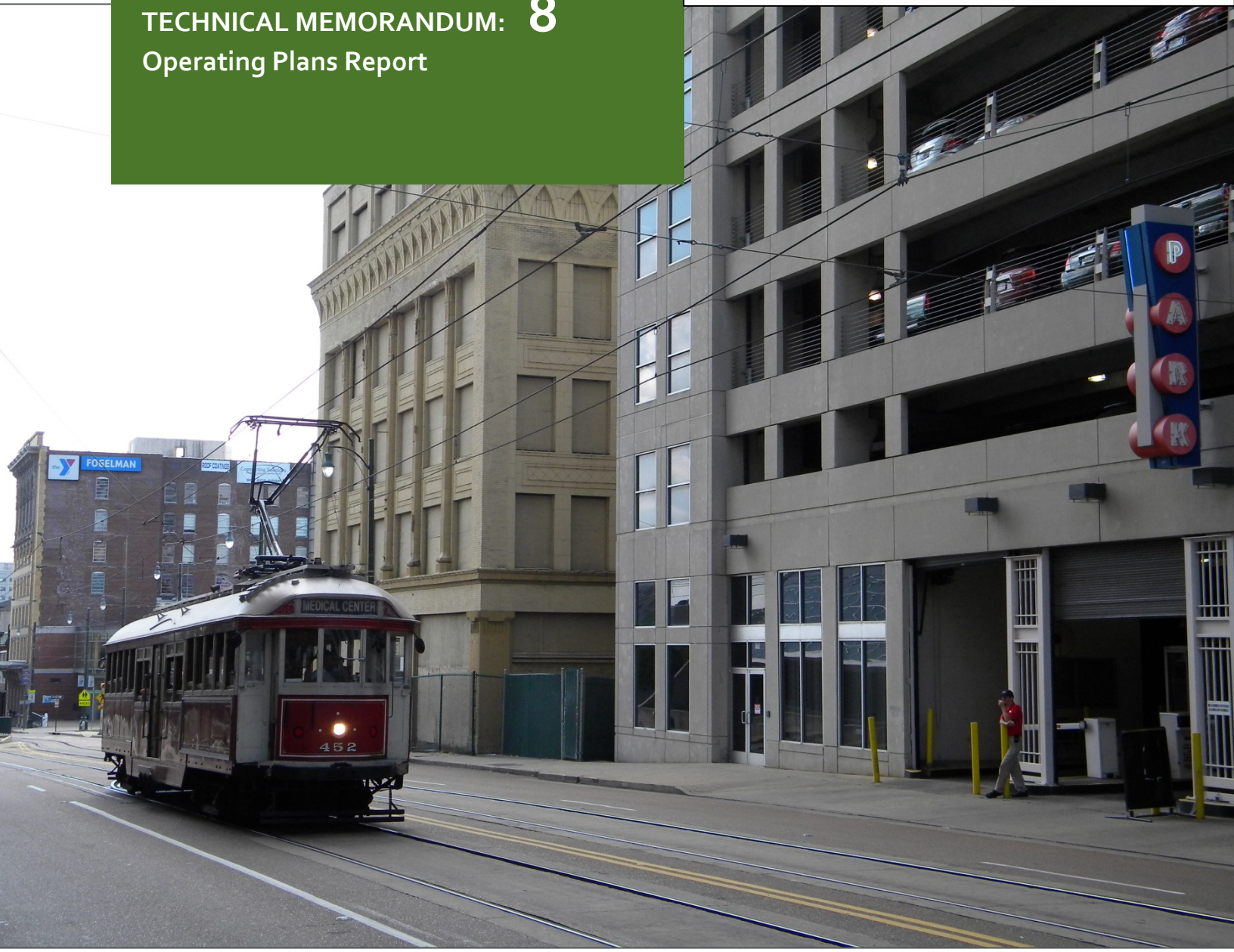
MEMPHIS AREA TRANSIT AUTHORITY

Midtown

Alternatives Analysis

THE MAC
Midtown Area Connector
Connecting Memphis from the Inside Out

TECHNICAL MEMORANDUM: 8
Operating Plans Report



July 2014

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Section 1|

Transit Operating Plans

The Memphis Midtown Alternatives Analysis is a multi-phase process designed to select a Locally Preferred Alternative (LPA) for improved High Capacity Transit (HCT) service such as light rail, streetcar, and/or BRT in Memphis' Midtown corridor. The process included an initial identification of potential alignments, a Tier 1 screening of these potential alignments to narrow the list down, the development of mode-specific service alternatives, and a Tier 2 Service Alternative evaluation to select a LPA. To guide decision-making during the AA phase and through the project's state and federal environmental processes, MATA has developed this technical report discussing the project's potential Transit Operating Plans.

Development of Final Alternatives

The study team began by soliciting input from stakeholders and the public to identify a long list of alignments that might be suitable for HCT. These candidate alignments were then pre-screened to eliminate any alignments that had significant drawbacks that would compromise their feasibility, ensuring that all the alignments to be analyzed would meet the most basic requirements for HCT service. These basic requirements were threefold:

- Alignments must serve sufficient population and employment density to generate sufficient demand for HCT service.
- Alignments must have adequate terminal anchors.
- Alignments must meet MATA's service design guidelines for good transit service design.

The process identified 16 potential alignments that meet the minimum requirements for HCT and were carried forward into the Tier 1 Screening (see Figure 1-1). Subsequently, the study team furthered narrowed the potential alignments to the following seven corridors:

Alignment 6 Airport via Poplar and Airways. Alignment 6 would serve Poplar Avenue, East Parkway, and Airways Boulevard between downtown Memphis and the Memphis International Airport. This alignment would serve downtown Memphis, Le Bonheur Children's Hospital, the VA Medical Center, Overton Park, the Levitt Shell, Christian Brothers University, the Kroc Center, Lamar/Airways Shopping Center, Airways Transit Center, and the airport. This alignment would serve several important transfer locations, at Cleveland Street, Cooper Street, East Parkway, Southern Avenue, Park Avenue, and Lamar Avenue.

Alignment 7 Germantown via Poplar. Alignment 7 would serve Poplar Avenue between downtown Memphis and Exeter Village Shopping Center in Germantown. This alignment would serve downtown Memphis, Le Bonheur Children's Hospital, the VA Medical Center, Overton Park, the Brooks Museum, the Levitt Shell, the Memphis College of Art, Benjamin Hooks Central Library, the University of Memphis, Oak Court Mall, Eastgate Shopping Center, Le Bonheur East Hospital, and Exeter Village Shopping Center. This alignment would serve a very important transfer location at Poplar Avenue and Cleveland Street.

Alignment 8 U of M via Poplar, Cooper and Union. Alignment 8 would serve Poplar Avenue, Cooper Street, and Union Avenue between downtown Memphis and the University of Memphis. This alignment would serve downtown Memphis, Le Bonheur Children's Hospital, the VA Medical Center, Overton Park, the Brooks Museum, the Levitt Shell, the Memphis College of Art, Overton Square, Benjamin Hooks Central Library, and the University of Memphis. This alignment would serve a very important transfer location at Poplar Avenue and Cleveland Street.

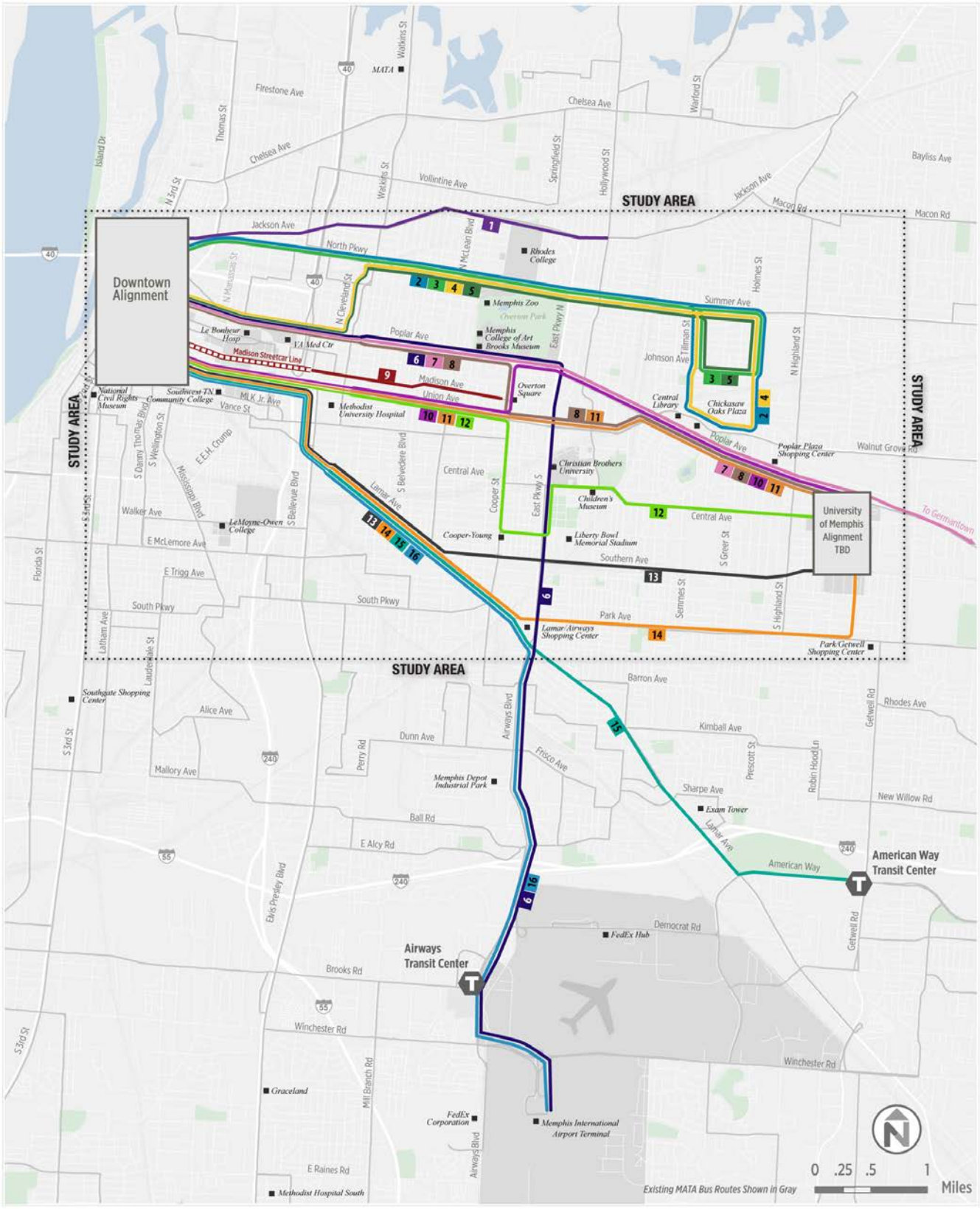
Alignment 9 Overton Square via Madison. Alignment 9 would extend the Madison Avenue trolley 1.5 miles from its current eastern terminus at Cleveland Street to Cooper Street. As an extension of the existing Madison Avenue trolley, this alignment's mode would be limited to trolley. This alignment would serve Minglewood Hall, Overton Square, and the various retail and commercial stores along Madison Avenue.

Alignment 11 U of M via Union and Poplar. Alignment 11 would serve Poplar Avenue and Union Avenue between downtown Memphis and the University of Memphis. This alignment would serve downtown Memphis, Southwest Tennessee Community College, Methodist University Hospital, Overton Square, Benjamin Hooks Central Library, and the University of Memphis. The alignment would serve an important location of transfer activity at Cleveland Street and Bellevue Boulevard. Depending on the alignment downtown, it could also serve AutoZone Park.

Alignment 23 Overton Square via Madison. Alignment 23 would serve Elvis Presley Boulevard, S. Bellevue Boulevard, N. Cleveland Street, and Watkins Street.This alignment is the only alignment that would serve Graceland on south side of Memphis. It would also serve the Methodist University Hospital. This alignment would also serve an important location of transfer activity at Union Avenue, Madison Avenue, and Popular Avenue.

Alignment 26 U of M via Union and Poplar. Alignment 26 would serve Union Avenue, Cooper Street, and Central Avenue between downtown Memphis and the University of Memphis. It would serve downtown Memphis, Southwest Tennessee Community College, Methodist University Hospital, Overton Square, Christian Brothers University, the Memphis Fairgrounds, and the University of Memphis. The alignment would serve an important location of transfer activity at Cleveland Street and Bellevue Boulevard. Depending on the alignment downtown, it could also serve AutoZone Park.

Figure 1: Potential Alignments



Section 2|

Integration with Other Transportation Modes

The Final Alternative alignments have been planned and conceptually designed to promote a seamless interface with other transportation modes. Interface requirements and potential impacts with MATA's bus and streetcar service, as well as and general traffic and pedestrian movements, are discussed in this section.

Interface with MATA's Bus and Streetcar Service

MATA provides fixed route bus, streetcar, and paratransit services throughout the Memphis metropolitan area. MATA operates a fleet of about 100 buses, 40 paratransit vans, and 10 streetcars, delivering more than 32,400 weekday trips and 9.4 million annual trips (MATA FY2014 National Transit Database report). The development of the Final Alternative service plans will incorporate the following goals in order to integrate the proposed premium transit alternatives with other existing and planned transit services:

- Promote and enhance connectivity in study area and region.
- Encourage routes that connect with proposed stations.
- Modify or eliminate duplicative service.
- Increase frequency, where warranted, to generate additional ridership.

Interface with General Traffic

The Final Alternatives feature either Bus Rapid Transit (BRT) or Streetcar technologies. In each case, the BRT and Streetcar alternatives are designed to operate in shared traffic lanes or semi-exclusive lanes. BRT buses will have to accelerate and decelerate in response to traffic congestion and signalized intersections. Segments will be identified where the BRT may require dedicated queue jump lanes and/or transit signal priority in order to allow for improved bus speeds and reliability.

Section 3|

Estimated BRT and Streetcar Travel Times

Preliminary estimates of round-trip travel times are based on vehicle performance characteristics for typical BRT buses and Streetcar vehicles, alignments and station locations, civil speed restrictions, station dwell times, and estimated signalized intersection delays. This section describes the vehicle performance characteristics and estimated station-to-station run times.

Vehicle Performance Characteristics

BRT and Streetcar vehicles typically have a maximum design speed of up to 55 miles per hour. However, the BRT and Streetcar alignments are designed to run on semi-exclusive and shared lanes, where the maximum speed is limited along sections of the alignment due to horizontal curve restrictions, signalized intersections spacing, interaction with automobile traffic, and civil speed limits for in-street operations imposed by affected jurisdictions. The BRT and Streetcar maximum speeds have been assumed to not exceed the corresponding civil speed limit for general traffic, usually 25 to 45 mph, for each roadway section of the alignment.

Vehicle Capacity and Passenger Load Standards

Vehicle capacity and passenger loading standards have been established in order to determine fleet requirements based on service frequency assumptions. A BRT vehicle has a seated capacity of 40 to 60 passengers, depending on the vehicle type (standard 40-foot or articulated 60-foot), and can accommodate 20 to 30 standing passengers, respectively. The typical Streetcar has a seated capacity of about 50 to 75 passengers, and can accommodate 30 to 40 standing passengers. The capacities of both vehicles will be used to balance vehicle availability against service demand during peak periods and special events.

Estimated Station-to-Station Run Times

Station-to-station run times were calculated using BRT and Streetcar performance characteristics. Fifteen (15) second station average dwell times were assumed for all stations. Each BRT and Streetcar alternative assumed transit signal priority along some segments of the alignment. Run time estimates are representative of service with traffic congestion during the peak hour, but may not capture delays due to "peak of the peak" congestion.

Tables 1 through **7** present detailed station-to-station run time estimates for each alternative.

Table 1: Estimated Run Time - Alternative 6

On Street	*At Street*	*Run Time (hr:min:sec)*
N Main Street	North Main Terminal	00:00:00
2nd Street	Jackson Avenue	00:01:27
2nd Street	Poplar Avenue	00:02:59
Poplar Avenue	N Lauderdale Street	00:04:16
Poplar Avenue	High Street	00:05:21
Poplar Avenue	Hamplin Place	00:06:16
Poplar Avenue	Manassas Street	00:07:21
Poplar Avenue	Le Bonheur Hospital (Ashland Street)	00:08:36
Poplar Avenue	VA Medical	00:10:01
Poplar Avenue	N Bellevue Boulevard	00:11:16
Poplar Avenue	N Cleveland Boulevard	00:12:31
Poplar Avenue	Stonewall Street	00:13:46
Poplar Avenue	Center City Shopping Center / Angelus Street	00:15:01
Poplar Avenue	McLean Boulevard	00:16:37
Poplar Avenue	Overton Park	00:17:42
Poplar Avenue	Cooper Street	00:18:57
Poplar Avenue	N Edgewood Street	00:20:02
East Parkway	Court Avenue	00:21:38
East Parkway	Union Avenue	00:23:13
East Parkway	Christian Brothers University	00:24:18
East Parkway	Central Avenue	00:25:33
East Parkway	Evelyn Avenue	00:26:28
East Parkway	Young Avenue	00:27:23
East Parkway	South Parkway	00:29:19
East Parkway	Park Avenue	00:30:34
East Parkway	Lamar Avenue	00:31:49
Airways Boulevard	Malone Avenue	00:32:44
Airways Boulevard	Lowell Avenue	00:33:59
Airways Boulevard	Dunn Avenue	00:35:56
Airways Boulevard	Memphis Depot	00:37:01
Airways Boulevard	Dwight Road	00:38:16
Airways Boulevard	Ball Road	00:39:21
Airways Boulevard	Ketchum Road	00:40:36
Airways Boulevard	Democrat Road	00:42:23
Airways Boulevard	Director's Row	00:43:48
Airways Boulevard	Airways Transit Center	00:45:13
Airways Boulevard	Winchester Road	00:46:59
Winchester Road	Jim McGehee Parkway	00:48:45
Jim McGhee Parkway	Memphis International Airport	00:50:22
		00:50:22

Table 2: Estimated Run Time - Alternative 7

On Street	*At Street*	*Run Time (hr:min:sec)*
N Main Street	North Main Terminal	00:00:00
2nd Street	2nd and Jackson Avenue	00:01:37
2nd Street	2nd and Market Avenue	00:03:29
Poplar Avenue	N Lauderdale Street	00:05:01
Poplar Avenue	High Street	00:06:12
Poplar Avenue	Hamplin Place	00:07:03
Poplar Avenue	Manassas Street	00:08:22
Poplar Avenue	Le Bonheur Hospital (Ashland Street)	00:09:48
Poplar Avenue	VA Medical	00:11:20
Poplar Avenue	N Bellevue Boulevard	00:12:42
Poplar Avenue	N Cleveland Boulevard	00:14:04
Poplar Avenue	Stonewall Street	00:15:29
Poplar Avenue	Center City Shopping Center / Angelus Street	00:16:53
Poplar Avenue	McLean Boulevard	00:18:47
Poplar Avenue	Overton Park	00:20:03
Poplar Avenue	Cooper Street	00:21:32
Poplar Avenue	N Edgewood Street	00:22:34
Poplar Avenue	N Hollywood Street	00:24:26
Poplar Avenue	N Bingham Street	00:25:45
Poplar Avenue	Scott Street	00:27:37
Poplar Avenue	Tillman Street	00:29:30
Poplar Avenue	Chicksaw Oaks Plaza	00:30:52
Poplar Avenue	Marne Street / East High School	00:32:04
Poplar Avenue	S Century Street	00:33:16
Poplar Avenue	Highland Street	00:34:47
Poplar Avenue	Deloach Street / University of Memphis	00:36:16
Poplar Avenue	E Galloway Drive	00:37:42
		00:37:42

Table 3: Estimated Run Time - Alternative 8

On Street	*At Street*	*Run Time (hr:min:sec)*
N Main Street	North Main Terminal	00:00:00
2nd Street	Jackson Avenue	00:01:40
2nd Street	Market Avenue	00:03:17
Poplar Avenue	N Lauderdale Street	00:04:56
Poplar Avenue	High Street	00:06:07
Poplar Avenue	Hamplin Place	00:06:58
Poplar Avenue	Manassas Street	00:08:16
Poplar Avenue	Le Bonheur Hospital (Ashland Street)	00:09:43
Poplar Avenue	VA Medical	00:11:15
Poplar Avenue	N Bellevue Boulevard	00:12:37
Poplar Avenue	N Cleveland Boulevard	00:13:59
Poplar Avenue	Stonewall Street	00:15:24
Poplar Avenue	Center City Shopping Center / Angelus Street	00:16:48
Poplar Avenue	McLean Boulevard	00:18:42
Poplar Avenue	Overton Park	00:19:58
Poplar Avenue	Cooper Street	00:21:27
Cooper Street	Madison (Overton Square)	00:23:08
Cooper Street	Union Avenue	00:24:21
Union Avenue	Edgewood Street	00:25:28
Union Avenue	East Parkway / Memphis Theo. Seminary	00:26:37
Union Avenue	Patricia Drive	00:27:28
Union Avenue	S. Alicia Drive	00:28:39
Poplar Avenue	Tillman Street	00:31:28
Poplar Avenue	Chicksaw Oaks Plaza	00:32:27
Poplar Avenue	Marne Street (East High School)	00:33:41
Poplar Avenue	S. Century Street	00:34:53
Poplar Avenue	Highland Street	00:36:49
Highland Street	Central Avenue	00:38:37
Central Avenue	Deloach Street	00:40:28
Central Avenue	University of Memphis	00:42:23
		00:42:23

Table 4: Estimated Run Time - Alternative 9

On Street	*At Street*	*Run Time (hr:min:sec)*
Main Street	Court Square	00:00:00
Madison Avenue	4th Street	00:02:12
Madison Avenue	Danny Thomas Boulevard	00:03:51
Madison Avenue	Orleans Street	00:05:27
Madison Avenue	Dunlap Street	00:07:13
Madison Avenue	Pauline Street	00:08:56
Madison Avenue	Montgomery Street	00:11:06
Madison Avenue	Cleveland Street	00:12:23
Madison Avenue	McNeil Street	00:13:38
Madison Avenue	Avalon Street	00:14:51
Madison Avenue	Evergreen Street	00:16:06
Madison Avenue	McLean Boulevard	00:17:23
Madison Avenue	Rembert Street	00:18:42
Madison Avenue	Overton Square / Cooper Street	00:20:07
Cooper Street	Union Avenue	00:21:20
Cooper Street	Vinton Avenue	00:22:47
Cooper Street	Central Avenue	00:24:17
Central Avenue	Cox Street (New York)	00:25:14
Central Avenue	East Parkway	00:26:27
Central Avenue	Early Maxwell Boulevard	00:27:44
		00:27:44

Table 5: Estimated Run Time - Alternative 11

On Street	*At Street*	*Run Time (hr:min:sec)*
Main Street	North Main Street	00:00:00
2nd Street	Jackson Avenue	00:02:30
2nd Street	Market Avenue	00:03:27
2nd Street	Jefferson Avenue	00:05:30
2nd Street	Madison Avenue	00:07:22
2nd Street	Union Avenue	00:08:48
Union Avenue	4th Street	00:10:04
Union Avenue	S Lauderdale Street	00:11:47
Union Avenue	Manassas Street	00:13:34
Union Avenue	S Pauline Street	00:15:44
Union Avenue	Bellevue Boulevard	00:17:23
Union Avenue	S Cleveland Street	00:18:42
Union Avenue	McNeil Street	00:20:02
Union Avenue	S Avalon Street	00:21:00
Union Avenue	S Belvedere Boulevard	00:22:12
Union Avenue	S McLean Boulevard	00:23:40
Union Avenue	S Rembert Street	00:24:42
Union Avenue	Cooper Street	00:26:05
Union Avenue	Edgewood Street	00:27:06
Union Avenue	East Parkway	00:28:13
Union Avenue	Patricia Drive	00:29:04
Union Avenue	S Alicia Drive	00:30:15
Poplar Avenue	Scott Street	00:31:43
Poplar Avenue	Tillmann Street	00:33:23
Poplar Avenue	Chicksaw Oaks Plaza	00:34:23
Poplar Avenue	Marne Street / East High School	00:35:21
Poplar Avenue	S Century Street	00:36:38
Poplar Avenue	Highland Street	00:38:33
Highland Avenue	Central Avenue	00:40:21
Central Avenue	Deloach Street	00:42:13
W Tiger Paw	Parking Lot	00:44:03
		00:44:03

Table 6: Estimated Run Time - Alternative 23

On Street	*At Street*	*Run Time (hr:min:sec)*
Watkins Street	Delano Avenue	00:00:00
Watkins Street	1515 N Watkins St	00:04:48
Watkins Street	Levee Road	00:06:14
Watkins Street	Chelsea Avenue	00:07:27
Watkins Street	Brown Avenue (Saints Court Apt)	00:08:41
Watkins Street	Vollintine Avenue	00:09:41
Watkins Street	Henry Avenue	00:10:28
Watkins Street	Jackson Avenue	00:11:42
Watkins Street	Tutwiler Avenue	00:12:29
Watkins Street	North Parkway	00:14:21
Cleveland Street	Overton Park Avenue	00:15:32
Cleveland Street	Poplar Avenue	00:16:23
Cleveland Street	Madison Avenue	00:17:51
Cleveland Street	Union Avenue	00:18:48
Union Avenue	Methodist University Hospital	00:19:45
Bellevue Boulevard	Peabody Avenue	00:21:19
Bellevue Boulevard	Lamar Avenue	00:22:30
Bellevue Boulevard	Heistan Place	00:23:36
Bellevue Boulevard	Walker Avenue	00:24:43
Bellevue Boulevard	McLemore Ave	00:25:52
Bellevue Boulevard	E Trigg Avenue	00:26:51
Bellevue Boulevard	South Parkway	00:27:47
Elvis Presley Boulevard	S Montgomery Street	00:29:09
Elvis Presley Boulevard	E Person Avenue	00:30:16
Elvis Presley Boulevard	Kimball Avenue	00:31:27
Elvis Presley Boulevard	Dunn Avenue	00:32:38
Elvis Presley Boulevard	Elliston Road	00:33:48
Elvis Presley Boulevard	Norris Road	00:35:00
Elvis Presley Boulevard	Alcy Road	00:36:19
Elvis Presley Boulevard	Carlton Road	00:36:59
Elvis Presley Boulevard	Clementine Road	00:38:01
Elvis Presley Boulevard	Brooks Road	00:39:59
Elvis Presley Boulevard	Gateway Drive	00:40:58
Elvis Presley Boulevard	Winchester Road	00:42:07
Elvis Presley Boulevard	Bluebird Road	00:43:00
Elvis Presley Boulevard	Graceland (3734 Elvis Presley Blvd)	00:44:13
Elvis Presley Boulevard	Laudeen Drive	00:45:29
Elvis Presley Boulevard	Family Dollar (4045 Elvis Presley Blvd)	00:46:19
Elvis Presley Boulevard	E Raines Road	00:47:13
		00:47:13

Table 7: Estimated Run Time - Alternative 26

On Street	*At Street*	*Run Time (hr:min:sec)*
N Main Street	North Main Terminal	00:00:00
2nd Street	Jackson Avenue	00:02:02
2nd Street	Market Avenue	00:03:02
2nd Street	Jefferson Avenue	00:05:26
2nd Street	Madison Avenue	00:07:00
2nd Street	Union Avenue	00:08:26
Union Street	4th Street	00:09:43
Union Street	S. Lauderdale Street	00:11:28
Union Street	S. Manassas Street	00:13:18
Union Street	S. Pauline Street	00:15:26
Union Street	S. Bellevue Boulevard	00:17:02
Union Street	S. Cleveland Street	00:18:21
Union Street	Kimbrough Place/S. McNeil Street	00:19:43
Union Street	S. Avalon Street	00:20:42
Union Street	S. Belvedere Boulevard	00:21:53
Union Street	S. McLean Boulevard	00:23:19
Union Street	S. Rembert Street	00:24:22
Union Street	Cooper Street	00:25:47
Cooper Street	Vinton Avenue	00:27:11
Cooper Street	Central Avenue	00:28:37
Central Avenue	New York Street	00:29:33
Central Avenue	E. Parkway Street	00:30:45
Central Avenue	Early Maxwell Boulevard	00:31:57
Central Avenue	S. Hollywood Street	00:33:15
Central Avenue	Buntyn Street	00:34:36
Central Avenue	W. Goodwyn Street	00:36:24
Central Avenue	Lafayette Street	00:37:20
Central Avenue	S. Greer Street	00:38:42
Central Avenue	S. Reese Street	00:39:45
Central Avenue	Highland Street	00:41:07
Central Avenue	Deloach Street / University of Memphis	00:43:00
Central Avenue	Zach H Curlin Street / University of Memphis	00:44:49
		00:44:49

Section 4|

Operating Plans

The BRT and Streetcar operating plans include general operating assumptions for each Final Alternative. The operating plans include the following level of service assumptions.

Span of Service

The BRT and Streetcar span of service is assumed to operate from 5:00 am to 12:00 am on weekdays, as shown in Table 8. Local bus service would be operated on Saturdays, Sundays, and holidays. BRT and Streetcar vehicles would run every 10 minutes during AM Peak, Midday, and PM Peak periods, and every 20 minutes in the evening.

Table 8: BRT & Streetcar Span of Service and Service Frequency

Day of Week	*Time Period*	*Time*	*Hours*	*Frequency*
Monday-Friday	AM Peak	5:00am - 8:30am	3.5	10 min.
	Midday	8:30am - 3:30pm	7.0	10 min.
	PM Peak	3:30pm – 6:30pm	3.0	10 min.
	Evening	6:30pm - 12:00am	5.5	20 min.
		Weekday Total	19.0	

Cycle Time and Layover Time

The cycle time consists of round-trip run time, and layover time and must be divisible by the proposed headway to determine peak vehicle requirements. Operations plans include time at the end-of-line for layovers to provide operators enough time to switch between tracks and vehicle cabs, take breaks, as required by union agreement, as well as provide for schedule recovery (i.e., a late bus or train can "catch up" to its schedule).

Peak and Fleet Vehicle Requirements

The peak vehicle requirement was calculated for each premium transit service, incorporating operating requirements based on service frequency and cycle times. The maintenance spare ration (MSR) was then applied to the peak vehicle requirement to determine the total fleet requirement, in order to estimate associated capital costs with procurement of new bus and rail vehicles. A 20% MSR is assumed for the BRT and Streetcar vehicle fleet, which is a commonly accepted standard in the transit industry.

Summary of Operating Requirements

Table 9 presents a summary of the operating requirements for operations for each of the alternatives, including peak vehicles, annual-vehicle hours, and vehicle miles. Tables 10 through 16 present the operations requirements for each of the alternatives.

Table 9: Summary of Operating Requirements

Alternative	One-Way Run Time	One-Way Distance	Peak Vehicles	Fleet Vehicles	Ann. Rev. Vehicle-Miles	Ann. Rev. Vehicle-Hours
6	50.37	11.75	11	13	584,400	46,300
7	37.70	7.81	9	11	388,400	36,600
8	42.38	8.49	10	12	422,400	41,440
9	27.73	5.10	7	8	253,500	29,720
11	30.77	8.63	7	8	429,100	29,720
23	47.22	11.04	11	13	548,900	44,890
26	44.82	9.10	10	12	452,400	41,440

Table 10: Operating Requirements - Alternative 6

			Span of Service & Service Frequency				*Cycle Time and Daily Trips*			*Operating Requirements*		
	Day of Week	*Annual Days*	*Time Period*	*Span of Service*	*Hours*	*Headway*	*Layover Time*	*Round Trip Cycle Time*	*One-Way Trips*	*Annual Revenue Miles*	*Annual Revenue Hours*	*Peak Vehicle Requirement*
Alignment 6	Monday-Friday	255	AM Peak	5:00am - 8:30am	3.5	10	9.3	110.0	42	125,900	9,820	11
			Midday	8:30am - 3:30pm	7.0	10	9.3	110.0	84	251,700	19,640	11
			PM Peak	3:30pm - 6:30pm	3.0	10	9.3	110.0	36	107,900	8,420	11
			Evening	6:30pm - 12:00am	5.5	20	19.3	120.0	33	98,900	8,420	6
									BRT Subtotal	**584,400**	**46,300**	**11**

Table 11: Operating Requirements - Alternative 7

			Span of Service & Service Frequency				*Cycle Time and Daily Trips*			*Operating Requirements*		
	Day of Week	*Annual Days*	*Time Period*	*Span of Service*	*Hours*	*Headway*	*Layover Time*	*Cycle Time*	*One-Way Trips*	*Annual Revenue Miles*	*Annual Revenue Hours*	*Peak Vehicle Requirement*
Alignment 7	Monday-Friday	255	AM Peak	5:00am - 8:30am	3.5	10	14.6	90.0	42	83,700	8,030	9
			Midday	8:30am - 3:30pm	7.0	10	14.6	90.0	84	167,300	16,070	9
			PM Peak	3:30pm - 6:30pm	3.0	10	14.6	90.0	36	71,700	6,890	9
			Evening	6:30pm - 12:00am	5.5	20	4.6	80.0	33	65,700	5,610	4
									BRT Subtotal	**388,400**	**36,600**	**9**

Table 12: Operating Requirements - Alternative 8

			Span of Service & Service Frequency				*Cycle Time and Daily Trips*			*Operating Requirements*		
	Day of Week	*Annual Days*	*Time Period*	*Span of Service*	*Hours*	*Headway*	*Layover Time*	*Cycle Time*	*One-Way Trips*	*Annual Revenue Miles*	*Annual Revenue Hours*	*Peak Vehicle Requirement*
Alignment 8	Monday-Friday	255	AM Peak	5:00am - 8:30am	3.5	10	15.3	100.0	42	91,000	8,930	10
			Midday	8:30am - 3:30pm	7.0	10	15.3	100.0	84	181,900	17,850	10
			PM Peak	3:30pm - 6:30pm	3.0	10	15.3	100.0	36	78,000	7,650	10
			Evening	6:30pm - 12:00am	5.5	20	15.3	100.0	33	71,500	7,010	5
									BRT Subtotal	**422,400**	**41,440**	**10**

Table 13: Operating Requirements - Alternative 9

			Span of Service & Service Frequency				Cycle Time and Daily Trips			Operating Requirements		
Alignment 9	Day of Week	Annual Days	Time Period	Span of Service	Hours	Headway	Layover Time	Cycle Time	One-Way Trips	Annual Revenue Miles	Annual Revenue Hours	Peak Vehicle Requirement
	Monday-Friday	255	AM Peak	5:00am - 8:30am	3.5	10	14.5	70.0	42	54,600	6,250	7
			Midday	8:30am - 3:30pm	7.0	10	14.5	70.0	84	109,200	12,500	7
			PM Peak	3:30pm - 6:30pm	3.0	10	14.5	70.0	36	46,800	5,360	7
			Evening	6:30pm - 12:00am	5.5	20	24.5	80.0	33	42,900	5,610	4
									BRT Subtotal	**253,500**	**29,720**	**7**

Table 14: Operating Requirements - Alternative 11

			Span of Service & Service Frequency				Cycle Time and Daily Trips			Operating Requirements		
Alignment 11	Day of Week	Annual Days	Time Period	Span of Service	Hours	Headway	Layover Time	Cycle Time	One-Way Trips	Annual Revenue Miles	Annual Revenue Hours	Peak Vehicle Requirement
	Monday-Friday	255	AM Peak	5:00am - 8:30am	3.5	10	8.5	70.0	42	92,400	6,250	7
			Midday	8:30am - 3:30pm	7.0	10	8.5	70.0	84	184,900	12,500	7
			PM Peak	3:30pm - 6:30pm	3.0	10	8.5	70.0	36	79,200	5,360	7
			Evening	6:30pm - 12:00am	5.5	20	18.5	80.0	33	72,600	5,610	4
									BRT Subtotal	**429,100**	**29,720**	**7**

Table 15: Operating Requirements - Alternative 23

			Span of Service & Service Frequency				Cycle Time and Daily Trips			Operating Requirements		
Alignment 23	Day of Week	Annual Days	Time Period	Span of Service	Hours	Headway	Layover Time	Cycle Time	One-Way Trips	Annual Revenue Miles	Annual Revenue Hours	Peak Vehicle Requirement
	Monday-Friday	255	AM Peak	5:00am - 8:30am	3.5	10	15.5	110.0	42	118,200	9,820	11
			Midday	8:30am - 3:30pm	7.0	10	15.5	110.0	84	236,500	19,640	11
			PM Peak	3:30pm - 6:30pm	3.0	10	15.5	110.0	36	101,300	8,420	11
			Evening	6:30pm - 12:00am	5.5	20	5.5	100.0	33	92,900	7,010	5
									BRT Subtotal	**548,900**	**44,890**	**11**

Table 16: Operating Requirements - Alternative 26

			Span of Service & Service Frequency				Cycle Time and Daily Trips			Operating Requirements		
Alignment 26	Day of Week	Annual Days	Time Period	Span of Service	Hours	Headway	Layover Time	Cycle Time	One-Way Trips	Annual Revenue Miles	Annual Revenue Hours	Peak Vehicle Requirement
	Monday-Friday	255	AM Peak	5:00am - 8:30am	3.5	10	10.4	100.0	42	97,400	8,930	10
			Midday	8:30am - 3:30pm	7.0	10	10.4	100.0	84	194,900	17,850	10
			PM Peak	3:30pm - 6:30pm	3.0	10	10.4	100.0	36	83,500	7,650	10
			Evening	6:30pm - 12:00am	5.5	20	10.4	100.0	33	76,600	7,010	5
									BRT Subtotal	**452,400**	**41,440**	**10**

Section 5|

Estimated Operating and Maintenance Costs

Annual operations and maintenance (O&M) cost estimates were developed for each of the Final Alternatives based on the operating plans described above, and fully allocated O&M cost models were developed from recent MATA National Transit Database reports and other sources.

MATA BRT and Streetcar O&M Unit Costs

The O&M model and cost estimation methods are consistent with the Federal Transit Administration (FTA) guidelines by developing fully allocated cost models utilizing multiple supply variables. O&M models were developed for both the BRT and Streetcar alternatives. The BRT O&M unit costs and cost estimates were prepared utilizing MATA's FY 2014 National Transit Database (NTD) operating and financial data for fixed route bus service, along with typical BRT station maintenance costs derived from similar BRT systems across the U.S.

Expenses were categorized by operating function (i.e. vehicle operation, vehicle maintenance, non-vehicle maintenance, and general administration) and broken out by the following expense categories reported:

- Operator Salaries & Wages
- Other Salaries & Wages
- Fringe Benefits
- Services
- Fuel & Lubricants
- Tires & Tubes
- Other Materials & Supplies
- Utilities
- Casualty & Liability
- Taxes
- Expense Transfers

Operating expenses, by operating function and expense category, were then allocated to one of the following driving supply variables:

- **Stations**: Total number of stations along the alignment (BRT only). This is based on reported station maintenance costs, per station location, for cleaning and maintenance of BRT stations.
- **Directional Route-Miles**: Total mileage in one direction that the vehicle travels while in revenue service (Streetcar only). Directional route-miles is an important O&M variable for Streetcar O&M costs because it is directly related to both track and catenary maintenance.
- **Garages or Yards**: Total number of maintenance storage facilities including bus garages and Streetcar maintenance and storage yards. For each of the BRT and Streetcar alternatives, it was assumed that MATA's existing facilities could accommodate the additional BRT and Streetcar vehicles, with only minor modifications.
- **Annual Revenue Bus/Train-Hours**: Total hours of revenue service operated by all BRT buses or Streetcar trains in one year.
- **Annual Revenue Bus/Car-Miles**: Total miles of revenue service operated by all BRT buses or Streetcar vehicles in one year.
- **Peak Vehicles**: The maximum number of BRT or Streetcar vehicles required for scheduled peak service.

The following equations, shown in **Table 17**, summarize the fully-allocated cost model used to estimate annual O&M costs for BRT and Streetcar operations:

Table 17: BRT and Streetcar Annual O&M Cost Equations

BRT										
Estimated Annual O&M Cost	=	Stations Unit Cost **X** Projected BRT Stations	+	Garage Unit Cost **X** Projected Garages	+	Bus-Hour Unit Cost **X** Projected Bus-Hours	+	Bus-Miles Unit Cost **X** Projected Bus-Miles	+	Peak Vehicles Unit Cost **X** Projected Peak Vehicles
Streetcar										
Estimated Annual O&M Cost	=	Route-Mile Unit Cost **X** Projected Route-Miles	+	Yard Unit Cost **X** Projected Yards	+	Train-Hour Unit Cost **X** Projected Train-Hours	+	Car-Mile Unit Cost **X** Projected Car-Miles	+	Peak Vehicles Unit Cost **X** Projected Peak Vehicles

Unit costs were then calculated based on actual total expenses and units of service supplied for each variable reported. Operating expenses assigned to each variable were then summed and divided by units of service to derive unit costs. **Tables 18** and **19** show the estimated BRT and Streetcar unit costs, respectively.

Table 18: BRT Annual O&M Unit Costs

	FULL ALLOCATION				
Expense Object	Garages	Bus-Hours	Bus-Miles	Peak Buses	BRT Stations
Operators Salaries/Wages	$0	$11,139,685	$0	$0	$0
Other Salaries/Wages	$333,474	$1,333,897	$4,001,691	$1,000,423	$0
Fringe Benefits	$270,600	$10,121,778	$3,247,201	$811,800	$0
Services	$241,307	$120,654	$1,689,149	$361,961	$0
Fuel & Lubricants	$0	$0	$5,251,861	$0	$0
Tires & Tubes	$0	$0	$3,624,104	$0	$0
Other Materials & Supplies	$74,344	$37,172	$520,409	$111,516	$0
Utilities	$314,512	$0	$0	$943,535	$0
Casualty/Liability	$0	$0	$0	$0	$0
Taxes	$0	$0	$0	$0	$0
Purchased Transportation	$0	$0	$0	$0	$0
Miscellaneous Expenses	$39,658	$19,829	$138,801	$198,288	$0
Expense Transfers	$0	$0	$0	$0	$0
	$1,273,895	$22,773,014	$18,473,216	$3,427,522	$0
Units of Service	1	434,710	5,714,650	137	1
FY 2014 Unit Cost	$1,273,895	$52.39	$3.23	$25,018	$10,000
Unit Cost (2016 Dollars)	$1,371,597	$56.40	$3.48	$26,937	$10,767

Variables:

1. Garages = number of bus storage and maintenance garages.
2. Hours = actual annual revenue bus-hours.
3. Miles = actual annual revenue bus-miles.
4. Buses = maximum buses operated in peak service.
5. Proposed BRT stations (from project alternatives).

Table 19: Streetcar Annual O&M Unit Costs

	FULL ALLOCATION				
	Yards	Train-Hrs	Car-Miles	Peak Veh.	Dir. Rt.-Miles
Operators Salaries/Wages	$0	$934,651	$0	$0	$0
Other Salaries/Wages	$92,960	$139,440	$511,279	$92,960	$92,960
Fringe Benefits	$71,419	$825,202	$392,805	$71,419	$71,419
Services	$43,646	$21,823	$283,697	$43,646	$43,646
Fuel & Lubricants	$0	$0	$16,393	$0	$0
Tires & Tubes	$59,644	$0	$178,933	$0	$0
Other Materials & Supplies	$33,775	$0	$236,422	$33,775	$33,775
Utilities	$11,367	$0	$85,250	$5,683	$11,367
Casualty/Liability	$0	$0	$0	$0	$0
Taxes	$0	$0	$0	$0	$0
Purchased Transportation	$0	$0	$0	$0	$0
Miscellaneous Expenses	$0	$0	$0	$1,428	$0
Expense Transfers	$0	$0	$0	$0	$0
	$312,810	$1,921,115	$1,704,778	$248,910	$253,166
Units of Service	1	42,119	309,748	10	10.0
Unit Cost (2013 Dollars	$312,810	$45.61	$5.50	$24,891	$25,317
Unit Cost (2016 Dollars)	$326,992	$47.68	$5.75	$26,020	$26,464

Variables:

1. Yards = number of storage and maintenance yards.
2. Route-miles = directional route-miles.
3. Train-hours = actual annual revenue train-hours.
4. Car-miles = actual annual revenue car-miles.
5. Vehicles = maximum streetcars operated in peak service.

BRT and Streetcar Estimated O&M Costs

Based on the operating plans and level of service for the BRT and Streetcar alternatives developed for the project, O&M costs were calculated by applying unit costs derived from the fully allocated model to the projected operating statistics. Costs were estimated using 2014 dollars, and inflated to 2016 dollars using a three percent annual inflation rate. O&M cost estimates are shown in **Table 20**.

Table 20: BRT and Streetcar Estimated Annual O&M Costs

	Incremental Annual O&M Costs				
Alternative	**Garages**	**Bus-Hours**	**Bus-Miles**	**Peak Buses**	**BRT Stations**
Alternative 6 (BRT)					
Units	0	46,300	584,400	11	39
Unit Cost by Variable	$1,371,597	$56.40	$3.48	$26,937	$10,767
Incremental Cost by Variable	$0	$2,611,530	$2,034,024	$296,309	$423,500
Total Incremental BRT Cost					$5,365,364
Alternative 7 (BRT)					
Units	0	36,600	388,400	9	27
Unit Cost by Variable	$1,371,597	$56.40	$3.48	$26,937	$10,767
Incremental Cost by Variable	$0	$2,064,406	$1,351,840	$242,435	$290,708
Total Incremental BRT Cost					$3,949,388
Alternative 8 (BRT)					
Units	0	41,440	422,400	10	30
Unit Cost by Variable	$1,371,597	$56.40	$3.48	$26,937	$10,767
Incremental Cost by Variable	$0	$2,337,404	$1,470,178	$269,372	$324,547
Total Incremental BRT Cost					$4,401,500
Alternative 11 (BRT)					
Units	0	29,720	429,100	7	23
Unit Cost by Variable	$1,371,597	$56.40	$3.48	$26,937	$10,767
Incremental Cost by Variable	$0	$1,676,342	$1,493,497	$188,561	$247,640
Total Incremental BRT Cost					$3,606,040
Alternative 23 (BRT)					
Units	0	44,890	548,900	11	39
Unit Cost by Variable	$1,371,597	$56.40	$3.48	$26,937	$10,767
Incremental Cost by Variable	$0	$2,531,999	$1,910,465	$296,309	$417,480
Total Incremental BRT Cost					$5,156,254
Alternative 26 (BRT)					
Units	0	41,440	452,400	10	32
Unit Cost by Variable	$1,371,597	$56.40	$3.48	$26,937	$10,767
Incremental Cost by Variable	$0	$2,337,404	$1,574,594	$269,372	$344,941
Total Incremental BRT Cost					$4,526,311

	Incremental Annual O&M Costs				
Alternative	**Yards**	**Train-Hrs**	**Car-Miles**	**Peak Veh.**	**Dir. Rt.-Miles**
Alternative 9 (Streetcar)					
Units	0	29,720	253,500	7	10.2
Unit Cost by Variable	$326,992	$47.68	$5.75	$26,020	$26,464
Incremental Cost by Variable	$0	$1,417,033	$1,458,456	$182,137	$269,936
Total Incremental BRT Cost					$3,327,561

NOTES:

1. All costs estimated in 2016 dollars.