Link To Table Of Contents

APPENDICES

APPENDIX A

ACCIDENTS AT RAILROAD CROSSINGS

Table A-1 Accidents at Railroad Crossings

Intersection (nearest)		Accident Class	Collision Type
1 ST N.	WACO	Pedestrian	
2 ND N.	WICHITA	Other vehicle	Rear end
2 ND N.	WICHITA	Other vehicle	Rear end
3 RD N.	WICHITA	Other vehicle	Rear end
3 RD N.	WICHITA	Railway train	
3 RD N.	WICHITA	Other vehicle	Angle
10 TH N.	WASHINGTON	Other vehicle	Angle
11 TH N.	WELLINGTON	Other vehicle	Rear end
13 TH N.	BARWISE	Other vehicle	Rear end
13 TH N.	ST. FRANCIS	Other vehicle	Rear end
13 TH N.	SANTA FE	Other vehicle	Head on
13 TH N.	BARWISE	Other vehicle	Rear end
13 TH N.	MARKET	Other vehicle	Angle
13 TH N.	MARKET	Other vehicle	Rear end
13 TH N.	MEAD	Other vehicle	
13 TH N.	MEAD	Other vehicle	Rear end
13 TH N.	MEAD	Other vehicle	Rear end
13 TH N.	ROOSEVELT	Other vehicle	Rear end
13 TH N.	ROOSEVELT	Other vehicle	Angle
13 TH N.	SANTA FE	Fixed object	Other post or pole
13 TH N.	SANTA FE	Other vehicle	Rear end
13 TH N.	WASHINGTON	Other vehicle	Rear end
13 TH N.	WESTLY	Other vehicle	Rear end
15 TH N.	SANTA FE	Other vehicle	Backed into
15 TH N.	WASHINGTON	Other vehicle	Angle
17 TH N.	MEAD	Other vehicle	Rear end
17 TH N.	MEAD	Other vehicle	Rear end
17 TH N.	SANTA FE	Other vehicle	Rear end
17 TH N.	EMPORIA	Fixed object	RR crossing fixtures
17 TH N.	MEAD	Railway train	
17 TH N.	MEAD	Railway train	
18 TH N.	SANTA FE	Railway train	
18 TH N.	MOSLEY	Railway train	
21 ST N.	BROADWAY	Other vehicle	Rear end
21 ST N.	MOSLEY	Other vehicle	Rear end
21 ST N.	MOSLEY	Other vehicle	Sideswipe-overtake
21 ST N.	MOSLEY	Other vehicle	Rear end
21 ST N.	BROADWAY	Other vehicle	Angle
21 ST N.	BROADWAY	Other vehicle	Rear end
21 ST N.	MOSELY	Other vehicle	Rear end
21 ST N.	MOSLEY	Fixed object	Other

Table A-1 Accidents at Railroad Crossings (continued)

Intersection (nearest)		Accident Class	Collision Type
21 ST N.	MOSLEY	Fixed object	RR crossing fixtures
21 ST N.	MOSLEY	Other vehicle	Sideswipe-overtake
21 ST N.	MOSLEY	Other vehicle	Rear end
21 ST N.	MOSLEY	Other vehicle	Angle
21 ST N.	MOSLEY	Other vehicle	Rear end
21 ST N.	MOSLEY	Other vehicle	Rear end
21 ST N.	MOSLEY	Other vehicle	Angle
21 ST N.	MOSLEY	Parked Vehicle	
25 TH N.	BROADWAY	Railway train	
29 TH N.	BROADWAY	Other vehicle	Angle
29 TH N.	BROADWAY	Other vehicle	Other
29 TH N.	BROADWAY	Fixed object	Curb
29 TH N.	BROADWAY	Other vehicle	Angle
29 TH N.	BROADWAY	Other vehicle	Angle
29 TH N.	BROADWAY	Other vehicle	Rear end
29 TH N.	OHIO	Railway train	
29 TH N.	ST. FRANCIS	Other vehicle	Rear end
33 RD N.	BROADWAY	Railway train	
37 TH N.	HILLSIDE	Other vehicle	Angle
37 TH N.	OHIO	Other vehicle	Rear end
37 TH N.	PARKWOOD	Fixed object	RR crossing fixtures
37 TH N.	BROADWAY	Railway train	
37 TH N.	HYDRAULIC	Fixed object	Other
45 TH N.	MAIZE	Fixed object	Culvert
53 RD N.	ARKANSAS	Fixed object	RR crossing fixtures
53 RD N.	ARKANSAS	Railway train	
53 RD N.	ARKANSAS	Other vehicle	Rear end
53 RD N.	WICHITA	Fixed object	Fence
61 ST N.	ARMSTRONG	Railway train	
61 ST N.	SENECA	Railway train	
69 TH N.	K-15	Railway train	
69 TH N.	WOODLAWN	Railway train	
69 TH N.	M08716	Overturned	
69 TH N.	WOODLAWN	Fixed object	Ditch
127 TH E.	83 RD S.	Fixed object	Other post or pole
127 TH E.	K-254	Fixed object	RR crossing fixtures
23 RD S.	311 TH W.	Fixed object	Building
39 TH S.	K-15	Fixed object	RR crossing fixtures
39 TH S.	R2202	Other vehicle	Rear end
39 TH S.	WEST	Railway train	
47 TH S.	K-15	Fixed object	Other

Table A-1 Accidents at Railroad Crossings (continued)

Intersection (nearest)		Accident Class	Collision Type
47 TH S.	K-15	Fixed object	Other
47 TH S.	K-15	Fixed object	Other
47 TH S.	WATER	Other vehicle	Angle
55 TH S.	US-81	Other vehicle	Rear end
63 RD S.	OLIVER	Other vehicle	Rear end
63 RD S.	SOUTHEAST	Other vehicle	Angle
63 RD S.	SOUTHEAST	Other vehicle	Rear end
71 ST S.	K-15	Fixed object	Guardrail
79 TH S.	SENECA	Railway train	
79 TH S.	SENECA	Railway train	
79 TH S.	SENECA	Railway train	
87 TH S.	SENECA	Railway train	
95 TH S.	MERIDIAN	Railway train	
111 TH S.	GREENWICH	Fixed object	Other
77 TH W.	WOODLAWN	Fixed object	Ditch
77 TH W.	WOODLAWN	Railway train	
119 TH W.	KELLOGG	Other vehicle	Rear end
167 TH W.	KELLOGG	Railway train	
167 TH W.	KELLOGG	Railway train	
215 TH W.	KELLOGG	Railway train	
231 ST W.	KELLOGG	Overturned	
279 TH W.	HARRY	Railway train	
ALBERT	QUEEN	Railway train	
BAYLEY	MARKET	Railway train	
BAYLEY	MEAD	Other vehicle	Rear end
BLAKE	MEAD	Fixed object	Other
BROADWAY	15 TH N.	Other vehicle	Rear end
BROADWAY	15 TH N.	Railway train	
BROADWAY	29 TH N.	Other vehicle	Angle
BROADWAY	37 TH N.	Other vehicle	Angle
BROADWAY	53 RD N.	Other vehicle	Rear end
BROADWAY	BAYLEY	Other vehicle	Angle
BROADWAY	BAYLEY	Other vehicle	Angle
BROADWAY	ORME	Other vehicle	Angle
BROADWAY	ORME	Other vehicle	Rear end
CENTRAL	MEAD	Other vehicle	Sideswipe-overtake
CENTRAL	MOSLEY	Other vehicle	Rear end
CENTRAL	MOSLEY	Other vehicle	Rear end
CENTRAL	MT. CARMEL	Other vehicle	Rear end
CENTRAL	MT. CARMEL	Other vehicle	Head on
CENTRAL	MT. CARMEL	Other vehicle	Angle

Table A-1 Accidents at Railroad Crossings (continued)

Intersection (nearest)		Accident Class	Collision Type
CENTRAL	MT. CARMEL	Pedestrian	
CENTRAL	SANTA FE	Fixed object	RR crossing fixtures
CENTRAL	SANTA FE	Other vehicle	Rear end
CENTRAL	SANTA FE	Other vehicle	Angle
CENTRAL	SANTA FE	Other vehicle	Rear end
CENTRAL	SANTA FE	Other vehicle	Rear end
CENTRAL	SANTA FE	Other vehicle	Rear end
CENTRAL	ST. FRANCIS	Other vehicle	Rear end
CENTRAL	ST. PAUL	Other vehicle	Rear end
CENTRAL	WICHITA	Other vehicle	Rear end
CENTRAL	WICHITA	Railway train	
CLIFTON	47 TH S.	Fixed object	Guardrail
DOUGLAS	FERN	Other vehicle	Angle
DOUGLAS	MILLWOOD	Other vehicle	Rear end
DOUGLAS	VINE	Fixed object	Sign post
EMPORIA	BAYLEY	Other vehicle	Angle
EMPORIA	BAYLEY	Other vehicle	Angle
EMPORIA	ORME	Other vehicle	Other
MERIDIAN	111 TH S.	Railway train	
GREENWICH	13 TH N.	Railway train	
71 ST S.	RIDGE	Railway train	
F612	95 TH S.	Railway train	
GLENN	BURTON	Other vehicle	Angle
GRAND	MAIN	Other vehicle	Angle
GRAND	MAIN	Other vehicle	Rear end
GRAND	MAIN	Other vehicle	Rear end
GRAND	MAIN	Other vehicle	Rear end
GRAND	MAIN	Other vehicle	Sideswipe-overtake
GREEN	MURDOCK	Other vehicle	Rear end
GREEN	MURDOCK	Other vehicle	Head on
GROVE	ELM	Other vehicle	Rear end
GROVE	MURDOCK	Other object	
GROVE	MURDOCK	Other vehicle	Sideswipe-overtake
GROVE	MURDOCK	Other vehicle	Angle
HARRY	HANDLE	Fixed object	Curb
HARRY	K-42	Other vehicle	Backed into
HARRY	MEAD	Non-collision	
HARRY	SANTA FE	Other vehicle	Rear end
HILLSIDE	9TH N	Other vehicle	Sideswipe-overtake
HILLSIDE	COUNTRY CLUB	Other vehicle	Rear end
HYDRAULIC	K-15	Fixed object	Curb

Table A-1 Accidents at Railroad Crossings (continued)

Intersection (nearest)		Accident Class	Collision Type
HYDRAULIC	SOUTHEAST	Other vehicle	Rear end
K-15	39 TH S.	Other vehicle	Rear end
K-15	39 TH S.	Other vehicle	Rear end
K-15	MAC ARTHUR	Other vehicle	Rear end
K-42	HARRY	Other vehicle	Angle
KECHI	OLIVER	Railway train	
KINKAID	MEAD	Railway train	
LINCOLN	MEAD	Other vehicle	Rear end
LINCOLN	MEAD	Other vehicle	Rear end
LINCOLN	MEAD	Railway train	
LINCOLN	SANTA FE	Other vehicle	Rear end
LINCOLN	WASHINGTON		
LINCOLN	WASHINGTON	Fixed object	Other
MAC ARTHUR	BROADWAY	Other vehicle	Rear end
MAC ARTHUR	K-15	Other vehicle	Rear end
MAC ARTHUR	WEST	Other vehicle	Rear end
MADISON	SENECA	Fixed object	Tree
MAIN	BAYLEY	Other vehicle	Angle
MAIN	ORME	Fixed object	Other
MAIN	ORME	Other vehicle	Rear end
MAIN	SANTA FE	Railway train	
MAIN	SANTA FE	Railway train	
MAIZE	KELLOGG	Fixed object	Other post or pole
MARKET	13 TH N.	Other vehicle	Rear end
MARKET	BAYLEY	Other vehicle	Angle
MARKET	ORME	Other vehicle	Angle
MARKET	ORME	Other vehicle	Angle
MARKET	ORME	Other vehicle	Angle
MC CORMICK	EDWARDS	Other vehicle	Angle
MC CORMICK	K-42	Fixed object	Utility pole, devices
MC CORMICK	K-42	Fixed object	RR crossing fixtures
MC CORMICK	K-42	Other vehicle	Sideswipe-overtake
MCLEAN	WALKER	Other vehicle	Angle
MCLEAN	WALKER	Other vehicle	Rear end
MEAD	BAYLEY	Fixed object	Other
MEAD	KINKAID	Fixed object	Curb
MERIDIAN	77 TH N.	Fixed object	Other
MERIDIAN	ORIENT	Other vehicle	Angle
MERIDIAN	ORIENT	Other vehicle	Rear end
MERIDIAN	ST. LOUIS	Other vehicle	Angle
MERIDIAN	ST. LOUIS	Other vehicle	Rear end

Table A-1 Accidents at Railroad Crossings (continued)

Intersection (nearest)		Accident Class	Collision Type
MOSLEY	MURDOCK	Fixed object	Other
MT. VERNON	K-15	Other vehicle	Angle
MT. VERNON	MEAD	Other vehicle	Angle
MURDOCK	MEAD	Railway train	
MURDOCK	MEAD	Railway train	
MURDOCK	SANTA FE	Other vehicle	Rear end
MURDOCK	SANTA FE	Other vehicle	Rear end
MURDOCK	WACO	Railway train	
MURDOCK	WASHINGTON	Other vehicle	Sideswipe-overtake
MURDOCK	WICHITA	Railway train	
MURDOCK	WICHITA	Other vehicle	Angle
MURDOCK	WICHITA	Pedestrian	
MURDOCK	WICHITA	Railway train	
MURDOCK	WICHITA	Railway train	
MURDOCK	WICHITA	Railway train	
MURDOCK	WICHITA	Railway train	
OLIVER	17 TH N.	Other vehicle	Rear end
OLIVER	37 TH N.	Other vehicle	Rear end
OLIVER	37 TH N.	Other vehicle	Rear end
PALISADE	55 TH S.	Other vehicle	Angle
PAWNEE	K-15	Other vehicle	Rear end
PAWNEE	MEAD	Fixed object	Other
PAWNEE	MEAD	Fixed object	Utility pole, devices
PAWNEE	MEAD	Other vehicle	Rear end
PAWNEE	MEAD	Other vehicle	
PAWNEE	MEAD	Pedalcycle	
PAWNEE	SANTA FE	Other vehicle	Angle
PAWNEE	SANTA FE	Other vehicle	Rear end
PAWNEE	SANTA FE	Other vehicle	Angle
PAWNEE	SOUTHEAST	Other vehicle	Rear end
PAWNEE	SOUTHEAST	Other vehicle	Rear end
199 TH W.	SANTA FE	Other vehicle	Rear end
199 TH W.	SANTA FE	Railway train	
R205	K-15	Other vehicle	Rear end
63 RD S.	K-15	Other vehicle	Rear end
63 RD S.	K-15	Railway train	
R2194	M07812	Railway train	
71 ST S.	87 TH S.	Other object	
71 ST S.	87 TH S.	Other object	
151 ST W.	53 RD N.	Railway train	
85 TH N.	RIDGE	Railway train	

Table A-1 Accidents at Railroad Crossings (continued)

Intersection (nearest)		Accident Class	Collision Type
RIDGE	29 TH N.	Other vehicle	Head on
ROCK	13 TH N.	Railway train	
ROCK	ROCKHILL	Fixed object	Utility pole, devices
ROCK	ROCKHILL	Other vehicle	Rear end
ROCK	ROCKHILL	Railway train	
SENECA	WALKER	Other vehicle	Rear end
SENECA	WALKER	Other vehicle	Angle
SENECA	WALKER	Other vehicle	Angle
SENECA	WALKER	Other vehicle	Rear end
SOUTHEAST	PAWNEE	Other vehicle	Angle
SOUTHEAST	PAWNEE	Other vehicle	Angle
ST. PAUL	NEWELL	Other vehicle	Rear end
TOPEKA	BAYLEY	Other vehicle	Angle
TURNPIKE	K-15	Other vehicle	Angle
TYLER	37 TH N.	Railway train	
TYLER	37 TH N.	Railway train	
TYLER	71 ST S.	Railway train	
TYLER	71 ST S.	Railway train	
TYLER	KELLOGG	Fixed object	Tree
WALKER	OSAGE	Other vehicle	Angle
WASHINGTON	MURDOCK	Other vehicle	Sideswipe-overtake
WASHINGTON	ZIMMERLY	Fixed object	Curb
WASHINGTON	ZIMMERLY	Other vehicle	Angle
WASSAL	SOUTHEAST	Other vehicle	Rear end
WEBB	13 TH N.	Fixed object	Guardrail
WEST	11 TH N.	Other vehicle	Rear end
WEST	29 TH S.	Other vehicle	Rear end
WEST	KELLOGG	Other vehicle	Rear end
WEST	PAWNEE	Other vehicle	Rear end
WEST	PAWNEE	Overturned	
WEST	ZOO	Other vehicle	Rear end
WEST	ZOO	Other vehicle	Other
WESTDALE	ZOO	Other vehicle	Angle
WOODLAWN	17 TH N.	Fixed object	Curb
WOODLAWN	17 TH N.	Overturned	
WOODLAWN	17 TH N.	Other vehicle	Rear end
WOODLAWN	39 TH N.	Railway train	
WOODLAWN	FARMVIEW	Other vehicle	Rear end
WOODLAWN	FARMVIEW	Other vehicle	Rear end

APPENDIX B

AGENCIES INTERVIEWED FOR WICHITA METROPOLITAN AREA ITS EARLY DEPLOYMENT STUDY

Table B-1 Agencies Interviewed for ITS Early Deployment Study

Agency or Organization	Contact(s)	Date
City of Wichita Dept. of Public Works	Scott Canfield	January 27, 1998
Sedgwick County Emergency Communications and Management	John Coslett Diane Gage	January 27, 1998
Wichita Fire Department	Chief Larry Garcia	January 27, 1998
Sedgwick County Planning	Dave Spears	January 27, 1998
Metropolitan Transit Authority	Stan Zienkowitz	January 27, 1998
State Highway Patrol	Lt. John Gaunt Lt. John Walters	January 28, 1998
KDOT-Wichita	Benny Tarverdi	January 28, 1998
City of Wichita Maintenance	Larry Henry	January 28, 1998
City of Wichita Police	Chief Mike Watson	January 28, 1998
Kansas Turnpike Authority	Jon Potter	February 17, 1998
Metropolitan Area Planning Department (MAPD)	Bill Stockwell	January 28, 1998

APPENDIX C

AGENCY RANKINGS OF ITS USER SERVICES

Table C-1 Agency Rankings of ITS User Services

ITS USER SERVICES	Wichita City DPW		Sedgwick Co. Emergency Communications		Wichita Fire Department		Sedgwick County Planning		MTA		SHP		KDOT		City Maintenance		City Police		MAPD		KTA	
	Priority	Implementation	Priority	Implementation	Priority	Implementation	Priority	Implementation	Priority	Implementation	Priority	Implementation	Priority	Implementation	Priority	Implementation	Priority	Implementation	Priority	Implementation	Priority	Implementation
En-Route Driver Information	Medium	Short	High	Short	Medium	Medium	High	Long	Low	Medium	High	Short	Medium	Medium	Medium	Medium	Low	Long	Medium	Medium	Medium	Medium
Route Guidance	Low	Long	Low	Long	None	None	Low	Long	Medium	Short	Medium	Medium	Medium	Medium	Medium	Long	High	Short	Medium	Medium	Medium	Medium
Traveler Services Information	Low	Short	Low	Short	Medium	Medium	Low	Long	Low	Long	Medium	Medium	Medium	Medium	High	Short	None	None	Low	Long	Medium	Medium
Traffic Control	High	Short	High	Short	High	Short	High	Medium	High	Short	High	Short	High	Short	High	Short	High	Short	High	Short	Low	Medium
Incident Management	High	Medium	Medium	Medium	Medium	Medium	High	Short	High	Short	High	Short	High	Short	High	Short	Low	Long	High	Short	Low	Medium
Emissions Testing and Mitigation	None	Long	Low	Long	None	None	Low	Long	Low	Long	Low	Long	Low	Long	Medium	Medium	None	None	Low	Long	None	None
Demand Management and Operations	None	Long	Low	Long	High	Short	Low	Long	Medium	Short	Medium	Medium	Medium	Medium	Medium	Medium	None	None	Low	Medium	None	None
Pre-Trip Travel Information	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Short	Medium	Medium	Medium	Medium	Medium	Medium	None	None	Low	Long	None	None
Ride Matching and Reservation	Low	Medium	Medium	Medium	High	Short	Low	Long	High	Short	Medium	Medium	Low	Long	Medium	Medium	None	None	Low	Short	None	None
Highway Rail Intersection	High	Short	High	Short	High	Short	High	Short	Medium	Short	High	Short	Low	Long	High	Short	Low	Long	High	Short	None	None
Public Transportation Management	Medium	Short	Medium	Short	Low	Long	Medium	Medium	High	Short	Medium	Medium	Medium	Medium	Medium	Medium	None	None	Low	Medium	Low	None
En-Route Transit Information	Low	Short	Medium	Short	Low	Long	Medium	Medium	High	Short	Medium	Medium	Medium	Medium	Low	Long	None	None	Low	Long	Medium	Medium
Personalized Public Transit	Medium	Medium	High	Medium	Medium	Long	Medium	Long	High	Short	Medium	Medium	Low	Long	Medium	Medium	None	None	Low	Long	Medium	Long
Public Travel Security	None	None	None	None	None	None	None	None	High	Short	Medium	Medium	Medium	Medium	Medium	Medium	Low	Long	Low	Long	High	Short
Electronic Payment Services	Medium	Low	Low	Long	Low	Long	Low	Long	High	Short	Medium	Medium	Medium	Medium	Medium	Medium	None	None	Medium	Medium	Low	Long
Commercial Vehicle Electronic Clearance	Low	None	None	None	Low	Long	Low	Long	Low	Long	High	Short	Low	Long	Low	Long	None	None	Low	Long	Medium	Medium
Automated Roadside Safety Inspection	Low	Low	Low	Long	None	None	Low	Long	Low	Long	High	Short	Medium	Medium	Low	Long	None	None	Low	Long	Medium	Medium
On-Board Safety Monitoring	Low	Low	Low	Long	Low	Long	Low	Long	Low	Long	High	Short	Medium	Medium	Medium	Medium	None	None	Low	Long	Medium	Medium
Commercial Vehicle Administrative Processes	Low	None	None	None	Low	Long	Low	Long	Low	Long	High	Short	Low	Long	Low	Long	None	None	Low	Long	Medium	Medium
Hazardous Material Incident Response	Medium	Short	High	Short	High	Short	High	Medium	Medium	Medium	High	Short	High	Short	High	Short	Medium	Medium	High	Short	High	Short
Freight Mobility	Low	Short	High	Short	Medium	Medium	Low	Long	Low	Long	High	Short	Medium	Medium	Medium	Medium	None	None	Low	Long	Medium	Medium
Emergency Notification and Personal Security	Medium	Long	High	Long	High	Short	Medium	Long	High	Short	High	Short	Medium	Medium	High	Short	None	None	Medium	Medium	Medium	Medium
Emergency Vehicle Management	High	Short	High	Short	High	Short	Medium	Medium	High	Short	High	Short	High	Short	High	Short	Short	Short	High	Short	Medium	Medium

APPENDIX D

GLOSSARY OF ITS USER SERVICES

GLOSSARY OF ITS USER SERVICES

Twenty-nine ITS user services have been identified by the Federal Highway Administration (FHWA). The 30 user services have been grouped into six "bundles", each of which represent the application of advanced technology to a specific transportation function. The six bundles of user services are:

- Travel and Transportation Management.
- Public Transportation Management.
- Electronic Payment.
- Commercial Vehicle Operations.
- Emergency Management.
- Advanced Vehicle Safety Systems.

Following is a brief description of each user service:

TRAVEL AND TRANSPORTATION MANAGEMENT

- **En-Route Driver Information:** Provides driver advisories and in-vehicle signing for convenience and safety.
- **Route Guidance:** Provides travelers with simple instructions on how to best reach their destinations.
- **Traveler Services Information:** Provides a business directory, or "yellow pages" of service information.
- **Traffic Control:** Manages the movement of traffic on streets and highways.
- **Incident Management:** Helps public and private organizations quickly identify incidents and implement a response to minimize their effects on traffic.
- **Emissions Testing and Mitigation:** Provides information for monitoring air quality and developing air quality improvement strategies.
- **Demand Management and Operations:** Supports policies and regulations designed to mitigate the environmental and social impacts of traffic congestion.
- **Pre-Trip Travel Information:** Provides information for selecting the best transportation mode, departure time, and route.
- **Ride Matching and Reservations:** Makes ride sharing easier and more convenient.
- **Highway-Rail Intersection:** Mitigates highway/railway conflicts

PUBLIC TRANSPORTATION MANAGEMENT

- **Public Transportation Management:** Automates operations, planning, and management functions of public transit system.
- **En-Route Transit Information:** Provides information to travelers using public transportation after they begin their trips.
- **Personalized Public Transit:** Provides flexibly-routed transit vehicles to offer more convenient customer service.
- **Public Travel Security:** Creates a more secure environment for public transit patrons and operators.

ELECTRONIC PAYMENT

- **Electronic Payment Services:** Allows travelers to pay for transportation services electronically.

COMMERCIAL VEHICLE OPERATIONS

- **Commercial Vehicle Electronic Clearance:** Facilitates domestic and international border clearance, minimizing stops.
- **Automated Roadside Safety Inspection:** Facilitates roadside inspections.
- **On-Board Safety Monitoring:** Senses the safety status of a commercial vehicle, cargo, and driver.
- **Commercial Vehicle Administration Processes:** Provides automatic collection and recording of travel distance, fuel purchased, and trip and vehicle data by jurisdiction.
- **Hazardous Materials Incident Response:** Provides immediate description of hazardous materials to emergency responders.
- **Freight Mobility:** Provides communications between drivers, dispatchers, and intermodal transportation providers.

EMERGENCY MANAGEMENT

- **Emergency Notification and Personal Security:** Provides immediate notification of an incident and an immediate request for assistance.
- **Emergency Vehicle Management:** Reduces the time it takes for emergency vehicles to respond to an incident.

ADVANCED VEHICLE SAFETY SYSTEMS

- **Longitudinal Collision Avoidance:** Helps prevent head-on, rear-end, or backing collisions between vehicles or between vehicles and other objects or pedestrians.
- **Lateral Collision Avoidance:** Helps prevent collisions when vehicles leave their lane of travel.
- **Intersection Collision Avoidance:** Helps prevent collisions at intersections.
- **Vision Enhancement for Collision Avoidance:** Improves the driver's ability to see the roadway and objects that are on or along the roadway.
- **Safety Readiness:** Provides warnings about the condition of the driver, the vehicle, and the roadway.
- **Pre-Collision Restraint Deployment:** Anticipates an imminent collision and activates passenger safety systems before the collision occurs, or much earlier in the crash event than is currently feasible.
- **Automated Highway Systems:** Provides a fully automated, "hands off", operating environment.

The technologies necessary for the user services in the Advanced Vehicle Safety Systems bundle are currently being researched at the national level and are not considered appropriate for implementation by local agencies during the planning horizon considered in the study.

APPENDIX E

CALCULATION OF ANTICIPATED BENEFITS

ANALYSIS TECHNIQUES AND ASSUMPTIONS

An analysis was conducted to assess the benefit to cost ratios for the various ITS implementations. These costs are itemized in the following text and in Tables E-1 through E-29. Based on other recent studies, it was assumed for this analysis that the travel time delay will be reduced by 25 percent. It was also assumed that the average fuel efficiency is 15 miles per gallon for speeds under 35 mph, the cost of fuel is $1.20 per gallon, and that the average speed during the delay period is 10 mph without ITS implementation.

The average speed is a function of vehicle volumes. Volume is inversely proportional to speed. For example, when volume increases, speed decreases. A representative average queue length of 2 miles is used for this analysis. During times of congestion, the average queue length is assumed to be the same, however the flow rates differ.

The benefits in the short term are based on 1996 ADT and accident values as documented by KDOT. The long term benefits are based on projected 2020 ADT volumes provided by the MAPD and KDOT. The medium term benefits are based on volumes extrapolated from the 1996 and the projected 2020 volumes. In order to best estimate the benefits of the system in future conditions, the number of accidents is assumed to grow at the same rate as the ADT's over the time frames.

It is assumed that 40 percent of the ADT encounters 30 percent of the total accidents as posted for the 1996 calendar year in incident sensitive areas (Figure 2-12). It is also assumed that 10 percent of the ADT will encounter 10 percent of the total accidents in the non-sensitive areas.

The following sections describe detailed analysis techniques used in calculating the benefits derived from implementing an incident detection and traffic management system as a whole using mainline detectors, video surveillance, and various modes of information dissemination (VMS, HAR, public broadcast, etc.).

Travel Delay Time Savings

Assuming the average queue length of 2 miles, the existing travel delay time can be estimated by using the following equation:

Travel Delay Time = (average queue length/average delay velocity) x 60
= (2 miles/10 mph) x 60 min/hour = 12 minutes

Using a 25 percent reduction in travel time delay with ITS implementation, the travel delay time is:

Travel Delay Time = 12 minutes x (1-.25) = 9 minutes

Using the assumptions listed above, the travel delay time benefits can be determined by the following equations:

Annual Travel Delay Time (hrs) (without ITS implementation)

= (ADT x 0.4 (0.1 in non-sensitive segments) x 12 minutes x (# of accidents) x 0.3 (0.1 in non-sensitive segments))/60 min/hr

Annual Travel Delay Time (hrs) (with ITS implementation)

= (ADT x 0.4 (0.1 in non-sensitive segments) x 9 minutes x (# of accidents) x 0.3 (0.1 in non-sensitive segments))/60 min/hr

or

Annual Travel Delay Time (hrs) (with ITS implementation)
= Annual Travel Delay Time (hrs) (without ITS implementation)
x (1-0.25)

Benefits and savings can be calculated by taking the difference of the two results. To quantify the dollar amounts of the travel delay time, a rate of $10.00 per hour is used in determining the loss of productivity for incident congestion.

Fuel Usage

The fuel used during delay periods can be calculated using the following formula:

Fuel Usage (without ITS implementation) = (Fuel Consumption Rate x Total Delay Time) + (Fuel Consumption per Start/Stop x Number of Stops)[1]

Where:

Fuel Consumption Rate = 0.72 gal/hr[1] (assuming 2 mile queue length and average 10 mph queue speed)

Total Delay Time = As calculated under "Travel Delay Time Savings"

Fuel Consumption per Start/Stop = 0.019 gal/stop[1] between 10 and 60 MPH

= 0.0016 gal/stop[1] between 0 and 10 MPH

Number of Stops = Assume 10 stops (1 from 60 MPH to 10 MPH and back, then 9 from 10 MPH to 0 MPH and back)

Based on USDOT's "Intelligent Transportation Infrastructure Benefits: Expected and Experienced", a 25% reduction in fuel usage can be assumed for the Wichita metropolitan area with ITS implementation.

The savings in fuel cost can be calculated by multiplying the fuel cost per gallon ($1.20) by the number of gallons used annually.

Emissions Reduction

Vehicle exhaust emissions can be reduced due to the reduction of incident related congestion. Using the emission rates extrapolated from Figure 7-10 and the annual travel delay time savings calculated previously, the reduction in emissions of CO, HC, and NO_x can be calculated as follows:

Reduction in CO = (Travel Delay Savings x (0.94 g CO/sec / 453.6 g/lb) x 3600 sec/hr)/2000 lb/ton

Reduction in HC = (Travel Delay Savings x (0.01 g CO/sec / 453.6 g/lb) x 3600 sec/hr)/2000 lb/ton

Reduction in NO_x = (Travel Delay Savings x (0.0085 g CO/sec / 453.6 g/lb) x 3600 sec/hr)/2000 lb/ton

[1] "Traffic Control Systems Handbook", USDOT/FHWA, January 1996, Tables 3-37 and 3-38.

Table E-1 I-135 Travel Delay Time and Cost Savings - Short Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	ANNUAL TRAVEL	ANNUAL TRAVEL DELAY	ANNUAL TIME	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	DELAY TIME (EXIST.) (HRS)	TIME (W/IMPROV.) (HRS)	DELAY SAVINGS (HRS)	DELAY SAVINGS
I135/U54,KELLOGG	BEGIN BRIDGE	75,440	84	151,860	113,895	37,965	$379,649
BEGIN BRIDGE	END BRIDGE	77,790	251	468,857	351,643	117,214	$1,172,142
END BRIDGE	21ST	76,940	72	132,663	99,497	33,166	$331,658
21ST	I135/K96	63,080	192	24,169	18,126	6,042	$60,421
I135/K96	0.6 MI N JCT K96	59,150	60	7,081	5,311	1,770	$17,704
0.6 MI N JCT K96	I135/K254	59,150	72	102,211	76,658	25,553	$255,528
TOTAL				887,000	665,000	222,000	$2,217,000

Table E-2 I-135 Fuel Use and Cost Savings - Short Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	TOTAL ANNUAL FUEL	TOTAL ANNUAL FUEL	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	USE (EXIST.) (GAL.)	USE (W/IMPROV.) (GAL)	FUEL SAVINGS (GAL.)	FUEL SAVINGS
I135/U54,KELLOGG	BEGIN BRIDGE	75,440	84	109,339	82,004	27,335	$32,802
BEGIN BRIDGE	END BRIDGE	77,790	251	337,577	253,183	84,394	$101,273
END BRIDGE	21ST	76,940	72	95,517	71,638	23,879	$28,655
21ST	I135/K96	63,080	192	17,401	13,051	4,350	$5,220
I135/K96	0.6 MI N JCT K96	59,150	60	5,099	3,824	1,275	$1,530
0.6 MI N JCT K96	I135/K254	59,150	72	73,592	55,194	18,398	$22,078
TOTAL				$639,000	$479,000	$160,000	$192,000

Table E-3 I-135 Emission Reductions - Short Term

ROADWAY SEGMENT		TOTAL CO EMISSIONS SAVINGS (TONS)	TOTAL HC EMISSIONS SAVINGS (TONS)	TOTAL NO_X EMISSIONS SAVINGS (TONS)
FROM	TO			
I135/U54,KELLOGG	BEGIN BRIDGE	141.62	1.51	1.28
BEGIN BRIDGE	END BRIDGE	437.23	4.65	3.95
END BRIDGE	21ST	123.71	1.32	1.12
21ST	I135/K96	22.54	0.24	0.20
I135/K96	0.6 MI N JCT K96	6.60	0.07	0.06
0.6 MI N JCT K96	I135/K254	95.32	1.01	0.86
TOTAL		827.01	8.80	7 48

Table E-4 US-54 Travel Delay Time and Cost Savings - Short Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	ANNUAL TRAVEL	ANN. TRAVEL DELAY	ANNUAL TIME	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	DELAY TIME (EX.) (HRS)	TIME (W/IMPROV) (HRS)	DELAY SAVINGS (HRS)	DELAY SAVINGS
0.4 MI E TYLER	MIDCONT/RIDGE IC	42,590	10	15,332	11,499	3,833	$38,331
MIDCONT/RIDGE IC	0.39ME MIDCONTIC	52,870	48	91,359	68,520	22,840	$228,398
0.39ME MIDCONTIC	WEST ST	53,900	38	73,541	55,156	18,385	$183,853
TOTAL				180,000	135,000	45,000	$451,000

Table E-5 US-54 Fuel Use and Cost Savings - Short Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	TOTAL ANNUAL FUEL	TOTAL ANNUAL FUEL	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	USE (EXIST.) (GAL.)	USE (W/IMPROV.) (GAL)	FUEL SAVINGS (GAL.)	FUEL SAVINGS
0.4 MI E TYLER	MIDCONT/RIDGE IC	42,590	10	11,039	8,280	2,760	$3,312
MIDCONT/RIDGE IC	0.39ME MIDCONTIC	52,870	48	65,779	49,334	16,445	$19,734
0.39ME MIDCONTIC	WEST ST	53.900	38	52,950	39,712	13,237	$15,885
TOTAL				130,000	97,000	32,000	$39,000

Table E-6 US-54 Emission Reductions - Short Term

ROADWAY SEGMENT		TOTAL CO EMISSIONS SAVINGS (TONS)	TOTAL HC EMISSIONS SAVINGS (TONS)	TOTAL NO_X EMISSIONS SAVINGS (TONS)
FROM	TO			
0.4 MI E TYLER	MIDCONT/RIDGE IC	14.30	0.15	0.13
MIDCONT/RIDGE IC	0.39ME MIDCONTIC	85.20	0.91	0.77
0.39ME MIDCONTIC	WEST ST	68.58	0.73	0.62
TOTAL		168.07	1 79	1.52

Table E-7 Total Benefits - Short Term

HIGHWAY	PRODUCTIVITY SAVINGS	FUEL COST SAVINGS	TOTAL
I-135	$2,217,000	$192,000	$2,409,000
I-235	-	-	-
K-96	-	-	-
US-54	$451,000	$39,000	$490,000
K-254	-	-	-
TOTALS (rounded)	**$2,670,000**	**$230,000**	**$2,900,000**

Table E-8 I-135 Travel Delay Time and Cost Savings - Medium Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	ANNUAL TRAVEL	ANNUAL TRAVEL DELAY	ANNUAL TIME	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	DELAY TIME (EXIST.) (HRS)	TIME (W/IMPROV.) (HRS)	DELAY SAVINGS (HRS)	DELAY SAVINGS
I135/K15	PAWNEE	69,521	131	18,196	13,647	4,549	$45,490
PAWNEE	I135/U54,KELLOGG	77,886	402	751,525	563,644	187,881	$1,878,813
I135/U54,KELLOGG	BEGIN BRIDGE	88,324	113	238,575	178,931	59,644	$596,437
BEGIN BRIDGE	END BRIDGE	93,081	350	781,448	586,086	195,362	$1,953,620
END BRIDGE	21ST	91,410	99	217,012	162,759	54,253	$542,530
21ST	I135/K96	79,332	290	552,561	414,420	138,140	$1,381,401
I135/K96	0.6 MI N JCT K96	71,519	85	145,719	109,290	36,430	$364,298
0.6 MI N JCT K96	I135/K254	83,492	125	250,663	187,998	62,666	$626,659
TOTAL				2,956,000	2,217,000	739,000	$7,389,000

Table E-9 I-135 Fuel Use and Cost Savings - Medium Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	TOTAL ANNUAL FUEL	TOTAL ANNUAL FUEL	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	USE (EXIST.) (GAL.)	USE (W/IMPROV.) (GAL)	FUEL SAVINGS (GAL.)	FUEL SAVINGS
I135/K15	PAWNEE	69,521	131	13,101	9,826	3,275	$3,930
PAWNEE	I135/U54,KELLOGG	77,886	402	541,098	405,824	135,275	$162,329
I135/U54,KELLOGG	BEGIN BRIDGE	88,324	113	171,774	128,830	42,943	$51,532
BEGIN BRIDGE	END BRIDGE	93,081	350	562,643	421,982	140,661	$168,793
END BRIDGE	21ST	91,410	99	156,249	117,187	39,062	$46,875
21ST	I135/K96	79,332	290	397,844	298,383	99,461	$119,353
I135/K96	0.6 MI N JCT K96	71,519	85	104,918	78,688	26,229	$31,475
0.6 MI N JCT K96	I135/K254	83,492	125	180,478	135,358	45,119	$54,143
TOTAL				2,128,000	1,596,000	532,000	$638,000

Table E-10 I-135 Emission Reductions - Medium Term

ROADWAY SEGMENT		TOTAL CO EMISSIONS SAVINGS (TONS)	TOTAL HC EMISSIONS SAVINGS (TONS)	TOTAL NO_X EMISSIONS SAVINGS (TONS)
FROM	TO			
I135/K15	PAWNEE	16.97	0.18	0.15
PAWNEE	I135/U54,KELLOGG	700.83	7.46	6.34
I135/U54,KELLOGG	BEGIN BRIDGE	222.48	2.37	2.01
BEGIN BRIDGE	END BRIDGE	728.73	7 75	6.59
END BRIDGE	21ST	202.37	2.15	1.83
21ST	I135/K96	515.28	5.48	4.66
I135/K96	0.6 MI N JCT K96	135.89	1.45	1.23
0.6 MI N JCT K96	I135/K254	233.75	2.49	2.11
TOTAL		2,756.31	29.32	24.92

Table E-11 US-54 Travel Delay Time and Cost Savings - Medium Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	ANNUAL TRAVEL	ANN. TRAVEL DELAY	ANNUAL TIME	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	DELAY TIME (EX.) (HRS)	TIME (W/IMPROV.) (HRS)	DELAY SAVINGS (HRS)	DELAY SAVINGS
0.4 MI E TYLER	MIDCONT/RIDGE IC	50,189	10	18,068	13,551	4,517	$45,170
MIDCONT/RIDGE IC	0.39ME MIDCONTIC	61,717	48	106,647	79,985	26,662	$266,617
0.39ME MIDCONTIC	WEST ST	63,371	38	86,692	65,019	21,673	$216,729
WEST ST	U54/K42	89,488	54	173,965	130,474	43,491	$434,912
U54/K42	0.5MI E MERIDIAN	76,956	72	199,470	149,602	49,867	$498,675
0.5MI E MERIDIAN	SYCAMORE	79,225	60	171,126	128,345	42,782	$427,815
SYCAMORE	MAIN	91,233	32	8,758	6,569	2,190	$21,896
MAIN	0.1 MI E TOPEKA	90,243	68	18,410	13,807	4,602	$46,024
0.1MI E TOPEKA	WASHINGTON	78,112	57	160,286	120,214	40,071	$400,715
WASHINGTON	I135/U54,KELLOGG	61,778	114	21,128	15,846	5,282	$52,820
I135/U54,KELLOGG	N ERIE	56,490	36	6,101	4,576	1,525	$15,252
N ERIE	CLIFTON	60,130	78	14,070	10,553	3,518	$35,176
CLIFTON	EDGEMOOR	59,580	202	36,105	27,079	9,026	$90,264
EDGEMOOR	ROCK RD	52,482	228	35,898	26,923	8,974	$89,744
ROCK RD	4LDIV/4L	42,649	118	15,098	11,323	3,774	$37,744
4LDIV/4L	4LD/4L	32,072	42	4,041	3,031	1,010	$10,103
4LD/4L	4L/4LD	26,781	12	964	723	241	$2,410
4L/4LDIV	GREENWICH RD	31,198	4	374	281	94	$936
GREENWICH RD	U54/K96	26,891	36	2,904	2,178	726	$7,261
U54/K96	E CO L	29,603	54	4,796	3,597	1,199	$11,989
TOTAL				1,085,000	814,000	271,000	$2,712,000

Table E-12 US-54 Fuel Use and Cost Savings - Medium Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	TOTAL ANNUAL FUEL	TOTAL ANNUAL FUEL	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	USE (EXIST.) (GAL.)	USE (W/IMPROV.) (GAL)	FUEL SAVINGS (GAL.)	FUEL SAVINGS
0.4 MI E TYLER	MIDCONT/RIDGE IC	50,189	10	13,009	9,757	3,252	$3,903
MIDCONT/RIDGE IC	0.39ME MIDCONTIC	61,717	48	76,786	57,589	19,196	$23,036
0.39ME MIDCONTIC	WEST ST	63,371	38	62,418	46,813	15,604	$18,725
WEST ST	U54/K42	89,488	54	125,255	93,941	31,314	$37,576
U54/K42	0.5MI E MERIDIAN	76,956	72	143,618	107,714	35,905	$43,086
0.5MI E MERIDIAN	SYCAMORE	79,225	60	123,211	92,408	30,803	$36,963
SYCAMORE	MAIN	91,233	32	6,306	4,730	1,577	$1,892
MAIN	0.1 MI E TOPEKA	90,243	68	13,255	9,941	3,314	$3,976
0.1MI E TOPEKA	WASHINGTON	78,112	57	115,406	86,554	28,851	$34,622
WASHINGTON	I135/U54,KELLOGG	61,778	114	15,212	11,409	3,803	$4,564
I135/U54,KELLOGG	N ERIE	56,490	36	4,393	3,295	1,098	$1,318
N ERIE	CLIFTON	60,130	78	10,131	7,598	2,533	$3,039
CLIFTON	EDGEMOOR	59,580	202	25,996	19,497	6,499	$7,799
EDGEMOOR	ROCK RD	52,482	228	25,846	19,385	6,462	$7,754
ROCK RD	4LDIV/4L	42,649	118	10,870	8,153	2,718	$3,261
4LDIV/4L	4LD/4L	32,072	42	2,910	2,182	727	$873
4LD/4L	4L/4LD	26,781	12	694	521	174	$208
4L/4LDIV	GREENWICH RD	31,198	4	270	202	67	$81
GREENWICH RD	U54/K96	26,891	36	2,091	1,568	523	$627
U54/K96	E CO L	29,603	54	3,453	2,590	863	$1,036
TOTAL				781,000	586,000	195,000	$234,000

Table E-13 US-54 Emission Reductions - Medium Term

ROADWAY SEGMENT		TOTAL CO EMISSIONS SAVINGS (TONS)	TOTAL HC EMISSIONS SAVINGS (TONS)	TOTAL NO_X EMISSIONS SAVINGS (TONS)
FROM	TO			
0.4 MI E TYLER	MIDCONT/RIDGE IC	16.85	0.18	0.15
MIDCONT/RIDGE IC	0.39ME MIDCONTIC	99.45	1.06	0.90
0.39ME MIDCONTIC	WEST ST	80.84	0.86	0.73
WEST ST	U54/K42	162.23	1.73	1.47
U54/K42	0.5MI E MERIDIAN	186.01	1.98	1.68
0.5MI E MERIDIAN	SYCAMORE	159.58	1.70	1.44
SYCAMORE	MAIN	8.17	0.09	0.07
MAIN	0.1 MI E TOPEKA	17 17	0.18	0.16
0.1MI E TOPEKA	WASHINGTON	149.47	1.59	1.35
WASHINGTON	I135/U54,KELLOGG	19.70	0.21	0.18
I135/U54,KELLOGG	N ERIE	5.69	0.06	0.05
N ERIE	CLIFTON	13.12	0.14	0.12
CLIFTON	EDGEMOOR	33.67	0.36	0.30
EDGEMOOR	ROCK RD	33.48	0.36	0.30
ROCK RD	4LDIV/4L	14.08	0.15	0.13
4LDIV/4L	4LD/4L	3.77	0.04	0.03
4LD/4L	4L/4LD	0.90	0.01	0.01
4L/4LDIV	GREENWICH RD	0.35	0.00	0.00
GREENWICH RD	U54/K96	2.71	0.03	0.02
U54/K96	E CO L	4.47	0.05	0.04
TOTAL		1,011.71	10.76	9 15

Table E-14 Total Benefits - Medium Term

HIGHWAY	PRODUCTIVITY SAVINGS	FUEL COST SAVINGS	TOTAL
I-135	$7,389,000	$638,000	$8,027,000
I-235	-	-	-
K-96	-	-	-
US-54	$2,712,000	$234,000	$2,946,000
K-254	-	-	-
TOTALS (rounded)	**$10,100,000**	**$870,000**	**$10,970,000**

Table E-15 I-135 Travel Delay Time and Cost Savings - Long Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	ANNUAL TRAVEL	ANNUAL TRAVEL DELAY	ANNUAL TIME	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	DELAY TIME (EXIST.) (HRS)	TIME (W/IMPROV.) (HRS)	DELAY SAVINGS (HRS)	DELAY SAVINGS
I135/KTA	I135/U81,47TH	19,560	57	2,234	1,675	558	$5,584
I135/U81,47TH	I135/I235	37,520	66	4,935	3,701	1,234	$12,337
I135/I235	HYDRAULIC	31,410	41	2,555	1,917	639	$6,388
HYDRAULIC	I135/K15	36,114	20	1,409	1,057	352	$3,523
I135/K15	PAWNEE	81,432	168	328,955	246,717	82,239	$822,389
PAWNEE	I135/U54,KELLOGG	90,792	516	1,125,117	843,837	281,279	$2,812,792
I135/U54,KELLOGG	BEGIN BRIDGE	101,208	141	342,979	257,234	85,745	$857,447
BEGIN BRIDGE	END BRIDGE	108,372	449	1,166,568	874,926	291,642	$2,916,420
END BRIDGE	21ST	105,880	126	320,070	240,052	80,017	$800,174
21ST	I135/K96	95,584	389	892,154	669,116	223,039	$2,230,385
I135/K96	0.6 MI N JCT K96	83,888	110	221,325	165,993	55,331	$553,311
0.6 MI N JCT K96	I135/K254	107,834	179	461,961	346,471	115,490	$1,154,902
I135/K254	SCL PARK CITY	68,908	36	58,949	44,212	14,737	$147,374
SCL PARK CITY	1.3 MN K254	97,200	81	189,911	142,433	47,478	$474,777
1.3 MN K254	NUAB WICHITA	31,884	87	5,550	4,162	1,387	$13,874
TOTAL				5,125,000	3,844,000	1,281,000	$12,812,000

Table E-16 I-135 Fuel Use and Cost Savings - Long Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	TOTAL ANNUAL FUEL	TOTAL ANNUAL FUEL	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	USE (EXIST.) (GAL.)	USE (W/IMPROV.) (GAL)	FUEL SAVINGS (GAL.)	FUEL SAVINGS (GAL.)
I135/KTA	I135/U81,47TH	19,560	57	1,608	1,206	402	$483
I135/U81,47TH	I135/I235	37,520	66	3,553	2,665	888	$1,066
I135/I235	HYDRAULIC	31,410	41	1,840	1,380	460	$552
HYDRAULIC	I135/K15	36,114	20	1,015	761	254	$304
I135/K15	PAWNEE	81,432	168	236,848	177,636	59,212	$71,054
PAWNEE	I135/U54,KELLOGG	90,792	516	810,084	607,563	202,521	$243,025
I135/U54,KELLOGG	BEGIN BRIDGE	101,208	141	246,945	185,209	61,736	$74,083
BEGIN BRIDGE	END BRIDGE	108,372	449	839,929	629,947	209,982	$251,979
END BRIDGE	21ST	105,880	126	230,450	172,838	57,613	$69,135
21ST	I135/K96	95,584	389	642,351	481,763	160,588	$192,705
I135/K96	0.6 MI N JCT K96	83,888	110	159,354	119,515	39,838	$47,806
0.6 MI N JCT K96	I135/K254	107,834	179	332,612	249,459	83,153	$99,784
I135/K254	SCL PARK CITY	68,908	36	42,444	31,833	10,611	$12,733
SCL PARK CITY	1.3 MN K254	97,200	81	136,736	102,552	34,184	$41,021
1.3 MN K254	NUAB WICHITA	31,884	87	3,996	2,997	999	$1,199
TOTAL				3,690,000	2,767,000	922,000	$1,107,000

Table E-17 I-135 Emission Reductions - Long Term

ROADWAY SEGMENT		TOTAL CO EMISSIONS SAVINGS (TONS)	TOTAL HC EMISSIONS SAVINGS (TONS)	TOTAL NO_x EMISSIONS SAVINGS (TONS)
FROM	TO			
I135/KTA	I135/U81,47TH	2.08	0.02	0.02
I135/U81,47TH	I135/I235	4.60	0.05	0.04
I135/I235	HYDRAULIC	2.38	0.03	0.02
HYDRAULIC	I135/K15	1.31	0.01	0.01
I135/K15	PAWNEE	306.76	3.26	2.77
PAWNEE	I135/U54,KELLOGG	1,049.22	11.16	9.49
I135/U54,KELLOGG	BEGIN BRIDGE	319.84	3.40	2.89
BEGIN BRIDGE	END BRIDGE	1,087.87	11.57	9.84
END BRIDGE	21ST	298.48	3.18	2.70
21ST	I135/K96	831.97	8.85	7.52
I135/K96	0.6 MI N JCT K96	206.39	2.20	1.87
0.6 MI N JCT K96	I135/K254	430.80	4.58	3.90
I135/K254	SCL PARK CITY	54.97	0.58	0.50
SCL PARK CITY	1.3 MN K254	177.10	1.88	1.60
1.3 MN K254	NUAB WICHITA	5.18	0.06	0.05
TOTAL		4,778.96	50.84	43.21

Table E-18 I-235 Travel Delay Time and Cost Savings - Long Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	ANNUAL TRAVEL	ANN. TRAV. DELAY	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	DELAY TIME (EX.) (HRS)	TIME (W/IMPROV.) (HRS)	DELAY SAVINGS (HRS)	DELAY SAVINGS (HRS)
I135/I235	MCARTHUR RD	28,994	43	3,732	2,799	933	$9,331
MCARTHUR RD	I235/K42	37,542	131	14,780	11,085	3,695	$36,951
I235/K42	BEG CONC REPL.	42,522	37	4,680	3,510	1,170	$11,700
BEG CONC REPL.	I235/U54	42,522	96	12,242	9,182	3,061	$30,606
I235/U54	ZOO BLVD	44,370	205	27,244	20,433	6,811	$68,109
ZOO BLVD	3.2MN ZOO BLVD	37,906	68	7,728	5,796	1,932	$19,321
3.2MN ZOO BLVD	I235/K96	28,102	31	2,584	1,938	646	$6,461
I235/K96	BROADWAY	41,912	24	2,971	2,228	743	$7,428
BROADWAY	I135/K254	35,874	21	2,224	1,668	556	$5,559
TOTAL				78,200	58,600	19,500	$195,000

Table E-19 I-235 Fuel Use and Cost Savings - Long Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	TOTAL ANNUAL FUEL	TOTAL ANNUAL FUEL	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	USE (EXIST.) (GAL.)	USE (W/IMPROV.) (GAL)	FUEL SAVINGS (GAL.)	FUEL SAVINGS
I135/I235	MCARTHUR RD	28,994	43	2,687	2,016	672	$806
MCARTHUR RD	I235/K42	37,542	131	10,642	7,981	2,660	$3,193
I235/K42	BEG CONC REPL.	42,522	37	3,370	2,527	842	$1,011
BEG CONC REPL.	I235/U54	42,522	96	8,815	6,611	2,204	$2,644
I235/U54	ZOO BLVD	44,370	205	19,616	14,712	4,904	$5,885
ZOO BLVD	3.2MN ZOO BLVD	37,906	68	5,565	4,173	1,391	$1,669
3.2MN ZOO BLVD	I235/K96	28,102	31	1,861	1,396	465	$558
I235/K96	BROADWAY	41,912	24	2,139	1,605	535	$642
BROADWAY	I135/K254	35,874	21	1,601	1,201	400	$480
TOTAL				56,300	42,200	14,100	$16,900

Table E-20 I-235 Emission Reductions - Long Term

ROADWAY SEGMENT		TOTAL CO EMISSIONS SAVINGS (TONS)	TOTAL HC EMISSIONS SAVINGS (TONS)	TOTAL NO_X EMISSIONS SAVINGS (TONS)
FROM	TO			
I135/I235	MCARTHUR RD	3.48	0.04	0.03
MCARTHUR RD	I235/K42	13.78	0.15	0.12
I235/K42	BEG CONC REPL.	4.36	0.05	0.04
BEG CONC REPL.	I235/U54	11.42	0.12	0.10
I235/U54	ZOO BLVD	25.41	0.27	0.23
ZOO BLVD	3.2MN ZOO BLVD	7.21	0.08	0.07
3.2MN ZOO BLVD	I235/K96	2.41	0.03	0.02
I235/K96	BROADWAY	2.77	0.03	0.03
BROADWAY	I135/K254	2.07	0.02	0.02
TOTAL		72.91	0.78	0.66

Table E-21 K-96 Travel Delay Time and Cost Savings - Long Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	ANNUAL TRAVEL	ANN. TRAVEL DELAY	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	DELAY TIME (EX.) (HRS)	TIME (W/IMPROV.) (HRS)	DELAY SAVINGS (HRS)	DELAY SAVINGS (HRS)
I135/K96	HILLSIDE	38,994	32	3,795	2,846	949	$9,487
HILLSIDE	OLIVER	47,934	41	5,837	4,377	1,459	$14,591
OLIVER	WOODLAWN	45,872	54	7,429	5,571	1,857	$18,572
WOODLAWN	ROCK RD	40,474	23	2,760	2,070	690	$6,901
ROCK RD	WEBB RD	27,962	51	4,289	3,217	1,072	$10,723
WEBB RD	ECLUAB WICHITA	23,524	23	1,645	1,234	411	$4,114
ECL WICHITA	21ST	19,288	13	767	575	192	$1,917
21ST	13TH	26,532	21	1,639	1,229	410	$4,098
13TH	KTA.IC.	19,368	30	1,759	1,320	440	$4,399
TOTAL				29,900	22,400	7,500	$75,000

Table E-22 K-96 Fuel Use and Cost Savings - Long Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	TOTAL ANNUAL FUEL	TOTAL ANNUAL FUEL	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	USE (EXIST) (GAL.)	USE (W/IMPROV.) (GAL)	FUEL SAVINGS (GAL.)	FUEL SAVINGS (GAL.)
I135/K96	HILLSIDE	38,994	32	2,732	2,049	683	$820
HILLSIDE	OLIVER	47,934	41	4,202	3,152	1,051	$1,261
OLIVER	WOODLAWN	45,872	54	5,349	4,011	1,337	$1,605
WOODLAWN	ROCK RD	40,474	23	1,987	1,491	497	$596
ROCK RD	WEBB RD	27,962	51	3,088	2,316	772	$926
WEBB RD	ECLUAB WICHITA	23,524	23	1,185	889	296	$355
ECL WICHITA	21ST	19,288	13	552	414	138	$166
21ST	13TH	26,532	21	1,180	885	295	$354
13TH	KTA.IC.	19,368	30	1,267	950	317	$380
TOTAL				21,500	16,200	5,400	$6,500

Table E-23 K-96 Emission Reductions - Long Term

ROADWAY SEGMENT		TOTAL CO EMISSIONS SAVINGS (TONS)	TOTAL HC EMISSIONS SAVINGS (TONS)	TOTAL NO_X EMISSIONS SAVINGS (TONS)
FROM	TO			
I135/K96	HILLSIDE	3.54	0.04	0.03
HILLSIDE	OLIVER	5.44	0.06	0.05
OLIVER	WOODLAWN	6.93	0.07	0.06
WOODLAWN	ROCK RD	2.57	0.03	0.02
ROCK RD	WEBB RD	4.00	0.04	0.04
WEBB RD	ECLUAB WICHITA	1.53	0.02	0.01
ECL WICHITA	21ST	0.72	0.01	0.01
21ST	13TH	1.53	0.02	0.01
13TH	KTA.IC.	1.64	0.02	0.01
TOTAL		27.90	0.30	0.25

Table E-24 US-54 Travel Delay Time and Cost Savings - Long Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	ANNUAL TRAVEL	ANN. TRAVEL DELAY	ANNUAL TIME	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	DELAY TIME (EX.) (HRS)	TIME (W/IMPROV.) (HRS)	DELAY SAVINGS (HRS)	DELAY SAVINGS
MAIZE RD	0.5ME MAIZE RD	40,560	28	40,884	30,663	10,221	$102,211
0.5ME MAIZE RD	0.4 MI E TYLER	43,584	40	62,761	47,071	15,690	$156,902
0.4 MI E TYLER	MIDCONT/RIDGE IC	59,050	10	21,258	15,944	5,315	$53,145
MIDCONT/RIDGE IC	0.39ME MIDCONTIC	70,564	48	121,935	91,451	30,484	$304,836
0.39ME MIDCONTIC	WEST ST	73,872	38	101,057	75,793	25,264	$252,642
WEST ST	U54/K42	112,846	54	219,373	164,529	54,843	$548,432
U54/K42	0.5MI E MERIDIAN	88,412	72	229,164	171,873	57,291	$572,910
0.5MI E MERIDIAN	SYCAMORE	89,910	60	194,206	145,654	48,551	$485,514
SYCAMORE	MAIN	102,316	32	117;868	88,401	29,467	$294,670
MAIN	0.1 MI E TOPEKA	100,336	68	245,623	184,217	61,406	$614,056
0.1MI E TOPEKA	WASHINGTON	87,624	57	179,804	134,853	44,951	$449,511
WASHINGTON	I135/U54,KELLOGG	66,496	114	22,742	17,056	5,685	$56,854
I135/U54,KELLOGG	N ERIE	59,510	36	6,427	4,820	1,607	$16,068
N ERIE	CLIFTON	71,420	78	16,712	12,534	4,178	$41,781
CLIFTON	EDGEMOOR	71,420	202	43,281	32,460	10,820	$108,201
EDGEMOOR	ROCK RD	64,494	228	44,114	33,085	11,028	$110,285
ROCK RD	4LDIV/4L	53,088	118	18,793	14,095	4,698	$46,983
4LDIV/4L	4LD/4L	37,796	42	4,762	3,572	1,191	$11,906
4LD/4L	4L/4LD	28,782	12	1,036	777	259	$2,590
4L/4LDIV	GREENWICH RD	37,796	4	454	340	113	$1,134
GREENWICH RD	U54/K96	29,372	36	3,172	2,379	793	$7,930
U54/K96	E CO L	36,146	54	5,856	4,392	1,464	$14,639
TOTAL				1,701,000	1,276,000	425,000	$4,253,000

Table E-25 US-54 Fuel Use and Cost Savings - Long Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	TOTAL ANNUAL FUEL	TOTAL ANNUAL FUEL	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	USE (EXIST.) (GAL.)	USE (W/IMPROV.) (GAL)	FUEL SAVINGS (GAL.)	FUEL SAVINGS
MAIZE RD	0.5ME MAIZE RD	40,560	28	29,437	22,078	7,359	$8,831
0.5ME MAIZE RD	0.4 MI E TYLER	43,584	40	45,188	33,891	11,297	$13,556
0.4 MI E TYLER	MIDCONT/RIDGE IC	59,050	10	15,306	11,479	3,826	$4,592
MIDCONT/RIDGE IC	0.39ME MIDCONTIC	70,564	48	87,793	65,845	21,948	$26,338
0.39ME MIDCONTIC	WEST ST	73,872	38	72,761	54,571	18,190	$21,828
WEST ST	U54/K42	112,846	54	157,948	118,461	39,487	$47,385
U54/K42	0.5MI E MERIDIAN	88,412	72	164,998	123,749	41,250	$49,499
0.5MI E MERIDIAN	SYCAMORE	89,910	60	139,828	104,871	34,957	$41,948
SYCAMORE	MAIN	102,316	32	84,865	63,649	21,216	$25,460
MAIN	0.1 MI E TOPEKA	100,336	68	176,848	132,636	44,212	$53,054
0.1MI E TOPEKA	WASHINGTON	87,624	57	129,459	97,094	32,365	$38,838
WASHINGTON	I135/U54,KELLOGG	66,496	114	16,374	12,281	4,094	$4,912
I135/U54,KELLOGG	N ERIE	59,510	36	4,628	3,471	1,157	$1,388
N ERIE	CLIFTON	71,420	78	12,033	9,025	3,008	$3,610
CLIFTON	EDGEMOOR	71,420	202	31,162	23,372	7,791	$9,349
EDGEMOOR	ROCK RD	64,494	228	31,762	23,822	7,941	$9,529
ROCK RD	4LDIV/4L	53,088	118	13,531	10,148	3,383	$4,059
4LDIV/4L	4LD/4L	37,796	42	3,429	2,572	857	$1,029
4LD/4L	4L/4LD	28,782	12	746	560	187	$224
4L/4LDIV	GREENWICH RD	37,796	4	327	245	82	$98
GREENWICH RD	U54/K96	29,372	36	2,284	1,713	571	$685
U54/K96	E CO L	36,146	54	4,216	3,162	1,054	$1,265
TOTAL				1,225,000	919,000	306,000	$367,000

Table E-26 US-54 Emission Reductions - Long Term

ROADWAY SEGMENT		TOTAL CO EMISSIONS SAVINGS (TONS)	TOTAL HC EMISSIONS SAVINGS (TONS)	TOTAL NO_X EMISSIONS SAVINGS (TONS)
FROM	TO			
MAIZE RD	0.5ME MAIZE RD	38.13	0.41	0.34
0.5ME MAIZE RD	0.4 MI E TYLER	58.53	0.62	0.53
0.4 MI E TYLER	MIDCONT/RIDGE IC	19.82	0.21	0.18
MIDCONT/RIDGE IC	0.39ME MIDCONTIC	113.71	1.21	1.03
0.39ME MIDCONTIC	WEST ST	94.24	1.00	0.85
WEST ST	U54/K42	204.57	2.18	1.85
U54/K42	0.5MI E MERIDIAN	213.70	2.27	1.93
0.5MI E MERIDIAN	SYCAMORE	181.10	1.93	1.64
SYCAMORE	MAIN	109.92	1.17	0.99
MAIN	0.1 MI E TOPEKA	229.05	2.44	2.07
0.1MI E TOPEKA	WASHINGTON	167.67	1.78	1.52
WASHINGTON	I135/U54,KELLOGG	21.21	0.23	0.19
I135/U54,KELLOGG	N ERIE	5.99	0.06	0.05
N ERIE	CLIFTON	15.58	0.17	0.14
CLIFTON	EDGEMOOR	40.36	0.43	0.36
EDGEMOOR	ROCK RD	41 14	0.44	0.37
ROCK RD	4LDIV/4L	17.53	0.19	0.16
4LDIV/4L	4LD/4L	4.44	0.05	0.04
4LD/4L	4L/4LD	0.97	0.01	0.01
4L/4LDIV	GREENWICH RD	0.42	0.00	0.00
GREENWICH RD	U54/K96	2.96	0.03	0.03
U54/K96	E CO L	5.46	0.06	0.05
TOTAL		1,586.51	16.88	14.35

Table E-27 K-254 Travel Delay Time and Cost Savings - Long Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	ANNUAL TRAVEL	ANN. TRAVEL DELAY	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	DELAY TIME (EX.) (HRS)	TIME (W/IMPROV.) (HRS)	DELAY SAVINGS (HRS)	DELAY SAVINGS (HRS)
I135/I235/K96	ECL WICHITA	18,806	21	1,162	871	290	$2,904
ECL WICHITA	4LDIV/2L	15,672	22	1,030	772	257	$2,574
TOTAL				2,200	1,600	500	$5,500

Table E-28 K-254 Fuel Use and Cost Savings - Long Term

ROADWAY SEGMENT		VOLUME	NUMBER OF	TOTAL ANNUAL FUEL	TOTAL ANNUAL FUEL	TOTAL ANNUAL	TOTAL ANNUAL
FROM	TO	(ADT)	ACCIDENTS	USE (EXIST.) (GAL.)	USE (W/IMPROV.) (GAL)	FUEL SAVINGS (GAL.)	FUEL SAVINGS
I135/I235/K96	ECL WICHITA	18,806	21	836	627	209	$251
ECL WICHITA	4LDIV/2L	15,672	22	741	556	185	$222
TOTAL				1,600	1,000	400	$500

Table E-29 K-254 Emission Reductions - Long Term

ROADWAY SEGMENT		TOTAL CO EMISSIONS SAVINGS (TONS)	TOTAL HC EMISSIONS SAVINGS (TONS)	TOTAL NO_X EMISSIONS SAVINGS (TONS)
FROM	TO			
I135/I235/K96	ECL WICHITA	1.08	0.01	0.01
ECL WICHITA	4LDIV/2L	0.96	0.01	0.01
TOTAL		2.04	0.02	0.02

APPENDIX F

ESTIMATE OF PROBABLE COST CALCULATIONS

CALCULATION OF ALTERNATE SYSTEMS' ANNUAL COSTS

The dollar costs to implement, operate, and maintain each of the three alternate architectures were calculated for each of the time-frames/level of deployment under consideration: short-term, medium-term, and long-term. These costs are itemized in the following text and in Tables F-1 through F-9. It should be noted that for evaluation purposes, a uniform equivalent annual cash flow ($C_{annualized}$) was calculated for the hybrid design alternative, the recommended alternative for the Wichita traffic management system. As formulated below, this consisted of the capital costs ($C_{capital}$) annualized over a time period of fifteen years and an assumed interest rate of 6%, and then added to the estimated annual operating costs ($C_{operating}$) and estimated annual maintenance costs ($C_{maintenance}$).

$$C_{annualized} = (C_{capital} \times CRF_{15,6\%}) + C_{operating} + C_{maintenance}$$

Where, $CRF_{15,6\%} = 0.103$.[2]

Estimated Capital Costs

The Estimated Capital Costs per item remain the same regardless of the system architecture (centralized, distributed, or hybrid).

Roadway Surveillance Equipment

CCTV:$40,000 per site:

Short-Term = 12 sites; Medium-term = 16 sites; Long-term = 20 sites
48 total sites

Detection: $10,000 per mile;

Short-Term = 7 miles; Medium-term = 16 miles; Long-term = 30 miles
53 total miles of coverage

Variable Message Signs (VMS)

Full matrix LED (3 rows, 18 characters/row, 18" character capability): $200,000/sign
As shown in Figure 6-2:

Short-Term = 14 VMS; Medium-Term = 3 VMS; Long-Term = 2 VMS
18 total VMS

Communications

$20/ft ($105,600/mi.) including fiber optic cable, installation, and termination (conduit and pullboxes to be installed by others) for short term. $45/ft ($237,600/mi.) for medium term and $30/ft ($158,400) for long term.

Short-Term = 15 miles; Medium-Term = 19 miles; Long-Term = 30 miles
64 total communication coverage

[2] *Civil Engineering Reference Manual, Sixth Edition*, Michael R Lindeburg, P.E , 1992

Highway Advisory Radio (HAR)

Permanent AM Radio installations: $35,000 per installation
Short-Term = 5 sites

Sign installation: $7,000 per sign, 32 signs total

Central Hardware and Software

For Centralized:
$1,602,000: includes $300,000 for video displays, $90,000 for central computer, $12,000 for 3 workstations, $100,000 for control equipment, $1,000,000 for software, and $100,000 for miscellaneous items.

For Distributed:
$1,388,000: includes $150,000 for video displays, $160,000 for 4 central servers (1 per agency), $28,000 for 7 workstations, $200,000 for control equipment, $750,000 for software, and $100,000 for miscellaneous items.

For Hybrid:
$1,467,000: includes $225,000 for video displays, $80,000 for 2 central servers (1 for transit, 1 for KDOT/ECC/DPW), $12,000 for 3 workstations, $200,000 for control equipment, $850,000 for software, and $100,000 for miscellaneous items.

Operations Center

All alternate designs are for a new facility to be built on public owned property. All building sizes assume enough space to accommodate the long-term system (53 miles of freeway coverage plus the arterial signal control system).

For Centralized.
Centralized facility with room for traffic operations, emergency management, and transit operators: 10,000 sq. ft. facility at $150/sq. ft.

For Distributed.
Distributed facility to handle traffic operations only: 2,000 sq. ft. facility at $150/sq. ft.

For Hybrid:
Hybrid facility with room for traffic operations and emergency personnel: 2,000 sq. ft. facility at $150/sq. ft. (space and cost sharing with the construction of a new Emergency Communications Center).

Estimated Annual Operating Costs

Additional Motorist Assistance Patrols: 2 at $200,000/yr

Staffing

For Centralized

Short and medium term : 1 manager, 1 signal system operator, 1 TMS operator, and 1 incident management/transit management system operator = $206,960

Long term: 1 manager, 1 assistant manager, 1 signal system operator, 2 traffic management system operators, 2 incident management/transit management system operators, 1 part time secretary = $362,360

For Distributed.

Short and Medium term: 1 operator for the traffic signal system; 1 manager and 1 TMS/Incident management system operator for freeway management; 1 manager and 1 TMS/Incident management system operator for emergency management = $337,520

Long term: 1 operator for the traffic signal system; 1 manager, 1 Incident management system operator and 1 TMS operator for freeway management; 1 manager, 1 Incident management system operator and 1 TMS operator for emergency management; 1 part-time secretary = $357,600

For Hybrid:

Short and medium term: 1 manager, 1 signal system operator, 1 TMS/incident management operator = $160,160

Long term: 1 manager, 1 assistant manager, 1 signal system operator, 3 TMS/incident management operators, 1 part time secretary = $303,760

Estimated Annual Maintenance Costs

Maintenance Personnel

For each alternative design, annual maintenance personnel costs were estimated to be $35,000 per year per maintainer. Assuming adequate field maintainers and control center maintainers for one shift, the total number of maintainers estimated to be needed for each alternative and for each time frame are:

For Centralized·

Short term = 3 maintainers; Medium term = 4 maintainers; Long term = 5 maintainers

For Distributed.

Short-term = 2 maintainers; Medium-term = 2 maintainers; Long-term = 3 maintainers

For Hybrid·

Short-term = 3 maintainers; Medium-term = 3 maintainers; Long-term = 4 maintainers

Factory Repair and Spare Equipment

For each alternative design, the annual costs for factory repair and spare equipment were assumed to be approximately 5% and 3%, respectively, of hardware costs.

Table F-1
Short Term Implementation - Centralized System

Capital Costs			
Item	Quantity	Unit Cost	Total
CCTV	12 ea.	$ 40,000 /ea.	$ 480,000
Variable Message Signs	14 ea.	$ 200,000 /ea	$ 2,800,000
Highway Advisory Radio	5 ea.	$ 35,000 /ea.	$ 175,000
HAR Signs	32 ea.	$ 7,000 /ea.	$ 224,000
Fiber Optic Communication	15 mi.	$ 20 /ft.	$ 1,584,000
Incident Detection *	7 mi.	$ 10,000 /mi	$ 70,000
Traffic Operations Center **	10,000 sq. ft.	$ 150 /sq. ft.	$ 1,500,000
Central Hardware and Software	L.S.		$ 1,602,000
Subtotal			**$ 8,435,000**
Contingency 10%			$ 843,500
Design and Implementation 10%			$ 843,500
Total Capital Cost			**$ 10,122,000**
Capital Recovery Factor (15 yrs, 6%)			0.103
Annualized Capital Cost (Rounded)			**$ 1,040,000**
Annual Operating and Maintenance Costs			
Item	Quantity	Annual Cost	Total
Motorist Assistance Patrol (in addition to existing)	2 patrols	$ 200,000 /yr.	$ 400,000
Leased T-1 Phone Lines	3 lines	$ 15,000 /yr.	$ 45,000
Dial-up Phone Lines	13 lines	$ 900 /yr.	$ 11,700
Staffing			
TMC Manager	1 person	$ 66,560 /yr	$ 66,560
Signal System Operator	1 person	$ 46,800 /yr.	$ 46,800
TMS Operator	1 person	$ 46,800 /yr.	$ 46,800
Incident Management/Transit System Operator	1 person	$ 46,800 /yr	$ 46,800
Maintenance Personnel	3 people	$ 32,000 /yr	$ 96,000
Maintenance			
Factory Repairs (5% of equip $)			$ 134,770
Spare Parts (3% of equip. $)			$ 80,862
Total Annual Operating and Maintenance Costs (Rounded)			**$ 980,000**

Total Annual Capital, Operating and Maintenance Costs (Rounded) $ 2,020,000

Fiber optic communications to cameras and incident detection along I-135 between K-96 and Kellogg (US-54) T-1 lines to outlying cameras and dial up lines to VMS's and incident detection at Ridge Road.

Leased lines -
1 line to 2 cameras at I-235/I-135 interchange
1 line to 2 cameras at I-235/US 54 interchange
1 line to camera at Ridge Rd/US 54 interchange

* Assumes two (2) detector stations per mile.

** This assumes that the Traffic operations Center will be housed in the same space as the new Emergency Communications Center If the Traffic Operations Center is to be a stand alone center, approximately 5,000 sq ft will be required.

Table F-2
Medium Term Implementation - Centralized System

Capital Costs			
Item	Quantity	Unit Cost	Total
CCTV	16 ea.	$ 40,000 /ea.	$ 640,000
Variable Message Signs	3 ea.	$ 200,000 /ea.	$ 600,000
Fiber Optic Communication	19 mi.	$ 45 /ft.	$ 4,514,400
Incident Detection	16 mi.	$ 10,000 /mi	$ 160,000
Subtotal			**$ 5,914,400**
Contingency 10%			$ 591,440
Design and Implementation 10%			$ 591,440
Total Capital Cost			**$ 7,097,280**
Capital Recovery Factor (15 yrs, 6%)			0.103
Annualized Capital Cost (Rounded)			**$ 730,000**
Annual Operating and Maintenance Costs			
Item	Quantity	Annual Cost	Total
Motorist Assistance Patrol	2 patrols	$ 200,000 /yr.	$ 400,000
Staffing			
TMC Manager	1 person	$ 66,560 /yr.	$ 66,560
Signal System Operator	1 person	$ 46,800 /yr.	$ 46,800
TMS Operator	1 person	$ 46,800 /yr.	$ 46,800
Incident Management/Transit System Operator	1 person	$ 46,800 /yr.	$ 46,800
Maintenance Personnel	4 people	$ 32,000 /yr.	$ 128,000
Maintenance			
Factory Repairs (5% of equip $)			$ 175,570
Spare Parts (3% of equip. $)			$ 105,342
Total Annual Operating and Maintenance Costs (Rounded)			**$ 1,020,000**

Total Annual Capital, Operating and Maintenance Costs (Rounded) $ 1,750,000

Leased telephone lines will be replaced with fiber optic trunk communication lines in this phase

Table F-3
Long Term Implementation - Centralized System

Capital Costs			
Item	Quantity	Unit Cost	Total
CCTV	20 ea.	$ 40,000 /ea.	$ 800,000
Variable Message Signs	2 ea.	$ 200,000 /ea.	$ 400,000
Fiber Optic Communication	30 mi.	$ 30 /ft.	$ 4,752,000
Incident Detection	30 mi.	$ 10,000 /mi	$ 300,000
Subtotal			**$ 6,252,000**
Contingency 10%			$ 625,200
Design and Implementation 10%			$ 625,200
Total Capital Cost			**$ 7,502,400**
Capital Recovery Factor (15 yrs, 6%)			0.103
Annualized Capital Cost (Rounded)			**$ 770,000**

Annual Operating and Maintenance Costs			
Item	Quantity	Annual Cost	Total
Motorist Assistance Patrol	2 patrols	$ 200,000 /yr.	$ 400,000
Staffing			
TMC Manager	1 person	$ 66,560 /yr.	$ 66,560
Assistant TMC Manager	1 person	$ 53,800 /yr.	$ 53,800
Signal System Operator	1 person	$ 46,800 /yr.	$ 46,800
TMS Operator	2 person	$ 46,800 /yr.	$ 93,600
Inc. Mgt. System Operator	1 person	$ 46,800 /yr.	$ 46,800
Transit Mgt.System Operator	1 person	$ 46,800 /yr.	$ 46,800
Secretarial/Clerical	0.5 person	$ 32,000 /yr.	$ 16,000
Maintenance Personnel	4 people	$ 32,000 /yr.	$ 128,000
Maintenance			
Factory Repairs (5% of equip $)			$ 188,370
Spare Parts (3% of equip. $)			$ 113,022
Total Annual Operating and Maintenance Costs (Rounded)			**$ 1,200,000**

Total Annual Capital, Operating and Maintenance Costs (Rounded) $ 1,970,000

Table F-4
Short Term Implementation - Distributed System

Capital Costs			
Item	Quantity	Unit Cost	Total
CCTV	12 ea.	$ 40,000 /ea.	$ 480,000
Variable Message Signs	14 ea.	$ 200,000 /ea.	$ 2,800,000
Highway Advisory Radio	5 ea.	$ 35,000 /ea.	$ 175,000
HAR Signs	32 ea.	$ 7,000 /ea.	$ 224,000
Fiber Optic Communication	15 mi.	$ 20 /ft.	$ 1,584,000
Incident Detection *	7 mi.	$ 10,000 /mi	$ 70,000
Traffic Operations Center **	2,000 sq. ft.	$ 150 /sq. ft.	$ 300,000
Central Hardware and Software	L.S.		$ 1,388,000
Subtotal			**$ 7,021,000**
Contingency 10%			$ 702,100
Design and Implementation 10%			$ 702,100
Total Capital Cost			**$ 8,425,200**
Capital Recovery Factor (15 yrs, 6%)			0.103
Annualized Capital Cost (Rounded)			**$ 870,000**

Annual Operating and Maintenance Costs			
Item	Quantity	Annual Cost	Total
Motorist Assistance Patrol (in addition to existing)	2 patrols	$ 200,000 /yr.	$ 400,000
Leased T-1 Phone Lines	3 lines	$ 15,000 /yr.	$ 45,000
Dial-up Phone Lines	13 lines	$ 900 /yr.	$ 11,700
Staffing			
City Signals			
System Operator	1 person	$ 46,800 /yr.	$ 46,800
Freeway Management			
Manager	1 person	$ 66,560 /yr.	$ 66,560
Incident Mgt. System Operator/ TMS Operator	1 person	$ 46,800 /yr.	$ 46,800
Emergency Management			
Manager	1 person	$ 66,560 /yr	$ 66,560
Manager	1 person	$ 46,800 /yr.	$ 46,800
Incident Mgt. System Operator/ TMS Operator	2 people	$ 32,000 /yr.	$ 64,000
Maintenance Personnel	2 people	$ 32,000 /yr.	$ 64,000
Maintenance			
Factory Repairs (5% of equip $)			$ 124,070
Spare Parts (3% of equip. $)			$ 74,442
Total Annual Operating and Maintenance Costs (Rounded)			**$ 1,060,000**

Total Annual Capital, Operating and Maintenance Costs (Rounded) $ 1,930,000

Fiber optic communications to cameras and incident detection along I-135 between K-96 and Kellogg (US-54) T-1 lines to outlying cameras and dial up lines to VMS's and incident detection at Ridge Road.

Leased lines -
- 1 line to 2 cameras at I-235/I-135 interchange
- 1 line to 2 cameras at I-235/US 54 interchange
- 1 line to camera at Ridge Rd/US 54 interchange

* Assumes two (2) detector stations per mile.

** This assumes that the Traffic operations Center will be housed in the same space as the new Emergency Communications Center. If the Traffic Operations Center is to be a stand alone center, approximately 5,000 sq.ft. will be required.

Table F-5
Medium Term Implementation - Distributed System

Capital Costs			
Item	Quantity	Unit Cost	Total
CCTV	16 ea.	$ 40,000 /ea.	$ 640,000
Variable Message Signs	3 ea.	$ 200,000 /ea.	$ 600,000
Fiber Optic Communication	19 mi.	$ 45 /ft.	$ 4,514,400
Incident Detection	16 mi.	$ 10,000 /mi	$ 160,000
Subtotal			**$ 5,914,400**
Contingency 10%			$ 591,440
Design and Implementation 10%			$ 591,440
Total Capital Cost			**$ 7,097,280**
Capital Recovery Factor (15 yrs, 6%)			0.103
Annualized Capital Cost (Rounded)			**$ 730,000**

Annual Operating and Maintenance Costs			
Item	Quantity	Annual Cost	Total
Motorist Assistance Patrol	2 patrols	$ 200,000 /yr.	$ 400,000
Staffing			
City Signals			
System Operator	1 person	$ 46,800 /yr.	$ 46,800
Freeway Management			
Manager	1 person	$ 66,560 /yr.	$ 66,560
Incident Mgt. System Operator/ TMS Operator	1 person	$ 46,800 /yr.	$ 46,800
Emergency Management			
Manager	1 person	$ 66,560 /yr.	$ 66,560
Manager	1 person	$ 46,800 /yr.	$ 46,800
Incident Mgt. System Operator/ TMS Operator	2 people	$ 32,000 /yr.	$ 64,000
Maintenance Personnel	2 people	$ 32,000 /yr.	$ 64,000
Maintenance			
Factory Repairs (5% of equip $)			$ 164,870
Spare Parts (3% of equip. $)			$ 98,922
Total Annual Operating and Maintenance Costs (Rounded)			**$ 1,070,000**

Total Annual Capital, Operating and Maintenance Costs (Rounded) $ 1,800,000

Leased telephone lines will be replaced with fiber optic trunk communication lines in this phase

Table F-6
Long Term Implementation - Distributed System

Capital Costs			
Item	Quantity	Unit Cost	Total
CCTV	20 ea.	$ 40,000 /ea.	$ 800,000
Variable Message Signs	2 ea.	$ 200,000 /ea.	$ 400,000
Fiber Optic Communication	30 mi.	$ 30 /ft.	$ 4,752,000
Incident Detection	30 mi.	$ 10,000 /mi	$ 300,000
Subtotal			**$ 6,252,000**
Contingency 10%			$ 625,200
Design and Implementation 10%			$ 625,200
Total Capital Cost			**$ 7,502,400**
Capital Recovery Factor (15 yrs, 6%)			0.103
Annualized Capital Cost (Rounded)			**$ 770,000**
Annual Operating and Maintenance Costs			
Item	Quantity	Annual Cost	Total
Motorist Assistance Patrol	2 patrols	$ 200,000 /yr.	$ 400,000
Staffing			
City Signals			
System Operator	1 person	$ 46,800 /yr.	$ 46,800
Freeway Management			
Manager	1 person	$ 53,800 /yr.	$ 53,800
TMS Operator	1 person	$ 46,800 /yr.	$ 46,800
Incident Mgt. System Operator	1 person	$ 46,800 /yr.	$ 46,800
Secretary/Clerical	0.5 person	$ 32,000 /yr.	$ 16,000
Emergency Management			
Manager	1 person	$ 53,800 /yr.	$ 53,800
TMS Operator	1 person	$ 46,800 /yr.	$ 46,800
Incident Mgt. System Operator	1 person	$ 46,800 /yr.	$ 46,800
Secretary/Clerical	0.5 person	$ 32,000 /yr.	$ 16,000
Maintenance Personnel	3 people	$ 32,000 /yr.	$ 96,000
Maintenance			
Factory Repairs (5% of equip $)			$ 218,470
Spare Parts (3% of equip. $)			$ 131,082
Total Annual Operating and Maintenance Costs (Rounded)			**$ 1,220,000**

Total Annual Capital, Operating and Maintenance Costs (Rounded) $ 1,990,000

Table F-7
Short Term Implementation - Hybrid System

Capital Costs			
Item	Quantity	Unit Cost	Total
CCTV	12 ea.	$ 40,000 /ea.	$ 480,000
Variable Message Signs	14 ea.	$ 200,000 /ea.	$ 2,800,000
Highway Advisory Radio	5 ea.	$ 35,000 /ea.	$ 175,000
HAR Signs	32 ea.	$ 7,000 /ea.	$ 224,000
Fiber Optic Communication	15 mi.	$ 20 /ft.	$ 1,584,000
Incident Detection *	7 mi.	$ 10,000 /mi	$ 70,000
Traffic Operations Center **	2,000 sq. ft.	$ 150 /sq. ft.	$ 300,000
Central Hardware and Software	L.S.		$ 1,467,000
Subtotal			**$ 7,100,000**
Contingency 10%			$ 710,000
Design and Implementation 10%			$ 710,000
Total Capital Cost			**$ 8,520,000**
Capital Recovery Factor (15 yrs, 6%)			0.103
Annualized Capital Cost (Rounded)			**$ 880,000**
Annual Operating and Maintenance Costs			
Item	Quantity	Annual Cost	Total
Motorist Assistance Patrol (in addition to existing)	2 patrols	$ 200,000 /yr.	$ 400,000
Leased T-1 Phone Lines	3 lines	$ 15,000 /yr.	$ 45,000
Dial-up Phone Lines	13 lines	$ 900 /yr.	$ 11,700
Staffing			
TMC Manager	1 person	$ 66,560 /yr.	$ 66,560
Signal System Operator	1 person	$ 46,800 /yr.	$ 46,800
Incident Mgt. System Operator/ TMS Operator	1 person	$ 46,800 /yr.	$ 46,800
Maintenance Personnel	3 people	$ 32,000 /yr.	$ 96,000
Maintenance			
Factory Repairs (5% of equip $)			$ 128,020
Spare Parts (3% of equip. $)			$ 76,812
Total Annual Operating and Maintenance Costs (Rounded)			**$ 920,000**

Total Annual Capital, Operating and Maintenance Costs (Rounded) $ 1,800,000

Fiber optic communications to cameras and incident detection along I-135 between K-96 and Kellogg (US-54) T-1 lines to outlying cameras and dial up lines to VMS's and incident detection at Ridge Road.

Leased lines -
1 line to 2 cameras at I-235/I-135 interchange
1 line to 2 cameras at I-235/US 54 interchange
1 line to camera at Ridge Rd/US 54 interchange

* Assumes two (2) detector stations per mile.

** This assumes that the Traffic operations Center will be housed in the same space as the new Emergency Communications Center. If the Traffic Operations Center is to be a stand alone center, approximately 5,000 sq.ft. will be required.

Table F-8
Medium Term Implementation - Hybrid System

Capital Costs			
Item	Quantity	Unit Cost	Total
CCTV	16 ea.	$ 40,000 /ea.	$ 640,000
Variable Message Signs	3 ea.	$ 200,000 /ea.	$ 600,000
Fiber Optic Communication	19 mi.	$ 45 /ft.	$ 4,514,400
Incident Detection	16 mi.	$ 10,000 /mi	$ 160,000
Subtotal			**$ 5,914,400**
Contingency 10%			$ 591,440
Design and Implementation 10%			$ 591,440
Total Capital Cost			**$ 7,097,280**
Capital Recovery Factor (15 yrs, 6%)			0.103
Annualized Capital Cost (Rounded)			**$ 730,000**
Annual Operating and Maintenance Costs			
Item	Quantity	Annual Cost	Total
Motorist Assistance Patrol	2 patrols	$ 200,000 /yr.	$ 400,000
Staffing			
TMC Manager	1 person	$ 66,560 /yr.	$ 66,560
Signal System Operator	1 person	$ 46,800 /yr.	$ 46,800
Incident Mgt. System Operator/ TMS Operator	1 person	$ 46,800 /yr.	$ 46,800
Maintenance Personnel	3 people	$ 32,000 /yr.	$ 96,000
Maintenance			
Factory Repairs (5% of equip $)			$ 168,820
Spare Parts (3% of equip. $)			$ 101,292
Total Annual Operating and Maintenance Costs (Rounded)			**$ 930,000**

Total Annual Capital, Operating and Maintenance Costs (Rounded) $ 1,660,000

Leased telephone lines will be replaced with fiber optic trunk communication lines in this phase

Table F-9
Long Term Implementation - Hybrid System

Capital Costs			
Item	Quantity	Unit Cost	Total
CCTV	20 ea.	$ 40,000 /ea.	$ 800,000
Variable Message Signs	2 ea.	$ 200,000 /ea.	$ 400,000
Fiber Optic Communication	30 mi.	$ 30 /ft.	$ 4,752,000
Incident Detection	30 mi.	$ 10,000 /mi	$ 300,000
Subtotal			**$ 6,252,000**
Contingency 10%			$ 625,200
Design and Implementation 10%			$ 625,200
Total Capital Cost			**$ 7,502,400**
Capital Recovery Factor (15 yrs, 6%)			0.103
Annualized Capital Cost (Rounded)			**$ 770,000**
Annual Operating and Maintenance Costs			
Item	Quantity	Annual Cost	Total
Motorist Assistance Patrol	2 patrols	$ 200,000 /yr.	$ 400,000
Staffing			
TMC Manager	1 person	$ 66,560 /yr.	$ 66,560
Assistant TMC Manager	1 person	$ 53,800 /yr.	$ 53,800
Signal System Operator	1 person	$ 46,800 /yr.	$ 46,800
Incident Mgt. System Operator/ TMS Operator	3 people	$ 46,800 /yr.	$ 140,400
Secretary/Clerical	0.5 person	$ 32,000 /yr.	$ 16,000
Maintenance Personnel	4 people	$ 32,000 /yr.	$ 128,000
Maintenance			
Factory Repairs (5% of equip $)			$ 222,420
Spare Parts (3% of equip. $)			$ 133,452
Total Annual Operating and Maintenance Costs (Rounded)			**$ 1,210,000**

Total Annual Capital, Operating and Maintenance Costs (Rounded) $ 1,980,000