

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
Alternate 4A-BRT	\$377.9	\$340	\$420
Alternate 4A-LRT	\$691.0	\$620	\$770
Alternate 4A-DMU	\$508.6	\$450	\$560
Alternate 4B-BRT	\$435.3	\$390	\$480
Alternate 4B-LRT	\$781.3	\$700	\$860
Alternate 4B-DMU	\$573.0	\$510	\$640
Alternate 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 CONSTRUCTION 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 CONSTRUCTION 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

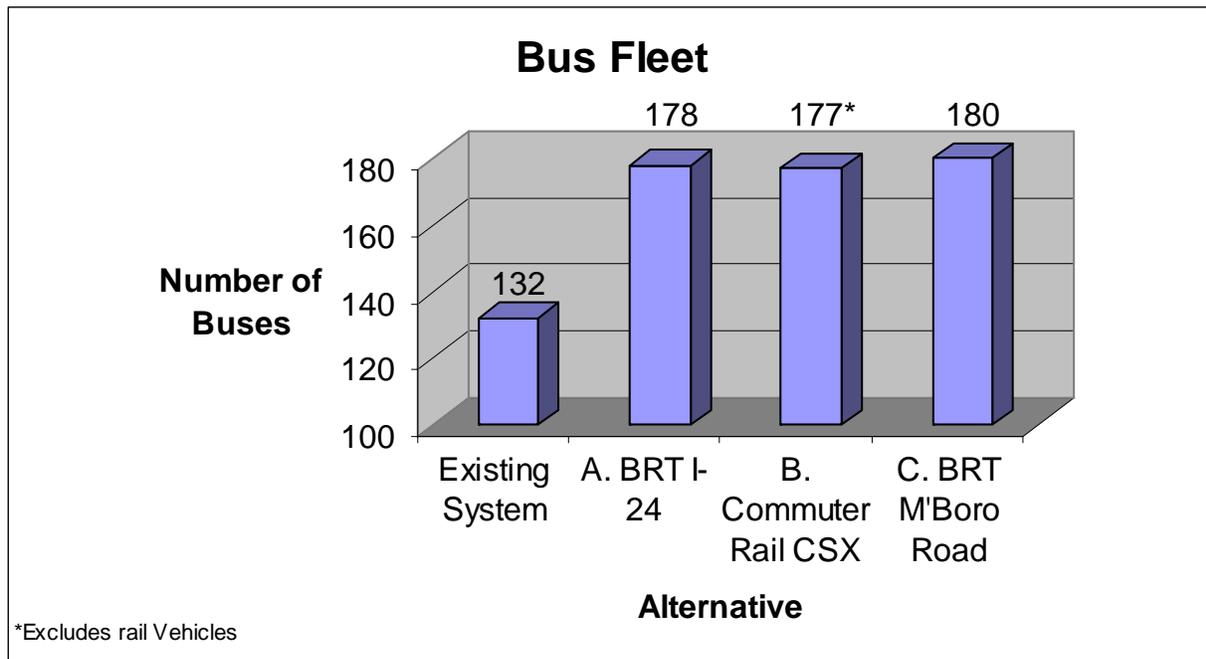
Table 9-4: Alternative C (BRT on I-24) Infrastructure Capital Cost Estimate (2005 Dollars)

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 Rutherford 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 CONSTRUCTION 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			
SITWORK & 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 Submittals 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	Revenue- Vehicle-Hours	Scheduled Revenue- Vehicle-Miles	Peak Vehicles	Annual Cost & Attribution 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)				
<i>Nashville Downtown Area</i>	2.70	Lump	\$ 500,000	\$ 1,350,000
<i>Murfreesboro Downtown Area</i>	3.00	Lump	\$ 250,000	\$ 750,000
Stations				
<i>MTA Transfer Center Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>Church St. Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>Broadway Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>Gateway Blvd. Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>Lafayette Street (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>Trevecca College (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Fesslers Lane (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Thompson Lane (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Donelson Pike/Dell (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Una Antioch Pike (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Bell Road (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Waldron Road (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Sam Ridley Parkway (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Downtown Smyrna (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Nissan Boulevard (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>SR 840 (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Thompson Road (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Downtown Murfreesboro (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>Broad/Tennessee (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>MTSU (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
Subtotal				\$ 3,650,000
Mainline Construction (Single Lane Reversible Busway, Murfreesboro Road)				
<i>North of Thompson Lane to Briley Parkway</i>	0.90	NC-5	\$ 6,223,109	\$ 5,600,798
<i>Reedwood (south of Harding/Donelson) to Rural Hill</i>	2.90	NC-4	\$ 6,223,109	\$ 18,047,016
<i>Queue Jump, Enon Springs, McNickle Drive</i>	0.70	NC-5	\$ 6,223,109	\$ 4,356,176
<i>Thompson Lane to Church Street (Murfreesboro)</i>	3.00	NC-7	\$ 6,223,109	\$ 18,669,327
Mainline Construction (Queue Jump Facilities at I-24 Interchanges)				
<i>Bell Road</i>	0.25	NC-4	\$ 6,223,109	\$ 1,555,777
<i>Waldron Road</i>	0.25	NC-4	\$ 6,223,109	\$ 1,555,777
<i>Sam Ridley Parkway</i>	0.25	NC-4	\$ 6,223,109	\$ 1,555,777
<i>Nissan Boulevard (Limited Stop Route Station)</i>	0.25	NC-4	\$ 6,223,109	\$ 1,555,777
<i>SR 96</i>	0.25	NC-4	\$ 6,223,109	\$ 1,555,777
Subtotal				\$ 54,452,204
OTHER CONSRUCTION ITEMS				
<i>Facility</i>				\$ -
<i>Traffic Engineering Improvements</i>				\$ 10,500,000
RIGHT-OF-WAY				
<i>Station Land</i>			\$ 125,000	\$ 5,000,000
<i>Mainline ROW</i>			\$ 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 Per Mile	BRT Cost Per Segment
Streetscape-Stop Improvements, downtown areas (Lump Sum)				
<i>Nashville Downtown Area</i>		Lump	\$ 500,000	
<i>Murfreesboro Downtown Area</i>		Lump	\$ 250,000	
Stations				
<i>MTA Transfer Center Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>Church St. Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	
<i>Broadway Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	
<i>Gateway Blvd. Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	
<i>Lafayette Street (Downtown Station Stop)</i>		STA. 1	\$ 150,000	
<i>Trevecca College (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Fessler's Lane (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Thompson Lane (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Donelson Pike/Dell (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Una Antioch Pike (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Bell Road (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Waldron Road (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Sam Ridley Parkway (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Downtown Smyrna (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Nissan Boulevard (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>SR 840 (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Thompson Road (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Downtown Murfreesboro (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>Broad/Tennessee (Downtown Station Stop)</i>		STA. 1	\$ 150,000	
<i>MTSU (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Subtotal</i>				\$ 700,000
Mainline Construction (Single Lane Reversible Busway, Murfreesboro Road)				
<i>North of Thompson Lane to Briley Parkway</i>		NC-5	\$ 6,223,109	
<i>Reedwood (south of Harding/Donelson) to Rural Hill</i>		NC-4	\$ 6,223,109	
<i>Queue Jump, Enon Springs, McNickle Drive</i>		NC-5	\$ 6,223,109	
<i>Thompson Lane to Church Street (Murfreesboro)</i>		NC-7	\$ 6,223,109	
<i>Subtotal</i>				\$ -
OTHER CONSTRUCTION ITEMS				
<i>Facility</i>				\$ -
<i>Traffic Engineering Improvements</i>				\$ 3,000,000
RIGHT-OF-WAY				
<i>Station Land</i>			\$ 125,000	\$ 1,000,000
<i>Mainline ROW</i>			\$ 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 Per Mile	BRT Cost Per Segment
Streetscape-Stop Improvements, downtown areas (Lump Sum)				
<i>Nashville Downtown Area</i>	1.35	Lump	\$ 500,000	\$ 675,000
<i>Murfreesboro Downtown Area</i>	1.50	Lump	\$ 250,000	\$ 375,000
Stations				
<i>MTA Transfer Center Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	
<i>Church St. Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	
<i>Broadway Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>Gateway Blvd. Station (Downtown Station Stop)</i>		STA. 1	\$ 150,000	
<i>Lafayette Street (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>Trevecca College (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Fesslers Lane (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Thompson Lane (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Donelson Pike/Dell (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Una Antioch Pike (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Bell Road (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Waldron Road (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Sam Ridley Parkway (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Downtown Smyrna (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>Nissan Boulevard (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	\$ 200,000
<i>SR 840 (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Thompson Road (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Downtown Murfreesboro (Downtown Station Stop)</i>		STA. 1	\$ 150,000	
<i>Broad/Tennessee (Downtown Station Stop)</i>		STA. 1	\$ 150,000	\$ 150,000
<i>MTSU (Limited Stop Route Station)</i>		STA. 2	\$ 200,000	
<i>Subtotal</i>				\$ 2,250,000
Mainline Construction (Single Lane Reversible Busway, Murfreesboro Road)				
<i>North of Thompson Lane to Briley Parkway</i>		NC-5	\$ 6,223,109	
<i>Reedwood (south of Harding/Donelson) to Rural Hill</i>		NC-4	\$ 6,223,109	
<i>Queue Jump, Enon Springs, McNickle Drive</i>		NC-5	\$ 6,223,109	
<i>Thompson Lane to Church Street (Murfreesboro)</i>		NC-7	\$ 6,223,109	
Mainline Construction (Queue Jump Facilities at I-24 Interchanges)				
<i>Bell Road</i>	0.25	NC-4	\$ 6,223,109	\$ 1,555,777
<i>Waldron Road</i>	0.25	NC-4	\$ 6,223,109	\$ 1,555,777
<i>Sam Ridley Parkway</i>	0.25	NC-4	\$ 6,223,109	\$ 1,555,777
<i>Nissan Boulevard (Limited Stop Route Station)</i>	0.25	NC-4	\$ 6,223,109	\$ 1,555,777
<i>SR 96</i>	0.25	NC-4	\$ 6,223,109	\$ 1,555,777
<i>Subtotal</i>				\$ 7,778,886
OTHER CONSTRUCTION ITEMS				
<i>Facility</i>				\$ -
<i>Traffic Engineering Improvements</i>				\$ 3,500,000
RIGHT-OF-WAY				
<i>Station Land</i>			\$ 125,000	\$ 3,000,000
<i>Mainline ROW</i>			\$ 2,000,000	\$ 4,920,000
TOTALS FOR ALTERNATIVE	4.10		---	\$ 22,498,886