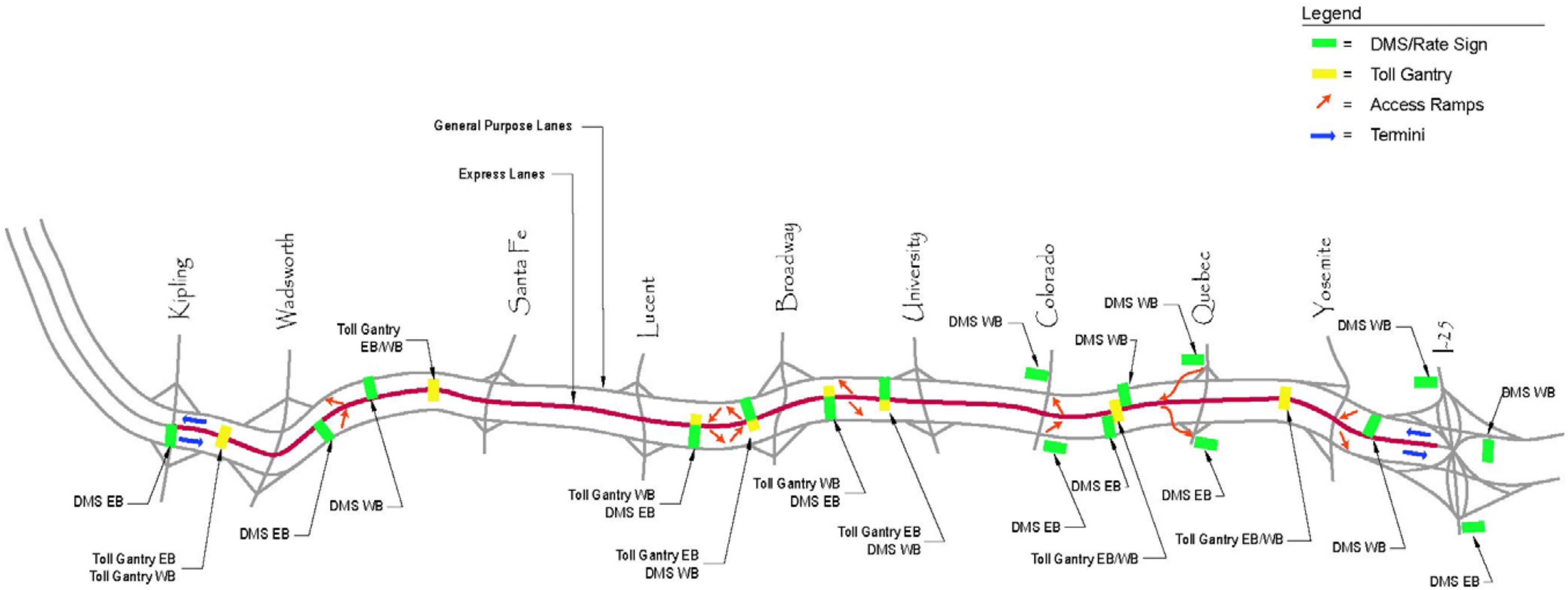
Figure 7.5
Toll Collection Scheme



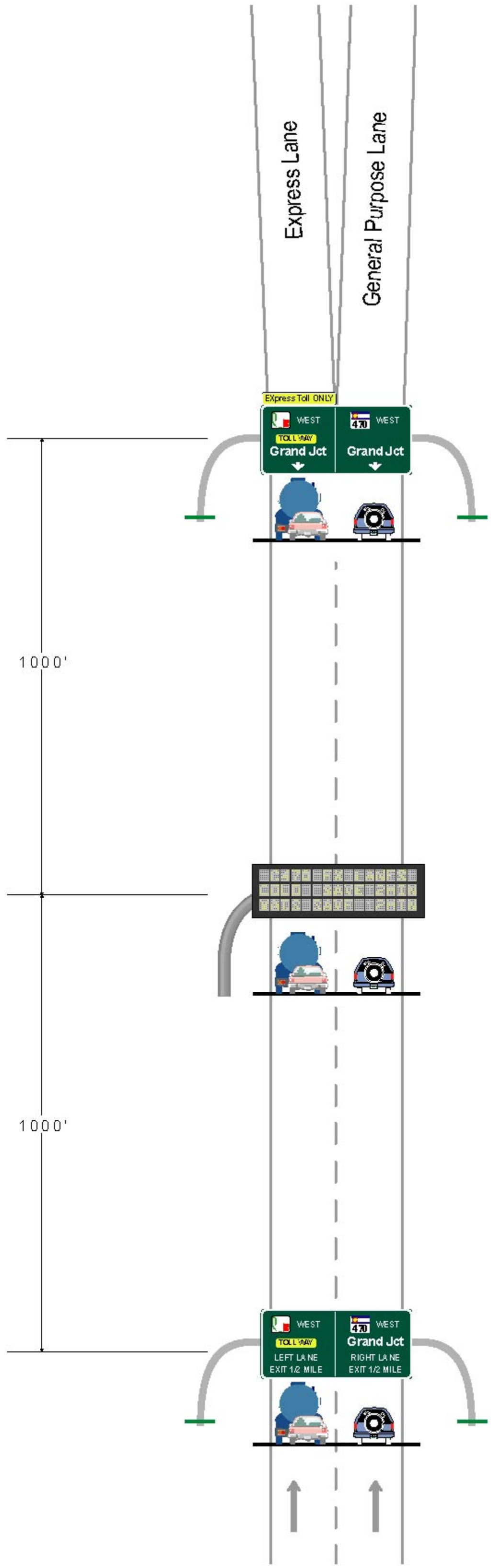
7.1.11 Signing

Because of the nature of two parallel roadways that each require separate markings, signing of express lane facilities is an important consideration. Too many signs carries the potential for driver confusion, leading to the possibility of missing exits, or worse, causing accidents. As a result, careful consideration must be given to the signing layout.

The first consideration in developing a signing concept is to distinguish between signs for express lanes and for general purpose lanes. This is typically accomplished with a supplemental plaque that identifies the express lane signing as separate from the general purpose lanes. FHWA is considering standardizing the color on signs as a universal indicator of toll facilities. Because purple has not yet been officially adopted, the project team opted for the current color of yellow, which alerts a driver to a cautionary situation. When a color is standardized for toll facilities, the yellow color can be changed accordingly.

A typical advance signing concept was developed for each access location, which considered both static guide signs and dynamic toll information signage. The typical configuration is shown in Figure 7.6.

Figure 7.6
Conceptual Signing Plan



After developing a typical sign configuration for access points, the project team considered the extent to which a specific signing plan was necessary in this study. After a cursory assessment of the character and complexity of the C-470 corridor, the project team concluded that only one location presented the potential for problematic signing – the I-25 Interchange complex. The rest of the corridor was thought to be straightforward, and it was believed that a safe and effective signing plan could be developed in final design.

A conceptual signing plan for the I-25 Interchange complex was developed to provide guidance to both the free and tolled lanes; this plan met the requirements for advance signing in the Manual on Uniform Traffic Control Devices. This concept was reviewed and initially accepted by the E-470 Public Highway Authority. The conceptual signing layout for the I-25 Interchange complex is included in Appendix D.

The C-470 express lanes will have two dynamic message signs (DMS) before each access point. The first DMS will display the expected time savings for the nearest destination and the express lanes terminus. The second DMS will display the toll price to the nearest destination and to the express lanes terminus. Both signs will be placed far enough in advance of the entry/exit point to allow drivers to read, process, and make a decision on the posted message. Figure 7.7 shows a layout of the potential messaging.

7.1.12 Intelligent Transportation Systems (ITS)

ITS will be used throughout the corridor to provide information on upcoming road conditions, toll rates, and travel times. As noted DMSs will be located before of each access point and will display the expected time savings and toll prices for using the express lanes. It is assumed that the posted travel time savings information would be computed from the loop detectors at the ramp metering locations on the general purpose lanes and compared to the travel time information compiled from the transponders on the express lanes.

In addition to the notification signs, electronic toll collection will be used throughout the system, reducing the need for toll plazas and allowing drivers to maintain freeway speeds. Fiber optic cable would be installed along the corridor length and connected to the existing E-470 fiber optic line to provide seamless data transfer between the two facilities.

Figure 7.7
Example Dynamic Message Sign Sequence

The C-470 toll facility would be monitored by pan-tilt-zoom video cameras positioned throughout the corridor to observe traffic conditions and alert facility personnel of incidents. At the toll gantries, video surveillance will provide violation enforcement.

7.2 COST ESTIMATES

Cost estimates were compiled for use in the financial feasibility calculations. The estimates included roadway capital costs, roadway operations and maintenance (O&M) costs, toll equipment capital costs, and toll equipment O&M costs. The capital costs were compiled from recent local and national unit costs for similar items. The roadway O&M costs were compiled based on 3-year historical averages for the C-470 corridor, while the toll equipment O&M costs were compiled based on national averages from similar toll facilities.

7.2.1 Roadway Capital Costs

Before beginning design of any corridor improvements, unit costs from CDOT construction projects completed in 2004 were compiled to develop average unit costs for bid items. These unit costs were then used to develop cost estimates used in the financial feasibility calculations. It was assumed that facility construction would begin in 2006; therefore, the 2004 unit costs were inflated to 2006 dollars, assuming a 3 percent inflation rate over 2 years. The unit costs used in the analysis are shown in Table 7.2.

Table 7.2
Roadway Capital Cost Unit Prices

Item Description	Unit	Unit Price $
Quantifiable Items		
Bridge Rail Type 10	LF	75.00
Concrete Median Cover	SF	8.00
Concrete Pavement (13")	SY	38.00
Curb and Gutter (Type 2)	LF	12.00
Earthwork (embankment)	CY	6.00
Guardrail Type 3	LF	12.00
Guardrail Type 7	LF	37.00
Retaining Walls	SF	50.00
Sidewalk	SY	25.00
Major Items		
Regular Straight Bridges	SF	80.00
Curved Flyovers	SF	130.00
Urban Over	SF	120.00
Railroad	SF	130.00
Remove Existing Bridges	SF	15.00
Noise Barrier	SF	35.00
Miscellaneous Items as Percentages		
Utilities		10.00
Removals, Resets, and Adjustments		10.00
Drainage		15.00
Landscape		6.00
Signing, Striping, Signals, Lighting		21.00
Traffic Control		26.00
Mobilization and Miscellaneous		20.00
Force Account Items		10.00
Total		118.00
Box Culvert Construction		
Box 1 (12x14)	LF	805.00

Note: All values are in 2004 Dollars

7.2.2 Toll Equipment Capital Costs

Unit cost information for toll collection equipment was compiled based on national averages for similar toll facilities. Unit costs were compiled for toll lane equipment, gantries, host servers, vehicle enforcement system (VES) data host, workstations, traffic management center (TMC)/video control, and transponders. Table 7.3 summarizes the necessary equipment, respective quantities, and unit costs for each element. The CTE will be required to purchase 20,000 transponders to initiate the system; therefore these costs are also included.

Table 7.3
Toll Equipment Capital Costs

Item Description	Quantity	Unit	Unit Price $	Total Cost $
Toll Lane Equipment	24	System Miles	200,000.00	4,800,000 .00
Gantries	10	Ea	300,000.00	3,000,000.00
Toll/VES Data Host	1	LS	1,000,000.00	1,000,000.00
Host Servers and Functions	1	LS	300,000.00	300,000.00
Workstations	4	Ea	10,000.00	40,000.00
TMC/Video Control	1	LS	500,000.00	500,000.00
Transponders	20,000	Ea	30.00	600,000.00
			Total (2004 Dollars)	10,240,000.00
			Total (2006 Dollars)	10,863,616.00

7.2.3 Operations Costs

The operations costs associated with the express lane facility include liability Insurance, highway patrol, roadside assistance, ITS equipment operation, toll audit and system inspection, toll transaction process, and video enforcement. A description of each is listed below.

- Liability insurance is based on the number of system miles along the express lane system using a national average for similar facilities.
- The highway patrol quantity assumes four full-time officers at an annual cost of $125,000. The roadside assistance item assumes one vehicle will be on call six hours per day, typically during the AM and PM peak hours.
- The annual cost for ITS equipment operation is based on national averages for similar facilities.
- The toll audit and system inspection element assumes five CTE staff members would be monitoring the tolling system and processing account information and billings from E-470. It is assumed that this cost will be distributed over five corridors; therefore the cost attributed to any one corridor is one fifth of this amount.
- The CTE is in negotiations with E-470 to process the toll transactions at a rate of $0.12 per transaction. This amount will include processing the transaction, general account maintenance, and mailing and processing bills.
- It is also assumed that E-470 will provide violation processing and video tolling of express toll customers when transponders fail or are not present in their vehicles. Operation unit costs are shown in Table 7.4.

Table 7.4
C-470 Express Lane Operations Costs

Item Description	Unit	Annual Cost $	Quantity	Total Annual Cost $
Liability Insurance	System Miles	18,000	12	216,000.00
Bond Insurance	% of Bond			-
Highway Patrol	LS	125,000	4	500,000.00
Roadside Assistance	LS	93,600	1	93,600.00
ITS Equipment Operation	LS	150,000	1	150,000.00
Toll Audit and System Inspection	LS	95,000	1	95,000.00
Total Operations Costs				**1,054,600.00***

(Total operations costs does not include toll transaction costs).
Note: All values are in 2004 Dollars

7.2.4 Maintenance Costs

Estimated maintenance costs for the C-470 express lanes were developed from historic maintenance costs of the existing corridor. The most recent 3 years of maintenance costs for the entire corridor were obtained from CDOT Region 6 Maintenance Staff. These costs were used to develop per-lane-mile costs that could be applied to the proposed lane miles of express lanes. The developed maintenance unit cost was calculated to be $7,620 per lane mile, which compares well within the average of similar corridors. Items such as fence repair, ditch repair, and landscaping were not included in the overall average because those items do not correspond to a self-contained express lane facility as compared to the general purpose lane facility. Maintenance costs calculations are shown in Table 7.5.

Table 7.5
C-470 Express Lane Maintenance Costs

Items Description	Unit	Annual Cost $	Quantity	Total Annual Cost $
Roadway Maintenance	Lane Mile	7,620.00	48	365,760.00
Roadside Gantry Toll System	Per Gantry	30,000.00	10	300,000.00
Host System Maintenance	LS	200,000.00	1	200,000.00
Engineering/Traffic Consulting	LS	100,000.00	1	100,000.00
Total Maintenance Costs				**965,760.00**

Note: All values are in 2004 Dollars

7.3 FINANCIAL FEASIBILITY ANALYSIS

7.3.1 Debt Financing Considerations

To determine the extent to which toll revenues can support debt retirement, it is instructive to compare the current value of the project's cash flow to its capital cost. The cash flow in this case refers to the annual stream of toll revenues remaining after paying for current O&M costs; which is referred to as net revenue. This long-term future cash flow is discounted back to present year dollars so as to allow a dollar-to-dollar correlation. The present value (or discount) rate is used to simulate the project owner's cost of capital. In the U.S., state and local governments finance capital infrastructure in the tax-exempt municipal bond market.

The Bond Buyer Revenue Bond index represents the average yields on a select 25 tax-exempt revenue bonds with 40-year maturities. The current bond market conditions are at approximately 5.75 percent. A range of bond rates from 5.50 percent to 6.0 percent was used in this analysis to represent variability in this rate.

In addition to varying the bond interest rates, coverage rates for senior and junior lien debt were also varied. While the senior lien coverage rate was held constant at 1.75, the junior lien coverage rate was varied from 2.19 to 2.99 to represent a range of variability. These individual rates yielded a composite coverage rate of 1.3 to 1.4.

By using varying rates for bond interest and coverage rates, an overall range of financial feasibility was determined. It was believed that such a range would be most appropriate at this preliminary feasibility level. It was believed that this would bracket the most likely range of scenarios that the CTE would face upon pursing bond issuance, and would therefore be a good indication of the likely feasibility of a potential express lanes facility on C-470.

The project's financial feasibility was measured by the financial feasibility factor, which simply compares the current value of its estimated future cash flow (net revenue after payment of financing costs, O&M costs, and capital reserve) to its initial capital construction cost. It is a measure of how much of the capital cost can be paid for by toll revenues. The final determination as to what percentage is or is not feasible is left to the discretion of the agency conducting the analysis.

Given the legislative and fiscal constraints of the CTE, the assumptions described were developed by the CTE for use in this study. As an Enterprise created in accordance with the Tax Payers' Bill of Rights (TABOR), the CTE can accept up to 10 percent of its annual revenue from state and local sources. It was assumed that the CTE would take full benefit of these sources of financing. The CTE estimates that it may be able to acquire up to 20 percent of a project's cost through various federal funding sources. Therefore, the underlying premise of the ELFS financial feasibility analysis is that up to 30 percent of a project's cost could be obtained from sources other than toll revenue. Considering that all senior lien and subordinated debt would be financed through toll revenue, the target feasibility factor for a financially feasible project was established at 70 percent.

7.3.2 Determination of Toll Structure

In theory, the concept of value pricing would allow toll rates to be varied dynamically as traffic conditions in the express lanes vary from minute to minute. Practically speaking, the interval with which toll rates are varied is limited by cost considerations for capital investment and operations costs. Accordingly, the CTE determined that the system would initially be set up with pre-set variable tolls. The decision to move toward a more dynamic toll structure would be deferred until revenues and technology made that option more realistic.

A graduated toll rate structure was developed based on the hourly distribution of traffic volumes. The model followed for establishing this structure was that of a peak period with the highest rate, a shoulder period with a somewhat reduced rate, and an off-peak period with a discount rate. The discussion below describes how each of those time periods and their respective toll rates were established.

Existing directional tube counts were used as the basis for determining the peak and off-peak shoulder periods. Existing traffic patterns were analyzed using projected 2025 traffic volumes. The time periods that exhibited volumes consistent with peak period volumes (95 to 100 percent of the peak volumes) were included in the peak period. Forecasted volumes indicated that the 2025 AM peak period will last for 90 minutes, and the PM peak period will last for 180 minutes. Similarly, volume to capacity ratios (V/C) and ratio of hourly volume to peak hour volume were used to determine the shoulder periods to the peak hour and off-peak periods. The shoulder period was established as the range of 75 to 95 percent of the peak volume, and the off-peak period was established as the range below 75 percent of the peak volume. The toll rate structure is shown in Table 7.6.

Table 7.6
Toll Rate Structure

Time Period	Hours
AM Off-Peak	5:00 - 5:30
AM Shoulder	5:30 - 6:30
AM Peak	6:30 - 8:00
AM Shoulder	8:00 - 9:00
AM Off-Peak	9:00 - 12:00
PM Off-Peak	12:00 - 2:00
PM Shoulder	2:00 - 3:00
PM Peak	3:00 - 6:00
PM Shoulder	6:00 - 7:00
PM Off-Peak	7:00 - 10:00

The driver's value of time derived from the value-of-time analysis discussed earlier in this report was used to establish the toll rate used in the AIMSUN model. The toll rate is set based on the requirement of maintaining operations at LOS C/D in the express lanes. The toll rate is varied until an equilibrium of LOS C/D is established. The actual toll rate and structure developed for the recommended alternative is discussed in Section 8.5, "Final Alternative Optimization."

7.3.3 Revenue and Feasibility Calculations

The gross revenue was calculated using the traffic volume, number of transactions, and toll rates generated from the AIMSUN model. The gross revenue was calculated by taking vehicles miles traveled for each corridor tolling segment and multiplying by the toll rate during that time period.

The net revenue was then calculated by subtracting the combined O&M costs from gross revenue. The senior lien debt was then determined by applying the 1.75 coverage rate. The remaining revenue was considered available to pay off subordinated debt, so the junior lien debt was determined using coverage rates of 2.19 and 2.99. The remaining net toll revenue (free cash) was then set aside as a capital reserve to pay for future maintenance and rehabilitation, and perhaps as additional revenue for future bonding.

The current value of the covered net toll revenue was then calculated. The aggregate current value of the covered net toll revenue over the 40-year bond term was then divided by the capital construction cost to produce the financial feasibility factor. As noted above, a range of factors was produced based on varying interest and coverage rates.

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