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Chapter 7
Deployment

Freeway Management Applications

This section focuses on the deployment of components of a freeway management system This deployment plan is based on the system architecture developed and described in Chapter 4, the technologies discussed in Chapter 5, and the benefits and costs evaluated in Chapter 6.

SHORT, MEDIUM, AND LONG TERM PRIORITIES

The short, medium, and long term priorities for the transportation system in the Kansas City area correspond closely to the short, medium, and long term intelligent transportation system (ITS) user services discussed in Chapter 3. These priorities are reflected in the deployment schedule, which is discussed in the next section. Short term priorities include priorities that should be addressed in the next five years. Medium term priorities should be addressed in five to ten years. Long term priorities should be addressed in ten years or more.

Short Term Priorities - Priorities for the short term focus on existing problems and identified needs. Thus, priorities include the need to respond to incidents, which account for a significant amount of congestion in the Kansas City area, and the need to identify and respond to locations of recurring congestion.

Short term priorities are met by a number of activities including deployment of a freeway monitoring and management system in selected corridors in the Kansas City area and coordination of the freeway management system with the use of arterials for diversion. A ramp metering project is recommended for implementation as a demonstration project on I-35 in Kansas from I-435 to the state line. This will require close cooperation between the Kansas Department of Transportation (KDOT) and local jurisdictions.

It is also recommended that local jurisdictions, in cooperation with KDOT and the Missouri Highway and Transportation Department (MHTD), initiate activities that would support the use of local arterials as alternate routes to the freeway. Activities include determination of appropriate timing plans for arterials that already have signal control systems that can support diversion activities, identification of priority arterials for equipment upgrade, and the initiation of activities to obtain funding for equipment upgrades, where necessary.

A final short term priority is enhanced institutional coordination, which will be necessary for a coordinated and comprehensive approach to transportation management, and will also be a critical component for the success of future activities. More detailed information about activities and projects to support short term priorities are discussed in the next section, *Deployment Schedule.*

Medium Term Priorities - Priorities for the medium term focus on expanding the framework that has been laid out in the short term and addressing conditions that might be expected in the foreseeable future. Medium term priorities include expanding the geographic extent of the freeway management system, expanding the freeway traffic management system to include ramp metering where appropriate (analysis will be based on findings of the demonstration project on I-35 in Kansas), broadening the scope of incident management activities to better address the special requirements posed by hazardous materials incidents, and expanding the kind of information provided to travelers, in an effort not only to inform, but also in an effort to have a greater influence on travel behavior

Another medium term priority is to further integrate the freeway system with the arterial and transit systems in the metropolitan area. This priority implies additional coordination with local jurisdictions for the installation of advanced signal control systems on arterial routes that will be used for diversion from the freeway. This also implies the provision of transit information in addition to freeway information for trip planning purposes.

Long Term Priorities - Long term priorities generally address issues that are not currently critical problems, and may include taking a proactive approach to potential problems. Long term priorities include expanding the freeway management system to encompass the entire metropolitan area, deployment of technologies related to emissions testing, coordinating with activities related to commercial vehicle applications, and the deployment of programs, technologies and facilities which would provide alternatives to the single occupancy vehicle. High occupancy vehicle (HOV) facilities and advanced ride matching programs are just a couple of ways to encourage alternatives to the single occupancy vehicle.

DEPLOYMENT SCHEDULE

The primary focus of the deployment plan is a freeway management system. System components have been identified for a freeway management system that provides coverage of the entire metropolitan area. Conceptual layouts for the placement of closed circuit television (CCTV) cameras, highway advisory radio (HAR) transmitters and signs, and variable message signs (VMSs) are shown in Figures 7-1, 7-2 and 7-3. Deployment of the components is recommended to be staged over four phases, which are shown in Figure 6-3. The locations identified in Figures 7-1, 7-2 and 7-3 are color coded to reflect the recommended staged deployment. Following a brief discussion of the basics of a freeway management system, each phase is addressed as it relates to deployment in the short, medium, and long term.

Freeway Management System - The proposed freeway management system and its components address short term priorities by meeting the need for incident detection, verification, and response.

Incident detection is provided by detector stations located every half mile. Computer algorithms automatically process the data from these detectors, displaying real-time travel speeds and providing notification of unusual traffic characteristics that might indicate an accident or incident. Incident detection may also be provided by other means, such as motorist assistance patrols (MAP) and cellular phone calls; the limitation of these mechanisms is that they do not provide continuous monitoring of conditions, and thus they cannot always be relied upon.

Incident verification is provided by CCTV. This visual verification provides not only information about the nature of the accident and the kind of equipment needed, but it also allows positive identification of incident location. Visual image detection (VID), which consists of CCTV and computer algorithms that analyze the visual image to determine operating characteristics, also provides incident detection capabilities and may be a viable alternative in the near future. While some systems use VID in conjunction with other means of detection, no system relies solely upon VID.

Incident response includes any action taken as a consequence of the situation on the freeway It might include contacting emergency responders through 911 or the dispatch of MAP, as well as all resulting communications with motorists, such as messages on HAR and VMSs, and information provided to traffic reporting agencies.

Short Term - Activities identified for deployment in the short term include all activities and projects to be implemented within five years. In addition to short term activities, priority "early winner" activities have been identified for deployment within two years.

The primary activity in the short term is the deployment of a freeway management system on Phase 1 facilities. Phase 1 encompasses the high priority corridors, including the downtown loop, I-70 east of downtown, I-35 just north of downtown, I-35 south of downtown, and the south leg of I-435. These facilities all carry high traffic volumes, and consequently, any breakdown in traffic flow, for instance due to an incident, can have significant impacts in terms of delay. Additional and more specific activities to be implemented in the short term are as follows.

- Permanent CCTV cameras, HAR, and VMSs should be installed as noted for Phase 1 in Figures 7-1, 7-2, and 7-3. Priority locations for CCTV cameras are shown in Figure 7-1, cost estimates include additional cameras (one every half mile) for complete coverage of the freeways. Detector stations should be located every half mile.

  While the technologies identified for deployment are primarily on the freeways, they include arterial VMSs on Metcalf and downtown to inform motorists in the two major employment centers of congestion before entering the freeway. A VMS is also specified for deployment on US 40, which serves as an alternate route for I-70. This VMS should be used to provide additional information for diversion, which may be particularly useful for motorists unaccustomed to leaving the freeway. Additional information on the installation of CCTV cameras, HAR and VMSs is provided in the next section, *Guide to Deployment*.

- A demonstration ramp metering project should be implemented on I-35 in Kansas from I-435 to the state line. Ramp metering will need to be closely coordinated with the local jurisdictions in the corridor to assure that arterial operations are not unduly affected. Additional information on ramp metering is provided in the next section, *Guide to Deployment*.

- Reference markers and overpass signing should be installed on all facilities in the metropolitan area, with priority corresponding to deployment phase. Reference markers should include route and directional information and should be placed every one-tenth of a mile on facilities with a high accident rate or high volume, and every half-mile on less traveled freeways. Location identifiers should be placed on all ramps.

Cellular telephone users can be educated about the system through informational inserts in cellular telephone bills and public service announcements. Dispatchers at 911 answer points will also need to be instructed as to how to interpret the information and solicit the information needed from callers.

- A permanent traffic operations center (TOC) should be established for the metropolitan area. This center may be located in the new MHTD District 4 office. Additional information on the TOC is provided in a later section, *Operations Plan*.

- Weather information should be available at the TOC This information can be accessed via a modem from the existing weather center in Kansas City, Missouri.

- Traffic conditions should be provided to traffic reporting agencies and to television and radio stations. The provision of traveler information directly to motorists via telephone and/or the Internet should also be explored. It might be possible to partner with a private entity for the provision of a highway advisory telephone service, which could be similar to the existing "time and temperature" phone number.

- A radio link should be provided for communication between the TOC and emergency responders after incident response has been initiated. Initial contact between the TOC and emergency responders should be made through the existing 911 system. The TOC should be connected to the 911 tandem computer, so calls can automatically be placed to the appropriate agency. TOC personnel would need to identify the location (possibly via a touchscreen map of the metropolitan area), and the kind of emergency response needed (fire, police, or medical), and the call would automatically be directed to the appropriate agency.

- The TOC should work with interested local public works agencies and emergency responders to establish video feed from the CCTV cameras controlled by the TOC to the local agencies and dispatch centers.

- Activities conducted by the TOC that are related to incident management should be in accordance with the guidelines established in the *Incident Management Program* for the Bi-State Kansas City area.

Early Winners: Short term efforts include "early winners", priority activities which are recommended for deployment within the next two years. These projects represent activities that are relatively low cost with a short development time, relatively high priority, and address the core infrastructure elements. These "early winner" projects are expected to be successful, and will enhance the public image of ITS, setting the stage for future projects.

- Freeway reference markers and signs on overpasses, marking the cross street, are recommended for deployment on all Phase 1 and Phase 2 freeway facilities. Reference markers are currently provided on some facilities, but are recommended for installation at one-tenth mile intervals on all Phase 1 and Phase 2 freeway facilities, and on all entrance and exit ramps to these facilities.

- Additional portable VMSs are recommended for procurement by both MHTD and KDOT. These signs can be used to provide en-route driver information and to facilitate incident management during severe incidents of significant duration These signs can also be used to enhance traffic management during construction and other pre-planned events. These signs can also be placed at locations where permanent VMSs are proposed. This will allow an inexpensive "trial run" prior to installation of a permanent sign, which requires significant capital investment.

- Legislation and regulations to facilitate the prompt removal of disabled and abandoned vehicles and freight from the freeway main lanes and shoulders are recommended in both Missouri and Kansas. The clearance times specified should vary depending on incident location (urban vs. rural), time of day (peak vs. off-peak), and day of week (weekend vs. weekday). While Kansas currently has legislation that allows KDOT and enforcement agencies to remove a vehicle left on a public highway after 48 hours or when the vehicle interferes with highway operations, this legislation could be enhanced by regulations that iterate specific and more stringent clearance times for facilities in urban areas. Removal times for commercial vehicles and freight should also be iterated, allowing the agency having jurisdiction to initiate clean up activities at the expense of the trucking firm or the entity responsible for the incident. Prompt removal of disabled vehicles and freight in the right-of-way would facilitate incident management and reduce vehicle delay.

- Expansion of the motorist assistance patrol (MAP) to provide full coverage of Phase 1 segments of I-35 and I-435 during the peak hours is recommended in Kansas. The recently implemented program in Kansas has been successful, but it could have a more significant impact on incident management in the peak periods if additional equipment and personnel were provided. Expansion of MAP is also recommended in Missouri, for example, service could be restored on the south leg of I-435. The continued coordination of MAP activities with other activities in terms of incident response and traffic control, and the sharing of information with traffic reporting agencies and any other entities that can enhance communications with the public is strongly recommended.

- Coordination of arterial signals into arterial signal systems is recommended on major arterials that may serve as alternate routes for freeway diversion and that currently have the hardware to support a diversion timing scheme. For example, coordination of the signals on 103rd and College Boulevard in Overland Park, Kansas, could be accomplished at a relatively low cost, because all of the intersections currently use type 170 microprocessor controllers. Coordination of arterial signals would enhance incident management activities by facilitating route diversion.

  Furthermore, traffic signal timing plans appropriate for freeway diversion should be developed for these alternate routes that have signal control hardware to support deployment. In Missouri, these systems would generally be developed and implemented by MHTD. In Kansas, these timing plans would need to be determined jointly with Overland Park and Lenexa. Although Kansas City, Kansas, has solid state equipment on State Avenue, which would function as an alternate route to I-70, they have expressed reservations about having anyone manually adjust the signal timing (via a PC), and they prefer to use adaptive signal control for changes in timing. Adaptive signal control would require additional hardware.

  Increased coordination among neighboring jurisdictions is also recommended, not only for signal timing, but also for construction activities. Currently, arterials that traverse multiple jurisdictions may not have their signals coordinated, this results in increased delay and driver frustration. Similarly, neighboring jurisdictions do not always coordinate construction activities, thus alternate routes are sometimes under construction at the same time that the major route is, limiting the number of routes available

- Standards for construction and reconstruction projects should be developed to reflect the needs of an intelligent transportation system. These standards would accommodate future needs that could easily be accommodated during roadway and/or shoulder construction and reconstruction activities. Standards should include design considerations for interchanges to accommodate ramp metering, provisions for conduit for power distribution and communications to ITS elements, and provisions for pull boxes. With respect to conduit for fiber optics, appropriate applications would include freeways and arterial diversion routes that do not have fiber optics, as well as connections from field equipment to the fiber optic backbone.

  Similarly, construction and reconstruction activities should consider the needs of emergency responders during incident management activities. For example, it is recommended that provisions for fire hoses be included in all noise walls that are being constructed or renovated in the metropolitan area. These holes should be located so that they correspond with fire hydrant locations, and should be marked clearly. These holes would allow fire fighters to more easily access the fire hydrants, facilitating response to freeway incidents involving a potential fire hazard. Efforts to provide for fire hoses in noise walls are already underway. KDOT recently coordinated with the Overland Park Fire Department to provide holes for fire hoses in the noise walls erected in conjunction with the reconstruction on the southern portion of I-435 in Johnson County.

- KDOT should pursue activities for the procurement of a fiber optics communications backbone on all interstates and major freeways in the Kansas City area. The possibility for a public/private partnership, such as the one that resulted in the deployment of fiber on all interstates in Missouri, and the possibility of coordinating with local businesses should be examined as a mechanism for reducing costs.

- A policy regarding the provision of traveler information should be developed. This policy would initially address issues such as whether alternate routes should be provided to motorists, and should evolve to address related issues in the future, as needed. This policy should also address price issues, for example whether all information should be provided without charge, or whether some users should pay a price for specialized information (for example, in the future, it might be appropriate to charge private entities who request the information in a certain format and then, in turn, provide the information to customers for a fee).

- CCTV cameras should be established in priority locations (indicated in Figure 7-1). In Missouri, these cameras would be monitored from the existing MHTD District Office. In Kansas, KDOT should work in coordination with the Cities of Lenexa and Overland Park for the placement of a CCTV camera at the interchange of I-35, US 169 and 87th Street or at another high priority interchange. Both Lenexa and Overland Park are considering installation of a CCTV camera for interchange/intersection monitoring. Cameras could be monitored by both the KDOT Kansas City Metro Office and the affected city.

- A partnership with a private entity (as discussed in a later section, *Public/Private Partnerships*) should be considered as an option for the provision of traveler information, especially in the short term. This kind of partnership would allow a system to be "up and running" in less than a year, and would not require that KDOT and MHTD dedicate staff or space to an interim TOC

- Efforts should be made to coordinate with planning agencies to assure that local and regional plans incorporate ITS concepts. Coordination activities should be initiated with Mid-America Regional Council (MARC) to assure that ITS projects are incorporated into the *Transportation Improvement Plan*, and with local planning agencies to assure that they understand ITS and how local applications can work together with ITS applications in the Kansas City area.

- With respect to the TOC, design activities for MHTD's new District Facility should consider inclusion of a TOC to serve the entire Kansas City metropolitan area. Thus, coordination will be required not only with MHTD but also with KDOT Ideally the facility would be sized to be large enough to serve the entire metropolitan area. At the very least, the proposed facility should be constructed to accommodate the needs of the deployment of Phase 1 and Phase 2, with the capability for expansion to serve the entire metropolitan area (Phase 3 and 4). More information about the TOC is provided in a later section, *Operations Plan.*

- Total station equipment, which facilitates and speeds up accident investigations, should be purchased for use on interstates. It is not necessary for each jurisdiction to purchase their own system, but a responding agency in each state should have access to this equipment. Because Kansas Highway Patrol (KHP) is involved in the investigation of all fatality accidents on the interstates in Kansas, they are a logical agency for procurement in Kansas. Similarly, procurement of a system by Kansas City, Missouri, would cover most of the interstate system in Phases 1 and 2 in Missouri.

Medium Term - Activities identified for deployment in the medium term include all activities and projects to be implemented within five to ten years.

One primary activity in the medium term is the deployment of a freeway management system on Phase 2 facilities. This would extend coverage north on I-29, west on I-70 and I-670, on a portion of I-635, on US 69 between I-35 and I-435 in Kansas, on I-70 east to I-470, and on I-435 north to Independence Avenue and south to Bannister Road. Deployment of Phase 2 would extend the coverage of the system on primary facilities, would provide information on alternate routes, and would complete several more loops, providing additional redundancy. Additional and more specific activities to be implemented in the medium term are as follows:

- Permanent CCTV cameras, HAR, and VMSs should be installed as noted for Phase 2 in Figures 7-1, 7-2, and 7-3. Additional CCTV cameras may be needed for complete coverage. Although not shown in Figure 7-1, these additional cameras were included in the cost estimate. Detector stations should be located every half mile.

- Ramp metering should be evaluated as a possible strategy to address recurring congestion and to break up platoons of vehicles and force single vehicle entry. Analysis should consider the results of the I-35 demonstration project in Kansas (to be conducted in the short term) as well as the operating and geometric characteristics of potential corridors.

Additional information related to ramp metering is provided later in this section under *General Deployment Guidelines*

- The TOC hardware (monitors and switching equipment) and software should be expanded, as needed, to accommodate additional Phase 2 freeway coverage.

- Continued use of the 911 system should be evaluated to determine if there is a need for a separate phone number for non-emergency freeway situations. Some emergency responders have expressed concern that the 911 line has and will become increasingly busy with non-emergency freeway related calls. Proponents of separate systems state that non-emergency traffic related calls are not the purpose of the 911 system, and the high volume of non-emergency calls may compromise the service to emergency calls. A non-emergency freeway service number could be used to allow motorists to provide information about vehicle disablements and other non-injury situations that require action but no emergency response. This number would be answered at the TOC. This information would then be disseminated by the TOC, and MAP or maintenance personnel could be dispatched as appropriate. A disadvantage of this system is that it would require motorists to make a decision as to which number to call.

- Incident data should be compiled and examined to determine if there are any patterns with respect to hazardous material incidents (whether hazardous materials are more prevalent at certain locations - such as near manufacturing plants, railway junctions or freeway sections with limited geometrics), and whether any particular kinds of hazardous material warrant greater tracking. If analysis indicates that some locations or types of hazardous material are disproportionately affected, appropriate action may be action. Such action may entail increased monitoring of "problem" sites, or increased tracking of "problem" substances. Activities related to hazardous material incident response and planning should be conducted with input from local hazardous material incident response agencies.

- Efforts should be made to provide transit information (such as information on transit routes and schedules) in conjunction with traffic information. This information may be provided via Internet or telephone, depending on the methods by which highway information is provided. The TOC need not directly be involved in the provision of this information, however, it will need to coordinate with transit entities so that this information may be provided through the central information server and/or other means of information dissemination.

Long Term - Activities identified for deployment in the long term include all activities and projects to be implemented in ten years or more.

One activity for deployment in the long term is complete coverage of the metropolitan area with a freeway management system. Extension of the freeway management system to all major freeways in the urban area would allow re-routing of through traffic around congested areas, and would allow traffic management on a systemwide basis. However, relatively low volumes on many of the Phase 3 and 4 facilities imply a relatively low benefit cost ratio at the present time and in the near future. Eventually, however, growth in traffic volumes, as well as decreasing prices for technologies, would be expected to result in more favorable benefit cost ratios. Additional and more specific activities to be implemented in the long term are as follows.

- Permanent CCTV cameras, HAR, and VMSs should be installed as noted for Phase 3 and 4 in Figures 7-1, 7-2, and 7-3. Additional CCTV cameras may be needed for complete coverage. Although not shown in Figure 7-1, these additional cameras were included in the cost estimate. Detector stations should be located every half mile.

  Benefit cost ratios should be used to guide the priority of deployment for Phases 3 and 4 These ratios should be re-calculated in the future to reflect volume increases, changes in accident rates, and changes in the price of equipment. Installation of equipment for freeway monitoring and verification on all facilities will result in complete coverage of the metropolitan area.

  Efforts should be made to coordinate the provision of information from the TOC with the provision of traveler services and other tourist information. This may include information kiosks at the airport and convention centers. This may also include integrating current traffic information into a computer "yellow page" system. Under this scenario, travelers could obtain information about all local barbecue restaurants, for example, as well as current travel times to each restaurant. It would even be possible to allow tourists to make "real-time" dinner reservations, so the restaurant could know they are coming and have their table ready when they arrive.

- Efforts should be made to coordinate the provision of information from the TOC with the provision of in-vehicle information, including en-route driver information and route guidance information. Although the TOC may not directly interface with in-vehicle devices, they should coordinate with private or other entities to provide this information. Under this scenario, current travel speeds could be used to determine the route with the shortest travel time.

- Technologies to facilitate commercial vehicle operations should be considered for deployment. Although many of these would be implemented by enforcement and administrative agencies, the TOC may benefit from interaction with commercial vehicle entities. In Minneapolis, the traffic management center provides information to commercial vehicles, who in turn serve as spotters, notifying the traffic management center of accidents or unusual travel conditions.

- Technologies to enhance compliance with clean air mandates should be considered for deployment. Such technologies might include emissions testing equipment and other means for point source pollution detection.

- Deployment of technologies to encourage alternatives to single occupancy vehicle commuting should be considered for deployment The provision of real-time carpool matching and flexible transit routing and scheduling are just two examples of possible activities. The provision of high occupancy vehicle (HOV) facilities should also be considered. Although these activities may be primarily conducted by local transit agencies and the MARC, information about these activities should be available through the information server.

On-Going - There are a number of activities that should be on-going in the short, medium and long term These activities reflect the need for institutional coordination as well as system evaluation.

- It will be necessary for the TOC to coordinate with local public works agencies and emergency response entities. In the future, it may also be necessary for the TOC to coordinate with transit providers and the Kansas Turnpike Authority (KTA), primarily for the exchange of information.

- As local jurisdictions acquire more sophisticated equipment, the need for the exchange of information will increase. For example, the TOC might want video feed for CCTV cameras operated by the city on arterials that serve as freeway diversion routes

- The TOC will need to coordinate with emergency responders on an on-going basis As more emergency response agencies acquire automatic vehicle location (AVL) systems, the TOC may wish to use these systems as probes to indicate travel speeds, especially on segments of the system without detectors or monitoring equipment. On the other hand, emergency responders may wish to use travel time information from the TOC to determine which vehicle and route should be used in response to a call.

- Although few transit vehicles regularly use the freeway, the TOC should coordinate with local transit agencies nonetheless. For example, the Kansas City Area Transportation Authority's (KCATA) AVL system may be used to provide information to the TOC about alternate routes in their jurisdiction. Furthermore, in the future, the TOC's information server may serve as a point source for information on all modes in the greater Kansas City area. Thus, coordination will be even more important.

- Local jurisdictions should initiate and continue efforts to upgrade signal control hardware on arterial routes, especially those appropriate for freeway diversion. As development spreads and volumes increase on freeway segments that are currently under capacity, the TOC will need to coordinate with additional cities for arterial diversion.

- Once cities have implemented signal control systems that can accommodate timing plans for freeway diversion, the TOC must work with the local agency to develop signal timing plans and policies. These plans and policies must be evaluated and modified, as necessary.

- Local agencies must notify the TOC of any construction or maintenance activities that would interfere with the use of an arterial as a diversion route.

- The TOC should coordinate with the KTA regarding current and planned ITS applications. For example, the TOC could use the K-tags as probes by installing readers on I-70. Future applications include exchanging information and providing information about traffic conditions on I-70 in Kansas City to travelers on the eastbound tollway, and vice versa.

- The detectors installed as part of the freeway management system should be used to gather information on "before" and "after" conditions. This information can be used for decision making for later study phases, to verify estimated benefits and increase the accuracy of projected benefits and benefit cost ratios.

- Data gathered by the freeway monitoring system can be used to identify the location, severity and duration of recurring congestion This detailed data can be sued to assess the need for and project the effectiveness of strategies such as ramp metering

- The impact of the provision of traveler information, including information about recurring congestion, incident related congestion, and alternate routes, may be evaluated using freeway data gathered by the freeway monitoring system.

GUIDE TO DEPLOYMENT

This is intended to be a guide for locating Intelligent Transportation System equipment along roadways in the Kansas City metropolitan area. This section addresses a number of issues, including diversion routes, variable message signs, CCTV cameras, detection equipment, arterial traffic control systems, HAR, and ramp metering

With respect to equipment, in general, currently available and acceptable, state of the art technology should be employed whenever possible. However, value engineering should be used to determine the most cost effective equipment to be used. The cost of training, maintenance and operations are also important criteria that should be considered.

Closed Circuit Television Cameras (CCTV) - On interstates and freeways, CCTV cameras should be placed to allow complete coverage of the roadway, this may require spacing as frequent as one every half mile. Selected priority locations for CCTV cameras are shown for each phase in Figure 7-1. The cost estimate includes provisions for additional cameras, and is based on a frequency of one camera every half mile.

CCTV camera priority locations include high accident locations, freeway to freeway interchanges, and interchanges with major arterials. More than one CCTV camera may be needed at some interchanges. These CCTV cameras will be used to verify the conditions of diversion routes before, during and after a diversion plan. In some cases, the capacity of an interchange may be unable to accept additional traffic volume, especially at peak traffic times. The CCTV images could be used to determine whether diversions should be continued or discontinued.

On diversion routes that are major arterial roadways with at least two lanes per direction, CCTV cameras should be considered for placement. These CCTV cameras would be used to verify the condition of the diversion routes before, during and after implementation of a diversion plan deployment. CCTV cameras located on arterial diversion routes may be implemented in conjunction with cities, providing an opportunity for shared costs and benefits.

Highway Advisory Radio Transmission (HAR) - It is recommended that a system of individual HAR transmitters be deployed to cover the entire metropolitan area. A conceptual layout of HAR coverage is provided in Figure 7-2 (approximate radius shown is 2.5 miles).

The transmission ranges should be set and the transmitters should be located such that they do not overlap or interfere with one another. There are two approaches to accomplish this, the first and recommended approach is to use a single frequency for the entire metropolitan area, in this case it would be 1610 AM. Under this scenario, drivers would be able to access information anywhere in the metropolitan area on the same frequency, minimizing confusion. A disadvantage of this is that there can be no overlap in coverage areas, or the message will become garbled. A second approach is to use different frequencies for adjacent transmitters. This approach allows more complete coverage, but requires drivers to know where they are and know the associated frequency, changing the radio station as they enter a new HAR coverage area

Local HAR should be coordinated with any future HAR along the Kansas Turnpike. Some degree of cooperation, coordination and shared use of the messages on HAR between the Kansas Turnpike, KDOT and MHTD should be developed based on the location, severity and impact of an incident on the adjacent agencies roadway

Variable Message Signs (VMSs) - The kind of VMS required, and the recommended placement of the sign varies, depending on the type of facility. Possible locations for VMSs for each phase are shown in Figure 7-3.

On interstates and freeways, VMSs should be placed prior to interchanges with other interstates and freeways for route diversion information. VMSs should be placed approximately three-fourths of a mile prior to the alternative route decision point, keeping in mind the sight distance necessary to read a three-panel message at the prevailing speed of the facility. Special attention should be given to vertical and horizontal curves.

On major arterial roadways that are two lanes per direction (such as Metcalf Avenue), VMSs should be placed prior to interchanges with interstate and freeways. VMSs should be placed approximately one-half mile prior to the decision point, keeping in mind the sight distance necessary to read a message at the prevailing speed of the facility. Special attention should be given to vertical and horizontal curves.

On minor arterial roadways that are two lanes total (such as the two lane, one-way streets downtown), the option of smaller, less sophisticated and less expensive changeable message signs (CMSs) should be considered. Options include rotating drum signs, blank-out signs, or electromechanical flip panel signs. These CMSs should be used because they are less expensive and because fewer motorists will see the information displayed on the CMS. The lower cost and the fact that fewer motorists will be impacted should be considered when determining the number of locations for deployment. The use of CMSs is less obtrusive and provides information to the motorist as to the condition of the adjacent facility (for example, normal conditions ahead are indicated by the absence of a message; congested conditions are indicated with an appropriate message).

In general, VMSs should not be located prior to interchanges with roadways that have little or no capacity to accept the diverted traffic.

Diversion Routes - Possible diversion routes are shown in Figure 7-3. Although ideally diversion routes are on freeways, many of the Phase 1 and 2 alternate routes are on arterials. For Phases 3 and 4, particularly for through trips, freeway alternate routes are recommended, although they are not shown in Figure 7-3.

In general, choices for traffic diversion routes should be prioritized as follows:

- First. Freeway to Freeway.
- Second Freeway to Major Arterial Roadway.

The key to mitigating the impact of diverted traffic on any one roadway is to provide the information as wide spread as possible to the motorists. This allows the motorist to choose the diversion route well in advance of the incident. Providing information to the motorist about the extent of the queue developed by the incident may help motorists decide whether to stay on their route to reach their destination.

If the alternate route has not been instrumented, then manual means of monitoring the alternate route should be deployed until the alternate route has been instrumented This can be accomplished through roaming service patrols and cellular call-in by motorists to the TOC.

An analysis of the capacity of the available adjacent alternative roadways should be performed. A list of criteria which might eliminate a roadway from consideration as a diversion route is as follows:

- Single lane in each direction.
- School located along the route.
- Hospital located along the route.
- No traffic signals to control traffic or increase capacity for diverted traffic
- Limited overhead clearance for large vehicles.
- Limited turning radii for large vehicles.
- Substandard roadway alignment or geometrics.
- Lack of shoulders.
- Residential areas.
- Heavy pedestrian traffic.
- Active railroad crossings.
- Substantial change in speed limits.
- Circuitous routes.
- Roads which require resurfacing and/or reconstruction.

Traffic Volume, Travel Speed and Traffic Density Detection Systems - Detection equipment should be deployed along interstates and freeways. Detection equipment may also be deployed along segments of roadways that act as links between diversion routes. These detection systems would provide valuable information about travel speeds and traffic volumes, information which can be used to determine the usefulness of a link for diversion purposes.

Detection Systems should be deployed on interstates and other freeways at half mile intervals or between interchanges. Whenever possible, detection equipment should be employed that is non-intrusive to the flow of traffic. This provides detection equipment that can be installed, operated and maintained with minimal disruption to traffic flow

On diversion routes that are major arterial roadways with at least two lanes per direction, detection systems can be used to evaluate the capability of the arterial to handle the additional volume resulting from freeway diversion. Such systems may be appropriate for deployment in the future by cities or other agencies with jurisdiction, however, such systems are not currently recommended.

Coordinated Arterial Traffic Signal Systems - Traffic signal control should be coordinated along all signalized arterials that may be used as diversion routes. These routes should be designated mutually by the city or agency with jurisdiction and by MHTD or KDOT. Possible alternate routes are shown in Figure 7-3. Key arterial diversion routes for Phase 1 and 2 include Truman Road, US 40, US 24 and Bannister Road in Missouri, and State Avenue, Metcalf Avenue, 103rd Street, and College Boulevard in Kansas.

Management of the coordinated arterial traffic signal system will depend on agreements worked out with each jurisdiction. For example, Kansas City, Kansas, prefers that adaptive signal control be used, so no agency will manually change the timing plan upon implementation of a diversion scheme.

On the other hand, Kansas City, Missouri, would be willing to allow the TOC to implement a pre-determined (and agreed upon) timing plan on a diversion route such as Truman Road. At other times, during typical operations, control would be maintained by Kansas City. Similarly, Overland Park, Kansas, would allow the TOC to implement a pre-determined timing plan when Overland Park engineers are not available. During office hours, however, the TOC would notify the city, and city engineers would implement the pre-determined timing plan.

In all cases, the affected city and MHTD and/or KDOT should work together to determine an appropriate timing plan prior to the incident. These timing plans should then be evaluated and modified, as necessary.

It is also important that issues related to liability be addressed prior to deployment. Records of all changes in signal timing will need to be kept, and issues related to agency liability will need to be addressed thoroughly.

Ramp Metering Demonstration Project - Ramp metering is recommended for implementation in the short term as a demonstration project on I-35 in Kansas from I-435 to the state line. Ramp metering is recommended for consideration in the medium term on other congested facilities in the Kansas City area.

Ramp metering is a tool used to reduce recurring traffic congestion on a freeway facility by managing vehicle flow from on-ramps. The on-ramp is equipped with a traffic signal that allows vehicles to enter the freeway at an interval. Ramp metering has a number of potential benefits including[1]:

- Reduction of freeway mainline congestion.
- Decrease in freeway mainline delay.
- Protection of freeway level of service.
- Reduction in ramp merging accidents.

This section provides an analysis of the potential for ramp metering on I-35 from I-435 to Southwest Trafficway. This section will examine the necessary elements in developing the

[1] Transportation Research Board, *Highway Capacity Manual*, 1994

standards for planning, operation, design and implementation of a ramp metering program study.

Ramp Metering Planning: Ramp metering is a transportation system management (TSM) approach to solving freeway congestion problems. An effective ramp metering program utilizes a series of entrance ramps within a specified corridor and treats them within a "system" configuration. The installation of ramp control signals should be preceded by an engineering and planning study of the physical and traffic conditions on the highway and surrounding arterials likely to be affected. After implementation of a ramp metering program, planning analysis should be maintained to observe the impacts of the system and to make program changes.

An I-35 ramp metering program study should include analysis of the ramps and ramp connections as well as the freeway itself and surface streets affected by the ramp control Types of traffic data which should be obtained for the study include, but are not limited to, traffic volumes, traffic accidents, operating speeds, travel time, and delay on I-35 and on alternate surface routes.

Analyzing the potential for a ramp metering program involves developing a set of criteria to determine whether freeway and ramp sections are a good candidate for a ramp meter. Each ramp meter should be individually planned to accommodate the surrounding traffic demand. Analysis should be made as to the desirable ramp metering rates, probable reductions in delay of freeway traffic, likely increases in delay to traffic on ramps and potential impact on surface streets[1]. Ramps are usually timed so that on-ramp demand will not exceed downstream freeway capacity. Additional analysis should include level of service, storage capacities on the ramp and whether suitable alternate surface routes have adequate capacity to accommodate additional traffic volume.

After the ramp metering program has been implemented, analysis should continue to follow the performance of the system. Adjustments to the system can be made as a result of this analysis. Because ramp metering imposes delay on vehicles wishing to enter the freeway, this disbenefit must be outweighed by the time savings and accident reduction for overall freeway travel.

Ramp Metering Operations: The primary objective of a ramp metering program is to improve the operating efficiency and safety of the existing freeway mainline. While freeway operations are improved, ramp operating efficiency is compromised. Ramp metering must be closely coordinated with arterial signal timing on nearby streets to assure that arterial operation is not unduly affected.

There are a number of basic strategies for inserting vehicles into the mainline freeway traffic. Each of the following metering operations provides a different level of sophistication of control. The best ramp metering operation is one that is tailored to the individual ramp characteristics and goals and objectives of the ramp metering program[2].

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[1] Federal Highway Administration, *Manual of Uniform Traffic Control Devices*, 1988

[2] Discussion on ramp metering operation is based on information provided in W McShane and R Roess, *Traffic Engineering*, 1990

Primary ramp metering operations include:

- *Simple Metering* - uses a fixed metering rate with an optional detector for sensing the presence of a vehicle. The green indication is generally 2 to 3 seconds long, sufficient to pass one vehicle

- *Demand-Responsive Metering* - uses freeway mainline information so that the ramp metering rate is computed in real-time to respond to current demand levels and freeway conditions.

Secondary ramp metering operations include·

- *Gap-Acceptance Metering* - uses a series of detectors in the shoulder lane of the upstream traffic to identify "acceptable gaps" and match a ramp vehicle to maximize the likelihood of a smooth merge. This method has special advantages for ramps with poor sight distance.

- *Pacer and Greenband Systems* - use a series of lights along the ramp to lead the vehicle along with the pace of the lights matched to the gap sensed on the mainline. The Greenband system uses a band of acrylic panels backed by floodlights every two feet to provide an image of a moving band

Ramp metering operations include five types of vehicle throughput. The type of throughput that is best suited for a particular ramp depends on the goals and objectives of the individual ramp, the entire ramp metering system and the existing ramp configurations. Five types of vehicle throughput include:

- Single vehicle throughput, single lane.
- Multiple vehicle throughput, single lane.
- Single vehicle throughput, dual lane.
- Multiple vehicle throughput, dual lane.
- Single vehicle lane metering with HOV bypass lane.

Ramp Metering Design: Design of the ramp metering facility includes all physical elements of the project, including upstream warning signs, ramp configuration and the ramp metering site. The on-ramp metering system should meet all of the standard design specifications for ramps and traffic control signals including the following design criteria from the *Manual of Uniform Traffic Control Devices.*

- The standard signal face for freeway entrance ramp control signals should be either a two-lens signal face containing red and green lenses or a standard three-lens signal face containing red, yellow and green lenses.

- Entrance ramps having more than one lane should have a signal head mounted on both the left and right side.

- The required signal faces should be mounted such that the height to the bottom of the housing of the lowest signal face is between 4.5 and 6 feet.

- All ramp control signals should utilize vertically aligned lenses with a minimum nominal diameter of 8 inches

- Ramp control signals need not be illuminated when not in use.

- Ramp control signals should be mounted close to the driver level.

Figure 7-4 illustrates a typical installation of the principle hardware components of a pretimed ramp control.

On-ramp vehicle storage should be adequate so as not to adversely impact adjacent streets. The metered on-ramp should be able to store between 5 percent (minimum) and 10 percent (desirable) of the peak hour ramp traffic volume with the assumption of 20 feet per vehicle On-ramp vehicle storage can be adjusted with the location of the ramp meter signal and the timing of the signal. Examples of single and double lane ramp metering placement are shown in Figure 7-5.

A standard estimated cost to implement the ramp metering program ranges from $25,000 - $35,000 per on-ramp or $50,000 - $70,000 per interchange[1]. This estimate includes the signal head, controller and the detectors. Any geometric improvements to the ramp would be an additional cost.

Ramp Metering Implementation: It is important to develop an Implementation Plan when planning a ramp metering program. Consideration should be given to public acceptance potential and enforcement requirements of ramp control, as well as alternative means of increasing capacity, reducing demand or improving characteristics of the freeway[2].

The following is a step approach to implementing a ramp metering program.

STEP 1 - Collect data and analyze existing conditions of freeway, ramp and arterial segments.
STEP 2 - Develop goals, objectives and policies regarding program.
STEP 3 - Prepare design layout.
STEP 4 - Implement public awareness campaign.
STEP 5 - Follow-up with program monitoring and improvement.

There are 12 arterial to freeway interchanges on I-35 from I-435 to the state line . All of these would be potential ramp metering candidates within the I-35 corridor system. Each location would be coordinated with the system-wide ramp metering program to facilitate improved traffic operation on I-35. It would also be possible to include the Southwest Trafficway entrance ramp in Missouri in the system. At this location, ramp metering could be implemented by using the existing traffic signals on northbound Southwest Trafficway and Broadway. It would also be possible to include freeway to freeway interchanges in a ramp metering system. All of these candidate ramp metering sites on I-35 are shown in Figure 7-6.

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[1] Final Report, Bi-State St. Louis Area Intelligent Vehicle Highway System Planning Study, April 1994
[2] Federal Highway Administration, *Manual of Uniform Traffic Control Devices*, 1988

Arterial to Freeway:

1 95th Street
2 87th Street
3 75th Street
4 67th Street
5. 63rd Street (Shawnee Mission Parkway)
6. Johnson Drive
7. Antioch Road
8. Lamar Avenue
9. Roe Avenue (18th Street Expressway)
10. Mission Road
11. 7th Street (Rainbow Boulevard)
12. Cambridge Circle
13. Southwest Trafficway

Freeway to Freeway:

14. I-435
15. U.S. 69
16. I-635

These 16 ramp interchange locations, together, make up a ramp metering system that can provide increased operating efficiency to the I-35 corridor. The ramp metering system provides a low cost TSM solution to a congested freeway corridor.

OPERATIONS PLAN

The key to success of the Kansas City freeway management system will be an effective program of operations and maintenance. This will require personnel located at the TOC, individuals responsible for field maintenance, and a management structure to coordinate and administer the overall operation. Training of staff, both initially and on a continuing basis as new equipment and functions are added, is critical to insure that the staff can provide maximum effectiveness. Complete and thorough system documentation is also necessary to effective operation. This section presents a review of actions and issues related to the operation and deployment of the future system. Procurement methods, staffing, TOC sizing, system start-up plan requirements, and operations plan requirements are also addressed.

Agreements and Memorandums of Understanding - In order to be effective, the proposed freeway management system must be conceived and operated in a cooperative effort by multiple state and municipal agencies. Generally, its purpose is to be responsive to traffic and incident conditions without regard to jurisdictional boundaries. The system will be designed as a unit, but it must operate in the context of decentralized functions and responsibilities. Since it will support and enhance current functions, the cooperative relationships established for its operation will extend beyond its functions of roadway monitoring, incident detection, incident response, and motorist information. The system will serve as an effective catalyst for communication among agencies involved in incident response.

A series of agreements and memorandums of understanding will be necessary to establish and support the freeway management system These will need to be developed over a period of time as an ordinary part of system design and development Multiple agreements or memorandums are advisable in lieu of a single document to provide flexibility for responding to future needs

Potential needs for cooperative agreements or memorandums of understanding would likely include four categories:

- Agency Support.
- System Construction, Operations, and Maintenance
- Emergency Response.
- Specialized Control Plans.

Agency Support· One of the first documents to be executed should be a joint statement of support for improved incident management systems and operations within the metropolitan Kansas City area. This should be a statement of policy, with specific roles and responsibilities to be identified in follow-up documents. This agreement should provide a statement of goals and objectives in support of a cooperative policy. The agency support statement should be signed by the state, county and city authorities. This document will serve to inform the public of intent and commitment to the system, and will provide general guidance (through goals, objectives, and policies) for further system development

To best serve its intended purpose, execution of the agency support agreement should be well publicized. This could include signing ceremonies by county, city and state officials and may include media coverage. In addition to indicating support and cooperation of involved jurisdictions, this will provide an early opportunity for public education regarding the character and intent of the system.

System Design, Construction, Maintenance, and Operations. Agreements will be necessary among participating jurisdictions and agencies to establish and operate the system. These will address the following categories: funding, system operation and maintenance, and functional roles and responsibilities. Among the topics which may need to be addressed for each category are the following:

- Funding
  - Engineering
  - Construction
  - Start-up
  - Operations
  - Maintenance

- System Operation and Maintenance
  - Traffic operations center
  - Field equipment
  - Administration and management
  - Staffing

- Functional Roles and Responsibilities
  - Communication responsibilities of traffic operations center
  - On site coordination (incident manager, call for tow trucks, etc.)
  - Role and limitations of motorist assistance patrols
  - Identification and management of diversion route systems
  - Operation of variable message signs and motorist information systems
  - Data links (CCTV, traffic counts, operating speeds, etc.)

Emergency Response - Agreements, legislation, and cooperative understandings should be developed for the coordination of incident response. Activities toward this end are currently underway. Changes may be needed as emergency response personnel interact and as the system design evolves but the system will not supplant or modify most established relationships Some potential new emergency response policies may require enabling legislation, including:

- Vehicle removal policies.
- Lane closure policies.
- Tow truck notification policies.

Specialized Control Plans - In addition to agreements and/or memorandums of understanding for day-to-day system operations and emergency response, it may be useful to establish roles, responsibilities, and relationships for special conditions. These include the following, as a minimum:

- Recurring special events (such as a Chiefs game)
- Unique special events (such as a presidential visit)
- Maintenance of traffic during construction
- Special incidents, such as hazardous material spills

Hours of Operation - Although cost estimates provided for 24 hour weekday operation, it would be reasonable to initiate monitoring on a more limited basis. Experience from other freeway management systems indicates that, at a minimum, the TOC needs to be staffed from the beginning of the morning rush hour to the end of the evening rush hour. One alternative would be 15 hour (generally 5:30 am to 8:30 p.m.) operation. Weekend staffing may not occur initially, but eventually it may be needed, especially during special events or adverse weather. Since the TOC will be located with the MHTD district office, it may be possible for TOC staff to perform other duties during the off-peak hours.

Two different strategies for providing staff have been utilized by different agencies: utilizing agency personnel (either existing or new hires), and contracting to a private organization to provide the personnel. In either case, the budgetary impact is essentially identical, although the specific budgetary categories may be different. As such, there is no distinction as to which approach is used.

During mid-day hours, when traffic is lighter, the operational staff can utilize some of their time to perform other activities that can be handled from within the control room. But the operator is still required to be immediately available to monitor and coordinate response to an incident which might occur. During the hours when the control room is not staffed, at night and on weekends, the system design and architecture must allow an auxiliary console to be located at a 24 hours per day facility, such as the emergency medical or police dispatch center. One logical place for this console would be in the Missouri Highway Patrol Office which will be located adjacent to the MHTD district office

TOC Operators - The specific functions that the operator needs to perform include.

- Utilizing the computer displays and CCTV screens to monitor and verify the traffic conditions and incidents on the freeways.
- Operating the computer systems, through a keyboard or mouse or joystick, to select different displays and to control field devices, such as VMSs and CCTV cameras
- Responding to status and alarm messages from the computer systems, again with a keyboard and mouse, that are generated when incidents are detected or equipment malfunctions are detected
- Utilizing telephone and radio equipment to communicate with police, fire personnel, and other personnel responding to an incident.
- Utilizing telephone or FAX equipment to communicate with media and the public regarding the status of an incident or current traffic conditions. This function may also be automated through the central information server, and/or through the provision of information via highway advisory telephone or the Internet.
- Operating recording equipment, such as a VCR, that would be utilized to capture the specifics of a particular incident.
- Troubleshooting and performing simple replacements for malfunctioning equipment in the TOC.
- Maintaining logs and other required records of activities.

Several different strategies, alternatives to the more traditional full-time agency technical or support staff, have been utilized by other TOCs for hiring operators. These include hiring part-time workers, including college students. If additional operators are needed during the peak periods, part-time employment may be a logical option.

The cost estimate includes provision for two operations per shift for Phase 1, two additional operators for Phase 2 (four total for Phases 1 and 2), and three additional operators for Phase 3 and 4 (seven total for Phases 1,2 and 3; ten total for all phases). It was assumed that 3.5 shifts would be used for all phases.

Equipment Maintenance - The maintenance and repair of all equipment must be accomplished in a timely fashion in order to achieve effective system operation. The typical goal for these systems is a four hour response time from the time a failure is reported until the equipment is returned to service. This requires a maintenance technician with adequate spares, appropriate tools and equipment, and up-to-date training.

Although the cost estimate provides for five maintenance people for Phase 1, with three additional people for Phase 2 (eight total for Phases 1 and 2), and seven additional people for

Phase 3 and Phase 4 (15 total for Phases 1, 2 and 3; and 22 total for all phases), it would be possible to initiate the system with fewer personnel. It is recommended that at least one technician be dedicated to ITS equipment. While it is possible to share this individual with other maintenance and support activities, it is important that the technician's first priority be the support of the field equipment, and not arterial signals or other equipment. This individual should be available prior to the start of any construction for the project to allow familiarity with the system design. The technician's input to the design process, to insure that maintainability is built into the system, will yield long-term benefits. The technician should serve as the field inspector during all construction work so that details are retained by an agency employee. Also, since the technician will have to live with or correct any problems created by the construction, there will be a strong incentive to get the system built correctly.

Another important role of the maintenance technician is to coordinate with other roadway maintenance or construction activities to minimize the disruption of field equipment. Because contractors and other organizations do not always recognize the importance of the field equipment and associated power and communications circuits, inadvertent actions can create problems. The maintenance technician, by being available or on-site during these potential disruptions, can minimize or eliminate equipment down-time

The maintenance technician needs to be well experienced in a wide range of skills, including electronics, communications, power distribution, cable installation and repair, portable generators, and general small scale mechanical repairs. Since the maintenance technician will be faced with diverse equipment and failure conditions, a broad set of general repair capabilities is required. Effective troubleshooting and problem isolation techniques, supported by a systematic and logical approach, is needed to quickly identify and correct problems. Preventive maintenance, locating and repairing small problems before they become major, and conscientious record keeping and documentation are also regular components of the equipment maintenance program.

System Management - A manager of the operators and maintenance technician will be required. It is desirable that this individual also have an engineering background so that broader system support and long-range upgrades can be handled. The role of the manager is to provide day-to-day supervision and scheduling of operations and maintenance activities, to coordinate with other agencies and organizations, to develop plans and policies for incident management and freeway monitoring, and to financially manage the operation by developing budgets and being responsible for operating within these budgets.

The manager will also be available to support the operator during a major incident, to be a higher level liaison with other agencies and the media, and to supervise a back-up person if regular operations personnel are not available. The manager will be responsible for training new operations personnel, and insuring that current staff are trained on new equipment and that refresher training is conducted for all personnel, as necessary.

The manager will be responsible for supervision of maintenance activities, insuring that adequate spares are available and that the maintenance technician has all the tools, equipment, and test devices needed to perform effectively. The manager must make certain that the technician's training is current and up-to-date. When a crises occurs, the manager must expedite support and repair services, and provide a buffer between the maintenance technician and other individuals, so that the technician can work without being disturbed.

When the maintenance technician is on vacation, sick-leave, at training, or otherwise unavailable The manager must also be able to fill-in and supervise or provide basic levels of equipment support and repair.

Support staff, such as secretarial, clerical and receptionist personnel, may be provided on a shared basis from the MHTD district office. Although the freeway management system and TOC do not require dedicated personnel, a part-time equivalent may need to be included in the budget to account for this labor component.

Implementation Plan - Part 655 409 of Title 23 Code of Federal Regulations requires the development of an Implementation Plan prior to the deployment of monitoring and control elements of an incident management plan. According to current guidelines, the Implementation Plan is to be completed prior to project design completion and must be approved by the Federal Highway Administration (FHWA) prior to authorization of construction funding. The Implementation Plan should finalize needed legislation, system design, procurement methods, construction management procedures, acceptance testing, and system start-up. It will also need to include an Operations Plan and Maintenance Plan which provide specific information regarding the equipment to be installed. The intent of the Operations Plan is to clearly describe all significant system features and the means for installing and operating the system An important element of the Operations Plan is the commitment of involved agencies to staff the system and fund its operation. Many of these issues must await design activities for an appropriate level of detail.

Traffic Operations Center (TOC) Concept - The Traffic Operations Center will serve as the centerpiece of the Kansas City freeway management system. Most ITS functions will be performed at the TOC. Both technically and visually, the TOC will play a major role in defining the success and public image of the Kansas City system.

The internal functions of the TOC will include items such as incident management, systems operations, freeway and arterial monitoring, congestion management, and other ITS activities. Important to the success of the internal operations of the TOC is the facilities (the building, grounds, utilities, etc.) and location. Adequate floor space, highway access, communication linkage, site security, building construction, and alternate route access all contribute to a successful TOC.

Although the proposed MHTD District 4 facility has been identified as the tentative location for the TOC for the entire metropolitan region, it is worthwhile to iterate the factors that should be considered when locating a TOC. If, for any reason, KDOT or MHTD need to find an alternate location for a TOC, potential sites should be evaluated with respect to these factors.

- Ownership. Ownership of the property is an important location. Whether the property is owned or leased has significant implications in terms of on-going expenses (such as rent) and stability, which would be affected by the lease term.

- Space Availability. Space availability refers to the amount of space available for the TOC. This is given in square feet for existing structures, and acreage for vacant lots.

- Highway Access. Highway access indicates distance to access the nearest highway facility, such as I-35, I-435, I-70, or I-470, for the proposed MHTD District 4 facility.

- Emergency Alternate Access   Alternate access lists alternate routes from the site to the highway system. These routes are in addition to those listed in the highway access category.

- Costs. Costs include approximate site preparation costs, which is the cost of all items necessary to prepare the site for the installation of the TOC. Included in this would be items such as building construction or renovation, utility connections/installations, communication linkage, property acquisition, etc.

- Communication Link Potential. This category reflects proximity to fiber optic networks, microwave towers, and telephone lines, types of telephone lines, cellular phone usage, short range microwave capabilities, etc. Proximity to the interstate is especially important when one considers the need to connect to the fiber optics communication infrastructure

- Site Utilities. Site utilities include existence or availability of utilities such as electricity, sewer, HVAC, gas, and water.

- Site Security. Site security includes items such as fences, barriers and adjacent types of development.

A program of minimum space needs for the TOC is shown in Table 7-1. These space needs are based on the assumption that the TOC is co-located with the MHTD District 4 facility. Some facilities in the TOC can be used to support other district functions Shared space includes two conference rooms, which can be used for other activities when not in use for traffic operations and management. One of these conference rooms will serve as a command center during severe incidents; the other conference room will serve as a media room. Both of these conference rooms should overlook the control room, and can serve as viewing rooms for tours of the facility.

Public Transportation Applications

This section addresses deployment of ITS components related to public transportation. The projects recommended for deployment are based on the user services discussed in Chapter 3, the technologies and applications discussed in Chapter 5, and the benefits and costs evaluated in Chapter 6.

In addition to the applications related to transit identified in the previous *Freeway Management Applications* section, such as high occupancy vehicle (HOV) facilities, and coordination with the provision of transit information through the TOC, it is recommended that the transit agencies in the Kansas City metropolitan area move forward with the technology applications that are already underway, such as the automation of KCATA's scheduling and telephone information system. Additionally, the other technology applications identified as high priorities and discussed in Chapter 5 should be considered for deployment. All of these applications can be implemented in the short term (within five years). These projects include the following.

- Telephone information center automation.
- On-bus audio and video monitoring.
- Bus stop video monitoring.

Table 7-1. Program of Space Needs for Traffic Operations Center to be Co-Located with New MHTD District Facility

rm qty.	description	size	sq. ft.	sq. ft. ext.	comments
1	Control Room	25 x 30	750	750	begin with 4 technicians, but size room for 6
	- control console				
	- video display				
	- secured area				
1	Equipment Room	20 x 20	400	400	Serves control room, locate adjacent to minimize cabl runs
	- possible raised floor				
	- possible cooling and UPS requirements				
	- consult with vendors				
1	Supervisor Office	10 x 10	100	100	Share function with a manager in existing traffic department
1	Secretary Cubicle	6 x 8	48	48	
1	Computer Storage Room	8 x 10	80	80	
	- paper and disk storage				
1	UPS Equipment	10 x 20	200	200	
1	Communications Room	8 x 10	80	80	
	- fiber optics				
	- telephone and switch equipment				
1	Open office area	8 x 10	80	240	Space for 3 work stations
1	Maintenance Area	-	-	-	Not on site, share with existing maintenance department
1	Break Room	10 x 15	150	150	Combine with building break rooms
	- counter/storage				
	- microwave				
	- sink/refrigerator				
	- coffee				
2	Toilet Rooms	6 x 9	54	108	Combine with toilets for building
	- ADA accessible				
2	Locker Areas	3 x 5	15	30	Combine with locker areas in building
	- coats and personal possessions				
1	Conference/viewing/command center	20 x 25	500	500	Combine with building conference areas Use as command center during incidents
	- adjacent to control room				
	- view windows				
1	Conference/viewing/media	10 x 12	120	120	Combine with building conference areas Use as media room for press conferences
	- adjacent to control room				
	- view windows				
1	Filing/storage area	5 x 5	25	25	
	Subtotal sf			2,831	
	Circulation @ 35%			991	
	Total sf			3,822	
	Deduct areas shared with building			(1,426)	
	Total dedicated sf			2,396	

- Park-and-ride lot video monitoring.
- Automatic vehicle location (AVL) expansion.
- Consolidated paratransit scheduling
- Personalized public transit

As these projects are implemented, opportunities for sharing systems among transit agencies should be pursued to achieve greater consolidation of transit service in the metropolitan area and to extend the benefits of technology to smaller transit operators. Improved institutional and jurisdictional coordination will increase the benefits associated with technological applications.

Other ITS applications should be considered for deployment as medium term priorities in five to ten years. These applications include additional public transportation management projects such as automatic passenger counting and automated bus stop announcements. These applications are examples that build on the AVL capability. Another example for consideration is provision of real-time schedule information through telephone information systems and electronic message signs installed at high activity bus stops

Other potential activities for medium term deployment are advanced ridesharing applications. The application of ITS technology to multi-modal transportation programs is rapidly developing and is being tested through advanced public transportation systems (APTS) operational field tests throughout the country. Agencies involved with the planning and management of public transportation in the metropolitan area should be alert to new products and applications that can address the specific objectives and problems of the Kansas City metropolitan area.

Interagency Coordination

Issues related to interagency coordination include agency roles and responsibilities, as well as deployment issues related to operations and maintenance. Interagency coordination is a critical factor to the success of the Kansas City ITS system. Interagency coordination is also an on-going issue that will require continued efforts, as agency personnel, procedures and policies change.

AGENCY ROLES AND RESPONSIBILITIES

The following is a description of the future roles and responsibilities of the agencies participating in establishing a freeway management system for the Kansas City area:

Kansas Department of Transportation (KDOT) and Missouri Highway and Transportation Department (MHTD) - KDOT and MHTD will oversee the development and operation of a traffic operation center (TOC) which will be the focal point for the freeway management system and the distribution of current traffic information. This system will eventually serve the entire interstate network and selected freeway facilities in the Kansas City metropolitan area, and will consist of the following:

- Control of all field equipment on the interstates and freeways in the system.

- Equipment, primarily covering the interstate and freeway network, includes a variable message sign (VMS) system, a traffic detection system, a closed circuit television (CCTV) monitoring system, and a highway advisory radio (HAR) system. Equipment also includes ramp metering equipment, such as the equipment implemented on I-35 in Kansas for the ramp metering demonstration project.

- A traveler information kiosk system in key generators in the area, highway advisory telephone (HAT), and an electronic bulletin board system for access by citizens and businesses in the area may be incorporated in the future.

- Other future systems, not justified by existing traffic conditions, may include freeway high occupancy vehicle (HOV) facilities. The need for these facilities should be continually evaluated over time.

- Information provided by the Kansas City regional weather information system should be available at the TOC. This system has already been developed and is fully operational. Access to this information will require a modem connection to the main facility in Kansas City, Missouri.

- The Kansas Turnpike has recently implemented K-Tag, a system which utilizes a transponder for electronic toll collection (ETC). In the future, if the population of K-Tag users increases sufficiently, transponder-equipped vehicles may be used as probes, allowing individual vehicle travel times to be measured between instrumented reader stations. With sufficient penetration, this direct measurement may be used to supplement other methods of detecting congestion along interstates and selected freeways.

- MHTD's traffic signal systems should be controlled from the TOC. Signal systems on diversion routes in cities should also be controlled from the TOC during incident diversion activity, when possible. The timing of the signal systems can be modified to accommodate additional demand when the facility is being used as an alternate route during deployment of a freeway diversion scheme.

- The activities of motorist assistance patrols should be coordinated with the TOC to help in the removal of disabled vehicles associated with minor incidents and vehicle disablements.

- These systems, described above, should be operated and maintained by KDOT and MHTD, either directly through increased staffing and training for employees of either or both agencies, or through a contract with an outside company or agency for the provision of the needed services.

- KDOT and MHTD or their contracted designee should have sole control of the operations of the TOC and component systems.

Local Jurisdictions/Public Works Departments - Local jurisdictions should upgrade their signal systems on key arterials, as necessary. Each arterial used for a freeway diversion plan should have a signal control system capable adapting to accommodate the addition demand that would be expected. This may consist of solid state controllers with remote control for the implementation of a variety of pre-determined timing plans, including those appropriate for a freeway diversion scheme. An alternative would be the use of adaptive signal control systems, which would automatically detect the increase in demand on the diversion route and increase capacity as needed. Coordination with the TOC will depend on the method by which signal timing plans are changed, as well as the agreements between the TOC and each local jurisdiction. Ideally, coordination and communication would consist of the following

- Although local jurisdictions will maintain primary control of the signal systems in their jurisdiction, timing plans to absorb the additional demand resulting from freeway diversion will be implemented by the TOC, by the city upon the recommendation of the TOC, or automatically implemented via adaptive signal control.

- Local jurisdictions will have access to current traffic conditions, including CCTV and additional data as needed, on the freeway facilities in their jurisdiction Local jurisdictions will be responsible for obtaining the funding and equipment necessary to access this information.

- Local signal systems should be coordinated with ramp metering (controlled by the TOC) to assure that operating conditions on the arterial are not unduly affected.

- KDOT and MHTD should retain primary control of the CCTV cameras on the interstates and freeways. Communications can be established for local agencies to view the CCTV camera images of facilities in their jurisdiction at any time. Local jurisdictions should be able to request selection and movement of the CCTV cameras in their jurisdiction. Requests should be granted by operators at the TOC when possible. It would also be possible to implement CCTV cameras that could be controlled from multiple locations (such by local jurisdictions and the TOC), under this scenario, the TOC would have primary control, and the TOC commands would override the local commands.

- CCTVs cameras located on arterial streets will be controlled by the agency responsible for implementing and operating such cameras, although the images should be available to both local jurisdictions and the TOC.

Law Enforcement - The state and local police should coordinate and communicate with the TOC when responding to incidents on the freeway system. This includes not only response by law enforcement officers, but also the response of Kansas Motorist Assistance Patrol, which is under the jurisdiction of the Kansas Highway Patrol.

- Local and state police should have no direct control of the operations of the freeway/expressway or traffic signal equipment.

- Local and state police should have access to CCTV camera images in their jurisdiction and should be able to request selection and movement of the CCTV cameras. The police desk should be able to view the freeway and arterial status traffic information displays. Law enforcement agencies will be responsible for obtaining the funding and equipment necessary to access this information.

- The TOC will communicate with law enforcement via either telephone or two-way radio.

Kansas Turnpike Authority (KTA) - The KTA should coordinate and communicate with the TOC on an as-needed basis. Of particular interest are incidents on I-70 west of downtown and the potential for use of the K-Tags for vehicle detection and for commercial vehicle applications.

- The KTA should have dial-up remote access to the traffic information and status display

- The K-Tag system implemented by the KTA may eventually be used as a means for detection of incidents, particularly on I-70 west of Kansas City This would be accomplished by placing transponder readers on the freeway, and would require an adequate population of K-Tag users.

Public Transportation - Local transit agencies should coordinate and communicate on an as-needed basis with the TOC Major transit agencies include the Kansas City Area Transportation Authority (KCATA), Johnson County Transit, and Public Transportation Division, Public Works Department, Kansas City, Kansas.

- Transit providers should be able to access current traffic information and any other information that would be valuable for their operations. Transit agencies will be responsible for obtaining the funding and equipment necessary to access this information. Transit agencies may use this information to re-route transit vehicles around congested areas.

- Transit providers should make information from their automatic vehicle location (AVL) systems available to the TOC, if the TOC has a need for this information. The agencies operating the TOC will be responsible for obtaining the funding and equipment necessary to access this information.

- Any freeway HOV facilities developed in the future should be developed in coordination with transit service providers, as well as arterial HOV facilities. HOV bypass facilities should be considered for implementation with ramp metering.

Emergency Response and Coordination - The TOC should utilize the existing 911 system for direct contact with emergency responders in the case of an accident on the freeway. The system should be set up so that the TOC operator will be automatically connected with the appropriate agency upon identification of the location of the incident and the kind of emergency response agency needed.

- The existing 911 system will be maintained as the primary mechanism for responding to emergencies on the freeways.

- The TOC should use two-way radio for communication with emergency responders for on-going coordination once the incident response has been initiated.

- In the future, if conditions warrant, a special number for reporting non-emergency incidents on the freeway should be implemented. This number would be answered by personnel at the TOC, who could then coordinate with the motorist assistance patrol (MAP), or other appropriate agencies, as needed. Implementation of a system such as this one, which requires motorists to make a determination as to the severity of the incident (for example, vehicle disablement versus injury accident) would require significant public education activities. This disadvantage would have to be considered relative to the need to relieve the 911 system of non-emergency calls.

Private Sector Involvement - Wherever possible, the private sector should be involved in developing and expanding the freeway management system and the distribution of traveler information.

- Private sector should include, but not be limited to, universities and colleges, manufacturing and service companies, the broadcast and print media, communications and entertainment companies, etc.

- Opportunities for public/private ventures should continue to be explored This avenue resulted in significant benefit for MHTD through the deployment of fiber on all interstates in the State of Missouri, and may result in similar benefits for Kansas. Additional aspects related to public/private activities for the provision of traveler information are discussed in the following section, *Funding Issues*.

- Other opportunities for private sector participation might include information kiosks, new products testing, and the development of an area wide communications network

- Information from the TOC should be available to traffic reporting agencies and cellular phone companies. Fees for traffic information (such as data required in a specialized format) should be outlined in a policy developed prior to deployment.

DEPLOYMENT ISSUES

One of the issues most critical to the success of the deployment of ITS in Kansas City is the continued coordination among local agencies. Coordination among agencies will allow a coordinated approach to project and system planning, will facilitate implementation through the cooperation of neighboring jurisdictions, will allow all agencies to benefit from the experiences of a few, and will enhance the effectiveness of the deployment of ITS projects.

Interagency coordination is perhaps one of the least expensive and most effective means of assuring the development of a seamless ITS system for the metropolitan area. It is recommended that all agencies on the Steering Committee continue to meet periodically, as needed. This group may expand to include representatives from cities or other agencies that are stakeholders in the deployment of ITS technologies.

Maintenance Issues - Agencies participating in the freeway management system should develop clear guidelines on the maintenance of the elements of the system. The following are beginning elements of assigning responsibilities for maintenance:

- An agreement between KDOT and MHTD for the maintenance of all aspects of the freeway management system, including the equipment and software at the TOC and in the field, needs to be developed. All maintenance agreements should be formalized and written, whether the work is done in-house by public agencies or by contract with private firms.

- With respect to field equipment, each state should be responsible for the maintenance of equipment in their jurisdiction, which does not preclude a coordinated approach to maintenance that may result in economies of scale

- Local jurisdictions and agencies should be responsible for maintenance of equipment they have purchased for communications with and for obtaining information from the TOC

- CCTV cameras and detection placed by the TOC on arterial streets that are primary diversion routes should be maintained by the TOC unless other agreements are made with the local jurisdiction.

- Space at the TOC should be reserved for maintaining, testing and troubleshooting; either on-site or off-site storage should be provided

Operations Issues - Agencies participating in the freeway management system should develop clear guidelines on the operations of the system. These responsibilities should evolve from the following initial principles of operation including:

- Any future ramp metering signals should be the responsibility of either MHTD or KDOT, unless other arrangements are made with the local jurisdiction.

- Compatibility with TOC software and operations should be considered during selection of new signal system equipment on arterials that may be used as freeway diversion routes

- Agreements between KDOT, MHTD and local jurisdictions for the operation of signal systems and other equipment on arterial facilities needs to be developed. These agreements would be expected to vary depending on the needs and desires of each local jurisdiction. All operating agreements should be formalized and written, whether the work is done in-house by public agencies or by contract with private firms.

Open Issues - There are several issues that will need to be continually explored as new information becomes available and as technology and circumstances change. These issues include

- Roles for the private sector.

- Funding sources, which vary depending on the kind of expenditure, the agency requesting funds, and changes in legislation and available funding.

- Level of deployment, which will affect the number and variety of affected agencies.

- "Open architecture", which is still being defined at the national level and which should be a significant consideration with respect to integration with in-vehicle navigation systems and other ITS applications in the future.

- The need to modify the system to incorporate new technologies.

Funding Issues

Funding issues include potential sources of funds, both traditional sources through the various levels of government, as well as newer sources, such as partnerships with private entities

POTENTIAL FUNDING SOURCES

Potential funding sources for elements of the ITS Strategic Deployment Plan vary, depending on the jurisdiction and the kind of project. Potential funding sources may include local funding, both city and county, state funding, including funds from KDOT and MHTD, and federal funding.

Federal funding sources include National Highway System (NHS) funds, Surface Transportation Program (STP) funds for projects not eligible for NHS funds, and Congestion Mitigation and Air Quality (CMAQ) funds. New Intermodal Surface Transportation Efficiency Act (ISTEA) legislation is expected for fiscal year 1998, which begins in October 1997. This legislation may designate funding for ITS projects recommended by the early deployment studies funded through the original ISTEA legislation. Opportunities to include ITS equipment as part of reconstruction activities should also be considered

Additionally, some projects may present the opportunity for funding from private entities, through joint ventures and other public/private partnerships, as well as through consumer driven technologies such as technologies that will be integrated into the automobile. Opportunities for public/private partnerships are discussed in the next section.

PUBLIC/PRIVATE PARTNERSHIPS

Deployment of an intelligent transportation system will likely involve partnerships with private industry, businesses and the academic community. In fact, currently the primary providers of traffic information are private entities that provide radio and television traffic reports. The extent of the partnerships that will be formed depends on several things. First, the need for partnerships must be adequately communicated and understood. Understanding can be enhanced by an intensive program to explain the goals and objectives of ITS and how these goals can be enhanced through partnerships. Second, public technical assistance (for example, to facilitate coordination with local jurisdictions) should be made available where possible, and its availability should be made explicit. Third, resources are limited in all sectors of society, and the benefits of participation for all affected entities should be examined and carefully delineated.

A general outline of the possibilities for ITS partnerships indicates three categories of techniques that can be implemented:

- Privately operated techniques.
- Public/private coordination and joint activities.
- Publicly-led activities.

In each of these categories, there is a need for coordination between private and public sectors to expand understanding and to assure their deployment. In some instances, there may also be a need for technical assistance from either the public or the private sector

The academic community may be able to play an important role, as well. Academic institutions are not only employers, but are also able to undertake a role in research and training. Coordination with academic institutions may include employment of student interns and participation in cooperative education programs, the provision of data for research and educational efforts, and student tours of the TOC. Bringing the academic community into the ITS programs can significantly broaden the approach to both the technical and institutional arrangements that are essential to the success of the program

Coordination with area colleges and universities can be pursued Possible activities include:

- Provision of data and video feed to regional colleges for research and educational activities.
- Research in transportation technology.
- Training in transportation fields, using teaching expertise at the colleges.
- Receiving information about transportation for use by their students.
- Developing kiosks to display information (for example, at University of Missouri, Kansas City, and University of Kansas Medical Center).

The potential for public/private coordination has been realized to some extent by MHTD through the installation of fiber optics cable on all interstates and selected freeways A similar arrangement is being pursued by KDOT. In addition to these activities, opportunities exist for coordination with private entities for the provision of current traffic information These activities may include the following.

KDOT and MHTD, working with other agencies, can develop and market the information that can be provided externally as a result of deployment of various ITS components. One of the principal methods of information delivery that has been suggested is the use of on-line technology. This technology can include a home page, with instructions on how to access the information. It can be free of charge or it can include methods of subscription which require payment in return for a password for access to the information. Another method of delivery of transportation information to a distribution source such as Cablevision. Both of these methods make use of existing communication network technology for distribution of transportation information. These alternatives and others should be explored in greater detail.

Tests of information dissemination might be pursued with employer human resource departments, who have an interest in safe and timely travel by employees. CCTV cameras on the freeway would be transmitted to employment centers and would allow people see the traffic conditions on the highways prior to beginning their trips. They could then make decisions about travel path or time of travel based on the information provided. Information might be transmitted to a commuter at home via teletext, telephone, television, or Internet, or to individual desk PCs for display at work. Another possibility is distribution of information via personal pagers.

The kiosk is another technology for distribution of information that is now being explored in several metropolitan areas. KDOT and MHTD may want to know more about its potential for the distribution of information to employment and recreation locations in the future

Coordination with local trucking agencies, as well as local cab and shuttle services may also be initiated. These entities might be sources of information and also consumers of current traffic information.

A Case Study, The Provision of Traveler Information through a Private Entity - Although many cities, such as San Antonio, Texas, and Seattle, Washington, have developed freeway management systems and traveler information systems solely through public agencies, the use of private agencies for the provision of these services has also become a viable alternative.

While there are a number of ways for a public agency to coordinate with a private entity for the provision of traveler information and other ITS components, one possible concept is easily demonstrated through examination of systems deployed elsewhere. One example, in a city similar in size and character to Kansas City, is the system recently deployed in Cincinnati, Ohio.

The greater Cincinnati area is currently served by *SmarTraveler*, an advanced traveler information system (ATIS) operated by SmartRoute Systems[1]. This system, which went on-line in June 1995, provides current transportation information via telephone for the metropolitan Cincinnati area within the I-275 loop, which encompasses urbanized areas in both Ohio and northern Kentucky. The information provided includes current, route specific information on traffic volumes, travel times, and alternate routes, if necessary. Schedule information on transit and airport shuttles, as well as carpools, is also available. Calls for traveler information are free local calls; cellular calls through selected cellular providers are also free of charge. After dialing the seven digit phone number or three digit cellular number, an audio menu is provided, this allows specific information to be selected on any of 16 travel routes in the area.

Current reports about traffic conditions are provided from 6 a.m. to 7 p.m., Monday through Friday. Information regarding special events and construction activities is available 24 hours a day. The information provided is based a variety of sources, including 15 remote-controlled CCTV cameras, two aircraft, a network of "mobile probes" (drivers who report traffic conditions by cellular phone or two-way radio), direct contact with transit agencies and shuttle services, radio contact with law enforcement and emergency responders, and direct communication with key state and local transportation agencies.

Cincinnati's *SmarTraveler* is the first phase of the Cincinnati/Northern Kentucky area's Advanced Regional Traffic Interactive Management & Information System (ARTIMIS). Funding for the system is provided primarily by the FHWA under the ISTEA legislation. Kentucky and Ohio also provide state funds for the service. The ARTIMIS system operates under the authority of the Kentucky Transportation Cabinet (KYTC), the Ohio Department of Transportation (ODOT), and the OKI Regional Council of Governments. When fully operational in 1996, ARTIMIS will include detectors, VMSs, area-wide HAR coverage, and freeway service patrols in addition to the *SmarTraveler* system. The total cost for ARTIMIS is approximately $35 million.

[1] Discussion of this system is based on information provided by SmartRoutes Systems

During the first 18 months of the contract, SmartRoutes built and is operating their own facility to provide ATIS for the Cincinnati area. For the remaining 21 months of the 39 month contract, SmartRoutes will operate the facilities currently being built by the Kentucky and Ohio Departments of Transportation. The public sector commits to purchase services for a specified period of time. SmartRoute Systems is also responsible for staffing and operating the center. A center such as the one in Cincinnati can be in operation within six months of the decision to implement. In some cases, negotiated agreements for profit sharing with public agencies of profits from sales of the database to private entities, such as cellular phone companies and paging companies.

The sale of information to private entities does raise the issue of equity. The philosophy generally espoused is that as long as the public has free access to the information (in this case via telephone), information can justifiably be sold to private entities.

Deployment of traffic information through a private entity should be considered in Kansas City, particularly in the short term. The fast implementation time, coupled with the fact that this system would relieve KDOT and MHTD of staffing and operation duties (at least in the short term), makes the option quite attractive. This arrangement would also allow the information to be provided prior to the construction of MHTD's new District 4 facility. One disadvantage is that equipment may not belong to KDOT or MHTD at the end of the contract, and thus expenditures do not contribute to the ITS infrastructure in the metropolitan area.

PROCUREMENT METHODS

Procurement Methods - An important element in the deployment of the Kansas City freeway management system is the method to be used for procurement. Several procurement techniques have been used throughout the country on related projects. These are outlined below:

Sole Source: the basis for a sole source procurement is the documented existence of only one technical or cost-effective solution to the requirements of a particular project. The most common basis for sole-source procurements is the requirement for compatibility with existing equipment, so that system-wide interoperability can be maintained. For initial systemwide procurement, compatibility with existing equipment is not a factor, and sole-source procurement is not advisable or practical.

For later project phases, sole-source procurement will probably be necessary to maintain equipment compatibility for specific devices, such as CCTV camera controllers. Operating and maintenance problems caused by incompatible equipment are design and procurement issues for the initial system. Conversion or replacement of non-interoperable devices before the end of their useful life is an expensive penalty to be paid for lack of foresight. Some of these issues related to compatibility will presumably be resolved by specification of national architecture standards.

Engineering/Contractor: This procurement method is the one typically used for highway projects. It is based on the concept that all critical system parameters can be fully specified and documented in a single set of contract documents (the Plans, Specifications, and

Estimates - PS & E package), that a single contractor is best suited to implement the project, and that the only criteria of significance for selecting the contractor is the initial bid price. The extensive experience with this process for highway construction has resulted in a very standardized set of procedures and rules within most highway agencies, severely restricting the flexibility of system designers and implementers

Two-Step Approach: This method modifies the engineer/contractor technique by separating the technical evaluation step from the financial step. This approach provides an opportunity to reject proposals that do not meet the technical criteria for the project This minimizes the risk of selecting a contractor whose bid is low, but who is not technically capable of performing the work. It also insures that the technical merits of each proposal are fully considered prior to award of a contract, instead of during the "material submittal" stage of a traditional highway construction contract.

Design/Build: In this approach, a single entity is selected to handle all the work associated with implementing the system. The design/builder is responsible for detail system design, procurement of all equipment, construction of all system elements, integration of the various sub-systems, and final system turn-on and operation. The fully functional system is then turned over to the operating agency. A design/build concept simplifies the number of contracts and the steps associated with taking a system from concept to operations. This can be beneficial if the designer/builder fully understands the project concept, and has the experience to successfully handle the full scope. Often the design/builder can use streamlined equipment purchase procedures, thereby speeding up the project schedule.

However, this approach limits the agency's role to that of limited oversight and monitoring of the activities of the design/builder. This can be beneficial since the agency personnel with direct operational experience and needs are typically not involved with the detailed design and thus cannot provide input and feedback during design and deployment.

System Manager/System Integrator: This procurement method divides the project into several sub-projects for each of the various sub-systems. The work is overseen by a system manager who administers each contract and is responsible for integrating the several sub-systems into an overall, operating system. The most effective structure for this approach is to use a design team consisting of agency and system manager personnel. The system manager converts the project plan into preliminary designs and defines sub-systems, develops PS&E packages for sub-systems, oversees bidding and award, supervises construction, selects and procures computer and communications hardware components, develops system software, integrates and tests sub-systems, and supervises operator training.

By assigning responsibility for total system success to the system manager, a single source of accountability and responsibility is defined. The involvement of agency personnel as part of the design team results in improved coordination and tighter cost controls. The agreement between the agency and the system manager is a negotiated contract, which can be easily adapted as project needs are refined. This provides increased flexibility to meet the specific project requirements, when compared to the typical fixed price turnkey or design/build contracts.

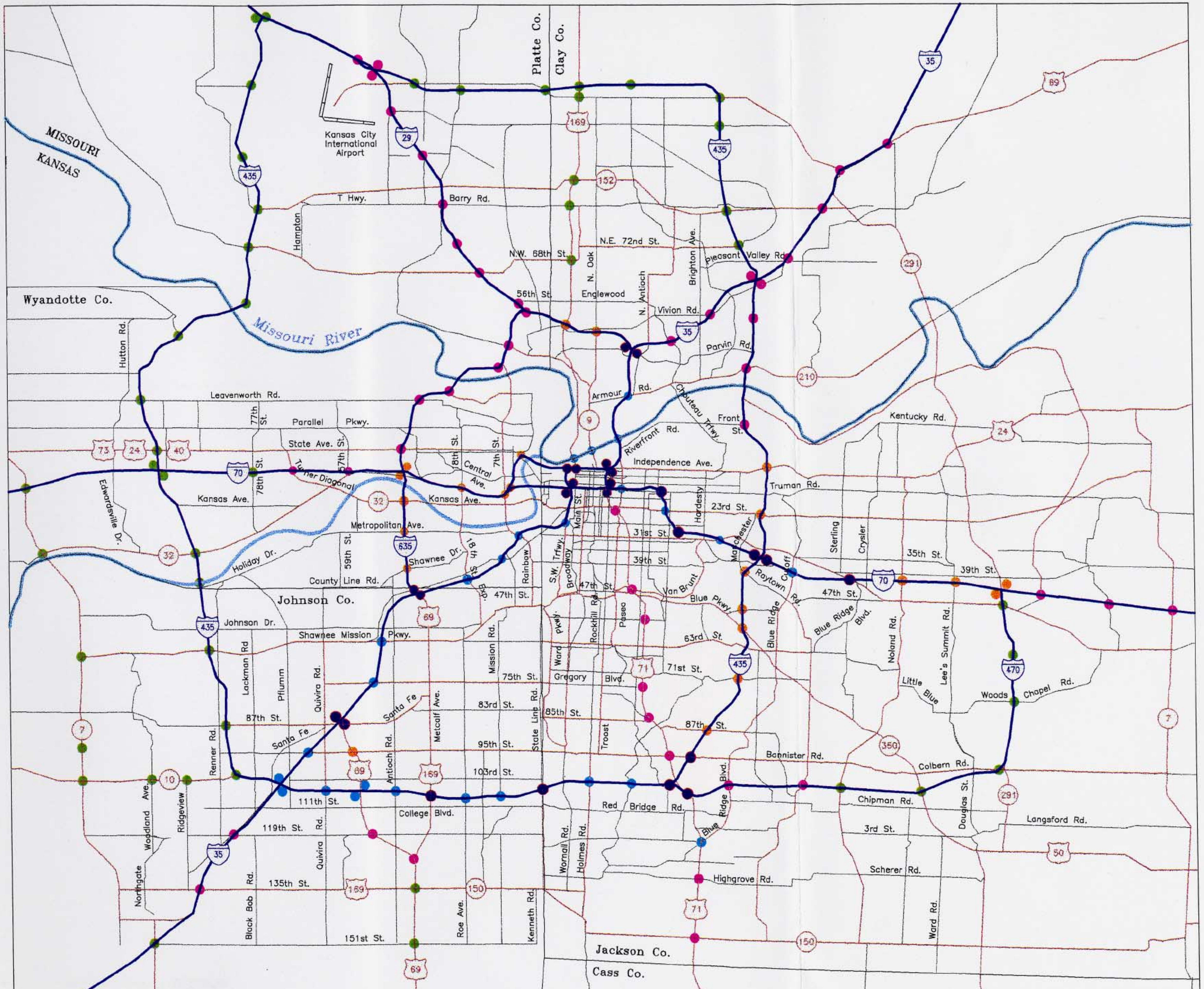
Conclusions

This document has outlined a plan for the strategic deployment of an ITS system in the Kansas City metropolitan area In the short term, this plan calls for the deployment of a freeway management system on priority corridors to facilitate incident management and address incident related congestion. In the future, the freeway management system will expand to encompass additional facilities and to coordinate with ITS activities undertaken by transit, local public works, and enforcement agencies.

While this plan identifies priorities for deployment and makes recommendations for activities in the short, medium, and long term, it is important to note the limitations associated with these recommendations. Any plan, such as this one, that incorporates "advanced technologies" as a component must change to reflect and utilize new technologies and applications The plan must also change to reflect changing circumstances in the metropolitan area. Thus, the recommendations set forth in this document should be considered guidelines, rather than constraints. Recommendations should be re-evaluated in light of future needs, future technologies, and future circumstances.

Regardless of the specific technologies used, or the user services implemented, the overriding focus of the ITS system must be to safely and efficiently meet the transportation needs of the Kansas City metropolitan area and other roadway users.

ITS Early Deployment Study
Strategic Deployment Plan

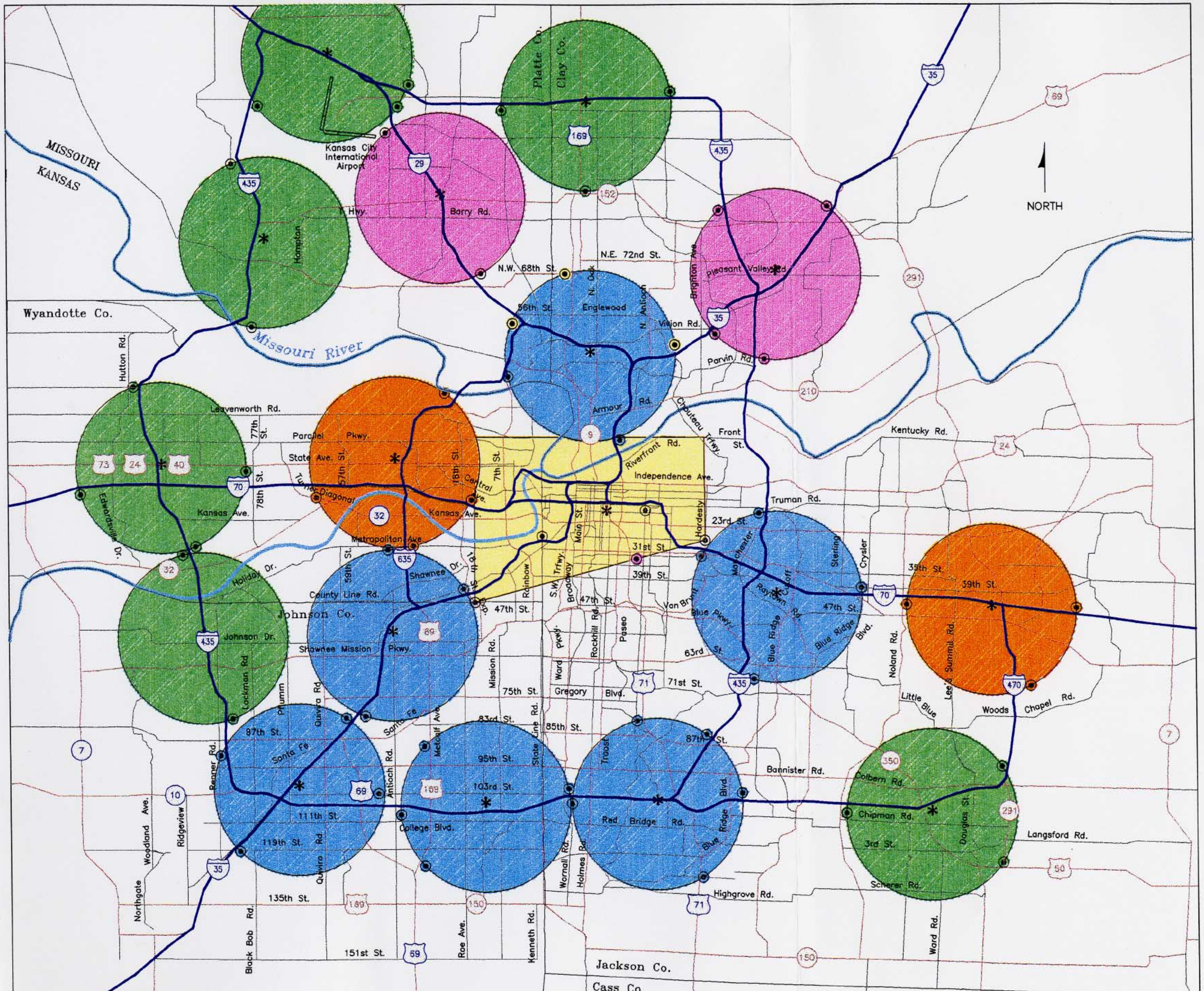


Legend

- Phase 1 - Highest Priority
- Other Phase 1
- Phase 2
- Phase 3
- Phase 4

FIGURE 7-1
Priority CCTV Camera Locations in Kansas City Area

ITS Early Deployment Study
Strategic Deployment Plan

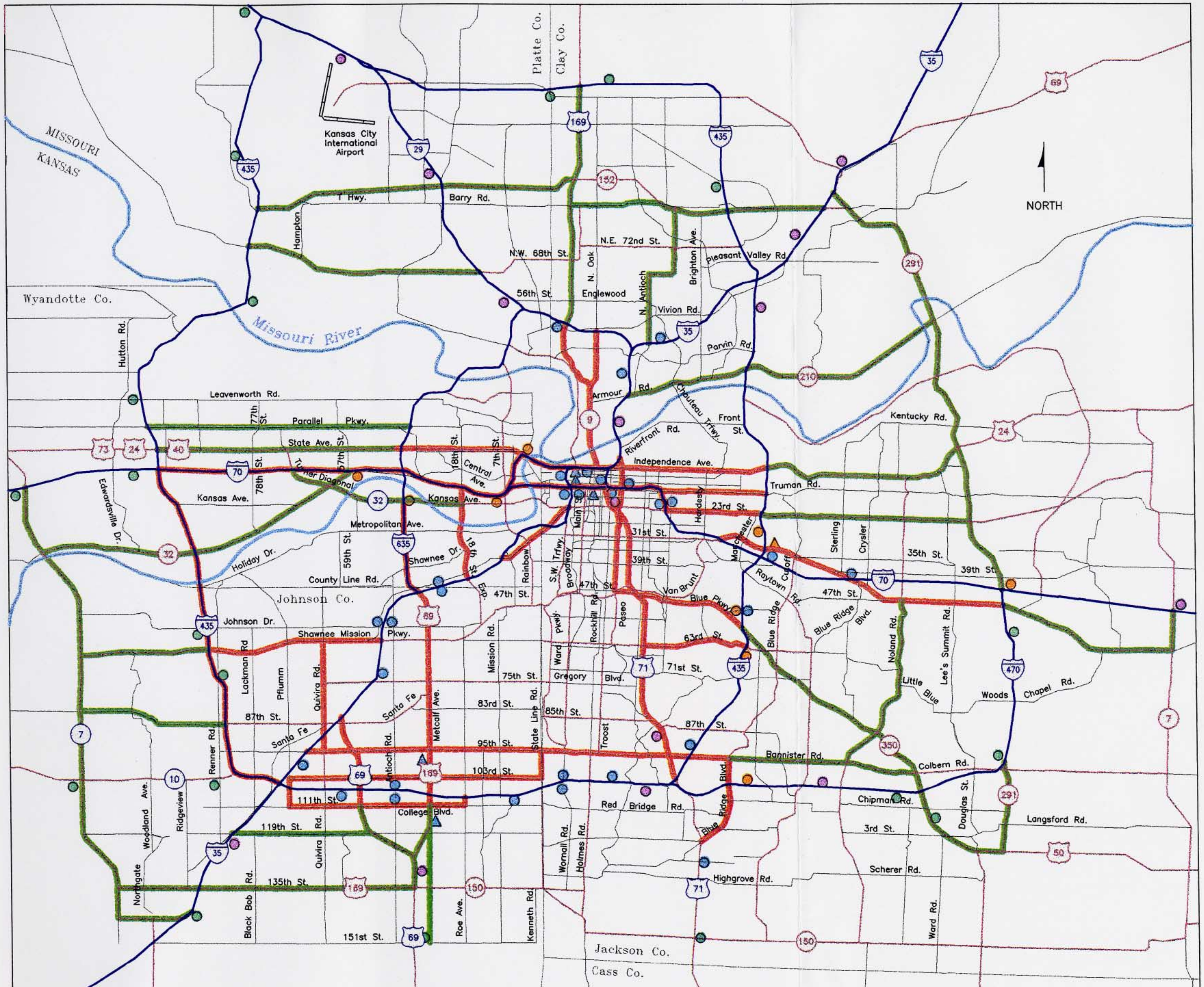


Legend

- Existing HAR Transmitter
- Existing HAR Sign
- Phase 1 HAR Transmitter
- Phase 1 HAR Sign
- Phase 2 HAR Transmitter
- Phase 2 HAR Sign
- Phase 3 HAR Transmitter
- Phase 3 HAR Sign
- Phase 4 HAR Transmitter
- Phase 4 HAR Sign

FIGURE 7-2
Idealized Highway Advisory Radio (HAR) Coverage

ITS Early Deployment Study
Strategic Deployment Plan



LEGEND

Variable Message Sign Locations

- Phase 1 Freeway
- Phase 1 Arterial
- Phase 2 Freeway
- Phase 2 Arterial
- Phase 3 Freeway
- Phase 4 Freeway

Possible Freeway Diversion Routes

- Phase 1 and 2
- Phase 3 and 4

FIGURE 7-3
Variable Message Sign Locations and Possible Diversion Routes

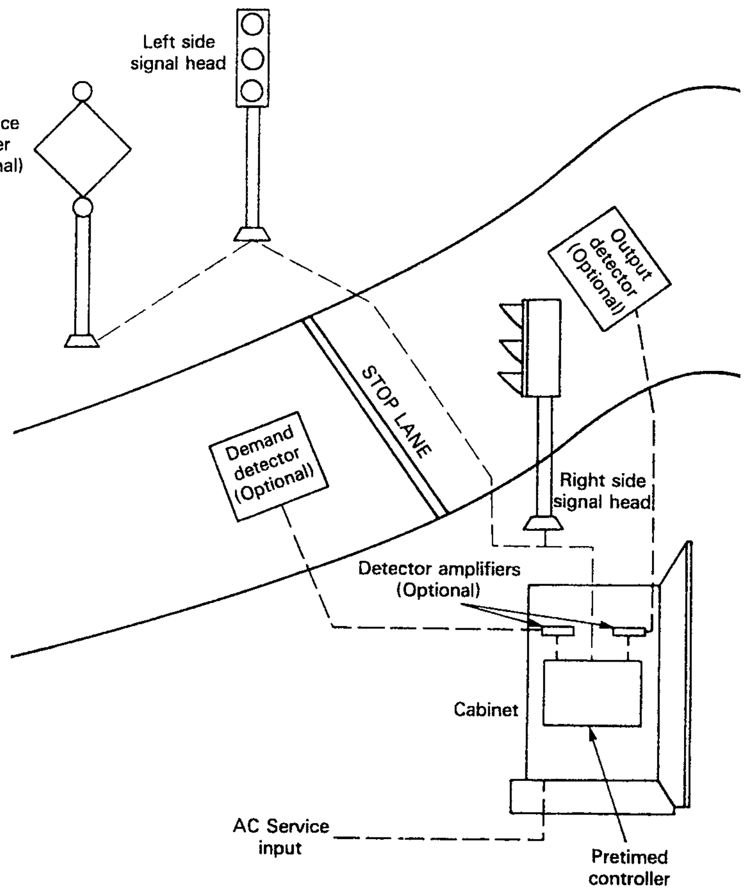
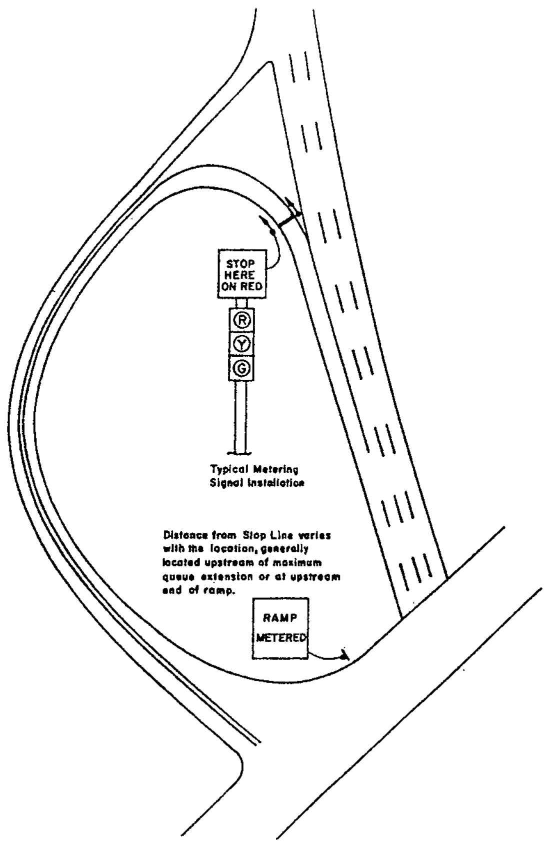


Figure 7-4. Principal Components of a Pretimed Ramp Control[1]

[1] Source C.W Blumentritt, C Pinnell and W.R McCasland, "Guidelines for Selection of Ramp Control Systems," NCHRP Report 232, Transportation Research Board, May 1981.

Typical Single Lane Ramp Metering Configuration



Typical Dual Lane Ramp Metering Configuration

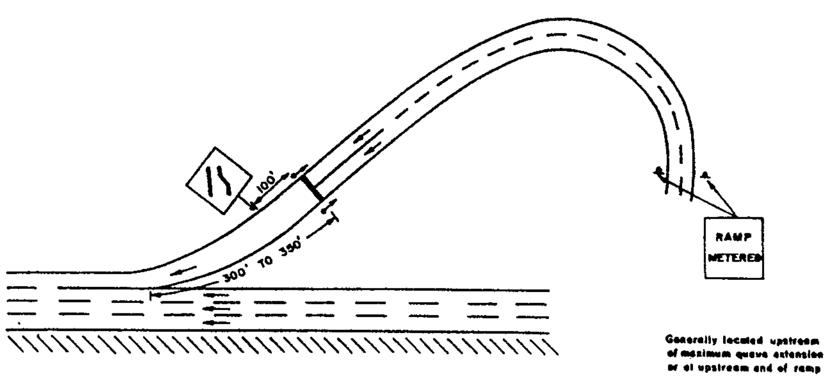
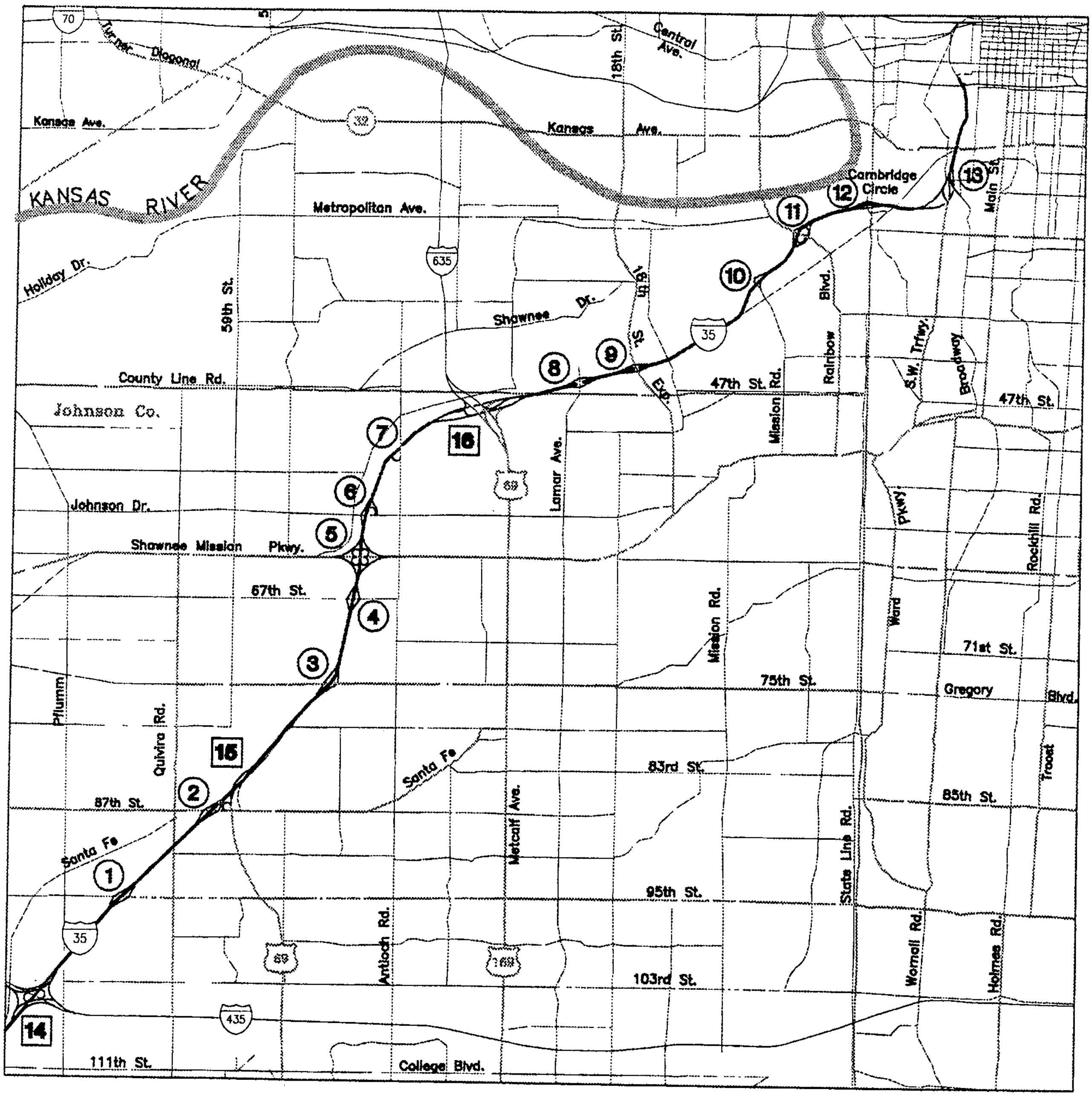


Figure 7-5. Typical Single and Dual Lane Ramp Metering Placement[1]

[1] Source. Phase 1 Report, I-395 Traffic Management System, Preliminary Functional Design and Operations Plan



Potential Ramp Meter Locations

(4) Arterial to Freeway

[14] Freeway to Freeway

Figure 7-6. Potential Ramp Meter Locations in I-35 Corridor