



KENTUCKY TRANSPORTATION CENTER

SAFETY EVALUATION OF NEW ROADS





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Research Report
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SAFETY EVALUATION OF NEW ROADS

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EXECUTIVE SUMMARY

The primary objective of this research study was to evaluate the crash history of bypass routes to determine if there were unusual patterns or changes in the crash history on these routes over the first years of operation. The focus of the evaluation was to collect data at bypass routes opened in recent years in Kentucky. Crash patterns were summarized with recommendations made for countermeasures to reduce the probability of crashes, specifically at intersections, with an emphasis on the early stages of operation. The literature was reviewed, crash data were obtained at nine case study bypasses, and discussions were held with representatives from traffic, design, and construction at various district offices across Kentucky.

The analysis found that the crash rates on the bypass routes are generally lower than statewide rates for the same type of highway. The exception was a higher fatal rate in a few instances. The large majority of crashes occurring on these routes have been at intersections. All of the fatal crashes were at intersections. The most common types of crashes have been an angle crash at stop approaches and rear end crashes at intersections with a traffic signal. There were several opposing left turn crashes at some signalized intersections. The angle crashes at the stop controlled intersections typically involved a driver stopping and then pulling into the path of a vehicle on the bypass. A driver disregarded the stop sign in only a small number of these crashes.

The major change in traffic control which has occurred at the intersections after the opening of the bypasses has been the installation of a traffic signal with this resulting in a large reduction in angle crashes. The occurrence of a large number of crashes immediately after the opening of a bypass was not generally found. The two fatal crashes which occurred on the Morganfield bypass in the first few weeks after opening, in which local drivers disregarded a stop sign, were exceptions to the typical crash pattern found at the other locations.

Recommendations were developed in the general areas of: public information, enforcement, traffic control and design. The recommendations were further divided into those which should be done and those which may be used. The recommendations relate to intersections since this is where the large majority of crashes, especially those resulting in serious injuries, occurred.

1.0 INTRODUCTION

Bypass routes continue to be built around urban areas in Kentucky. Roadways are also being reconstructed with new alignments. Both bypasses and reconstructing roads with new alignments result in new intersections on existing routes. Typically, the objectives of bypass routes are to relieve traffic congestion and improve overall safety of the affected areas. Economic factors may also affect the decisions to construct a bypass or new road. However, the construction of these roads creates new intersections which may conflict with established patterns and habits of local drivers. The combination of an unfamiliar highway and driver-related inadequacies may result in initial safety and operational issues for new routes.

The primary objective of this research was to evaluate the crash history of bypass routes to determine if there were changes in the crash history on these routes over the first years of operation. The focus of the evaluation was to collect data at bypass routes opened in recent years in Kentucky. Crash patterns were summarized with recommendations made for countermeasures to reduce the probability of crashes, specifically at intersections, with an emphasis on the early stages of operation of the new roadway.

2.0 PROCEDURE

The study consisted of the following tasks: a) reviewing the literature to identify past studies in this area, b) collecting crash data at a sample of case studies, and c) meeting with personnel at the highway district offices to solicit input on problems encountered and potential countermeasures. Recommendations were made by the Division of Traffic for case study bypass routes. A few additional routes were also selected. The meetings in the various district offices included representatives from the areas of traffic, design, and construction in order to obtain input based on a broad range of experience. For highway districts with a case study bypass included in the analysis, the opening date for the bypass was obtained as well as a history of the traffic control measures in place when the road was opened and traffic control added later.

3.0 RESULTS

3.1 Review of Literature

There have only been a limited number of studies dealing with the safety aspects of bypasses. However, in the general area of intersection safety, there has been substantial research concerning the traffic control and design of at-grade intersections. Typical traffic control measures at stop approaches are to place more signs, increase the size of signs, place pavement markings, install rumble strips, or install an intersection beacon. More innovative treatments include: designs such as indirect left-turn movements and roundabouts or traffic control measures such as active warning signs directed at reducing the speed of vehicles on the major roadway.

3.2 Case Studies

Data were obtained for nine bypasses constructed in the past few years across Kentucky. The data included crash history, a summary of the traffic control measures taken when the bypass was first opened, and changes in traffic control made since the opening in response to problem areas. Following is a summary of the analyses at the various bypasses. The first year of crash data available for use in the analysis was 1995. Comparisons were made between the crash data at these locations with statewide data. One type of comparison was the percentage of crashes at intersections. The statewide average for intersection-related crashes on “non-interstate and parkway” roadways is 35 percent with the percentage 23 percent in rural areas and 46 percent in urban locations.

3.2.1 Hopkinsville Bypass

The Hopkinsville bypass connects US 68 on the east and west sides of Hopkinsville. There is a connecting road (KY 1682) at the end of the bypass on the west side of Hopkinsville which continues north to KY 107. The length of the portion of the bypass included in the analysis is about 11 miles. A short portion (between US 41A and KY 107) was opened in 1995 with the remainder opened in 1998.

The bypass has four lanes with a depressed grass median. The speed limit is 55 mph. It is classified as a principal arterial with about 60 percent rural and 40 percent urban. There is a wide range in traffic volume from about 5,000 to 17,000 vehicles per day with a weighted volume for the total length of the bypass of about 9,000.

The bypass has partial control of access with a limited number of at-grade intersections with state and local roads. There are eight intersections with other state maintained roads with seven of the intersections having a traffic signal and one an intersection beacon. All of the signals, except the one at KY 695, were installed when the bypass was opened. The KY 695 intersection originally had a stop sign with an intersection beacon which was replaced with a signal after a fatal crash. There was not a crash history or traffic volume which would have met typical warrants for a traffic signal at the KY 695 intersection. There are no beacons at the few intersections with non-state maintained roads.

There were press releases with substantial publicity when the bypass was opened along with emphasis on enforcement. Variable message signs were used as a temporary traffic control device. Rumble strips were placed on approaches where a stop was not required previous to the opening of the bypass.

A left turn phase has been added at the US 41A intersection with no other signals currently having a separate phase for left turns. Sight distance is not limited at the intersections but there have been comments that the offset left turn lanes can result in an opposing left turning vehicle restricting sight distance.

Following is a summary of the number of traffic crashes from the opening of the first section of the bypass through June 2002. The first year with complete data is 1999. The milepoint locations of the crash data given on the crash reports are not consistent which made identifying all crashes difficult. Also, different route numbers and names have been listed on the crash reports when referring to the bypass.

<u>YEAR</u>	<u>TOTAL</u>	<u>INTERSECTION</u>	<u>INJURY</u>	<u>FATAL</u>
1995	4	0	0	0
1996	2	1	1	0
1997	4	2	1	0
1998	3	2	0	0
1999	26	15	6	1
2000	21	11	6	1
2001	24	12	10	2
2002 (January-June)	13	11	4	2
Total	97	54	28	6

The crash rate for the three-year period of 1999 through 2001 was 65 C/100MVM. This compares to a statewide rate of 124 C/100MVM for rural four-lane divided (non-interstate and parkway) highways. The number of crashes per year has remained fairly stable since 1999.

There have been six fatal crashes on the bypass for which a report could be identified. All were at intersections with three at KY 107 and one each at KY 695, US 41, and US 41A. The crash at KY 695 was a right angle which occurred when a driver stopped at the stop sign and then pulled into the path of a vehicle on the bypass. One of the crashes at the KY 107 was an opposing left turn. The remaining four crashes involved a driver disregarding a red indication at a traffic signal. The fatal crash rate for 1999 through 2001 was 3.7 C/100MVM compared to a statewide rate of 1.3 C/100MVM on this type of road. The injury rate was 26 C/100MVM compared to a statewide rate of 38 C/100MVM.

Following is a summary of the number of crashes at major intersections. About 56 percent of the crashes occurred at an intersection which is a low percentage when compared to the other bypasses. Approximately 22 percent of these crashes occurred during non-daylight hours. The most common non-intersection crash involved a collision with a deer.

<u>Intersection</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>Total</u>
KY 107	0	0	0	5	4	6	5	20
US 41A	1	2	2	1	2	2	0	10
KY 272	0	0	0	4	2	0	1	7
KY 695	0	0	0	2	2	1	2	7
US 41	0	0	0	1	1	1	1	4

The data show the highest number of crashes has occurred at the KY 107 intersection.

The most common type was an opposing left turn collision involving vehicles on the bypass with 12 this type of crash. Seven of the 10 crashes at the US 41A intersection were rear end with a fatal and injury angle crash involving a driver disregarding the red indication. Five of the seven crashes at the KY 272 intersection involved an opposing left turn with the remaining two right angle crashes in which a driver disregarded the red signal. The two crashes at the KY 695 intersection in 1999 were angle collisions occurring prior to the traffic signal. In both of these crashes (one fatal) the driver stopped and then pulled into the path of a vehicle on the bypass. Of the five crashes after the signal was installed, two were rear end, one was an opposing left turn, one was an angle with an emergency vehicle entering against a red indication, and one involved a driver turning at too high a speed onto the side road and sideswiping a stopped vehicle.

3.2.2 Morganfield Bypass

The Morganfield bypass connects US 60 on the east and west sides of Morganfield. The length of this portion of the bypass is about 3 miles. There is an extension of the bypass (KY 3393) from US 60 on the west side of Morganfield to KY 56. The bypass was opened in January 2002. The bypass has two lanes with full width shoulders. The speed limit is 55 mph. It is classified as a rural principal arterial.

The bypass has partial control of access. There are intersections with US 60 on both ends and with KY 56 and KY 2091. The intersection with US 60 west of Morganfield has a traffic signal. Intersection beacons were placed at the other US 60 intersection and the KY 56 intersection when the bypass opened and were added at the KY 2091 intersection.

There were press releases and other publicity prior to the opening of the bypass. A substantial amount of law enforcement was present after the opening. Variable message signs with the message that there was a stop ahead were placed on the stop approaches. The stop signs were placed prior to opening and uncovered about one week before the official opening of the bypass. Rumble strips were installed on the side road stop approaches. Thermoplastic material was used for the rumble strips to obtain both an audible and visual warning.

There were three angle collisions within the first month of the opening. Two of these were fatal crashes at KY 2091 with the remaining crash at KY 56. All were during daylight conditions. The two fatal crashes at KY 2091 involved local drivers not stopping at the stop sign with one on each side street approach. There is over 1,000 feet of sight distance on both approaches with warning provided by rumble strips, a stop ahead sign, and a stop sign. A variable message sign warning of the stop condition was also in operation when the two fatal crashes occurred. The stop and stop ahead signs were later dual mounted with an intersection beacon installed. The driver at KY 56 stopped and pulled in front of a vehicle on the bypass.

After these three crashes, there were only two other crashes (both were non-injury) in the first six months of the bypass operation. One was a rear end at the signal at US 60 west of

Morgantown. The other was a right angle collision in which a driver stopped at the KY 56 intersection and pulled into the path of a vehicle on the bypass. The driver gave the explanation that he thought the intersection was a four-way stop although there was a “cross traffic does not stop” sign placed under the stop sign.

3.2.3 Somerset Bypass

The Somerset bypass (KY 917) connects US 27 (south of Somerset) and KY 80 (east of Somerset). The length of the bypass is about 7.1 miles. The section starting at US 27 extending about one-half the total length of the bypass (milepoint 0 to 3.5) was opened in July 1995. This is a four lane divided section with a depressed grass median and has a functional classification of urban principal arterial. The remaining portion (milepoint 3.6 to 7.1), which ends at KY 80, was opened in July 1997. This is a two-lane section and has a functional classification of rural principal arterial.

The speed limit is 55 mph for the total length of the bypass. The traffic volume varies from about 10,000 to 15,000 vehicles per day with a significant truck volume. The weighted volume is about 11,000. The area adjacent to the bypass is mostly rural.

The bypass has partial control of access with a limited number of at-grade intersections with state and local roads. There are currently five intersections with traffic signals. None of the remaining intersections have an intersection beacon. Traffic signals were installed at the US 27, KY 80, and KY 192 intersections when the bypass was opened. Signals were later added at the KY 769 and KY 1247 intersections.

There was limited newspaper and radio publicity when both sections of the bypass were opened but no concentrated efforts. Specific increased enforcement has not been requested at any time. The only temporary traffic control used at any of the intersections was variable message signs on KY 769 warning of the stop condition for one to two weeks after opening.

The only location which has been the source of citizen complaints related to safety was the KY 769 intersection which is in the two lane section opened in July 1997. A traffic signal was added in September 1998 with an advance warning flasher added in December 2001. The traffic signal at KY 1247 was placed due to traffic volumes. There have been no other specific signs, signals, or markings placed in response to a safety issue.

Following is a summary of the number of traffic crashes from the opening of the first section of the bypass in July 1995 through June 2002.

<u>YEAR</u>	<u>TOTAL</u>	<u>INTERSECTION</u>	<u>INJURY</u>
1995	7	5	2

1996	1	1	0
1997	35	27	14
1998	31	17	11
1999	31	14	10
2000	27	22	15
2001	43	35	16
2002 (January-June)	14	10	8
Total	189	131 (57 injury)	76

All but two of the 27 crashes at intersections in 1997 occurred in the six months after the complete bypass was opened. All but five of these crashes involved an angle collision. There was no indication in any of the crash reports that a driver failed to observe a stop sign. The statements of the drivers who stopped and pulled into the path of a vehicle on the bypass were either that they did not see that vehicle or they thought there was adequate time to cross the road.

The crash rate for the five-year period of 1997 through 2001 was 117 C/100MVM. This compares to statewide rates of 123 C/100MVM for rural, four lane divided (non-interstate) roadways and 252 C/100MVM for rural, two lane roads.

There have been five reported fatal crashes on the bypass. All were at intersections with three at KY 769, one at KY 1247 and one at KY 2302. The fatal crashes at KY 769 were right angle with one prior to the addition of the traffic signal (in which the driver on KY 769 did not stop) and two after the signal was installed. Both of the crashes which occurred after the signal installation involved a vehicle disregarding the red signal, and these crashes were factors in the addition of advance warning flashers at this location. The fatal crash at KY 1247 was in 1995 and involved a right angle collision. The fatal crash at KY 2302 occurred in 2001 and involved an opposing left turn collision with both vehicles on KY 914.

The fatal crash rate for 1997 through 2001 was 2.8 C/100MVM which compares to statewide rates of 1.4 C/100MVM for rural, four lane divided (non-interstate) and 3.0 C/100MVM for rural two lane roads. The injury crash rate of 46 C/100MVM compares to statewide rates of 40 C/100MVM for rural, four lane divided (non-interstate) and 85 for rural, two lane roadways.

Following is a summary of the number of crashes at the major intersections. About 69 percent of the crashes on the bypass occurred at an intersection. This high percentage occurring at intersections is consistent with the other bypasses and shows where the emphasis in safety improvements should be made.

<u>Intersection</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>Total (I*)</u>
KY 769			5	9	2	1	4		21 10

KY 1247S**			3	1	3	6	5	2	19	10
KY 1247N**	3		4			1	3	1	12	9
KY 192			1	1	2	6	4		14	5
Enterprise Drive	1	1	6	3			1	2	14	8
KY 1642	1		4	2	2	1	2		12	3
US 27			3	1	1	3	4		12	2
KY 80			1		3	2	6		12	1
KY 2302							2	2	4	3

- Injury crash

** The KY 1247S intersection does not have a traffic signal. A signal was installed at the KY 1247N intersection in March 1998.

The data shows that the highest number of crashes occurred at the KY 769 intersection which was opened in July 1997. Following is a description of the crashes at this intersection. There were four crashes in the first month. Almost all of the crashes (17 of the 21) were right angle involving a vehicle on KY 769 failing to yield to a vehicle on the bypass. The number was reduced dramatically when the traffic signal was added on September 28, 1998 but some severe crashes continued to occur involving a driver disregarding the red signal. This resulted in the addition of the advance warning flashers on December 14, 2001. It should be noted that, prior to the installation of the traffic signal, the majority of the drivers who failed to yield the right of way when they entered the bypass from KY 769 were local residents. In all but one case, the driver stopped before entering the bypass, and then proceeded into the intersection.

<u>Date</u>	<u>Fatal</u>	<u>Injury</u>	<u>Residence/Driver 1</u>	<u>Description</u>
7/4/97	0	0	Eubank	Angle WB/NB (thought 4 way)
7/6/97	0	7	Somerset	Angle SB/WB (stopped)
7/26/97	0	0	Somerset	Angle SB/EB (thought 4 way)
7/26/97	0	0	Science Hill	Angle NB/EB (stopped)
11/29/97	0	1	Ferguson	Angle NB/WB (stopped)
1/13/98	0	0	Somerset	Angle SB/EB (stopped)
1/25/98	1	2	Somerset	Angle NB/WB (did not stop)
4/16/98	0	0	Taylor Mill	Angle NB/EB (thought veh. turning)
4/30/98	0	0	Somerset	Angle NB/EB (stopped)
5/23/98	0	4	Nancy	Angle SB/EB (stopped)
7/10/98	0	1	Somerset	Angle EB/SB (stopped)
7/17/98	0	0	Somerset	Angle SB/EB (stopped)
9/27/98	0	0	Eubank	Angle SB/EB (stopped)
11/10/98	0	0	Keavy	RE EB
5/28/99	0	1	Somerset	Angle NB/WB
8/14/99	0	0	Akron, Ohio	Angle WB/SB (ran red)

<u>Date</u>	<u>Fatal</u>	<u>Injury</u>	<u>Residence/Driver 1</u>	<u>Description</u>
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6/23/00	2	3	Virgie	Angle	EB/NB (ran red)
4/15/01	0	2	Toledo, Ohio	RE	EB
6/9/01	0	0	Science Hill	RE	WB
8/30/01	0	0	Goshen, Ohio	RE	WB
9/10/01	2	2	Halie	Angle	WB/SB (ran red)

The intersection with the second highest number of crashes is the KY 1247S intersection which has had 19 crashes. The most common collision at this intersection has been a right angle collision involving a side road vehicle attempting to enter KY 914. There were seven angle collisions at the KY 1247N intersection prior to the signal installation with the number of crashes reduced substantially after the signal was installed.

A traffic signal was installed at the KY 192 intersection when the bypass was opened in 1997. Of the 14 crashes at this intersection, seven were rear end with five right angle in which a driver disregarded a red signal, and two were opposing left turn. Traffic signals were also installed at the US 27 and KY 80 intersections when they were opened. Of the 24 crashes at these two intersections, 19 involved a rear end collision.

The remaining two intersections with more than 10 crashes were KY 1642 and Enterprise Drive. Both of these intersections are on the four lane section of the bypass. Of the 26 crashes at these two intersections, 19 involved an angle collision.

Only 22 of the 131 crashes at intersections occurred during darkness. This represents 17 percent of the intersection crashes.

3.2.4 Auburn Bypass

When US 68 was changed to a four-lane highway it bypassed the business section of Auburn. While this is not a typical bypass, the new four lane does bypass Auburn and is connected to the US 68X business route on both sides of Auburn. The length of US 68 over this section is approximately 3 miles.

US 68 is a four-lane roadway with a depressed grass median. It has a 55 mph speed limit and a functional classification of rural principal arterial. The weighted ADT is about 9,500. A portion of the new road had been constructed for a substantial time before the road was opened for traffic in October 1995 .

The bypass has partial control of access with a limited number of at-grade intersections with state and local roads. There is currently one intersection (KY 103) with a traffic signal while none of the other intersections have an intersection beacon. The signal at KY 103 was installed in November 1999.

There was publicity and police enforcement at the opening of the new section of US 68. There was a large police presence for a few weeks after opening since the road had been

constructed but not opened for a substantial time period (about two years). Local drivers were accustomed to driving across the new road without stopping. At the KY 103 intersection, an intersection beacon, oversized stop and stop ahead signs, and rumble strips were provided when the road was opened. A temporary variable message sign noting the stop ahead condition was also used at the KY 103 intersection. The only complaints received for any location on the section of road concerned the KY 103 intersection with requests made for the installation of a traffic signal which was later added.

Following is a summary of the number of traffic crashes from the opening of this section of US 68 in October 1995 through June 2002.

<u>YEAR</u>	<u>TOTAL</u>	<u>INTERSECTION</u>	<u>INJURY</u>
1995 (starts October)	5	5	3
1996	10	5	2
1997	16	12	10
1998	8	3	3
1999	13	11	8
2000	9	6	3
2001	8	4	1
2002 (January-June)	6	4	3
Total	75	50 (31 injury)	33

The crash rate for the 3- mile section for the 5 years of 1997 through 2001 is 104 C/100MVM. This compares to the statewide crash rate (rural four-lane divided, non-interstate) of 123 C/100MVM. The calculations show that the total crash rate for the bypass is not above the statewide average for this type of highway. However, the injury and fatal rates of 69 and 3.8 C/100MVM were higher than the statewide rates of 40 and 1.5 C/100MVM.

There have been two fatal crashes on this road with both at the KY 103 intersection. The crashes were on November 2, 1999 and September 18, 2000. The crash in November 1999 was a right angle collision which occurred prior to the installation of the signal. The driver on KY 103 stopped and pulled into the path of a vehicle on US 68. A driver on KY 103 disregarded the red signal in the September 2000 fatal crash resulting in a right angle collision.

Following is a summary of the number of crashes at specific intersections. The data show the majority of all crashes (about 67 percent) and almost all injury crashes have occurred at an intersection. Only 7 of the intersection crashes (14 percent) occurred during darkness. The large majority of the crashes occurred at the KY 103 intersection. The number of crashes at this intersection decreased dramatically after the installation of the traffic signal.

1995 1996 1997 1998 1999 2000 2001 2002 Total (I*)

KY 103	5	4	11	3	7	4	2	36 (27)
US 68X/Matlock					2	2	3	8 (1)
Old 68		1	1					2
Sugar Maple							1	1 2 (1)
KY 722					1			1 (1)
Cemetery Rd.					1			1 (1)

- Injury crash

Following is a description of the crashes at the KY 103 intersection. There were five crashes in the first month. The crashes at this intersection were almost all angle. Prior to the traffic signal, local drivers on KY 103 would stop at the intersection and then pull into the path of a vehicle on US 68. The explanations were that they did not see the vehicle or thought they had time to cross the road. There is no sight distance problem for a driver on KY 103 to observe vehicles on US 68 or for drivers on KY 103 to observe the stop signs.

<u>Date</u>	<u>Fatal</u>	<u>Injury</u>	<u>Residence/Driver 1</u>	<u>Description</u>
10/28/95	0	2	Unknown	Angle (SB/EB) (20-35 mph)
11/25/95	0	0	Unknown	Angle (NB/EB)
11/26/95	0	2	Unknown	Angle (SB/EB)
11/27/95	0	0	Unknown	Angle (SB/WB) (5-10 mph)
11/30/95	0	3	Unknown	Angle (NB/EB) (10-20 mph)
7/11/96	0	0	Unknown	Angle (NB/EB) (20-30 mph)
7/31/96	0	2	Unknown	Angle (NB/WB) (30-45 mph)
9/20/96	0	2	Unknown	Angle (NB/WB) (30-40 mph)
10/4/96	0	0	Unknown	Angle (SB/EB)
2/22/97	0	5	Auburn	Angle (SB/EB) (stopped)
2/23/97	0	2	Auburn	Angle (NB/WB) (stopped)
3/7/97	0	2	Auburn	Angle (NB/WB) (stopped)
3/8/97	0	9	Auburn	Opposing LT (EB/WB)
3/26/97	0	1	Auburn	Angle (NB/WB) (stopped)
5/9/97	0	1	Auburn	Angle (SB/EB) (stopped)
6/15/97	0	2	Russellville	Angle (NB/EB) (stopped)
7/15/97	0	1	Tennessee	Angle (NB/WB) (stopped)
8/2/97	0	2	Russellville	Angle (SB/WB) (stopped)
8/4/97	0	7	Auburn	Angle (NB/WB) (did not stop)
12/6/97	0	1	Russellville	Angle (SB/EB) (stopped)
7/4/98	0	1	Bowling Green	Angle (NB/WB) (stopped)
10/11/98	0	3	Auburn	Angle (NB/WB) (stopped)
12/19/98	0	2	Adairville	Angle (SB/EB) (stopped)

<u>Date</u>	<u>Fatal</u>	<u>Injury</u>	<u>Residence/Driver 1</u>	<u>Description</u>
2/3/99	0	0	Auburn	Angle (NB/WB) (stopped)

5/10/99	0	2	Glasgow	Angle (SB/WB) (stopped)
7/10/99	0	3	Auburn	Angle (SB/EB) (stopped)
10/7/99	0	5	Auburn	Angle (SB/EB) (stopped)
10/14/99	0	1	Auburn	Angle (NB/WB)
10/21/99	0	1	Auburn	Angle (NB/WB) (stopped)
11/2/99	1	0	Auburn	Angle (SB/EB) (stopped)
5/28/00	0	3	Auburn	Opposing LT (WB/EB)
6/20/00	0	0	Elkhorn	Opposing LT (WB/EB)
7/30/00	0	0	Auburn	Opposing LT (WB/EB)
9/18/00	1	3	Bowling Green	Angle (SB/WB) ran red light
5/14/02	0	2	Russellville	Angle (WB/NB) ran red light
5/15/02	0	0	Russellville	Angle (SB/WB) ran red light

3.2.5 Russellville Bypass

The Russellville bypass connects US 79 (west of Russellville) and US 68 (east of Russellville). The length of the bypass is about 5.2 miles. About one mile of the bypass (between US 79 and US 68 on the west side of Russellville) is marked as US 431 with the remaining 4.2 miles marked as US 68. Sections were opened at various times with the complete bypass opened in 1998. Crash data with consistent milepoint information were available starting in 1998. The bypass is a four lane roadway with a depressed grass median. The speed limit is 55 mph. The weighted ADT is approximately 6,000. The roadway is classified as a principal arterial. About one half of the bypass is classified as urban although observations show all of the adjacent land use has rural characteristics.

The bypass has partial control of access with a limited number of at-grade intersections with state and local roads. There are currently seven intersections with traffic signals. The only intersection where a traffic signal was added after the bypass was opened was at KY 178.

There was typical publicity when the bypass was opened and enforcement officers were placed at each intersection. Variable message signs were used when the bypass was first opened. There has been no location which was the source of complaints. There was a question concerning right of way control at the KY 178 intersection when it was opened. This location had four angle crashes in 1998 with the number of crashes reduced since the traffic signal was installed in 1999. None of the 1998 angle crashes involved a driver disregarding the stop sign.

Following is a summary of the number of traffic crashes from the completion of the bypass in 1998 through June 2002.

<u>YEAR</u>	<u>TOTAL</u>	<u>INTERSECTION</u>	<u>INJURY</u>
1998	10	9	6
1999	23	14	9

2000	24	19	11
2001	22	15	5
2002 (January-June)	9	6	1
Total	88	63 (29 injury)	32

The crash rate for the three years of 1999 through 2001 was 202 C/100MVM. This compares to the statewide crash rate of 124 C/100MVM on rural, four lane divided (non-interstate) highways and 293 C/100MVM for urban four lane roads. About 2.5 miles of the 5.2 total miles is classified as urban. About 71 percent of the crashes occurred at an intersection with almost all of the injury crashes (91 percent) at an intersection. The injury crash rate was 73 C/100MVM compared to 38 and 74 C/100MVM on rural and urban four lane roads. Of the 63 crashes at an intersection, 13 (21 percent) occurred during darkness.

The only fatal crash between 1998 and 2002 occurred on September 25, 1999 at the intersection with US 68X on the west side of Russellville. It was an opposing left turn crash which involved a driver disregarding a red indication since there was a separate left turn phase.

Following is a summary of the number of crashes at the intersections.

<u>Intersection</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>Total (I*)</u>
US 68/US 431	0	3	3	5	3	14 (3)
US 68 (east)	2	3	3	2	0	10 (6)
KY 79	1	2	4	2	1	10 (4)
KY 178	4	3	0	1	0	8 (4)
US 431X-KY3519	1	0	2	3	1	7 (4)
Concord Road	0	1	4	1	0	6 (4)
US 79	0	0	2	0	1	3 (1)
Sarah Lane	0	2	0	0	0	2 (1)
Newtown Road	1	0	0	0	0	1
Highland Lick	0	0	1	0	0	1 (1)
Sevenson Mill	0	0	0	1	0	1 (1)

- Injury crashes

There is a traffic signal at most of these intersections (US68/US 421, US 68 (east), KY 79, KY 178, US 431X, and US 79). The most common types of crashes involved an opposing left turn at a traffic signal (15 crashes), rear end at a traffic signal (14 crashes), right angle at a stop sign (13 crashes), and right angle at a traffic signal (11 crashes). The right angle crashes at stop approaches did not involve a driver disregarding the stop sign. The driver typically stated he did not see the vehicle on the bypass although sight distance was not limited. The opposing left turn crashes at signals were typically at the signals without an exclusive left turn phase. Right angle crashes at a traffic signal involved a driver disregarding a red indication (usually while trying to travel through the intersection just after the end of the yellow).

3.2.6 Irvine Bypass

The Irvine bypass (KY 499) connects KY 52 west of Irvine to KY 89 north of Irvine. The length of the bypass is about 1.5 miles. The bypass was opened in July 2000. The only major intersections on the road are the intersections at each end. The bypass has two lanes with full width paved shoulders. The speed limit is 55 mph. It is classified as a rural major collector. The ADT is approximately 4,900.

There was no special publicity when the bypass was opened and no coordinated enforcement activities. Both the KY 52 and KY 89 intersections currently have traffic signals which were installed a few months after the bypass was opened. Roadway lighting at the intersections was also provided when the traffic signals were added. Grade warning signs on the intersection approaches on each end have been added.

The only reported problems when the bypass was opened involved drivers not stopping at the T-type intersections at each end. There is a downgrade on the bypass approaching both of these intersections. The only reported crashes at these intersections were at KY 52 (one in 2000 and two in 2001) with two of these three rear end and one a single vehicle. All reported crashes were during daylight. None of the crashes involved a fatality and one involved an injury. Evidence at the intersections showed there were some unreported incidents involving drivers on the bypass not stopping at these intersections.

Crash data show eight reported crashes occurring in the first two years after the bypass was opened (July 2000 through June 2002) with three at an intersection. This is a crash rate of 149 C/100MVM compared to a statewide rate for rural, two lane roads of 246 C/100MVM.

3.2.7 Harrodsburg Bypass

The Harrodsburg bypass connects US 127 on the north and south sides of Harrodsburg. The length is about 4.5 miles. The road continues as KY 390 past the US 127 intersection on the north side of Harrodsburg. The bypass has four lanes with a depressed grass median. The speed limit is 55 mph. It is classified as a rural principal arterial. The traffic volume varies from about 7,700 to 9,000 vehicles per day with a weighted volume of about 8,300.

The bypass was opened for traffic on September 4, 1998. The bypass has partial control of access with a limited number of at-grade intersections. There are four intersections with a traffic signal (both US 127 intersections, US 68, and KY 152) with the turn on date for these signals the day the bypass opened. There are two additional intersections with a crossroad warning sign. None of the intersections has an intersection beacon.

Following is a summary of the number of crashes from 1998 through June 2002. Almost all of the crashes (90 percent) occurred at an intersection.

<u>YEAR</u>	<u>TOTAL</u>	<u>INJURY</u>	<u>FATAL</u>	<u>INTERSECTION</u>
1998	12	3	1	11
1999	15	4	0	15
2000	34	14	0	30
2001	28	13	1	26
2002 (Jan/June)	9	1	0	6
Total	98	35	2	88

The crash rates for the three year period of 1999 through 2001 were 188, 76 and 2.4 C/100MVM for total, injury, and fatal crashes, respectively. This compares to statewide rates of 124, 38, and 1.3 C/100MVM for rural, four lane divided (non-interstate) roadways. The higher rates were related to the number of crashes at the two US 127 intersections.

Two fatal crashes were identified in this time period. One was a right angle crash at US 68 which occurred in 1998. The other was an opposing left turn crash at KY 152 in 2001. This intersection has a traffic signal with no separate left turn phase.

Following is a summary of the number of crashes at the major intersections.

<u>Intersection</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>Total</u>
US 127 (north)	2	7	14	11	0	34
US 127 (south)	3	3	8	6	2	22
US 68	4	2	2	3	0	11
KY 152	1	1	5	2	1	10
KY 1989	0	1	1	3	1	6
Bellows Mill	1	1	0	1	2	5

A review of the crash reports shows 15 of the 34 crashes at the US 127 (north) were opposing left turn. Sixteen of the 22 crashes at US 127 (south) were single vehicle related to loss of control while merging from US 127 onto the bypass. Five of the 11 crashes at US 68 were opposing left turn with four right angle. Eight of 10 crashes at KY 152 were opposing left turn. Four of 6 crashes at KY 1989 were right angle while all 3 crashes at Bellows Mill were right angle. Considering all intersections, the most common were opposing left turn (17 crashes) followed by right angle (15 crashes). About 23 percent occurred during non-daylight hours.

Of the eight crashes at intersections in 1998 in the first months after the bypass was opened, seven were at intersections with right of way controlled by a traffic signal. They involved either involved a driver disregarding a red light or an opposing left turn type of collision.

3.2.8 Richmond Bypass

The new portion of the Richmond Bypass (US 25) connects the old bypass at its

intersection with KY 52 to Interstate 75. Crash data were obtained from the intersection with KY 52 (milepoint 16.257) to the intersection with US 25X (milepoint 19.932) for a length of about 3.7 miles. This portion of the bypass was opened in May 1998.

The bypass has four lanes with a depressed grass median. The speed limit is 55 mph. About 2.3 miles is classified as urban principal arterial with 1.4 miles rural principal arterial. The traffic volume ranges from about 18,600 to 20,500 with a weighted average of approximately 19,200.

The bypass has partial control of access with a limited number of at-grade intersections with state and local roads. There are three intersections with signals (US 25X, Four Mile Road, and KY 52). The US 25X signal has protected/permissive left turn phasing while the KY 52 intersection has protected left turn phasing. None of the other intersections have intersection beacons with side road warning signs provided in a few instances.

Following is a summary of crash data from 2000 through June 2002. The milepoint data were not useable prior to 2000.

<u>YEAR</u>	<u>TOTAL</u>	<u>INJURY</u>	<u>FATAL</u>	<u>INTERSECTION</u>
2000	53	16	0	34 (11 injury)
2001	38	10	0	23 (8 injury)
2002 (Jan/June)	12	1	0	10 (no injury)
Total	103	27	0	67 (19 injury)

The crash rate for 2000 through 2001 was 177 C/100MVM for all crashes and 50 C/100MVM for injury crashes. This compares to statewide rates of 124 and 293 C/100MVM for rural and urban four lane, non-interstate roadways, respectively. Statewide injury rates are 39 and 80 C/100MVM for rural and urban four lane non-interstate roadways, respectively.

Following is a summary of the number of traffic crashes at major intersections. About 65 percent of the crashes occurred at an intersection.

<u>Intersection</u>	<u>2000</u>	<u>2001</u>	<u>2002 (Jan-June)</u>	<u>Total</u>
KY 52	8	9	4	21
US 25X	11	1	5	17
Four Mile Road	5	7	1	13
KY 1986	9	3	0	12

Trends in types of crashes were noted; 16 of 20 crashes at the KY 52 intersection were rear end, 7 of 17 crashes at the US 25X intersection were opposing left turn, 5 of 13 crashes at the Four Mile Road intersection were opposing left turn with 4 angle and 4 rear end, and 9 of 12 crashes at the KY 1986 intersection were angle (most involved left turns from KY 1986).

3.2.9 Cadiz Bypass

The Cadiz bypass connects US 68 on the east and west side of Cadiz. It was opened in November 1993. The length of the bypass is about 4.75 miles. The bypass has two lanes with a full width shoulder. It is classified as a rural principal arterial. The speed limit is 55 mph. The traffic volume ranges from about 4,000 to 4,900 with a weighted average of approximately 4,500 vehicles per day.

The bypass has partial control of access with at grade intersections. There are intersections with US 68X on either side, with two state-maintained roads (KY 139 and KY 1175), and a few local roads (Lakota, Tanyard). There are no traffic signals with right of way controlled by stop signs on the side roads. Most of the side road approaches have dual mounted stop and stop ahead signs with a stop bar and a “cross traffic does not stop” sign below the stop sign. Intersection beacons are installed at three intersections (US 68X west, Lakota, and KY 139). The beacons at US 68X west and KY 139 were installed when the bypass was opened in 1993. There is a side road warning sign with no advisory speed at three intersections (KY 1175, Tanyard, and Lakota) and with an advisory speed of 45 mph at one intersection (KY 139). Two of the intersections have roadway lighting (US 68X west and Lakota).

Following is a summary of the number of crashes on the bypass from 1995 through 2001. There has not been a large range in the number of crashes over these years.

<u>YEAR</u>	<u>TOTAL</u>	<u>INTERSECTION</u>	<u>INJURY</u>
1995	16	8	6
1996	14	8	5
1997	13	9	2
1998	15	9	5
1999	14	10	2
2000	19	16	10
2001	19	15	8
Total	110	75 (33 injury)	38

The crash rate for the five year period of 1997 through 2001 was 205 C/100MVM which compares to the statewide average for rural two-lane roads of 252 C/100MVM. The injury crash rate is 69 C/100MVM which compares to the statewide average of 85 C/100MVM. There was only one fatal crash on the bypass during this five-year period which was a right angle crash at the west US 68X intersection in 1996.

Following is a summary of the number of crashes at the major intersections. About 68 percent of the crashes occurred at an intersection.

<u>Intersection</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>Total</u>
US 68X (east)	1	1	2	3	4	4	5	20

KY 139	3	4	2	2	0	1	5	17
US 68X (west)	2	2	3	2	2	4	1	16
Lakota Drive	0	1	1	1	2	5	3	13
KY 1175	2	0	0	1	1	2	0	6
N. Tanyard	0	0	1	0	1	0	1	3

There were trends in the crash patterns at the intersections. At the US 68X (east) intersection, 18 of the 20 crashes were right angle with most involving a driver pulling from the stop sign and attempting to turn left across westbound traffic. At the KY 139 intersection, 14 of the 17 crashes were right angle with most involving a driver attempting to cross the bypass from a stop. All of the 16 crashes at the US 68X (west) intersection were right angle with four in which the report noted that the driver on the side road failed to stop. At Lakota Drive, 8 of the 13 crashes were rear end.

3.3 Discussions with District Offices

Discussions were held with representatives from each of the 12 district offices. Representatives from traffic, design, and construction were present during most of the meetings. If one of the case study bypasses was located in the district, information concerning that bypass was obtained. In addition, a general discussion was held concerning the problems associated with opening a new road and potential countermeasures. Suggestions made from previous meetings were discussed to determine the general opinion for specific designs and traffic control measures. There was not a consensus on some of the more innovative treatments. For example, many did not agree with the use of a mountable median on the side road while others thought it was an acceptable traffic calming technique.

4.0 SUMMARY

The analysis found that the overall and injury crash rates on the bypass routes were generally lower than statewide rates for the same type of highway. Higher fatal crash rates were related to the large majority of crashes occurring at intersections. The percentage of crashes at intersections was much higher than on other roads. All fatal crashes were at intersections. The most common types of crashes have been angle crashes at stop approaches and rear end crashes at intersections with a traffic signal. There were also several opposing left turn crashes at some signalized intersections. The angle crashes at the stop controlled intersections have typically involved a driver stopping and then pulling into the path of a vehicle on the bypass. A driver disregarded the stop sign in only a small number of these crashes.

The major change which has occurred at the intersections after the opening of the bypass has been the installation of a traffic signal with this change resulting in a large reduction in angle crashes. The occurrence of a large number of crashes immediately after the opening of a bypass was not generally found. The two fatal crashes which occurred on the Morganfield bypass in the first few weeks after opening, in which a local driver disregarded a stop sign, were exceptions to

the typical crash pattern.

5.0 RECOMMENDATIONS

Recommendations were developed in the following general areas: public information, enforcement, traffic control and design. The recommendations were further divided into those which should be done and those which may be used. The recommendations relate to intersections since this is where the large majority of all crashes and every fatal crash occurred (resulting in the high fatal crash rates at some locations). Following is a summary of the recommendations.

Measures which should be used when a road is opened include:

Public Information

1. Work with local media to inform motorists of the opening date.
2. Work with local media to inform drivers of the characteristics of the high speed rural roadway and safety considerations at intersections.
3. Use variable message signs on major side road approaches to the new road for a few days prior to opening to inform motorists of the opening date.
4. Utilize the Public Information Officer position in the district offices to provide information to the media.

Enforcement

1. Work with local and state police and motor vehicle enforcement to provide an enforcement presence during the first weeks after opening.

Traffic Control

1. Use variable message signs for about one month after the opening of new intersections on approaches where there is a potential for a driver disregarding a stop sign or traffic signal indication.
2. Place stop bars at the proper stopping location on all stop approaches.
3. Place intersection warning signs on the mainline in advance of major intersections.
4. Place "cross traffic does not stop sign" where appropriate on stop signs.
5. Place temporary rumble strips on stop approaches (use thermoplastic striping to provide both an audible and visual warning).

Design

1. Add turn lanes with pavement arrow markings on side road approaches as a method of altering the alignment for drivers on the side road approaching the new road (note that a possible line of sight limitation from an adjacent vehicle must be considered).

Measures which may be used when a road is opened include:

Public Information

1. Place flaggers at major intersections on opening date to inform motorists of changes.

Traffic Control

1. Dual mount and oversize stop signs.
2. Dual mount and oversize stop ahead signs if sight distance to intersection is limited.
3. Consider use of intersection beacons at major intersections.
4. Consider use of beacon on stop ahead or stop sign.
5. Consider use of technology which would either: a) warn a driver on the side road that his speed was too high to stop at the upcoming stop sign or b) warn a driver on the main road that a vehicle was stopped on the side road approach at the next intersection.
6. Use “cross traffic does not stop” sign as an advance sign on the approach to the stop sign.
7. Use projected or actual traffic volume information to determine if a traffic signal is warranted at major intersections.
8. Consider exclusive left turn phasing for signals at intersections with 55 mph speed limit.
9. Consider partial roadway lighting at major intersections (especially if traffic signal installed).
10. If sight distance is limited, consider placing stop ahead word message on pavement.
11. At traffic signals where there are factors such as a grade, high truck volume, restricted sight distance, or high speeds consider use of an advance warning flasher.
12. Consider placement of a permanent active sign displaying the speed of motorists on the new road at the approach to major intersections where the side road has a stop condition.

Design

1. Provide a traffic calming device such as painted or mountable islands for channelization for the side road approaches (use of a PCC mountable median with an asphalt pavement provides a visual outline of the island).
2. Consider a design which reduces the number of conflict points (the design could involve either allowing right turns only from the side road with U-turns adjacent to the intersection or the use of a roundabout).
3. Use a different type of pavement in the immediate approach to the intersection on the side road to provide warning to drivers approaching the intersection.
4. Consider use of speed humps on side street approach.
5. If possible, do not provide a long tangent with high design speed on side road approaches.

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