

Research Report
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**EVALUATION OF
CONDITION-RESPONSIVE WORK ZONE TRAFFIC CONTROLS
AT THE I-75 CLAYS FERRY BRIDGE**

by

Jerry G. Pigman
Research Engineer

Kenneth R. Agent
Research Engineer

and

Joel M. Weber
Research Engineer

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, Kentucky

in cooperation with

Kentucky Transportation Cabinet
Commonwealth of Kentucky

and

Federal Highway Administration
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EXECUTIVE SUMMARY

The objective of this study was to document the effectiveness of the application of advanced technologies for the real-time control and management of traffic in the work zone at the I 75 Clays Ferry Bridge reconstruction project. A description is given for each of the condition-responsive traffic control devices used on the project. A summary of the usage of each system is given along with a rating of its performance and effectiveness. The evaluation includes an analysis of accident data in the vicinity of the Clays Ferry Bridge for the period of January 1990 through June 1997. The possibility of future use of the various technologies was discussed.

Use of a video camera system was found to be an effective method to monitor activities at the construction site. Several improvements to the standard method of using a variable message sign were found to make them more effective and responsive to existing conditions. Included were the following: 1) placing a message on the sign only when warranted by a specific incident, 2) controlling the signs remotely and typically using pre-programmed messages, and 3) using multiple signs with the first sign placed several miles prior to the work activity. Motorists use of highway advisory radio (HAR) was very limited, and the AM stations generally had a poor reception quality. The future use of HAR at construction sites was determined to have limited applications unless improvements could be made in reception and usage. It was determined that inadequate maintenance of the HAR systems may have contributed to the reduced quality of the signal and resulting usage. Use of a video-based vehicle detection system to provide alarms was not successful although its failure may be related to the type of equipment used. While the use of a weather detection system has the ability to provide specific weather and pavement data, it was a problem to properly operate and maintain at an active work site.

There was an increase in the annual total number of traffic accidents during construction compared to before construction but the annual number of injury and fatal accidents did not change. A substantial part of the increase in total accidents was the result of the large increase in rear end collisions.

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James Ballinger, Resident Engineer, KY Department of Highways
Charles Bowman, KY State Police, Richmond Post
Ron Herrington, Lexington-Fayette County, Traffic Engineering Division
Glenn Jilek, Federal Highway Administration, KY Division
Larry McMurray, KY Department of Highways, District 7 Traffic
Wayne Mosley, KY Department of Highways, District 7 Construction
John Patterson, Lexington-Fayette County, Fire Division
Charles Schaub, KY Department of Highways, Multimodal Programs
David Smith, KY Department of Highways, State Highway Engineer's Office
Bill Thompson, Lexington-Fayette County, Police Division
David Leddy, Lexington-Fayette County, Police Division

1.0 INTRODUCTION

1.1 Background

Construction and maintenance work zones have always presented potentially hazardous locations within the highway environment. Studies have shown that accident rates increase in many instances when work zones are established. Among the factors cited as causes for the increase in accident rates are: 1) inappropriate use of traffic control devices, 2) poor traffic management, 3) inadequate or improper warning and directions, and 4) lack of real-time motorist information and warning. Traffic control in work zones is usually provided by signs, markings, and delineation installed when the project begins and traffic control is left in place until the project is completed. Functions of traffic control devices are to alert drivers of impending conditions, provide warning of hazards, and direct drivers through the work zone.

Traffic control in the work zone has not traditionally been adjusted when conditions in the work zone change as a result of a specific incident or activity. This static nature of the work zone traffic control would be adequate if the work zone was a stable environment; however, work zones are dynamic and requirements fluctuate based on conditions such as time of day, specific type of work in progress, incidents, accidents, and weather. Advanced detection and communication systems are available which enable real-time response to the changing conditions in a work zone. Opportunities exist for enhanced management of traffic by the application of condition-responsive, traffic control technology.

1.2 Project Description

The project involved the Interstate 75 (I-75) Clays Ferry Bridge over the Kentucky River at milepoint 98. Two-lane spans in the northbound and southbound directions were replaced with one six-lane span. The bridge was within an almost 40-mile section of interstate where two lanes were being added to the current four lanes. The I-75 northbound bridge over the Kentucky River at Clays Ferry was built in 1946 as a two-lane bridge to carry US 25 traffic. The southbound bridge was built in 1963 as part of the interstate highway system. The current Clays Ferry construction project consisted of reconstructing the existing bridges and building a third bridge between them. The three bridges were then connected to form one unified bridge. The new bridge spans 1,736 feet at a height of 245 feet above the river. The reconstructed bridge carries six lanes of traffic with 14-foot exterior shoulders and 10-foot interior shoulders. Work began on the project in December 1993, with a scheduled completion date in July 1998. The cost of the project was approximately \$32,000,000.

In addition to the standard traffic control methods, several technologies were used to manage traffic in the work zone at the Clays Ferry Bridge project. Video cameras and a vehicle detection system were installed to monitor traffic, while variable message signs (VMS) and highway advisory radio (HAR) were used to provide real-time information to motorists. A weather detection system was installed to provide warning of hazardous events such as fog and snow. Information was also

provided to motorists over the existing Traffic Information Network (TIN) maintained by the Lexington Fayette Urban County Government (LFUCG), Division of Traffic Engineering.

1.3 Objective and Methodology

The objective of this study was to document the effectiveness of the application of advanced technologies for the real-time control and management of traffic in the work zone at the I-75 Clays Ferry Bridge reconstruction project. A description is given for each of the condition-responsive traffic control devices used on the project. A summary of the usage of each system is given along with a rating of its performance and effectiveness. The evaluation includes an analysis of accident data in the vicinity of the Clays Ferry Bridge for the period of January 1990 through June 1997. The possibility of future use of the various technologies was discussed.

2.0 WORK ZONE TRAFFIC CONTROL COMPONENTS

Traffic control at the Clays Ferry bridge project was accomplished through a combination of conventional traffic control devices and applications of new technologies. Conventional traffic control included standard advance warning signs, construction barriers, cones, restriping, and standard variable message signs (VMS). New technologies included traffic monitoring with video cameras and detection equipment as well as remote communication for real-time control of each VMS and integration of VMSs with highway advisory radio (HAR). The total cost the new technologies was slightly less than \$500,000 or about 1.5 percent of the total project cost. The existing Traffic Information Network (TIN) was also utilized. The various components were implemented for the purpose of enhancing traffic flow during the construction project and with the potential for permanent mitigation, after completion of the construction project, of traffic hazards such as snow, ice, fog, delay, incidents, and accidents.

2.1 Video Camera System

Two video surveillance cameras were placed near the construction site. One camera was placed on the Fayette County side of the bridge with the other on the Madison County side. The cameras were positioned to provide a view of the bridge and both approaches. The cameras provided the ability to observe traffic for approximately one mile on either side of the bridge. The cameras systems had pan, tilt and zoom capabilities. However, due to cost restraints, the camera on the Madison County side operated from a fixed position. The camera on the Fayette County side was equipped with the pan, tilt, and zoom capability. The cost of the video camera system was approximately \$20,000.

The video signals were converted to data and transmitted via telephone lines to the Lexington Fayette Urban County Government (LFUCG) Traffic Management Center which is located in downtown Lexington about 14 miles from the bridge. The Center then converted the data to video and sent it through the Telecable hub, across "C" cable, to the LFUCG Divisions of Police and Fire,

and the Department of Highways' District Office. Both the police and District Office have color monitors linked to the system to allow them to view I-75 in the Clays Ferry area. Control of the pan, tilt and zoom capabilities for the camera was provided at these offices. A schematic of the video camera detection and communication process is presented in Figure 1.

2.2 Variable Message Signs

Variable message signs were used in a portable application for the Clays Ferry Bridge project. Three VMS were used for each direction of travel on I-75 to the construction site. The bridge is located near milepoint 98. The VMS locations on the southbound approach were at milepoints 100.4, 104.6, and 110.3. On the northbound approach, the VMS locations were located at milepoints 89.0, 93.4 and 96.3. The signs were located approximately one quarter mile before interchange ramps to ensure an adequate warning distance was provided to the driver prior to the recommended action displayed on the VMS. The first sign was about nine to 12 miles from the bridge. Each sign was also positioned to provide adequate sight distance for a driver to read the message on the sign.

The signs were operated remotely using a personal computer and modem, in conjunction with cellular phone technology. They provided motorists with up-to-date information on roadway conditions with messages submitted by the resident engineer or other representatives of the Department of Highways. The decision was made that the signs would only be activated when warranted by conditions in the work zone. In previous work zone applications, there would be some type of message on the signs at all times with the message changed when appropriate. The logic was that motorists would be more responsive if the sign was used only when there was a specific need. If there was always a message on the sign, the local motorists would become accustomed to seeing a message and would not be as likely to read the message.

Prior to the start of the project, lists of specific messages were developed for use on each of the three signs in each direction. The text of each message was in response to various situations which were anticipated that could occur during construction. Each VMS had three lines with eight characters per line. Messages were developed for the following situations: 1) an accident, 2) blasting, 3) a lane closure, 4) trucks entering or exiting the roadway, 5) a road blockage, 6) fog, 7) ice on the bridge, and 8) congestion. The length of each message was kept to a minimum so that a driver would have time to read the complete text of the message. Each sign had two messages provided in sequence with about three seconds provided for each message. In many cases, the first sign advised the motorists to tune to the highway advisory radio. An example would be the messages for an accident in which the first sign had the messages "Turn to Radio AM 1610 (or 530)" and "Accident Ahead" with the second and third signs having the messages "Accident Ahead" and "Be Prepared to Stop." Presented in Appendix A is a listing of the pre-programmed message options available for the project.

Each VMS cost \$40,000 resulting in a total cost of \$240,000 for the six signs. The sign specifications noted that the signs would provide three-line messages with each line 15 inches in height. The signs were capable of providing at least 40 pre-programmed messages. The signs were

a hybrid of bulb and disc-type sign. The sign, generator, controls, and all auxiliary equipment were mounted on a trailer so the signs could be moved if necessary.

2.3 Highway Advisory Radio

Highway advisory radio (HAR) was another technology used to provide drivers advance information concerning road conditions and construction activities. HAR is a low-power, short-range radio broadcast system designed and installed in this application to inform motorists of conditions existing or anticipated on an upcoming section of highway. The HAR used on the Clays Ferry project broadcast messages on AM frequencies 530 and 1610, with the VMSs used to alert drivers to tune to the proper frequency.

Two systems were installed in conjunction with the project. One unit was installed at the Kentucky Department of Highways' Madison County maintenance building (near milepoint 91.6) with the other site in Fayette County at the I-64/I-75 interchange (near milepoint 110.5). The amount of information that could be broadcast was limited by the frequency coverage zone. The messages could be recorded and changed remotely. This was accomplished by telephone linkage to the recording and transmitting equipment.

The HAR used was the Travelers Information Station manufactured by Information Station Specialists (ISS). This is a 10 watt station with a signal range minimum of 2.5 miles. A rooftop style was used at the Madison County maintenance facility while the unit near the I-64/I-75 interchange was pole mounted. The three primary components of the station are an AM transmitter with integral audio processor and power supply, AM broadcast antenna, and digital voice recorder with battery backup and microphone. Lightning and power surge arrestors were provided. The station had a pre-built wire groundplane which had a 10-foot radius. An unlimited number of messages could be recorded and played in a message sequencing format. The total storage time for the prerecorded messages was limited to 24 minutes. The total cost for the two stations was approximately \$20,000.

Prior to the start of the project, lists of messages were developed to use for specific anticipated situations. Pre-recorded messages were made to deal with accidents, blasting, lane closures, trucks entering or exiting, blocking of the interstate requiring a detour, fog, ice, and congestion. Each message had the same following general format:

- Attention Statement - general information about the construction project which was the same for all messages
- Problem Statement - description of problem
- Location Statement - where appropriate
- Effect Statement - result of problem
- Action Statement - recommended action for driver
- Endorsement - note that announcement presented by KyTC and LFUCG and identify call letters

Following is an example of the message for a traffic accident.

- Attention Statement - You are approaching a major bridge reconstruction project. The project involves the Interstate 75 Clays Ferry Bridge over the Kentucky River at milepoint 98. The two existing two-lane spans are being replaced with one six-lane span. The bridge is within an almost 40-mile section of interstate where two lanes will be added to the current four lanes.
- Problem Statement - A traffic accident has been reported in the (northbound/southbound) lanes. One message was recorded for each direction.
- Location Statement - The location is near milepoint x. Messages were recorded for milepoints 90 through 114.
- Effect Statement - The accident may result in significant delays.
- Action Statement - Traffic speeds may slow significantly so be prepared to stop.

All the prerecorded messages were assigned a number. To use these messages, reference was made to a series of appropriate numbers. When needed, new messages could be recorded and immediately played. Presented in Appendix B is a listing of the pre-recorded messages prepared for use with the HAR.

The HAR was only used when a situation occurred which warranted use of the VMSs. The motorists were informed to tune to the appropriate frequency on the first of the series of VMSs.

2.4 Vehicle Detection System

A video detection system operated by the LFUCG traffic control center was used to analyze the video data to determine when possible incidents occurred. Queues on or in advance of the bridge could be detected by the software package which detected lack of motion. When an incident was detected, this information could then be sent to emergency personnel and state transportation officials. The system also had the potential to count and classify vehicles.

The system used was the Mobilizer Wide Area Traffic Measurement System manufactured by Condition Monitoring Systems. The three major components of the Mobilizer system are; the Smart Sensor Interface which extracts vehicle data from the video and transmits it to the traffic management center, the Mobilizer Advanced Tracking System which reduced interface data into traffic flow information, and the Roadside Equipment Interface which transforms interface data output into a format used by for local signal control. These three components integrate with video cameras, communications subsystems, and traffic management center hardware and software to form a complete Advanced Traffic Management System measurement and information system. The cost of the Mobilizer system was approximately \$22,000.

2.5 Weather Detection System

The weather sensors at the Clays Ferry Bridge are part of a statewide Roadway Weather Information System (RWIS). The system used the SCAN roadway sensor manufactured by Surface Systems, Inc. (SSI). A weather tower constructed near the north end of the bridge contains a Remote Processing Unit (RPU) and several atmospheric sensors. The atmospheric sensors detect temperature, humidity, wind, and precipitation. There is a separate visibility sensor to detect dense fog. Two temporary pavement sensors were initially installed in the northbound lanes. The pavement sensors detect the presence of snow or moisture on the pavement, pavement temperature, and chemical concentration. The temporary sensors were replaced by four permanent pavement sensors.

Data from the sensors are collected by the RPU and transmitted via modem to a Central Processing Unit (CPU) located at the offices of the Kentucky Department of Highways in Frankfort. The data can be accessed remotely by the LFUCG Traffic Management Center and the Department of Highways District Office. The system was added to the bridge project contract at a cost of \$176,770. The cost was higher than normal apparently due to the process of adding the weather system to a major bridge reconstruction project. A more typical cost for a similar system at other locations, where there are limited complications, has been found to be approximately \$80,000.

3.0 PROJECT PHASING

The bridge construction project involved four phases. A description of each phase and the dates of significant events are given below. In addition to project phasing, there were additional activities associated with initiating and managing the project which were documented in a chronology and presented in Appendix C.

Phase I

Phase I consisted of constructing a third bridge span, between the two existing bridges, and building the southbound detour in the median. Work started in December 1993. However, much of the work at the beginning of the project was conducted below the existing bridges and had minimal effect on I-75 traffic. The variable message signs were installed in April 1994. The video camera system and the highway advisory radio were operational by June 1994. The vehicle detection (Mobilizer) system was installed in July 1994. Traffic was maintained on the existing pavement during this phase.

Phase II

Phase II included the reconstruction of the southbound bridge deck while southbound traffic was maintained on the median detour. This phase also included shifting the southbound traffic back to the reconstructed southbound bridge and building a northbound detour in the median. Southbound

traffic was switched to the middle bridge span in October 1995. The road weather information system was installed in June 1996 but was not operational at that time. The southbound traffic was switched onto the newly reconstructed southbound bridge, and the northbound traffic was routed onto the middle span, in August 1996. Presented in Figure 2 is a photographic view of the bridge during Phase II when traffic was diverted to the middle span and the southbound span was under construction.

Phase III

Phase III consisted of reconstructing the northbound bridge while northbound traffic was maintained on the detour. The traffic was then shifted back to the reconstructed northbound bridge. The RWIS became operational in January 1997. The northbound traffic was switched onto the newly reconstructed northbound bridge in August 1997.

Phase IV

Phase IV involved connecting the three bridges and constructing the permanent median barrier wall. It also included the removal of the detour pavement and the widening and overlay of existing pavement and shoulders of the approaches. Permanent pavement sensors for the RWIS were installed in February 1998. Anticipated completion for the entire bridge reconstruction project is July 1998.

4.0 EVALUATION RESULTS

4.1 Accident Data

Accident data at the bridge site and for a three mile distance on either side of the bridge were obtained from two sources. One source was the central file maintained on computer, which contains all reported accidents in the state, while the second source was the accident records maintained by the resident engineer for the project. The location of each accident was determined from the milepoint identified on the police report. The Clays Ferry bridge connects Fayette and Madison Counties. The milepoint on I-75 for the county line is 97.5. Accidents were placed into one-mile sections for three miles north and south of the bridge. Collisions occurring on the bridge were placed in the section from the bridge to one mile south (in Madison County). Various information related to each accident, such as severity, type, road surface condition, weather condition, and direction of travel, were obtained.

As noted in the project phasing description, the experimental traffic control components, except the RWIS, were installed at various times in 1994. Work which resulted in shifting of the traffic started in 1995. Therefore, 1994 was used as a transition year with the data for the four-year period of 1990 through 1993 used as the before period and compared to the 2.5-year period of 1995 through June 1997 as the construction period.

Total accidents occurring in the one-mile sections are summarized in Table 1 with injury and fatal accidents given in Table 2. Following is a summary of the number of accidents per year in the before and construction periods; combining northbound and southbound accidents. The location shown in the following summary is the distance from the bridge.

<u>Location</u>	<u>Total Accidents per Year</u>		<u>Injury/Fatal Accidents per Year</u>	
	<u>Before Period</u>	<u>Construction Period</u>	<u>Before Period</u>	<u>Construction Period</u>
0-1 Mile	27.8	32.8	8.0	7.7
1-2 Miles	15.8	22.0	6.5	7.2
2-3 Miles	16.0	22.8	7.8	6.0
All	59.5	77.6	22.2	22.4

Considering the annual number of all accidents, there was a 30 percent increase during construction compared to before construction. The increase was almost 20 percent in the one mile sections either side of the bridge with the increase about 40 percent for the sections one to three miles from the bridge. However, the annual numbers of injury and fatal accidents were almost identical before and during the construction. There were three fatal accidents in the before period compared to one during construction.

There was a major difference in the increase in the annual number of accidents by direction of travel. The increase was about 50 percent northbound while only 10 percent southbound. Almost all of the increase in the northbound accidents occurred in the sections south of the bridge (including the bridge). About one half of the increase occurred in the one-mile section including the bridge.

Part of the increase in accidents during construction related to an increase in snow and ice related accidents. The annual number of this type of accident increased from 6.0 before to 10.0 during construction. The increase resulted from 21 snow and ice accidents in 1996 with seven occurring on one day and six on another day. The annual number in the one-mile section including the bridge was almost identical before and during construction (3.5 before and 3.6 during). The percentage of snow and ice related accidents increased from 10 percent before to 13 percent during construction. This compares to a statewide average of 13 percent on all rural interstates. The percentage in the one-mile section including the bridge was 18 percent before and 15 percent during construction.

There was also an increase in the annual number of wet pavement accidents from 9.5 before to 12.0 during construction. The number of wet pavement accidents on the one-mile section including the bridge increased from 2.5 before to 4.8 during construction. The percentage of accidents occurring on a wet pavement was almost identical with 16 percent before and 15 percent during construction. This compares to a statewide average of 15 percent on wet pavement on rural

interstates. The percentage on the one-mile section including the bridge was 13 percent before and 19 percent during construction.

There was not a substantial change in the number of accidents occurring during darkness. The annual number changed from 20 before to 22 during construction. The percentage was 34 before compared 28 percent during construction. This compares to a statewide average of 39 percent during darkness on rural interstates. The percentage on the one-mile section including the bridge was 33 percent before and 23 percent during construction.

The type of collision was investigated. The four general types of collisions which constituted the majority of the accidents were rear end, sideswipe, fixed object, and single vehicle. The increase in the annual number of accidents during construction was primarily the result in the large increase in rear end collisions (64 percent increase). There was also an increase in sideswipe collisions (18 percent) while there was only a minor change in fixed object (6 percent decrease) and single vehicle (7 percent increase) accidents. When only injury/fatal accidents were summarized, the number of rear end collisions was almost identical (a 2 percent decrease during construction).

The accidents occurring on the bridge were included in the section from the bridge to one mile south. The annual number of accidents for this section increased by 30 percent during construction. This increase was entirely the result of an increase in the northbound direction. The number of accidents northbound increased by 58 percent while the number southbound decreased by six percent. The increase was primarily the result of a large increase in the number of sideswipe collisions. The largest number of accidents prior to construction involved a fixed object but sideswipe collisions were the most common during construction.

While fog is sometimes present at the Clays Ferry bridge, it was not often listed as the weather condition at the time of an accident. Fog was listed as the weather condition four times in the before period and was not listed during the construction period. There were three additional accidents in which fog was listed during 1994 which was not included in the analysis.

It was not possible to relate the change in the number of accidents to the use of experimental traffic control techniques. Some increase in accidents could be expected during the construction period, and there is no way to predict how many accidents there would have been if only conventional traffic procedures had been used.

4.2 Usage of Traffic Control Components

The extent of the use of the various new technology work zone traffic control components were documented. Records were kept documenting the date, message, and duration of the use of the CMS and HAR. Meetings were held periodically to discuss the status of the various components.

At the end of the project, individuals representing Kentucky Department of Highways and

Lexington Traffic Engineering who were involved in the implementation of the project were surveyed to determine their opinion of the various components. Subjective opinions were obtained using a scale of 1 to 5 with a rating of 5 being excellent and a 1 rating being poor. Surveys were obtained from 12 individuals with some only responding to a portion of the survey. The number of ratings for a specific component varied from four to ten. The survey also contained questions asking if the respondent would recommend using the system in the future. Comments were also requested.

4.2.1 Video Camera System

There are video cameras on both sides of the bridge with feeds to LFUCG (traffic engineering, police, and fire) and the KDOH District Office. LFUCG used the video to monitor I-75 traffic and to provide real-time information over the Traffic Information Network (TIN). KDOH construction personnel used the video to monitor traffic and to decide when to activate the VMS and HAR. KDOH maintenance personnel used the video for snow and ice monitoring.

The video camera system received a performance rating of 4.1 and an effectiveness rating of 4.5. The CMS was the only traffic control component receiving a higher rating. Nine of the ten respondents answering this portion of the survey noted they would recommend using a similar camera monitoring system in the future. The consensus of the survey was that the video camera system provided valuable information concerning activity and the level of congestion at the construction site to a range of users which were then able to use this information to both inform the public and respond to a given situation.

The comment was made that the communication link between the camera and user must be very high quality for the system to be effective. After construction, a new pole was installed adjacent to the bridge overpass north of the bridge to provide a permanent location for the Fayette County camera. The Madison County camera is a fixed camera and will stay at the same location as during construction. The current telephone link has performed well with the controller being the source of any problem. The video was of acceptable quality, but there has been a problem with controlling the camera (pan/tilt) on the Fayette County side. The video is 3 to 10 frames per second (not real time) compared to a real time rate of 30 frames per second.

4.2.2 Variable Message Signs

Three VMSs were placed on each approach. The signs were remotely controlled using mainly pre-planned messages and were activated only when the situation warranted. There was documented use of the signs on 436 occasions. All of the pre-planned messages were used except the ones related to fog. The northbound signs were used more often than the southbound. The first sign in the sequence was used less often than the next two. Following is a summary of the usage of these signs giving the condition existing when the sign was activated, the number of times it was used for the condition, and the average time period the sign was activated.

<u>Condition</u>	<u>Number of Times Used</u>	<u>Average Time (Minutes)</u>
Trucks Entering/Exiting	250	535
Ice on Bridge	5	542
Lane Closure	50	324
Accident	47	117
Blasting	64	83
Congestion	17	117
Road Blocked	3	2,270

The VMSs received the highest rating of any of the traffic control components with a performance rating of 4.7 and an effectiveness rating of 4.8. All ten of those responding indicated they would recommend using this system in the future.

Respondents stated that the procedure of only placing messages on the signs when incidents and activities warranted worked well. It was noted that this was the most frequently used of the experimental active devices. The process of developing standard messages, which could be programmed when appropriate, was beneficial. Construction personnel stated that they thought the signs were used by motorists because they noticed a difference in traffic after the signs were placed into operation. More than one respondent stated that the signs were placed at an appropriate distance from the project and that these types of signs are sometimes placed too close to the project. Providing three signs in each direction allowed the first sign to be placed at a substantial distance from the start of the construction. Placing signs even farther from the construction site was suggested. The capability to remotely change the signs was rated as being a good attribute but was also a high maintenance item. The signs were somewhat susceptible to lightning strikes.

The question of the use of the signs after construction is completed was discussed with KDOH and LFUCG personnel. The ownership of the signs will be returned to the KDOH after the project is completed so an issue is the future use of the signs. A question related to the permanent use of the signs would be the operational requirements such as maintaining the power supply and responding to vandalism. Only one problem with vandalism was reported over the past four years. KDOH currently has no definite plans for the long-term use of these specific signs. They are beginning to use similar signs across the state to warn motorists of incidents and of severe weather and roadway conditions. Consideration should be given to the use of two permanent signs on each side of bridge. The future use of VMSs in Fayette County could be coordinated on the interstate system as a traffic control device.

4.2.3 Highway Advisory Radio

There were 88 documented instances of the use of the HAR during the construction project. About 80 percent of the usage was for the northbound (AM 1610) station rather than the southbound (AM 530) station. This could be related to the stronger signal for the northbound direction, and similar to VMS, an apparent greater need for information dissemination to northbound drivers.

Following is a summary of the documented usage giving the condition and number of times used and length of time in operation for each condition.

<u>Condition</u>	<u>Number of Times Used</u>	<u>Average Time (Minutes)</u>
Trucks Entering/Exiting	51	559
Lane Closure	10	294
Accident	12	120
Blasting	12	49
Road Blocked	3	2,082

There were also pre-programmed messages for ice on bridge, congestion, and fog which were not used.

The HAR received an average performance rating of 2.33 and an effectiveness rating of 1.66. Only one of five responding indicated they would recommend using this system in the future.

Among the problems noted with the HAR was poor reception at the nearest major interchange areas. There was also a problem with convincing motorists to listen to the radio and the evaluators commented that motorists did not use the HAR as much as was anticipated. A survey was conducted at a rest area at a time when the VMSs were informing drivers to tune to the HAR. A total of 200 drivers were asked if they observed the VMSs which had the messages "Tune to AM Radio (530 or 1610)" and "Trucks Entering or Exiting." About three-fourths of the drivers stated they had observed the message to tune to the appropriate radio station. However, the survey found only three percent of the motorists actually utilized the HAR system. One reason for the extremely low usage rate could be related to the activity at the time which was trucks entering and exiting the highway. There was no congestion and only 14 percent indicated they had observed any construction-related truck activity. Therefore, drivers were not motivated to use the HAR. However, the problem of convincing drivers to use the HAR was illustrated. Positive findings were that 98 percent indicated they understood the signs and 68 percent stated the overall information given was useful.

A possible improvement to consider in the future use of HAR could be to use an FM station which could provide a better broadcast signal a greater distance from the construction site. Another problem with increasing motorists usage could be their low expectations from past experiences at other locations which could have adversely affected their tendency to use the HAR.

The reliability was disappointing and the signal was generally weak. The extent of use by the KDOH was reduced as the project progressed because of their perception that not many motorists listened to the radio message.

An evaluation of the two HAR systems by the manufacturer's representative after the project ended revealed that the Fayette County site was inoperable due to a break in the power supply

conduit to the cabinet. The Madison County site had a blown fuse and was transmitting with reduced electric field strength. After repairing the HAR units, listening tests were performed and it was determined that the Fayette HAR transmitting on 530 kHz could be heard clearly for approximately 6 miles and the Madison HAR transmitting on 1610 kHz could be heard clearly for approximately 8 miles. This appears to be an indication that most of the problems associated with equipment could be reduced or eliminated with increased attention to the maintenance of the HAR systems.

The two HAR locations are licensed and can remain in operation. Another option for increasing the driver utilization would be to advise motorists to tune to the HAR through information provided on the Lexington-Fayette Traffic Information Network.

4.2.4 Vehicle Detection System

The vehicle detection (Mobilizer) system received the lowest performance rating (1.75) of any of the devices and the second lowest effectiveness rating (1.86). Only one of the four responding evaluators indicated they would recommend using this system in the future although two other respondents indicated they would consider using a similar system involving motion detection technology if it was supported adequately by the manufacturer.

The general opinion was that the concept was good but there had been little opportunity to detect delays. A problem with properly implementing the system was inadequate support from the company. The result was that the system was never fully operational. However, it was noted that similar systems have been used effectively as an alarm system for incident management. The Mobilizer system was able to count traffic but not able to classify vehicles by type. Its proposed use as an alarm system was not utilized.

The Mobilizer system used a black and white fixed camera. It may be better utilized at a permanent location rather than a construction zone. A factor in the decision to evaluate this system was the cost which was less than one half that of the systems which have been used effectively.

4.2.5 Weather Detection System

The weather detection system received a performance rating of 2.43 and an effectiveness rating of 2.57. It was not able to be used effectively during the construction activity but should be more useful after completion of the project. Its reliability has not been established. The potential use of such a system was recognized with all eight of those responding indicating that they would recommend using this system in the future. Similar systems at other locations in Kentucky have proven to function as expected and the output data has been used to support management of winter weather operations by the Department of Highways.

The visibility sensor has not been operational. There was a problem associated with installing this system at an active construction site due to maintenance problems.

5.0 RECOMMENDATIONS

5.1 Future Use of Experimental Work Zone Traffic Control Devices

Following is a summary of the recommendations for future use of the various work zone traffic control devices evaluated in this project.

Video Camera System:

This provides an effective method of monitoring the activities at a construction site. It could be used at long term construction projects where the activity was limited in length or where a specific portion of the site should be monitored. A practical method of information transmission between the camera system and monitoring location must be present.

Variable Message Signs:

While variable message signs have been used for many years at work zones, this project demonstrated several improvements which can be made to make them more effective and responsive to existing conditions. The procedure of placing a message on the sign only when there is a specific activity or condition which would warrant a message is recommended. The signs should be capable of being operated remotely with a list of messages developed prior to the beginning of the construction activity. The number of signs and the distance of the first sign from the construction site would be dependent on the characteristics (speed, traffic volume, roadway geometrics) of the specific work zone. At major construction sites, there should be multiple signs with the first sign placed several miles prior to the work activity.

Highway Advisory Radio

The results of this project would not justify use of highway advisory radio as part of the traffic control at a specific work site. Future use of HAR may be improved with the use of FM frequencies or stronger AM signals. These options could improve reception, but have not been approved by the Federal Communications Commission. A problem recognized at the end of the project which could offer the possibility of improving quality of the signal and increasing usage was inadequate maintenance of the systems. An alternative to HAR could be a statewide network of radio stations similar to the Traffic Information Network maintained by the Lexington-Fayette Urban County Government.

Vehicle Detection System

The vehicle detection system used in this project was not successful although its ineffectiveness may be related to the type of equipment used. However, the concept of vehicle detection as an alarm system for incident management has potential for use in areas with high traffic volumes where congestion frequently occurs.

Weather Detection System

Use of a weather detection system has the ability to provide site-specific weather and pavement data to highway maintenance personnel. However, problems were identified with maintaining the system in an active work zone. When the installation of a weather system is included in a construction project, the equipment should be installed near the end of the project.

5.2 Future Use of Traffic Control Devices at Clays Ferry Bridge

The video camera system should be maintained at the Clays Ferry bridge to monitor I-75 traffic. The camera could detect incidents and the existence of fog or ice at the bridge. Two VMSs should be maintained on each approach to the bridge to allow appropriate messages to be displayed to motorists. The signs could be located before and after the interchanges immediately north and south of the bridge. These signs should be coordinated with other VMSs on the interstate system. Since an FCC license was obtained to install the HAR, they will remain in place and should be utilized when possible. To insure satisfactory performance, a plan should be developed to assign maintenance responsibility for the HAR systems. Coordination with the Lexington-Fayette TIN may increase use of the HAR.

The RWIS should be integrated with the VMS and HAR to provide warning when there is fog or ice on the bridge. The RWIS has the capability of measuring the visibility at bridge level. The stopping sight distance on wet pavement at 70 mph is 800 feet (approximately 0.15 mile). Messages for VMS and statements for HAR that could be used when the RWIS indicates that visibility is less than 800 feet are listed below.

VMS MESSAGES:

SIGN 1	TUNE TO RADIO AM 1610 (530)	DENSE FOG AHEAD
SIGN 2	DENSE FOG ON BRIDGE	REDUCE SPEED

HAR STATEMENTS:

Problem Statement - Dense fog has been reported at the Clays Ferry Bridge.
Effect Statement - The fog will result in reduced visibility and potential delay.
Action Statement - Traffic speeds may slow significantly so be prepared to stop.

The RWIS displays a warning when there is moisture on the roadway that is close to freezing,

but it will not confirm the presence of ice or snow. Messages for VMS and statements for HAR that could be used when the RWIS provides a snow/ice warning are listed below.

VMS MESSAGES:

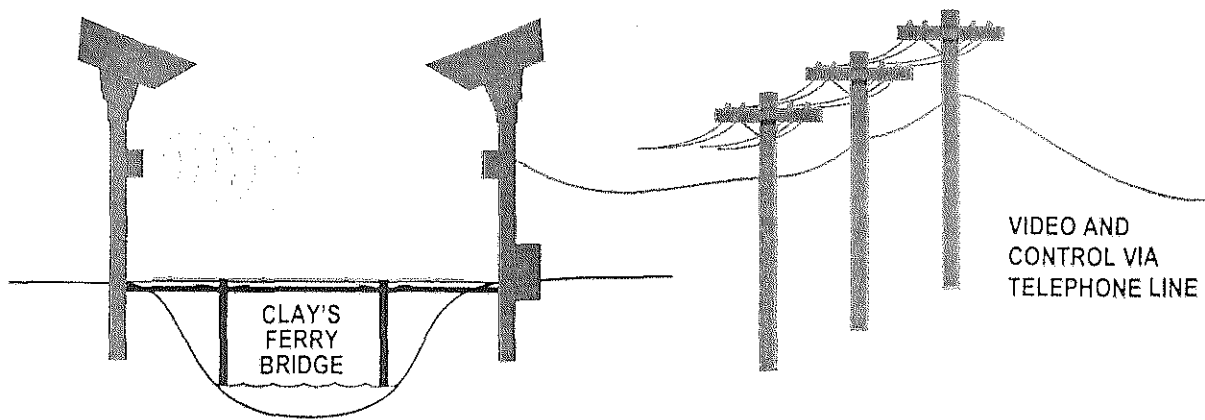
SIGN 1	TUNE TO RADIO AM 1610 (530)	POSSIBLE ICE ON BRIDGE
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SIGN 2	POSSIBLE ICE ON BRIDGE	REDUCE SPEED
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HAR STATEMENTS:

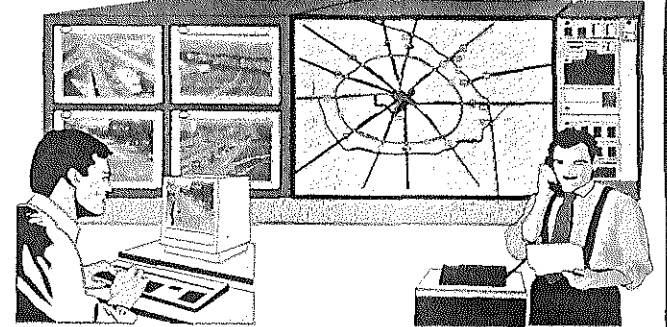
Problem statement -	Snow or ice is possible on the Clays Ferry Bridge.
Effect statement -	Ice forms on bridges before other roadway surfaces. This may result in a slippery surface, possibly loss of control, or potential delay.
Action statement -	Traffic speeds may slow significantly so be prepared to stop.

Figure1. CLAY'S FERRY BRIDGE



TRAFFIC MANAGEMENT CENTER

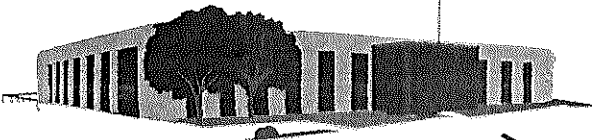
THE CENTER RECEIVES THE DATA AND CONVERTS IT TO VIDEO. THE VIDEO IS TRANSMITTED VIA CABLE LINK TO LEXINGTON POLICE AND FIRE COMMUNICATION CENTERS AND THE KENTUCKY DEPARTMENT OF HIGHWAYS DISTRICT 7 OFFICE.



VIDEO DATA IS ANALYZED TO DETERMINE POSSIBLE INCIDENTS AND TO NOTIFY EMERGENCY RESPONSE PERSONNEL FOR DISPATCH.

CAMERAS ARE PLACED AT EACH END OF THE CLAY'S FERRY BRIDGE, ONE IN FAYETTE COUNTY AND THE OTHER IN MADISON COUNTY. BOTH CAMERAS HAVE PAN, TILT AND ZOOM CAPABILITIES. VIDEO IS TRANSMITTED FROM MADISON COUNTY TO FAYETTE COUNTY USING WIRELESS TECHNOLOGY WHERE BOTH VIDEO SIGNALS ARE CONVERTED TO DATA AND TRANSMITTED VIA TELEPHONE LINES TO THE TRAFFIC MANAGEMENT CENTER.

17



INTERMEDIA HUB

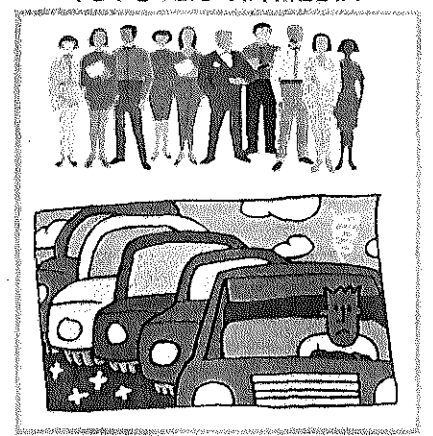
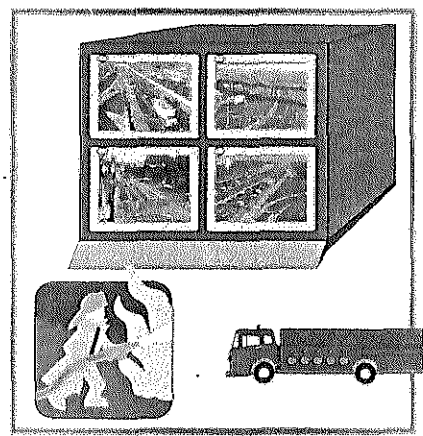
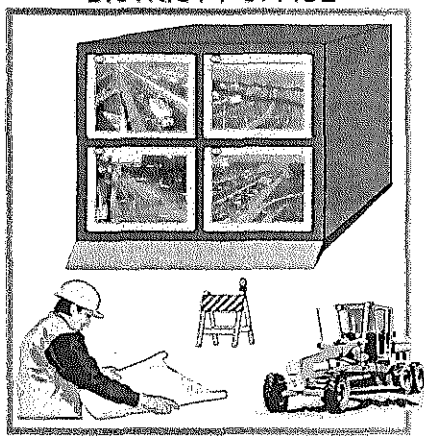
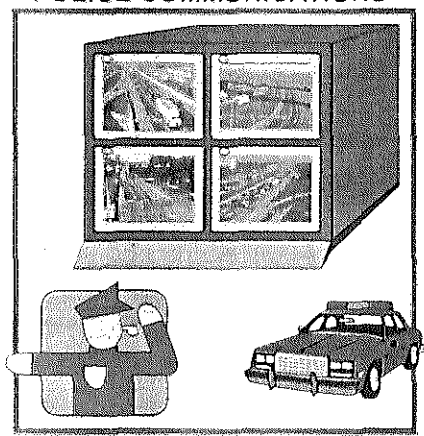
TRAFFIC INFORMATION NETWORK

POLICE COMMUNICATIONS

DISTRICT 7 OFFICE

FIRE COMMUNICATIONS

TO PUBLIC VIA MEDIA



THE POLICE AND FIRE DISPATCH AND THE DISTRICT 7 OFFICE HAVE FOUR 20-INCH MONITORS TO VIEW ALL TRAFFIC CAMERAS IN FAYETTE COUNTY INCLUDING THE CLAY'S FERRY CAMERAS, THE DIVISION OF TRAFFIC ENGINEERING WILL MAINTAIN THESE CAMERAS AND THE CONTROL FOR PAN, TILT AND ZOOM.

CLAY'S FERRY BRIDGE - PHASE II

Figure 2.

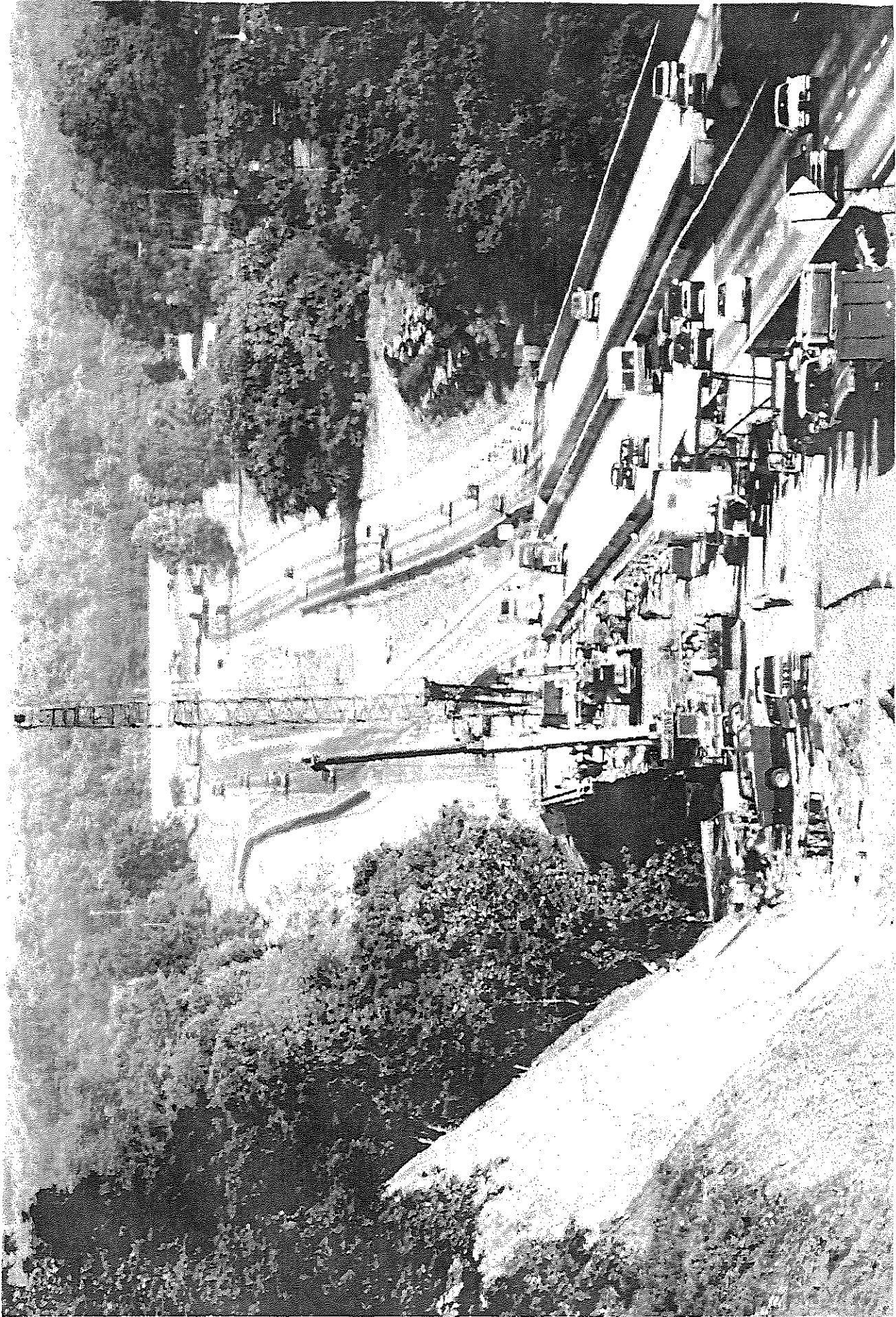


Table 1. Total Accidents at Construction Site.

YEAR	SECTIONS*					
	NORTH OF BRIDGE			SOUTH OF BRIDGE		
	2-3 MILES	1-2 MILES	BRIDGE - 1 MILE	BRIDGE - 1 MILE	1-2 MILES	2-3 MILES
1990	6	9	5	19	3	13
1991	7	7	6	21	7	6
1992	8	8	18	21	8	8
1993	7	10	6	15	11	9
1994	13	15	2	22	5	11
1995	7	16	6	17	4	10
1996	4	13	7	27	13	18
1997 (Jan.- June)	6	6	7	18	3	12

* Bridge located at milepoint 97.543. All accidents at bridge placed in section from bridge to one mile south.

1990-1993 Before Period
 1995-June 1997 Construction Period

Table 2. Total Injury/Fatal Accidents at Construction Site.

YEAR	SECTIONS*					
	NORTH OF BRIDGE			SOUTH OF BRIDGE		
	2-3 MILES	1-2 MILES	BRIDGE - 1 MILE	BRIDGE - 1 MILE	1-2 MILES	2-3 MILES
1990	3	3	2	5	0	5
1991	7	4	3	4	2	1
1992	4	5	4	8	4	5
1993	3	3	3	3	5	3
1994	8	3	0	5	2	3
1995	4	6	3	2	1	3
1996	0	4	1	8	5	4
1997 (Jan.- June)	0	1	2	7	1	4

* Bridge located at milepoint 97.543. All accidents at bridge placed in section from bridge to one mile south.

1990-1993 Before Period
 1995-June 1997 Construction Period

Appendix A

Listing of Pre-Programed Messages for Use with VMS

The two messages used on each sign for various conditions are listed below. When a message is different in each direction, alternate text is shown in parentheses.

ACCIDENT

SIGN 1	TUNE TO RADIO AM 1610 (530)	ACCIDENT AHEAD
SIGNS 2-3	ACCIDENT AHEAD	BE PREPARED TO STOP

BLASTING

SIGN 1	TUNE TO RADIO AM 1610 (530)	BLASTING AHEAD
SIGNS 2-3	BLASTING AHEAD	BE PREPARED TO STOP

LANE CLOSURE

SIGN 1	TUNE TO RADIO AM 1610 (530)	X LANE (RT or LT) CLOSED AHEAD
SIGN 2	X (RT or LT) LANE CLOSED	X (6-SB, 5-NB) MILES AHEAD
SIGN 3	X (RT or LT) LANE CLOSED	2 MILES AHEAD

TRUCKS ENTERING OR EXITING

SIGN 1	TUNE TO RADIO AM 1610 (530)	TRAFFIC INFO
SIGN 2	TRUCKS EXITING/ ENTERING	X (6-SB, 5-NB) MILES AHEAD
SIGN 3	TRUCKS EXITING/ ENTERING	AT BRIDGE

ROAD BLOCKED

SIGN 1	TUNE TO RADIO AM 1610 (530)	ROAD BLOCKED AHEAD
SIGN 2	ROAD BLOCKED	X (6-SB, 5-NB) MILES AHEAD
SIGN 3	ROAD BLOCKED	2 MILES AHEAD

FOG

SIGN 1	TUNE TO RADIO AM 1610 (530)	TRAFFIC INFO
SIGN 2	DENSE FOG	X (6-SB, 5-NB) MILES AHEAD
SIGN 3	DENSE FOG	2 MILES AHEAD

ICE ON BRIDGE

SIGN 1	TUNE TO RADIO AM 1610 (530)	TRAFFIC INFO
SIGN 2	ICE ON BRIDGE	X (6-SB, 5-NB) MILES AHEAD
SIGN 3	ICE ON BRIDGE	2 MILES AHEAD

CONGESTION

SIGN 1	TUNE TO RADIO AM 1610 (530)	TRAFFIC INFO
SIGNS 2-3	CONGESTION AHEAD	EXPECT DELAY

Appendix B

Listing of Pre-Programmed Messages for Use with HAR

The messages used for each condition are listed. All messages use the following format:

- Attention Statement - You are approaching a major bridge reconstruction project. The project involves the Interstate 75 Clays Ferry Bridge over the Kentucky River at milepoint 98. The two existing two-lane spans are being replaced with one six-lane span. The bridge is within an almost 40-mile section of interstate where two lanes will be added to the current four lanes. (Same for all conditions)
- Problem Statement - Description of problem (accident, lane closure)
- Location Statement - Where appropriate
- Effect Statement - Result of problem (delay, brief or long stopped traffic)
- Action Statement - Recommended action for driver (be prepared to stop, alternate route)
- Endorsement- Note that announcement presented by LFUCG and KyTC; identify call letters. (Same for all conditions)

Accident

- Problem Statement - A traffic accident has been reported in the (northbound/southbound) lanes. (One statement for each direction)
- Location Statement - The location is near milepoint x. (Vary x from 90 to 114)
- Effect Statement - The accident may result in significant delays.
- Action Statement - Traffic speeds may slow significantly so be prepared to stop.

Blasting

- Problem Statement - As a part of the construction project, blasting activity is underway near the bridge. The blasting activity should last no longer than 15 minutes.
- Effect Statement - The blasting may result in short delays
- Action Statement - Traffic speeds may slow significantly so be prepared to stop.

Lane Closure

- Problem Statement - As a part of the construction project, the (right/left) lane will be closed temporarily. (One statement for each lane)
- Location Statement - The location is near milepoint x. (Vary x from 90 to 114)
- Effect Statement - The lane closure may result in delays.
- Action Statement - All traffic should merge into the (left/right) lane. (One statement for each lane) Be prepared for a reduction in speeds.

Trucks Entering or Exiting

- Problem Statement - As a part of the construction project, trucks are currently entering and exiting the highway near the bridge.
- Effect Statement - The trucks will enter and exit the highway at a reduced speed.
- Action Statement - Be alert to slow moving construction truck traffic.

Road Blocked

- Problem Statement - Due to a traffic accident, Interstate 75 (northbound/southbound) will be blocked for a substantial amount of time. (One statement for each direction)
- Location Statement - The location is near milepoint x. (Vary x from 90 to 114)
- Effect Statement - This blockage will result in significant delays.
- Action Statement - (Statement for southbound direction) - Traffic should consider an alternate route. To use the alternate route, follow Interstate 64 eastbound to Winchester. Take exit 94. Proceed south on KY 1958 to KY 627. Turn right and continue south. This road will lead you back to Interstate 75 at a point south of the accident.
- (Statement for northbound direction) - Traffic should consider an alternate route. To use the alternate route, take exit 95. Proceed north on KY 627 to KY 1958 at Winchester. Turn left onto KY 1958 and continue north to Interstate 64. Take Interstate 64 west to Lexington. This road will lead you back to Interstate 75 at a point north of the accident.

Fog

- Problem Statement - Dense fog has been reported at the Clays Ferry Bridge.
- Effect Statement - The fog will result in reduced visibility and potential delay.
- Action Statement - Traffic speeds may slow significantly so be prepared to stop.

Ice on Bridge

- Problem Statement - Ice has been reported on the Clays Ferry Bridge.
- Effect Statement - Ice forms on bridges before other roadway surfaces. This may result in a slippery surface, possible lose of control, or potential delay.
- Action Statement - Traffic speeds may slow significantly so be prepared to stop.

Congestion

- Problem Statement - Increased traffic volume has resulted in traffic congestion.
- Effect Statement - The congestion may result in significant delays.
- Action Statement - Traffic speeds may slow significantly so be prepared to stop.

Appendix C

Chronology of the Clays Ferry Bridge Project

CHRONOLOGY OF PROJECT

CONDITION-RESPONSIVE WORK ZONE TRAFFIC CONTROLS I-75 CLAYS FERRY BRIDGE

- 11-16-92 CREWZ proposal was submitted by KYTC in response solicitation by FHWA.
- 2-19-93 Meeting was held at the KYDOH District 7 Office to discuss traffic control needs for the Clays Ferry Bridge reconstruction project. A request was made to have KYTC, LFUCG Traffic, and KTC develop a plan for implementing a video camera monitoring system and other components of the CREWZ proposal which offered potential for implementation as part of the traffic control advance warning system at the bridge.
- 2-23-93 Informed by FHWA that CREWZ proposal had not been funded.
- 2-25-93 Meeting was held between KYTC, LFUCG, and KTC to develop a phased plan for implementation of the CREWZ proposal. The result was a three-phase plan, with addition tasks associated with monitoring and evaluation. Information received from the KYTC indicated that funding was available only for the video camera system.
- 3-4-93 Meeting of KYTC, LFUCG, KTC, and Finance Cabinet representatives to discuss the potential for application of highway advisory radio (HAR). Discussions were initiated to consider the option of revising specifications for the changeable message signs to convert them to remotely controlled operation.
- 3-10-93 HAR presentations were made by Digital Recorders, Inc. and Information Station Specialists.
- 3-11-93 Meeting of KYTC, LFUCG, and KTC was held to discuss traffic control components to be submitted to Frankfort as priority for funding.
- 3-18-93 A five-phase proposal over five years for \$638,000 was submitted to the KYTC separately from the activity which was underway through KYTC District 7.
- Funding for \$100,000 was approved by KYTC to have LFUCG Traffic work with District 7 to implement a video camera monitoring system for the Clays Ferry Bridge project.
- 8-6-93 Proposal by KTC was resubmitted as a Federal-Aid Research Task with first-year funding of \$75,000 for purchase and installation of highway advisory radio

(HAR), and monitoring and evaluation of the other traffic control components (video camera, and changeable message signs).

- 11-22-93 One-year project for \$75,000 was approved by the KYTC.
- 12-22-93 Meeting was held with representatives of KYTC, LFUCG, and KTC to discuss traffic control components being considered for the Clays Ferry Bridge project. The plan to install a video camera system and link to the District 7 Office and Lexington Traffic and Police was presented by Ron Herrington and Charlie Powers. The decision to use telephone lines to transmit messages from the bridge to Lexington was noted. Responsibility for changing messages on the CMS was given to the Resident Engineer (James Ballinger). Preliminary discussions concerning procurement of the HAR and the "Mobilizer" were held.
- 1-27-94 James Ballinger reported that the CMS equipment offered by the contractor was approved by the KYTC. Eight signs were purchased; each with the capability of providing 3 lines of messages and 8 letters per line, with letter size of 18 inches. The CMS also had the capability of remote communication by telephone. Visibility of the signs is required to be a minimum of 900 feet. A recommendation was made for formation of a committee to develop protocol and message content for the CMS. The committee was expected to have representatives from KYTC, LFUCG, FHWA, KTC, and the bridge contractor.
- 2-3-94 A letter was transmitted from FHWA to KYTC approving \$50,000 funding as a Federal-Aid Research Task and the remaining \$25,000 from state funds for purchase/installation of the HAR.
- 2-10-94 Meeting of the Clays Ferry CMS/HAR Committee was held to discuss protocol and message scenarios for uses of CMS and HAR at the bridge.
- 3-3-94 Notification was transmitted from KYTC to KTC indicating funding arrangements for evaluation/monitoring by KTC and purchase of the HAR.
- 3-10-94 Presentations and field demonstrations of HAR were made by representatives of Digital Recorders, Inc. and Information Station Specialists. The field demonstrations were made on I-75 in Fayette and Madison Counties with temporary equipment used to display their capabilities.
- 3-21-94 Meeting of the CMS/HAR Committee was held to discuss the following: 1) status of the project, 2) the scope of traffic control components to be included in the project, 3) results of the HAR demonstrations, 4) preliminary specifications for the HAR, 5) CMS and HAR protocol and message content, and 6) status of the emergency message sign being proposed by the Bluegrass Army Depot.

It was noted that the CMS equipment proposed by the contractor was expected to be delivered by April 1.

The CMS/HAR Committee recommended that the HAR procurement be processed as a turn-key operation and specifications should be submitted to the Committee for review prior to advertisement.

The Committee also recommended that operational protocol be established for the CMS to permit operation only when construction activity was underway and an appropriate message was available to display.

The message sign being proposed by emergency response representatives in Madison County and the Bluegrass Army Depot was described to be 21 feet x 7 feet with 2 rows and a maximum of 15 characters at 12 inches high. There were two signs being proposed at a cost of approximately \$100,000. Proposed placement of the signs was in the vicinity of the Milepoint 99 for southbound traffic and Milepoint 62 for northbound traffic.

3-23-94

A meeting was held between representatives of KYTC District 7, KYTC Central Office Traffic and Planning, and KTC to discuss a response to the request that the Bluegrass Army Depot receive a permit to install two message signs on I-75 for use in case of an emergency related to the nerve gas stored at the Army Depot. It was agreed that a response should be prepared which recommended joint usage by the Army Depot and KYTC, with modification to the signs required to have them capable of displaying multiple messages rather than a single message. The modifications would permit the KYTC to incorporate the signs into the traffic control system at Clays Ferry Bridge and also be used for emergency situations at the Army Depot. A letter for Sec. Kelly's signature was to be prepared and transmitted to the emergency response unit in Madison County (CSEPP).

3-30-94

Draft technical requirements for HAR were prepared by the KTC staff and submitted to the CMS/HAR Committee for review.

4-15-94

A meeting of the CMS/HAR Committee was held to discuss the operational protocol and message content for the CMS.

Rob Bostrom from the KYTC Division of Planning attended the meeting to present the proposal for purchase and application of the "Mobilizer" system. He noted that the system was continuous traffic monitoring equipment which could count, classify, and detect motion or lack of motion through the video camera and traffic loop components.

- 5-10-94 Notice of award of contract was sent to Information Station Specialists to provide HAR at two sites on I-75 in Fayette and Madison Counties. The price of the contract was \$18,618.
- 6-1-94 A meeting of the CMS/HAR Committee was held to provide a status report on the various traffic control components planned for installation at Clays Ferry. It was noted that the video camera system was operational with signals being transmitted back to the Lexington Traffic Control Center. The CMS were reported to be in place and being used upon demand at the site. The HAR was scheduled for installation during the week of June 20th.
- 6-10-94 A meeting of the CMS/HAR Committee was held to finalize CMS and HAR message content. In addition, plans were made for installation of the HAR by addressing issues related to site preparation and message recording.
- 6-17-94 A meeting of the CMS/HAR Committee was held to finalize plans for installation of the HAR and to plan for a press conference on June 27th.
- 6-20-94 Information Station Specialists (ISS) began installation of the HAR at the Fayette and Madison County sites.
- 6-21-94 The HAR systems were placed into operation and appeared to be functioning.
- 6-24-94 The HAR voice recorder at the Madison County site was determined to be functioning improperly and ISS was requested to repair the system prior to the press conference on June 27th.
- 6-26-94 ISS made arrangements with a local electronics representative to test the HAR system and make repairs prior to June 27th. A replacement voice recorder was shipped to Lexington as a temporary solution to the improperly functioning recorder.
- 6-27-94 ISS representatives installed the temporary voice recorder and operation of the Madison County HAR began with a limited number of messages (the temporary recorder had less recording time than the permanent recorder).
- A press conference was held at the US 25 overpass north of the Clays Ferry Bridge. Representatives were present from the KYTC, LFUCG, KTC, and Madison County Fiscal Court. Coverage of the press conference was provided by the Lexington TV stations and radio stations.
- 7-11-94 A meeting of the CMS/HAR Committee was held for the purpose of discussing the status of the project and interagency communication/coordination

requirements. The process for notification of an accident or incident was discussed the need for training or informational meetings with police and fire personnel was noted. Telephone numbers were exchanged for representatives of Lexington Police and Fire Divisions and the KSP Richmond Post.

It was reported by Lexington Traffic that the Mobilizer system was scheduled for installation on July 12th. A single black and white video camera will be the means of monitoring and video signal will be provided to the Lexington Traffic Control Center.

A request was made for James Ballinger to maintain a log of the applications of both CMS and HAR.

In addition, the KTC staff was requested to provide a draft plan for monitoring and evaluation of the project and present it at the next meeting.

8-16-94

A meeting of the CMS/HAR Committee was held for the purpose of discussing the status of the project, the need for improved interagency communication, and an evaluation plan for the project. Detailed discussions were held concerning the potential applications of detour signs at interchanges with I-75 in Fayette County.

Lexington Traffic and Police and KYTC District 7 scheduled a field inspection to select alternate routes and placement of detour signs.

An updated list of contacts for emergency response was provided to KYTC by Lexington Police and Fire representatives.

A request was made by Lexington Fire to have the KYTC consider placing a cut in the median barrier wall on I-75 between the Horse Park and Georgetown exits for emergency use.

A request was also made by Lexington Fire to provide more frequent reference points (in addition to standard milepoints) on I-75 for use by emergency response personnel.

Lexington Traffic reported that the Mobilizer system was installed and was expected to be operational soon. It was also noted that one of the video cameras at Clays Ferry had been temporarily out of order due to a lighting strike.

A draft copy of the monitoring and evaluation plan for the project was presented by the KTC staff.

- 9-27-94 A meeting of the CMS/HAR Committee was held for the purpose of reviewing the status of the project. Issues addressed at the meeting included the following: 1) interagency communication, 2) application of permanent detour signs, 3) concrete barrier cuts to facilitate emergency response, 4) application of reference markers for improved location for emergency response, and 5) status of the message sign proposed for use by the Bluegrass Army Depot and Madison County CSEPP.
- 10-15-94 A meeting of representatives of KYTC, LFUCG, KTC, and TRW was held at the Resident Engineer's office at the Clays Ferry Bridge for the purpose of discussing the potential for application of fog and ice detection devices at the bridge. Background and status of the traffic control components were presented to the TRW representatives. An agreement was reached to have the TRW representatives work with the KTC staff to develop a proposal on fog and ice detection for submission to the KYTC.
- 10-19-94 Correspondence was sent to Bill Monhollon with the Transportation Cabinet requesting that Federal-Aid Research Task 64 titled "Condition-Responsive Work Zone Traffic Controls" be extended through December 31, 1995, without additional funding. Project funding for the Transportation Center was \$75,000, of which \$25,000 was set aside for purchase of two Highway Advisory Radio system installations.
- 11-18-94 A meeting of the CMS/HAR Advisory Committee was held for the purpose of reviewing the status of the project. Subjects addressed at the meeting included following: 1) status of traffic control components installed in conjunction with the bridge project, 2) interagency communication/coordination, 3) consideration of temporary and permanent detour signs in the Lexington area, 4) status of the reference sign system, and 5) a presentation by TRW on fog and ice detection systems.
- 12-14-94 A preliminary proposal and cost estimate was provided by TRW in conjunction with SCAN-Surface Systems.
- 2-23-95 A meeting was held between Transportation Cabinet and Transportation Center representatives to discuss the process for implementation of a fog and ice detection system at Clays Ferry. The outcome of the meeting was to arrange a time for TRW and SCAN representative to meet with the Advisory Committee and determine actions necessary to place a weather detection system at the bridge. A plan was made to meet and develop a final proposal with sufficient detail to be incorporated into the project as a change order.

- 3-21-95 A meeting of the Advisory Committee for the Clays Ferry Bridge Project was held for the purpose of discussing the status of various traffic control components presently operational at the bridge. In addition, representatives of TRW and SCAN-Surface Systems were invited to attend and present more detailed information on the proposed weather monitoring system. After the meeting, most of the Committee members traveled to the Clays Ferry Bridge for an inspection of the current activities and selection of potential locations for the weather system sensors and monitoring devices. Following the bridge inspection, the SCAN representative conducted a tour of the weather system presently operating at Bluegrass Airport.
- 4-26-95 A meeting was held between Transportation Cabinet and Transportation Center representatives to discuss Surface Systems' proposal for a weather system at the Clays Ferry Bridge. Several issues were discussed concerning the details of the proposal and it was determined that more information was required in order to evaluate the proposal. The KTC staff was requested to obtain additional information from Surface Systems and report back to KYTC.
- 5-9-95 Another meeting was held between the SSI representative and representatives of KYTC and KTC. The purpose was to finalize the SCAN proposal and seek sufficient information to prepare a change order for incorporation of the weather system in the bridge contract. SCAN was requested to revise and resubmit the proposal.
- 5-15-95 A final equipment list and cost estimate were received from SCAN Systems for the Clays Ferry Bridge installation. Details were provided for the visibility sensors and roadway surface sensors. It was noted that four copies of the software for accessing the weather system data would be provided (District 7 Office, Lexington Traffic Control Center, KYTC Central Office in Frankfort, and UK Transportation Center). Additionally, six months of SCAN-CAST pavement forecast was to be provided as part of the package. SSI also provided the SCAN Plus CPU at no cost with only the licensing fee of \$7,500. The CPU (central processing unit) will be able to communicate with numerous RPU's (remote processing units), as well as other CPU's for data exchange. SSI's total estimated price for equipment and services was \$73,014; excluding installation cost.
- 5-25-95 Information was received from SSI related to a satellite-based observation/forecasting system which could be used to supplement the on-site sensors at the Clays Ferry Bridge. KYTC decided not to subscribe to the service at this time, but to test the weather sensing system at the bridge and determine at a later date whether additional information would be beneficial.

- 6-19-95 A representative of the Tennessee Department of Transportation was contacted to discuss the fog detection system in operation on I-75 north of Chattanooga. From conversations with Don Dollinger, an explanation of the activation protocol was prepared and transmitted to KYTC representatives. Further discussions were held with KYTC representatives concerning the CMS activation process when fog or adverse weather is detected at the Clays Ferry Bridge. Additional information about the system capabilities for interface with activation devices was requested by Chuck Jones, the SSI representative. He indicated that SSI was willing to develop software to review and monitor visibility levels and automatically activate CMS based on system information.
- 7-26-95 A survey was conducted to determine drivers' response to the CMS and HAR being used in advance of the Clays Ferry project. Drivers stopping at rest areas south of Richmond and north of Georgetown were asked if they noticed the CMS indicating "Trucks Entering or Exiting" and "Tune to AM Radio 530 or 1610" and whether they tuned to the HAR station to hear the message. Results of the survey indicated about two-thirds noticed the CMS; however, only three percent tuned to the HAR station to listen to the message.
- 10-2-95 Barriers were placed and I-75 southbound traffic was switched from the original southbound span to the newly constructed middle span.
- 6-95 RWIS was installed, but did not become operational until the winter of 1996.
- 8-95 The southbound traffic was switched onto the newly reconstructed southbound bridge, and the northbound traffic was routed onto the middle span.
- 1-96 The RWIS became operational.
- 8-97 Northbound traffic was switched onto the reconstructed northbound bridge.
- 2-97 Permanent pavement sensors for the RWIS were installed.
- 1-23-98 A meeting of the Advisory Committee was held for the purpose of updating the most recent activities and to seek input from the Committee to supplement the evaluation process.