planned and programmed improvements included in the regional transportation improvement program (TIP) and the financially constrained long range transportation plan (LRTP), which consisted of minimal changes to existing bus routes. To be implemented by 2030, the TSM alternative consisted of a system of bus routes similar to those proposed to operate under Alternative A (BRT on I-24) but without the support of the dedicated busway, which intended to allow the buses to bypass congested auto traffic in the corridor.

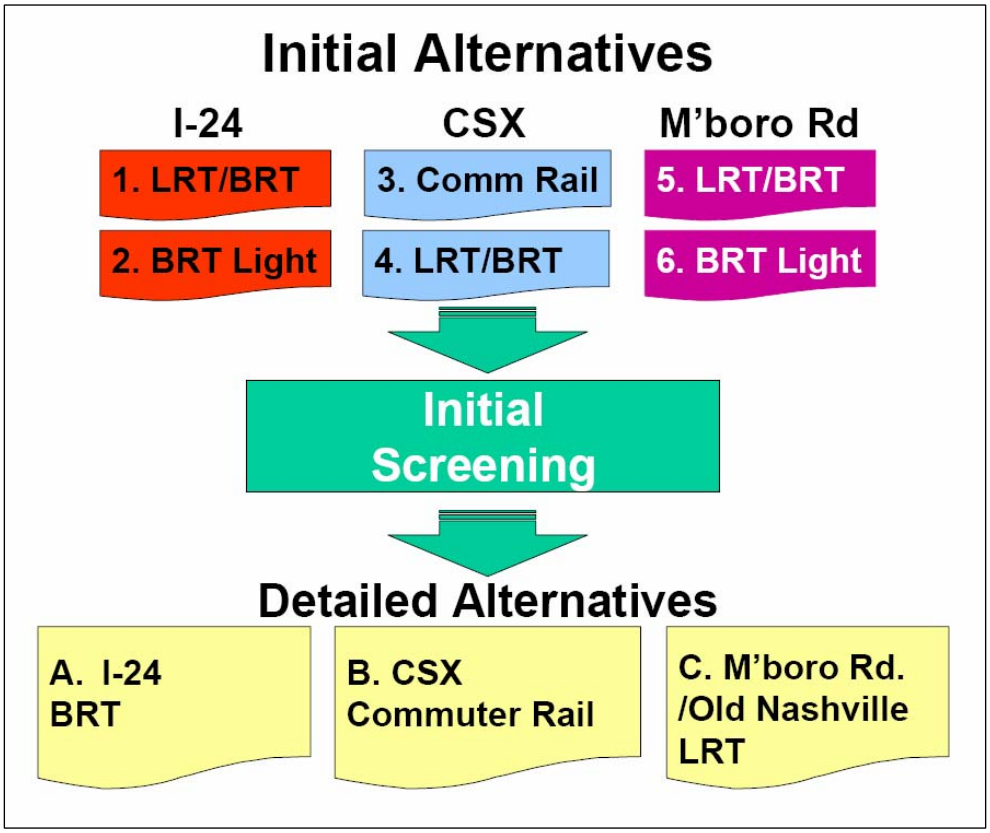


Figure 10-1 Alternative Selection Process

These alternatives were developed at a higher level of geographic and operational detail than the alternatives developed for the initial evaluation and received a more thorough and intensive analysis process. Capital cost estimates for these alternatives were developed at a higher level of detail, and operating cost estimates, as well as estimates of transit ridership, were performed for these alternatives.

10.3 Proposed Locally Preferred Alternative (LPA)

The proposed LPA for the Southeast Corridor was developed based on the analysis of the three alternatives in the detailed evaluation phase. The Steering Committee examined the results of

the analysis, including the numbers of persons and jobs served, the capital and operating cost of the alternatives, and the ridership estimates, and combined the best performing and lowest cost elements of the alternatives into a single strategy. Cost and ridership estimates were prepared for two distinct versions of the alternative as it was developed and refined.

In addition, ridership estimates were prepared for the LPA in which the assumptions concerning future land use were changed to direct future growth in the corridor into areas around major transit stops and stations, since transit services and facilities can have a direct affect on surrounding land use and land use can have an effect on transit ridership. This was done to test the degree to which ridership would be improved if transit-supportive land use policies were enacted in the corridor. These land use changes would positively benefit transit, but their impacts on non-transit related systems are not evaluated in this study. Land use changes enacted by local government entities must also be evaluated for their impacts on water and sewerage systems, schools, roadway networks and other systems and services.

The elements of the proposed LPA represent a strategy to build transit demand in the corridor from the relatively modest current level to a level that could warrant significant financial investment in transit improvements. The proposed LPA represents the highest investment level that could be supported by the number of potential riders who are projected to exist in the corridor, and generates the other benefits of transit investment in the corridor such as potential environmental benefits and the ability to shape future development. A number of factors in the future, such as the performance of new RTA and MTA transit services, the price of fuel, future growth and distribution of population in the corridor, land use patterns, local transportation priorities, the availability of funding, and other factors, could change the potential for new transit services in the corridor. The study anticipates that at various stages, these factors will be revisited, and the recommendations will be potentially modified based on changing conditions in the corridor and in the region.

10.3.1 Summary of the Proposed LPA

The proposed Locally Preferred Alternative strategy for the southeast corridor is an Enhanced Bus, or Transportation System Management (TSM) alternative. The strategy consists of a network of new and expanded bus services operating on Murfreesboro Road (US 41) and I-24 between Nashville and Murfreesboro and serving LaVergne, Smyrna, and Rutherford County gradually introduced over a period of more than 20 years. It differs from the TSM alternative tested in the Phase II screening of alternatives in that it includes bus services operating on both Murfreesboro Road and on I-24. These improvements would ultimately be supported by infrastructure improvements, including the development of improved bus stops to serve as stations along the route, improvements at intersections and the development of intersection “queue jump” facilities at congested intersections along the corridor to allow buses to bypass congested traffic conditions. Short sections of single lane, reversible bus lanes are proposed for specific congested areas of the corridor to allow buses to bypass the congested traffic conditions. Nashville-Davidson County is implementing an ITS system that would serve Murfreesboro Road from Nashville International Airport north. This ITS system is programmed and is not part of the Southeast Corridor project but would provide a basis for transit-supportive intersection improvements in the area. Partly on the basis of public recommendation, the proposed LPA also includes the addition of queue jump facilities at key I-24 interchanges as part of a regional ramp metering initiative. The improvements included in the full build-out of the LPA are shown in Figure 10-2. Figure 10-3 is a schematic diagram showing bus connections

and service frequencies. Figure 10-4 shows the sequence for short, medium, and long-term improvements.

The proposed LPA is recommended to be implemented in three phases. In the short-term, the improvements are largely limited to a significant increase in express and local bus service. The mid-term phase includes a further expansion of bus service and improvements to station stops and transit centers. Major infrastructure improvements are programmed for the long-term.

Figure 10-2 Proposed Locally Preferred Alternative Strategy

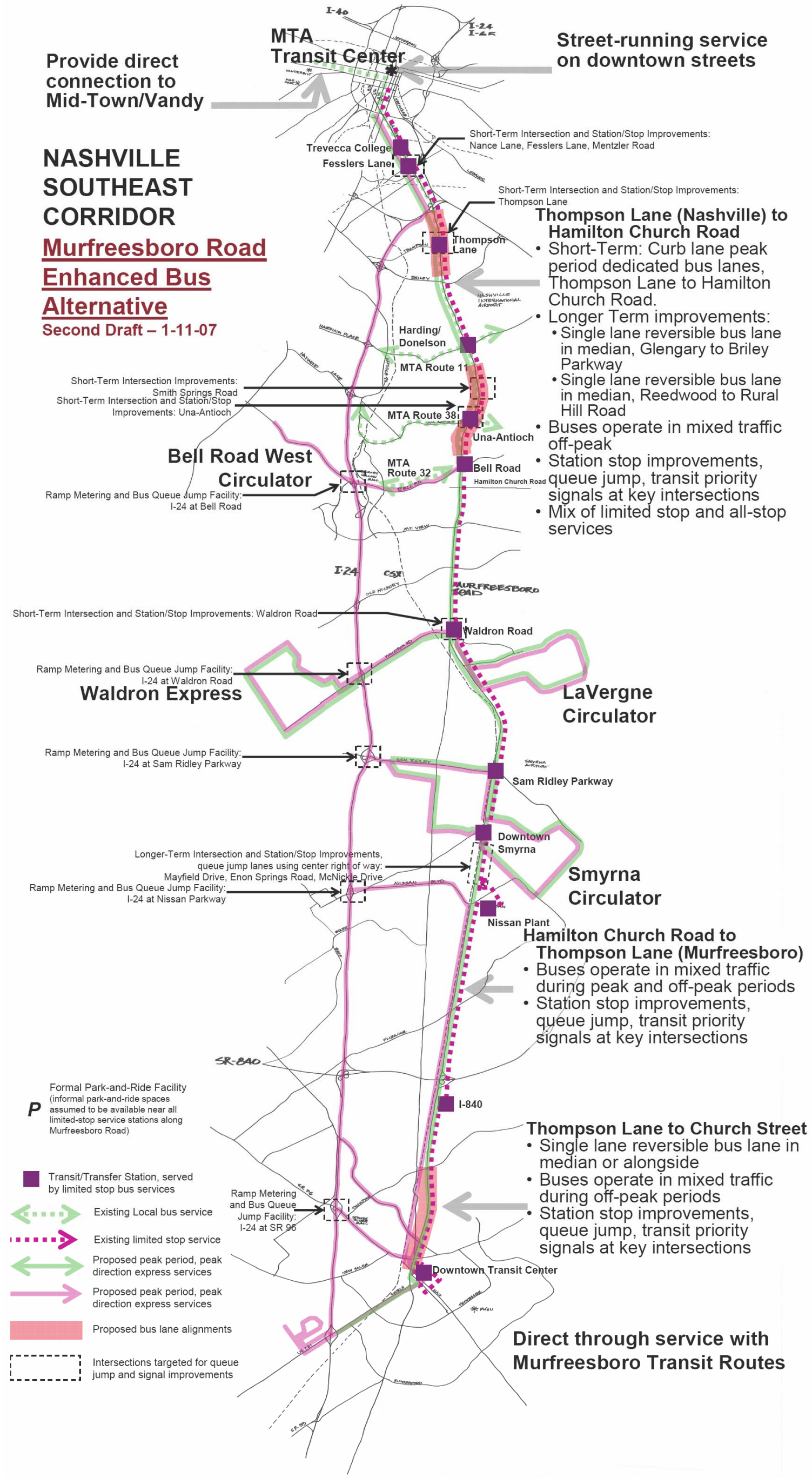


Figure 10-3 Proposed Locally Preferred Alternative Strategy-Bus Service Schematic Diagram

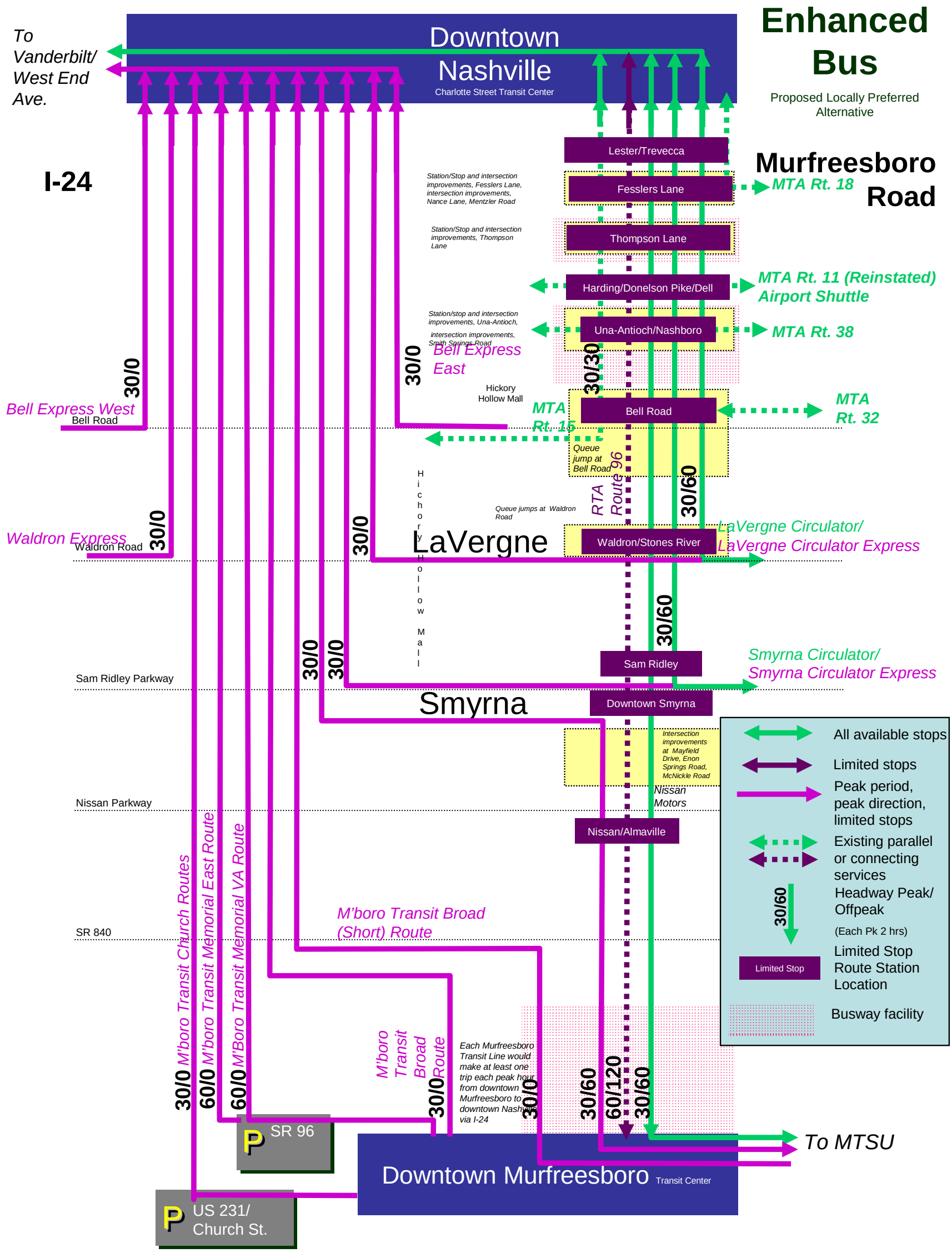
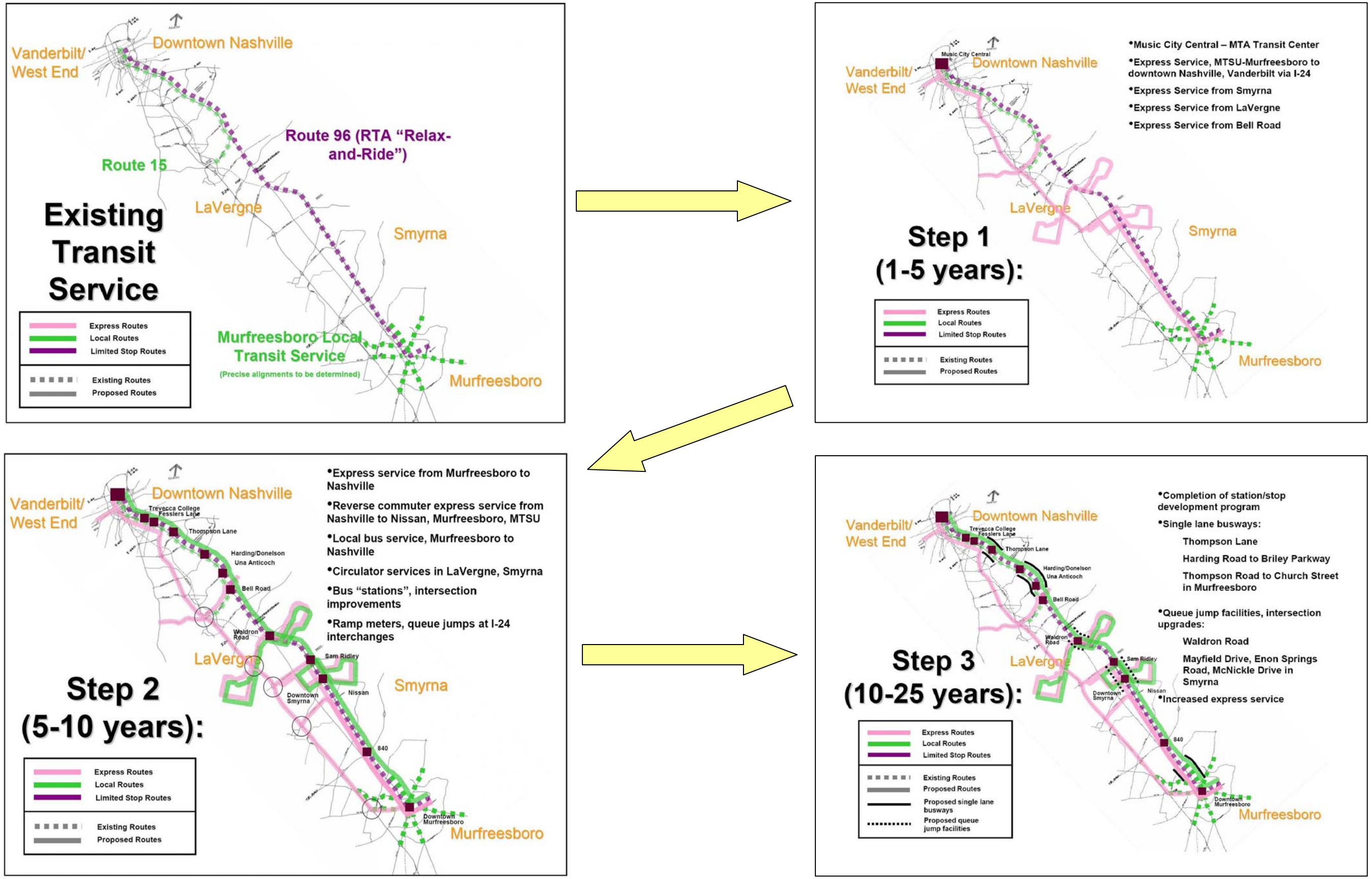


Figure 10-4 Sequential order of recommended improvements



10.3.2 Short-Term Improvements (0-5 Years)

Short-term improvements would begin building implementation immediately and would extend until completion, a period expected to take about five years. The short-term improvements are largely oriented to expanding bus service in the corridor. Improvements include the expansion of the express bus network to provide better service for commuters to downtown Nashville from Murfreesboro, Rutherford County, Smyrna and LaVergne. These services would primarily circulate through the communities they serve before transitioning to I-24 for the trip to downtown Nashville. The improvements also include more frequent service on RTA's 96 "Relax-and-Ride" service from Murfreesboro to Nashville via Murfreesboro Road. Infrastructure improvements in this phase are limited to the MTA's proposed Music City Central downtown transit transfer center, which is programmed and funded for construction and is to be completed in 2008 and is not formally a part of the Southeast Corridor study recommendations. The short-term improvements are shown graphically in Figure 10-5.

The short-term recommendations are designed to gradually build ridership to above its current level by providing a greater variety and frequency of service in the corridor.

Specific recommended improvements include:

- Implementation of an express bus route operating from Murfreesboro and Smyrna to downtown Nashville and the Vanderbilt-West End area via Murfreesboro Road, Sam Ridley Parkway and I-24.
- Express bus routes from Smyrna, LaVergne and the Bell Road-Hickory Hollow Mall area to downtown Nashville and Vanderbilt-West End. These routes would circulate through the communities on a route, the precise alignment of which has yet to be determined, and would be revisited prior to implementation. The routes would then enter the freeway to complete their trips to downtown Nashville, continuing on to the Vanderbilt-West End area of Nashville as a continuous route, most likely near interchange areas. The study assumes that park-and-ride spaces would be available for use by commuters at commercial parking lots along the off-freeway portion of the route. Formal park-and-ride lots have not been included in the proposed LPA.
- Connection of the regional transit network to the proposed circulator bus system being introduced in Murfreesboro. The City of Murfreesboro is in the process of implementing a local bus service to provide transit connections within their community. These routes would connect to an express bus service operating from Downtown Murfreesboro to downtown Nashville and Vanderbilt.
- Provision of bus service between Hickory Hollow Mall and Nashville International Airport to provide a local bus connection between the airport and the express and local bus services operating in the corridor between Nashville and Murfreesboro.
- Completion of the MTA downtown transfer center (MTA Central Station) at Charlotte Street.

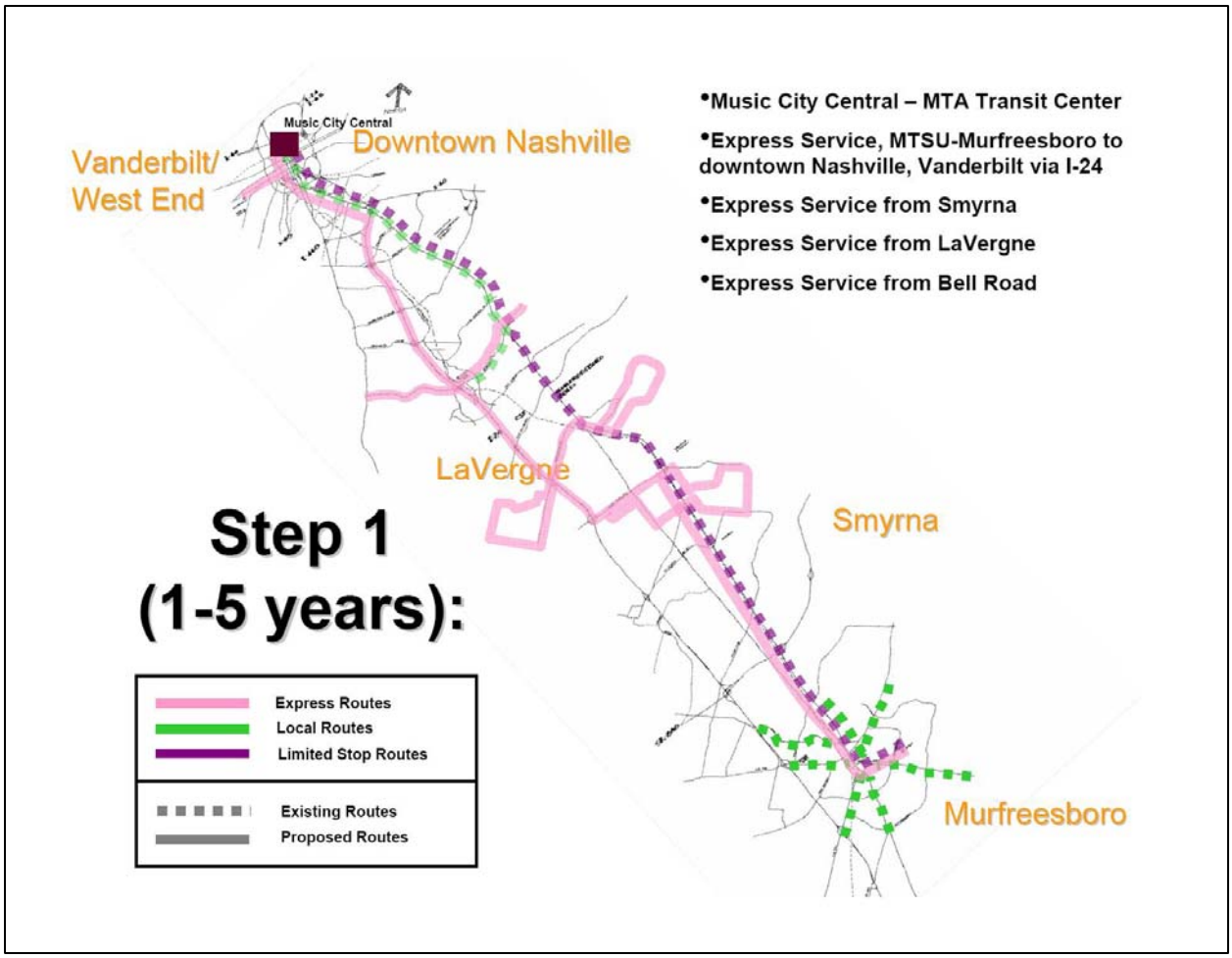


Figure 10-5 Short-Term Improvements

10.3.3 Mid-Term Improvements (5-10 Years)

In the mid term, the number and types of bus routes will continue to increase during the gradual expansion of the transit market in the corridor. In addition, infrastructure improvements—in the form of transit stations at key intersections along Murfreesboro Road and the development of "queue jump" facilities at key intersections in the corridor—will provide improved amenities and travel speed for bus passengers in the corridor. The improvements recommended in the medium term are illustrated in Figure 10-6:

- Introduction of distinctive buses for operation in express and skip-stop service in the corridor. Buses with a distinctive look and with amenities that appeal to longer-distance travelers (padded seats, reading lights, tray tables, foot rests) and potentially alternative power (such as hybrid diesel-electric or natural gas powered buses) help to differentiate between corridor express services and more typical local bus service, which will help attract commuters to downtown Nashville and other riders who use the bus in spite of having access to an automobile. An example of a commuter or busway vehicle is shown in Figure 10-10. Such buses typically cost 1.5 to four times the cost of a standard diesel transit bus.
- Implementation of regular local bus service on Murfreesboro Road from Murfreesboro to downtown Nashville. Service would operate in both north-west and south-east directions at 30 minute intervals during rush hour periods and 60 minutes during midday and evening periods.

- Introduction of circulator bus services in Smyrna and LaVergne. These buses would operate as local circulator routes within neighborhoods in Smyrna and LaVergne before reaching Murfreesboro Road, on which they would continue to downtown Nashville using local transit routes, which would expand the volume of bus service on Murfreesboro Road.
- Development of queue jump facilities at the I-24 Interchanges at:
    - Bell Road
    - Waldron Road
    - Sam Ridley Parkway
    - Nissan Parkway
    - SR 96

  These facilities would consist of a single lane, up to ¼ mile in length, in the inbound (northbound) interchange ramp that would allow buses to bypass auto traffic waiting to enter the traffic stream on I-24. The queue jump facilities are proposed to accompany the introduction of ramp metering at all I-24 interchanges in the corridor as an element of the implementation of a regional Intelligent Transportation System (ITS) system in the Nashville Region. Ramp meters have been recommended only at I-24 interchanges where express bus service is proposed to enter the freeway. These facilities would reduce travel time on inbound commuter express bus routes and would thus improve transit ridership in the corridor.
- Express service on I-24 from Murfreesboro to downtown Nashville and West End-Vanderbilt.
- Implementation of reverse-commute express service via I-24 from downtown Nashville to the Nissan Auto Plant, Murfreesboro and MTSU.
- Development of station "stops" at some major intersections along Murfreesboro Road and in downtown Nashville:
    - Church St., Broadway, Gateway Boulevard, and Lafayette Street in downtown Nashville
    - Trevecca Nazarene University
    - Fesslers Lane/Thompson Lane
    - Donelson Pike/Dell Manufacturing Facility
    - Una Antioch Pike
    - Bell Road Waldron Road
    - Sam Ridley Parkway
    - Downtown Smyrna
    - Nissan Boulevard
    - SR 840
    - Thompson Road Downtown Murfreesboro
    - Broad/Tennessee
    - MTSU

  The plan assumes that up to 12 of these stations will be constructed within the five-to-ten year period, with the locations based on ridership on the existing transit system at that time. The remainder of the stations will be constructed in the longer term period as transit patronage increases. Some examples of the types of improvements proposed for stations are shown in the photos in Figure 10-12. Improvements could include shelters, or semi-climate controlled interior spaces, seating, upgraded landscaping, signage and lighting, paved connections to adjacent developments and parking, and crosswalk treatments to facilitate pedestrians crossing major roadways. Formal park-and-ride lots at stations have not been included in the recommendations and are assumed to be available at adjacent developments for use by commuters. Improvements would be sized and scaled appropriately to the surrounding development and the space available in the right of way. Thus, larger scale shelters and waiting areas would be constructed in areas outside

downtown Nashville, while more minimal facilities would be provided in the more constrained spaces available in downtown Nashville.

- Local bus services operating on Murfreesboro Road between LaVergne, Smyrna and downtown Nashville and West End-Vanderbilt.
- Conversion of RTA Route 96 to skip stop service, making stops only at selected intersections along Murfreesboro Road, and increasing service frequency on the route. The route would make stops only at the station stops identified above.

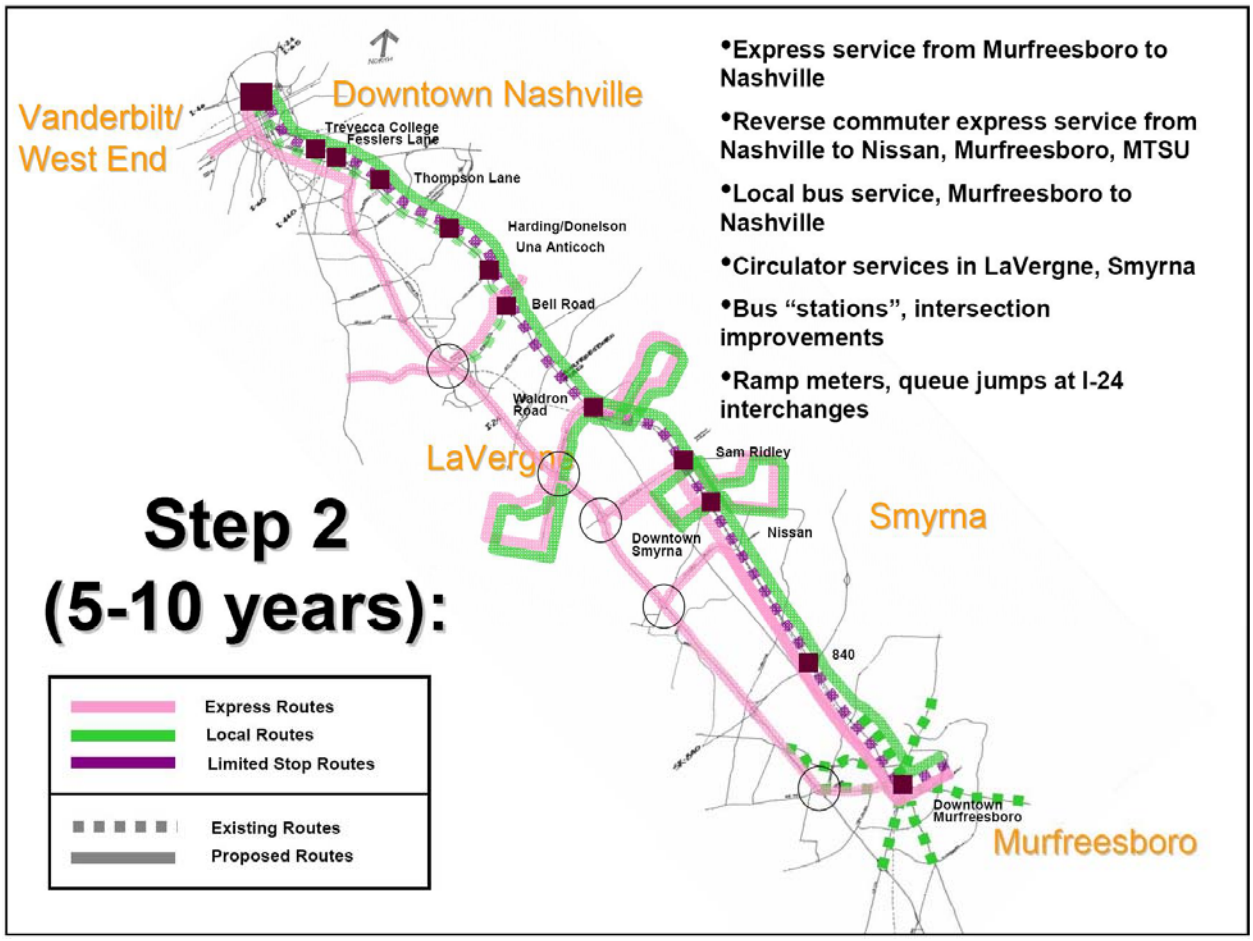


Figure 10-6 Medium Term Improvements

10.3.4 Long-Term Improvements (10-25 years)

In the longer term, major infrastructure improvements would continue to improve transit conditions, while bus service would continue to cover more areas of the corridor and increase service frequency. In addition to the completion of the transit skip stop station program begun in the mid-term period, the main development in the long-term period would be the improvement of busways and intersections at selected congested intersections on Murfreesboro Road. These improvements would further benefit transit by allowing it to bypass congested traffic conditions. These improvements not only would continue building transit ridership in the corridor, but also could potentially serve as a precursor to some form of full length bus rapid transit or rail transit system. Some of the improvements to intersections or busway developments could be

developed during an earlier time period if their development could be programmed to coincide with roadway reconstruction projects in the selected areas.

The improvements identified for the long term period include the following:

- Increased frequency on express bus service from Murfreesboro to downtown Nashville and Vanderbilt-West End via I-24 and I-40.
- Development of intersection and signal improvements to allow transit to bypass congested traffic conditions at the following locations:
    - Thompson Lane,
    - Una-Antioch/Nashboro,
    - Waldron Road, in LaVergne
    - Mayfield Drive in Smyrna
    - Enon Springs Road in Smyrna
    - McNickle Road in Smyrna

  Figure 10-7 illustrates an example of intersection bus queue jumping lanes.

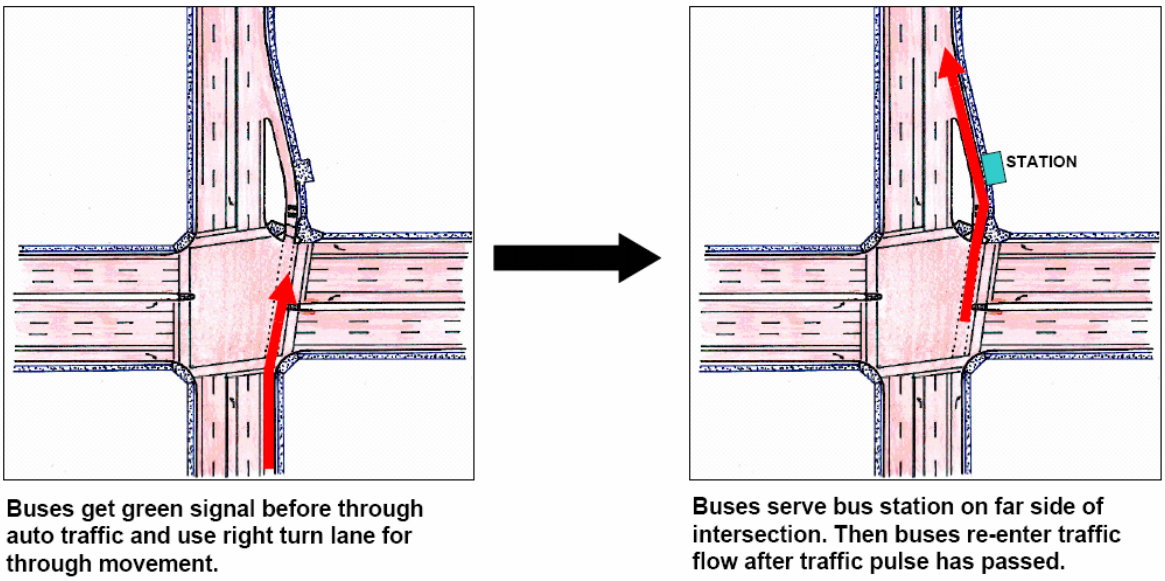


Figure 10-7 Example of a queue jumping lane intersection improvement

- Completion of limited stop station improvements in downtown Murfreesboro and selected major stop locations along the corridor that were not completed in the mid-term phase of development.
- Development of single lane, reversible bus lanes in the median or along one side of Murfreesboro Road at the following locations:
    - North and south of Thompson Lane
    - South of Harding Road-Donelson Pike to north of Bell Road.
    - In Murfreesboro from Thompson Road south to Church Street.

  The precise start and end points of the busways and their configuration (for example, whether they are located in the center of the roadway alignment or on the eastern or western sides of the roadway) will be determined at a later stage of development. A potential cross section of a single lane reversible busway shown in Figure 10-8. As the figure shows, the busway would be 12 feet in width and would be separated by landscaped

medians or barriers to prevent auto traffic from entering the lane. The lane would operate in the park direction (north in morning, south in the afternoon) and would be closed to traffic during the midday periods.

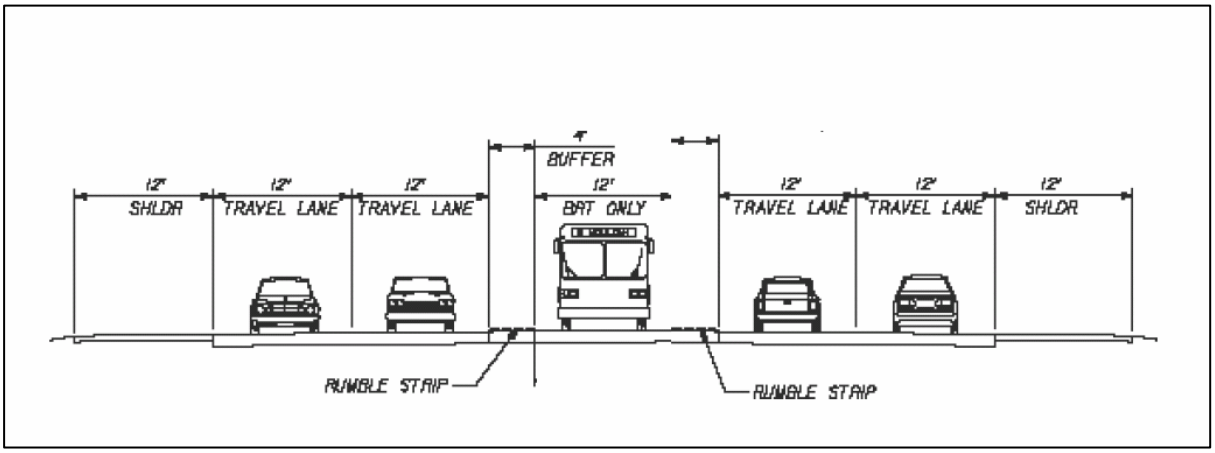


Figure 10-8 Potential bus lane cross section

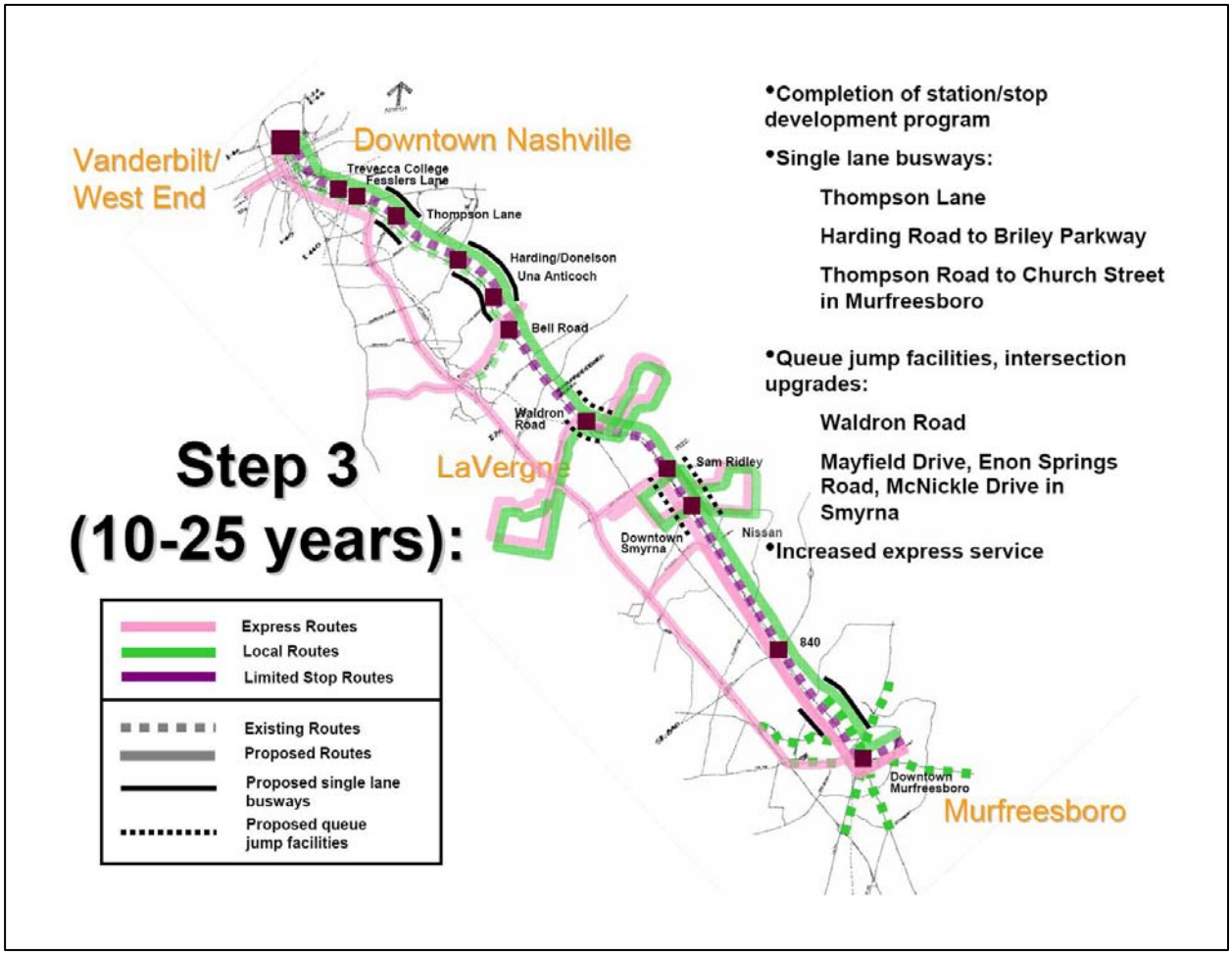


Figure 10-9 Long-Term

The configuration of a reversible lane facility along one side of the roadway, as opposed to in the center, would require significant signal and signage improvements over and above those required for a center lane facility to ensure, for example, that turning drivers in the intersection do not turn their vehicles into the busway or into the path of a crossing bus. Alleviating these and other potential driver and pedestrian safety concerns would add to the signal delays experienced by both buses and autos at effected intersections, leading this reversible lane facility to have a significant disadvantage to a side facility. Potential cross sections for the proposed bus lanes are shown in Figure 10-8. A diagram of the proposed long-term improvements for the corridor is shown in Figure 10-9.

10.3.5 Operating Plan for Proposed LPA

The proposed LPA represents a dramatic increase in bus service in the corridor. The plan calls for the implementation of four new types of service in the corridor:

- Express bus services using I-24 to provide direct service between downtown Nashville and communities along the corridor including the Bell Road area, LaVergne, Smyrna, Rutherford County and Murfreesboro.
- Local bus service along the full length of Murfreesboro Road, to provide a basic level of bus service for travelers in the corridor and to support the wide variety of intra-corridor trips that do not end at the terminal areas of the corridor, downtown Nashville or Murfreesboro.
- Circulator services within corridor communities, to provide a basic level of transit service within the communities and to provide a direct connection between corridor neighborhoods, commercial developments and the longer-distance transit services operating on I-24 and Murfreesboro Road.
- Reverse-commute service to allow travelers from the city of Nashville and other corridors to travel to employment centers in the corridor, including employers in the Bell Road area and in LaVergne, Smyrna and Murfreesboro.

These new services are not meant to *replace* the existing local bus services operating in the northern (Nashville-Davidson County) portion of the corridor, the RTA Relax-and-Ride service operating throughout the corridor or the new bus system currently in development in Murfreesboro. They are, rather, intended to supplement and, in some cases, modify these existing services to create an integrated network which would provide transit services fitted to the diverse transportation markets existing in the southeast corridor.

Express Bus Service on I-24

The proposed express bus services would originate in neighborhoods in the central and southern areas of the corridor, including various areas of Murfreesboro and unincorporated Rutherford County, LaVergne, Smyrna and the Bell Road area in southern Nashville-Davidson County. The service would be oriented to serve commuters from throughout the corridor to downtown Nashville and the West End area. This market represents a small minority of trips that occur in the corridor. However, because the vast majority of these trips are destined to relatively small and walkable areas (downtown Nashville and the Vanderbilt-West End area), and occur within just a short span of time each day, they are one of the strongest markets for transit service and have the greatest potential impact on traffic congestion. The recommendations in the LPA would provide them with a high level of high quality transit service. Much of the express service was recommended for implementation in the short-term, while implementation of the local service was recommended for the mid-term period, primarily because no express service currently exists in the corridor.

In the short-term, express routes would originate at the following locations:

- MTSU and downtown Murfreesboro via Murfreesboro Road to Sam Ridley Parkway in Smyrna
- Smyrna (Sam Ridley Parkway)
- LaVergne (Waldron Road)
- Bell Road-Hickory Hollow Mall

In all, six express bus routes have been programmed to originate from various areas of Murfreesboro, with routes entering I-24 from the US 231, SR 96 and SR 840 interchanges and from the Sam Ridley Parkway interchange in Smyrna. The first of these, in the short-term, would originate at MTSU and operate north on Broad Street-Murfreesboro Road to Smyrna, from which it would operate west to I-24 via Sam Ridley Parkway. In the mid-term, a second express route would originate from Murfreesboro and a route originating in Nashville would operate a reverse-commute express service to the Nissan Motors factory in Smyrna and to Murfreesboro and MTSU. In the Long-Term, four additional routes originating in Murfreesboro and traveling to Nashville would be added as demand warrants their addition.

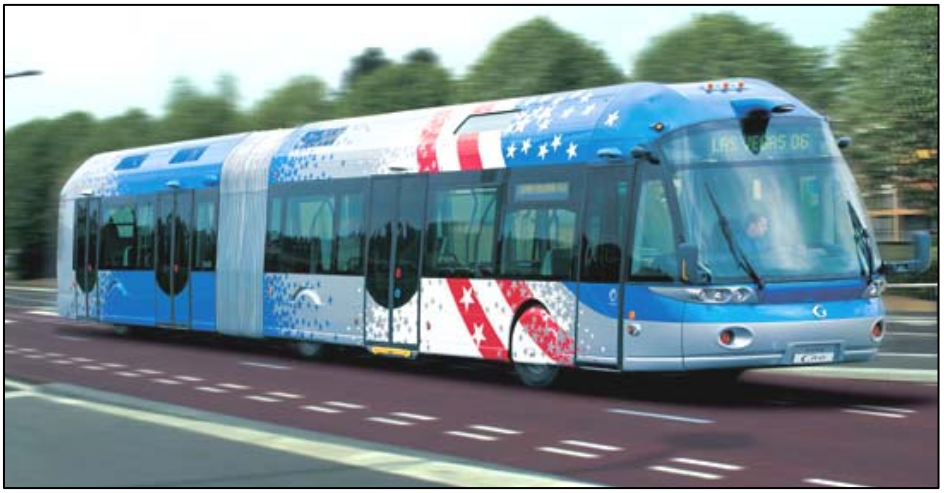


Figure 10-10 Distinctive Vehicle for Commuter Express or Busway Services

After operating a circulation route through their communities and making stops at park-and-ride sites located at existing commercial parking areas along their routes, the buses would enter I-24 and use the HOV lanes north to Harding Road before re-entering mixed traffic south of downtown Nashville. The buses would then exit and travel into downtown Nashville via Lafayette Street. In the mid-term, queue jump facilities would be added to the interchanges where the buses would enter the freeway to provide them with a speed and travel time advantage over other vehicles. However, no extension of the HOV lanes on I-24 is proposed as part of this LPA.

All of the express routes (other than the reverse commute route) would operate to downtown Nashville, operating through downtown Nashville north to the Music City Central transit center and dropping off passengers for transfer to MTA local bus routes and a circulator route. Then, the express route would continue as a through service to the Vanderbilt-West End area. Operating as a single through route to the West End would promote ridership that would likely be lost if passengers were forced to transfer to a local bus or circulator route. The reverse commute route would originate at the MTA's downtown transit center. The routes would stop at all local bus stops in the downtown area and in the West End.

The routes would use distinctive coaches to differentiate the proposed service from other bus service in the area and provide more comfortable padded seating, reading lights, footrests and other amenities appropriate for longer-distance trips. An example of this type of distinctive coach is shown in Figure 10-10. These coaches would have a seated capacity of 45 on a standard 40 foot sized vehicle to more than 50 for an articulated 60 foot vehicle. These services also would charge premium fares similar to those charged on the existing Relax-and-Ride service (full fare is currently $2.50).

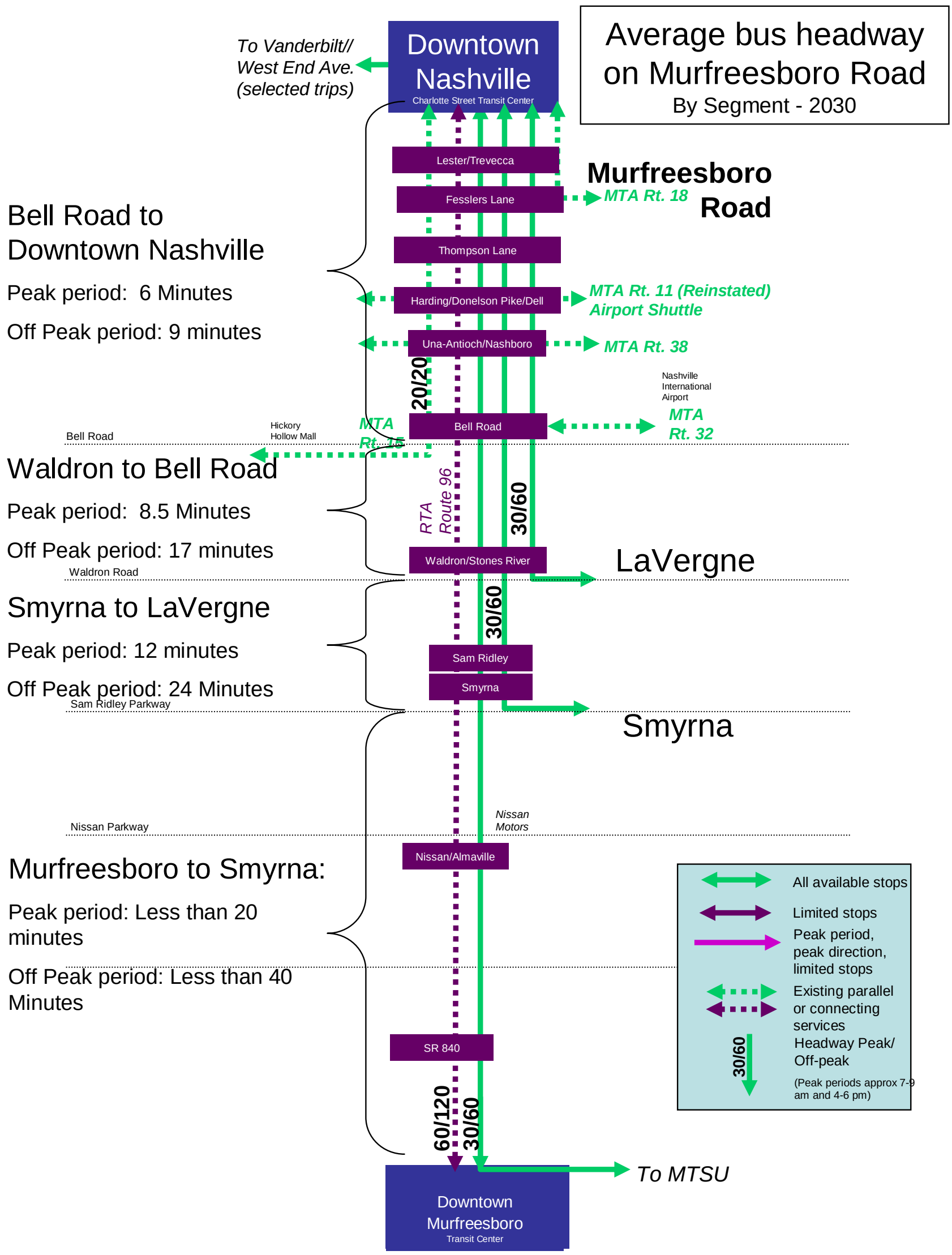
Service frequencies for the bus services that would operate under the full implementation of the LPA (at the end of the Long-Term phase) are shown in Figure 10-3 on page LPA-6. Most of the express routes would operate in the peak direction (northbound in the morning, southbound in the afternoon) and during the peak period (terminating downtown between approximately 7:00 and 9:00 a.m., leaving downtown between approximately 4:00 and 6:00 p.m.), with no mid-day, evening, night or weekend-holiday service. Most of the routes would operate at a 30 minute frequency during the periods in which they operate, thus operating 4-5 trips per day in each direction. The MTSU/Murfreesboro-to-Nashville via Sam Ridley express route is assumed to offer bi-directional off-peak service at a 60-minute headway during the off-peak period and 30 minutes during the peak in order to allow passengers who need to travel off-peak and in the evenings an express option between downtown Nashville, Smyrna and Murfreesboro. MTSU students and workers in industries that do not work a typical nine-to-five workday would likely require such a service. The route serving Nissan Motors would operate on Nissan's shift schedule. Two of the Murfreesboro express routes, the Memorial East and Memorial VA routes, would each operate on a 60 minute frequency during the peak periods, but cover some of the same alignment.

Local and Skip Stop Bus Routes on Murfreesboro Road (US 41)

Bus services in the corridor are now essentially local bus routes. MTA's Route 15 provides a relatively high frequency of bus service between Hickory Hollow Mall and downtown Nashville via Bell Road and Murfreesboro Road. MTA provides no service outside Nashville-Davidson County. The service operates on weekdays during peak, mid-day and evening periods in both directions and provides a basic level of service on weekends and holidays. RTA's Route 96 "Relax and Ride" service operates on Murfreesboro Road from Murfreesboro to Nashville, providing service and making stops at all locations along the length of the corridor. Currently, however, the route operates only during the peak travel periods (from approximately 6:00 to 9:00 a.m. and from 3:30 to 6:30 p.m) on weekdays. The proposed City of Murfreesboro transit service will serve only the portion of US 41 (Broad Street in Murfreesboro) that lies within the city.

The Southeast Corridor study's analysis of travel patterns in the corridor indicated that travel patterns in the corridor are complex, with many trips of varying length occurring between locations within the corridor and only a small percentage of commuter trips to downtown Nashville. In addition to the rapid growth in Rutherford County and the relative lack of existing service, this pattern suggested that there was a strong need for transit services that provided a basic level of bus transit service throughout the corridor, operating on its main north-south arterial roadway, Murfreesboro Road. The diagram in Figure 10-11 (which supplements the information in Figure 10-3) shows the headways of the local bus services proposed for implementation through the short-, medium-, and long-term periods and provides calculations of

Figure 10-11 Proposed Composite Local and Skip-Stop Bus Headways on Murfreesboro Road (US 41)



the combined (or composite) headways for the local service for each segment of Murfreesboro Road.

The goal for development of local service on Murfreesboro Road was to make service as frequent, fast and convenient as possible, so as to make it competitive with driving and to support the corridor as a focus for transit oriented development in the region.

Figure 10-12 Examples of skip stop station improvements

As Figure 10-11 shows, the existing Route 15 service operates at a headway of approximate 20 minutes all day, providing frequent basic service on Murfreesboro Road from Bell Road north to downtown Nashville. The planned City of Murfreesboro service will provide service at a 30 minute frequency on the portion of Murfreesboro Road (Broad Street) within Murfreesboro. While the short-term priority is to provide express service for commuters (which currently does not exist), expansion of the local service begins in the medium term with the addition of three new routes:

- A local bus route operating at a 30 minute headway between MTSU and Murfreesboro to Downtown Nashville and the Vanderbilt-West End area via Murfreesboro Road and the extension of the Smyrna Circulator bus route. Each trip on this and other community circulator routes would begin as a community circulator, serving local streets within each community. The route would then follow Sam Ridley Parkway to Murfreesboro Road, stopping at the intersection to allow transfers to other bus routes before continuing north on Murfreesboro Road to downtown Nashville and the Vanderbilt-West End area, operating as a local bus route along Murfreesboro Road.
- Operation of the LaVergne circulator route in the same manner as the Smyrna route, with through service to downtown Nashville and the Vanderbilt-West end area.

Operating the circulator routes as extensions of the local bus routes means that they can serve as feeder-distribution routes for express and skip stop service operating on Murfreesboro Road, and also provide local passengers within the neighborhoods with a “one-seat ride” between their homes and downtown Nashville. Transit riders, particularly suburban “choice” riders, strongly resist transferring between services. The routes would make all stops along Murfreesboro Road and throughout its alignments in downtown Nashville and in the West End area.

In addition, the RTA Route 96 “Relax-and-Ride” service would be recast at this point as a skip stop service from MTSU and downtown Murfreesboro to downtown Nashville and the West End area. This service, similar to an express service, would stop only 12 times between Murfreesboro and Nashville at the following locations:

- Downtown Murfreesboro
- SR 840
- Almaville Road/Nissan Boulevard
- Downtown Smyrna
- Sam Ridley Parkway
- Waldron/Stones River Boulevard
- Bell Road
- Una Antioch Nashboro Pike
- Harding Road/Donelson Pike (Dell)
- Thompson Lane
- Fesslers Lane
- Lester Road/Trevecca Nazarene University

The precise locations of these stops and the locations of downtown stops would be determined at future stages of development based on ridership property ownership, engineering constraints and other considerations. The route would terminate in downtown Nashville at the Music City Central Transit Center. Some trips would continue west to the Vanderbilt/West End area via Charlotte Street or West End Avenue. These services would use 40 foot suburban style vehicles with a capacity of 45, or articulated vehicles with a capacity of more than 50.

The limited stop pattern would allow the buses to operate at a faster speed and would provide improved travel times for longer-distance travelers in the corridor. Passengers could transfer from the limited stop station locations along the corridor to local bus service for access to areas between stops or to local communities served by community circulator services. The skip stop service would provide an express trip once an hour in each direction during peak periods and once every two hours during the off-peak and evening periods. All of the local services are assumed to operate from 5 a.m. to midnight five days a week, with a lower level of service on weekends and holidays. The skip stop locations would also be served by the local bus service and thus would have the highest frequency of bus service of any location along the corridor. The skip stop locations are often located within areas where busway improvements would be located, areas which are expected to become the focus of transit oriented development in the corridor.

Generally, the individual bus services would operate at a headway of 30 minutes during the peak period and at 60 minutes during the off-peak. The services would combine with existing bus routes serving the corridor, and the service frequency would “accumulate” as it proceeds northward into the more densely populated areas of the corridor to provide increasingly frequent services to areas approaching Nashville. As the diagram in Figure 10-11 shows, the combined headways of service between downtown Murfreesboro and Smyrna would be about 20 minutes (the level would be lower on Broad Street within Murfreesboro, where the City of Murfreesboro would also provide service at a headway of 30 minutes). Between Smyrna and LaVergne the headway would fall to 12 minutes during the rush hour periods and 24 minutes off-peak, with the introduction of the Smyrna circulator bus. North of Waldron Road, with the introduction of the LaVergne circulator route, the headways would fall to 8.5 minutes during the peak period and 17 minutes during the off-peak. With the addition of the MTA Route 15, peak period service on Murfreesboro Road would fall to 6 minutes during the peak and 9 minutes during the off-peak periods. At this frequency in the area from Bell Road north, service would come so frequently that service schedules would be unnecessary during peak periods; a bus would arrive within a few moments of the arrival of a bus passenger at the stops. Such service levels have been found to promote high transit use in other cities.

The local and skip stop services would benefit from intersection improvements and would be the primary users of the short sections of busway at congested locations, both improvements proposed in the long-term. These improvements would provide travel speed advantages over driving, reducing travel time between Murfreesboro and Nashville by up to 10 minutes, an advantage that would provide a significant benefit to travelers, resulting in higher ridership.

Community Circulator Services

The community circulator services are generally not so much separate bus services as they are the southern end of the various local and express bus services, which comprise the bulk of the new services proposed in the LPA. The express and local bus routes originating in LaVergne and Smyrna and on Bell Road would operate as circulators within their local area, connecting residential and employment areas east and west of Murfreesboro Road to each other and to destinations along Murfreesboro Road. As noted above, these routes would then continue north, either as express buses operating on I-24 or as local buses operating on Murfreesboro Road. In both cases, this would provide through service to downtown Nashville and the Vanderbilt-West End area. In Smyrna and LaVergne, these services would constitute the only proposed local bus service in these communities and would provide the basic level of service for all transit users, including the transit dependent populations who live and work in those communities.

Approximate alignments for these services were identified for the purposes of transportation modeling and are shown in the figures describing the alignments. However, more detailed analysis of the communities and their needs would be required before implementation. The express services would be implemented in LaVergne, Smyrna and along Bell Road during the short-term period, while the local services would be in place during the mid-term. By combining these two services, the communities would enjoy 15 minute service frequencies on their circulator services during the peak period (combining the 30 minute frequencies for the express and local services) and 60 minutes headways off-peak. The circulator services presumably would be operated with standard local and suburban style transit buses up to 40 feet in length. Articulated vehicles could not be used for the circulator services due to constraints on operating these large vehicles on local streets.

Existing MTA transit routes provide circulator services in the Nashville area, including the distribution of passengers transferring in the downtown area from routes originating in the corridor. A circulator route that currently connects the Nashville Star commuter rail service to downtown Nashville and the West End area is assumed to continue operation and would supplement the distribution of passengers in the downtown area. All routes connecting to downtown Nashville would operate through downtown and some trips on each route would connect to the West End via Charlotte Street.

Reverse Commute Services

The fourth market targeted by the proposed LPA is reverse commuters, commuters from Nashville-Davidson County who travel primarily in the southbound direction in the corridor for employment or educational opportunities. This includes employees and potential employees in the Nashville region who desire transit connections to Dell, Nissan, and other major employers in the corridor, as well as students and potential students of MTSU, Trevecca Nazarene University, and other educational centers in the corridor. The proposed LPA includes a number of local, skip stop and express service opportunities to support reverse commute trips in the corridor. These include:

- The local services proposed for Murfreesboro Road, all of which are bi-directional services that operate a balanced schedule in the peak (northbound) and reverse peak (southbound) directions. These services would provide a minimum of 30 minute frequency service (in most cases, much more frequent service) between all areas of the corridor along Murfreesboro Road.
- Skip stop service operates a balanced schedule in both the northbound and southbound directions along Murfreesboro Road between Nashville and Murfreesboro-MTSU, stopping at 12 key locations at a headway of one hour during peak periods and two hours during off-peak periods.
- Express Service operating a balanced schedule in both the northbound and southbound directions between downtown Nashville, Smyrna, and Murfreesboro MTSU, during traditional peak travel periods only.
- A reverse-directional service connecting Nissan Motors in Smyrna, downtown Murfreesboro and MTSU, operating at the schedule of shift changes at Nissan Motors.

This package of services would provide reverse commuters with a high volume of services and a semblance of the convenient mix of services that exists for commuters. The result is greatly increased opportunities for Nashville residents to take advantage of the employment and educational opportunities of the southeast corridor.

10.4 Ridership Estimates for Proposed LPA

Ridership estimates were prepared for the ultimate build-out of the proposed services and not for the increments of service developed in the short- and mid-term periods.

The methodology employed for preparing the ridership forecasts for the LPA used the same underlying assumptions as those employed for Alternatives A, B, and C and for the No-Build and original TSM/Enhanced Bus alternatives. The Nashville area MPO's regional model was used to estimate ridership. This model was adjusted to account for the performance of new types of service, including Commuter Rail and busway-BRT services, and for changes in the environment (principally recent changes in the cost of fuel). A second estimate of ridership was prepared for the LPA to simulate the probable effect of changes in land use on transit ridership. Specifically, these adjustments simulated the effect of the projected growth in the corridor between the years 2000 and 2030 being concentrated within ½ mile of the skip stop station locations identified in Figure 10-1, which presumably would make transit more attractive and increase ridership.

The estimates of ridership results for the three earlier "build" alternatives and for the LPA with and without the concentrated land use assumption are shown in Table 10-1. Estimates of 2030 transit boardings for the corridor are shown in Table 10-2. Both of these tables are illustrated in charts in Figures 13 and 14 respectively. These tables show the estimated increase in ridership

between the no-build system (consisting of the existing MTA and RTA bus and rail systems, with minor modifications) and the various build alternatives. The estimates are prepared on a system-wide basis to include all of the existing and proposed services in the Nashville region in order to ensure that all of the new ridership generated by the new service (including travelers from outside the corridor who transfer to services in the corridor) are counted and also ensure that the corridor service does not take credit for riders already using the existing system (such as those using the current MTA Route 15 or RTA Route 96). As the table shows, the combination of express service on I-24 and frequent local and skip stop service on Murfreesboro Road generates more ridership than busway service on either facility (or, indeed, on both facilities combined).

Table 10-1 Increase in System Wide Ridership Generated by Alternatives A, B and C, Proposed LPA, and Proposed LPA with Concentrated Land Use

Alternative	Estimated Increase in System-Wide Transit Ridership (Riders per Day)
A. BRT I-24	100-400
B. Commuter Rail CSX	500-800
C. BRT M'Boro Road	800-1,300
Proposed LPA (Enhanced Bus I-24 and Murfreesboro Road)	1,300-1,600
Proposed LPA With Improved Land Use	1,600-2,200

Table 10-2 Year 2030 Transit Boardings in the Corridor

Year 2030 Transit Boardings in the Corridor			
Alternative	Total Boardings	Change from NB	Change from TSM
No-Build	3,100		-1,900
TSM	5,200	2,200	
Alt A (BRT on I-24)	6,300	3,200	1,100
Alt B CSX Commuter Rail	5,200	2,200	0
Alt C Murfreesboro/ Old Nashville BRT	6,100	3,000	900
Enhanced Bus	6,500	3,400	1,300
Enhanced Bus with Modified Land Use	7,300	4,200	2,100
Corridor Routes include:			
15, 32, 96(relax & ride), All corridor Guideway routes, all			
Total boardings based on upper limit of range in Table 4.1			

Figure 10-13 Estimate of System-Wide increase in ridership

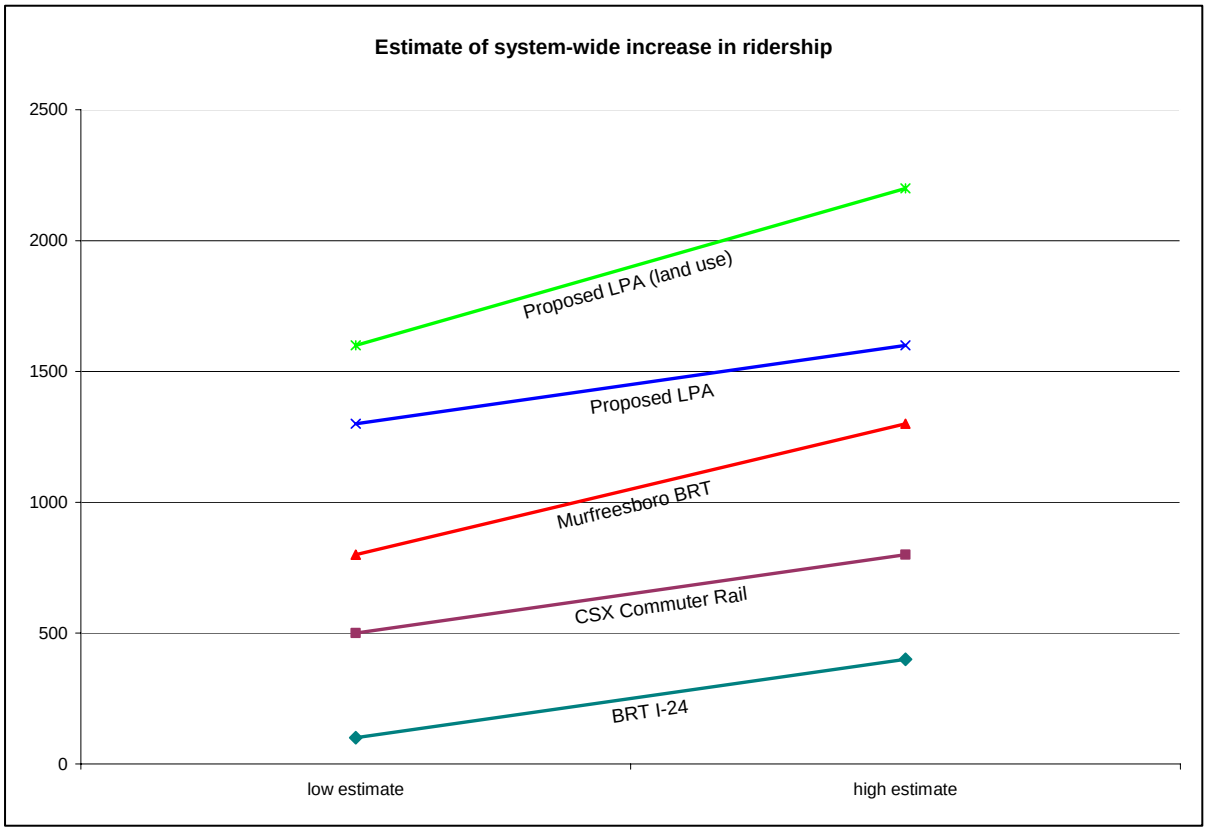


Figure 10-14 Year 2030 Transit Boardings in the corridor

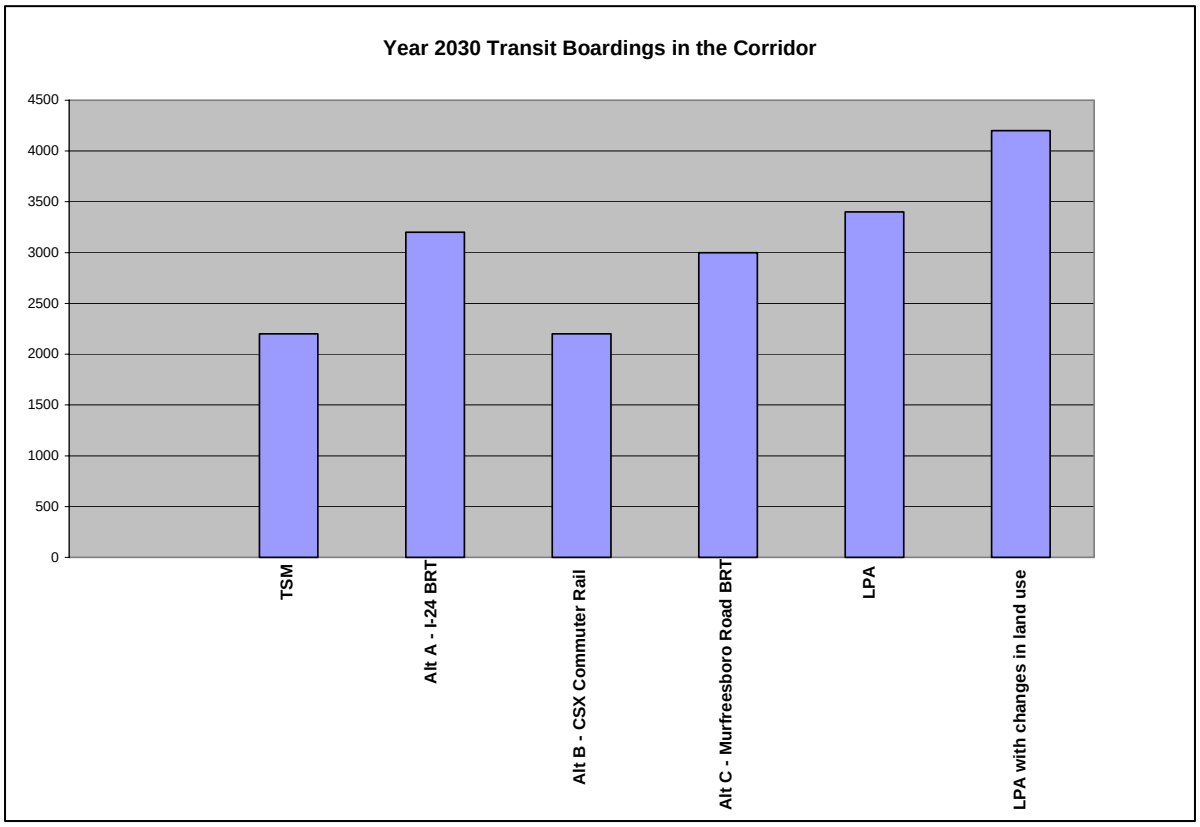


Table 10-3 Comparison of change in Vehicle Miles Traveled (VMT) and Vehicles Hours Traveled (VHT) for Detailed Alternatives and Locally Preferred Alternatives

Alternative	VMT	VHT	VMT Change (from No-Build)	VMT % Change (from No-Build)	VHT Change (from No-Build)	VHT % change (from No-Build)
No-Build	30,160,420	1,052,491	0	0.00%	0	0.00%
TSM	30,149,191	1,052,128	-11,229	-0.04%	-363	-0.03%
1. I-24 BRT	30,144,716	1,052,050	-15,704	-0.05%	-441	-0.04%
2. CSX Commuter Rail	30,145,286	1,052,044	-15,134	-0.05%	-447	-0.04%
3. M'Boro/Old Nashville BRT	30,139,361	1,051,874	-21,059	-0.07%	-617	-0.06%
LPA	30,142,546	1,051,944	-17874.00	-0.06%	-547	-0.05%
LPA with Land Use Changes	30,138,541	1,051,796	-21879.00	-0.07%	-695	-0.07%

Identifying ridership on individual services within a transit network is difficult under a bus-based system. However, approximate estimates of ridership generated by specific areas were estimated as follows (these numbers exceed the number of new riders, as some of these riders are currently using existing MTA or RTA services):

Smyrna Area: 440 daily riders (480 under Improved Land Use)
LaVergne Area: 350 daily riders (390 under Improved Land Use)
Murfreesboro Area: 1,140 daily riders (1,250 under Improved Land Use)
Bell Road Express: 130 daily riders (130 under Improved Land Use)
Existing Route 96: 150 daily riders (180 under Improved Land Use)
Nissan Express : 170 daily riders (190 under Improved Land Use)

The estimates of ridership show that the proposed investment in transit service and infrastructure in the corridor will provide transportation benefits to thousands of people and will increase the transit market in the corridor dramatically. However, the ridership estimates remain relatively low, causing the Steering Committee to recommend an incremental enhanced bus alternative instead of a rail or busway-based system. The estimates remain as accurate as possible given the existing local transit model and the relatively little experience in the community with express bus and rail transit services. The Steering Committee anticipates revisiting these results as further refinements are made to the region's travel demand model and as new data inputs from rail and express bus transit services in other corridors provide a clearer picture of the propensity for area residents to use premium transit services when they are made available.

10.5 Cost Estimates for Proposed LPA

Estimates of costs were prepared for capital cost items (including transit infrastructure such as stations and busways, additional buses and other improvements) and for the operating costs of the additional transit service that make up the LPA. These cost estimates were prepared using standard cost estimating methodologies typically used for FTA New Starts Alternatives Analysis projects. A summary of the operating and capital cost estimates for the full build-out of the LPA and for each of the phases (short-term, mid-term and long-term) is listed in Table 10-3.

Table 10-4 Operating and Capital Costs for Proposed LPA, by Development Phase (in millions of 2005$)

Cost Summary	Capital					Annual Operating
	Stations	Busway/ Streetscape Miles	Infrastructure Costs	Vehicle Costs	Total Capital	Incremental Cost (over No Build) ($million)
1-5 Years	4	0	4.7	23.0	27.7	3.9
5-10 Years	12	0	22.5	17.5	40.0	11.1
10-25 Years	4	13.2	65.8	12.5	78.3	13.0
Total	20	13.2	93.0	53.0	146.0	

10.5.1 Operating Cost

The operating cost estimates were based on a fully-burdened resource build-up cost model as recommended by FTA. The estimates disaggregated costs as reported in the FTA's National Transit Database (NTD) for transit operations in the Nashville area. Costs were averaged for the three most recent years (2003-2005) for which NTD data is available, with each of the past years inflated to a common (2005) level. The costs account in part for the increase in fuel costs that occurred in 2004 and 2005. The modeling technique assigns the costs of operating fixed route bus service into four categories:

- Costs that vary according to the miles of service operated,
- Costs that vary according to the hours of service operated,
- Costs that vary according to the number of vehicles operated, and
- Administrative costs

Costs assigned to the miles, hours or number of vehicles operated are divided by the number of hours, miles and vehicles operated to develop a cost factor for each of these categories. Costs associated with administration are divided by the total operating cost for fixed route bus service to identify an administrative markup percentage.

The cost drivers that generate the cost estimates are taken from the travel demand forecasts, which provide for each alternative an estimate of the number of miles, hours of service and the number of buses that would be required to operate each route. FTA requires that cost estimates be developed on a system-wide basis to ensure that all of the costs associated with an alternative are captured. For each alternative tested, including the LPA, the total number of hours, miles and vehicles were estimated and subtracted from the number of hours, miles and vehicles required under the no-build system (a system similar to the existing operation). The remaining number of hours, miles and vehicles under each alternative was then multiplied by their respective cost factors and added together. This number was then multiplied by the administrative cost percentage factor to determine the administrative costs associated with the alternatives. The costs generated by the service cost drivers (the hours, miles and number of vehicles) were then added to the administrative costs to establish the total costs. The process was repeated for each phase of development to isolate costs associated with the improvements recommended for implementation in that phase.

As Table 10-4 shows, operating costs of the services (primarily express routes) initiated in the first five years would be about $4 million per year. With the addition of significant local bus service in the mid-term period, the cost increases to $11 million per year. With slight increases in service, primarily the implementation of a few new express routes, the costs in the long term increase to about $13 million per year. These costs do not include the operation of existing or programmed bus services, including MTA, RTA and the proposed Murfreesboro City services,

which would be in operation whether or not the recommendations of this study were implemented.

10.5.2 Capital Costs

Capital costs include the cost of all real property, vehicles and structures, including buses, transit stations, streetscape materials, the construction of busways and queue jumps, roadway widening, signal systems and other items that support the proposed LPA. These costs were developed on a unit cost basis using a standard capital costing model, with unit costs updated to 2005 levels using inputs from TDOT's records of recent projects. These costs take into account the recent increases in fuel, steel, and concrete costs that occurred in 2004 and 2005. Table 10-5 shows the cost estimating worksheet for the infrastructure elements of the full build-out of the LPA, while Table 10-2 shows the estimates for each interim stage. The estimates take into account costs of purchasing land and building stations. The MTA's Music City Central station is not included in the cost estimates as its development is not driven by this project, and thus, it is part of the "no-build" system.

The estimated number of buses generated by the model, which were used in the operating cost estimates, is subtracted from the no-build to generate the incremental number of buses needed. This number is multiplied by a cost factor of $500,000 per vehicle to derive the total cost for vehicles in each development phase.

As Table 10-4 shows, the estimated total capital cost of the proposed LPA is $146 million. Of this, about $93 million would cover the infrastructure, including the busway sections, skip stop transit stations, and intersection and queue jump improvements, and about $53 million would be required for additional buses. More than 100 additional buses would be required to operate the proposed services in the full implementation of the LPA (including spare vehicles, which comprise 15% of the vehicle fleet). The bulk of these vehicles (about 46) would be required in the short term to provide the new express services proposed in the short term, while each following increment of service would require additional vehicles in smaller numbers. This estimate assumes only the cost of the initial purchase of buses for each new route and does not include the replacement of buses, which must be replaced at 12 year intervals. As the estimates indicate, relatively little capital costs occur in the short-and mid-terms, with the majority of capital costs (about half) occurring in the long-term period. This pattern of investment will ensure that major high cost investments will not go forward until the new services have had the opportunity to increase ridership in the corridor.

10.6 Conclusion

The Southeast Corridor study Steering Committee identified and evaluated a range of transit options to provide service to this fast growing corridor. The analysis of these transit options found that, barring unforeseen changes in conditions, the most feasible strategy is a phased approach in which new transit services would be incrementally added. Supporting infrastructure would be added later and more slowly as ridership grows and the corridor and the region's capacity to financially support the improvements increases, as land use in the corridor gradually focuses on the transit corridors and on transit oriented development patterns, and as ridership on the existing Music City Star rail system and other RTA corridor transit services continues to grow and is reflected in regional modeling estimates. The incremental approach is beneficial in two distinct ways: it immediately provides services to meet the pressing transportation needs of the corridor and it gives service providers, government officials, and the public time to resolve some of the issues in the corridor regarding land use, ridership, and funding while building transit ridership in the corridor to support the future development of expanded service.

Table 10-5 Infrastructure Cost Worksheet for Proposed LPA (2005$)

PREFERRED ALTERNATIVE: Partial Busway and Stations on Murfreesboro Road				
Description	**Miles**	**Const Type**	**BRT Cost PerMile**	**BRT Cost Per Segment**
Streetscape-Stop Improvements, downtown areas (Lump Sum)				
Nashville Downtown Area	2.70	Lump	$ 500,000	$ 1,350,000
Murfreesboro Downtown Area	3.00	Lump	$ 250,000	$ 750,000
Stations				
MTA Transfer Center Station (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Church St. Station (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Broadway Station (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Gateway Blvd. Station (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Lafayette Street (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Trevecca College (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Fesslers Lane (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Thompson Lane (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Donelson Pike/Dell (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Una Antioch Pike (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Bell Road (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Waldron Road (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Sam Ridley Parkway (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Downtown Smyrna (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Nissan Boulevard (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
SR 840 (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Thompson Road (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Downtown Murfreesboro (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
Broad/Tennessee (Downtown Station Stop)		STA. 1	$ 150,000	$ 150,000
MTSU (Limited Stop Route Station)		STA. 2	$ 200,000	$ 200,000
Subtotal				$ 3,650,000
Mainline Construction (Single Lane Reversible Busway, Murfreesboro Road)				
North of Thompson Lane to Briley Parkway	0.90	NC-5	$ 6,223,109	$ 5,600,798
Reedwood (south of Harding/Donelson) to Rural Hill	2.90	NC-4	$ 6,223,109	$ 18,047,016
Queue Jump, Enon Springs, McNickle Drive	0.70	NC-5	$ 6,223,109	$ 4,356,176
Thompson Lane to Church Street (Murfreesboro)	3.00	NC-7	$ 6,223,109	$ 18,669,327
Mainline Construction (Queue Jump Facilities at I-24 Interchanges)				
Bell Road	0.25	NC-4	$ 6,223,109	$ 1,555,777
Waldron Road	0.25	NC-4	$ 6,223,109	$ 1,555,777
Sam Ridley Parkway	0.25	NC-4	$ 6,223,109	$ 1,555,777
Nissan Boulevard (Limited Stop Route Station)	0.25	NC-4	$ 6,223,109	$ 1,555,777
SR 96	0.25	NC-4	$ 6,223,109	$ 1,555,777
Subtotal				*$ 54,452,204*
OTHER CONSRUCTION ITEMS				
Facility				$ -
Traffic Engineering Improvements				$ 10,500,000
RIGHT-OF-WAY				
Station Land			$ 125,000	$ 5,000,000
Mainline ROW			$ 2,000,000	$ 17,340,000
TOTALS FOR ALTERNATIVE	**14.45**		**---**	**$ 93,042,204**

11.0 Financial Assessment

11.1 Introduction

The cost of the proposed LPA, while far below the cost of some of the alternatives analyzed in this study, remains a large increase in the scale of the transit service currently operating in the Nashville region. Chapter 11 describes strategies for funding the development and operation of the proposed LPA, identifying possible scenarios and guidance to creating the combination of local, state, and Federal funding that could support the implementation of the various projects that comprise the LPA.

11.2 Project and Partner Descriptions

11.2.1 Description of the Project Sponsor and Funding Partners

The Nashville Area Metropolitan Planning Organization (MPO) has managed the Southeast corridor study as part of the metropolitan transportation planning process for the urbanized area. The urbanized area boundaries encompass Davidson, Rutherford, Sumner, Williamson, Wilson, and parts of Maury and Robertson counties. Transit improvements in the Southeast corridor project will primarily serve Nashville-Davidson and Rutherford Counties.

While the Nashville Area MPO is managing this study, it has not been determined what agency would own the proposed facilities and operate the services. The improvements may be operated by one of the cities or counties, by a new entity or by one or several of the following agencies. The three existing transit operating entities are:

- The *Nashville Metropolitan Transit Authority* (MTA), a division of Nashville-Davidson County Metro government, which currently runs the local bus system in Nashville-Davidson County. MTA operates more than 30 routes in Davidson County, as well as van paratransit service. In 2004, the MTA had an operating budget of $29.6 million and a capital budget of more than $10 million.
- The *Regional Transportation Authority* (RTA), founded in 1988, serves the nine county area surrounding Nashville. It currently operates carpool, vanpool, park-and-ride, and guaranteed ride home services. RTA operates “relax-and-ride” regional commuter bus service in the Southeast Corridor (Route 96) and in the northeast corridor between Hendersonville and downtown Nashville. RTA also is responsible for the Music City Star commuter rail service which opened in 2006 and runs between Nashville and Lebanon.
- The City of Murfreesboro is in the process of developing a city funded and operated system of bus routes oriented to the city’s downtown area and extending into residential and commercial areas throughout the city.

Other potential funders and (less likely) operators include:

- The *Tennessee Department of Transportation* (TDOT) may also be considered a funding partner. As Tennessee’s principal transportation agency, TDOT is committed to developing all aspects of the state’s transportation system, including both roadway and transit improvements. Since the proposed Southeast corridor transit improvements would use state owned roads and interstates, the TDOT also will have an interest in the project and may be able to incorporate transit elements into some highway improvement projects.

- The *individual cities and counties* served by the project may also be considered funding or operating partners, as well. Metro Nashville-Davidson County, Rutherford County, and the cities of LaVergne, Smyrna, and Murfreesboro are all represented on the project Steering Committee and may be in a position to fund some of the proposed facilities and services.

As discussed below, the proposed LPA is a collection of coordinated but discrete services and facilities proposed for tiered implementation over a 25 year period. Given the decentralized nature of the proposed improvements, it is likely, or nearly assured, that the implementation of the proposed services will be divided across multiple operators. Capital and operating funding most likely will be split among multiple jurisdictions and will vary by service, facility, and time period. Services could begin implementation under multiple jurisdictions to be regrouped later under a single jurisdiction, or vice versa.

11.2.2 Description of the Project

The Nashville Area MPO identified a need to improve transportation in one of the region's highest population and employment growth corridors, the southeast corridor between Nashville and Murfreesboro, Tennessee. This corridor suffers from heavy traffic congestion, lacks mobility options and has other pressing transportation needs. In order to determine the most cost-effective and acceptable transit improvement, the MPO and other local and regional entities conducted the Southeast Corridor High-Performance Transit Alternatives Study to evaluate a range of transit alternatives to address the corridor's transportation needs. The study identified a range of transit options, including expansions of bus service, bus rapid transit (BRT) and BRT "light" , (BRT operations without dedicated guideway), light rail and commuter rail on three alignments I-24 (which has an existing HOV lane in much of its alignment in the corridor), the CSX rail corridor, and US 41 or Murfreesboro Road. This process undertaken by the study is documented in Chapters 4, 5 and 10.

The process result is a locally preferred alternative (LPA) that includes phased implementation of expanded express and local bus service and of short sections of busway guideway and other transit-supportive infrastructure improvements intended to allow buses to bypass congested traffic conditions and to meet the other goals and objectives of the project. This type of improvement option is referred to in transit planning literature as an "Enhanced Bus" or "Transportation System Management" ("TSM") alternative. The LPA is expected to build transit ridership and help to shape future development while generating transportation and environmental benefits. As service is implemented, ridership gains in this and other corridors become well documented, and land use changes begin to take effect, the corridor may be re-examined to consider additional improvements.

The proposed LPA includes 3 phases of implementation over a 25-year time frame. Detailed descriptions of the phases are included in Chapter 10; additional financial information relating to the phases is included in Appendix 11A. A brief description of each phase appears below:

Phase 1: Short-Term Improvements (0-5 years) – Short-term improvements focus on providing a greater variety and frequency of service within the corridor. Improvements

include adding new express service in several areas, purchasing distinctive vehicles to enhance corridor bus services, and completing The Music City Central downtown transfer center at Charlotte Street. The cost of this transit center was programmed prior to the completion of the project and is not included in the cost estimates or financial plan.

Phase 2: Medium-Term Improvements (5-10 years) – Medium-term improvements consist of both expanding express bus service options, adding local bus service and beginning the development of transit supportive infrastructure in the corridor. Enhancement projects include developing queue jump facilities at key interchanges on I-24 and transit "stations" along Murfreesboro Road to serve as stops for limited stop bus service and as nodes to promote transit-supportive development. Projects in this phase include adding circulator bus services in Smyrna and LaVergne, local bus service between Murfreesboro and Nashville, and adding reverse commute express service.

Phase 3: Long-Term Improvements (10-25 years) – The long-term improvements incorporate further expansion of bus service together with continued station improvements at major stop locations, and development of single, reversible bus lanes. Most of the major capital improvements included in the project are programmed for the longer-term period, to allow ridership to grow and development changes to take place before major capital investments are begun.

11.2.3 Funding Plan Introduction

The development of the LPA will generate a number categories of capital and operating costs. A number of potential revenue sources exist to meet these costs. These include federal, state, and local level sources; each with varying requirements and revenue potentials. The following sections describe what capital and operating costs are associated with each phase, and then details potential federal, state, and local funding sources. Detailed appendices can be found at the end of this document.

11.3 Capital Plan

11.3.1 Capital Costs

While the total capital cost for this project is $146 million in year of expenditure dollars, the majority of the capital expenditures occur in the last 15 years of this 25-year project. During the first phase, the majority of the capital investment is in vehicle purchases. In the next five years, expenditures on vehicles remain about the same while infrastructure costs increase to over $30 million. The third phase of this project requires that the majority of the capital investment is in infrastructure costs.

Costs for this project are separated by phases and they are summarized in 2005 nominal dollars in Table 11-1 and in year of expenditure (YOE) dollars in Table 11-2 below.

Table 11-1 Capital Costs of Proposed LPA

Phase	**Busway/ Streetscape Miles Built**	**Infrastructure Costs** (millions of 2005$)	**Vehicle Costs** (millions of 2005$)	**Total Costs** (millions of 2005$)
1: 1-5 Years (2008-2013)	0	$5	$23	$28
2: 5-10 Years (2013-2018)	0	$23	$18	$40
3: 10-25 Years (2018-2033)	13	$66	$13	$78
Total	**13**	**$93**	**$53**	**$146**

Table 11-2 Capital Costs of Proposed LPA

Phase	**Busway/ Streetscape Miles Built**	**Infrastructure Costs** (millions of year of expenditure $)	**Vehicle Costs** (millions of year of expenditure $)	**Total Costs** (millions of year of expenditure $)
1: 1-5 Years (2008-2013)	0	$5	$26	$32
2: 5-10 Years (2013-2018)	0	$29	$23	$52
3: 10-25 Years (2018-2033)	13	$111	$21	$155
Total	**13**	**$146**	**$70**	**$238**

Notes:
1) To arrive at YOE dollars, cost estimates in 2005 dollars were escalated based on increases to the consumer price index from US Bureau of Labor Statistics 2002 to 2006 data (2.63%).
2) YOE assumed to be 2010 for phase 1, 2015 for phase 2, and 2025 for phase 3.

11.3.2 Potential Capital Revenue Sources

Capital costs would most likely be addressed through a mixture of federal, state, and local sources. Brief descriptions and order-of-magnitude estimates of potential revenue are described below.

Federal Capital Revenue Sources
States and transit agencies can obtain federal funds through different means depending on the funding program. Some of the funds are distributed based on a formula while other funds require agencies to apply for the money through a competitive process. The following section identifies federal funds for which the LPA project might qualify.

Urbanized Area Formula (Section 5307) funds are distributed by the Federal Transit Administration (FTA) to regions with more than 200,000 people. The formula includes such factors as bus revenue vehicle miles, bus passenger miles, fixed guideway revenue vehicle miles, and fixed guideway route miles, population and population density. Nashville received $6,801,714 in 2006[1] and it has the potential to increase the

total significantly once the LPA is implemented. It should be noted that the majority of this funding probably would not be available until the later portion of the project.

Section 5309 Rail and Fixed Guideway Modernization funds are allocated by formula to urban areas with existing fixed guideway systems that have been operating for at least seven years. This includes buses operating in HOV lanes. Nashville currently does not receive any of these funds; however, it could potentially receive some funds for a BRT project operating in HOV lanes after it has been in operation for seven years).

Section 5309 Bus and Bus Facilities funds are available to public agencies and state and local governments on a discretionary basis. In most years, bus funds are earmarked by Congress as part of the appropriations process.

Section 5309 New Starts & Small Starts programs could provide major capital funding. for construction of new fixed guideway systems or extensions to existing fixed guideway systems. These funds are distributed based on a competitive FTA evaluation process. Considering the scale of the southeast corridor LPA, the proposed improvements could be advanced as a Small Starts project with simplified procedures and reporting requirements. For Small Starts, the Federal government can provide a maximum of $75 million. In order to be eligible to receive Small Starts funding, a project must:

- Have a total project cost of less than $250 million and must have a Small Starts funding requirement of no more than $75 million.
- Meet at least one of the following three criteria:
    1) Meet the definition of a fixed guideway (i.e., exclusive right-of-way for transit and other high occupancy vehicles) for at least 50% of the project length in the peak period,
    2) Be a fixed guideway project, or
    3) Be a corridor-based bus project with the following minimum elements:
        - Substantial transit stations,
        - Traffic signal priority/pre-emption, to the extent, if any, that there are traffic signals in the corridor,
        - Low-floor vehicles or level boarding,
        - Branding of the proposed service, and
        - 10 minute peak/15 minute off-peak headways or better while operating at least 14 hours/weekday.

As currently defined, the southeast corridor LPA may not satisfy New or Small Starts criteria. While the southeast corridor transit plan includes queue jump facilities and is likely to operate low-floor vehicles, attention should be paid to branding, quantity of stations, and meeting headways and operating hour requirements. As currently constituted, the total busway mileage in the ultimate build-out of the LPA is below 50% of the total alignment. Future traffic conditions or engineering constraints could result in the guideway being extended at additional cost, which under the current guidelines would allow it to meet the funding requirement for this program. The LPA appears to meet the requirements of the other guidelines, though FTA would make a determination as to whether the LPA meets the requirements of its programs.

The LPA or some elements of it might also qualify as a “Very Small Start” if it meets other eligibility requirements, including having a total capital cost of less than $50 million (including all project elements) and less than $3 million per mile, exclusive of rolling

stock. The total capital cost of the LPA exceeds $50 million, so a portion would have to be designated a separate project to qualify for "Very Small Starts" funding.

The Federal Transit Administration favors projects that are not smaller portions or phases of larger projects. For this reason, portions of the LPA that qualify for this type of funding might be split off from the rest of the program.

Congestion Mitigation and Air Quality Program (CMAQ) is a flexible program that may be used for transit or highway purposes. The goal of CMAQ funds are to fund projects that help reach national ambient air quality standards. They can also be used for operating costs during the first three years of a project. Funds are allocated to the Nashville MPO, and the MPO policy board decides how to allocate this money between highway and transit. Historically, the Nashville MPO receives between $4 and $4.5 million. The Nashville MPO TIP report shows a $2 million surplus of CMAQ funding in 2008.[2] It will be up to the MPO to decide how much of the CMAQ allocation, if any, that the southeast corridor project receives.

Surface Transportation Program (STP) funds are capital funds eligible for expenditure on highway and public transportation capital improvements, car and vanpool projects, fringe and corridor parking facilities, bicycle and pedestrian facilities, and intercity or intracity bus terminals and bus facilities. These funds are distributed to states based on a formula containing federal aid highway lane miles, vehicle miles and estimated tax payments attributable to highway users. STP funding is allocated to the MPO through the state Department of Transportation. In 2008 $17.3 million in remaining STP funding will be available in the Nashville and Murfreesboro areas, while $1.7 million in remaining funds will exists throughout the rest of the MPO.[3]

Other Federal-aid Highway Funding may also be available for this project. Currently the State of Tennessee receives $680 million in total federal-aid highway funding.[4] This is distributed through a number of programs including: National Highway System funding, Interstate maintenance, bridges funding, a number of safety and planning programs, plus the CMAQ and STP programs mentioned above. The Nashville Area MPO may work with the Tennessee DOT to determine whether some elements of the LPA might be implemented in conjunction with planned highway improvements, or might be funded with Federal-aid highway monies.

State Capital Revenue Sources

The TDOT historically pays half of the required local match for federal funding. Typically, 20 percent of funding is required to be provided locally to qualify for federal funding, which results in a 10 percent contribution from the State. If this project were funded through the "Small Starts" federal funding program, a larger local match would likely be required. Considering that a large portion of this project would be operated or constructed on state highways, TDOT may be prepared to assume responsibility for some of the funding. Portions of this project may also be eligible for highway funding since portions of the BRT route are planned on highways and in HOV lanes. These improvements could be made in conjunction with highway improvement projects as described in the Federal Highway Funding section.

Local Capital Revenue Sources

While this project will provide transportation between Murfreesboro in Rutherford County and Nashville in Davidson County, much of the planned bus service would benefit those living and working in surrounding counties as well, through reduced congestion, greater mobility and reduced air pollution. Furthermore, southeast corridor transit improvements might be combined with transit investments in other corridors as part of a regional transit funding initiative. For this reason, analysis was completed using all counties in the Nashville Area MPO and separately for Davidson and Murfreesboro counties. Note that some forecasts exclude Maury and Robertson Counties because the data available was limited.

Eight potential local revenue sources were identified. Five of the sources were included because they were recommended in the *Nashville Regional Transportation Funding - A Strategic Review* by ICF Consultants. ICF analyzed the wheel tax, sales tax, emissions fee, gas tax, and impact fee. These analyses were modified for this chapter. In addition, a hotel tax, rental car tax, emissions fee exemption fees, and sales tax caps on automobiles were added based on the recommendation of the study's Financial Advisory Committee in September 2004.

All of these taxes currently exist at either or both the state and county levels. While the emissions fee, rental car tax, and motor fuel tax are only charged at the state level, the wheel tax and impact fee are collected at the county level. Table 11-3 shows the allowable tax rates and fees and legislation caps by county and state.

Table 11-3 Existing Local Tax Sources

Source	Wheel Tax (1)	Sales Tax	Emissions Fee (2)	Gas Tax	Impact Fee (1)	Hotel (1)	Rental Car	Late Model Exemption	Tax Cap on Cars
Davidson (Nashville)	$55	2.25%	N/A	None	None	4%	None	N/A	$1,600
Rutherford (Murfreesboro)	$40	2.75%	N/A	None	$1,500 per dwelling	3%	None	N/A	$1,600
Maury	$25	2.25%	None	None	$0.50/$0.30 per SF (7)	5%	None	N/A	$1,600
Robertson	$35	2.25%	None	None	$1.50/$0.30 per SF (7)	5%	None	N/A	$1,600
Sumner	$50	2.25%	N/A	None	$0.70/$0.40 per SF (7)	5%	None	N/A	$1,600
Williamson	$25	2.25%	N/A	None	$1/$0.44/$0.68 per SF (8)	4%	None	N/A	$1,600
Wilson	$25	2.25%	N/A	None	$1,000 per dwelling	3%	None	N/A	$1,600
County Limit	None (4)	2.75%	N/A	$0.01	Private Act (9)	County specific (3)	None (5)	Unknown	Set at state level (6)
State of Tennessee	None	7%	$10	$ 0.214	None	None	3%	N/A	$3,200

Notes:
1) University of Tennessee County Technical Assistance service, *Tennessee County Tax Statistics* , January 2007.
2) Counties designated "None" do not have emissions inspection requirements. Counties designated "N/A" have emissions testing requirements, but the fee is collected through the state government.
3) The hotel tax is regulated in each county by a Private Act of the state legislature.
4) Counties may levy any flat fee on vehicle registrations.
5) Rental car tax is currently only levied at the state level.
6) The state legislature determines the cap. The cap has been raised to $3,200 but all revenues on sales above $1,600 are allocated to the state level.
7) Applies to residential/commercial
8) Applies to residential outside of city/commercial/residential within city
9) Impact fees can only be levied by amendment to the Private Acts of the county.

These sources have a wide range of revenue potential and many other considerations. The descriptions below illustrate the positive and negative attributes of each revenue source.

Wheel Tax – This tax refers to annual fees levied on each vehicle. The State of Tennessee allows counties to apply this tax as long as it is a flat fee for every vehicle in a particular class. This tax can be enacted by a two thirds majority of the county legislature, a popular vote by the public, or by act of the Tennessee State Legislature.[5]

The wheel tax is advantageous because it already exists in all counties, so no new collection mechanisms are necessary. Additionally, wheel taxes are closely related to transportation. A $1 wheel tax increase imposed by all counties in the Nashville urbanized area would generate approximately $1.2 million in fiscal year 2008.[6] The revenue from Davidson and Rutherford Counties represent a substantial $810,000 of the total. This is less significant than most of the other potential sources.

Sales Tax - Currently the State of Tennessee allows counties to levy up to a 2.75 percent sales tax above the 7 percent state sales tax. Rutherford County levies the full 2.75 percent, while all other counties in the urbanized area have a 2.25 percent tax. The tax rate can be raised by a majority vote.

If all counties were to levy the full allowable tax, approximately $100 million could be raised across the urbanized area in 2008. Revenues of $69 million could be raised in Davidson County alone. This would provide the largest amount of revenues compared to the other potential local revenue sources. However, 50 percent of the sales tax is earmarked for school funding and the other half is available for general allocation, reducing the amount available for transportation[7] by half. Even at $50 million per year, a sales tax is by far the most significant source. Tennessee already has one of the highest sales tax rates in the country, however, and the Nashville-Davidson County has one of the highest combinations of local and state sales taxes at more than 9%. Sales taxes are widely held to be a regressive tax, affecting lower income persons more than those with higher incomes.

Emissions Fee - Certain urban areas in Tennessee require registered cars to receive an emissions test. Within the Nashville MPO region, this includes Davidson, Rutherford, Sumner, Williamson, and Wilson counties. The current fee for an emissions inspection is $10. The test costs $8.20 to administer, giving the state a revenue of $1.80 per vehicle inspection.[8] Raising the emissions fee by $1 would increase revenue by approximately $900,000 in 2008 at the state level; $650,000 would come from Davidson and Rutherford Counties. This would require action of the state legislature, as well as allocation from the state government to the project. Additionally, $900,000 in annual revenue is one of the lowest revenue levels among the local sources.

Gas Tax Increase - Currently the State of Tennessee allows each county to levy a $0.01 per gallon tax on gasoline. No counties in the Nashville region currently apply this tax. Implementation is subject to voter approval and is intended for public transit projects.

A $0.01 per gallon gas tax increase over Davidson, Rutherford, Sumner, Williamson, and Wilson counties would generate approximately $7.8 million revenue dollars in 2008. This is the second highest potential annual revenue among the analyzed sources. Tennessee's gas tax is currently less than the national average, but recently rising fuel costs may make a new gas tax unpopular and, if passed, particularly vulnerable to repeal.

Development Impact Fees – These fees are charged to developers when a new residence or commercial space is added. The intent is to charge new development for the impact it has on shared facilities. Currently a number of counties in the Nashville area charge impact fees. Table 11-4 provides details of the current fees.

Were all counties to add a $100 per dwelling and a $1 per commercial square foot impact fees, the region would generate approximately $3.3 million in revenue in 2008. $3.3 million could be considered mid-range revenue potential. Development fees area one-time charge on property owners or developers and do not represent a continuous revenue stream, so this source might be most appropriate for covering capital costs instead of the annual operating costs. To some degree, impact fees could increase development costs and slow development in the area.

Hotel/Motel Tax - Tennessee law allows counties and cities to levy a privilege tax on hotel and motel stays. This tax is applied as a percentage of the cost of a hotel stay. Currently the hotel tax in Nashville area counties varies between 3 percent and 5 percent.

A 1 percent increase across all counties would create approximately $5.8 million in revenue in 2008. While this is a significant potential revenue source, it is heavily dependent on the receipts from Davidson County. Davidson's hotel tax revenues would represent more than 80 percent of the total revenue and Davidson and Rutherford Counties would represent $4.9 million of the revenue.

A hotel tax may have public support because it is levied on visitors to the region and not residents. However, a hotel tax does not have a strong tie to transportation. Changing the hotel tax rate requires an amendment to the "Private Acts" of the individual county, which is enacted by the state legislature. Additionally, each "Private Act" may prescribe a different allocation of hotel tax revenues, which could prevent them from wholly or partially being used to support public transit service.

Rental Car Tax – This tax is a percentage levied on the cost of a rental car. Currently the State of Tennessee levies a 3% tax on all rental cars.[9] If a 1 percent rental car tax was levied across the region the total revenue would total approximately $400,000 in 2008. Applying the tax to only Davidson and Rutherford Counties would raise an estimated $250,000 per year. A rental car tax may also be more politically acceptable than other local taxes since it will be paid primarily by visitors to the region. However, the prospective revenues are the lowest of the analyzed sources.

Late Model Auto Exemption from Emissions Testing - As described in the emissions fee section, an emission test is required in Davidson, Rutherford, Sumner, Williamson, and Wilson counties. Currently, new automobiles are not required to be inspected during their first year of ownership due to the fact that they nearly always pass. Revenue could be created by charging the emissions testing fee for the first year of ownership without actually performing the testing.

The collection of the $10 fee for exempt new vehicles across the five counties would generate approximately $1.2 million in 2008 (this assumes that the entire $10 fee would be retained by the State of Tennessee because there is no need to cover the costs of testing). The revenue from Davidson and Rutherford Counties is estimated at $740,000. The revenue generated by this option is less than one fifth of the potential revenue from a gasoline tax. It is also worth noting that these revenues are now collected by the Tennessee Department of Environment and Conservation, not by TDOT or another transportation entity, and thus may not be accessible for use to support public transportation. [10]

Sales Tax Increase on Cars - Counties in Tennessee currently are subject to a sales tax, capped at $3,200, but only the first $1,600 is allocated for local use (the remaining revenue is allocated for state use). While most automobile sales likely exceeded the sales cap, raising the limit on the sales tax or allocating the revenue above $1,600 to transit would require state action. Raising the limit specifically on automobiles would create a close tie between the tax increase and transportation. A limited increase of $100 would create approximately $400,000 in revenue for 2008 across the urbanized area. The revenue from Davidson and Rutherford counties is estimated to be $250,000. Both tax bases represent a relatively small revenue stream. Moreover, sales taxes are regressive, affecting lower income individuals more strongly.

Local Revenue Sources' Summary

Table 11-4, shown below, details the likely contribution of each revenue source. The estimates of the potential revenue in 2008, rounded to the nearest ten-thousand to imply the relative imprecision of the estimates. Sales tax clearly has the greatest revenue potential by being at least 6 times greater than the other sources - a 0.5% increase would create approximately $100 million in 2008 revenue, $50 million of which would potentially be available for transit. A hotel tax and motor fuel tax would also be significant when compared to the other analyzed sources. See Appendix 11A for detailed forecasts, assumptions, and methods.

Table 11-4 Potential Local Funding Options Revenue Summary 2008 ($ 1000 YOE)

Source	Wheel Tax (1)	Sales Tax (1) (5)	Emissions Fee (1)	Gas Tax (1) (4)	Impact Fee (1) (4)		Hotel	Rental Car	Late Model Exemption	Tax Cap on Cars
					Residential	Office/Retail				
Increment	**$1**	**0.50%**	**$1**	**$0.01**	**$100/dwel**	**$1/SF**	**1%**	**1%**	**$10**	**$100**
Davidson (Nashville)	$680	$69,000	$550				$4,600	$180	$650	$210
Rutherford (Murfreesboro)	$130	$0	$100				$300	$72	$88	$37
Maury	Not Included in Analysis (3)						$65	$1	$46	$13
Robertson	Not Included in Analysis (3)						$41	$11	$28	$8
Sumner	$120	$5,400	$99				Insufficient Data	$46	$68	$19
Williamson	$130	$24,000	$110				$550	$62	$290	$82
Wilson	$95	$6,100	$76				$210	$33	$47	$14
Davidson - Nashville Totals	**$810**	**$69,000**	**$650**	**Individual Data not Available**	**Individual Data not Available**	**Individual Data not Available**	**$4,900**	**$250**	**$740**	**$250**
Total	**$1,200**	**$100,000**	**$940**	**$7,800**	$1,900	$1,400	**$5,800**	**$410**	**$1,200**	**$380**
					$3,300					

Notes:
1) Values computed using forecasts from the *Regional Transportation Funding—A Strategic Review*, ICF Consulting.
2) All numbers are rounded to 2 significant figures.
3) Forecasts not available in the *Regional Transportation Funding—A Strategic Review,* ICF Consulting.
4) Forecasts were reported as aggregate for entire MPO region.
5) 50% of sales tax revenue are earmarked for school spending.

11.4 Operating Plan

11.4.1 Operating & Maintenance (O&M) Costs

The estimated operating costs of the proposed transit improvements were generated based on miles of service, hours of service, number of vehicles, and administrative costs. The estimating techniques used are described in 9.0 Cost Estimates. The costs shown in Table 11-5 represent additional O&M costs incurred by system improvements. They do not account for existing and continuing operational costs; however, they do incorporate all previous phases' operating costs. So, for example, during phase 2, the total operating costs incurred in 2005 dollars is $11 million and this includes the additional operating and maintenance cost for phases 1 and 2. By the time phase 3 is complete, the total operating cost for the proposed LPA is $28 million, which is almost the same as the current Nashville MTA operating budget.

Table 11-5 Operating Costs of Proposed LPA ($ Millions)

Phase	Annual Incremental Operating Cost Increase (YOE $)	Annual Incremental Operating Cost Increase (2005 $)
1: 1-5 Years (2008-2013)	$4	$4
2: 5-10 Years (2013-2018)	$14	$11
3: 10-25 Years (2018-2033)	$22	$13
Total	$41	$28

Notes:
1) To arrive at YOE dollars, cost estimates in 2005 dollars were escalated based on increases to the consumer price index from US Bureau of Labor Statistics 2002 to 2006 data (2.63%).
2) YOE assumed to be 2010 for phase 1, 2015 for phase 2, and 2025 for phase 3.

11.4.2 Potential Operating and Maintenance Revenue Sources

Operating costs will probably be addressed through a mixture of passenger fare revenues and local sources because these are both revenue sources that are collected on an ongoing basis. The local sources are the same as listed above in the 11.3.2 Potential Capital Revenue Sources section. Passenger fare revenues (in 2005 dollars) under the LPA are estimated to generate the following annual increase over the "No Build" scenario, based on the proposed ridership increases and assuming an average fare of $1.50 for local and $1.75 for express service:

- Between $650,000 and $800,000 with existing land use patterns, or
- Between $900,000 to $1.1 million with transit-supportive modifications to land-use

11.5 Implementation Issues

11.5.1 Other Planned Capital Projects in Region

Consideration must be given to competition for similar capital and operating funds in the Nashville region. The MPO's 2030 Long Range Transportation Plan discusses future alternatives analysis on the following additional corridors:[11]

- I-65 North – Nashville to Sumner County
- I-40 East – Nashville to Lebanon
- I-40 West – Nashville to Bellevue
- I-65 South – Nashville to Williamson County
- Northeast – Nashville to Gallatan

RTA is currently operating a commuter rail line in the I-40 East corridor between Nashville and Lebanon. RTA bus service is in place in the I-65 North corridor to Sumner County and an MIS began in 2007 to consider further improvements in that corridor. If studies were to recommend further transit improvements in these or other corridors, they could compete for similar federal, state, and local funds in the future. Additionally, non-transportation-related capital investments for the region such as new schools, water or sewer system improvements and other public infrastructure investments may draw on the same revenue sources. On the other hand, a region-wide emphasis on transit could be used to justify increases taxes and fees, as well as including all counties in the Nashville MPO as a tax base. A region-wide transit plan may be required to focus attention on transit needs and the potential for transit to shape the region's growth, and to build the regional consensus required to support tax increases. In addition, a wide view of the region's overall capital investment needs including both transit, roadway-based transportation, and other public investment should be considered when determinations are made about funding.

11.5.2 Legislation, Referendum, and Planning Approvals Needed

In order to implement the proposed LPA along the Nashville – Murfreesboro corridor, the Nashville MPO should be aware of the legislative and planning obstacles it might face. MPO and other regional transportation leaders will have to work with appropriate government officials to pass legislation to increase local taxes, as well as bolster public support and address planning approval needs. As described in Table 11-6, revenue sources require a number of different levels and mechanisms of approval. The Tennessee state government must be engaged to raise the hotel tax, emissions fee, impact fee, rental car tax, and the single use items sales tax cap. While other taxes can be changed at the county level they require either a two thirds vote of the county legislature or a majority popular vote. Additionally, planning approval must be gained from local and state authorities.

Table 11-6 Required Action to Utilize Revenue Sources

Tax	Required Government Action
Wheel Tax	Any flat tax is allowed on vehicle registrations. Must be

	passed by 2/3 vote of county legislature or majority vote of county legislature with a referendum.
Sales Tax	Limited at 2.75% by state law. The limit must be changed by the state legislature. The county may raise the sales tax within the limit.
Emissions Fee	This fee is levied at the state level so action of the state legislature would be required to increase the fee.
Gas Tax	State action is required to increase the 1 cent per gallon local limit. Counties can enact this tax specifically for transit funding.
Impact Fee	Must be enacted through Private Act of the county by the state legislature.
Hotel Tax	Must be enacted through Private Act of the county by the state legislature.
Rental Car Tax	Only levied at the state level. Would require new legislation.
Late Model	Would require new legislation.
Tax Cap on Vehicles	Would require action of the state legislature.

11.5.3 Innovative Financing Techniques

Innovative financing methods may also offer potential opportunities to supplement traditional funding sources.. Historically, any financing mechanisms termed “innovative” have primarily been debt instruments. Today, many transit agencies look for new ways to cover costs since costs, led by rising costs of health care for workers, fuel, and building materials, are outpacing the growth of traditional funding sources.

Alternative methods for delivering projects, such as design-build, provide opportunities to accelerate project completion and to limit cost uncertainty. Additionally, outsourcing of operations and maintenance functions, as appropriate and permissible within labor agreements, may be considered to allow agencies to focus on core services as efficiently as possible.

Public-private partnerships (PPPs) for development and operation of transit service (as opposed to assets, which is already typically utilized by transit agencies) are also an area worthy of considerable consideration. PPP activity in the roads sector is quite strong currently, and several transit systems are also under consideration by state/local and private entities. As policymakers and stakeholders become more comfortable with PPPs in the US, transit should see additional activity. Transit oriented development and partnerships with land owners and developers may offer a means to create value for public transportation agencies at and around transit stations.

11.6 Conclusions

Currently, this $248 million (year of expenditure) and 25-year project has no dedicated revenue sources. This chapter has noted available federal, state, and local funding options that offer a funding mix that can potentially cover all costs and generate the necessary political support.

Federal funding is potentially available for this project through a number of programs. 5307, 5309, including the Modernization Program and New Starts and Small Starts, and CMAQ/STP all provide capital funding with varying eligibility requirements. 5307 and CMAQ/STP funding is already allocated to the Nashville region, so it will be up to the Nashville Area MPO officials to decide how much, if any, might be dedicated to this project. Finally, the Small Starts program is a viable funding source that could potentially provide between 60 and 80 percent of the capital funds depending on how this project fares in the competitive process.

State level support of this project is also important because portions of the project will take place on state owned and operated roadways. The TDOT historically has contributed 10 percent of a project's capital cost, which is half of the local match required for federal funding.

Eight local sources were identified as potential funding options. These sources were evaluated to determine revenue potential, ease of implementation, and potential legal limitations. By far, the most significant potential revenue source is the sales tax. If all remaining counties in the Nashville urbanized area were to raise the local sales tax to the 2.75 percent limit, $100 million could be raised in 2008, of which half could be available for transit and other general spending within the area of collection. A gas tax or hotel tax would also raise relatively high revenues ($7.8 million and $5.8 million respectively). While these taxes are not as significant as a sales tax, they do have some advantages. A 1 cent gas tax has already been authorized specifically for transit spending. The hotel tax is advantageous because there is an existing collection mechanism and it would be levied on visitors to the area. The wheel tax may be easiest to implement because it is fairly unrestricted. The only requirement is that it is a flat rate and it has a clear link to transportation. A $1 increase in the wheel tax would create $1.2 million dollars across the Nashville MPO.

The potential revenue sources in this chapter illustrate a mix of federal, state, and local funding. Each of the funding options has specific advantages, requirements, and challenges that must be considered when determining the final capital and operating funding mix.

In order to proceed in obtaining funding for the proposed southeast corridor project, the following list provides suggested action items for the Nashville Area MPO:

1. Amend the MPO's long range transportation plan to include the southeast corridor project
2. Determine who will own and operate the Southeast corridor transit project
3. If interested in seeking Small Starts funding, determine what project alterations are required to meet the eligibility criteria, and then seek FTA approval for entry into Project Development
4. Determine what portion of the project the Tennessee Department of Transportation is willing to fund
5. Develop a financial plan for the project
6. Pursue state legislation approvals and changes associated with any new or increased taxes, as needed

These actions will help to develop a more complete implementation plan, garner the appropriate public support, and obtain the necessary funding sources for the project.

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[1] Federal Transit Administration, *Federal Register FY 06*.
[2] Nashville Area MPO, *Transportation Improvement Plan FY06 through FY08,* September 2005.
[3] ibid
[4] Federal Highway Administration, *2005 Highway Statistics, Table FA – 4*.
[5] TCA 5-8-102
[6] See tax summary table
[7] University of Tennessee, County Technical Assistance Service, *County Tax Statistics*, January 2007.
[8] *Regional Transportation Funding—A Strategic Review*, ICF Consulting
[9] Tennessee Department of Revenue
[10] ibid
[11] Nashville Area MPO, *2030 Long Range Transportation Plan*, June 21 2006.