Cotton Belt Corridor Regional Rail

Operations and Maintenance Cost Methodology and Results Technical Memorandum

September 6, 2013
(Update to prior June 24, 2013 memo)

Prepared for Dallas Area Rapid Transit
General Planning Consultant Managed by URS Corporation

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1.0 INTRODUCTION

The Cotton Belt Corridor Regional Rail project proposes regional rail service along an east-west rail corridor passing through portions of Collin, Dallas and Tarrant counties in North Central Texas. The corridor's planning history stretches back for almost 30 years.

This document presents operations and maintenance (O&M) cost estimates for the Cotton Belt Corridor Regional Rail alternatives and describes the process by which annual O&M costs have been estimated. Rail alternatives in this project would affect DART's existing bus operations and also light rail connections at one station on the Red Line.

1.1 Project Background

Some noteworthy milestones in the history of the Cotton Belt Rail corridor are:

- The corridor has been included in various DART service plans since 1983.
- Also beginning in 1983, the corridor has been included in the North Central Texas Council of Governments (NCTCOG) metropolitan transportation plans as an alignment alternative for passenger rail.
- In 1990, DART purchased 52 miles of the corridor for potential future passenger rail.
- In 2005, the Fort Worth Transportation Authority (The T) initiated planning for the Southwest-to-Northeast Rail Corridor Project (now known as TEX Rail), which would implement passenger rail service between southwest Fort Worth and Dallas/Fort Worth International Airport (DFW Airport) by 2013. This rail corridor uses the Cotton Belt Corridor from Tower 60 in Fort Worth to DFW Airport.
- In 2006, the DART Board of Directors adopted the *2030 Transit System Plan* which included the Cotton Belt corridor as the preferred alignment for east-west service between the Red Line light rail transit (LRT) system and DFW Airport.
- DART completed the *Cotton Belt Corridor Environmental Review* in September 2008.
- In 2009, the Cotton Belt corridor was included in the NCTCOG's long-range transportation plan, *Mobility 2030: The Metropolitan Transportation Plan for the Dallas-Fort Worth Area – 2009 Amendment*. With an anticipated DART revenue service date between 2025 and 2030, local and regional leaders are exploring possible ways to accelerate service to this corridor, including a public-private partnership funding option.
- To help accelerate the revenue service date for the Cotton Belt Rail, in 2010 NCTCOG conducted a *Conceptual Engineering and Funding Study* (CE&FS). The introduction to this study's report is the primary source of the milestone information listed above.

Potential private partners noted that more detailed project definition and environmental clearance would be needed before advancing the project. Accordingly, DART is leading the effort to develop and consider alternatives and document environmental effects. It is in connection with this documentation that operations and maintenance cost estimates were produced for the Cotton Belt Corridor Regional Rail project.

1.2 Project Alternatives

As documented in the project's *Transit Operating Plans Technical Memorandum* (updated September 2013), the Cotton Belt Corridor Regional Rail project is completing the evaluation of transit alternatives that would add to the system DART operated in 2012:

- No-Build: The No-Build Alternative includes existing (i.e., Spring of 2012) transit service plus the DART's Orange Line Extension and The T's TEX Rail project, both to Dallas-Fort Worth International Airport. One bus route would be realigned to terminate at the Jack Hatchell Transit Center. There would be no changes to existing service frequencies for the remaining 24 defined bus routes in the Cotton Belt corridor.

- Build Alternative 1: Build Alternative 1 reflects a Cotton Belt alignment from DFW Terminal A/B to Shiloh Road with a north alignment in Plano. There are two variations for this alternative in the Cypress Waters area. Alternative 1a would deviate from the railroad corridor to serve a station at North Lake. Alternative 1b would remain in the railroad corridor and there would be no North Lake Station. Alternative 1 stations between the DFW Terminal A/B and Shiloh Road would be at DFW North, North Lake (Alternative 1a only), Downtown Carrollton, Addison Transit Center, Knoll Trail, Preston Road, Renner Village, University of Texas at Dallas (UTD)/Synergy, 12th Street, and Shiloh Road. Rail service would operate every 20 minutes during peak periods and hourly in the midday. Most bus routes in the corridor would have no change to alignment or service frequency; some of them would serve new rail stations along their existing alignments. A few routes would be extended or their alignments deviated to serve rail stations; most route frequencies would remain unchanged. Three new bus routes would be added.

- Build Alternative 2: Build Alternative 2 reflects a Cotton Belt alignment between DFW Terminal A/B and Shiloh Road with a south alignment in Richardson/Plano. There are two variations for this alternative in the Cypress Waters area. Alternative 2a would deviate from the railroad corridor to serve a station at North Lake. Alternative 2b would remain in the railroad corridor and there would be no North Lake Station. Stations would be almost identical to the corresponding variations in Alternative 1, except between the UTD/Synergy and 12th Street stations, where the alignment would also serve the existing President George Bush Turnpike (PGBT) LRT station. As such, the majority of proposed bus operations would not change in relation to Build Alternative 1. Rail service would operate every 20 minutes during peak periods and hourly in the midday.

The two Build Alternatives would interface at a new Red Line LRT station in Plano. **Figure 1-1** illustrates the proposed Cotton Belt rail alignments under consideration for this project.

Two Minimum Operating Segment options have been identified:

- MOS Alternative 1: The Minimum Operating Segment (MOS) Alternative 1 reflects a Cotton Belt alignment from DFW Airport to Downtown Carrollton. The stations for the MOS Alternative are at DFW, DFW North, North Lake, and Downtown Carrollton. Rail service would operate every 20 minutes during peak periods and hourly in the midday. New bus routes would provide convenient connections between DFW and Downtown Carrollton, and between Addison and Plano.

- MOS Alternative 2: The Minimum Operating Segment (MOS) Alternative 2 reflects a Cotton Belt alignment from DFW Airport to Addison Road. Stations for the MOS Alternative are at DFW, DFW North, North Lake, Downtown Carrollton, and Addison. Rail service would operate every 20 minutes during peak periods and hourly in the midday. A new bus route would provide convenient connections between Addison and Plano.

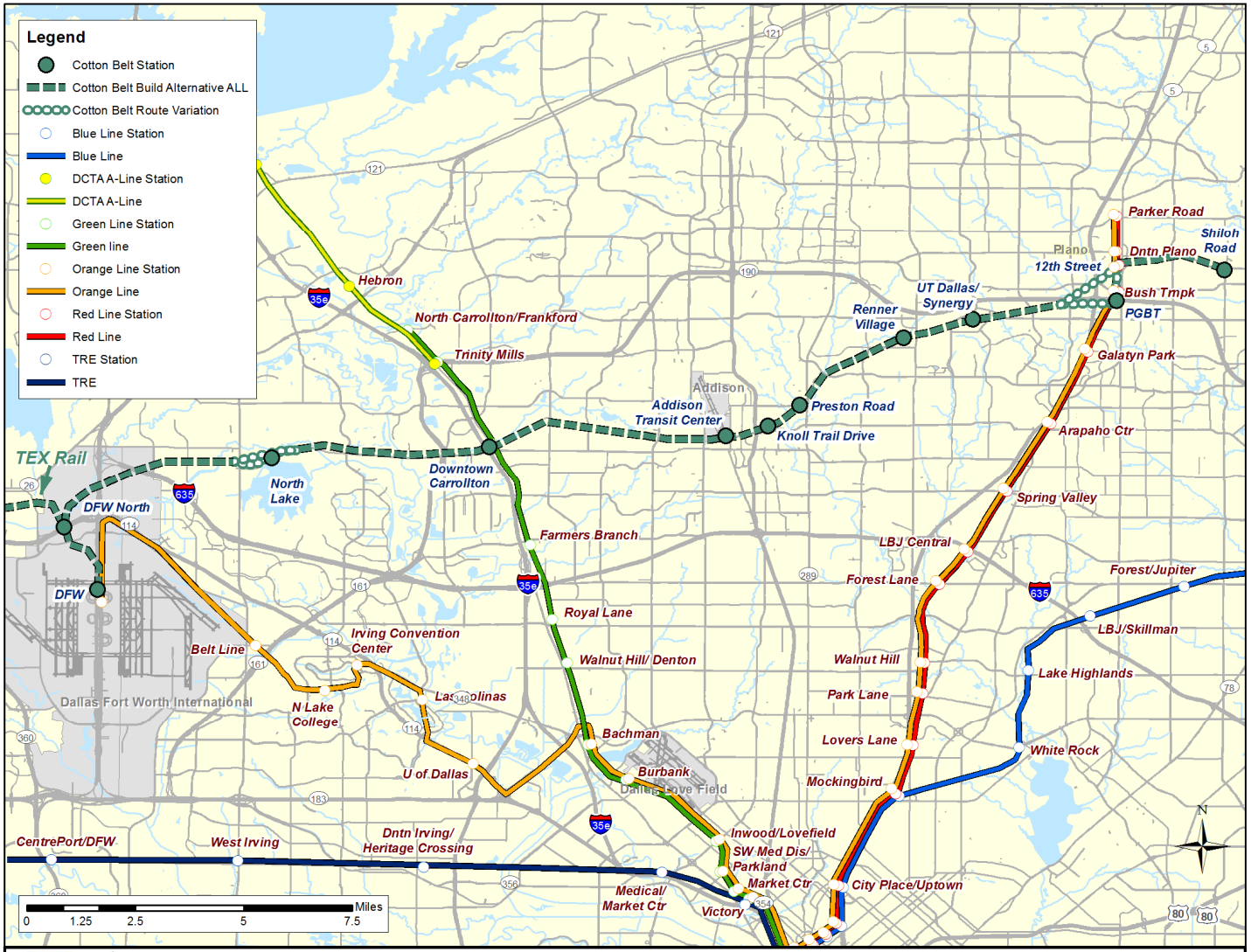

Figure 1-1
All Rail Build Alternatives

2.0 O&M COSTING OVERVIEW

Operations and maintenance cost estimates are important in the planning process because design-year projections are one of the inputs required to determine a project's cost effectiveness. An O&M cost model estimates the annual cost to operate, maintain and administer a transit system for a given set of service indicators. O&M costs are expressed as the annual total of employee wages & salaries, fringe benefits, contract services, materials & supplies, utilities and other day-to-day expenses incurred in the operation and maintenance of a transit system.

In general, steps of the O&M cost estimating process are:

1. Develop methodology for estimating O&M costs
2. Develop appropriate cost model(s) to evaluate alternatives
3. Calibrate the model for current year operations
4. Generate operating plans and statistics for each study alternative
5. Estimate annual transit operating and maintenance costs for each study alternative

This memorandum documents all but Step 4, as they have been applied to the Cotton Belt Corridor Regional Rail project. The project's operating plans and service plan definitions are documented separately. Capital cost estimates, for construction and equipment purchases, are not part of the O&M cost estimating process.

The Federal Transit Administration (FTA) believes the fully-allocated cost model is the best approach to O&M costing, because it is: a) able to reflect cost differences by mode and service type; b) structured based on actual operating experience; and c) sensitive to future changes in cost factors. The FTA has issued guidelines that specify the following methodology for calculating O&M costs:

- Compute costs by estimating labor and materials needed to provide a current level of service, and then apply unit costs to the estimated future labor and material cost items;
- Calculate costs based on operating characteristics by mode (e.g., LRT train-hours) rather than for all modes combined (e.g., system-wide passengers);
- Model each reported labor and non-labor expense separately to ensure that equations are mutually exclusive and cover all operating costs; and
- Model expense items as variable, meaning that cost estimates will change with projected changes in service.

A cost allocation model assumes that each expense incurred by a transit system is 'driven' by a key supply variable such as revenue-hours, revenue-miles, or the number of peak vehicles. Combining recent actual O&M costs with the quantity of relevant supply variables establishes unit costs and productivity ratios. These mathematical relationships can then be applied to different sets of service indicators (such as projected future expansions or cut-backs). The result is an estimated annual cost specific to each test scenario.

2.1 General Model Structure

The structure of the Cotton Belt O&M cost models is consistent with the spreadsheet table exhibits presented in Chapter 4, Operating and Maintenance Costs, of FTA's *Procedures and Technical Methods for Transit Project Planning* (Draft Version 3). The model's data and calculations progress from the base year expense items and amounts on the left side of the spreadsheet, through the assignment of driving

variables, to productivity and inflation, and end with the estimated incremental cost of a study alternative on the right side of the spreadsheet.

- Line Items and Base Year Costs: The first section of a cost model contains O&M expense line items, a recent annual expense for each item and a column for noting whether a line item's existing unit cost is adjusted in the model or a new unit cost has been added.

- Base Year Unit Costs: As pointed out in the FTA guidelines, O&M costs are related to (or 'driven' by) different supply variables. Supply variables can be considered causal because as they increase, so do the related expenses. The second section of a spreadsheet model is for the supply variable unit cost rates; one column is designated for each variable used as a driver for estimating the cost of a project alternative. Usually, unit rates are calculated by dividing the actual annual expense for the line item by the value of the relevant supply variable. For example, if bus operators' salaries and wages cost the transit agency $54,800,000 annually, and 2,009,500 revenue hours of service is the associated supply variable, then the unit cost rate for operators' salaries and wages would be $27.27 per revenue hour. In other words, the model would adjust this line item by $27.27 for each revenue hour of service that is added or cut from the system in a tested scenario.

- Productivity Ratios: Line item productivity ratios are calculated in the third section of the model with columns that display the resource variable used for the calculation (which may be the line item's supply variable, or it may be something else related to the supply variable, such as work hours for salary and wage expenses), the value of the resource variable, and the factor that results from dividing the resource value by the supply value.

- Estimated Cost of a Test Scenario: For each line item expense, the last columns in the spreadsheet contain the base year resource unit cost (supply variable unit cost divided by resource/supply factor), an inflation factor, and the model estimates of resource unit cost and annual cost. The Cotton Belt Rail models are designed to allow inflation of DART's 2010 base year expenses to represent 2012 dollars using the Bureau of Labor Statistics' Consumer Price Index (CPI-U) for the Dallas-Fort Worth area.

2.2 Cotton Belt O&M Models

The Cotton Belt Rail project alternatives require O&M costs to be estimated for DART bus and light rail transit, as well as regional rail. Since DART currently operates bus and light rail transit in the region, these models are based on DART's actual expenses, system characteristics and service statistics as reported to the National Transit Database (NTD) for the 2010 report year. Regional rail is anticipated to be different from the existing Trinity Railway Express (TRE), jointly operated by DART and the T. The regional rail alternative is envisioned to resemble Denton County Transportation Authority's (DCTA) A-Train, which initiated revenue service in 2011. For purposes of O&M cost estimation, regional rail in the Cotton Belt corridor is assumed to be provided by the same contract operator and with the same type of vehicle as is used for the A-Train service. A separate cost model has therefore been prepared for regional rail, primarily using the 2013 budget for DCTA's A-Train. This budget reflects the first full year of operation with the Stadler fleet, the same vehicles assumed for the Build Alternatives of this study. In addition, the regional rail cost model incorporates some of the general administration elements from the more established TRE to represent DART's oversight of a new regional rail service. Annual O&M costs for all Cotton Belt alternatives are presented in 2012 dollars. Each O&M cost model is described in following sections of this document.

3.0 BUS O&M COST METHODOLOGY

The DART bus O&M cost model is based on 2010 expenses and service statistics for directly-operated motor buses as reported to the NTD. The cost model is intended to estimate the additional expenses, or savings, related to changes in the background bus service that accompany each of the project's Build Alternatives.

3.1 Key Supply Variables

After collection of financial and service data, preparation of the spreadsheet cost model began with the selection of key driving supply variables for the existing bus system. Variables selected were:

- *Annual Revenue Bus-Hours* - account for the hours that vehicles travel while in revenue service over the entire fiscal year. Revenue bus-hours include layover and schedule recovery, but exclude time for deadhead, operator training and maintenance testing.

- *Annual Revenue Bus-Miles* - are the miles that vehicles travel while in revenue service over the entire fiscal year. Revenue bus-miles include layover and schedule recovery, but exclude miles for deadhead, operator training and maintenance testing. The model distinguishes bus-miles operated by existing vehicle fuel type: diesel and liquefied natural gas (LNG), and also includes compressed natural gas (CNG) bus-miles to account for DART's future bus fleet plans.

- *Total Peak Buses* - is the maximum number of passenger service vehicles actually operated simultaneously on an average weekday. In some cases, peak buses may be used as a supply variable when the model needs to base line item expenses on overall bus system size.

- *Operating Garages* - are the number of garages from which buses are dispatched into service. These garages also serve as general purpose maintenance facilities for inspecting, servicing and maintenance work on buses.

- *Bus Passenger Facilities* - for the bus system passenger facilities include transit centers, transfer centers and park-and-ride lots.

Table 3-1 shows the key supply variables and values used to represent the model's base year [fiscal year (FY) 2010] inputs.

Table 3-1 DART Bus O&M Cost Model - Supply Variable Inputs	
Supply Variable Inputs	**2010 Existing**
Bus	
Annual Revenue Bus-Hours	2,009,486
Annual Revenue Bus-Miles - Diesel	20,492,744
Annual Revenue Bus-Miles- LNG	6,830,915
Annual Revenue Bus-Miles- CNG	0
Total Peak Buses	556
Operating Garages (buses dispatched into svc.)	3
Bus Passenger Facilities	14

DART owns one garage that has been closed as a vehicle operations facility for cost-saving purposes and functions only as a non-revenue vehicle shop; this garage has not been included in the cost model.

For existing bus passenger facilities, DART staff reported nine transit centers, two transfer centers and three park-and-ride lots as of August 23, 2011 for a total of 14 facilities. These passenger facilities are treated equally in the model to provide a simple simulation for the incremental cost of adding new facilities that may be associated with a project alternative.

3.2 Line Item Expenses

After selecting the key supply variables, the next step in model development was to record DART's bus expenses as a series of line items. The agency's NTD report format categorizes operating expenses within the four functional areas of Vehicle Operations, Vehicle Maintenance, Non-Vehicle Maintenance and General Administration. Within these functional areas, line item expenses are further classified as salaries & wages, fringe benefits, services, materials & supplies, utilities, casualty and liability, taxes & fees and miscellaneous. Various NTD reports and supplemental information provided by DART staff enabled additional line items to be modeled in greater detail. DART staff indicated that certain line item expenses in the NTD actually are influenced by more than one of the model's supply variables. Accordingly, DART identified the specific line items and the appropriate driving variables and percentage splits for use in the model. These splits are based on DART staff's experiences with operating expenditures. Split line items include:

- *Vehicle Operations*: Non-Operator Salaries & Wages are 80% driven by revenue bus-hours and 20% driven by the number of operating garages. Fringe Benefits are allocated proportionally to the same driving variables.

- *Vehicle Maintenance*: Salaries & Wages, Fringe Benefits, Fuel & Lubricants and Tires & Tubes are also 80% driven by revenue bus-hours and 20% driven by the number of operating garages.

- *Non-Vehicle Maintenance*: Salaries & Wages, Fringe Benefits, Professional & Technical Services and Materials & Supplies are 90% driven by the number of operating garages and 10% driven by the number of bus passenger facilities.

The model incorporates NTD-reported employee work hours as a resource variable for estimating salaries and wages by functional area for the project alternatives. Fringe benefit cost estimates in the model also pivot off labor work hours.

The bus O&M cost model breaks down revenue miles by fuel type (diesel and LNG) and uses gallons of fuel as the resource variable for estimating those fuel costs in the future. DART staff provided their estimated cost of $0.33/mile for CNG, which the model uses as the unit cost for future year alternatives. DART intends to convert 100% of its bus fleet to CNG-fueled buses.

After the line items were established, each one was assigned a key supply variable as its most relevant cost driver, then unit costs and productivity ratios were calculated.

Table 3-2 summarizes the dollar impact that each of the bus model's key supply variables has on the calibration system (2010 base year). The unit costs in this table reflect the dollar amount the model will adjust for each added or deleted unit of a supply variable – the incremental change from the calibration bus system. In other words, for each CNG revenue bus-mile added, the model will increase its total estimate by $2.00; for each revenue bus-hour deleted, the model will subtract $53.73 from its estimate, and so forth.

Table 3-2
DART Bus O&M Cost Model - Supply Variable Impacts for the 2010 Calibration Bus System (in 2010 dollars)

Key Supply Variable	Share of Total O&M Cost		Unit Cost
	Dollar Amount	Percentage	
Annual Revenue Bus-Hours	$107,972,192	43.9%	$53.73
Annual Revenue Bus-Miles - Diesel	$47,059,037	19.1%	$2.30
Annual Revenue Bus-Miles- LNG	$15,106,677	6.1%	$2.21
Annual Revenue Bus-Miles- CNG	$0	0.0%	$2.00
Total Peak Buses	$3,013,390	1.2%	$5,420
Operating Garages (buses dispatched into svc.)	$71,878,670	29.2%	$23,959,557
Bus Passenger Facilities	$888,474	0.4%	$63,462
Total	**$245,918,440**	**100.0%**	

Table 3-3 presents the bus O&M cost model worksheet for the 2010 base year, created with the base year supply variables shown in **Table 3-1**. Model results have been inflated to 2012 dollars using the Bureau of Labor Statistics' CPI-U for the Dallas-Fort Worth area.

Table 3-3
DART Bus O&M Cost Model

																Inflation Factor:	1.050
				Bus Supply Variable Unit Cost Rate ($2010)							Productivity Ratio			Base Year		Results in:	2012$
Expense Line Item	2010 Bus Expenses	Existing Unit Cost Adjusted	New Unit Cost Added	Revenue Bus-Hours	Diesel Rev. Bus-Miles	LNG Rev. Bus-Miles	CNG Rev. Bus-Miles	Operating Garages	Passenger Facilities	Total Peak Buses	Resource Variable	Resource Value	Resource/ Supply	Resource Unit Cost	Inflation Factor	Resource Unit Cost	Estimated Annual Cost
VEHICLE OPERATIONS																	
OPERATORS' SALARIES & WAGES	*$54,798,572*			$27.27							Work Hours	2,693,861	1.341	$20.34	1.050	$21.36	$57,541,917
OTHER SALARIES & WAGES - Rev-Hours Driven (80%)	*$15,773,367*			$7.85							Work Hours	292,056	0.145	$54.01	1.050	$56.71	$16,563,019
OTHER SALARIES & WAGES - Oper Garage Driven (20%)	*$3,943,342*							$1,314,447			Work Hours	73,014	24,338	$54.01	1.050	$56.71	$4,140,755
FRINGE BENEFITS - Rev-Hours Driven	*$33,302,245*			$16.57							Work Hours	2,985,917	1.486	$11.15	1.050	$11.71	$34,969,433
FRINGE BENEFITS - Oper Garage Driven	*$1,860,826*							$620,275			Work Hours	73,014	24,338	$25.49	1.050	$26.76	$1,953,984
PROFESSIONAL & TECHNICAL SERVICES	*$1,682,465*									$3,026	Peak Buses	556	1.000	$3,026	1.050	$3,178	$1,766,693
FUEL & LUBRICANTS - Diesel Miles Driven	*$12,862,742*	*X*			$0.63						Gallons	6,211,040	0.303	$2.07	1.050	$2.17	$13,506,681
FUEL & LUBRICANTS - LNG Miles Driven	*$3,707,912*	*X*				$0.54					Gallons	4,754,655	0.696	$0.78	1.050	$0.82	$3,893,538
FUEL & LUBRICANTS - CNG Miles Driven	*n/a*		*X*				$0.33				Revenue Miles	n/a	1.000	$0.33	1.050	$0.35	$0
TIRES & TUBES	*$1,825,512*				$0.07	$0.07	$0.07				Revenue Miles	27,323,659	1.000	$0.07	1.050	$0.07	$1,916,901
OTHER MATERIALS & SUPPLIES	*$632,207*							$210,736			Garages	3	1.000	$210,736	1.050	$221,286	$663,857
TAXES & FEES	*$1,309,541*									$2,355	Peak Buses	556	1.000	$2,355	1.050	$2,473	$1,375,100
MISCELLANEOUS EXPENSES	*$3,930,299*							$1,310,100			Garages	3	1.000	$1,310,100	1.050	$1,375,686	$4,127,059
VEHICLE MAINTENANCE																	
SALARIES & WAGES - Rev-Miles Driven (80%)	*$18,074,723*				$0.66	$0.66	$0.66				Work Hours	618,896	0.023	$29.20	1.050	$30.67	$18,979,586
SALARIES & WAGES - Oper Garage Driven (20%)	*$4,518,681*							$1,506,227			Work Hours	154,724	51,575	$29.20	1.050	$30.67	$4,744,897
FRINGE BENEFITS - Revenue Miles Driven	*$8,529,294*				$0.31	$0.31	$0.31				Work Hours	618,896	0.023	$13.78	1.050	$14.47	$8,956,291
FRINGE BENEFITS - Operating Garage Driven	*$2,132,324*							$710,775			Work Hours	154,724	51,575	$13.78	1.050	$14.47	$2,239,073
PROFESSIONAL & TECHNICAL SERVICES	*$912,626*				$0.03	$0.03	$0.03				Revenue Miles	27,323,659	1.000	$0.03	1.050	$0.04	$958,314
FUEL & LUBRICANTS - Rev-Hours Driven (80%)	*$4,058,036*			$2.02							Revenue Hours	2,009,486	1.000	$2.02	1.050	$2.12	$4,261,191
FUEL & LUBRICANTS - Oper Garage Driven (20%)	*$1,014,509*							$338,170			Garages	3	1.000	$338,170	1.050	$355,099	$1,065,298
TIRES & TUBES - Rev-Hours Driven (80%)	*$39,972*			$0.02							Revenue Hours	2,009,486	1.000	$0.02	1.050	$0.02	$41,973
TIRES & TUBES - Oper Garage Driven (20%)	*$9,993*							$3,331			Garages	3	1.000	$3,331	1.050	$3,498	$10,493
OTHER MATERIALS & SUPPLIES	*$14,580,139*				$0.53	$0.53	$0.53				Revenue Miles	27,323,659	1.000	$0.53	1.050	$0.56	$15,310,055
TAXES & FEES	*$21,384*									$38.46	Peak Buses	556	1.000	$38	1.050	$40	$22,455
MISCELLANEOUS EXPENSES	*$126,488*							$42,163			Garages	3	1.000	$42,163	1.050	$44,273	$132,820
NON-VEHICLE MAINTENANCE																	
SALARIES & WAGES - Oper Garage Driven (90%)	*$2,524,847*							$841,616			Work Hours	102,501	34,167	$24.63	1.050	$25.87	$2,651,247
SALARIES & WAGES - Passenger Facilities Driven (10%)	*$280,539*								$20,038		Work Hours	11,389	814	$24.63	1.050	$25.87	$294,583
FRINGE BENEFITS - Operating Garages Driven	*$1,191,452*							$397,151			Work Hours	102,501	34,167	$11.62	1.050	$12.21	$1,251,099
FRINGE BENEFITS - Passenger Facilities Driven	*$132,384*								$9,456		Work Hours	11,389	814	$11.62	1.050	$12.21	$139,011
PROF & TECH SERVICES - Oper Garage Driven (90%)	*$4,126,595*							$1,375,532			Garages	3	1.000	$1,375,532	1.050	$1,444,394	$4,333,181
PROF & TECH SERVICES - Pass. Facilities Driven (10%)	*$458,511*								$32,751		Pass Facilities	14	1.000	$32,751	1.050	$34,390	$481,465
MATERIALS & SUPPLIES - Oper Garage Driven (90%)	*$153,375*							$51,125			Garages	3	1.000	$51,125	1.050	$53,685	$161,054
MATERIALS & SUPPLIES - Pass. Facilities Driven (10%)	*$17,042*								$1,217		Pass Facilities	14	1.000	$1,217	1.050	$1,278	$17,895
TAXES & FEES	*$563*							$188			Garages	3	1.000	$188	1.050	$197	$591
MISCELLANEOUS EXPENSES	*$298*							$99			Garages	3	1.000	$99	1.050	$104	$313
GENERAL ADMINISTRATION																	
SALARIES & WAGES	*$21,201,780*							$7,067,260			Work Hours	631,002	210,334	$33.60	1.050	$35.28	$22,263,191
FRINGE BENEFITS	*$9,959,916*							$3,319,972			Work Hours	631,002	210,334	$15.78	1.050	$16.57	$10,458,533
PROFESSIONAL & TECHNICAL SERVICES	*$6,652,663*							$2,217,554			Garages	3	1.000	$2,217,554	1.050	$2,328,570	$6,985,711
MATERIALS & SUPPLIES	*$1,869,532*							$623,177			Garages	3	1.000	$623,177	1.050	$654,375	$1,963,125
UTILITIES	*$3,439,980*							$1,146,660			Garages	3	1.000	$1,146,660	1.050	$1,204,064	$3,612,193
CASUALTY & LIABILITY	*$1,672,765*				$0.06	$0.06	$0.06				Revenue Miles	27,323,659	1.000	$0.06	1.050	$0.06	$1,756,508
TAXES & FEES	*$51,488*							$17,163			Garages	3	1.000	$17,163	1.050	$18,022	$54,066
MISCELLANEOUS EXPENSES	*$2,537,512*							$845,837			Garages	3	1.000	$845,837	1.050	$888,182	$2,664,546
TOTALS	***$245,918,440***			**$53.73**	**$2.30**	**$2.21**	**$2.00**	**$23,959,557**	**$63,462**	**$5,420**							**$258,229,693**
2010 Resource Variable Values				**2,009,486**	**20,492,744**	**6,830,915**	**0**	**3**	**14**	**556**							

1. Splits in line item costs that are driven by multiple variables were provided by DART staff.
2. CNG unit cost provided by DART staff and is included for DART plans on switching 100% of fleet to CNG in future.
3. NTD Fringe Benefit Rate for VO, VM and NVM = 47.2%
4. NTD Fringe Benefit Rate for G&A = 47.0%

Revenue Hours	2,009,486
Diesel Bus-Miles	20,492,744
LNG Bus-Miles	6,830,915
CNG Bus-Miles	0
Peak Buses	556
Oper Garages	3
Pass. Facilities	14

4.0 LIGHT RAIL TRANSIT O&M COST METHODOLOGY

The DART light rail transit O&M cost model is based on 2010 expenses and service statistics reported to the NTD. The purpose of this model is to account for the annual cost to operate and maintain a new station on the Red Line, where the project's Build Alternatives are proposed to interface with the LRT system.

4.1 Key Supply Variables

After collection of financial and service data, modeling proceeded with the selection of the key driving supply variables for the existing light rail transit system:

- *Annual Revenue Train-Hours* - are the hours that trains, of any number of passenger cars, travel while in revenue service over the entire fiscal year. Revenue train-hours include layover and schedule recovery, but exclude time for deadhead, operator training and maintenance testing.

- *Annual Revenue Car-Miles* - account for the miles that passenger vehicles travel while in revenue service over an entire fiscal year. Revenue car-miles include layover and schedule recovery, but exclude miles for deadhead, operator training and maintenance testing.

- *Peak Cars* - is the maximum number of passenger service vehicles actually operated simultaneously on an average weekday. The model may use peak cars as a variable when it needs to estimate a line item cost based on overall LRT system size.

- *Passenger Stations* - are passenger boarding and alighting facilities with a platform, which may include stairs, escalators, canopies, wind shelters, lighting, ticket machines and signage. For this project, the cost model was developed to distinguish at-grade, aerial and subway stations primarily for purposes of costing out differences in security and facilities maintenance costs. A more in-depth discussion of these cost differences is provided below.

- *Fixed Guideway Directional Route Miles* - represents the track miles in each direction that trains travel in revenue service. Directional route miles exclude staging or storage tracks at the beginning or end of a rail line. From a maintenance perspective, the guideway includes all buildings and structures dedicated to the operation of LRT including track, tunnels, bridges and the electrification system.

- *Yards* - usually comprised of storage track and maintenance shops, are the sites where light rail vehicles are inspected, repaired, maintained and stored. It is not uncommon for both heavy and light maintenance activities to occur in the same facility.

Table 4-1 shows the key supply variables and values used to represent the model's base year (FY 2010) inputs.

Table 4-1 DART Light Rail Transit O&M Cost Model - Supply Variable Inputs	
Supply Variable Inputs	**2010 Existing**
Light Rail	
Annual Revenue Train-Hours	163,376
Annual Revenue Car-Miles	4,941,155
Peak Cars	76
Passenger Stations	
At-Grade	33
Aerial (incl. one recessed station)	5
Subway	1
Fixed Guideway Directional Route Miles	97.2
Yards	1

4.2 Line Item Expenses

After selecting the key supply variables, the next step in model development was to record DART's light rail expenses as a series of line items. The NTD report format categorizes operating expenses as Vehicle Operations, Vehicle Maintenance, Non-Vehicle Maintenance and General Administration. Within these categories, line item expenses are classified as salaries & wages, fringe benefits, services, materials & supplies, utilities, casualty & liability, taxes & fees and miscellaneous. Supplemental information provided by DART staff enabled select line items to be modeled in greater detail. DART staff indicated that certain line item expenses in the NTD actually are influenced by more than one of the model's supply variables. Accordingly, DART identified the specific line items and the appropriate driving variable and percentage splits for use in the model. Split line items include:

- *Vehicle Operations*: Non-Operator Salaries & Wages are 70% driven by train-hours, 20% driven by the number of yards and 10% driven by total stations. Fringe Benefits are allocated proportionally to the same driving variables.

- *Vehicle Maintenance*: Fuel & Lubricants and Tires & Tubes are 60% driven by track miles and 40% driven by the number of yards.

- *Non-Vehicle Maintenance:* Salaries & Wages are 62% driven by total stations, 21% driven by the number of yards and 17% driven by track miles. The model applies these same splits to Fringe Benefits, Professional & Technical Services and Materials & Supplies.

DART staff supplemented the NTD's total Vehicle Operations employee work hours with operator work hours, which allows the model to calculate non-operator work hours and apply DART's line item splits to Vehicle Operations' salaries, wages and fringe benefits. The model splits all relevant line items according to DART's direction.

The LRT cost model also distinguishes station types. Although most of DART's light rail stations are at-grade, there were five stations in FY 2010 with vertical circulation (aerial or recessed) and one subway station with vertical circulation and ventilation systems. The classification of light rail stations is provided in the **Appendix** included in this Technical Memorandum. In terms of maintenance and security staff deployment, DART staff considers aerial stations to be twice as expensive as an at-grade

facility and the subway station is four times more expensive than an at-grade station. These agency assumptions were incorporated in the unit cost calculations for line items driven by station type.

After the line items were established, each one was assigned a key supply variable as its most relevant cost driver, then unit costs and productivity ratios were calculated.

Table 4-2 summarizes the dollar impact that each of the LRT cost model's key supply variables has on the calibration system (2010 base year). The unit costs in this table reflect the dollar amount the model will adjust for each added or deleted unit of a supply variable – the incremental change from the calibration LRT system. In other words, for each revenue car-mile added, the model will increase its total estimate by $6.15; for each revenue train-hour deleted, the model will subtract $140.70 from its estimate, and so forth.

Table 4-2
DART Light Rail Transit O&M Cost Model - Supply Variable Impacts for the 2010 Calibration LRT System (in 2010 dollars)

Annual Revenue Train-Hours	$22,987,540	20.5%	$140.70
Annual Revenue Car-Miles	$30,380,759	27.1%	$6.15
Peak Cars	$1,111,499	1.0%	$14,625
Passenger Stations			
At-Grade	$9,988,029	8.9%	$302,668
Aerial (incl. one recessed station)	$3,026,676	2.7%	$605,335
Subway	$1,210,670	1.1%	$1,210,670
Fixed Guideway Directional Route Miles	$3,730,441	3.3%	$38,379
Yards	$39,551,769	35.3%	$39,551,769
Total	**$111,987,382**	**100.0%**	

Table 4-3 presents the LRT O&M cost model worksheet, created with the base year supply variable inputs from **Table 4-1**. Model results have been inflated to 2012 dollars using the Bureau of Labor Statistics' CPI-U for the Dallas-Fort Worth area.

Table 4-3
DART Light Rail Transit O&M Cost Model

															Inflation Factor:	1.050
			Light Rail Supply Variable Unit Cost Rate (2010$)								Productivity Ratio			Base Year		Results in:	2012$
Expense Line Item	2010 Light Rail Expenses	Existing Unit Cost Adjusted	Revenue Train-Hours	Revenue Car-Miles	Yards	Revenue Track-Miles	At-Grade Stations	Aerial Stations	Subway Stations	Peak Cars	Resource Variable	Resource Value	Resource/ Supply	Resource Unit Cost	Inflation Factor	Resource Unit Cost	Estimated Annual Cost
VEHICLE OPERATIONS																	
OPERATORS' SALARIES & WAGES	*$5,969,493*		$36.54								Work Hours	359,340	2.199	$16.61	1.050	$17.44	$6,268,340
OTHER SALARIES & WAGES -Train-Hours Driven (70%)	*$9,648,202*		$59.06								Work Hours	215,269	1.318	$44.82	1.050	$47.06	$10,131,213
OTHER SALARIES & WAGES -Yards Driven (20%)	*$2,756,629*				$2,756,629						Work Hours	61,505	61,505	$44.82	1.050	$47.06	$2,894,632
OTHER SALARIES & WAGES -Tot. Stations Driven (10%)	*$1,378,315*	X					$29,326	$58,652	$117,303		Work Hours	30,753	654	$44.82	1.050	$47.06	$1,447,316
FRINGE BENEFITS - Train-Hours Driven	*$7,369,845*		$45.11								Work Hours	574,609	3.517	$12.83	1.050	$13.47	$7,738,797
FRINGE BENEFITS - Yards Driven	*$1,300,828*				$1,300,828						Work Hours	61,505	61,505	$21.15	1.050	$22.21	$1,365,950
FRINGE BENEFITS - Total Stations Driven	*$650,414*	X					$13,839	$27,677	$55,354		Work Hours	30,753	654	$21.15	1.050	$22.21	$682,975
PROFESSIONAL & TECHNICAL SERVICES	*$1,106,656*									$14,561	Peak Cars	76	1.000	$14,561	1.050	$15,290	$1,162,058
OTHER MATERIALS & SUPPLIES	*$381,716*				$381,716						Yards	1	1.000	$381,716	1.050	$400,826	$400,826
UTILITIES	*$9,194,490*			$1.86							Rev Car-Miles	4,941,155	1.000	$1.86	1.050	$1.95	$9,654,788
TAXES & FEES	*$1,893*									$24.91	Peak Cars	76	1.000	$24.91	1.050	$26.15	$1,988
MISCELLANEOUS EXPENSES	*$292,423*				$292,423						Yards	1	1.000	$292,423	1.050	$307,062	$307,062
VEHICLE MAINTENANCE																	
SALARIES & WAGES	*$9,035,205*			$1.83							Work Hours	280,797	0.057	$32.18	1.050	$33.79	$9,487,529
FRINGE BENEFITS	*$4,263,629*			$0.86							Work Hours	280,797	0.057	$15.18	1.050	$15.94	$4,477,076
PROFESSIONAL & TECHNICAL SERVICES	*$527,051*			$0.11							Rev Car-Miles	4,941,155	1.000	$0.11	1.050	$0.11	$553,436
FUEL & LUBRICANTS - Track Miles Driven (60%)	*$363,206*					$3,737					Track Miles	97.2	1.000	$3,737	1.050	$3,924	$381,389
FUEL & LUBRICANTS - Yards Driven (40%)	*$242,138*				$242,138						Yards	1	1.000	$242,138	1.050	$254,260	$254,260
TIRES & TUBES - Track Miles Driven (60%)	*$19,625*					$201.91					Track Miles	97.2	1.000	$201.91	1.050	$212	$20,608
TIRES & TUBES - Yards Driven (40%)	*$13,084*				$13,084						Yards	1	1.000	$13,084	1.050	$13,739	$13,739
OTHER MATERIALS & SUPPLIES	*$6,141,239*			$1.24							Rev Car-Miles	4,941,155	1.000	$1.24	1.050	$1.31	$6,448,684
TAXES & FEES	*$2,950*									$38.82	Peak Cars	76	1.000	$38.82	1.050	$40.76	$3,098
MISCELLANEOUS EXPENSES	*$129,691*				$129,691						Yards	1	1.000	$129,691	1.050	$136,184	$136,184
NON-VEHICLE MAINTENANCE																	
SALARIES & WAGES - Total Stations Driven (62%)	*$6,419,094*	X					$136,576	$273,153	$546,306		Work Hours	232,829	4,954	$27.57	1.050	$28.95	$6,740,449
SALARIES & WAGES - Yards Driven (21%)	*$2,174,209*				$2,174,209						Work Hours	78,862	78,862	$27.57	1.050	$28.95	$2,283,055
SALARIES & WAGES - Track Miles Driven (17%)	*$1,760,074*					$18,108					Work Hours	63,840	657	$27.57	1.050	$28.95	$1,848,188
FRINGE BENEFITS - Total Stations Driven	*$3,029,110*	X					$64,449	$128,898	$257,797		Work Hours	232,829	4,954	$13.01	1.050	$13.66	$3,180,755
FRINGE BENEFITS - Yards Driven	*$1,025,989*				$1,025,989						Work Hours	78,862	78,862	$13.01	1.050	$13.66	$1,077,352
FRINGE BENEFITS - Track Miles Driven	*$830,563*					$8,545					Work Hours	63,840	657	$13.01	1.050	$13.66	$872,142
PROF. & TECH. SERVICES - Total Stations Driven (62%)	*$1,787,823*	X					$38,039	$76,078	$152,155		Stations	39	1.000	$38,039	1.050	$39,943	$1,877,326
PROF. & TECH. SERVICES - Yards Driven (21%)	*$605,553*				$605,553						Yards	1	1.000	$605,553	1.050	$635,868	$635,868
PROF. & TECH. SERVICES - Track Miles Driven (17%)	*$490,210*					$5,043					Track Miles	97.2	1.000	$5,043	1.050	$5,296	$514,751
MATERIALS & SUPPLIES - Total Stations Driven (62%)	*$960,619*	X					$20,439	$40,877	$81,755		Stations	39	0.830	$24,631	1.050	$25,864	$1,008,710
MATERIALS & SUPPLIES - Yards Driven (21%)	*$325,371*				$325,371						Yards	1	1.000	$325,371	1.050	$341,660	$341,660
MATERIALS & SUPPLIES - Track Miles Driven (17%)	*$263,396*					$2,710					Track Miles	97.2	1.000	$2,710	1.050	$2,845	$276,582
TAXES & FEES	*$2,485*					$25.57					Track Miles	97.2	1.000	$25.57	1.050	$26.85	$2,609
MISCELLANEOUS EXPENSES	*$882*					$9.07					Track Miles	97.2	1.000	$9.07	1.050	$9.53	$926
GENERAL ADMINISTRATION																	
SALARIES & WAGES	*$15,405,778*				$15,405,778						Work Hours	270,460	270,460	$56.96	1.050	$59.81	$16,177,027
FRINGE BENEFITS	*$7,269,843*				$7,269,843						Work Hours	270,460	270,460	$26.88	1.050	$28.23	$7,633,788
PROFESSIONAL & TECHNICAL SERVICES	*$5,264,523*				$5,264,523						Yards	1	1.000	$5,264,523	1.050	$5,528,077	$5,528,077
MATERIALS & SUPPLIES	*$898,004*				$898,004						Yards	1	1.000	$898,004	1.050	$942,960	$942,960
UTILIITES	*$751,373*				$751,373						Yards	1	1.000	$751,373	1.050	$788,988	$788,988
CASUALTY & LIABILITY	*$1,219,145*			$0.25							Rev Car-Miles	4,941,155	1.000	$0.25	1.050	$0.26	$1,280,178
TAXES & FEES	*$31,847*				$31,847						Yards	1	1.000	$31,847	1.050	$33,441	$33,441
MISCELLANEOUS EXPENSES	*$682,771*				$682,771						Yards	1	1.000	$682,771	1.050	$716,952	$716,952
TOTALS (not including Fringe Benefits)	***$111,987,382***		**$141**	**$6.15**	**$39,551,769**	**$38,379**	**$302,668**	**$605,335**	**$1,210,670**	**$14,625**							**$117,593,733**
2010 Resource Variable Values			**163,376**	**4,941,155**	**1**	**97.2**	**33**	**5**	**1**	**76**							

Rev Train-Hours	163,376
Rev Car-Miles	4,941,155
Peak Cars	76
At-Grade Sta	33
Aerial Sta	5
Subway Sta	1
Track Miles	97
Yards	1

Notes:
1. Splits in line item costs that are driven by multiple variables were provided by DART staff.
2. Weighting of at-grade, aerial and subway station unit costs provided by DART staff.
3. NTD Fringe Benefit Rates = 47.2%

5.0 REGIONAL RAIL O&M COST METHODOLOGY

The project's regional rail O&M cost model combines the 2013 budget and estimated service statistics for DCTA's A-Train with select cost experience derived from the TRE NTD for 2010. Available data from the A-Train was used because the Cotton Belt Rail Build Alternatives assume the same vehicle type and contract operator used by DCTA and the 2013 budget reflects the first full year of operation with DCTA's Stadler fleet. A-Train calibration expenses were deflated to 2012 dollars using a factor of three percent.

Supplemental cost experience from TRE was used for general and administrative expenses under the assumption that these unit costs were more representative for DART as the operating agency. TRE-based expenses for 2010 were inflated to 2012 dollars with the same CPI factor used for DART's bus and light rail models.

5.1 Key Supply Variables

After collection of financial and service data, modeling proceeded with selection of the key driving supply variables for a new regional rail line:

- *Annual Revenue Train-Hours* - account for the hours that trains, of any number of passenger cars, travel while in revenue service over the entire fiscal year. Revenue train-hours include layover and schedule recovery, but exclude time for deadhead, operator training and maintenance testing.

- *Annual Revenue Passenger Car-Miles* - are the miles that passenger vehicles travel while in revenue service over an entire fiscal year. Revenue car-miles include layover and schedule recovery, but exclude miles for deadhead, operator training and maintenance testing.

- *Peak Passenger Cars* - is the maximum number of passenger service vehicles actually operated simultaneously on an average weekday. The model may use peak cars as a variable when it needs to estimate a line item cost based on overall regional rail system size.

- *Revenue Route Miles* - is expressed as the number of route miles over which trains travel in revenue service, which excludes staging or storage tracks at the beginning or end of a rail line.

- *Passenger Stations* - are passenger boarding and alighting facilities with a platform, which may include stairs, escalators, canopies, wind shelters, lighting, ticket machines and signage.

- *Yards* - usually comprised of storage track and maintenance shops, are the sites where rail vehicles are inspected, repaired, maintained and stored. It is not uncommon for both heavy and light maintenance activities to occur in the same facility.

Table 5-1 shows the key supply variables and values used to represent the model's base year (FY 2013) inputs. Regional rail calibration statistics were obtained from DCTA staff.

Table 5-1 DART Regional Rail Cost Model - Supply Variable Inputs	
Supply Variable Inputs	**2013 Calibration**
Regional Rail	
Annual Revenue Train-Hours	11,258
Annual Revenue Passenger Car-Miles	597,518
Peak Passenger Cars	8
Route Miles	21
Agency Maintained Stations	4
Yards	1

5.2 Line Item Expenses

After selecting the key supply variables, the next step in model development was to organize the A-Train budget as a series of line items within the functions of Contract Vehicle Operations & Maintenance, Contract Non-Vehicle Maintenance and Contract Management Fees & Insurance. The line items modeled on the A-Train are believed to be representative for cost estimating purposes, because the study assumes the same contractor and the same type of vehicle for DART's regional rail alternatives.

To estimate expenses related to general administration of regional rail, the model was based on DART's corresponding costs for TRE, factored by 33 percent to reflect sharing with the TRE service.

After the line items were established, each one was assigned a key supply variable as its most relevant cost driver. In some cases, the model has split line item costs because they are assumed to be strongly influenced by more than one of the supply variables. Unit costs and productivity ratios were calculated, after the following split line items were included:

- *Contract Management Fees & Insurance*: Contract Operations-based Services are modeled as 50% car-miles driven and 50% train-hours driven.

- *DART General Administration*: Service costs are assumed to be equally influenced by yards and passenger stations.

Table 5-2 summarizes the dollar impact that each of the regional rail cost model's key supply variables has on the calibration system (base year). The unit costs in this table reflect the dollar amount the model will adjust for each added or deleted unit of a supply variable – the incremental change from the calibration bus system. In other words, for each revenue passenger car-mile added, the model will increase its total estimate by $7.44; for each revenue train-hour deleted, the model will subtract $523.48 from its estimate, and so forth.

Table 5-2 DART Regional Rail Cost Model - Supply Variable Impacts for the 2013 Calibration Rail System (in 2012 dollars)			
Annual Revenue Train-Hours	$5,893,324	51.3%	$523.48
Annual Revenue Passenger Car-Miles	$4,447,266	38.7%	$7.44
Peak Passenger Cars	$135,000	1.2%	$16,875
Route Miles	$718,743	6.3%	$34,225.84
Agency Maintained Stations	$58,642	0.5%	$14,660
Yards	$244,698	2.1%	$244,698
Total	**$11,497,672**	**100.0%**	

Table 5-3 presents the regional rail O&M cost model worksheet, created with the base year supply variable inputs from **Table 5-1**. Model results are in 2012 dollars.

Table 5-3
Regional Rail O&M Cost Model

																Regional Rail Deflation	0.970
					Regional Rail Supply Variable Unit Cost Rate						Productivity Ratio			Base Year		Results in:	2012$
Expense Line Item	*Regional Rail Expenses*	*Cost Source*	*Existing Unit Cost Adjusted*	*New Unit Cost Added*	Revenue Train-Hours	Revenue Car-Miles	Yards	Route Miles	Stations	Peak Cars	Resource Variable	Resource Value	Resource/ Supply	Resource Unit Cost	Inflation Factor	Resource Unit Cost	Estimated Annual Cost
CONTRACT VEHICLE OPERATIONS & MAINTENANCE																	
COMMUTER RAIL CONTRACT SERVICE	*$3,083,551*	*FY13 DCTA Budget*			$273.90						Rev Train-Hours	11,258	1.000	$273.90	0.970	$265.68	$2,991,045
STAFF SUPPORT SERVICES	*$75,000*	*FY13 DCTA Budget*								$9,375	Peak Cars	8	1.000	$9,375	0.970	$9,094	$72,750
FUEL	*$1,753,750*	*FY13 DCTA Budget*				$2.94					Gallons	412,647	0.691	$4.25	0.970	$4.12	$1,701,138
PHONE DISPATCH	*$25,806*	*FY13 DCTA Budget*					$25,806				Yards	1	1.000	$25,806	0.970	$25,032	$25,032
MAINTENANCE OF EQUIPMENT	*$60,000*	*FY13 DCTA Budget*								$7,500	Peak Cars	8	8.000	$938	0.970	$909	$58,200
CONTRACT NON-VEHICLE MAINTENANCE																	
TVM REVENUE COLLECTION AND MAINTENANCE	*$33,110*	*FY13 DCTA Budget*					$33,110				Yards	1	1.000	$33,110	0.970	$32,117	$32,117
MAINTENANCE OF WAY	*$718,743*	*FY13 DCTA Budget*						$34,226			Track Miles	21.0	1.000	$34,226	0.970	$33,199	$697,180
STATION PLATFORM MAINTENANCE	*$16,560*	*FY13 DCTA Budget*							$4,140		Stations	4	1.000	$4,140	0.970	$4,016	$16,063
ADDITIONAL YARD EXPENSES	*$1,200*	*FY13 DCTA Budget*					$1,200				Yards	1	1.000	$1,200	0.970	$1,164	$1,164
CONTRACT MANAGEMENT FEES & INSURANCE																	
CONTRACT OPER. CAR-MILES RELATED FEES	*$1,795,076*	*FY13 DCTA Budget*				$3.00					Rev Car-Miles	597,518	1.000	$3.00	0.970	$2.91	$1,741,223
CONTRACT OPER. TRAIN-HOURS RELATED FEES	*$1,735,413*	*FY13 DCTA Budget*			$154.15						Rev Train-Hours	11,258	1.000	$154.15	0.970	$149.53	$1,683,351
CONTRACT OPER.-BASED SERVICES - Car-Mi Driven (50%)	*$489,319*	*FY13 DCTA Budget*				$0.82					Rev Car-Miles	597,518	1.000	$0.82	0.970	$0.79	$474,639
CONTRACT OPER.-BASED SERVICES - Train-Hr Driven (50%)	*$489,319*	*FY13 DCTA Budget*			$43.46						Rev Train-Hours	11,258	1.000	$43.46	0.970	$42.16	$474,639
CASUALTY & LIABILITY	*$409,121*	*FY13 DCTA Budget*				$0.68					Rev Car-Miles	597,518	1.000	$0.68	0.970	$0.66	$396,847
DART GENERAL ADMINISTRATION (see Note #3)																	
SALARIES & WAGES	$1,872,182	*TRE 2010 NTD (FY12$)*	X		$35.31						Rev Train-Hours	17,658	1.000	$35.31	1.000	$35.31	$397,476
FRINGE BENEFITS	$883,466	*TRE 2010 NTD (FY12$)*	X		$16.66						Rev Train-Hours	17,658	1.000	$16.66	1.000	$16.66	$187,565
SERVICES - Yards Driven (50%)	$315,928	*TRE 2010 NTD (FY12$)*	X				$105,204				Yards	1	1.000	$105,204	1.000	$105,204	$105,204
SERVICES - Station Driven (50%)	$315,928	*TRE 2010 NTD (FY12$)*	X						$10,520		Stations	10	1.000	$10,520	1.000	$10,520	$42,082
OTHER MATERIALS & SUPPLIES	$72,306	*TRE 2010 NTD (FY12$)*	X				$24,078				Yards	1	1.000	$24,078	1.000	$24,078	$24,078
UTILITIES	$73,424	*TRE 2010 NTD (FY12$)*	X				$24,450				Yards	1	1.000	$24,450	1.000	$24,450	$24,450
MISCELLANEOUS EXPENSES	$92,644	*TRE 2010 NTD (FY12$)*	X				$30,850				Yards	1	1.000	$30,850	1.000	$30,850	$30,850
TOTALS	***$14,311,845***				**$523**	**$7.44**	**$244,698**	**$34,226**	**$14,660**	**$16,875**							**$11,177,093**
2011 Resource Variable Values - A-Train					**11,258**	**597,518**	**1**	**21.0**	**4**	**8**						Rev Train-Hours	11,258
2010 Resource Variable Values - TRE					**17,658**	**1,239,709**	**1**	**36.2**	**10**	**18**						Rev Car-Miles	597,518
																Peak Cars	8
																Route Miles	21.0
																Stations	4
																Yards	1

Notes:
1. Costs for Contract Operations & Maintenance, Non-Vehicle Maintenance and Mgmt Fees & Insurance obtained from FY 2013 Denton A-Train budget, factored to FY 2012 dollars.
2. DART Gen. Administration costs based on DART's TRE general administration costs, inflated to 2012 dollars to be consistent with the A-Train budget.
3. DART Gen. Administration unit costs factored to reflect shared administrative costs with TRE service by: 0.33

6.0 BUILD ALTERNATIVES O&M COST RESULTS

The cost models described above were used to generate annual O&M cost estimates for each of the Cotton Belt alternatives. Information used as model inputs were obtained from the project's definition of alternatives and operating plans. **Table 6-1** summarizes the model runs by alternative, showing the modal characteristics assumed as well as the O&M cost estimated.

For the four Build Alternatives, the incremental annual O&M costs compared to the No-Build Alternative (in 2012 dollars) range from $26.8 to $28.3 million, with approximately $20.9 to $21.3 million as the cost of Cotton Belt Rail service, $635,000 for maintaining a new Red Line station adjacent to the Cotton Belt's 12th Street station, and the remainder accounting for the cost of improved bus service.

Table 6-1
Cotton Belt Rail O&M Cost Estimates

	Base Year	No Build	Alt. 1a: North w/ N. Lake	Alt. 1b: North w/o N. Lake	Alt. 2a: South w/ N. Lake	Alt. 2b: South w/o N. Lake	MOS 1	MOS 2
Operating Expenses ($2012)								
Bus	$258,229,693	$250,308,987	$256,836,851	$255,523,773	$256,717,177	$255,480,516	$254,340,785	$253,464,822
Light Rail	$117,593,733	$117,593,733	$118,229,373	$118,229,373	$118,229,373	$118,229,373	$117,593,733	$117,593,733
Regional Rail	$0	$0	$21,026,188	$20,943,920	$21,250,693	$21,167,371	$5,672,862	$12,749,857
Total Cost of Alternative	$375,823,426	$367,902,720	$396,092,412	$394,697,066	$396,197,244	$394,877,259	$377,607,381	$383,808,412
Incremental Cost to No Build			$28,189,691	$26,794,345	$28,294,523	$26,974,539	$9,704,660	$15,905,692
Characteristics of Bus Ops								
Annual Revenue Bus-Hours	2,009,486	2,009,486	2,085,665	2,069,514	2,084,050	2,068,757	2,053,622	2,044,829
Annual Revenue Bus-Miles - Diesel	20,492,744	0	0	0	0	0	0	0
Annual Revenue Bus-Miles - LNG	6,830,915	0	0	0	0	0	0	0
Annual Revenue Bus-Miles - CNG	0	27,329,045	28,312,822	28,134,925	28,301,929	28,137,376	28,033,742	27,858,177
Total Peak Buses	556	556	585	580	584	579	567	565
Operating Garages (buses dispatched into	3	3	3	3	3	3	3	3
Bus Passenger Facilities	14	14	14	14	14	14	14	14
Total Cost/Bus-Hour	$129	$125	$123	$123	$123	$123	$124	$124
Total Cost/Bus-Mile	$9.45	$9.16	$9.07	$9.08	$9.07	$9.08	$9.07	$9.10
Characteristics of Light Rail Ops								
Annual Revenue Train-Hours	163,376	163,376	163,376	163,376	163,376	163,376	163,376	163,376
Annual Revenue Car-Miles	4,941,155	4,941,155	4,941,155	4,941,155	4,941,155	4,941,155	4,941,155	4,941,155
Peak Cars	76	76	76	76	76	76	76	76
Passenger Stations								
At-Grade	33	33	33	33	33	33	33	33
Aerial (incl. one recessed station)	5	5	6	6	6	6	5	5
Subway	1	1	1	1	1	1	1	1
Fixed Guideway Directional Route Miles	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2
Yards	1	1	1	1	1	1	1	1
Total Cost/Train-Hour	$720	$720	$724	$724	$720	$720	$720	$720
Total Cost/Car-Mile	$23.80	$23.80	$23.93	$23.93	$23.80	$23.80	$23.80	$23.80
Characteristics of Regional Rail Ops								
Annual Revenue Train-Hours	0	0	18,800	18,800	18,800	18,800	8,030	16,000
Annual Revenue Passenger Car-Miles	0	0	1,363,500	1,354,900	1,390,100	1,381,400	150,300	501,200
Peak Passenger Cars	0	0	18	18	18	18	4	8
Route Miles	0.0	0.0	27.4	27.2	27.9	27.8	4.8	16.1
Agency Maintained Stations	0	0	11	10	12	11	2	5
Yards	0	0	1	1	1	1	1	1
Total Cost/Train-Hour	n/a	n/a	$1,118	$1,114	$1,130	$1,126	$706	$797
Total Cost/Passenger Car-Mile	n/a	n/a	$15.42	$15.46	$15.29	$15.32	$37.74	$25.44

APPENDIX: LIGHT RAIL STATION TYPES

Dallas Area Rapid Transit
Cotton Belt Corridor Project
O&M Cost Models
LIGHT RAIL STATION TYPES

	Line(s)	Station Name	Opened	At-Grade	Aerial/ Recessed*	Subway	Comments
1	Red	Westmoreland	1996	X			
2	Red	Hampton	1996	X			
3	Red	Tyler/Vernon	1996	X			
4	Red	Dallas Zoo	1996	X			
5	Red/Blue	8th & Corinth	1996	X			
6	Red/Blue	Cedars	1996	X			
7	Red/Blue	Convention Center	1996	X			
8	Red/Blue + TRE	Union	2008	X			Orig built 1916; re-built 2008
9	Red/Blue	Victory	2004	X			Select wkdy + special events
10	Red/Blue/Green	West End	1996	X			
11	Red/Blue/Green	Akard	1996	X			
12	Red/Blue/Green	St. Paul	1996	X			
13	Red/Blue/Green	Pearl	1996	X			
14	Red/Blue	Cityplace	2004			X	
15	Red/Blue	Mockingbird	1997		X*		Recessed with elevator, 2 escalators
16	Red	Lovers Lane	1997	X			
17	Red	Park Lane	2002		X		Opened '97 at-grade; rebuilt '02 aerial
18	Red	Walnut Hill	2002		X		
19	Red	Forest Lane	2002		X		
20	Red	LBJ Central	2002	X			
21	Red	Spring Valley	2002		X		
22	Red	Arapahoe Center	2002	X			
23	Red	Galatyn Park	2002	X			
24	Red	Bush Turnpike	2002	X			
25	Red	Downtown Plano	2002	X			
26	Red	Parker Road	2002	X			
27	Blue	Ledbetter	1997	X			
28	Blue	VA Medical Center	1997	X			
29	Blue	Kiest	1997	X			
30	Blue	Illinois	1996	X			
31	Blue	Morrell	1996	X			
32	Blue	Fair Park	2009	X			Special events
33	Blue	Baylor Medical Center	2009	X			Special events
34	Blue	Deep Ellum	2009	X			Special events
35	Blue	White Rock	2001	X			
36	Blue	LBJ/Skillman	2002	X			
37	Blue	Forest/Jupiter	2002	X			
38	Blue	Downtown Garland	2002	X			Orig built 1997 as a transit center
39	Green	MLK Jr.	2009	X			
	Totals by Type			33	5	1	39 reported in 2010 NTD

Cotton Belt Corridor Regional Rail

Operations and Maintenance Cost Methodology and Results Technical Memorandum

September 6, 2013
(Update to prior June 24, 2013 memo)

Prepared for Dallas Area Rapid Transit
General Planning Consultant Managed by URS Corporation

Cotton Belt Corridor Regional Rail

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1.0 INTRODUCTION

The Cotton Belt Corridor Regional Rail project proposes regional rail service along an east-west rail corridor passing through portions of Collin, Dallas and Tarrant counties in North Central Texas. The corridor's planning history stretches back for almost 30 years.

This document presents operations and maintenance (O&M) cost estimates for the Cotton Belt Corridor Regional Rail alternatives and describes the process by which annual O&M costs have been estimated. Rail alternatives in this project would affect DART's existing bus operations and also light rail connections at one station on the Red Line.

1.1 Project Background

Some noteworthy milestones in the history of the Cotton Belt Rail corridor are:

- The corridor has been included in various DART service plans since 1983.
- Also beginning in 1983, the corridor has been included in the North Central Texas Council of Governments (NCTCOG) metropolitan transportation plans as an alignment alternative for passenger rail.
- In 1990, DART purchased 52 miles of the corridor for potential future passenger rail.
- In 2005, the Fort Worth Transportation Authority (The T) initiated planning for the Southwest-to-Northeast Rail Corridor Project (now known as TEX Rail), which would implement passenger rail service between southwest Fort Worth and Dallas/Fort Worth International Airport (DFW Airport) by 2013. This rail corridor uses the Cotton Belt Corridor from Tower 60 in Fort Worth to DFW Airport.
- In 2006, the DART Board of Directors adopted the *2030 Transit System Plan* which included the Cotton Belt corridor as the preferred alignment for east-west service between the Red Line light rail transit (LRT) system and DFW Airport.
- DART completed the *Cotton Belt Corridor Environmental Review* in September 2008.
- In 2009, the Cotton Belt corridor was included in the NCTCOG's long-range transportation plan, *Mobility 2030: The Metropolitan Transportation Plan for the Dallas-Fort Worth Area – 2009 Amendment*. With an anticipated DART revenue service date between 2025 and 2030, local and regional leaders are exploring possible ways to accelerate service to this corridor, including a public-private partnership funding option.
- To help accelerate the revenue service date for the Cotton Belt Rail, in 2010 NCTCOG conducted a *Conceptual Engineering and Funding Study* (CE&FS). The introduction to this study's report is the primary source of the milestone information listed above.

Potential private partners noted that more detailed project definition and environmental clearance would be needed before advancing the project. Accordingly, DART is leading the effort to develop and consider alternatives and document environmental effects. It is in connection with this documentation that operations and maintenance cost estimates were produced for the Cotton Belt Corridor Regional Rail project.

1.2 Project Alternatives

As documented in the project's *Transit Operating Plans Technical Memorandum* (updated September 2013), the Cotton Belt Corridor Regional Rail project is completing the evaluation of transit alternatives that would add to the system DART operated in 2012:

- No-Build: The No-Build Alternative includes existing (i.e., Spring of 2012) transit service plus the DART's Orange Line Extension and The T's TEX Rail project, both to Dallas-Fort Worth International Airport. One bus route would be realigned to terminate at the Jack Hatchell Transit Center. There would be no changes to existing service frequencies for the remaining 24 defined bus routes in the Cotton Belt corridor.

- Build Alternative 1: Build Alternative 1 reflects a Cotton Belt alignment from DFW Terminal A/B to Shiloh Road with a north alignment in Plano. There are two variations for this alternative in the Cypress Waters area. Alternative 1a would deviate from the railroad corridor to serve a station at North Lake. Alternative 1b would remain in the railroad corridor and there would be no North Lake Station. Alternative 1 stations between the DFW Terminal A/B and Shiloh Road would be at DFW North, North Lake (Alternative 1a only), Downtown Carrollton, Addison Transit Center, Knoll Trail, Preston Road, Renner Village, University of Texas at Dallas (UTD)/Synergy, 12th Street, and Shiloh Road. Rail service would operate every 20 minutes during peak periods and hourly in the midday. Most bus routes in the corridor would have no change to alignment or service frequency; some of them would serve new rail stations along their existing alignments. A few routes would be extended or their alignments deviated to serve rail stations; most route frequencies would remain unchanged. Three new bus routes would be added.

- Build Alternative 2: Build Alternative 2 reflects a Cotton Belt alignment between DFW Terminal A/B and Shiloh Road with a south alignment in Richardson/Plano. There are two variations for this alternative in the Cypress Waters area. Alternative 2a would deviate from the railroad corridor to serve a station at North Lake. Alternative 2b would remain in the railroad corridor and there would be no North Lake Station. Stations would be almost identical to the corresponding variations in Alternative 1, except between the UTD/Synergy and 12th Street stations, where the alignment would also serve the existing President George Bush Turnpike (PGBT) LRT station. As such, the majority of proposed bus operations would not change in relation to Build Alternative 1. Rail service would operate every 20 minutes during peak periods and hourly in the midday.

The two Build Alternatives would interface at a new Red Line LRT station in Plano. **Figure 1-1** illustrates the proposed Cotton Belt rail alignments under consideration for this project.

Two Minimum Operating Segment options have been identified:

- MOS Alternative 1: The Minimum Operating Segment (MOS) Alternative 1 reflects a Cotton Belt alignment from DFW Airport to Downtown Carrollton. The stations for the MOS Alternative are at DFW, DFW North, North Lake, and Downtown Carrollton. Rail service would operate every 20 minutes during peak periods and hourly in the midday. New bus routes would provide convenient connections between DFW and Downtown Carrollton, and between Addison and Plano.

- MOS Alternative 2: The Minimum Operating Segment (MOS) Alternative 2 reflects a Cotton Belt alignment from DFW Airport to Addison Road. Stations for the MOS Alternative are at DFW, DFW North, North Lake, Downtown Carrollton, and Addison. Rail service would operate every 20 minutes during peak periods and hourly in the midday. A new bus route would provide convenient connections between Addison and Plano.

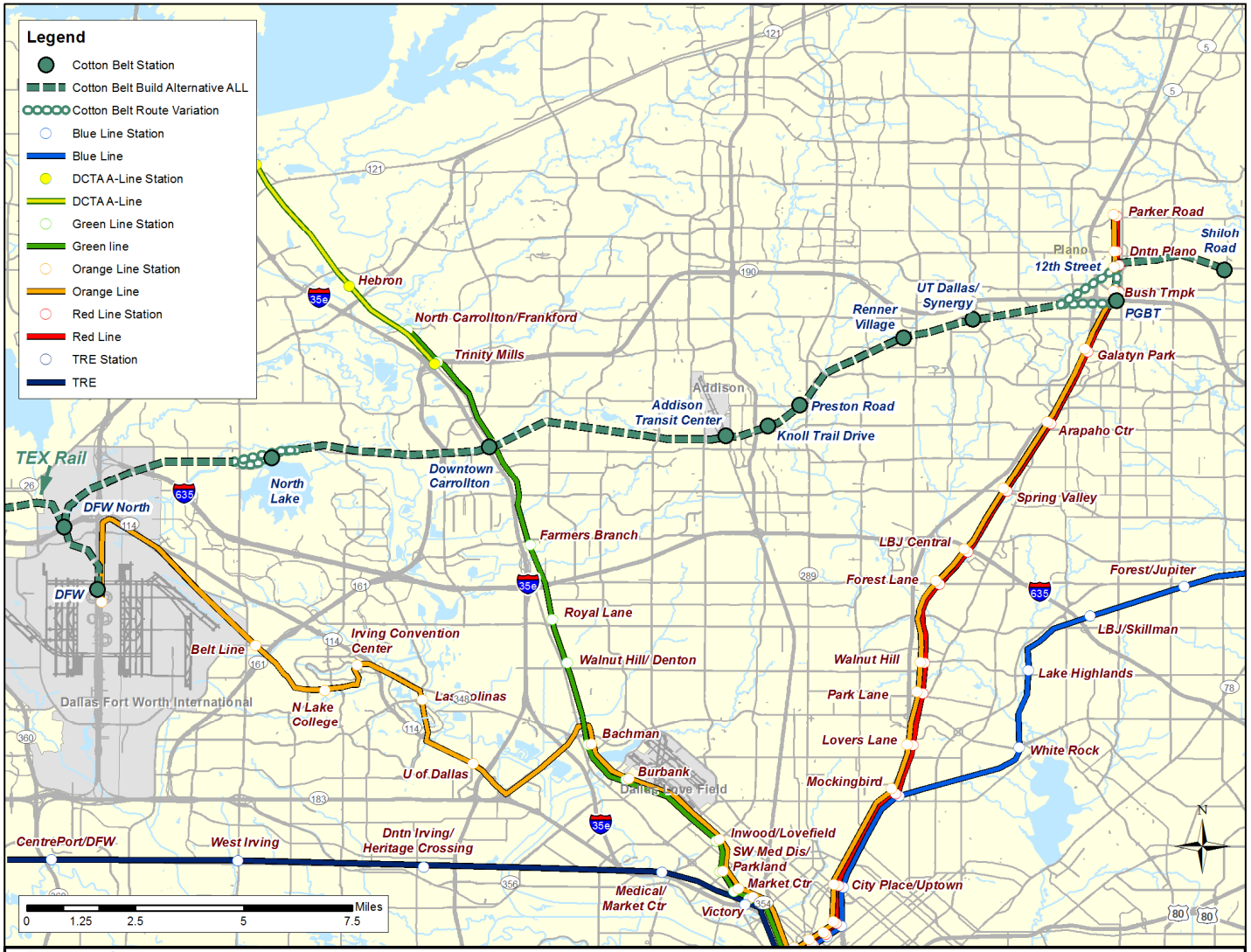

Figure 1-1
All Rail Build Alternatives

2.0 O&M COSTING OVERVIEW

Operations and maintenance cost estimates are important in the planning process because design-year projections are one of the inputs required to determine a project's cost effectiveness. An O&M cost model estimates the annual cost to operate, maintain and administer a transit system for a given set of service indicators. O&M costs are expressed as the annual total of employee wages & salaries, fringe benefits, contract services, materials & supplies, utilities and other day-to-day expenses incurred in the operation and maintenance of a transit system.

In general, steps of the O&M cost estimating process are:

1. Develop methodology for estimating O&M costs
2. Develop appropriate cost model(s) to evaluate alternatives
3. Calibrate the model for current year operations
4. Generate operating plans and statistics for each study alternative
5. Estimate annual transit operating and maintenance costs for each study alternative

This memorandum documents all but Step 4, as they have been applied to the Cotton Belt Corridor Regional Rail project. The project's operating plans and service plan definitions are documented separately. Capital cost estimates, for construction and equipment purchases, are not part of the O&M cost estimating process.

The Federal Transit Administration (FTA) believes the fully-allocated cost model is the best approach to O&M costing, because it is: a) able to reflect cost differences by mode and service type; b) structured based on actual operating experience; and c) sensitive to future changes in cost factors. The FTA has issued guidelines that specify the following methodology for calculating O&M costs:

- Compute costs by estimating labor and materials needed to provide a current level of service, and then apply unit costs to the estimated future labor and material cost items;
- Calculate costs based on operating characteristics by mode (e.g., LRT train-hours) rather than for all modes combined (e.g., system-wide passengers);
- Model each reported labor and non-labor expense separately to ensure that equations are mutually exclusive and cover all operating costs; and
- Model expense items as variable, meaning that cost estimates will change with projected changes in service.

A cost allocation model assumes that each expense incurred by a transit system is 'driven' by a key supply variable such as revenue-hours, revenue-miles, or the number of peak vehicles. Combining recent actual O&M costs with the quantity of relevant supply variables establishes unit costs and productivity ratios. These mathematical relationships can then be applied to different sets of service indicators (such as projected future expansions or cut-backs). The result is an estimated annual cost specific to each test scenario.

2.1 General Model Structure

The structure of the Cotton Belt O&M cost models is consistent with the spreadsheet table exhibits presented in Chapter 4, Operating and Maintenance Costs, of FTA's *Procedures and Technical Methods for Transit Project Planning* (Draft Version 3). The model's data and calculations progress from the base year expense items and amounts on the left side of the spreadsheet, through the assignment of driving

variables, to productivity and inflation, and end with the estimated incremental cost of a study alternative on the right side of the spreadsheet.

- Line Items and Base Year Costs: The first section of a cost model contains O&M expense line items, a recent annual expense for each item and a column for noting whether a line item's existing unit cost is adjusted in the model or a new unit cost has been added.

- Base Year Unit Costs: As pointed out in the FTA guidelines, O&M costs are related to (or 'driven' by) different supply variables. Supply variables can be considered causal because as they increase, so do the related expenses. The second section of a spreadsheet model is for the supply variable unit cost rates; one column is designated for each variable used as a driver for estimating the cost of a project alternative. Usually, unit rates are calculated by dividing the actual annual expense for the line item by the value of the relevant supply variable. For example, if bus operators' salaries and wages cost the transit agency $54,800,000 annually, and 2,009,500 revenue hours of service is the associated supply variable, then the unit cost rate for operators' salaries and wages would be $27.27 per revenue hour. In other words, the model would adjust this line item by $27.27 for each revenue hour of service that is added or cut from the system in a tested scenario.

- Productivity Ratios: Line item productivity ratios are calculated in the third section of the model with columns that display the resource variable used for the calculation (which may be the line item's supply variable, or it may be something else related to the supply variable, such as work hours for salary and wage expenses), the value of the resource variable, and the factor that results from dividing the resource value by the supply value.

- Estimated Cost of a Test Scenario: For each line item expense, the last columns in the spreadsheet contain the base year resource unit cost (supply variable unit cost divided by resource/supply factor), an inflation factor, and the model estimates of resource unit cost and annual cost. The Cotton Belt Rail models are designed to allow inflation of DART's 2010 base year expenses to represent 2012 dollars using the Bureau of Labor Statistics' Consumer Price Index (CPI-U) for the Dallas-Fort Worth area.

2.2 Cotton Belt O&M Models

The Cotton Belt Rail project alternatives require O&M costs to be estimated for DART bus and light rail transit, as well as regional rail. Since DART currently operates bus and light rail transit in the region, these models are based on DART's actual expenses, system characteristics and service statistics as reported to the National Transit Database (NTD) for the 2010 report year. Regional rail is anticipated to be different from the existing Trinity Railway Express (TRE), jointly operated by DART and the T. The regional rail alternative is envisioned to resemble Denton County Transportation Authority's (DCTA) A-Train, which initiated revenue service in 2011. For purposes of O&M cost estimation, regional rail in the Cotton Belt corridor is assumed to be provided by the same contract operator and with the same type of vehicle as is used for the A-Train service. A separate cost model has therefore been prepared for regional rail, primarily using the 2013 budget for DCTA's A-Train. This budget reflects the first full year of operation with the Stadler fleet, the same vehicles assumed for the Build Alternatives of this study. In addition, the regional rail cost model incorporates some of the general administration elements from the more established TRE to represent DART's oversight of a new regional rail service. Annual O&M costs for all Cotton Belt alternatives are presented in 2012 dollars. Each O&M cost model is described in following sections of this document.

3.0 BUS O&M COST METHODOLOGY

The DART bus O&M cost model is based on 2010 expenses and service statistics for directly-operated motor buses as reported to the NTD. The cost model is intended to estimate the additional expenses, or savings, related to changes in the background bus service that accompany each of the project's Build Alternatives.

3.1 Key Supply Variables

After collection of financial and service data, preparation of the spreadsheet cost model began with the selection of key driving supply variables for the existing bus system. Variables selected were:

- *Annual Revenue Bus-Hours* - account for the hours that vehicles travel while in revenue service over the entire fiscal year. Revenue bus-hours include layover and schedule recovery, but exclude time for deadhead, operator training and maintenance testing.

- *Annual Revenue Bus-Miles* - are the miles that vehicles travel while in revenue service over the entire fiscal year. Revenue bus-miles include layover and schedule recovery, but exclude miles for deadhead, operator training and maintenance testing. The model distinguishes bus-miles operated by existing vehicle fuel type: diesel and liquefied natural gas (LNG), and also includes compressed natural gas (CNG) bus-miles to account for DART's future bus fleet plans.

- *Total Peak Buses* - is the maximum number of passenger service vehicles actually operated simultaneously on an average weekday. In some cases, peak buses may be used as a supply variable when the model needs to base line item expenses on overall bus system size.

- *Operating Garages* - are the number of garages from which buses are dispatched into service. These garages also serve as general purpose maintenance facilities for inspecting, servicing and maintenance work on buses.

- *Bus Passenger Facilities* - for the bus system passenger facilities include transit centers, transfer centers and park-and-ride lots.

Table 3-1 shows the key supply variables and values used to represent the model's base year [fiscal year (FY) 2010] inputs.

Table 3-1 DART Bus O&M Cost Model - Supply Variable Inputs	
Supply Variable Inputs	**2010 Existing**
Bus	
Annual Revenue Bus-Hours	2,009,486
Annual Revenue Bus-Miles - Diesel	20,492,744
Annual Revenue Bus-Miles- LNG	6,830,915
Annual Revenue Bus-Miles- CNG	0
Total Peak Buses	556
Operating Garages (buses dispatched into svc.)	3
Bus Passenger Facilities	14

DART owns one garage that has been closed as a vehicle operations facility for cost-saving purposes and functions only as a non-revenue vehicle shop; this garage has not been included in the cost model.

For existing bus passenger facilities, DART staff reported nine transit centers, two transfer centers and three park-and-ride lots as of August 23, 2011 for a total of 14 facilities. These passenger facilities are treated equally in the model to provide a simple simulation for the incremental cost of adding new facilities that may be associated with a project alternative.

3.2 Line Item Expenses

After selecting the key supply variables, the next step in model development was to record DART's bus expenses as a series of line items. The agency's NTD report format categorizes operating expenses within the four functional areas of Vehicle Operations, Vehicle Maintenance, Non-Vehicle Maintenance and General Administration. Within these functional areas, line item expenses are further classified as salaries & wages, fringe benefits, services, materials & supplies, utilities, casualty and liability, taxes & fees and miscellaneous. Various NTD reports and supplemental information provided by DART staff enabled additional line items to be modeled in greater detail. DART staff indicated that certain line item expenses in the NTD actually are influenced by more than one of the model's supply variables. Accordingly, DART identified the specific line items and the appropriate driving variables and percentage splits for use in the model. These splits are based on DART staff's experiences with operating expenditures. Split line items include:

- *Vehicle Operations*: Non-Operator Salaries & Wages are 80% driven by revenue bus-hours and 20% driven by the number of operating garages. Fringe Benefits are allocated proportionally to the same driving variables.

- *Vehicle Maintenance*: Salaries & Wages, Fringe Benefits, Fuel & Lubricants and Tires & Tubes are also 80% driven by revenue bus-hours and 20% driven by the number of operating garages.

- *Non-Vehicle Maintenance*: Salaries & Wages, Fringe Benefits, Professional & Technical Services and Materials & Supplies are 90% driven by the number of operating garages and 10% driven by the number of bus passenger facilities.

The model incorporates NTD-reported employee work hours as a resource variable for estimating salaries and wages by functional area for the project alternatives. Fringe benefit cost estimates in the model also pivot off labor work hours.

The bus O&M cost model breaks down revenue miles by fuel type (diesel and LNG) and uses gallons of fuel as the resource variable for estimating those fuel costs in the future. DART staff provided their estimated cost of $0.33/mile for CNG, which the model uses as the unit cost for future year alternatives. DART intends to convert 100% of its bus fleet to CNG-fueled buses.

After the line items were established, each one was assigned a key supply variable as its most relevant cost driver, then unit costs and productivity ratios were calculated.

Table 3-2 summarizes the dollar impact that each of the bus model's key supply variables has on the calibration system (2010 base year). The unit costs in this table reflect the dollar amount the model will adjust for each added or deleted unit of a supply variable – the incremental change from the calibration bus system. In other words, for each CNG revenue bus-mile added, the model will increase its total estimate by $2.00; for each revenue bus-hour deleted, the model will subtract $53.73 from its estimate, and so forth.

Table 3-2
DART Bus O&M Cost Model - Supply Variable Impacts for the 2010 Calibration Bus System (in 2010 dollars)

Key Supply Variable	Share of Total O&M Cost		Unit Cost
	Dollar Amount	Percentage	
Annual Revenue Bus-Hours	$107,972,192	43.9%	$53.73
Annual Revenue Bus-Miles - Diesel	$47,059,037	19.1%	$2.30
Annual Revenue Bus-Miles- LNG	$15,106,677	6.1%	$2.21
Annual Revenue Bus-Miles- CNG	$0	0.0%	$2.00
Total Peak Buses	$3,013,390	1.2%	$5,420
Operating Garages (buses dispatched into svc.)	$71,878,670	29.2%	$23,959,557
Bus Passenger Facilities	$888,474	0.4%	$63,462
Total	**$245,918,440**	**100.0%**	

Table 3-3 presents the bus O&M cost model worksheet for the 2010 base year, created with the base year supply variables shown in **Table 3-1**. Model results have been inflated to 2012 dollars using the Bureau of Labor Statistics' CPI-U for the Dallas-Fort Worth area.

Table 3-3
DART Bus O&M Cost Model

																Inflation Factor:	1.050
				Bus Supply Variable Unit Cost Rate ($2010)							Productivity Ratio			Base Year		Results in:	2012$
Expense Line Item	2010 Bus Expenses	Existing Unit Cost Adjusted	New Unit Cost Added	Revenue Bus-Hours	Diesel Rev. Bus-Miles	LNG Rev. Bus-Miles	CNG Rev. Bus-Miles	Operating Garages	Passenger Facilities	Total Peak Buses	Resource Variable	Resource Value	Resource/ Supply	Resource Unit Cost	Inflation Factor	Resource Unit Cost	Estimated Annual Cost
VEHICLE OPERATIONS																	
OPERATORS' SALARIES & WAGES	*$54,798,572*			$27.27							Work Hours	2,693,861	1.341	$20.34	1.050	$21.36	$57,541,917
OTHER SALARIES & WAGES - Rev-Hours Driven (80%)	*$15,773,367*			$7.85							Work Hours	292,056	0.145	$54.01	1.050	$56.71	$16,563,019
OTHER SALARIES & WAGES - Oper Garage Driven (20%)	*$3,943,342*							$1,314,447			Work Hours	73,014	24,338	$54.01	1.050	$56.71	$4,140,755
FRINGE BENEFITS - Rev-Hours Driven	*$33,302,245*			$16.57							Work Hours	2,985,917	1.486	$11.15	1.050	$11.71	$34,969,433
FRINGE BENEFITS - Oper Garage Driven	*$1,860,826*							$620,275			Work Hours	73,014	24,338	$25.49	1.050	$26.76	$1,953,984
PROFESSIONAL & TECHNICAL SERVICES	*$1,682,465*									$3,026	Peak Buses	556	1.000	$3,026	1.050	$3,178	$1,766,693
FUEL & LUBRICANTS - Diesel Miles Driven	*$12,862,742*	*X*			$0.63						Gallons	6,211,040	0.303	$2.07	1.050	$2.17	$13,506,681
FUEL & LUBRICANTS - LNG Miles Driven	*$3,707,912*	*X*				$0.54					Gallons	4,754,655	0.696	$0.78	1.050	$0.82	$3,893,538
FUEL & LUBRICANTS - CNG Miles Driven	*n/a*		*X*				$0.33				Revenue Miles	n/a	1.000	$0.33	1.050	$0.35	$0
TIRES & TUBES	*$1,825,512*				$0.07	$0.07	$0.07				Revenue Miles	27,323,659	1.000	$0.07	1.050	$0.07	$1,916,901
OTHER MATERIALS & SUPPLIES	*$632,207*							$210,736			Garages	3	1.000	$210,736	1.050	$221,286	$663,857
TAXES & FEES	*$1,309,541*									$2,355	Peak Buses	556	1.000	$2,355	1.050	$2,473	$1,375,100
MISCELLANEOUS EXPENSES	*$3,930,299*							$1,310,100			Garages	3	1.000	$1,310,100	1.050	$1,375,686	$4,127,059
VEHICLE MAINTENANCE																	
SALARIES & WAGES - Rev-Miles Driven (80%)	*$18,074,723*				$0.66	$0.66	$0.66				Work Hours	618,896	0.023	$29.20	1.050	$30.67	$18,979,586
SALARIES & WAGES - Oper Garage Driven (20%)	*$4,518,681*							$1,506,227			Work Hours	154,724	51,575	$29.20	1.050	$30.67	$4,744,897
FRINGE BENEFITS - Revenue Miles Driven	*$8,529,294*				$0.31	$0.31	$0.31				Work Hours	618,896	0.023	$13.78	1.050	$14.47	$8,956,291
FRINGE BENEFITS - Operating Garage Driven	*$2,132,324*							$710,775			Work Hours	154,724	51,575	$13.78	1.050	$14.47	$2,239,073
PROFESSIONAL & TECHNICAL SERVICES	*$912,626*				$0.03	$0.03	$0.03				Revenue Miles	27,323,659	1.000	$0.03	1.050	$0.04	$958,314
FUEL & LUBRICANTS - Rev-Hours Driven (80%)	*$4,058,036*			$2.02							Revenue Hours	2,009,486	1.000	$2.02	1.050	$2.12	$4,261,191
FUEL & LUBRICANTS - Oper Garage Driven (20%)	*$1,014,509*							$338,170			Garages	3	1.000	$338,170	1.050	$355,099	$1,065,298
TIRES & TUBES - Rev-Hours Driven (80%)	*$39,972*			$0.02							Revenue Hours	2,009,486	1.000	$0.02	1.050	$0.02	$41,973
TIRES & TUBES - Oper Garage Driven (20%)	*$9,993*							$3,331			Garages	3	1.000	$3,331	1.050	$3,498	$10,493
OTHER MATERIALS & SUPPLIES	*$14,580,139*				$0.53	$0.53	$0.53				Revenue Miles	27,323,659	1.000	$0.53	1.050	$0.56	$15,310,055
TAXES & FEES	*$21,384*									$38.46	Peak Buses	556	1.000	$38	1.050	$40	$22,455
MISCELLANEOUS EXPENSES	*$126,488*							$42,163			Garages	3	1.000	$42,163	1.050	$44,273	$132,820
NON-VEHICLE MAINTENANCE																	
SALARIES & WAGES - Oper Garage Driven (90%)	*$2,524,847*							$841,616			Work Hours	102,501	34,167	$24.63	1.050	$25.87	$2,651,247
SALARIES & WAGES - Passenger Facilities Driven (10%)	*$280,539*								$20,038		Work Hours	11,389	814	$24.63	1.050	$25.87	$294,583
FRINGE BENEFITS - Operating Garages Driven	*$1,191,452*							$397,151			Work Hours	102,501	34,167	$11.62	1.050	$12.21	$1,251,099
FRINGE BENEFITS - Passenger Facilities Driven	*$132,384*								$9,456		Work Hours	11,389	814	$11.62	1.050	$12.21	$139,011
PROF & TECH SERVICES - Oper Garage Driven (90%)	*$4,126,595*							$1,375,532			Garages	3	1.000	$1,375,532	1.050	$1,444,394	$4,333,181
PROF & TECH SERVICES - Pass. Facilities Driven (10%)	*$458,511*								$32,751		Pass Facilities	14	1.000	$32,751	1.050	$34,390	$481,465
MATERIALS & SUPPLIES - Oper Garage Driven (90%)	*$153,375*							$51,125			Garages	3	1.000	$51,125	1.050	$53,685	$161,054
MATERIALS & SUPPLIES - Pass. Facilities Driven (10%)	*$17,042*								$1,217		Pass Facilities	14	1.000	$1,217	1.050	$1,278	$17,895
TAXES & FEES	*$563*							$188			Garages	3	1.000	$188	1.050	$197	$591
MISCELLANEOUS EXPENSES	*$298*							$99			Garages	3	1.000	$99	1.050	$104	$313
GENERAL ADMINISTRATION																	
SALARIES & WAGES	*$21,201,780*							$7,067,260			Work Hours	631,002	210,334	$33.60	1.050	$35.28	$22,263,191
FRINGE BENEFITS	*$9,959,916*							$3,319,972			Work Hours	631,002	210,334	$15.78	1.050	$16.57	$10,458,533
PROFESSIONAL & TECHNICAL SERVICES	*$6,652,663*							$2,217,554			Garages	3	1.000	$2,217,554	1.050	$2,328,570	$6,985,711
MATERIALS & SUPPLIES	*$1,869,532*							$623,177			Garages	3	1.000	$623,177	1.050	$654,375	$1,963,125
UTILITIES	*$3,439,980*							$1,146,660			Garages	3	1.000	$1,146,660	1.050	$1,204,064	$3,612,193
CASUALTY & LIABILITY	*$1,672,765*				$0.06	$0.06	$0.06				Revenue Miles	27,323,659	1.000	$0.06	1.050	$0.06	$1,756,508
TAXES & FEES	*$51,488*							$17,163			Garages	3	1.000	$17,163	1.050	$18,022	$54,066
MISCELLANEOUS EXPENSES	*$2,537,512*							$845,837			Garages	3	1.000	$845,837	1.050	$888,182	$2,664,546
TOTALS	***$245,918,440***			**$53.73**	**$2.30**	**$2.21**	**$2.00**	**$23,959,557**	**$63,462**	**$5,420**							**$258,229,693**
2010 Resource Variable Values				**2,009,486**	**20,492,744**	**6,830,915**	**0**	**3**	**14**	**556**							

1. Splits in line item costs that are driven by multiple variables were provided by DART staff.
2. CNG unit cost provided by DART staff and is included for DART plans on switching 100% of fleet to CNG in future.
3. NTD Fringe Benefit Rate for VO, VM and NVM = 47.2%
4. NTD Fringe Benefit Rate for G&A = 47.0%

Revenue Hours	2,009,486
Diesel Bus-Miles	20,492,744
LNG Bus-Miles	6,830,915
CNG Bus-Miles	0
Peak Buses	556
Oper Garages	3
Pass. Facilities	14

4.0 LIGHT RAIL TRANSIT O&M COST METHODOLOGY

The DART light rail transit O&M cost model is based on 2010 expenses and service statistics reported to the NTD. The purpose of this model is to account for the annual cost to operate and maintain a new station on the Red Line, where the project's Build Alternatives are proposed to interface with the LRT system.

4.1 Key Supply Variables

After collection of financial and service data, modeling proceeded with the selection of the key driving supply variables for the existing light rail transit system:

- *Annual Revenue Train-Hours* - are the hours that trains, of any number of passenger cars, travel while in revenue service over the entire fiscal year. Revenue train-hours include layover and schedule recovery, but exclude time for deadhead, operator training and maintenance testing.

- *Annual Revenue Car-Miles* - account for the miles that passenger vehicles travel while in revenue service over an entire fiscal year. Revenue car-miles include layover and schedule recovery, but exclude miles for deadhead, operator training and maintenance testing.

- *Peak Cars* - is the maximum number of passenger service vehicles actually operated simultaneously on an average weekday. The model may use peak cars as a variable when it needs to estimate a line item cost based on overall LRT system size.

- *Passenger Stations* - are passenger boarding and alighting facilities with a platform, which may include stairs, escalators, canopies, wind shelters, lighting, ticket machines and signage. For this project, the cost model was developed to distinguish at-grade, aerial and subway stations primarily for purposes of costing out differences in security and facilities maintenance costs. A more in-depth discussion of these cost differences is provided below.

- *Fixed Guideway Directional Route Miles* - represents the track miles in each direction that trains travel in revenue service. Directional route miles exclude staging or storage tracks at the beginning or end of a rail line. From a maintenance perspective, the guideway includes all buildings and structures dedicated to the operation of LRT including track, tunnels, bridges and the electrification system.

- *Yards* - usually comprised of storage track and maintenance shops, are the sites where light rail vehicles are inspected, repaired, maintained and stored. It is not uncommon for both heavy and light maintenance activities to occur in the same facility.

Table 4-1 shows the key supply variables and values used to represent the model's base year (FY 2010) inputs.

Table 4-1 DART Light Rail Transit O&M Cost Model - Supply Variable Inputs	
Supply Variable Inputs	**2010 Existing**
Light Rail	
Annual Revenue Train-Hours	163,376
Annual Revenue Car-Miles	4,941,155
Peak Cars	76
Passenger Stations	
At-Grade	33
Aerial (incl. one recessed station)	5
Subway	1
Fixed Guideway Directional Route Miles	97.2
Yards	1

4.2 Line Item Expenses

After selecting the key supply variables, the next step in model development was to record DART's light rail expenses as a series of line items. The NTD report format categorizes operating expenses as Vehicle Operations, Vehicle Maintenance, Non-Vehicle Maintenance and General Administration. Within these categories, line item expenses are classified as salaries & wages, fringe benefits, services, materials & supplies, utilities, casualty & liability, taxes & fees and miscellaneous. Supplemental information provided by DART staff enabled select line items to be modeled in greater detail. DART staff indicated that certain line item expenses in the NTD actually are influenced by more than one of the model's supply variables. Accordingly, DART identified the specific line items and the appropriate driving variable and percentage splits for use in the model. Split line items include:

- *Vehicle Operations*: Non-Operator Salaries & Wages are 70% driven by train-hours, 20% driven by the number of yards and 10% driven by total stations. Fringe Benefits are allocated proportionally to the same driving variables.

- *Vehicle Maintenance*: Fuel & Lubricants and Tires & Tubes are 60% driven by track miles and 40% driven by the number of yards.

- *Non-Vehicle Maintenance:* Salaries & Wages are 62% driven by total stations, 21% driven by the number of yards and 17% driven by track miles. The model applies these same splits to Fringe Benefits, Professional & Technical Services and Materials & Supplies.

DART staff supplemented the NTD's total Vehicle Operations employee work hours with operator work hours, which allows the model to calculate non-operator work hours and apply DART's line item splits to Vehicle Operations' salaries, wages and fringe benefits. The model splits all relevant line items according to DART's direction.

The LRT cost model also distinguishes station types. Although most of DART's light rail stations are at-grade, there were five stations in FY 2010 with vertical circulation (aerial or recessed) and one subway station with vertical circulation and ventilation systems. The classification of light rail stations is provided in the **Appendix** included in this Technical Memorandum. In terms of maintenance and security staff deployment, DART staff considers aerial stations to be twice as expensive as an at-grade

facility and the subway station is four times more expensive than an at-grade station. These agency assumptions were incorporated in the unit cost calculations for line items driven by station type.

After the line items were established, each one was assigned a key supply variable as its most relevant cost driver, then unit costs and productivity ratios were calculated.

Table 4-2 summarizes the dollar impact that each of the LRT cost model's key supply variables has on the calibration system (2010 base year). The unit costs in this table reflect the dollar amount the model will adjust for each added or deleted unit of a supply variable – the incremental change from the calibration LRT system. In other words, for each revenue car-mile added, the model will increase its total estimate by $6.15; for each revenue train-hour deleted, the model will subtract $140.70 from its estimate, and so forth.

Table 4-2
DART Light Rail Transit O&M Cost Model - Supply Variable Impacts for the 2010 Calibration LRT System (in 2010 dollars)

Annual Revenue Train-Hours	$22,987,540	20.5%	$140.70
Annual Revenue Car-Miles	$30,380,759	27.1%	$6.15
Peak Cars	$1,111,499	1.0%	$14,625
Passenger Stations			
At-Grade	$9,988,029	8.9%	$302,668
Aerial (incl. one recessed station)	$3,026,676	2.7%	$605,335
Subway	$1,210,670	1.1%	$1,210,670
Fixed Guideway Directional Route Miles	$3,730,441	3.3%	$38,379
Yards	$39,551,769	35.3%	$39,551,769
Total	**$111,987,382**	**100.0%**	

Table 4-3 presents the LRT O&M cost model worksheet, created with the base year supply variable inputs from **Table 4-1**. Model results have been inflated to 2012 dollars using the Bureau of Labor Statistics' CPI-U for the Dallas-Fort Worth area.

Table 4-3
DART Light Rail Transit O&M Cost Model

															Inflation Factor:	1.050
			Light Rail Supply Variable Unit Cost Rate (2010$)								Productivity Ratio			Base Year		Results in:	2012$
Expense Line Item	2010 Light Rail Expenses	Existing Unit Cost Adjusted	Revenue Train-Hours	Revenue Car-Miles	Yards	Revenue Track-Miles	At-Grade Stations	Aerial Stations	Subway Stations	Peak Cars	Resource Variable	Resource Value	Resource/ Supply	Resource Unit Cost	Inflation Factor	Resource Unit Cost	Estimated Annual Cost
VEHICLE OPERATIONS																	
OPERATORS' SALARIES & WAGES	*$5,969,493*		$36.54								Work Hours	359,340	2.199	$16.61	1.050	$17.44	$6,268,340
OTHER SALARIES & WAGES -Train-Hours Driven (70%)	*$9,648,202*		$59.06								Work Hours	215,269	1.318	$44.82	1.050	$47.06	$10,131,213
OTHER SALARIES & WAGES -Yards Driven (20%)	*$2,756,629*				$2,756,629						Work Hours	61,505	61,505	$44.82	1.050	$47.06	$2,894,632
OTHER SALARIES & WAGES -Tot. Stations Driven (10%)	*$1,378,315*	X					$29,326	$58,652	$117,303		Work Hours	30,753	654	$44.82	1.050	$47.06	$1,447,316
FRINGE BENEFITS - Train-Hours Driven	*$7,369,845*		$45.11								Work Hours	574,609	3.517	$12.83	1.050	$13.47	$7,738,797
FRINGE BENEFITS - Yards Driven	*$1,300,828*				$1,300,828						Work Hours	61,505	61,505	$21.15	1.050	$22.21	$1,365,950
FRINGE BENEFITS - Total Stations Driven	*$650,414*	X					$13,839	$27,677	$55,354		Work Hours	30,753	654	$21.15	1.050	$22.21	$682,975
PROFESSIONAL & TECHNICAL SERVICES	*$1,106,656*									$14,561	Peak Cars	76	1.000	$14,561	1.050	$15,290	$1,162,058
OTHER MATERIALS & SUPPLIES	*$381,716*				$381,716						Yards	1	1.000	$381,716	1.050	$400,826	$400,826
UTILITIES	*$9,194,490*			$1.86							Rev Car-Miles	4,941,155	1.000	$1.86	1.050	$1.95	$9,654,788
TAXES & FEES	*$1,893*									$24.91	Peak Cars	76	1.000	$24.91	1.050	$26.15	$1,988
MISCELLANEOUS EXPENSES	*$292,423*				$292,423						Yards	1	1.000	$292,423	1.050	$307,062	$307,062
VEHICLE MAINTENANCE																	
SALARIES & WAGES	*$9,035,205*			$1.83							Work Hours	280,797	0.057	$32.18	1.050	$33.79	$9,487,529
FRINGE BENEFITS	*$4,263,629*			$0.86							Work Hours	280,797	0.057	$15.18	1.050	$15.94	$4,477,076
PROFESSIONAL & TECHNICAL SERVICES	*$527,051*			$0.11							Rev Car-Miles	4,941,155	1.000	$0.11	1.050	$0.11	$553,436
FUEL & LUBRICANTS - Track Miles Driven (60%)	*$363,206*					$3,737					Track Miles	97.2	1.000	$3,737	1.050	$3,924	$381,389
FUEL & LUBRICANTS - Yards Driven (40%)	*$242,138*				$242,138						Yards	1	1.000	$242,138	1.050	$254,260	$254,260
TIRES & TUBES - Track Miles Driven (60%)	*$19,625*					$201.91					Track Miles	97.2	1.000	$201.91	1.050	$212	$20,608
TIRES & TUBES - Yards Driven (40%)	*$13,084*				$13,084						Yards	1	1.000	$13,084	1.050	$13,739	$13,739
OTHER MATERIALS & SUPPLIES	*$6,141,239*			$1.24							Rev Car-Miles	4,941,155	1.000	$1.24	1.050	$1.31	$6,448,684
TAXES & FEES	*$2,950*									$38.82	Peak Cars	76	1.000	$38.82	1.050	$40.76	$3,098
MISCELLANEOUS EXPENSES	*$129,691*				$129,691						Yards	1	1.000	$129,691	1.050	$136,184	$136,184
NON-VEHICLE MAINTENANCE																	
SALARIES & WAGES - Total Stations Driven (62%)	*$6,419,094*	X					$136,576	$273,153	$546,306		Work Hours	232,829	4,954	$27.57	1.050	$28.95	$6,740,449
SALARIES & WAGES - Yards Driven (21%)	*$2,174,209*				$2,174,209						Work Hours	78,862	78,862	$27.57	1.050	$28.95	$2,283,055
SALARIES & WAGES - Track Miles Driven (17%)	*$1,760,074*					$18,108					Work Hours	63,840	657	$27.57	1.050	$28.95	$1,848,188
FRINGE BENEFITS - Total Stations Driven	*$3,029,110*	X					$64,449	$128,898	$257,797		Work Hours	232,829	4,954	$13.01	1.050	$13.66	$3,180,755
FRINGE BENEFITS - Yards Driven	*$1,025,989*				$1,025,989						Work Hours	78,862	78,862	$13.01	1.050	$13.66	$1,077,352
FRINGE BENEFITS - Track Miles Driven	*$830,563*					$8,545					Work Hours	63,840	657	$13.01	1.050	$13.66	$872,142
PROF. & TECH. SERVICES - Total Stations Driven (62%)	*$1,787,823*	X					$38,039	$76,078	$152,155		Stations	39	1.000	$38,039	1.050	$39,943	$1,877,326
PROF. & TECH. SERVICES - Yards Driven (21%)	*$605,553*				$605,553						Yards	1	1.000	$605,553	1.050	$635,868	$635,868
PROF. & TECH. SERVICES - Track Miles Driven (17%)	*$490,210*					$5,043					Track Miles	97.2	1.000	$5,043	1.050	$5,296	$514,751
MATERIALS & SUPPLIES - Total Stations Driven (62%)	*$960,619*	X					$20,439	$40,877	$81,755		Stations	39	0.830	$24,631	1.050	$25,864	$1,008,710
MATERIALS & SUPPLIES - Yards Driven (21%)	*$325,371*				$325,371						Yards	1	1.000	$325,371	1.050	$341,660	$341,660
MATERIALS & SUPPLIES - Track Miles Driven (17%)	*$263,396*					$2,710					Track Miles	97.2	1.000	$2,710	1.050	$2,845	$276,582
TAXES & FEES	*$2,485*					$25.57					Track Miles	97.2	1.000	$25.57	1.050	$26.85	$2,609
MISCELLANEOUS EXPENSES	*$882*					$9.07					Track Miles	97.2	1.000	$9.07	1.050	$9.53	$926
GENERAL ADMINISTRATION																	
SALARIES & WAGES	*$15,405,778*				$15,405,778						Work Hours	270,460	270,460	$56.96	1.050	$59.81	$16,177,027
FRINGE BENEFITS	*$7,269,843*				$7,269,843						Work Hours	270,460	270,460	$26.88	1.050	$28.23	$7,633,788
PROFESSIONAL & TECHNICAL SERVICES	*$5,264,523*				$5,264,523						Yards	1	1.000	$5,264,523	1.050	$5,528,077	$5,528,077
MATERIALS & SUPPLIES	*$898,004*				$898,004						Yards	1	1.000	$898,004	1.050	$942,960	$942,960
UTILIITES	*$751,373*				$751,373						Yards	1	1.000	$751,373	1.050	$788,988	$788,988
CASUALTY & LIABILITY	*$1,219,145*			$0.25							Rev Car-Miles	4,941,155	1.000	$0.25	1.050	$0.26	$1,280,178
TAXES & FEES	*$31,847*				$31,847						Yards	1	1.000	$31,847	1.050	$33,441	$33,441
MISCELLANEOUS EXPENSES	*$682,771*				$682,771						Yards	1	1.000	$682,771	1.050	$716,952	$716,952
TOTALS (not including Fringe Benefits)	***$111,987,382***		**$141**	**$6.15**	**$39,551,769**	**$38,379**	**$302,668**	**$605,335**	**$1,210,670**	**$14,625**							**$117,593,733**
2010 Resource Variable Values			**163,376**	**4,941,155**	**1**	**97.2**	**33**	**5**	**1**	**76**							

Rev Train-Hours	163,376
Rev Car-Miles	4,941,155
Peak Cars	76
At-Grade Sta	33
Aerial Sta	5
Subway Sta	1
Track Miles	97
Yards	1

Notes:
1. Splits in line item costs that are driven by multiple variables were provided by DART staff.
2. Weighting of at-grade, aerial and subway station unit costs provided by DART staff.
3. NTD Fringe Benefit Rates = 47.2%

5.0 REGIONAL RAIL O&M COST METHODOLOGY

The project's regional rail O&M cost model combines the 2013 budget and estimated service statistics for DCTA's A-Train with select cost experience derived from the TRE NTD for 2010. Available data from the A-Train was used because the Cotton Belt Rail Build Alternatives assume the same vehicle type and contract operator used by DCTA and the 2013 budget reflects the first full year of operation with DCTA's Stadler fleet. A-Train calibration expenses were deflated to 2012 dollars using a factor of three percent.

Supplemental cost experience from TRE was used for general and administrative expenses under the assumption that these unit costs were more representative for DART as the operating agency. TRE-based expenses for 2010 were inflated to 2012 dollars with the same CPI factor used for DART's bus and light rail models.

5.1 Key Supply Variables

After collection of financial and service data, modeling proceeded with selection of the key driving supply variables for a new regional rail line:

- *Annual Revenue Train-Hours* - account for the hours that trains, of any number of passenger cars, travel while in revenue service over the entire fiscal year. Revenue train-hours include layover and schedule recovery, but exclude time for deadhead, operator training and maintenance testing.

- *Annual Revenue Passenger Car-Miles* - are the miles that passenger vehicles travel while in revenue service over an entire fiscal year. Revenue car-miles include layover and schedule recovery, but exclude miles for deadhead, operator training and maintenance testing.

- *Peak Passenger Cars* - is the maximum number of passenger service vehicles actually operated simultaneously on an average weekday. The model may use peak cars as a variable when it needs to estimate a line item cost based on overall regional rail system size.

- *Revenue Route Miles* - is expressed as the number of route miles over which trains travel in revenue service, which excludes staging or storage tracks at the beginning or end of a rail line.

- *Passenger Stations* - are passenger boarding and alighting facilities with a platform, which may include stairs, escalators, canopies, wind shelters, lighting, ticket machines and signage.

- *Yards* - usually comprised of storage track and maintenance shops, are the sites where rail vehicles are inspected, repaired, maintained and stored. It is not uncommon for both heavy and light maintenance activities to occur in the same facility.

Table 5-1 shows the key supply variables and values used to represent the model's base year (FY 2013) inputs. Regional rail calibration statistics were obtained from DCTA staff.

Table 5-1 DART Regional Rail Cost Model - Supply Variable Inputs	
Supply Variable Inputs	**2013 Calibration**
Regional Rail	
Annual Revenue Train-Hours	11,258
Annual Revenue Passenger Car-Miles	597,518
Peak Passenger Cars	8
Route Miles	21
Agency Maintained Stations	4
Yards	1

5.2 Line Item Expenses

After selecting the key supply variables, the next step in model development was to organize the A-Train budget as a series of line items within the functions of Contract Vehicle Operations & Maintenance, Contract Non-Vehicle Maintenance and Contract Management Fees & Insurance. The line items modeled on the A-Train are believed to be representative for cost estimating purposes, because the study assumes the same contractor and the same type of vehicle for DART's regional rail alternatives.

To estimate expenses related to general administration of regional rail, the model was based on DART's corresponding costs for TRE, factored by 33 percent to reflect sharing with the TRE service.

After the line items were established, each one was assigned a key supply variable as its most relevant cost driver. In some cases, the model has split line item costs because they are assumed to be strongly influenced by more than one of the supply variables. Unit costs and productivity ratios were calculated, after the following split line items were included:

- *Contract Management Fees & Insurance*: Contract Operations-based Services are modeled as 50% car-miles driven and 50% train-hours driven.

- *DART General Administration*: Service costs are assumed to be equally influenced by yards and passenger stations.

Table 5-2 summarizes the dollar impact that each of the regional rail cost model's key supply variables has on the calibration system (base year). The unit costs in this table reflect the dollar amount the model will adjust for each added or deleted unit of a supply variable – the incremental change from the calibration bus system. In other words, for each revenue passenger car-mile added, the model will increase its total estimate by $7.44; for each revenue train-hour deleted, the model will subtract $523.48 from its estimate, and so forth.

Table 5-2 DART Regional Rail Cost Model - Supply Variable Impacts for the 2013 Calibration Rail System (in 2012 dollars)			
Annual Revenue Train-Hours	$5,893,324	51.3%	$523.48
Annual Revenue Passenger Car-Miles	$4,447,266	38.7%	$7.44
Peak Passenger Cars	$135,000	1.2%	$16,875
Route Miles	$718,743	6.3%	$34,225.84
Agency Maintained Stations	$58,642	0.5%	$14,660
Yards	$244,698	2.1%	$244,698
Total	**$11,497,672**	**100.0%**	

Table 5-3 presents the regional rail O&M cost model worksheet, created with the base year supply variable inputs from **Table 5-1**. Model results are in 2012 dollars.

Table 5-3
Regional Rail O&M Cost Model

																Regional Rail Deflation	0.970
					Regional Rail Supply Variable Unit Cost Rate						Productivity Ratio			Base Year		Results in:	2012$
Expense Line Item	*Regional Rail Expenses*	*Cost Source*	*Existing Unit Cost Adjusted*	*New Unit Cost Added*	Revenue Train-Hours	Revenue Car-Miles	Yards	Route Miles	Stations	Peak Cars	Resource Variable	Resource Value	Resource/ Supply	Resource Unit Cost	Inflation Factor	Resource Unit Cost	Estimated Annual Cost
CONTRACT VEHICLE OPERATIONS & MAINTENANCE																	
COMMUTER RAIL CONTRACT SERVICE	*$3,083,551*	*FY13 DCTA Budget*			$273.90						Rev Train-Hours	11,258	1.000	$273.90	0.970	$265.68	$2,991,045
STAFF SUPPORT SERVICES	*$75,000*	*FY13 DCTA Budget*								$9,375	Peak Cars	8	1.000	$9,375	0.970	$9,094	$72,750
FUEL	*$1,753,750*	*FY13 DCTA Budget*				$2.94					Gallons	412,647	0.691	$4.25	0.970	$4.12	$1,701,138
PHONE DISPATCH	*$25,806*	*FY13 DCTA Budget*					$25,806				Yards	1	1.000	$25,806	0.970	$25,032	$25,032
MAINTENANCE OF EQUIPMENT	*$60,000*	*FY13 DCTA Budget*								$7,500	Peak Cars	8	8.000	$938	0.970	$909	$58,200
CONTRACT NON-VEHICLE MAINTENANCE																	
TVM REVENUE COLLECTION AND MAINTENANCE	*$33,110*	*FY13 DCTA Budget*					$33,110				Yards	1	1.000	$33,110	0.970	$32,117	$32,117
MAINTENANCE OF WAY	*$718,743*	*FY13 DCTA Budget*						$34,226			Track Miles	21.0	1.000	$34,226	0.970	$33,199	$697,180
STATION PLATFORM MAINTENANCE	*$16,560*	*FY13 DCTA Budget*							$4,140		Stations	4	1.000	$4,140	0.970	$4,016	$16,063
ADDITIONAL YARD EXPENSES	*$1,200*	*FY13 DCTA Budget*					$1,200				Yards	1	1.000	$1,200	0.970	$1,164	$1,164
CONTRACT MANAGEMENT FEES & INSURANCE																	
CONTRACT OPER. CAR-MILES RELATED FEES	*$1,795,076*	*FY13 DCTA Budget*				$3.00					Rev Car-Miles	597,518	1.000	$3.00	0.970	$2.91	$1,741,223
CONTRACT OPER. TRAIN-HOURS RELATED FEES	*$1,735,413*	*FY13 DCTA Budget*			$154.15						Rev Train-Hours	11,258	1.000	$154.15	0.970	$149.53	$1,683,351
CONTRACT OPER.-BASED SERVICES - Car-Mi Driven (50%)	*$489,319*	*FY13 DCTA Budget*				$0.82					Rev Car-Miles	597,518	1.000	$0.82	0.970	$0.79	$474,639
CONTRACT OPER.-BASED SERVICES - Train-Hr Driven (50%)	*$489,319*	*FY13 DCTA Budget*			$43.46						Rev Train-Hours	11,258	1.000	$43.46	0.970	$42.16	$474,639
CASUALTY & LIABILITY	*$409,121*	*FY13 DCTA Budget*				$0.68					Rev Car-Miles	597,518	1.000	$0.68	0.970	$0.66	$396,847
DART GENERAL ADMINISTRATION (see Note #3)																	
SALARIES & WAGES	$1,872,182	*TRE 2010 NTD (FY12$)*	X		$35.31						Rev Train-Hours	17,658	1.000	$35.31	1.000	$35.31	$397,476
FRINGE BENEFITS	$883,466	*TRE 2010 NTD (FY12$)*	X		$16.66						Rev Train-Hours	17,658	1.000	$16.66	1.000	$16.66	$187,565
SERVICES - Yards Driven (50%)	$315,928	*TRE 2010 NTD (FY12$)*	X				$105,204				Yards	1	1.000	$105,204	1.000	$105,204	$105,204
SERVICES - Station Driven (50%)	$315,928	*TRE 2010 NTD (FY12$)*	X						$10,520		Stations	10	1.000	$10,520	1.000	$10,520	$42,082
OTHER MATERIALS & SUPPLIES	$72,306	*TRE 2010 NTD (FY12$)*	X				$24,078				Yards	1	1.000	$24,078	1.000	$24,078	$24,078
UTILITIES	$73,424	*TRE 2010 NTD (FY12$)*	X				$24,450				Yards	1	1.000	$24,450	1.000	$24,450	$24,450
MISCELLANEOUS EXPENSES	$92,644	*TRE 2010 NTD (FY12$)*	X				$30,850				Yards	1	1.000	$30,850	1.000	$30,850	$30,850
TOTALS	***$14,311,845***				**$523**	**$7.44**	**$244,698**	**$34,226**	**$14,660**	**$16,875**							**$11,177,093**
2011 Resource Variable Values - A-Train					**11,258**	**597,518**	**1**	**21.0**	**4**	**8**						Rev Train-Hours	11,258
2010 Resource Variable Values - TRE					**17,658**	**1,239,709**	**1**	**36.2**	**10**	**18**						Rev Car-Miles	597,518
																Peak Cars	8
																Route Miles	21.0
																Stations	4
																Yards	1

Notes:
1. Costs for Contract Operations & Maintenance, Non-Vehicle Maintenance and Mgmt Fees & Insurance obtained from FY 2013 Denton A-Train budget, factored to FY 2012 dollars.
2. DART Gen. Administration costs based on DART's TRE general administration costs, inflated to 2012 dollars to be consistent with the A-Train budget.
3. DART Gen. Administration unit costs factored to reflect shared administrative costs with TRE service by: 0.33

6.0 BUILD ALTERNATIVES O&M COST RESULTS

The cost models described above were used to generate annual O&M cost estimates for each of the Cotton Belt alternatives. Information used as model inputs were obtained from the project's definition of alternatives and operating plans. **Table 6-1** summarizes the model runs by alternative, showing the modal characteristics assumed as well as the O&M cost estimated.

For the four Build Alternatives, the incremental annual O&M costs compared to the No-Build Alternative (in 2012 dollars) range from $26.8 to $28.3 million, with approximately $20.9 to $21.3 million as the cost of Cotton Belt Rail service, $635,000 for maintaining a new Red Line station adjacent to the Cotton Belt's 12th Street station, and the remainder accounting for the cost of improved bus service.

Table 6-1
Cotton Belt Rail O&M Cost Estimates

	Base Year	No Build	Alt. 1a: North w/ N. Lake	Alt. 1b: North w/o N. Lake	Alt. 2a: South w/ N. Lake	Alt. 2b: South w/o N. Lake	MOS 1	MOS 2
Operating Expenses ($2012)								
Bus	$258,229,693	$250,308,987	$256,836,851	$255,523,773	$256,717,177	$255,480,516	$254,340,785	$253,464,822
Light Rail	$117,593,733	$117,593,733	$118,229,373	$118,229,373	$118,229,373	$118,229,373	$117,593,733	$117,593,733
Regional Rail	$0	$0	$21,026,188	$20,943,920	$21,250,693	$21,167,371	$5,672,862	$12,749,857
Total Cost of Alternative	$375,823,426	$367,902,720	$396,092,412	$394,697,066	$396,197,244	$394,877,259	$377,607,381	$383,808,412
Incremental Cost to No Build			$28,189,691	$26,794,345	$28,294,523	$26,974,539	$9,704,660	$15,905,692
Characteristics of Bus Ops								
Annual Revenue Bus-Hours	2,009,486	2,009,486	2,085,665	2,069,514	2,084,050	2,068,757	2,053,622	2,044,829
Annual Revenue Bus-Miles - Diesel	20,492,744	0	0	0	0	0	0	0
Annual Revenue Bus-Miles - LNG	6,830,915	0	0	0	0	0	0	0
Annual Revenue Bus-Miles - CNG	0	27,329,045	28,312,822	28,134,925	28,301,929	28,137,376	28,033,742	27,858,177
Total Peak Buses	556	556	585	580	584	579	567	565
Operating Garages (buses dispatched into	3	3	3	3	3	3	3	3
Bus Passenger Facilities	14	14	14	14	14	14	14	14
Total Cost/Bus-Hour	$129	$125	$123	$123	$123	$123	$124	$124
Total Cost/Bus-Mile	$9.45	$9.16	$9.07	$9.08	$9.07	$9.08	$9.07	$9.10
Characteristics of Light Rail Ops								
Annual Revenue Train-Hours	163,376	163,376	163,376	163,376	163,376	163,376	163,376	163,376
Annual Revenue Car-Miles	4,941,155	4,941,155	4,941,155	4,941,155	4,941,155	4,941,155	4,941,155	4,941,155
Peak Cars	76	76	76	76	76	76	76	76
Passenger Stations								
At-Grade	33	33	33	33	33	33	33	33
Aerial (incl. one recessed station)	5	5	6	6	6	6	5	5
Subway	1	1	1	1	1	1	1	1
Fixed Guideway Directional Route Miles	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2
Yards	1	1	1	1	1	1	1	1
Total Cost/Train-Hour	$720	$720	$724	$724	$720	$720	$720	$720
Total Cost/Car-Mile	$23.80	$23.80	$23.93	$23.93	$23.80	$23.80	$23.80	$23.80
Characteristics of Regional Rail Ops								
Annual Revenue Train-Hours	0	0	18,800	18,800	18,800	18,800	8,030	16,000
Annual Revenue Passenger Car-Miles	0	0	1,363,500	1,354,900	1,390,100	1,381,400	150,300	501,200
Peak Passenger Cars	0	0	18	18	18	18	4	8
Route Miles	0.0	0.0	27.4	27.2	27.9	27.8	4.8	16.1
Agency Maintained Stations	0	0	11	10	12	11	2	5
Yards	0	0	1	1	1	1	1	1
Total Cost/Train-Hour	n/a	n/a	$1,118	$1,114	$1,130	$1,126	$706	$797
Total Cost/Passenger Car-Mile	n/a	n/a	$15.42	$15.46	$15.29	$15.32	$37.74	$25.44

APPENDIX: LIGHT RAIL STATION TYPES

Dallas Area Rapid Transit
Cotton Belt Corridor Project
O&M Cost Models
LIGHT RAIL STATION TYPES

	Line(s)	Station Name	Opened	At-Grade	Aerial/ Recessed*	Subway	Comments
1	Red	Westmoreland	1996	X			
2	Red	Hampton	1996	X			
3	Red	Tyler/Vernon	1996	X			
4	Red	Dallas Zoo	1996	X			
5	Red/Blue	8th & Corinth	1996	X			
6	Red/Blue	Cedars	1996	X			
7	Red/Blue	Convention Center	1996	X			
8	Red/Blue + TRE	Union	2008	X			Orig built 1916; re-built 2008
9	Red/Blue	Victory	2004	X			Select wkdy + special events
10	Red/Blue/Green	West End	1996	X			
11	Red/Blue/Green	Akard	1996	X			
12	Red/Blue/Green	St. Paul	1996	X			
13	Red/Blue/Green	Pearl	1996	X			
14	Red/Blue	Cityplace	2004			X	
15	Red/Blue	Mockingbird	1997		X*		Recessed with elevator, 2 escalators
16	Red	Lovers Lane	1997	X			
17	Red	Park Lane	2002		X		Opened '97 at-grade; rebuilt '02 aerial
18	Red	Walnut Hill	2002		X		
19	Red	Forest Lane	2002		X		
20	Red	LBJ Central	2002	X			
21	Red	Spring Valley	2002		X		
22	Red	Arapahoe Center	2002	X			
23	Red	Galatyn Park	2002	X			
24	Red	Bush Turnpike	2002	X			
25	Red	Downtown Plano	2002	X			
26	Red	Parker Road	2002	X			
27	Blue	Ledbetter	1997	X			
28	Blue	VA Medical Center	1997	X			
29	Blue	Kiest	1997	X			
30	Blue	Illinois	1996	X			
31	Blue	Morrell	1996	X			
32	Blue	Fair Park	2009	X			Special events
33	Blue	Baylor Medical Center	2009	X			Special events
34	Blue	Deep Ellum	2009	X			Special events
35	Blue	White Rock	2001	X			
36	Blue	LBJ/Skillman	2002	X			
37	Blue	Forest/Jupiter	2002	X			
38	Blue	Downtown Garland	2002	X			Orig built 1997 as a transit center
39	Green	MLK Jr.	2009	X			
	Totals by Type			33	5	1	39 reported in 2010 NTD