Dixie Highway Corridor Study

A Plan for Transportation & Traffic Optimization

Executive Summary

Prepared for:

Ohio Kentucky Indiana
Regional Council of Governments

Prepared by:

TEC Engineering, Inc.

Bayer Becker
CDS Associates, Inc.
Dan Pinger Public Relations, Inc.
Northrop Grumman Mission Systems

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May 2005

Advisory Committee Chairman

Judge R. Scott Kimmich, Kenton County Deputy Judge-Executive

Advisory Committee

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Robert Yoder, City of Erlanger

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1. EXECUTIVE SUMMARY

OVERVIEW

The Dixie Highway Corridor Study was conducted by the Ohio-Kentucky-Indiana Regional Council of Governments (OKI), in response to a request from the Kenton County Fiscal Court. The study analyzes traffic and transportation issues on Dixie Highway within the Kenton County limits. Active participation from local officials, the Advisory Committee, and the public has resulted in the recommendations contained in this report.

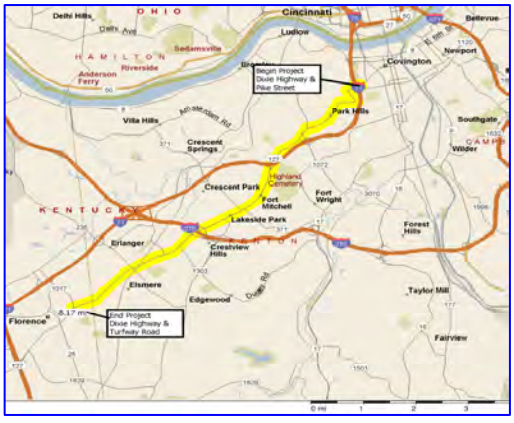
The study presents recommendations for improving safety and traffic flow and reducing delay along this heavily congested corridor. Given that lane additions are not feasible, recommendations will focus on improving traffic operations by using a combination of new technologies and traditional improvements. Solutions include coordinated traffic signal systems, intersection improvements, signal preemption for emergency vehicles, and interconnection with ARTIMIS for managing traffic overflows from I-71/75. The study recommendations are expected to reduce overall travel time through the corridor by 20-40%.

This study is the first in the Cincinnati metropolitan region to focus on increasing traffic throughput on an arterial without adding lanes. This concept has great potential for similar arterials in other developed corridors in the region.

THE STUDY AREA

The 8-mile project corridor in Kenton County, Kentucky is bounded by Pike Street in Covington (the I-71/75 interchange) and Turfway Road just west of the county line. The study area includes nine jurisdictions: The Cities of Elsmere, Ft. Mitchell, Lakeside Park, Ft. Wright, Edgewood, Crestview Hills, Erlanger, Park Hills, and Covington. Dixie Highway is the most heavily traveled and congested arterial in Kenton County and is relied upon for local access and regional connectivity, and as an alternative route to I-71/75 when incidents or congestion occur. Congestion is noted particularly during the Peak Hours. This condition is amplified by the built-out urban nature of the corridor.

The bulk of Dixie Highway within the project corridor is a four lane roadway with 10 foot lanes and a 35 mph speed limit. A section to the south of I-275 widens to six 12 foot lanes with a 45 mph speed limit. The roadway experiences heavy traffic volumes throughout the day, up to 30,000 vehicles.



While traveling the study corridor, several different area types can be noted, including the central business districts of Covington and Fort Mitchell, the highly commercial districts of Edgewood, Crestview Hills, and Elsmere, and the residential neighborhoods of Park Hills and Lakeside Park. Overall, however, Dixie Highway is a highly urbanized commercial corridor.

STUDY PROCESS

The Dixie Highway Corridor Study was developed with oversight from the Dixie Highway Corridor Advisory Committee, including representatives from all nine municipalities in the corridor as well as the Transit Authority of Northern Kentucky (TANK), the Kenton County Fiscal Court, the Kentucky Transportation Cabinet, the Northern Kentucky Area Planning Commission (NKAPC), and the Kenton County Public Works.

Public Input

Input was sought from the general public in a variety of formats. A project website established early in the study provided the opportunity to email comments. The site included information on the study's progress, as well as media coverage. A public meeting midway through the study process gave attendees a chance to view informational displays and videos of travel time studies and accident recordings. In this format, the public could ask questions and discuss the study with the study team. A survey was completed by all attendees as well. Finally, interviews with local officials were completed for additional perspective on transportation issues in the corridor.

Data Collection and Analysis

The study involved extensive and detailed inventory and data analysis. These data provided the study team with a thorough understanding of the functioning of the Dixie Highway Corridor. Data collected included:

- Signal inventory – including the location of 44 signals, associated hardware and software, timing and phasing, and operating condition
- Traffic counts – peak hour counts at 19 intersections, 24-hour counts at stations at each end of the project area, and several mechanical counts
- Travel time studies – before and after signal maintenance and timing improvements
- Pavement markings and signage
- Accident records – 1500 accidents from 2001-2003 plotted by type of accident, weather and pavement conditions, and time of day; collision diagrams
- Driveway locations
- Surveys of local residents, emergency response agencies, transit operators, and school officials
- Traffic monitoring and accident recording – cameras installed at key intersections, with video broadcast to the website
- Capacity analysis – all intersections and arterial segments, existing and future (2015) conditions, peak hours and freeway overflow conditions

In addition to data on existing conditions, modeling was conducted to project a variety of future traffic conditions. Data were analyzed to determine optimal signal timing for Dixie Highway, and then the results of these new timing plans were modeled to evaluate their effectiveness.

Base data are available in a 1400-page report entitled *Dixie Highway Corridor Study: Field Inventory Report.* Copies are available on CD. In addition, information is available in the *Dixie Highway Corridor Study: Public Involvement & Modeling Documentation* which is also available on CD.

TRANSPORTATION PROBLEMS

At the same time that Dixie Highway is a major transportation artery for local and regional traffic, it is generally inefficient, and traffic is frequently slowed by congestion and freeway overflows. On a daily basis, the worst traffic conditions involve southbound traffic during the PM Peak, with an average travel time of 22 minutes that includes 10 minutes of delay (based on travel times at the beginning of the study). The accident rates along Dixie Highway exceed the state average for similar locations at 11 intersections and 8 mid-block locations, with the highest rate between Kenton Lands and Edgewood Roads.

Traffic conditions are projected to get worse if improvements are not made. Added congestion in response to freeway incidents is of particular concern. Over the next ten years, freeway incidents are projected to increase travel times on Dixie Highway by more than 40% when they occur during peak hours (for northbound traffic during the AM Peak and southbound traffic during the PM Peak).

One of the major contributors to traffic problems on Dixie Highway is the significant variation in daily flow, especially during the AM and PM Peak Hours. In addition, Dixie Highway experiences large influxes of traffic from Interstate 71/75. Since Dixie Highway parallels the Interstate in Northern Kentucky, drivers often divert onto Dixie Highway from interchanges at Buttermilk Pike, Kyles Lane, and Twelfth Street. These influxes can increase the traffic on Dixie Highway by as much as 30% and overwhelm the signal system, causing traffic backups.

The physical conditions of the built environment are a major cause of the transportation problems on Dixie Highway. Moreover, existing development reduces options for expanding right-of-way and applying access management. Land is not available for widening lanes or intersections or for adding turn lanes. In areas with commercial development, the number, location, and design of curb-cuts contributes to congestion and accidents, especially where driveways are located close to intersections.

Another aspect of development that contributes to problem conditions is the number and design of intersections. Traffic entering and exiting Dixie Highway from intersecting streets contributes to congestion as additional vehicles are accommodated into the overall flow.

Offset intersections, where streets do not intersect at right angles to form a normal four-legged intersection, further contribute to delay and the potential for accidents. Because of the offset condition, traffic signals operate each side street approach as a separate phase, creating a large amount of lost time for the main street. The impact of offset intersections on signal placement and timing impedes efficient traffic progression and contributes to driver confusion and the potential for accidents. Dixie Highway has numerous offset intersections, including McAlpin and Garvey, Bartlett and May, Eastern and Kentaboo, and Buttermilk and Orphanage.

In conjunction with the intersections, Dixie Highway has 44 traffic signals in the study area. The spacing between the signals is extremely varied, and often signals are in close proximity as a result of the offset intersections and large number of driveways throughout the project corridor. Optimal signal spacing along a roadway similar to Dixie Highway is one signal every 1250 feet, but the spacing between traffic signals on Dixie Highway varies between 100 feet to more than a mile. The proximity of some signals to each other, combined with the spacing, makes it difficult to coordinate the signals to favor progression in both directions and move traffic efficiently.

Another problem is a general lack of turn lanes, especially left turn lanes. Intersections with heavy turn volumes create significant delay along the project corridor. Left-turning vehicles block the left through lane and cause a backup until the turn is completed. Drivers aware of these conditions tend to use the rightmost lane, resulting in disproportionate use of the curb lane.

In areas with on-street parking, Dixie Highway is reduced to one lane in each direction. In addition, traffic slows down in response to parking maneuvers.

There are 18 schools in the Dixie Highway Corridor and some of them are grouped in close proximity to each other. At the beginning and end of school hours, especially during the AM Peak, traffic volumes increase significantly in these areas in response to the influx of student drivers, school buses, and parents. Children exiting and entering vehicles pose an additional safety concern.

There are approximately 100 TANK bus stops in the corridor. It appears that bus stops have been added as necessary over the years, but none have been eliminated. In some locations, the bus may stop at nearly every block. Every time the bus stops, it decreases the capacity on Dixie Highway as the bus blocks the rightmost through lane.

In general, the traffic conditions on Dixie Highway are the result of the combined impact of many small problems, and the solutions call for a variety of recommendations.

RECOMMENDED IMPROVEMENTS

The recommendations of the Dixie Highway Corridor Study are divided into short term, mid-term and long term recommendations. Short term recommendations are focused on enhancing the operation of the existing signal system with improvements that are easily and quickly implemented and relatively inexpensive. The mid-term recommendations are aimed at significantly improving the operation of the traffic signal system, adding new technologies to improve safety, and laying the groundwork for policy or management changes that would help improve travel time and are recommended for implementation within five years based on considerations of time and cost. The long term recommendations primarily involve capital projects (spot improvements) to address specific problem locations in the corridor. These improvements, which will require preliminary work, are recommended for implementation within ten years.

The implementation of these recommendations will fall in some cases to the Kentucky Transportation Cabinet (KYTC) and in others to the local jurisdictions. The KYTC has primary responsibility for Dixie Highway in Kentucky. This responsibility includes maintenance of the road as well as operation and maintenance of the traffic signals. The local KYTC District office

and the local jurisdictions have provided information and invaluable assistance that have contributed to the development of this study's recommendations. The initiative and continued support of KYTC and local communities will be critical to the implementation of the study recommendations.

The recommendations are presented in table format at the end of this Executive Summary along with a brief description of each recommendation and a cost estimate. Additional details are provided below and in the full report.

SHORT TERM RECOMMENDATIONS
(FOR IMPLEMENTATION WITHIN THE YEAR)

The short term recommendations are focused on optimizing the operation of the existing signal system. Specifically, they call for correcting a number of traffic signal operational problems that contribute to traffic delay and for instituting a new timing plan, designed to move traffic more efficiently.

During the course of this study, KYTC responded to 90% of the recommendations to correct problems related to signal maintenance and implemented the recommended plan for signal timing. The maintenance problems that remain to be addressed involve signal phasing issues. Implementation of the remaining short term recommendations would further optimize operation of the existing signal system.

Recommendations were developed based on a review of signal timing and phasing at each intersection and also a detailed inventory. The inventory involved a comprehensive review of signal placement, locations and types of controllers, detector locations, interconnect, equipment conditions, and other information affecting signal operation. The inventory resulted in the identification of a variety of problems that reduced the efficiency of signal operation and contributed to traffic delays (including detector failures, missing or malfunctioning master controllers, and odd signal phasing). Most of the identified problems were maintenance issues that could be addressed at relatively low cost.

As a result of the improvements implemented thus far in response to the short-term recommendations, significant reductions in travel time were achieved in a number of locations. For the PM Peak Hour, travel times for southbound traffic were reduced most significantly between Rosemont Drive and Dudley Road (58%) and between Beechwood Road and Expressway Plaza (51%). During the PM Peak Hour for northbound traffic, travel reductions greater than 50% were measured for segments from approximately Parkside Drive to Turfway Road (61%), Montgomery Drive to Kenton Lands Road, (71%), and Arcadia Avenue to Buttermilk Pike (58%). Similar travel time reductions can also be expected for some segments for traffic during the AM Peak Hour. Based on available data, it would be reasonable to expect an overall decrease in travel time for the length of the corridor of approximately 10%.

MID-TERM RECOMMENDATIONS

(FOR IMPLEMENTATION WITHIN THE NEXT FIVE YEARS)

The following recommendations focus primarily on changes to the traffic signal system and on studies to identify solutions for specific problems. The recommended changes to the signal system represent the single most effective strategy for reducing travel time on Dixie Highway. The recommended signal system changes would produce the greatest degree of improvement in traffic flow in the shortest amount of time. The recommended studies would identify solutions for addressing problem conditions documented in this study.

Closed Loop Signal System

A closed loop system would expedite traffic flow on Dixie Highway by enabling signals to respond more efficiently to daily fluctuations in traffic volumes. In addition, a closed loop system could reduce the delays caused by signal malfunctions and provide the potential to further improve traffic flow and safety through remote control of signal changes and an interconnect with ARTIMIS (to respond to traffic surges from I-71/75).

With a closed loop system, signals would be programmed so that changes in the traffic volume identified at the system detectors would readjust the timing of the entire system. That is, signal timing would operate based on traffic volume instead of time of day. Throughout the peak and non-peak periods that typically occur on a daily basis, the signal timing would automatically readjust to expedite traffic flow and prevent traffic back-ups.

The closed loop system would further enhance traffic flow by its ability to identify malfunctions that cause traffic delay. The system includes a capability to provide remote monitoring and notification of problems that can be addressed by maintenance, such as detector failures. A closed loop system would also allow for the installation of additional equipment that would further enhance traffic flow on Dixie Highway such as a traffic camera system and ARTIMIS interconnection as recommended below.

Implementation of a closed loop signal system would involve converting the existing system by the addition of certain hardware devices and new software to manage traffic patterns typical of Dixie Highway. In the process of converting to a closed loop system, each signal location should be evaluated to determine if it is warranted, and the system division should be reevaluated to ensure that the signals are optimally coordinated.

The improved movement on Dixie Highway would involve somewhat more delay on the side streets, but the overall travel time would be decreased significantly. The implementation of the recommended closed loop system could reduce delays by 10-30% compared to existing travel times conducted at the beginning of this study.

Traffic Camera System (requires closed loop signal system)

The addition of a camera system to a closed loop signal system would further reduce delays by enabling signals to be adjusted from a remote location. More specifically, cameras would enable changes in traffic flow to be identified and managed from a centralized signal management center. Because the camera feed can be viewed anywhere, the management center could be

located at the KYTC District 6 office or at the Traffic Operations Center in Frankfort, as preferred.

This recommendation requires the installation of cameras to provide full coverage of the Dixie Highway Corridor. The broadcasting media should be selected based on a cost-benefit analysis. The addition of a traffic camera system would improve the response time to traffic problems and system malfunctions, and would expand the capabilities of the closed loop system, improving the benefits experienced from it.

ARTIMIS Interconnection (requires closed loop signal system)

It is recommended that the closed loop signal system be tied into ARTIMIS. The unpredictable surges of traffic onto Dixie Highway during I-71/75 freeway incidents overwhelm the normal operation of the Dixie Highway signal system. An ARTIMIS interconnection would allow the traffic signal timing on Dixie Highway to be changed from a remote location to accommodate this additional traffic. ARTIMIS operators could make these adjustments before back-ups occur. Modeling indicates that the interconnection could improve travel time on Dixie Highway by 10% to 20% under the conditions that occur during freeway events.

Signal Preemption for Emergency Vehicles

It is recommended that signal preemption be provided for emergency vehicles. Signal preemption enables traffic signals to immediately allocate a green light at the approach of an emergency vehicle. For Dixie Highway, it is recommended that signal preemption be provided by sound-activated sensors installed with traffic signals. These sensors would detect the sirens from emergency vehicles from any of the various jurisdictions using Dixie Highway. This recommendation is supported by police, fire, and EMS operators in the corridor and is expected to improve response time of emergency personnel and improve safety at intersections (a study of Colerain Avenue in Hamilton County showed that the EMS travel time was decreased by as much as 22%).

Signal Hardware Improvements

For a few intersections, signal operation on Dixie Highway could be improved by adding, eliminating, or re-locating signal devices. Specific recommendations are as follows:

- *Fortside Drive* - removal of a pressure sensor (to prevent confusion by the loop detector) and relocation of a traffic signal (to provide better visibility at the intersection; the signal for westbound traffic is currently directed toward a building rather than the driveway)
- *St. John's Road/Ridge Road* - relocation of eastside loops (to be moved further back to improve signal operation on Dixie Highway)
- *Beechwood Avenue* - addition of a detection device in the private driveway opposite Beechwood (to improve safety and improve signal operation on Dixie Highway)
- *SB I-71/75 ramp in Fort Mitchell* - relocation of detectors on the westbound approach (to be moved further forward and improve signal operation on Dixie Highway)
- *Winding Way* - relocation of detectors on the east side of the intersection (to be moved further back and improve signal operation on Dixie Highway)

Access Management Plan

It is recommended that local governments participate in the development and implementation of a long-range plan for access management along the Dixie Highway Corridor. The plan would expedite efforts to manage access and insure a coordinated approach to access management along the corridor. It would link access management to opportunities provided by future redevelopment. The access management plan would include a development plan for Dixie Highway (as the basis for access management standards) and would establish standards and regulations for managing access.

Implementation of access management improvements in an urban area that is already developed is a long-term process. This study facilitates access management with information and design scenarios for improving access at approximately 100 locations in the corridor (provided in the full report). The recommended access management plan, which will be developed through the coordinated efforts of OKI and NKAPC, will provide the basis for a sustained and systematic effort to improve access along Dixie Highway. The level of improvement that can be realized by the implementation of access management changes is difficult to measure, but such improvements will have an incremental effect in reducing accidents in commercial areas along the corridor and improving travel time.

Study of On-Street Parking

A study is recommended to assess options for eliminating on-street parking, which currently contributes to congestion and safety problems on Dixie Highway. Two locations are of particular concern: near Montague Avenue and near Orphanage Road. The study would make recommendations for eliminating on-street parking in these two locations based on a review of parking options and the impacts on residents and businesses. Elimination of on-street parking could expand capacity up to 60% at these locations.

Pedestrian Improvements

Measures that improve safety for pedestrians and reduce the duration of pedestrian exposure in the roadway also improve traffic flow and safety. The following pedestrian improvements are recommended:

- *Crosswalk markings* – It is recommended that all crosswalks be clearly delineated with striping and signage in order to enhance safety for both pedestrians and vehicles, and also that crosswalks be reviewed to ensure the shortest possible crossing, which would in turn minimize exposure of pedestrians to vehicle traffic and minimize the pedestrian clearance interval.
- *Pedestrian pushbuttons and signal heads* – Pedestrian pushbuttons are recommended for optimizing the safety of pedestrian crossings and also optimizing the traffic signal "green time" on Dixie Highway. This device is recommended for 23 locations.
- *"Countdown" pedestrian signal heads* - It is recommended that the Kentucky Transportation Cabinet include Dixie Highway in its current effort to install "countdown" pedestrian signal heads in Northern Kentucky.

Management Issues for Consideration

Two areas where initiative is needed from local institutions or organizations involve the impacts of schools and buses on Dixie Highway traffic conditions. School and TANK officials could help

reduce congestion and improve safety on Dixie Highway, but the issues recommended for their consideration may be difficult to implement.

In addition, KYTC is asked to consider changes to the traffic signal clearance interval timings along the corridor. The clearance interval refers to the length of time during which a traffic signal displays the yellow or all-red indication. Implementation of this recommendation would work to improve the safety of the corridor.

- *Staggering of School Hours* - It is recommended that consideration be given to staggering the starting and ending times of the schools along Dixie Highway, especially those in close proximity to other schools.
- *Review of Bus Stops* - It is recommended that TANK review its approximately 100 bus stop locations to determine if some can be eliminated. Also, TANK should review options for providing bus bump-outs, which would remove buses that are stopped or loading from the roadway.
- *Clearance Intervals* – It is recommended that KYTC review the allotted time for the yellow and all red intervals provided along Dixie Highway. This study inventoried the time currently allocated for each approach and presents recommended clearance interval timings for each signal location (provided in the full report).

LONG TERM RECOMMENDATIONS

(FOR IMPLEMENTATION WITHIN THE NEXT TEN YEARS)

The following recommendations focus on changes to the infrastructure of Dixie Highway. Many of the recommendations involve spot geometric improvements that would enhance traffic flow and decrease the number of accidents along the corridor. These include the realignment of offset intersections, the addition of turn lanes, and reconstruction of a railroad overpass. In addition, a recommendation is made to extend the ARTIMIS system onto Dixie Highway to reduce congestion related to incidents.

Realignment of Offset Intersections

Based on analysis conducted as part of this study, several offset intersections are recommended for realignment so that they would form normal four-legged intersections (details in full report) and provide horizontal and vertical alignment that meets applicable design and sight distance standards. In addition, left turn lanes should be constructed at intersections during realignment. The following streets are recommended for realignment with Dixie Highway.

- *McAlpin Avenue/Garvey Avenue*
- *Goodridge Drive/Bustetter Drive*
- *Eastern Avenue/Kentaboo Drive*
- *Sunnymede Drive/Requardt Lane*
- *Virginia Avenue/Superior Drive*
- *Pleasant Ridge Avenue/Church Driveway*
- *Kyles Lane/George Huser Drive*

The realignment of these intersections will decrease the time lost at these intersections related to existing signal timing and will decrease the potential for accidents.

Addition of Turn Lanes

The addition of turn lanes, especially left turn lanes, would greatly benefit the traffic flow on Dixie Highway. Dedicated turn lanes allow turning traffic to exit the traffic flow ahead of the turn, thus allowing through traffic to continue unimpeded. This type of improvement is not possible at many locations, because of lack of available right-of-way or the high cost to purchase right-of-way. It is recommended that turn lanes be installed at the following intersections where these issues are not prohibitive.

- *Beechwood Road* – add a northbound left turn lane from Dixie Highway
- *Highland Avenue* – add a southbound left turn lane from Dixie Highway
- *Dudley Road* – add a northbound right turn lane from Dixie Highway

The addition of turn lanes at these locations will result in a decrease in delay at these sites by as much as 50%. In addition, the potential for congestion related accidents at these intersections will be reduced.

Reconstruction of Railroad Overpass

The bridge located just north of the intersection of Commonwealth Avenue and Dixie Highway should be redesigned to be a single span, eliminating the support in the middle of the roadway. In addition, the vertical alignment at this location should be improved at the same time.

The decrease in congestion that would result from this improvement is difficult to determine, but the number of accidents at this location would be significantly reduced. The improvements in sight distance for northbound and southbound traffic is expected to reduce accidents at the intersections of Dixie with Commonwealth, Erlanger, Alice and Hallam.

Access Management Improvements

Access spacing (spacing of curb-cuts, driveways, intersections) is a key contributor to traffic flow and safety, since vehicles entering and exiting the roadway require adjustments on the part of passing drivers. Angle-type accidents are common where access is poor or confusing. A number of access issues, such as groups of closely-spaced driveways, have been identified in the Dixie Highway Corridor as part of this study.

In this study, an access management plan is recommended under mid-term recommendations, and information and design scenarios for improving access are presented for approximately 100 locations in the corridor (in the full report). For some high-accident locations, access management issues would be addressed by the realignment of intersections, addition of turn lanes, or implementation of other improvements recommended in this plan, but the following recommendations would specifically improve access management at sites with high accident rates that are not otherwise addressed by plan recommendations.

- *Kenton Lands Road to Edgewood Road* (19.11 accidents per million vehicle miles) – eliminate one driveway, install five right-in/right-out islands, and implement a cross easement in one location

- *Turfway Road to Bustetter Dr./Goodridge Dr.* (16.47 accidents per million vehicle miles) - eliminate two driveways and install one right-in/right-out island

- *Kyles Lane to Sleepy Hollow Drive* (8.10 accidents per million vehicle mile) – close three driveways, install one right-in/right-out island, and reconfigure one piece of property to become an access roadway

Study of ARTIMIS Extension

It is recommended that the ARTIMIS system be extended onto Dixie Highway to provide drivers on both Dixie Highway and I-71/75 with real-time information on conditions on both routes. Delay and congestion would be reduced by the use of this information as a basis for travel decisions. As a first step for extending ARTIMIS to Dixie Highway, a study would be needed to determine logistics and technology needs. This study would evaluate the area and recommend technologies for installation (e.g., detectors, cameras, Dynamic Message Signs, etc.), the means of connecting field devices to ARTIMIS and relaying information to the KYTC Traffic Operations Center, and standard protocol. ARTIMIS has been well documented for its benefits in reducing congestion and improving emergency response time and safety on Cincinnati area freeways. An ARTIMIS extension would greatly benefit the Dixie Highway Corridor.

BENEFITS

In general, the benefits of implementing this study's recommendations will be realized by increased capacity on Dixie Highway (increase in traffic throughput), reduced travel time, and improved safety. If all of the improvements recommended for the next five years were to be implemented, their combined effect on travel from one end of the corridor to the other would be to reduce travel time by an estimated 30%, with a similar benefit for increased throughput.

The recommendations that produce the greatest overall improvement for travel on Dixie Highway are related to the traffic signal system. In addition to signal improvements already implemented as a result of this study, installation of the recommended closed loop system would produce even greater benefits. In addition to traffic signal system improvements, other study recommendations can bring about significant improvements at specific locations (such as problem intersections) or under certain conditions (such as the occurrence of traffic surges in response to freeway incidents), as indicated in the following table and summarized below.

For the short-term signal improvements, recommendations for maintenance and signal timing improvements already implemented by KYTC have reduced overall travel time (i.e., travel for length of the corridor) by an estimated 10% during PM travel peak. This estimate is based on a travel time study for the length of the corridor in which driving times after improvements were implemented were compared with driving times before the improvements were implemented. The travel time study revealed a detector failure at Garvey Avenue, which caused increased delay and offset some of the improvements, so that the reduction in travel time is presented as an

estimate rather than a measure of actual improvement. For some segments, however, travel time reductions measured more than 50%.

For the mid-term and long-term recommendations, an additional reduction in travel time of 10-30% for the length of the corridor can be expected following the implementation of a closed loop system and related changes in signal timing. Additional benefits would be realized during traffic surges from recommendations for a camera system and ARTIMIS interconnect. Additional benefits would also be realized as the result of site-specific recommendations, such as signal hardware improvements, the removal of on-street parking (expected to expand capacity in these locations by as much as 60%), the emergency vehicle preemption system (to result in a reduction in the travel time of emergency vehicles by up to 22%), and the construction of recommended turn lanes (to decrease delay in these locations by as much as 50%).

Implementation of the study's recommendations will also improve safety, both at high-accident locations and for the corridor overall. The recommendations that will affect safety most directly are those that involve access management, intersection realignments, and the railroad bridge reconstruction.

MID-TERM RECOMMENDATIONS

RECOMMENDATION	DISCUSSION	BENEFITS	COST*
CLOSED LOOP SIGNAL SYSTEM	Signal system will react to daily fluctuations in traffic, allow remote operation of the system, and notify operators of maintenance issues; need to review signal system division & traffic signal warrants	Signal timing that suits traffic best can offer a 10%-30% decrease in travel times+	$100,000
TRAFFIC CAMERA SYSTEM	In order to adequately implement remote timing plans, it is necessary to see the traffic conditions	Camera systems would allow operators to see the real time traffic conditions. Improve the efficiency of the Closed Loop System	$2,500/camera, plus broadcasting – corridor will need to be evaluated to determine # of cameras & best broadcasting options
ARTIMIS INTERCONNECTION	Would allow traffic signal timing to be remotely changed to accommodate additional freeway traffic diverted due to freeway incident. Would require signal timing plans to be developed	Based on Synchro traffic models, travel time would decrease by 10%-20% (during overflow events) with the implementation of improved timing+	$80,000
SIGNAL PREEMPTION FOR EMERGENCY VEHICLES	System to allow the signals to immediately give a green light to approaching emergency vehicles	Will improve response time by emergency vehicles; does not detrimentally impact progression on main street. Study on Colerain Avenue resulted in a 22% decrease in EMS travel time+	$500,000
SIGNAL HARDWARE IMPROVEMENTS			
• Fortside & Dixie	A pressure sensor has been found at the intersection of Fortside & Dixie; the westbound traffic signal is aimed at the building, not at the driveway	Pressure sensor removal will remove any possible confusion between this detector and the actual loop detector; moving WB signal head will provide better visibility	$15,000
• St. John's & Dixie	EB loop detectors are set too far forward; vehicles will eventually run the light	Vehicles could potentially stop behind the loops, never requesting the signal; will improve the operation of the traffic signal	$6,000
• Beechwood & Dixie	No detection provided for the private driveway opposite Beechwood Drive; vehicle must run the red light to enter traffic stream	Will allow vehicles in this private drive to place a call for the signal; will improve the operation of the traffic signal	$2,000
• Winding Way	WB loop detectors are set too far forward; vehicle will eventually run the light	Vehicles could potentially stop behind the loops, never requesting the signal; will improve the operation of the traffic signal	$6,000

• SB I-75 Ramp & Dixie	Detectors on the SB I-71/75 ramp are set too far back; vehicles will eventually run the light	Vehicles could potentially stop in front of the loops, never requesting the signal	$6,000
ACCESS MANAGEMENT PLAN	Complete a study to provide a development plan on Dixie Highway and establish standards and regulations for managing access	Reduction in the number of driveways on Dixie will reduce the frequency of accidents. The study will provide a plan to facilitate access management	$125,000
STUDY OF ON-STREET PARKING	Complete a study to assess options for eliminating on-street parking	On street parking reduces capacity on Dixie, reduction or removal could greatly improve capacity. Near the Montague/Western intersection, removal of parking could improve the capacity of this segment by up to 60%+	$100,000
PEDESTRIAN IMPROVEMENTS			
• Crosswalk Markings	Pedestrian crosswalks not adequately delineated in all locations; some crosswalks not optimally placed to minimize pedestrian exposure	Improves pedestrian safety	-
• Pedestrian Pushbuttons & Signal Heads	Pedestrian signal heads do not rest in "WALK", therefore pushbuttons should be provided for all signal heads associated with the main street	Allows the Dixie Highway pedestrians to request the "WALK" signal; promotes continuity throughout corridor	$150,000
• "Countdown" Pedestrian Heads	KYTC has been installing "countdown" pedestrian signal heads throughout Northern Kentucky	Promotes continuity throughout Northern Kentucky	$300,000
MANAGEMENT ISSUES FOR CONSIDERATION			
• Staggering of School Hours	Starting and ending times for schools along Dixie Highway need to be reviewed. Several schools have similar starting and ending times	Will reduce the number of vehicles on Dixie during the AM Peak Hour, stagger vehicles throughout Peak	
• Review of Bus Stops	Review the number and location of bus stops along the corridor. Several have been added over the years, appears none have been consolidated/removed. Consider use of bus pullouts	Bus pullouts will remove buses out of roadway while stopped, decreasing bottlenecks. Removing/consolidating bus stops will reduce the number of times buses stop	
• Clearance Intervals	KYTC should review the yellow and all-red times for each intersection. Several intersections have shorter clearance intervals than necessary	Will increase the safety of each intersection. Yellow and all-red time allows vehicles to safely enter and clear the intersection	

LONG TERM RECOMMENDATIONS

RECOMMENDATION	DISCUSSION	BENEFITS	COST*
REALIGNMENT OF OFFSET INTERSECTIONS			
• McAlpin/Garvey & Dixie	Realign existing intersection to form a normal four approach intersection	Decrease in lost time at the intersection because east and west approaches can run together, decrease in accidents at intersection	$450,000
• Goodridge/Bustetter & Dixie	Realign existing intersection to form a normal four approach intersection	Decrease in lost time at the intersection because east and west approaches can run together, decrease in accidents at intersection	$325,000
• Eastern/Kentaboo & Dixie	Realign existing intersection to form a normal four approach intersection	Decrease in lost time at the intersection because east and west approaches can run together, decrease in accidents at intersection	$600,000
• Sunnymede/Requardt & Dixie	Realign existing intersection to form a normal four approach intersection	Decrease in accidents at intersection	$400,000
• Virginia/Superior & Dixie	Realign existing intersection to form a normal four approach intersection	Decrease in accidents at intersection	$600,000
• Pleasant Ridge/Church Driveway & Dixie	Realign existing intersection to form a normal four approach intersection	Decrease in lost time at the intersection because east and west approaches can run together, decrease in accidents at intersection	$120,000
• Kyles/George Huser & Dixie	Realign existing intersection to form a normal four approach intersection	Decrease in lost time at the intersection because east and west approaches can run together, decrease in accidents at intersection	$1,450,000
ADDITION OF TURN LANES			
• Dudley/Summit & Dixie	Provide a NB right turn lane. Large backups in the NB rightmost lane as several vehicles attempt to turn right onto Dudley Road. Right-of-way for the additional lane is available in this location	Decrease in right turning vehicles blocking the right through lane. Could decrease delay at intersection by up to 50%+	$275,000

• Beechwood Road	Provide a NB left turn lane. Large backups in the NB leftmost lane as several vehicles attempt to turn left onto Beechwood Road. Right-of-way for the additional lane is available in this location	Decrease in left turning vehicles blocking the left through lane. Could decrease delay at intersection by up to 50%+	$200,000
• Highland Avenue	Provide a SB left turn lane. Large backups in the SB leftmost lane as several vehicles attempt to turn left onto Highland Avenue. Right-of-way for the additional lane is available in this location	Decrease in left turning vehicles blocking the left through lane. Could decrease delay at intersection by up to 50%+	$200,000
RECONSTRUCTION OF RAILROAD OVERPASS	Replace the existing railroad bridge located to the north of Commonwealth & Dixie with a single span. Review the vertical alignment of Dixie in this area	Increased sight distance for SB & NB traffic. Reduction in accidents at intersections of Dixie with Commonwealth, Erlanger, Alice & Hallam	$5,000,000
ACCESS MANAGEMENT IMPROVEMENTS			
• Kenton Lands Road to Edgewood Road	Control access conditions to improve safety and traffic flow. Elimination of one driveway, installation of five right-in/right-out islands, and implementation of a cross easement in one location	Reduction in the frequency of angle-type accidents from the current 19.11 per million vehicle miles	$100,000
• Turfway Road to Bustetter Dr./Goodridge Dr.	Control access conditions to improve safety and traffic flow. Elimination of two driveways and installation of one right-in/right-out island	Reduction in the frequency of angle-type accidents from the current 16.47 per million vehicle miles	$20,000
• Kyles Lane to Sleepy Hollow Drive	Control access conditions to improve safety and traffic flow. Closure of three driveways, installation of one right-in/right-out island, and reconfiguration of one piece of property to become an access roadway	Reduction in the frequency of angle-type accidents from the current 8.10 per million vehicle miles	$300,000
STUDY OF ARTIMIS EXTENSION	Study to review possibility of extending the ARTIMIS system onto Dixie Highway. Review of hardware necessary to extend system	ARTIMIS system has greatly reduced fuel consumption, number of fatalities, and emergency response time on Cincinnati area freeways	$250,000

*Costs represent estimates for construction only
+Traffic signal improvement listed is for this improvement only. Improvement percentages are not cumulative, but a combination of recommendations will result in improved conditions