EFFECTS OF
FRONTAGE ROAD CONVERSION

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EFFECTS OF FRONTAGE ROAD CONVERSION

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DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Arkansas State Highway and Transportation Department or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

EFFECTS OF FRONTAGE ROAD CONVERSION

by
J. L. Gattis, Ph.D., P.E., Christopher Hanning, and Lynette K. Duncan

CHAPTER 1
INTRODUCTION

The purpose of this research project was to examine effects associated with the conversion of the Interstate 30 (I-30) frontage roads in the central Arkansas area from two-way operation to one-way operation in 2002. The following traits of traffic operations and land use were examined.

1. Traffic volumes in the corridor before the conversion were compared with volumes after the conversion.
2. Speeds before and after the conversion were compared.
3. Travel times between selected nodes along the frontage roads in the study corridor were collected before the conversion to one-way operation and compared to travel times that were collected approximately one year after conversion.
4. The number of crashes before the conversion was compared with the number after the conversion.
5. Types of land use and vacancy data were collected before and after the conversion, and compared.
6. Sales tax data for certain businesses in the study corridor were collected. These data were analyzed to determine the economic effect of the conversion on businesses.
7. Business owners and operators in the corridor were surveyed to ascertain their opinions about the conversion of the frontage roads, and to determine if opinions changed over time.

DESCRIPTION OF THE STUDY CORRIDOR

Interstate 30 (I-30) is a major route for transporting goods and people across the country. It begins in Fort Worth, Texas, and extends eastward through Dallas, Texarkana, and Little Rock before ending at a junction with Interstate 40 in North Little Rock, Arkansas.

The segment of I-30 along which the frontage roads were converted is approximately 16.3 mi (26.2 km) long. The west end of the segment is the Sevier Street interchange, southwest of the interchange with State Highways (SH) 5 and 35 in Benton, Arkansas. The east end is the University Avenue (US 70) interchange in Little Rock, Arkansas. Exhibit 1-1 shows the corridor area.

Corridor History

Construction on what are now the two westbound main lanes of the study area segment began in September 1951. These two lanes were opened to two-way traffic in August 1954. Construction on what are now the two eastbound main lanes began in April 1955. These two lanes were opened in August 1958, creating a four-lane divided highway. Construction on interchanges along the highway began in April 1956, and frontage road construction began in December 1956. The frontage roads and interchanges were completed in June 1960, and opened to traffic shortly thereafter.

When the frontage roads on both sides of the freeway were opened to traffic, they functioned as two-way streets. This may have been because of the large distances between overpasses, and the relatively rural setting at the time that the freeway corridor was designed and constructed.

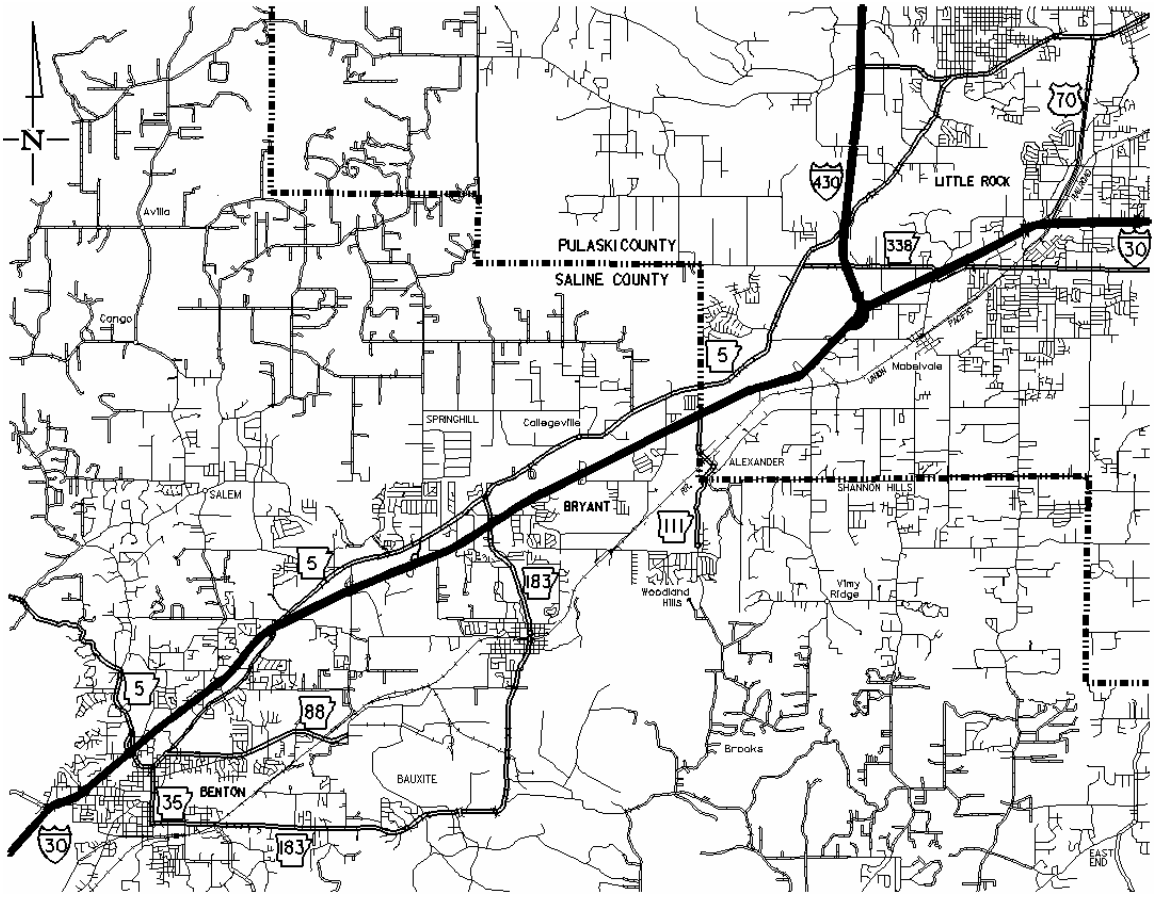

EXHIBIT 1-1 Map of the Frontage Road Corridor

The Changing Corridor

Due to the population growth and increased demand for traffic capacity, in the early 1990s the Arkansas State Highway and Transportation Department (AHTD) began to study the possibility of widening the I-30 main lanes, modifying the frontage roads, and rehabilitating interchanges in the study corridor. Converting the frontage roads from two-way to one-way operation was considered at this time. The AHTD held public hearings on March 2, and 4, 1993, and received a total of approximately 280 comments from local residents and businesses. From the preferences expressed and shown in Exhibit 1-2, the majority favored modified two-way frontage roads. These modifications would have entailed completely separating the frontage road from the interstate main lanes. On- and off-ramps from the main lanes would have been redirected from their current connections with the frontage roads to connect directly to the cross road. This would have created two intersections in close proximity to each other on the cross road, on each side of the main freeway lanes.

Due to the response from local residents and businesses favoring modified frontage roads with two-way operation or supporting no change to the corridor, and pressure from politicians

speculating that widening the corridor would encourage population migration from Little Rock to the suburbs in Saline County, the AHTD decided to postpone corridor improvements.

EXHIBIT 1-2 Opinions from Public Hearings of March 2 and 4, 1993

Land Owner Type	Supported One-way Frontage Roads	Supported Modified Two-way Frontage Roads	Supported No Change
Residents	28	202	10
Businesses	8	31	1
TOTAL	36 (12.9%)	233 (83.2%)	11 (3.9%)

The Interstate Rehabilitation Program and Conversion

In 1999, Arkansas voters approved a $950 million Interstate Rehabilitation Program (IRP). The program plan allowed AHTD to rehabilitate over 350 of the 655 mi (560 of the 1050 km) of interstate highways in the state. The program included the study corridor, and called for improving some of the interchanges, and changing the frontage roads to one-way operation.

In the spring of 2002, reconstruction began on the I-30 main lanes. The frontage roads, which had been operated as two-way roads since they were opened to traffic in 1960, were converted to one-way operation at 9:00 am on October 8, 2002. By the time of the conversion, the entire study corridor was under reconstruction. This is important to note, since construction on the main lanes may affect traffic on the frontage roads.

The corridor comprising this study area originally included nine interchanges, one of which was the Sevier Street interchange at the west and of the study area. A new interchange with the south terminus of Interstate 430 was opened to traffic in November 1975. An additional four overpasses were built and opened to traffic prior to the conversion of the frontage roads to one-way operation. One more overpass was still under construction when the conversion occurred. With 15 interchanges now in the study corridor, the maximum distance between any two interchanges is approximately 1.9 mi (3.1 km).

The conversion of the frontage roads from two-way to one-way operation was implemented with traffic control devices, such as signs, pavement markings, and orange and white construction drums. The drums were used to close the left or inside frontage road lane, in case any motorist unaware of the conversion attempted to turn left from a driveway or side street and drive against the flow of traffic. After a period for drivers to become accustomed to the new one-way operation, many of the drums that had been placed on the roadway at the time of the conversion were removed from the frontage roads on November 21, 2002. However, other drums associated with main lane and interchange construction remained.

For a while, two short segments of the frontage roads in the study corridor remained two-way. The first segment was the south frontage road between the Sevier Street overpass and the entrance ramp just east of this overpass. There were no businesses along this short segment. The second segment was also a south frontage road, between the intersection with Mabelvale Pike and Baseline Road. Conversion to one-way operation occurred after additional main lane and interchange construction activity.

Exhibit 1-3 shows a section of two-way frontage road just outside of the corridor limits. Exhibit 1-4 shows the construction drums in place just after the conversion. Exhibit 1-5 displays some of the signs used to implement the conversion.

EXHIBIT 1-3 Example of a Two-way Frontage Road Near the Corridor

EXHIBIT 1-4 View of the Frontage Road Soon After Conversion to One-way Operation

EXHIBIT 1-5 Example of the Signs Necessitated by Conversion to One-way Operation

A principal objective of this research is to inform transportation officials and engineers of the effects that frontage road conversion has on a roadway network and its surrounding land use.

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CHAPTER 2
BACKGROUND AND LITERATURE REVIEW

Frontage roads are roadways that lie between the main lanes of roadway and the abutting private property. They generally run parallel to main roadway. The frontage roads can be found on one or both sides of the freeway, and may or may not be continuous. Frontage roads are also known by other terms such as access roads, outer roads, or service roads.

A main purpose of frontage roads is to provide access to abutting property, and therefore allow the main lanes of a roadway to be relatively or totally free of intersections with cross streets and driveways. Frontage roads often have the effect of separating local traffic from the higher speed through traffic. Thus, frontage roads preserve the through characteristic of the highway while allowing the highway to be unaffected by the development of the surrounding roadside.

Frontage roads may also distribute and collect traffic between local streets and highway ramps and interchanges. They may also provide an alternative to the freeway when demand on the freeway becomes too high, or when capacity on the freeway is lost due to an accident, roadway maintenance, construction, or other reason.

In practice, frontage roads sometimes function as a type of hybrid facility. They often have ramps like a freeway and intersections like an arterial street. Because of this hybrid type of functionality, they may have special operational and design considerations. The distance between the exit ramp and a downstream intersection is a design consideration that is unique to frontage roads.

Frontage roads can be operated as either one-way or two-way streets. Two-way frontage roads offer more convenient and less circuitous travel, as compared to one-way frontage roads. This can be a significant factor when the distance between roads that cross over the main roadway is great. If a frontage road is connected to another road only on one end, it has to be operated as a two-way roadway. From an operational and safety standpoint, one-way frontage roads are much preferred (AASHTO, 2001 p. 344). One-way frontage roads are failed to offer greater safety in the form of reduced vehicular turning and crossing maneuvers at intersections, and less potential for wrong-way entry onto the freeway at exit ramps.

The type of land use surrounding a roadway toward or has a great impact on the design and function of frontage roads. If a frontage road is short, discontinuous, and serves a relatively rural area, traffic may be light and the frontage road may act much like a local road. However, if a frontage road is long, continuous, or serves a highly developed area, it may function as an arterial and serve both local traffic and overflow from the freeway.

Compared to many other roadway design and operation topics, relatively little research has been conducted on frontage roads. Previous research studies were identified and reviewed. Summaries of issues that are the most pertinent to this research project are presented.

WARRANTS FOR CONVERSION

Several reports that attempted to develop warrants to convert frontage roads from two-way to one-way were reviewed. These warrants were based on many traffic attributes such as volume, delay, and crash rates. The amount and nature of the land development along the frontage road was also a consideration.

Texas Study by Woods

In the early-1980s, Woods conducted a frontage road operational safety study in Texas to identify problems at ramp-frontage road intersections, and suggested warrants for conversion from two-way to one-way frontage road operation. He attempted to justify conversion to one-way operation by identifying conditions under which two-way operation was unsafe. Along with observing erratic maneuvers, accident data were collected at ramp-frontage road intersections. From these data, unsafe conditions were identified. Warrants for conversion to one-way operation could then be developed.

Woods identified nine different erratic maneuvers drivers made at frontage road–ramp intersections. These maneuvers were observed at intersections with both one-way and two-way frontage roads. He found an unusually high percentage of erratic maneuvers at intersections of one-way frontage roads and slip type exit ramps. This is probably due to the general "openness" of the slip ramp design used in Texas (Woods, 1984, p. 14). Based on these observed maneuvers, changes in geometric design and traffic control were suggested.

Woods conducted a statistical analysis on the accident data that were collected for the frontage road-ramp intersections. First, it was determined if a significant difference in accident rates existed between different ramp types. If no significant difference was found, then it was to be determined if a significant difference in accident rates existed between operational modes of the frontage roads. It was found that no significant differences were found between the various ramp types regardless of frontage road operation. It was found, however, that degree of land use development and volume of frontage road traffic were factors that contributed significantly to accident rates.

Woods also conducted a before and after study of accident rates at ramp intersections on frontage roads that were converted from two-way to one-way. The before and after methodology has an inherent weakness in that it must be assumed that no time trend changes will occur. In reality, this rarely, if ever, occurs (Woods, 1984, p. 26). It was found that sites that had an accident rate of 20 per mile or more had a significant reduction in accidents.

From this work, Woods produced a benefit/cost ratio for conversion. Several assumptions were made for calculating this ratio. A moderately urbanized area with 5000 vpd on the frontage roads, 20,000 vpd on the cross street, 1.5 miles between interchanges, 20.0 accidents per mile on average, and ramp modifications that cost $40,000/mile was assumed. A benefit/cost ratio of 1.88 was calculated. This showed that conversion from one-way to two-way will not only reduce the accident rates in moderate to highly developed areas, but would also save the motorists money.

These analyses led to warrants for conversion, based on frontage road volume and accident rates. First, a volume warrant based on land use development was developed. In rural areas, a warranting condition of 7500 vpd on both frontage roads was given for conversion from one-way to two-way operation. Woods gave 0 percent to 30 percent development as a rural area. Warrants of 6000 vpd in intermediate areas (30 percent to 60 percent development), and 5000 vpd in urban areas (60 percent to 100 percent development) were also given. The accident rate warrant given was 20 accidents per mile of frontage road average for three years, or 30 accidents per mile of frontage road in one year.

Texas Study by Messer, Stover, and Gattis

In the late 1980s, Messer et al. developed warrants for converting frontage roads operating as two-way to one-way. The authors defined their warrants in three levels, the Basic Warrant,

the Average Daily Traffic Warrant, and the Peak-Hour Traffic Warrant. These warrants are volume based and reflect safety and capacity considerations.

The Basic Warrant was described as converting two-way frontage roads to one-way operation when the safety and operational benefits predicted for one-way operation exceed those estimated for existing two-way flow based on related traffic volume measurements (Messer et al., 1988, p. 43). Instead of giving numerical values to describe this Basic Warrant, the authors gave a verbal warrant stating that when traffic congestion becomes too high or the frontage roads become unsafe, they should be converted to one-way. They stated that this conversion should take place as soon as possible.

The Average Daily Traffic Warrant was based on traffic demands estimated for the average day of the year. This warrant is a kind of numerical limit for the Basic Warrant stated earlier. For an interchange consisting of a two-way two-lane frontage road and a two-lane cross road, like many of the interchanges found in the I-30 study corridor, Messer et al. gave a volume entering an interchange of 20,000 vehicles per day (vpd) as the desirable warrant for converting the frontage roads to one-way. The authors gave a 25,000 vpd as an absolute maximum tolerable volume. Congestion and delays are reduced at the interchanges and ramps by an estimated 35 percent during peak hours (Messer et al., 1988, p. 44). They also suggested that safety will significantly improve.

The Peak-Hour Traffic warrant that Messer et al. developed is based on turning movements at a signalized intersection along the frontage road. They suggested that it is desirable to convert from two-way to one-way operation when the existing traffic volumes on the critical turning movements at the signalized diamond interchanges reach 65 percent of their phase capacity during the peak 15-minute period of the morning or afternoon peak hour (Messer et al., 1988, p. 44). They also gave 80 percent of their phase capacity during the peak 15-minute period as the maximum tolerable limit. However, it should be noted that there were no signalized intersections along the I-30 frontage roads in the study corridor prior to conversion.

DELAY STUDIES

Studies that investigated delay along frontage roads were reviewed. Delay along frontage roads can occur at junctions with entry or exit ramps. Gattis et al. also noted that there are other sources of delay along frontage roads, including intersections with cross streets, and intersections with driveways or local side streets.

As part of their investigation into warrants for the conversion, the authors examined delay to frontage road vehicles at intersections with freeway ramps. They found that some of the delay along frontage roads may be greater for two-way operation than for one-way. It is inherent that a one-way frontage road system will have increased travel time due to increased indirection. However, some of this increase in travel time can be offset by lower one-way frontage road delays, such as delay at frontage road-ramp intersections, as compared to delays on two-way frontage roads. A one-way frontage road will have no opposing movements across intersections, but two-way operation will have opposing left, through, and right turning movements from the opposite side of the intersection. These opposing movements will have a greater potential for delays.

The authors developed a set of mathematical models that could be used to estimate the delay to frontage road vehicles at intersections with ramps. The models were based on volumes for both the ramp and frontage road. From these models it was found that the delay incurred by frontage road traffic yielding to ramp traffic at a ramp–frontage road intersection increases as

either the ramp or frontage road volumes increase (Gattis et al., 1988, p. 52). The models show that as volumes on the ramp and frontage road increase, a sharp rise in delay could be expected. They also note that safety warrants could call for conversion from two-way to one-way frontage road operation before excessive delays occur.

LAND USE STUDIES

Gattis and Stover conducted surveys to gain insight into how conversion of a frontage road from two-way operation to one-way operation affected the land use of the surrounding area. The survey results indicated that the potential for the greatest negative impact resulting from conversion to one-way operation was to those tracts of land located upstream of an exit ramp or downstream of an entry ramp (Gattis et al., 1989).

It was also noted that different types of businesses were affected differently. Businesses with little competition or businesses that sold a unique product or service would be not be affected as greatly as other, more common types of businesses (e.g. fast food restaurants). This was found to be especially true for those businesses that were located outside the pairs of ramps of a diamond interchange.

Land use planning must be coordinated with roadway facility planning. Many of the problems and adverse reactions to conversion to one-way frontage roads result from an apparent lack of such planning (Gattis et. al., 1989). Conversion to one-way operation could be greeted with less resentment if the surrounding land were not totally reliant on the frontage road. That is where coordinated planning can come into play. Developers should be given written notice that frontage road operation could change in the future when building permits are issued. State agencies should coordinate roadway network layouts with local governments so that businesses would not become dependent on two-way frontage roads for adequate access.

Backup or alternate roadways need to be present also. Without these redundant types of roads, a community can become dependent on two-way frontage roads. A negative impact on the local transportation system, and local economy, can be had when the frontage roads are converted to one-way operation if the local roadway network is insufficient. The best way to avoid this negative impact is to have an adequate backup roadway network in place before the frontage roads are converted.

PUBLIC ATTITUDES ABOUT FRONTAGE ROAD CONVERSION

As part of their investigation into frontage road conversion warrants, Stover et al. conducted an attitudinal survey concerning one-way and two-way frontage roads. They interviewed 121 individuals in 15 different towns in Texas. Those interviewed included city staff and council members, real estate appraisers and developers, and owners and managers of businesses that abutted the frontage roads. The towns where these interviews took place all had at least one freeway facility with one-way and/or two-way frontage roads. The survey that was administered contained questions that would produce responses that could be quantitatively analyzed. Open-ended questions were also asked so the interviewees could express their opinions about frontage road operation. A vast majority of the interviews were conducted in person, while the remaining interviews were conducted over the phone or were completed and mailed back to the interviewer at a later date.

The survey showed that almost everyone believed that one-way frontage road operation is safer than two-way operation. However, it was found that these same people did not understand the capacity and operational advantages of one-way frontage roads. City staff and council

members favored one-way operation and believed that frontage roads should be operated as one-way roads when they are first constructed. This same group of interviewees also believed that the presence of two-way frontage roads leads to an underdeveloped supporting local roadway system. Most businesspersons and real estate persons had an opposite opinion on both frontage road operation and the supporting roadway network. However, most members of both groups favored freeways with frontage roads as opposed to having freeways without frontage roads.

Most of the interviewees expressed the opinion that the longer the frontage roads were operated in a two-way manner, the more opposition to conversion there would be from the general public. Also, most interviewees felt that conversion to one-way would be detrimental to businesses that are along the frontage roads. It was generally felt that the biggest impact would be felt by businesses that are located downstream from an entrance ramp and upstream of an exit ramp. Most expressed that these businesses would be more severely impacted if they did not have the supported roadway system to help.

A large portion of the city staff and council members expressed the need to develop engineering guidelines to help deal with conversion of the frontage roads should it take place in their city. Most of these same people showed views that were compatible with those of highway department officials. Working closely with local officials would help facilitate the conversion process. Also, such an approach should help avoid "the highway department is telling us what we will do" attitude (Stover et al., 1987, p. 29). The authors also suggested that addressing individual fears and objections to frontage road conversion in a concerned manner is very effective in dealing with those individuals that express opposition.

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CHAPTER 3
DATA COLLECTION AND REDUCTION

Data were collected to describe several transportation and land use effects associated with the conversion of the frontage roads. The AHTD collected and provided volume and speed data. The researchers collected travel time, collision, land use, and tax data. The researchers also administered an opinion survey to businesses along the frontage roads.

VOLUME AND SPEED DATA

The volume counters recorded the passage of a vehicle over a single road tube placed perpendicular to the traffic flow. The classifiers relied on a pair of road tubes spaced at a fixed distance to determine volume, speed, vehicle class. The classifiers were preset to group vehicle speeds into 5 mile per hour (8 kilometer per hour) bins. The AHTD set the classifiers to bin vehicular speed to begin at 40 mph (64.4 km/h) and below. The next was 41 mph (66.0 km/h) to 45 mph (72.4 km/h), the next 46 mph (74.0 km/h) to 50 mph (80.5 km/h), and so on until vehicles traveling at 86 mph (138.4 km/h) and above were binned together. The classifiers placed vehicles into one of 15 different classifications based on weight and axel spacing.

The devices were set to record data in 15-minute increments. The AHTD downloaded the raw data from each counter and stored it in computer files. Individual files contained data that were collected for a single day and in for one direction. The files also contained descriptive information such as station number, county, and city, where applicable.

Collecting Before-Conversion Data

Prior to converting the frontage roads to one-way operation, the AHTD identified 71 different locations, or stations, in the I-30 study corridor at which to place volume counters or classifiers. These locations were on both the I-30 frontage roads and on segments of nearby parallel arterial roads (Military Road in Benton, State Highway 5 between Benton and Little Rock, Mabelvale West Road in Little Rock, and Mabelvale Pike in Little Rock). Volume counters were placed at 40 locations, and classifiers were placed at 31 sites.

Of the 40 volume counter locations, 15 of them were where the frontage road would be converted to one-way operation. Two of the volume counters were set out at locations where the frontage road would remain as a two-way roadway during the study period, 11 were placed at locations on parallel roadways, and the remaining 12 were on overpasses. The volume counter at station 56, on the Mabelvale West Road overpass, malfunctioned during the before-conversion counts and did not record any data. This reduced the number of volume counters from 40 to 39.

Of the 31 classifiers, 30 of were placed at locations along the frontage road that would be converted to one-way operation. One classifier was placed on a parallel roadway, State Highway 5 (SH 5), just north of the SH 5 overpass which was under construction and was not opened to traffic until after the conversion to one-way operation. The classifier at station 57, on the south frontage road just east of the Mabelvale West Road overpass, could not be placed at the same location to collect data after conversion due to construction. Since there is a street between the original location and the location that was used after conversion, the data collected at this station were ignored. That reduced the overall total of usable classifier stations to 30.

Data for the “before” condition were collected prior to the conversion of the frontage roads on October 8, 2002. Since the number of stations exceeded the number of available counters and classifiers, the data collection was done in two phases. During phase one, the AHTD placed 30

volume counters and 19 classifiers in the I-30 study corridor between September 24, 2002, and September 30, 2002. During phase two, 10 volume counters and 12 classifiers were placed at the remaining identified locations between October 1, 2002, and October 7, 2002.

Collecting After-Conversion Data

Data for the "after" condition were collected approximately one year after the conversion took place. With all of the needed equipment available, the counters and classifiers were placed and picked up within one week's time. The AHTD set out the volume counters during the week of September 15, 2003 thru September 19, 2003. Of the 40 volume counters, 27 were set out on Monday, 10 on Tuesday, and the remaining three were set out on Wednesday. The AHTD then picked up 24 of the volume counters on Wednesday, 12 on Thursday, and three on Friday. Of the 31 classifiers, 29 of them were set out on Monday, and the remaining two were set out on Tuesday. The AHTD then picked up 27 of the classifiers on Wednesday, and three on Thursday. Although the counters and classifiers collected data for different periods of time, they were all set out for a minimum of three days (i.e. Monday thru Wednesday, Tuesday thru Thursday, or Wednesday thru Friday).

Due to reconstruction on the main lanes, some segments of the inside lane of the frontage roads were closed to traffic during the week the "after" condition data were collected. While the "before" condition data collected data for both lanes in both directions, some of the "after" data could only be collected for one lane, the outside lane. No matter if data were collected for one or two lanes in one direction, the total volume was reported.

Collecting Long-Term After-Conversion Data

Speeds and volumes were again measured in 2006. The AHTD set out equipment and collected data between October 30 and November 2, and again between November 13 and November 15. All of the 13 volume counters were set out during the week of October 30, 2006, were set out on Monday. The AHTD then picked up seven of the first set counters on Wednesday and the remaining six on Thursday. The counters and classifiers collected data for a minimum of 48 hours. All of the eight volume counters set out during the week of November 13, 2006 were set out on Monday and they were all picked up by the AHTD on Wednesday. The second set of counters placed the week of November 13, 2006 repeated the counts made during the week of October 30, 2006. The second set of classifiers and counters collected data for a minimum of 48 hours except for Station 41, which was collected data just short of 48 hours, from 9:30 AM on November 13, 2006 to 8:45 AM on November 15, 2006.

TRAVEL TIME DATA

Before the frontage roads were converted to one-way operation, travel time runs between selected points in the I-30 corridor were made in an AHTD van. The routings included overpasses and what would become wrong-direction frontage road travel after conversion to one-way operation. The travel time runs were conducted to document before and after changes in the I-30 frontage road travel times between various nodes along the corridor.

The runs were conducted with an 8 mm video camera placed on a tripod that was secured to the front passenger's seat of the van. The camcorder recorded the road ahead, and the coded a visible time and date stamp as it was recording. This time stamp recorded to the nearest second.

An average-car technique was used while making all travel time runs. The van traveled as close to the average speed of the traffic stream as possible. Travel times between nodes were then transcribed while viewing the recorded videotape.

Same-Direction Runs

Travel time runs were made that corresponded to the direction of traffic on the main lanes (i.e., the van was driven west on the north frontage road, and driven east on the south frontage road). These runs would be compared to the same type of after condition runs since this would be the only direction of travel after the conversion to one-way operation. Each run began at the intersection of the frontage road with University Avenue in Little Rock on the north side of the I-30 main lanes. Time and nodes were recorded while traveling west to Sevier Street in Benton, crossing over the main lanes via the Sevier Street overpass, and heading east on the south side of the main lanes back to the frontage road intersection with University Avenue.

A total of eight same-direction runs were made before the frontage road was converted to one-way operation. These eight travel time runs were made September 26 and 27, 2002, during both overcast and sunny conditions. A small amount of light rain did fall, mostly in the form of drizzle, during some of the travel time runs, but the rain's effect on travel time was considered negligible. Any main lane construction that was being done while these "before" runs were conducted had no effect on the data collected.

A total of eight same-direction travel times runs were made approximately one year after the frontage roads were converted to one-way operation. These runs were conducted during sunny conditions. Much more main lane construction activities were going on while these runs were being conducted. Some segments of the frontage road inside lane (i.e. the lane closest to the freeway main lanes) were closed due to this heavy construction activity. The inside lane was closed by using orange and white construction drums. Although "after" travel times may have been affected by the construction activity, these effects are out of the scope of this study.

Opposite Direction and Crossover Runs

Opposite direction travel time runs were comprised of routings via the overpasses and along the frontage road in the direction opposite that of the main lanes (i.e., traveling west on the south frontage road and east on the north frontage road). These runs were conducted in a "zigzag" fashion. For example, traveling west on the north frontage road, using an overpass to cross the main lanes, continuing to travel west along the south frontage road until reaching the next overpass, crossing back over the main lanes to the north frontage road, then continuing in the same westward direction.

Crossover travel time runs were comprised of travel along the frontage road in the same direction as the main lane traffic and using overpasses in a "looping" fashion. For example, traveling east along the frontage road to the second overpass encountered, crossing over the main lanes, traveling west back towards the starting point to the first overpass encountered – the overpass that was skipped earlier – crossing back over the main lanes, and again traveling east to the second overpass. This "looping" pattern of travel was continued from one end of the study corridor to the other end.

There were four opposite direction runs conducted before the frontage roads were converted to one-way. These four runs began each time at the intersection of the frontage road with University Avenue in Little Rock on the north side of the I-30 main lanes. A complete run constituted traveling west in a zigzag pattern until reaching Sevier Street, then returning to

University Avenue in a zigzag pattern as well. Care was taken to ensure that each segment of frontage road and each overpass were driven in both directions while making these zigzag runs. These runs were made on October 4, 2002, under sunny conditions.

One crossover run was made after the frontage roads were converted to one-way. This run was conducted by beginning at the Sevier overpass in Benton and traveling east towards Little Rock. Care was taken to ensure that each overpass was traveled in both directions (i.e. crossing over the main lanes in both a north and south direction). This crossover run was conducted on November 4, 2003, under sunny conditions. A crossover run had to be conducted in the "after" condition as opposed to the "zigzag" runs conducted in the "before" condition since it was impossible to travel in a direction that opposed the direction of travel in the main lanes.

From these runs, six routes were developed. The routes that were developed and investigated for opposite direction and crossover runs were in the western end, in the central part of, and in the eastern end of the study corridor. One of the routes utilized the new SH 5 crossover, which did not exist before conversion.

COLLISION DATA

To gain insight into the safety effects of converting two-way frontage roads to one-way operation, crash histories in the before (2000-2001) and the after (2005-2006) periods were compared. The initial plan was to use the 2003-2004 interval for the "after" period, but examinations of the crash data from those years showed that a number of crashes were listed as having occurred in construction zones. Therefore, the analysis was suspended until sufficient time had passed so that construction was completed. Vehicular collision data were obtained from the Arkansas State Highway and Transportation Department (AHTD), the Arkansas State Police (ASP), and the Revenue Division of the Arkansas Department of Finance and Administration. AHTD also furnished a detailed strip-map of the corridor, which included frequently-labeled log miles (LM); this map proved to be quite helpful.

The data analysis began with a review of the summary crash record files, in which each crash occupies a line in a large data file. All of the collisions that were recorded as having occurred on Interstate 30 in Saline or Pulaski Counties were extracted. From that set, all of those that occurred between the beginning (Sevier Street, LM 115.82) and ending (University Avenues, LM 132.18) log miles were extracted. Those listed with a log mile outside of the limits were scanned to identify crashes which might have occurred within the limits but were incorrectly coded. Also, a search was conducted for crashes that were coded on another roadway at its intersection with Interstate 30.

For the file containing the preliminary group of crashes occurring within the limits of the research project, each row was examined to identify incongruities which suggested either a misconception on the part of the reviewer or an error in the data base. For instance, a crash listed both as having occurred on the freeway and having stop traffic-control would be marked as suspect. For all of those crash listings which raised questions, the researchers obtained and reviewed the individual crash report to clear up misconceptions and possible errors. For the 2000 and 2001 crashes, this review was performed by reading paper copies at the Arkansas State Police headquarters building. For 2005 and 2006 crashes, the researchers reviewed digitized crash reports on computers in the offices of the Revenue Division. Exhibit 3-1 shows a computer screen of the search for a particular crash, and Exhibit 3-2 shows a person reviewing an individual crash report.

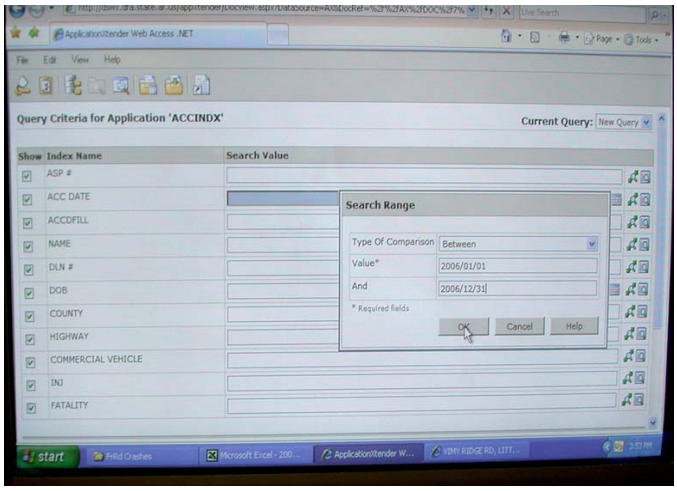

EXHIBIT 3-1 Computer Screen to Search for Individual Crash Reports

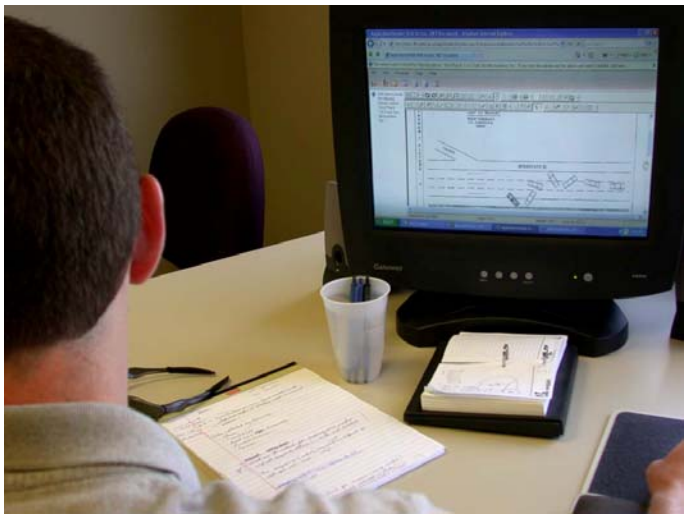
EXHIBIT 3-2 Reviewing a Crash Report

LAND USE AND OCCUPANCY DATA

In order to assess land use changes that accompanied the conversion from two-way to one-way operation, the properties abutting the frontage roads were inventoried to record the type of land use. The freeway corridor was divided into three segments (a Benton segment, a Bryant segment, and a Little Rock segment), because they have different levels of development. The approximately 4.8 mi (7.7 km) long Benton segment extends from the Sevier Street overpass to the Alcoa Road overpass. The Bryant segment is approximately 5.7 mi (9.2 km) long and extends from the Alcoa Road overpass to the County Line Road overpass. The approximately 5.8 mi (9.3 km) long Little Rock segment is from the County Line overpass to University Avenue.

Also, segments of two parallel arterial roads were also inventoried, in order to have data from property along unchanged roadways with which to make comparisons. These parallel control roads were Military Road in Benton and State Highway 5 near Little Rock. The Military Road segment in Benton was approximately 1.3 mi (2.1 km) long, extending from Jameson Road

on the south end to just north of Coby Road. The SH 5 segment was a 1.0 mi (1.6 km) long, from Bivens Loop Road, about 0.5 mi (0.8 km) south of County Line Road, to a bridge roughly 0.5 mi (0.8 km) north of County Line Road.

Initial Survey

Construction plans for the rehabilitation of the I-30 main lanes were used in making the inventory of land use along the frontage roads. While one person drove a vehicle along the frontage road and stopped at driveways, another person wrote as much descriptive information on the plans about the site as could be determined by inspection. Information such as business name, street address, land use type, and phone number taken from signs on the property were among the details that were logged. After logging the sites along the frontage roads onto the construction plans, the data were transcribed into a computer spreadsheet.

Video logs of the properties along the frontage road and the two segments of roadways used for comparison were taken with an 8 mm video camera on November 20, 2002. To do this, one person drove along the frontage roads at a relatively slow rate of speed, while another person videotaped the properties on the right side of the road. This video log was used to help answer any questions that arose while transcribing the inventory of sites from the construction plans to computer spreadsheets.

Defining Land Use Categories

Defining the land use categories was an iterative process. Since the majority of the properties abutting the roads were used for some type of business, for simplicity this report often uses the term "business" to describe the land use, even though some tracts were being used for residential or other non-business purposes.

An initial list of land use categories was created after reviewing a video inventory. Then, a field inventory was conducted on November 6, 2002, and the categories were revised. A second and final field survey was conducted on November 20, 2002, and the land use categories were revised once more and finalized. Exhibit 3-3 lists the land use categories.

0. Vacant
1. Motel
2. Restaurant
3. Vehicle, Equipment Sales
4. "Small" Retail Store
5. "Large" Retail Store (e.g. lumber yard, home improvement)
6. Specialty Retail Store (unique/rare product line)
7. Other Retail Store
8. Gas Station (with or without other services)
9. Repair Shop
10. Industrial (e.g. construction, warehouse, trucking)
11. Church, Funeral Home
12. Institutional (e.g. hospital, nursing home)
13. Professional, Office, Service
14. Other

EXHIBIT 3-3 Land Use Categories

The land use categories were created to reflect the types of land use encountered along the frontage roads and the parallel roadways. When creating the categories, one consideration was to create types that would be expected to generate a similar amount of traffic, or number of trip ends.

Some sites had multiple activities, such as selling both storage buildings and concrete monuments. Some had a combination of manufacturing and sales. These manufacturing and sales businesses were typed as industrial. Examples of properties list as "other" include: residences, nightclubs, and auction houses.

A few tracts were developed as shopping centers, with many tenants. In these cases, only the most visible occupants and those closest to the street were recorded.

Some land use types were not obvious and were challenging to classify. In a few instances, the researchers encountered parcels whose use they could not identify with certainty.

Over time, it was recognized that it was difficult to consistently differentiate between the range of businesses encountered. Therefore, land use types 4, 6, and 7 (small retail store, specialty retail store, and other retail store) were combined during the analyses.

Subsequent Inventories

To determine what changes took place after the frontage roads were converted to one-way operation, land uses along the frontage roads and the control roads were inventoried in November, 2002, and again in March 2006.

The lists of businesses from 2002, 2003, and 2006 were compared. Any business or land use that changed was noted, as were any sites that had become vacant or any new businesses that opened after the conversion. If a building had been constructed on a previously vacant tract, but the building was still unoccupied, the tract was coded as having changed, and in both years the site was classified as vacant. A few businesses did relocate within the corridor; since the record was made on a tract-by-tract basis, such cases were coded as land use changes.

TAXABLE REVENUE DATA

Taxable revenue data for the months of February, May, August, and November 2000, 2001, 2002, and 2003 were collected from the Little Rock Convention and Visitors Bureau for 20 businesses located on the frontage roads in the study corridor. All of these businesses were restaurants and hotels. Due to a special Little Rock City sales tax, revenue for restaurants and motels was part of public record. There was no such tax in Saline County, so taxable revenue data could not be obtained.

Of these 20 businesses, nine of them had access only from the frontage road, six businesses had frontage road access and alternate access from another road, and the remaining five businesses were not located on the frontage roads. Taxable revenue data for businesses located on the frontage road were compared to taxable revenue data for businesses that were not located on the frontage roads to determine the economic impact of the conversion. Also, a comparison between frontage road businesses with either type of access was made to determine if conversion of the frontage road had greater economic effects on those businesses with frontage road access only.

OPINION SURVEY DATA

Comments from the public had been solicited at a public hearing conducted by the AHTD in 1993. Since these surveys were about ten years old, a new survey was created. The survey was

administered to owners or managers of businesses along the frontage road. The final survey form used in this study is shown in an appendix.

Preparing and Testing the Survey Instrument

A trial survey form was prepared containing the name of the surveyor, date, business name, address and phone number, along with the name of the person being interviewed. This trial survey consisted of four questions concerning the conversion of the frontage roads to one-way operation. The first question of the trial survey asked, "Before the frontage roads were converted from two-way to one-way operation in October 2002, I…" with responses of, "was for the conversion, opposed the conversion, had no opinion\undecided, or did not know the conversion was about to occur" given as choices. The second question asked "Now that the conversion from two-way to one-way operation has occurred, I …" with responses of, "am for the conversion, am opposed to the conversion, or have no opinion\undecided" given as choices. The third asked "Which do you think is safer?" with responses of, "One-way frontage roads, two-way frontage roads, or no difference\equally safe" given as choices. The final question asked, "How has the conversion of the frontage roads to one-way operation affected your business\organization?" No choice of response was given for this question: only comments were taken. This trial survey was conducted on four sites on November 5, 2002.

Survey Refinement

Based on responses given during the trial survey, the survey was revised. A fifth question that asked, "Does your site rely entirely on the frontage road for access, or does another road also serve your site?" was added to the survey. It had, "solely on frontage road, already had alternate access, or constructed alternate access after conversion", as possible responses. The answer of "no response" was also added to each question. A response of "do not know" to any of the questions was marked as no response. A list of land use types was added to facilitate entering the response. These types were the same as the land use types used for the inventory of the properties. This second iteration was administered to nine businesses on November 20, 2002.

Finalized Survey

Since the land use types were revised during the inventory of businesses along the frontage road, the survey was also revised one last time. Responses of, "none, hurt, improved, or other" were given as choices to the question, "How has the conversion of the frontage roads to one-way operation affected your business\organization?" However, comments were still taken with this question. This final version was administered to 51 businesses on December 17 and 18, 2002, to 11 businesses on January 7, 2003, and to 8 over the telephone on January 9, 2003. The prior 13 surveys had recorded additional comments that allowed them to be converted into the final version. The total number of surveys was 83.

Conducting the Initial Survey

The initial surveys were conducted between November 2002 and January 2003, within a three-month window after the conversion occurred. The surveys were conducted by visiting different sites, asking to speak with an owner or manager, obtaining identifying information such as address, and asking them the questions in the survey. Their responses were marked on individual survey forms.

Surveyors tried to avoid locations with obvious alternate access. However, a few sites had an alternate access that could not be easily seen, so they were included in the survey.

Surveys were not administered to land use category types 11 (churches, funeral homes) and 12 (institutional), as it was thought that their traffic patterns were less likely to be affected by the change than were other types of land uses. In the office, the data were transcribed to a computer spreadsheet so that the data could be more easily analyzed.

Conducting the Follow-up Survey

A follow-up survey was conducted in November of 2003, approximately one year after conversion of the frontage roads, to determine if attitudes about frontage roads with one-way operation had changed during this time period. The same person interviewed during the initial survey was sought out for the follow-up interview. However, due to turnover at businesses in the study corridor, this was not always possible. Of the 83 persons initially interviewed, only 55 of them could be interviewed again. If the same person was found to interview, the same questions asked in the initial survey were asked in the follow-up survey, with the exception of omitting the second question which asked, "Before the frontage roads were converted from two-way to one-way operation in October 2002, I…". It was reasoned that the answers received for this question would not be different from the initial survey. If the same person was not found to interview again, this question was asked.

Of the five businesses that were surveyed during the initial period that could not be surveyed during the follow-up period, four of them had closed, and one had moved. Of the 78 surveys administered during the follow up period, the same person was interviewed in 55 instances, and there were 23 new interviewees.

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CHAPTER 4
DATA ANALYSIS AND RESULTS

This chapter describes how the collected data were analyzed. As previously stated, data pertaining to volume, speed, travel time, collisions, land use, tax receipts, and opinions from business owners were collected along the frontage roads in the I-30 corridor between the Sevier Street overpass in Benton, Arkansas, and University Avenue in Little Rock, Arkansas.

ANALYSIS OF VOLUME DATA

Volume data collected in the I-30 study corridor were analyzed to assess to what degree volumes on frontage roads changed after conversion from two-way to one-way operation. Volumes were measured with mechanical counters at locations determined by AHTD. Before counts were made in September and early October of 2002. Initial "after" counts were made in September 2003, and later "after" counts were made in early November 2006.

At each volume measuring station, the "before" condition volume data were collected for an entire seven days, including weekends. However, due to equipment and time constraints, the "after" condition volume data were collected for only a three or four day period. Therefore, only data from the same three or four day period were compared, as it is known that different days of the week produce different volumes.

The average 15-minute increment volumes for those days that data were collected were determined and a flow rate (vehicles per hour) was then calculated by simply multiplying these volumes by four. Flow rates before conversion were then placed on a graph with flow rates after conversion at the same location. Visual inspection was then conducted to determine if there were any erratic changes in volume patterns during data collection occurred. If visual inspection of a flow rate graph reveled that there was a problem with the data collection, that station was ignored.

After inspection of the flow rate graphs, it was found that data collected after conversion by five volume counters at stations number 5, 7, 8, 13, and 14 had to be discarded. These data were discarded due to the fact that a contractor conducting overpass reconstruction work shut down the interstate main lanes during the overnight hours and diverted traffic onto the frontage roads. These volume counters showed an irregular spike in overnight volumes and therefore produced an artificially high average daily volume. Discarding these stations reduced the total number of stations from 69 to 64.

Data from three other stations also was discarded. Stations 35, 59, and 60 were at sites where newly constructed temporary exits built due to main lane construction were placed at locations that affected the data that were collected after conversion. These stations showed an irregular overall increase in traffic volume. Therefore, these stations were also discarded. This reduced the total number of stations from 64 to 61.

For each station, the daily volumes were computed by first averaging the volumes for each 15-minute period. For instance, at station 28 in 2006, volume data were collected from 9:30 Monday morning through 12:30 Wednesday afternoon. For the most part, two 15-minute counts were averaged, but from 9:30 to 12:30, three 15-minute counts were averaged. Then, the averaged 15-minute counts were added to arrive at a daily volume. These average daily volumes before and after the conversion were compared to determine to what extent traffic volume had changed.

Frontage Road Volumes

Of the 38 stations along the frontage roads where volumes were measured, two of them (stations 3 and 63) were at locations where the frontage road was not converted to one-way operation during the 2002 to 2003 comparison period. Although they were converted after completion of the main lane reconstruction, these two stations were excluded from the frontage road volume analysis. The data from these stations are presented separately. Exhibit 4-1 shows the average daily volume before and after conversion for the 36 stations along the frontage road where it was converted to one-way operation in 2002. During 2006, data were collected only at 12 of these stations.

EXHIBIT 4-1 Frontage Road Daily Volumes

Station	Before - 2002			After - 2003			After - 2006		
Number	EB	WB	Total	EB	WB	Total	EB	WB	Total
2	979	5838	6817		6721	6721		4749	4749
4	1797	2864	4661		2046	2046		2258	2258
9	5194	1826	7020	7844		7844			
10	5353	2351	7704	7472		7472			
11	1840	2793	4633		3601	3601		4398	4398
17	1595	7427	9022		6557	6557		7822	7822
19	2638	2709	5347	3794		3794			
20	1805	2482	4287		2562	2562		3208	3208
22	2459	2534	4993	4917		4917			
23	1267	1688	2955		3651	3651		4032	4032
24	1997	2073	4070	4772		4772			
26	1070	7730	8800		10350	10350		16467	16467
27	9509	2353	11862	11718		11718			
28	504	1981	2485		3185	3185		4679	4679
29	3110	2180	5290	5967		5967			
31	1176	2344	3520		3728	3728		6276	6276
32	2629	2370	4999	5771		5771			
36	13247	2691	15938	14086		14086			
37	1720	3371	5091		4402	4402		3680	3680
38	3234	1820	5054	4942		4942			
41	1308	2987	4295		2956	2956		1605	1605
42	2770	1458	4228	3547		3547			
44	2836	1535	4371	3488		3488			
45	1573	6483	8056		6905	6905		6278	6278
46	8056	2119	10175	7895		7895			
50	1024	2463	3487		4490	4490			
51	2911	2735	5646	4672		4672			
53	1149	3808	4957		5943	5943			
54	4836	1819	6655	5915		5915			
55	2942	6515	9457		11148	11148			
58	356	656	1012		1477	1477			
61	670	6515	7185		5589	5589			
64	1049	2674	3723		3601	3601			
65	1065	1391	2456	1753		1753			
67	820	560	1380		1225	1225			
68	2014	1992	4006	2361		2361			
Total	98502	107135	205637	100914	90137	191051			
Average	2736	2976	5712	2803	2504	5307			

The computations showed that the average of the volume from all of these frontage road stations was over 5700 vpd before conversion. After conversion in 2003, the average volume at these frontage road stations had dropped to just over 5300 vpd. To compare the 2006 volumes with those from 2002 and 2003, the counts for only those stations at which counts were conducted in all three years were extracted. Exhibit 4-2 shows these volumes.

EXHIBIT 4-2 Frontage Road Daily Volumes for Stations Counted in All Three Years

Station	Before - 2002			After - 2003			After - 2006		
Number	EB	WB	Total	EB	WB	Total	EB	WB	Total
2	979	5838	6817	-	6721	6721	-	4749	4749
4	1797	2864	4661	-	2046	2046	-	2258	2258
11	1840	2793	4633	-	3601	3601	-	4398	4398
17	1595	7427	9022	-	6557	6557	-	7822	7822
20	1805	2482	4287	-	2562	2562	-	3208	3208
23	1267	1688	2955	-	3651	3651	-	4032	4032
26	1070	7730	8800	-	10350	10350	-	16467	16467
28	504	1981	2485	-	3185	3185	-	4679	4679
31	1176	2344	3520	-	3728	3728	-	6276	6276
37	1720	3371	5091	-	4402	4402	-	3680	3680
41	1308	2987	4295	-	2956	2956	-	1605	1605
45	1573	6483	8056	-	6905	6905	-	6278	6278
Total	16,634	47,988	64,622	-	56,664	56,664	-	65,452	65,452
Average	1386	3999	5385	-	4722	4722	-	5454	5454

From the counts taken at a smaller number of stations for all three years, even though there was a sizeable drop in volume from 2002 to 2003, the total volume in the 2006 counts had risen to slightly above that of the volume before the conversion was made in 2002. It should be noted that comparing 2002 with 2006, more stations show a drop in volume, even though the sum was greater in 2006. More insight could have been gained if more 2006 volume data were available. Volumes did grow at the majority of stations from 2003 to 2006.

Exhibit 4-3 shows the change in average daily volume that occurred on the frontage road from 2002 to 2003. Total volumes (i.e. both north and southbound volumes before conversion) were used for comparison. Most stations showed a decrease in volume, but some locations showed an increase. Comparing the 2002 with the 2003 traffic counts, the total average daily volume for all stations combined on the frontage roads dropped by over 7%. For the subset of stations at which volumes were collected in all three periods, there was a 1% increase from 2002 to 2006.

The average daily volume data were subjected to statistical analysis to determine if the conversion of the frontage roads significantly changed average daily volumes on the frontage road. The null hypothesis was that there was no change in average daily volumes along the frontage road, and the alternative hypothesis was that the volume could have either increased or decreased. A paired t-test was conducted on the difference in average daily volumes at each station before and after conversion. A significance level of $\alpha=0.10$ was used. Since the paired t-test produced a p-value of 0.04, less than $\alpha=0.10$, it was concluded that the null hypothesis could

be rejected. This shows that there was a significant change in the average daily volumes on the frontage roads one year after conversion to one-way operation. The mean change in volume was -405, indicating that volumes decreased from 2002 to 2003.

EXHIBIT 4-3 Change in Frontage Road Daily Volumes After Conversion

Station Number	Comparing 2002 to 2003 Change	%	Comparing 2002 to 2006 Change	%
2	-96	-1.4%	-2068	-30.3%
4	-2615	-56.1%	-2403	-51.6%
9	824	11.7%		
10	-232	-3.0%		
11	-1032	-22.3%	-235	-5.1%
17	-2465	-27.3%	-1200	-13.3%
19	-1553	-29.0%		
20	-1725	-40.2%	-1079	-25.2%
22	-76	-1.5%		
23	696	23.6%	1077	36.5%
24	702	17.3%		
26	1550	17.6%	7667	87.1%
27	-144	-1.2%		
28	700	28.2%	2194	88.3%
29	677	12.8%		
31	208	5.9%	2756	78.3%
32	772	15.4%		
36	-1852	-11.6%		
37	-689	-13.5%	-1411	-27.7%
38	-112	-2.2%		
41	-1339	-31.2%	-2690	-62.6%
42	-681	-16.1%		
44	-883	-20.2%	-1778	-22.1%
45	-1151	-14.3%		
46	-2280	-22.4%		
50	1003	28.8%		
51	-974	-17.3%		
53	986	19.9%		
54	-740	-11.1%		
55	1691	17.9%		
58	465	45.9%		
61	-1596	-22.2%		
64	-122	-3.3%		
65	-703	-28.6%		
67	-155	-11.2%		
68	-1645	-41.1%		
Total	-14586	-7.1%	830	1%

Two-way Frontage Road Volumes

The average daily volumes for the two stations located on segments of frontage road that were not converted to one-way operation in October 2002 are listed in Exhibit 4-4. The change in average daily volumes for these two stations is given in Exhibit 4-5.

EXHIBIT 4-4 Two-way Frontage Road Daily Volumes

Station Number	Before - 2002 EB	WB	Total	After - 2003 EB	WB	Total
3	5294	537	5831	3572	369	3941
63	13718	6312	20030	12151	4832	16983
Total	19012	6849	25861	15723	5201	20924
Average	9506	3425	12931	7862	2601	10462

EXHIBIT 4-5 Change in Two-way Frontage Roads Daily Volumes

Station Number	Eastbound 2002-2003 Change	%	Westbound 2002-2003 Change	%	Total 2002-2003 Change	%
3	-1722	-32.5%	-168	-31.3%	-1890	-32.4%
63	-1567	-11.4%	-1480	-23.5%	-3047	-15.2%
Total	-3289	-17.3%	-1648	-24.1%	-4937	-19.1%

The total average daily volume from the two stations combined dropped from 2002 to 2003 by 4937 vpd, a reduction of over 19%. It is interesting to note that not only did average daily volumes drop on frontage roads that were converted, but also volumes dropped even more on those two short segments that were not converted to one-way operation.

Overpass Volumes

Volume data were collected at 11 of the overpasses through the study corridor. A new overpass for SH 5 was completed and opened to traffic after the frontage roads were converted. Therefore, no before-and-after comparison of average daily volumes could be made at this overpass. Volumes were counted at one location in 2006.

Stations 30, 40, 52, and 66 were at crossovers, while the other stations were at overpasses with interchanges. Exhibit 4-6 shows the average daily volume before and after conversion for stations located on overpasses. Exhibit 4-7 shows the change in average daily volumes on overpasses.

At some of the overpasses the volumes increased, while at others they decreased. An overall increase of 4% was found to have taken place on the overpasses between 2002 and 2003.

The data were analyzed with two-sided paired t-tests to determine if the conversion of the frontage roads was associated with a change in the average daily volumes on overpasses. The null hypothesis was that there was no change in average daily volumes on overpasses. The

difference in average daily volume at each station before and after conversion was the response variable. A significance level of α=0.10 was used. The resulting p-value was much greater than α=0.10, so the null hypothesis could not be rejected. This indicates that the average daily volumes were not statistically significantly different on overpasses after conversion to one-way operation.

EXHIBIT 4-6 Overpass Daily Volumes

Station	Before - 2002			After - 2003			After - 2006		
Number	NB	SB	Total	NB	SB	Total	NB	SB	Total
1	5137	5818	10955	4340	7083	11423			
6	8910	10350	19260	8470	11644	20114			
16	10241	12077	22318	8751	9162	17913			
25	4408	8149	12557	4974	8383	13357			
30	2504	1896	4400	1973	2532	4505			
34	9913	4934	14847	10936	14240	25176			
40	1184	1075	2259	1843	405	2248	1484	330	1814
47	4001	5876	9877	3440	6181	9621			
52	1301	2601	3902	1775	3698	5473			
62	6392	7440	13832	5110	6159	11269			
66	2496	4026	6522	3031	1432	4463			
Total	56487	64242	120729	54643	70919	125562			
Average	5135	5840	10975	4968	6447	11415			

EXHIBIT 4-7 Change in Overpass Daily Volumes After Conversion

Station	Northbound		Southbound		Total		Total	
Number	2002-2003		2002-2003		2002-2003		2002-2006	
	Change	%	Change	%	Change	%	Change	%
1	-797	4.3%	1265	21.7%	468	4.3%		
6	-440	-4.9%	1294	12.5%	854	4.4%		
16	-1490	-14.6%	-2915	-24.1%	-4405	-19.7%		
25	566	12.8%	234	2.9%	800	6.4%		
30	-531	-21.2%	636	33.5%	105	2.4%		
34	1023	10.3%	9306	188.6%	10329	69.6%		
40	659	55.7%	-670	-62.3%	-11	-0.5%	-445	-19.7%
47	-561	-14.0%	305	5.2%	-256	-2.6%		
52	474	36.4%	1097	42.2%	1571	40.3%		
62	-1281	-20.1%	-1281	-17.2%	-2563	-18.5%		
66	535	21.4%	-2594	-64.4%	-2059	-31.6%		
Total	-1844	-3.3%	6677	10.4%	4833	4.0%		

Parallel Roadway Volumes

Two roadways run parallel to I-30 through the study corridor. One is Military Road on the south side of I-30 in Benton. The other roadway is SH 5 on the north side of I-30 between

Benton and Little Rock. Several counters were placed at stations along these roadways to assess the effects of frontage road conversion on the volumes on these parallel routes.

Two counters were placed on roadways that connect the Baseline Road overpass with the Otter Creek Road overpass in southwest Little Rock. This is an alternate route for motorists to travel between these two overpasses. These roads are Mabelvale Pike and Mabelvale West Road. Counters were placed on these roadways to determine if motorists used an alternate route to the converted frontage roads.

These parallel and alternate roadways were used as a control group. By comparing the changes in volume on the frontage roads to changes in volume on the other roadways, the effect of frontage road conversion was better determined.

There were a total of 12 stations located on one of the three parallel roadways. Of these 12 stations, one, station number 18, was placed on Military Rd. near the south end of the newly opened SH 5 overpass, and one, station 21, was placed on SH 5 near the north end of the same overpass. The average daily volumes at these two locations increased by an exceedingly large amount due to their close proximity to the new overpass. These two stations were omitted from the comparison and their data are presented separately.

Exhibit 4-8 shows the average daily volume before and after conversion for stations located on these parallel routes, while Exhibit 4-9 shows the change. Inspection of these exhibits revealed that all but one station located on parallel routes showed an increase in average daily volume. A total increase of just over 15% was found to have occurred on these parallel routes between the 2002 (before conversion) and the 2003 (after conversion) counts.

EXHIBIT 4-8 Parallel Roadway Daily Volumes

Station Number	Before - 2002 NB	SB	Total	After - 2003 NB	SB	Total
Military Rd.						
12	12493	9718	22211	11349	11231	22580
15	3235	3537	6772	4747	5536	10283
Total	15728	13255	28983	16096	16767	32863
Hwy. 5						
31A	4370	5534	9904	5330	6670	12000
33	7939	7693	15632	7877	8959	16836
39	5466	5639	11105	7372	6593	13965
43	6372	6572	12944	8122	7473	15595
48	7205	8961	16166	8450	8289	16739
49	8513	8986	17499	10025	10480	20505
Total	39865	43385	83250	47176	48464	95640
Mabelvale West Rd.						
69	4492	4468	8960	5800	6911	12711
70	3866	4302	8168	3392	4459	7851
Total	8358	8770	17128	9192	11370	20562
Total	63951	65410	129361	72464	76601	149065
Average	6395	6541	12936	7246	7660	14907

EXHIBIT 4-9 Change in Parallel Roadway Daily Volumes After Conversion

Station Number	Northbound 2002-2003 Change	%	Southbound 2002-2003 Change	%	Total 2002-2003 Change	%
Military Rd.						
12	-1144	-9.2%	1513	15.6%	369	1.7%
15	1512	46.7%	1999	56.5%	3511	51.9%
Total	368	2.3%	3512	26.5%	3880	13.4%
SH 5						
31A	960	22.0%	1136	20.5%	2096	21.2%
33	-62	-0.8%	1266	16.5%	1204	7.7%
39	1906	34.9%	954	16.9%	2860	25.8%
43	1750	27.5%	901	13.7%	2651	20.5%
48	1245	17.3%	-672	-7.5%	573	3.5%
49	1512	17.8%	1494	16.6%	3006	17.2%
Total	7311	18.3%	5079	11.7%	12390	14.9%
Mabelvale West Rd.						
69	1308	29.1%	2443	54.7%	3751	41.9%
70	-474	-12.3%	157	3.7%	-317	-3.9%
Total	834	10.0%	2600	29.7%	3434	20.1%
Total	8513	3.3%	11191	17.1%	19704	15.2%

A two-sided paired t-test was conducted on the difference in average daily volumes at each station before and after conversion. The null hypothesis was that there was no change in average daily volumes on the control roads. A significance level of α=0.10 was used when this test was conducted. The resulting p-value equaled 0.0018, less than α=0.10. Therefore, it was concluded that the null hypothesis could be rejected, and that the average daily volumes were statistically significantly changed on the control roads after conversion to one-way operation. The volumes on the control roads increased from 2002 to 2003.

Volumes at Control Stations Near State Highway 5 Overpass

The average daily volumes for the two stations located on control roads near the newly opened SH 5 overpass are given in Exhibit 4-10. The change in average daily volumes for these two stations is given in Exhibit 4-11.

EXHIBIT 4-10 Daily Volumes Near State Highway 5 Overpass

Station Number	Before - 2002 NB	SB	Total	After - 2003 NB	SB	Total
18	873	659	1432	18471	3333	21804
21	1409	1741	3150	2705	3073	5778
Total	2282	2400	4682	21176	6406	27582
Average	1141	1200	2341	10588	3403	13791

EXHIBIT 4-11 Change in Daily Volumes near State Highway 5 Overpass

Station Number	Northbound 2002-2003 Change	%	Southbound 2002-2003 Change	%	Total 2002-2003 Change	%
Military Rd.						
18	17598	2015.8%	2674	405.8%	20272	1323.2%
21	1296	92.0%	1332	76.5%	2628	83.4%
Total	18894	828.0%	4006	166.9%	22900	489.1%

The preceding exhibits show large increases in average daily volumes following the completion of the SH 5 overpass. The more than ten-fold increase at station 18 was perhaps due to locating the counter in close proximity to the section of road that was closed due to construction of the overpass. The large increase in average daily volume at station 21 could be due to this same factor.

Overall Study Corridor Volumes

Exhibit 4-12 shows the change in average daily volume for all stations located in the study corridor from 2002 to 2003. Inspection of the exhibit showing data from all 57 stations analyzed found that although traffic on the frontage roads decreased, there was a 2.2% increase in traffic through the entire study corridor.

The data were subjected to statistical analysis to determine if the volumes in the entire study corridor significantly changed after the conversion of the frontage roads. The null hypothesis was that there was no change in average daily volumes in the corridor between 2002 and 2003. A paired t-test was conducted on the difference in average daily volumes at each station before and after conversion, with a significance level of α=0.10. Results of the paired t-test found the p-value equaled 0.5330, greater than α=0.10. Due to this, it was concluded that the null hypothesis could not be rejected. This indicates that the average daily volumes were not statistically significantly higher through the study corridor after conversion to one-way operation.

Volume Analysis Summary

Inspection of the average daily volumes before and after conversion for stations located on the frontage road, overpasses, and parallel roadways revealed that changes in vehicular traffic volume were mixed. Volumes increased at some stations, decreased at others, and a few stations had little change in volume.

These statistical tests found that while average daily volumes did not significantly increase through the entire study corridor from 2002 to 2003, they did significantly increase on the control roads and significantly decreased on the frontage roads. Overpass volumes did not significantly change. Considering volumes at the fewer number of stations at which counts were made in 2006, volumes on average rose from 2003 to 2006 to about the preconversion level. However, comparing volumes at individual stations, some had sizeable decreases while others had sizeable increases, making it difficult to conclude what the longer-term trend was.

EXHIBIT 4-12 Change in Average Daily Volumes After Conversion

Station Number	2002-2003 Change	%	Station Number	2002-2003 Change	%
1	468	4.3%	39	2860	25.8%
2	-96	-1.4%	40	-11	-0.5%
4	-2615	-56.1%	41	-1339	-31.2%
6	854	4.4%	42	-681	-16.1%
9	824	11.7%	43	2651	20.5%
10	-232	-3.0%	44	-883	-20.2%
11	-1032	-22.3%	45	-1151	-14.3%
12	369	1.7%	46	-2280	-22.4%
15	3511	51.9%	47	-256	-2.6%
16	-4405	-19.7%	48	573	3.5%
17	-2465	-27.3%	49	3006	17.2%
19	-1553	-29.0%	50	1003	28.8%
20	-1725	-40.2%	51	-974	-17.3%
22	-76	-1.5%	52	1571	40.3%
23	696	23.6%	53	986	19.9%
24	702	17.3%	54	-740	-11.1%
25	800	6.4%	55	1691	17.9%
26	1550	17.6%	58	465	46.0%
27	-144	-1.2%	61	-1596	-22.2%
28	700	28.2%	62	-2563	-18.5%
29	677	12.8%	64	-122	-3.3%
30	105	2.4%	65	-703	-28.6%
31	208	5.9%	66	-2059	-31.57
31A	2096	21.2%	67	-155	-11.2%
32	772	15.4%	68	-1645	-41.1%
33	1204	7.7%	69	3751	41.9%
34	10329	69.6%	70	-317	-3.9%
36	-1852	-11.6%			
37	-689	-13.5%	Total	9951	2.2%
38	-112	-2.2%			

Comparisons among counts taken in 2002, 2003, and 2006 are somewhat clouded by the effects of heavy construction activity during the 2003 counts. At two stations (18 and 21) located on parallel routes near the new SH 5 overpass, volumes after the conversion and the opening of the overpasses showed marked increases. Stations 61, 64, 65, 67, and 68, which were located near the some of the heaviest construction work, showed a marked decrease in volume in 2003. Stations 3 and 63, located on segments of frontage road that were not converted to one-way operation until later, showed a decrease in 2003 volume as well.

ANALYSIS OF SPEED DATA

Speeds increased after the conversion of frontage roads from two-way to one-way. Of the 30 stations where the speed was collected, 24 of them showed a rise in speed.

Speeds recordings were made at the stations listed in Exhibit 4-13 during all three (2002, 2003, and 2006) data collection periods. This table lists both the average speed and the percent of vehicles in 5 mph speed increments, taken from the files furnished by AHTD. In general, the

mean speeds on the frontage roads increased after conversion, then decreased by 2006, in some cases to below the before-conversion 2002 levels.

EXHIBIT 4-13 Frontage Road Speeds

	Mean	0-40	40-45	45-50	50-55	55-60	>60
Sta 4							
Before-2002	41	56.2%	25.5%	12.8%	4.6%	0.8%	0.2%
After- 2003	44	28.9%	31.4%	24.0%	11.3%	3.3%	1.1%
After- 2006	45	0.2%	67.1%	28.3%	0.4%	1.4%	2.5%
Sta 20 WB							
Before-2002	43	35.8%	33.5%	20.4%	8.1%	1.8%	0.5%
After- 2003	47	12.3%	28.2%	32.1%	20.0%	5.6%	1.8%
After- 2006	45	0.2%	60.6%	36.1%	0.1%	1.5%	1.5%
Sta 23 WB							
Before-2002	48	12.7%	19.8%	26.3%	26.5%	11.1%	3.6%
After- 2003	50	8.2%	14.9%	24.8%	28.7%	16.0%	7.4%
After- 2006	45	0.6%	69.1%	27.6%	0.6%	0.7%	1.5%
Sta 28 WB							
Before-2002	48	16.6%	17.7%	24.1%	24.3%	11.7%	5.6%
After- 2003	59	2.7%	2.0%	6.6%	18.1%	26.2%	44.5%
After- 2006	45	0.7%	72.0%	23.1%	0.0%	0.5%	3.7%
Sta 31 WB							
Before-2002	46	24.0%	19.8%	26.0%	21.2%	7.1%	2.0%
After- 2003	50	14.2%	9.8%	21.4%	29.2%	16.9%	8.5%
After- 2006	45	0.3%	67.5%	29.8%	0.1%	0.9%	1.4%
Sta 37 WB							
Before-2002	45	26.8%	28.5%	24.8%	14.2%	4.3%	1.3%
After- 2003	42	49.5%	29.3%	13.9%	5.4%	1.2%	0.7%
After- 2006	46	0.3%	47.8%	46.8%	0.1%	2.1%	2.8%
Sta 41 WB							
Before-2002	48	13.0%	20.2%	27.8%	24.7%	10.3%	4.2%
After- 2003	56	0.7%	3.9%	14.0%	30.5%	28.0%	22.8%
After- 2006	44	10.4%	63.2%	22.8%	0.4%	0.9%	2.3%

Note: all speed in miles per hour (mph)

For each station, cumulative percent distributions were computed for each of the three years. Then, the values for all of the stations were averaged separately for each of the three years. Exhibit 4-14 is the plot of these cumulative distribution curves. Comparing 2003 (after conversion) with 2002 (before conversion), there is roughly a 4 to 5 mph shift to the right or increase in speeds for a large percent of the drivers. Comparing 2006 with 2002, drivers that had been on the slow end of the spectrum had increased their speeds, but the faster drivers seemed to have slowed, with the result that a larger percent of drivers were now in a band extending from just below 40 mph to just below 50 mph. The 2006 speeds were much less dispersed than the 2002 or the 2003 speeds.

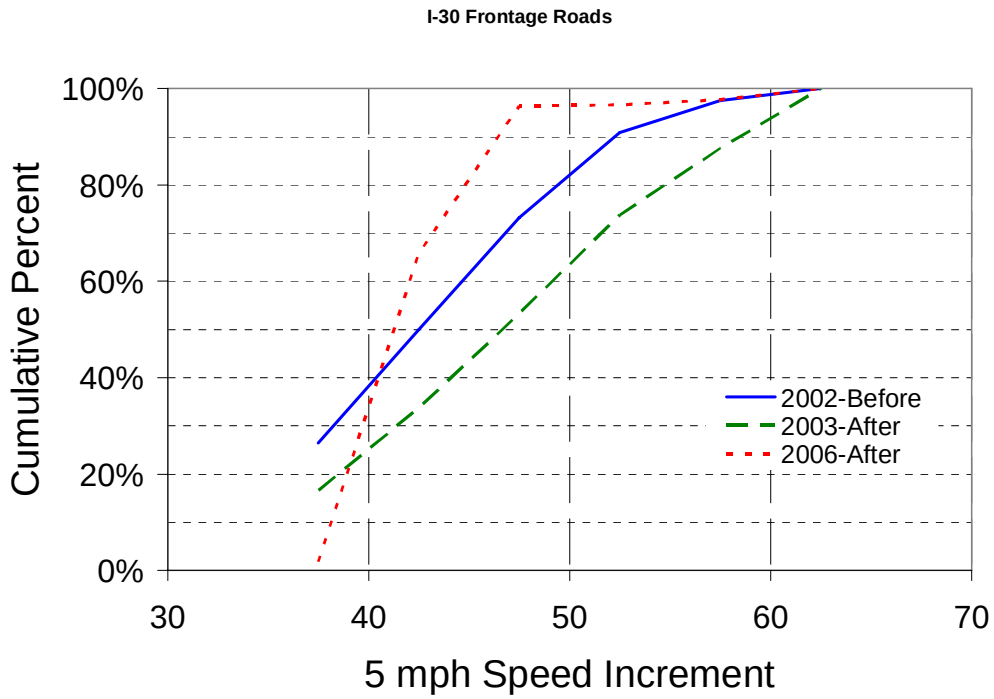

EXHIBIT 4-14 Cumulative Speed Distribution Curves

ANALYSIS OF TRAVEL TIME DATA

Travel time data collected for the I-30 study corridor were analyzed to determine if there was a change in travel times between identified nodes on the frontage road. Data were collected before and after conversion by driving a van equipped with a video camera through the I-30 corridor while the camera was recording and coding the time on videotape. Travel times between nodes were then transcribed from the recorded videotape to a computer spreadsheet for analysis. Different types of runs made during the data collection periods.

Same direction runs were those which involved traveling west on the north frontage road or east on the south frontage road. A before-and-after comparison of these runs was made to determine if there were any significant changes in travel times between nodes.

Opposite direction and crossover runs were also made before and after conversion to determine if travel times to destinations on the other side of the main lanes were different. This analysis was done by breaking up the crossover runs into short segments, and then combining these segments to create fictitious routes with destinations on both the same and opposite side of the main lanes. Not only were the departing travel times compared, but the returning travel times were compared as well.

Same Direction Runs

Since the "same direction" runs were between the same nodes, a comparison of before and after travel times was made. The analysis began by determining the average travel time of the eight before and eight after runs between nodes. Then, the difference between these average travel times was found. The differences in travel times were statistically tested to determine if

the travel times after conversion were significantly different from those before conversion. Same direction travel times along both the north and south frontage road are presented in Exhibit 4-15.

EXHIBIT 4-15 Same Direction Travel Times

Segment From	To	Avg. Time Before-2002 (sec)	Avg. Time After-2003 (sec)	Δ Time (sec)
Forbing Rd.	Chicot Rd. OP	55	59	4
Chicot Rd. OP	McDaniels Dr.	33	38	5
McDaniels Dr.	Baseline Rd.	88	80	-8
Baseline Rd.	Childers St.	35	47	12
Childers St.	Sibley Hole Rd.	38	34	-4
Sibley Hole Rd.	Mabelvale Rd. OP	107	96	-11
Mabelvale Rd. OP	Vimy Ridge Rd. OP	49	46	-3
Vimy Ridge Rd. OP	County Line Rd. OP	138	121	-17
County Line Rd. OP	Shobe Rd.	42	37	-5
Shobe Rd.	Raymar Rd. OP	99	89	-10
Raymar Rd. OP	Wal-Mart	83	74	-9
Wal-Mart	Hwy, 183 OP	51	45	-6
Hwy. 183 OP	Prickett Rd.	44	39	-5
Prickett Rd.	Springhill Rd. OP	52	47	-5
Springhill Rd. OP	Alcoa Rd. OP	92	74	-18
Alcoa Rd. OP	Hwy. 5 OP	94	81	-13
Hwy. 5 OP	Deerfield Rd.	58	46	-12
Deerfield Rd.	Congo Rd. OP	54	40	-14
Congo Rd. OP	Wright Ave.	64	56	-8
Wright Ave.	Hwy. 5/35 OP	83	70	-13
Hwy. 5/35 OP	Sevier St. OP	80	71	-9
Start of Fr. Rd.	Hwy. 5/35 OP	10	8	-2
Hwy. 5/35 OP	Main St.	23	21	-2
Main St.	Landers Rd.	73	59	-14
Landers Rd.	Congo Rd. OP	49	37	-12
Congo Rd.	Hwy. 5 OP	94	77	-17
Hwy. 5 OP	Alcoa Rd. OP	113	92	-21
Alcoa Rd. OP	Springhill Rd. OP	75	67	-8
Springhill Rd. OP	Prickett Rd.	57	47	-10
Prickett Rd.	Hwy. 183 OP	62	53	-9
Hwy. 183 OP	Raymar Ed. OP	109	99	-10
Raymar Rd. OP	Shobe Rd.	100	89	-11
Shobe Rd.	County Line Rd. OP	50	49	-1
County Line Rd. OP	Vimy Ridge Rd. OP	125	114	-11
Vimy Ridge Rd. OP	Mabelvale Rd. OP	60	57	-3
Mabelvale Rd. OP	Sibley Hole Rd.	80	74	-6
Sibley Hole Rd.	Mabelvale Pike	59	67	8
Mabelvale Pike	Baseline Rd.	29	24	-5
Baseline Rd.	St. @ Crest of Hill	57	55	-2
St. @ Crest of Hill	Chicot Rd. OP	37	38	1
Chicot Rd. OP	University Ave.	32	35	3
Total Round Trip Time in seconds		2732	2454	-278
Total Round Trip Time in minutes		45:32	40:54	-4:38 (-6.8%)

NOTE: OP = overpass

Inspection of the previous exhibit revealed one important detail. Nearly all of the travel times between nodes on both the north and south frontage roads decreased after conversion. There was an overall decrease of almost 7%.

Of the six node-pairs that had an increase in travel time, four of them--Forbing Rd. to Chicot Rd. overpass, and Chicot Rd. overpass to McDaniels Dr. on the north frontage road; Baseline Rd. to Chicot Rd. overpass, and Chicot Rd. overpass to University Ave. on the south frontage road--were on the far eastern end of the study corridor. The heavy amount of construction activity in this area may have contributed to the increase. The inside lanes on both the north and south frontage roads were closed to traffic due to construction. Although there was construction throughout the study corridor, the section between University Avenue and Baseline Road in Little Rock had the most intense activity.

To determine if the conversion of the frontage roads significantly changed travel times between the selected nodes, a paired t-test was conducted on the difference in travel time before and after conversion. The null hypothesis was that there was no change in travel times along the frontage road, and the alternative hypothesis was that the travel time either increased or decreased. A significance level of $\alpha=0.10$ was used. Since the resulting p-value was almost 0, the null hypothesis was rejected. This proved that same direction travel times between nodes were significantly different after conversion of the frontage road to one-way operation. The difference was a decrease in travel time.

Opposite Direction and Crossover Runs

Six opposite direction and crossover routes were created to evaluate the differences in travel times over routes that required crossovers. First, origins and destinations for six different routes were created. The most probable route a motorist would take between the origin and destination was then established. The total round trip time was found by summing the time it took to travel on the segments of the routes. The impact of the conversion was found by calculating the difference in travel times before and after conversion.

ROUTE ONE

The first route analyzed was from Boone Road (on the south frontage road) to Topps Shoes, located on the north frontage road. The model utilized the new SH 5 overpass after conversion. The route before conversion started at the intersection of Boone Road and the south frontage road, traveled east to the Alcoa Road overpass where it crossed I-30, then traveled west to Topps Shoes. The return trip was modeled to use the same segments of roadway.

The destination route after conversion was modeled using the same segments. However, the return trip was modeled to travel west on the north frontage road from Topps Shoes to the new SH 5 overpass. The route crossed over the interstate main lanes using the new SH 5 overpass, then traveled east on the south frontage road to return to Boone Rd. Exhibit 4-16 shows a sketch of both the before and after routes that were used in the comparison.

This modeled route actually produced travel times that were less after conversion. Both the departure and return trip travel times were less with one-way frontage roads. The total round trip time was three minutes and 28 seconds less, based on average travel times. This is mainly due to the newly constructed SH 5 overpass. This overpass was not available to motorist until after conversion. Better traffic flow characteristics of one-way frontage roads also influenced this decrease in travel times.

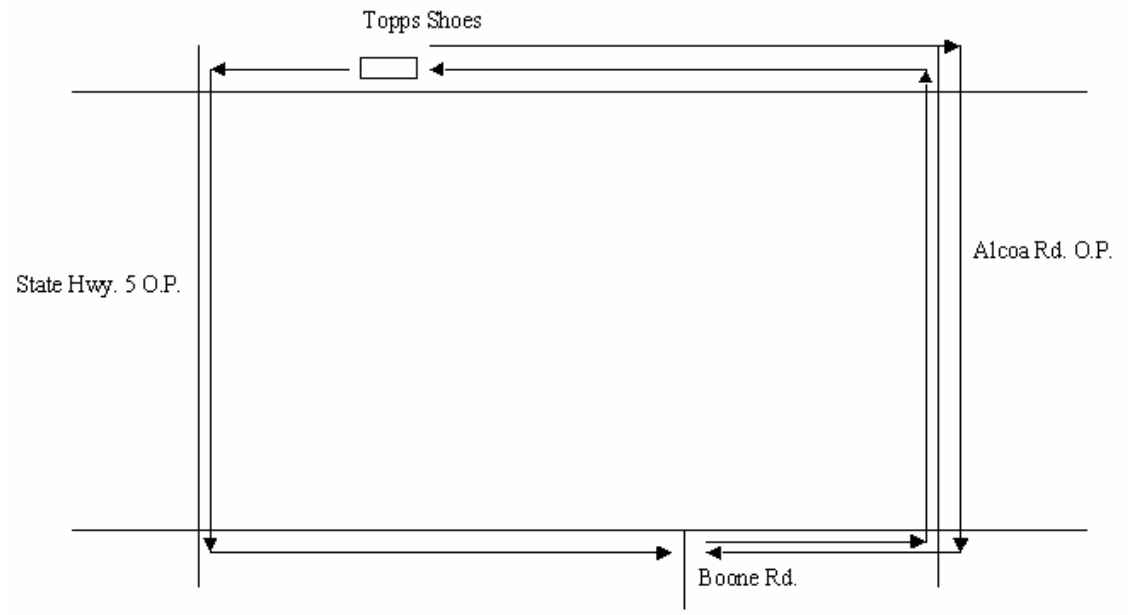

EXHIBIT 4-16 Diagram of Crossover Route One

ROUTE TWO

The second route modeled was between Lora Dr. on the south frontage road and Wal-Mart on the north frontage road in the Bryant area. Before conversion, the route began at the south frontage road intersection with Lora Dr., proceeded west to the SH 183 overpass where it crossed over I-30, then proceeded east on the north frontage road to the Wal-Mart driveway. The return trip used the same segments of roadway. After conversion, the route proceeded east from Lora Dr. to the Reymar Rd. overpass, crossed over I-30, then went west on the north frontage road to Wal-Mart. The return trip went west to the SH 183 overpass, turned south over I-30, then traveled east on the south frontage road to Lora Dr. Exhibit 4-17 shows a sketch of both the before and after routes that were used in the comparison.

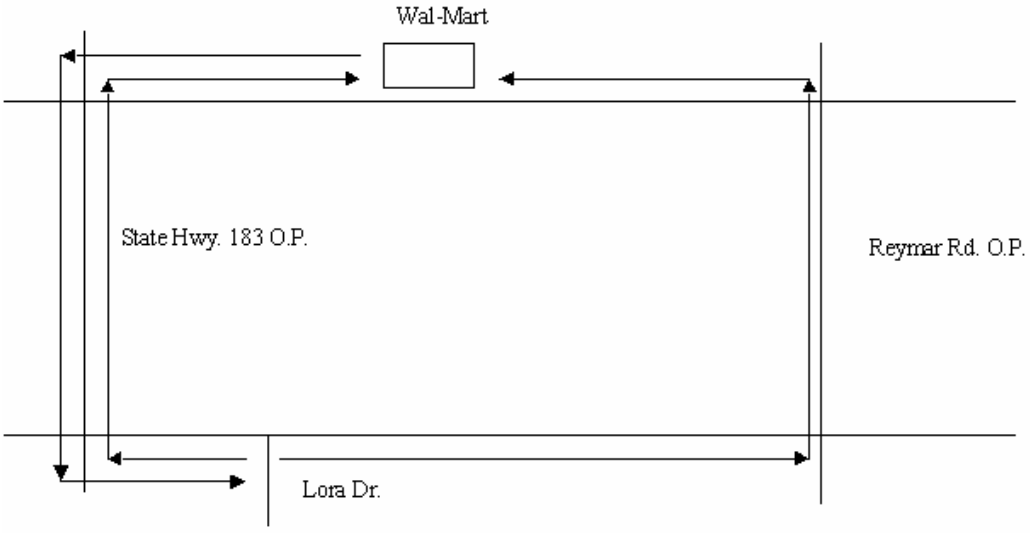

EXHIBIT 4-17 Diagram of Crossover Route Two

This modeled route produced a total round trip time that was only slightly higher after conversion. The average increase in time was just over one minute.

ROUTE THREE

The third route was from S. Shobe Rd. to Moix RV. Both nodes are located on the south frontage road. The before conversion route was between S. Shobe Rd. and Moix R.V. on the south frontage road. The after conversion route used the same departure route. However, due to one-way operation, a more circuitous return route had to be taken. Starting at Moix R.V. a motorist would travel east on the south frontage road to the Vimy Ridge Rd. overpass, cross over the main lanes to the north frontage road; travel west to the SH 183 overpass, cross back over I-30, and finally head east on the south frontage road to S. Shobe Rd. Exhibit 4-18 shows a sketch of both the before and after routes that were used in the comparison.

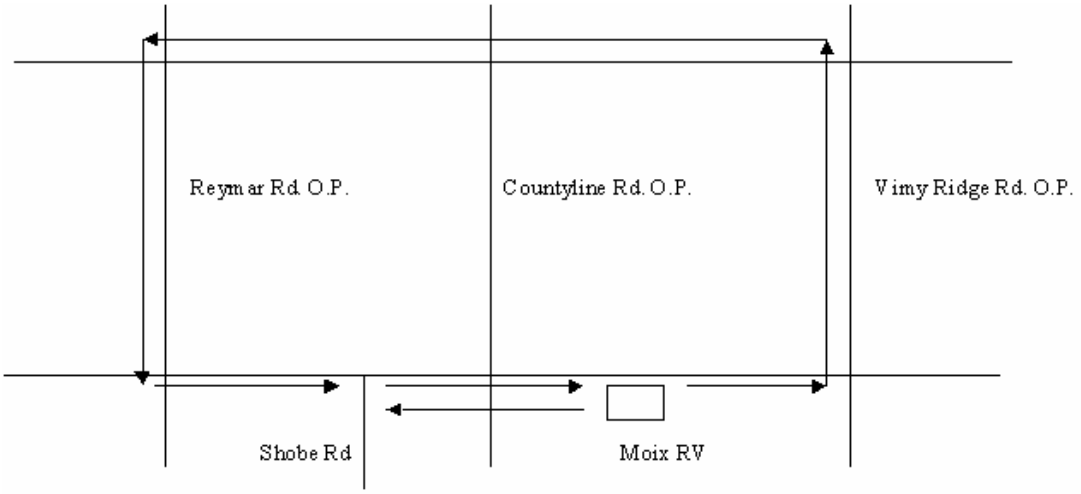

Exhibit 4-18 Diagram of Crossover Route Three

The third route modeled showed a large increase in total travel time, going from an average travel time of four minutes and 40 seconds, to just over ten minutes after conversion. This is due to the large increase in travel distance due to one-way operation. Perhaps a driver familiar with the local roadway network would have found a different return route rather than take the more circuitous route along the frontage road.

ROUTE FOUR

The forth route modeled began at S. Shobe Rd. again, but the destination was the Little Rock Expo Center on the north frontage road. The route before conversion began heading east on the south frontage road to the County Line Rd. overpass, crossed over the interstate, then continued east to the destination on the north frontage road.

The after conversion route modeled for comparison was the same as the previous after conversion route modeled. The route traveled east to the Vimy Ridge Rd. overpass to crossover the main lanes, then turned west to the Expo Center. The return route was also the same. Exhibit 4-19 shows a sketch of both the before and after routes that were used in the comparison.

Inspection found that although the after conversion route was longer and more circuitous, round trip travel time increased less than two minutes. Again, although much greater in travel

distance, the travel time did not increase as greatly due to better traffic flow characteristics of one-way operation on the frontage roads.

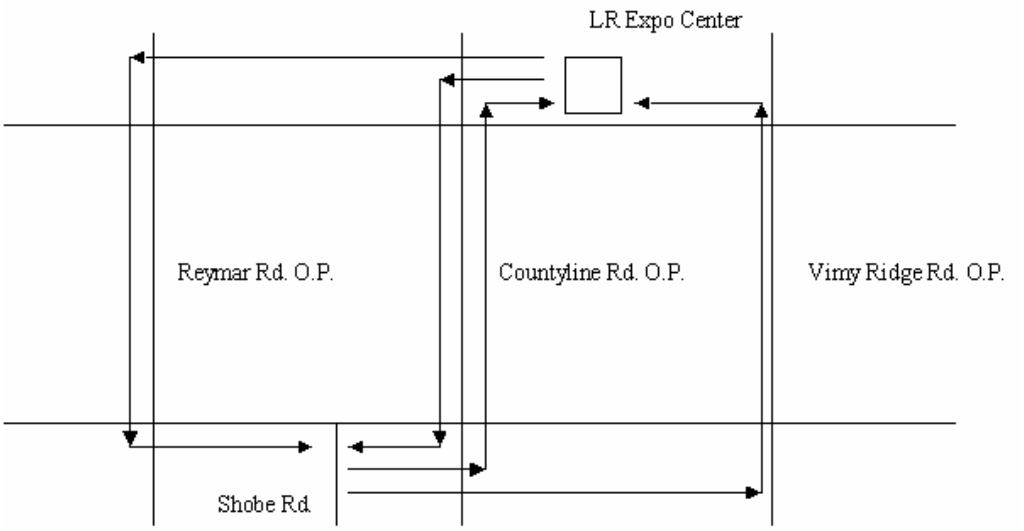

EXHIBIT 4-19 Diagram of Crossover Route Four

ROUTE FIVE

The fifth route modeled was a very short trip between Childers Dr. and Sibley Hole Rd., both located on the north frontage road. The before conversion route simply traveled back and forth from Childers Dr. to Sibley Hole Rd. and back along the frontage road. Exhibit 4-20 shows a sketch of both the before and after routes that were used in the comparison.

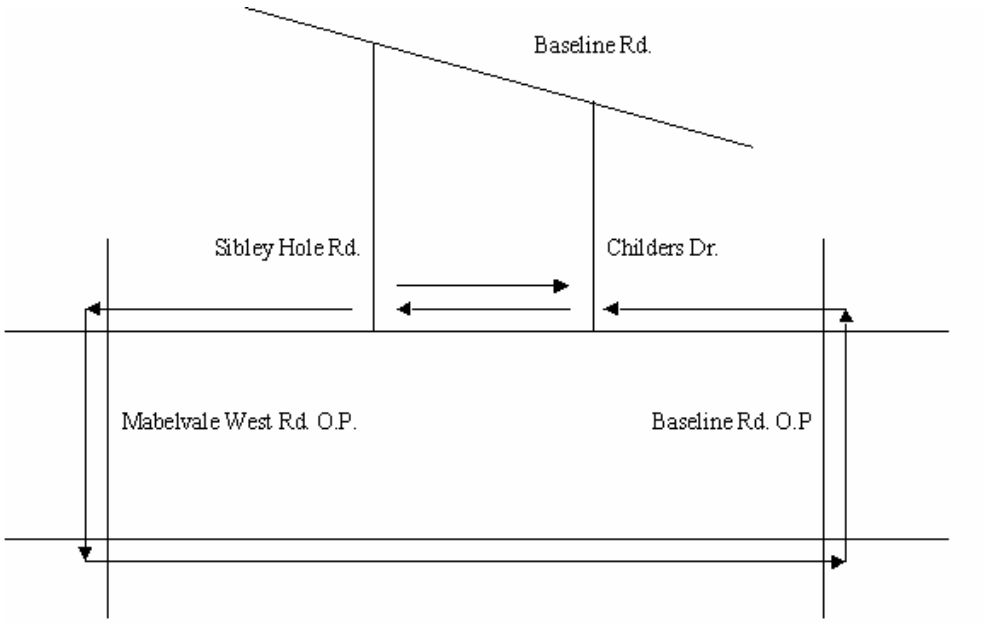

EXHIBIT 4-20 Diagram of Crossover Route Five

The after conversion route modeled for comparison used the same short route from Childers Dr. west to Sibley Hole Rd. However, the return route was much greater in distance. A motorist would have to continue to travel west on the north frontage road to the Mabelvale West Rd. overpass, crossover the interstate, turn heading east on the south all the way to the Baseline Rd. overpass, cross back over the main lanes, then turn back heading west to Childers Rd.

As expected, a very large increase in round trip travel time was found. Although the departure trip travel time decreased from 44 seconds to 32 seconds after conversion, the total round trip increased over six minutes. Again, the increase in route circuity caused this increase.

This route was modeled to illustrate an important factor that needs to be considered before conversion of any roadway from two-way to one-way operation: the development of the surrounding roadway network. In this example, a motorist would most likely travel north on Sibley Hole Rd., turn east on Baseline Rd, to reach Childers Dr. rather than travel the long route around the frontage roads to return to Childers Dr.

ROUTE SIX

The final route modeled began at the north end of the Chicot Rd. overpass and went to the south frontage road intersection with Baseline Rd. The routes modeled were the same before and after conversion. It began at the north end of the Chicot Rd. overpass, used the overpass service road to travel to the north frontage road. There, it turned west along the frontage road to the Baseline Rd. overpass, crossed over the interstate, turned east to Baseline Rd. The return trip turned east on the south frontage road to the Chicot Rd. overpass where it crossed the main lanes to the routes origin. Exhibit 4-21 shows a sketch of both the before and after routes that were used in the comparison.

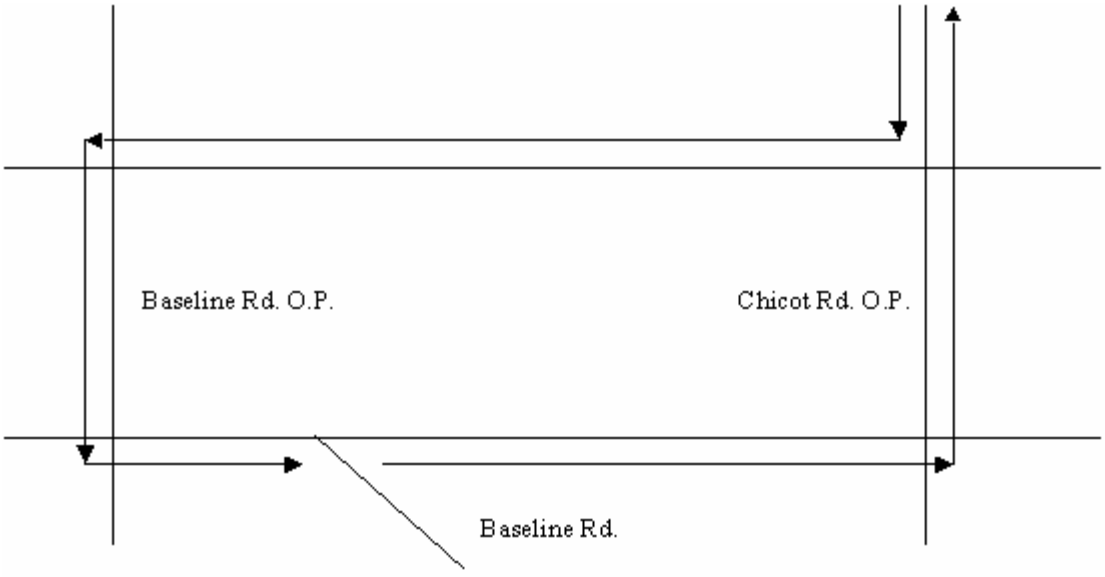

EXHIBIT 4-21 Diagram of Crossover Route Six

Although the before and after routes were exactly the same, an increase of 36 seconds was found. This may be due to the fact that this is the area where the most intense construction

activity took place during the "after" data collection period. Associated with the construction in this area was the inside lane closure, an increase in delay due to a temporary stop sign placed at an exit ramp along the route, and a decrease in speed.

CROSSOVER SUMMARY

Exhibits 4-22, 4-23, and 4-24 show the results from the crossover travel time analysis.

EXHIBIT 4-22 Before Conversion Crossover Travel Times

Route	From	To	Outward Time	Return Time	Total Time
1	Boone Rd.	Topps Shoes	4:12	4:34	8:46
2	Lora Dr.	Wal-Mart	5:28	2:38	8:06
3	S. Shobe Rd.	Moix RV Sales	2:10	2:30	4:40
4	S. Shobe Rd.	LR Expo Center	4:10	4:00	8:10
5	Childers Dr.	N. Sibley Hole Rd.	0:44	0:35	1:19
6	N. Chicot Rd.	Baseline Rd.	4:16	2:35	6:51

EXHIBIT 4-23 After Conversion Crossover Travel Times

Route	From	To	Outward Time	Return Time	Total Time
1	Boone Rd.	Topps Shoes	3:22	1:56	5:18
2	Lora Dr.	Wal-Mart	3:42	5:34	9:15
3	S. Shobe Rd.	Moix RV Sales	1:30	8:38	10:08
4	S. Shobe Rd.	LR Expo Center	5:05	5:03	10:08
5	Childers Dr.	N. Sibley Hole Rd.	0:32	6:54	7:26
6	N. Chicot Rd.	Baseline Rd.	6:10	2:17	7:27

EXHIBIT 4-24 Round Trip Crossover Travel Times

Route	From	To	Outward Time	Return Time	Total Time	% Change
1	Boone Rd.	Topps Shoes	8:45	5:17	-3:28	-39.6%
2	Lora Dr.	Wal-Mart	8:06	9:15	1:09	14.2%
3	S. Shobe Rd.	Moix RV Sales	4:40	10:08	5:28	117.1%
4	S. Shobe Rd.	LR Expo Center	8:11	10:08	1:57	23.8%
5	Childers Dr.	N. Sibley Hole Rd.	1:19	7:26	6:07	464.6%
6	N. Chicot Rd.	Baseline Rd.	6:51	7:27	0:36	8.8%

Note: Route #6 "after" time probably adversely affected by construction

Travel Time Analysis Summary

Inspection of same direction travel times found that almost all times between nodes decreased. Those few segments between nodes where travel time increased may have been influenced more by the heavy construction activity in the area than by conversion of the frontage

road. A statistical analysis showed that there was a significant decrease in same direction travel times.

Inspection of the opposite direction and crossover runs revealed that there was an increase in travel times. However, this is expected because of the increase of travel distance due to conversion of the frontage roads. Investigation found that a large increase in circuity translated to a large increase in travel time. One example illustrated the importance of the development of the surrounding roadway network. One model showed that travel times decreased due to the erection of a new overpass. Another model used the same routes before and after conversion. Although travel time did increase, this may have been influenced by heavy reconstruction activity in the area.

ANALYSIS OF COLLISION DATA

The data for those crashes which the researchers determined had occurred within the limits of the research project were reviewed for apparent inconsistencies and possible errors. When the researchers identified data that were possibly incorrect, they reviewed the individual crash report to determine from the narrative and the drawing where the crash most likely occurred. A notation was made to show either that the crash had occurred at the location listed in the computer file, or to show a corrected location.

When reviewing freeway main lane crash totals, keep in mind the changes in traffic volume over time (see Exhibit 4-25). Volumes at three representative locations, one in the western part of the study corridor, one in the middle, and one in the eastern part show that from before conversion in 2002 to after conversion to one-way operation in 2003, traffic volumes were relatively unchanged. Recall that then entire freeway corridor was undergoing reconstruction in 2003. With construction completed, and the freeway expanded from four to six lanes, spot volumes had grown by more than 25% in 2006.

EXHIBIT 4-25 Representative Volumes

Location	2001	2002	2003	2006
East end: I-30 east of Baseline Road	67,000	63,000	63,060	86,600
Middle: I-30 west of log mile 121.36	60,000	60,000	61,100	82,900
West end: I-30 west of log mile 117.57	50,000	52,000	52,300	68,500

NOTE: volumes from "Annual Average Daily Traffic Estimates", AHTD

Exhibit 4-26 lists collision numbers for the 2000-2001 (before conversion) and the 2005-2006 (after conversion) periods. On the freeway main lanes, the number of crashes went from 669 to 398, a decrease of 271 or 40%. On the corridor frontage roads and at frontage road intersections, the 2000-2001 total of 726 decreased by 235 (or 30%) to 491 in 2005-2006. Although the number of ramp crashes increased by 20%, the change from 36 crashes before conversion to 42 after conversion is relatively insignificant.

EXHIBIT 4-26 Collisions Before and After Converting the Frontage Roads to One-Way Traffic

2000-2001 Collisions	Freeway	Frontage Road	Ramp	Total
Crashes in initial database	925	519	37	1481
Review suggested the recorded location was incorrect	259	18	5	282
Crashes listed at other location but should be this	3	211	4	121
Sum of both errors	262	229	9	
Crashes at revised location	669	726	36	1431
Crashes on Loop, Cross road, outside of area 49; Unknown 1				

2005-2006 Collisions	Freeway	Frontage Road	Ramp	Total
Crashes in initial database	431	316	278	1025
Review suggested the recorded location was incorrect	33	186	240	459
Crashes listed at other location but should be this	2	16	8	26
Sum of both errors	35	202	248	
Crashes at revised location	398	491	42	931
Crashes on Loop, Cross road, outside of area 89; Unknown 2				

The conversion of the frontage roads to one-way operation was accompanied by construction of new overpasses, and the reconfiguration of existing overpasses and ramps. Therefore, the change in frontage road operation was not the only altered variable. However, when considering the physical scope and expanse of the changes, the extent of the frontage road changes dwarfs the extent of many of the other changes.

The number of and the proportion of the collisions which the researchers determined to be miscoded is a noteworthy finding. Comparing "Crashes in initial database" with "Crashes at revised location", one can observe that the findings would have been different had the extensive detailed review of suspect crash locations not taken place. This highlights the need to upgrade collision locating and coding methods, so subsequent safety analyses will not produce a misleading picture of the situation.

ANALYSIS OF LAND USE AND OCCUPANCY DATA

In order to assess land use changes associated with the conversion of the frontage road from two-way to one-way operation, the properties abutting the frontage roads were inventoried. The freeway corridor was divided into a Benton segment (from the Sevier Street overpass to the Alcoa Road overpass), a Bryant segment (from the Alcoa Road overpass to the County Line Road overpass), and a Little Rock segment (from the County Line overpass to University Avenue). In addition, segments of two roadways that paralleled the corridor were inventoried for comparison. These were Military Road in Benton (from Jameson Road on the south end to just north of Coby Road) and State Highway 5 (about 0.5 mi either side of County Line Road) near Little Rock.

The inventory of businesses (or other occupants) at the time of conversion was compared to an inventory of businesses in November, 2003, approximately one year after conversion took place. Another inventory was conducted in March 2006, to make longer-term comparisons. The researchers considered three types of changes: business added, business changed, or business closed. Note that it is possible that a business that was deemed to have closed may have moved to another location outside of the study corridor.

Land Use Change Totals

Comparing changes in land use one year after conversion to one-way operation, it was found that 12 new businesses were added to vacant properties along the frontage roads, the business had changed at 20 sites, and 21 had sites had become vacant.

At the sites where there was a change, it appeared that 11 of them changed land use type, and 9 changed names but appeared to remain the same type of land use. Along the control roads one year after conversion, 3 new businesses were added to vacant lots. In addition, 3 places changed, and 3 places had become vacant.

From 2002 to 2006 along the frontage roads, there were 20 additions, 49 changes, and 32 vacancies created. Along the parallel control roads, there were 5 additions, 7 changes, and 8 vacancies.

Exhibit 4-27 describes the land use for each section of the frontage roads before conversion, and Exhibits 4-28 and 4-29 show the land use for each section of the frontage roads after conversion. Exhibit 4-30 shows the land use for the two parallel control road segments before and after conversion.

EXHIBIT 4-27 Frontage Road Land Use Before Conversion in 2002

Land Use	Benton	Bryant	Little Rock	Total	% of All
0 Vacant	24	36	38	98	24.3%
1 Motel	5	0	7	12	3.0%
2 Restaurant	11	3	8	22	5.5%
3 Vehicle, Equipment Sales	18	24	13	55	13.6%
5 Large Retail Store	5	10	4	19	4.7%
7 Small, Other Retail Store	17	19	25	61	15.1%
8 Gas Station	4	3	5	12	3.0%
9 Repair Shop	4	4	6	14	3.5%
10 Industrial	7	10	13	30	7.4%
11 Church, Funeral Home	7	4	4	15	3.7%
12 Institutional	2	1	1	4	1.0%
13 Prof., Office, Service	6	11	7	24	6.0%
14 Other	12	14	11	37	9.2%
Total of not vacant	98	103	104	305	75.7%
TOTAL	122	139	142	403	100.0%

EXHIBIT 4-28 Frontage Road Land Use After Conversion in 2003

Land Use	Benton	Bryant	Little Rock	Total	% of All
0 Vacant	24	32	44	100	24.8%
1 Motel	5	0	7	12	3.0%
2 Restaurant	11	3	7	21	5.2%
3 Vehicle, Equipment Sales	18	27	12	57	14.1%
5 Large Retail Store	5	10	4	19	4.7%
7 Small, Other Retail Store	17	20	24	61	15.1%
8 Gas Station	4	3	5	12	3.0%
9 Repair Shop	4	2	6	12	3.0%
10 Industrial	7	10	12	29	7.2%
11 Church, Funeral Home	7	5	4	16	4.0%
12 Institutional	2	2	1	5	1.2%
13 Prof., Office, Service	6	11	7	24	6.0%
14 Other	12	14	9	35	8.7%
Total of not vacant	98	107	98	303	75.2%
TOTAL	122	139	142	403	100.0%
Total Added 2002-2003	2	7	3	12	
Total Changed 2002-2003	10	7	3	20	
Total Closed 2002-2003	8	4	9	21	

EXHIBIT 4-29 Frontage Road Land Use After Conversion in 2006

Land Use	Benton	Bryant	Little Rock	Total	% of All
0 Vacant	24	38	47	109	27.0%
1 Motel	5	0	7	12	3.0%
2 Restaurant	11	3	7	21	5.2%
3 Vehicle, Equipment Sales	18	24	11	53	13.2%
5 Large Retail Store	5	8	4	17	4.2%
7 Small, Other Retail Store	17	20	24	61	15.1%
8 Gas Station	4	3	5	12	3.0%
9 Repair Shop	4	2	7	13	3.2%
10 Industrial	7	10	11	28	6.9%
11 Church, Funeral Home	7	5	4	16	4.0%
12 Institutional	2	3	1	6	1.5%
13 Prof., Office, Service	6	9	9	24	6.0%
14 Other	12	16	9	37	9.2%
Total of not vacant	98	101	95	294	73.0%
TOTAL	122	139	142	403	100.0%
Total Added 2002-2006	8	7	5	20	
Total Changed 2002-2006	21	20	8	49	
Total Closed 2002-2006	8	9	15	32	

EXHIBIT 4-30 Parallel Control Route Land Use Before and After Conversion

Land Use	2002 Total	%	2003 Total	%	2006 Total	%
0 Vacant	19	17.6%	21	19.1%	24	21.8%
1 Motel	0	0.0%	0	0.0%	0	0.0%
2 Restaurant	7	6.5%	7	6.4%	8	7.3%
3 Vehicle, Equipment Sales	5	4.6%	4	3.6%	6	5.5%
5 Large Retail Store	11	10.2%	11	10.0%	10	9.1%
7 Small, Other Retail	14	13.0%	12	10.9%	10	9.1%
8 Gas Station	2	1.9%	2	1.8%	2	1.8%
9 Repair Shop	4	3.7	4	3.6%	4	3.6%
10 Industrial	4	3.7%	4	3.6%	3	2.7%
11 Church, Funeral Home	4	3.7%	4	3.6%	4	3.6%
12 Institutional	3	2.8%	5	4.5%	5	4.5%
13 Professional, Office, Service	15	13.9%	15	13.6%	14	12.7%
14 Other	20	18.5%	21	19.1%	20	18.2%
Total of not vacant	89	82.4%	89	80.9%	86	78.2%
TOTAL	108	100.0%	110	100.0%	110	100.0%
Total Added, from 2002 until:			3		5	
Total Changed, from 2002 until:			3		7	
Total Closed, from 2002 until:			3		8	

Determining Whether Comparisons Can Be Made with Control Sections

If the land uses along the frontage roads differed significantly from the land uses along the parallel control roads in 2002, then it would be difficult to make a fair evaluation of any subsequent changes after conversion to one-way operation. For example, if a large percentage of change took place in "Type 3 - vehicle, equipment sales" land use along the frontage roads, it would skew the results of a comparison with the control roads, since there was a large difference in the percentages of that type of land use between the two roadways.

The chi-square distribution was employed to determine if the 2002 land uses along the frontage road were similar to the 2002 land uses along the control roads before conversion. The null hypothesis was that the distributions of land use types along the control roads and along the frontage roads were similar in 2002. The test p-value equaled 0.0008, less than α=0.10, so the null hypothesis was rejected. This indicates that the distribution of land uses along the parallel control roads were statistically significantly different from the distribution of land uses along the frontage roads in 2002. Exhibit 4-31 shows the chi-square value for each land use type on both the frontage and control roads.

EXHIBIT 4-31 Chi-square Values to Compare Land Use Types Before Conversion

Land Use Code	Control Number	Control Chi-square	Frontage Number	Frontage Chi-square
0	19	1.3	98	0.4
1	0	2.5	12	0.7
2	7	0.1	22	0.0
3	5	4.7	55	1.2
5	11	3.4	19	0.9
7	14	0.2	61	0.1
8	2	0.3	12	0.1
9	4	0.0	14	0.0
10	4	1.4	30	0.4
11	4	0.0	15	0.0
12	3	1.6	4	0.4
13	15	5.5	24	1.5
14	20	5.3	37	1.4

Since there were significant differences between land uses along the control roads and land uses along the frontage roads, the chi-square value calculated for each type of land use was inspected. Those land use types that had a chi-square value greater than 3.0 were flagged and excluded from subsequent comparisons, since the larger chi-square value indicates a larger difference in the proportion of the land used for a given type. For instance, about 14% of the parcels along the frontage roads were used for vehicle or equipment sales, while only about 5% of the tracts along the control routes had this land use. From this inspection, it was reasoned that excluding the four land types listed in Exhibit 4-32 would improve the quality of the comparisons. From an examination of the numbers in this table, the magnitude of the changes that took place on the control roads and the frontage roads were similar.

After removing the four land use types that had chi-square values greater than three, another chi-square test was conducted , with the null hypothesis that the distributions of types of

businesses on the frontage roads and control roads were similar, and with a significance level of α=0.10. This test produced a p-value exceeding 0.4, so this time the null hypothesis was not rejected. After excluding the four land use categories, the remaining land uses proportions along the control and the frontage roads before conversion were not statistically significantly different. Exhibit 4-33 shows the chi-square values for each land use type after excluding the four previously discussed types.

EXHIBIT 4-32 Numbers of Each Type of Land Use for Those Excluded

Land Use	Control roads 2002	Chi-square	2003	2006	Frontage road 2002	Chi-square	2003	2006
3 Vehicle, Equipment Sales	5	4.7	4	6	55	1.2	57	53
5 Large Retail Store	11	3.4	11	10	19	0.9	19	17
13 Prof., Office, Service	15	5.5	15	14	24	1.5	24	24
14 Other	20	5.3	21	20	37	1.4	35	37
TOTAL	51	--	51	50	135		135	131

EXHIBIT 4-33 Chi-square Values for Subset of Land Use Types Before Conversion

Land Use Code	Control Number	Control Chi-square	Frontage Number	Frontage Chi-square
0	19	0.1	98	0.0
1	0	2.1	12	0.4
2	7	0.7	22	0.2
7	14	0.1	61	0.0
8	2	0.1	12	0.0
9	4	0.2	14	0.0
10	4	0.6	30	0.1
11	4	0.1	15	0.0
12	3	2.6	4	0.5

NOTE: Land use types 3, 5, 13, 14 excluded

Comparing Land Use Changes Between Frontage Roads and Control Roads

The researchers proceeded with the comparison of the three types of changes (business added, business changed, business closed) between land use along the frontage road and land use along the parallel control roads. First, there was an overall comparison of changes that took place, regardless of the type of change, to determine if the conversion affected the frontage roads more than the control roads. That was followed by a comparison of the type of changes that took place, to determine if the conversion affected the type of change along frontage roads more than along the control roads.

When making these comparisons, the following conventions were employed to exclude the four types of land use (Vehicle, equipment sales; Large retail; Professional, offices, services; and Other) that would skew the results of an analysis.

For businesses added, the prior land use was "0-vacant". The tract was excluded from the analysis if the site changed to an excluded land use category.

For businesses changed, either the prior or the resulting land use could be one of the excluded categories. The tract was excluded from the analysis if the site changed from (had previously been) an excluded land use category.

For businesses closed, the resulting land use was "0-vacant". The tract was excluded from the analysis if the site changed from (had previously been) an excluded land use category.

OVERALL COMPARISON OF CHANGE

A chi-square test was conducted to determine if the distribution of change in land use on the frontage roads was significantly different from the distribution of change in land use on the parallel control roads. The null hypothesis was that the proportion of changed land use on the frontage road was similar to the proportion of change on the control roads. Comparing 2002 with 2003, the chi-square test produced a p-value of 0.48. Comparing 2002 with 2006, the p-value was 0.60. In both cases the p-value exceeded α=0.10, indicating that the change in land use on the two roadways were not statistically significantly different from each other. Exhibit 4-34 shows the number and percentage of changes in land use on both the frontage roads and control roads.

EXHIBIT 4-34 Overall Land Use Changes

Road type	No change	Changed
Comparing 2002 to 2003		
Control roads	51 (86.4%)	8 (13.6%)
Frontage roads	242 (90.3%)	26 (9.7%)
Comparing 2002 to 2006		
Control roads	45 (76.3%)	14 (23.7%)
Frontage roads	214 (79.9%)	54 (20.1%)

COMPARING THE TYPE OF CHANGE

Next, a chi-square test was conducted to determine if the distribution of changes in land use differed significantly between the frontage roads and the control roads. The null hypothesis was that there was no difference, and a significance level of α=0.10 was used. For the comparison of 2002 with 2003, the chi-square test produced a p-value of 0.59, and for the 2002 to 2006 comparison, a p-value of 0.84, so it was concluded that the null hypothesis could not be rejected. This indicates that the distribution of the types of land use change did not differ significantly between the frontage and control roads. Exhibit 4-35 shows the number and percentage of the three types of land use change and those businesses that did not change on both the frontage roads and control roads.

EXHIBIT 4-35 Comparing Types of Land Use Change for Control and Frontage Roads

Road type	No change	Added	Changed	Closed
Comparing 2002 to 2003				
Control Roads	51 86.4%	3 5.1%	3 5.1%	2 3.4%
Frontage Roads	242 90.3%	5 1.9%	12 4.5%	9 3.4%
Comparing 2002 to 2006				
Control Roads	45 76.3%	4 6.8%	6 10.2%	4 6.8%
Frontage Roads	214 79.9%	11 4.1%	26 9.7%	17 6.3%

Comparing Land Use Changes by Segments

A similar analysis was conducted to compare the land use changes among the Benton, Bryant, and Little Rock frontage road segments. The null hypothesis was that the distributions of land use types among the three segments were similar in 2002. The test performed to determine whether the three sections had similar proportions of the different land use types before conversion in 2002 resulted in a chi square value of 0.28, greater than the α=0.10 significance level, so the null hypothesis was not challenged. This means that all of the land use types could be included in the subsequent tests.

Next, the changes among the three segments were compared. As before, there was an overall comparison of changes that took place, regardless of the type of change, to determine if the conversion affected one segment more than the others. That was followed by a comparison of the type of changes that took place, to determine if the conversion affected the type of change along one segment more than the others.

For the first of these tests, the null hypothesis was that the proportion of unchanged and changed tracts along the frontage roads in each of the three segments were similar, with an α=0.10 significance level. The p-value from the 2002 to 2003 comparison was 0.37, and from 2002 to 2006 was 0.14, indicating in both comparisons that the proportions were similar. Exhibit 4-36 displays the proportions of unchanged and changed tracts in each of the three segments.

EXHIBIT 4-36 Overall Land Use Change for the Three Segments

Segment	No change	Changed
Comparing 2002 to 2003		
Benton	102 83.6%	20 16.4%
Bryant	121 87.1%	18 12.9%
Little Rock	127 89.4%	15 10.6%
Comparing 2002 to 2006		
Benton	85 69.7%	37 30.3%
Bryant	103 74.1%	36 25.9%
Little Rock	114 80.3%	28 19.7%

The next test examined the specific type of change (business added, business changed, business closed) to assess differences among the three frontage road segments. The null hypothesis was that there was no difference, and a significance level of α=0.10 was used. For the comparison of 2002 with 2003, the chi-square test produced a p-value of 0.104, and for the 2002 to 2006 comparison, a p-value of 0.06. Although from 2002 to 2003 this outcome calls for the acceptance of the null hypothesis, it is on the margin. The differences from 2002 to 2006 were statistically significant. Exhibit 4-37 shows the number and percentage of the three types of land use change and the unchanged. Inspection of the table shows that from 2002 to 2003, a higher proportion of the tracts in Benton experienced changes, the tracts in Bryant had a more additions and fewer closures, and fewer of the Little Rock tracts changed. From 2002 to 2006, tracts in the Little Rock segment experienced less change and more closings.

EXHIBIT 4-37 Types of Land Use Changes for the Three Segments

Road type	No change	Added	Changed	Closed
Comparing 2002 to 2003				
Benton	102 83.6%	2 1.6%	**10 8.2%**	8 6.6%
Bryant	121 87.1%	**7 5.0%**	7 5.0%	**4 2.9%**
Little Rock	127 89.4%	3 2.1%	**3 2.1%**	9 6.3%
Comparing 2002 to 2006				
Benton	85 69.7%	8 6.6%	21 17.2%	8 6.6%
Bryant	103 74.1%	7 5.0%	20 14.4%	9 6.5%
Little Rock	114 80.3%	5 3.5%	**8 5.6%**	**15 10.6%**

A chi-square test was then conducted to evaluate the distribution of the types of changes in land use. The null hypothesis was that there was no difference, and a significance level of α=0.10 was used. For the comparison of 2002 with 2003, the chi-square test produced a p-value of 0.07, and for the 2002 to 2006 comparison, a p-value of 0.06, so it was concluded that the null hypothesis could be rejected in both comparisons. This indicates that the distribution of the types of land use change differed among the three segments.

Exhibit 4-38 shows the number and percentage of the three types of land use change. From 2002 to 2003, Benton had relatively fewer additions and Bryant had more. Bryant had proportionately fewer closures, while Little Rock had more. The Little Rock segment had fewer changes from one business to another. From 2002 to 2006, the tracts in the Little Rock segment showed less change and more closings.

Land Use Change Summary

It was determined that in 2002, before the conversion the frontage roads to one-way operation, the proportions of the property abutting the parallel control roads with certain land uses (vehicle and equipment sales; large retail; professional, offices, and services; and other) differed from the proportions along the frontage roads. This difference would bias any comparison, so four types of land use were excluded from the comparisons between the parallel control roads and the frontage roads.

EXHIBIT 4-38 Types of Land Use Change on Three Segments

Road type	Added		Changed		Closed	
Comparing 2002 to 2003						
Benton	**2**	**10%**	10	50%	8	40%
Bryant	**7**	**39%**	7	39%	**4**	**22%**
Little Rock	3	20%	**3**	**20%**	**9**	**60%**
Comparing 2002 to 2006						
Benton	8	22%	21	57%	8	22%
Bryant	7	19%	20	56%	9	25%
Little Rock	5	18%	**8**	**28%**	**15**	**54%**

Statistical analyses of the remaining land use types found that the changes in land use along the frontage roads were not significantly different from the changes that occurred along the parallel control roads either from 2002 to 2003 or from 2002 to 2006. However, it was found that the nature of change did differ significantly among the Benton, Bryant, and Little Rock segments of the frontage roads. One year after conversion, the Bryant frontage road segment had more additions while the Little Rock segment had more closures. From 2002 to 2006, the Little Rock segment had fewer changed tracts and more closed tracts.

ANALYSIS OF RESTAURANT AND HOTEL SALES TAX DATA

The Little Rock Convention and Visitors Bureau furnished taxable revenue data for the months of February, May, August, and November 2000, 2001, 2002, and 2003 from 20 restaurants and hotels located in the study corridor. A comparison was made between the taxable revenue from 15 businesses on the frontage road and the taxable revenue from five businesses not located on the frontage road.

Due to either a lack of record keeping, or businesses that were delinquent on their taxes, all of the requested data could not be obtained. There were numerous missing data, especially for those businesses not located on the frontage road. Therefore, the results presented here are tentative.

Frontage Road Businesses versus Non-Frontage Road Businesses

Exhibit 4-39 shows a time-based chart of mean taxable revenue for businesses located on the frontage roads, and those businesses located on the control roads. It should be noted that due to lack of availability, data for only one (Ryan's Steakhouse) of the five businesses not located on the frontage road were used in the graph. The vertical line in the graph shows the time of conversion. The graph shows that the control road business sales had a seasonal trend. The sales trends for frontage road businesses were found to be more constant throughout the year.

A t-test of the difference in means before and after conversion was conducted to determine if there was a statistically significant difference in taxable revenue for these businesses. The null hypothesis that there was no difference in mean taxable revenue before and after conversion was used. A significance level of α=0.10 was used in this test. The frontage road test resulted in a p-value of 0.3311, greater than α=0.10. The control road test gave a p-value of 0.81, greater than

α=0.10. It was concluded that the null hypothesis could not be rejected for either location. This indicates that there was not a statistically significant difference in taxable revenue before and after conversion for either location.

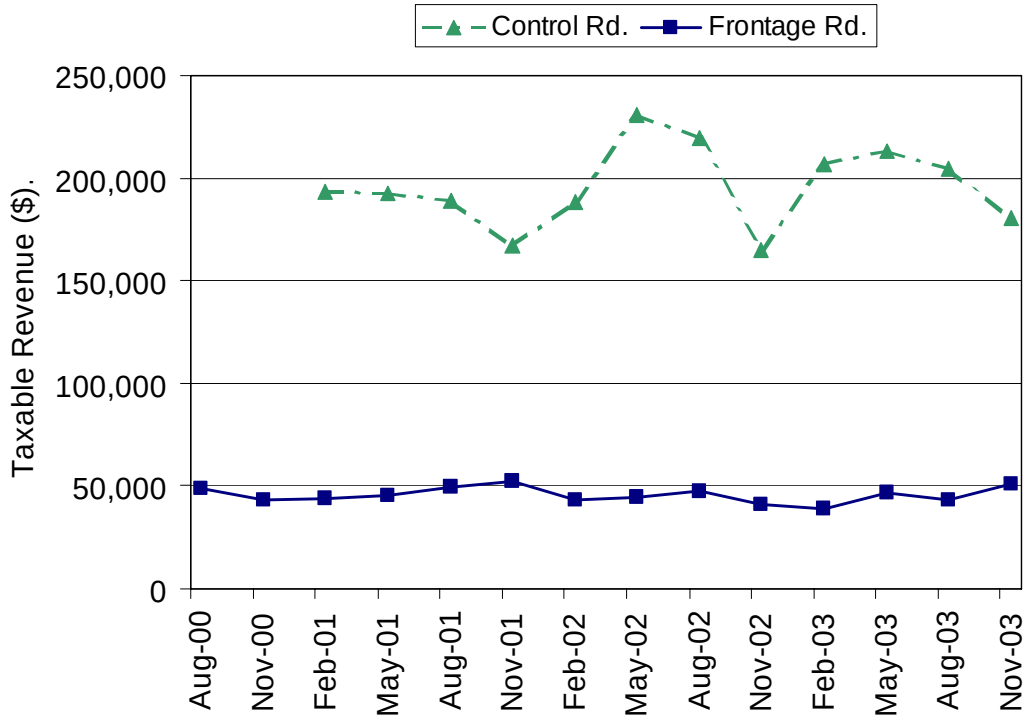

EXHIBIT 4-39 Time Trends of Taxable Revenue

Frontage Road Access Only Versus Frontage Road and Alternate Access

Due to the fact that there was a large amount of missing data for those businesses not located on the frontage road, a more in depth analysis of just those businesses on the frontage road was conducted.

Exhibit 4-40 shows a time-based chart of mean taxable revenue for businesses with frontage road access only, and frontage road and alternate access.

Inspection of the Exhibit above shows that the mean sales of businesses with both types of access were somewhat similar and constant. The "hiccup" at the November 2001, and August 2002 dates was caused by missing data from one of the six businesses.

A repeated measure analysis of variance (ANOVA) was conducted on the taxable revenue data that were collected. A significance level of α=0.10 was used. The response variable used was percent change in revenue calculated for each business as the percent change from the mean revenue for that business before the conversion. Terms used in the model were: Date, type of access (i.e. frontage road access only, or frontage road and alternate access), conversion (i.e.

before or after conversion), and all two-way interactions between these terms. After the data were placed in the model, each non-significant term was removed one at a time beginning with the interactions.

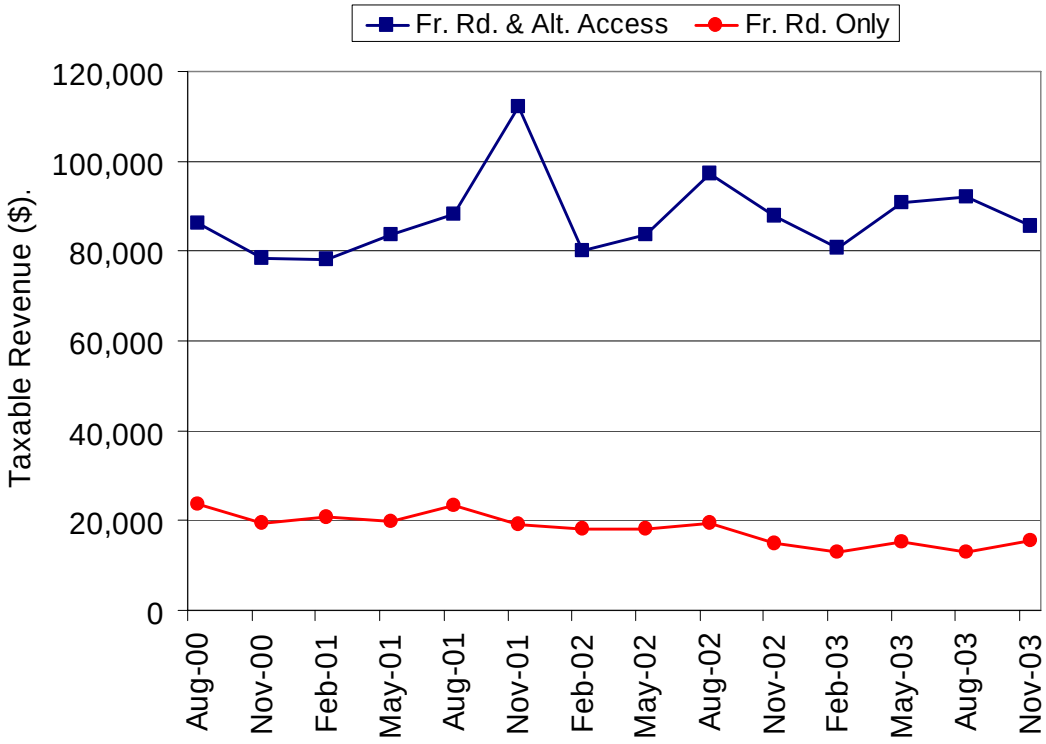

EXHIBIT 4-40 Time Trends of Taxable Revenue

Results of the model found the p-value equaled 0.19, greater than α=0.10. From this, it was concluded that the null hypothesis could not be rejected. This indicates that there was not a statistically significant difference in taxable revenue before and after conversion for both businesses with frontage road access only and frontage road and alternate access.

Another model that used only the terms "Access" and "Date" was analyzed to determine if conversion affected frontage roads with dissimilar types of access differently. Again, a significance level of α=0.10 and the response variable percent change in revenue calculated for each business as the percent change from the mean revenue for that business before the conversion was used.

Results of repeated measure ANOVA found that the p-value for the "Access" term equaled 0.89, greater than α=0.10. This indicated that there was no statistically significant difference in sales between the two different types of access. The p-value for the "Date" term equaled 0.0001, less than α=0.10. This indicated that there was a statistically significant downward trend in sales over time.

Exhibit 4-41 shows a plot of the percent change in revenue calculated for each business over time.

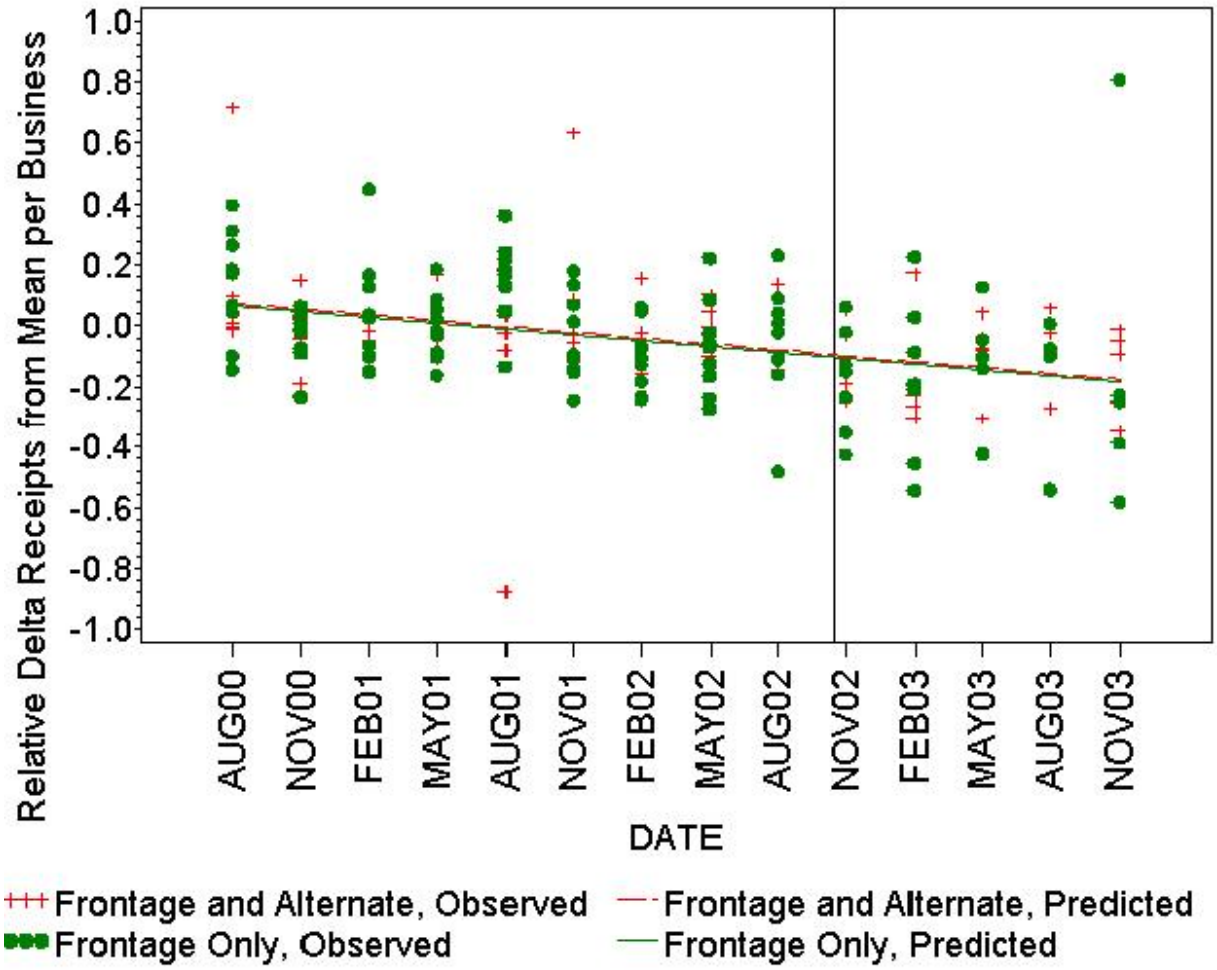

EXHIBIT 4-41 Percent Change in Revenue for Each Business Over Time

Again, due to the fact that no all the requested data could be obtained, results of these tests are tentative. There were two businesses for which only partial data were found. One business with both frontage road and alternate access went out of business a few months before the conversion. Another business, with only frontage road access only, ceased operation after the conversion.

Tax Data Analysis Summary

A test on the difference of means found that there was not a statistically significant difference in taxable revenue before and after conversion for businesses located on both the frontage road and on control roads.

A repeated measure analysis of variance (ANOVA) analysis found that there was not a significant difference in taxable revenue before and after conversion for frontage road businesses with both types of access.

Investigation of the "Access" and "Date" terms of the repeated measure analysis of variance (ANOVA) model found that there was not a significant difference between types of access. It

was found that there was a significant downward trend in taxable revenue that began before conversion and continued after.

ANALYSIS OF BUSINESS OWNER OPINION DATA

Although comments from the public had been previously solicited at a public hearing conducted by the AHTD in 1993, these surveys were about ten years old. Therefore, a new survey was created and administered to owners or managers of businesses along the frontage road. This survey was given to determine if attitudes about frontage road conversion changed over a period of about a year.

Responses from Initial Survey

A list of the survey questions and recorded responses from the initial survey by land use category are provided in Exhibit 4-42.

EXHIBIT 4-42 Initial Survey Questions and Responses

Question #1

"Does your site rely entirely on the frontage road for access, or does another road also serve your site?"
Response 1: solely on frontage road
Response 2: already had alternate access
Response 3: constructed alternate access after conversion
Response 4: no response

	Type of Business													
	1	2	3	4	5	6	7	8	9	10	13	14	Total	%
Response														
1	4	3	16	5	5	11	2	3	4	7	5	1	66	79.5%
2	0	1	1	2	2	3	0	0	1	4	1	0	16	19.3%
3	0	1	0	0	0	0	0	0	0	0	0	0	0	0.0%
4	0	0	0	0	0	0	0	1	0	0	0	0	1	1.2%

Question #2

"Before the frontage road was converted from two-way to one-way operation in October, 2002, I…"
Response 1: was for the conversion
Response 2: opposed the conversion
Response 3: had no opinion/undecided
Response 4: did not know the conversion was about to occur
Response 5: no response

	Type of Business													
	1	2	3	4	5	6	7	8	9	10	13	14	Total	%
Response														
1	2	1	2	0	5	12	0	1	0	7	2	0	32	38.6%
2	2	3	8	4	2	2	1	2	3	2	1	1	31	37.3%
3	0	1	4	3	0	0	1	0	2	1	3	0	15	18.1%
4	0	0	2	0	0	0	0	0	0	1	0	0	3	3.6%
5	0	0	1	0	0	0	0	1	0	0	0	0	2	2.4%

Question #3

"Now that the conversion from two-way to one-way operation has occurred, I…"
Response 1: am for the conversion
Response 2: am opposed to the conversion
Response 3: have no opinion/undecided
Response 4: no response

	Type of Business													
	1	2	3	4	5	6	7	8	9	10	13	14	Total	%
Response														
1	2	1	5	2	4	5	1	0	1	6	5	0	32	38.6%
2	1	4	11	4	3	9	0	3	4	4	1	1	45	54.2%
3	1	0	0	1	0	0	1	0	0	1	0	0	4	4.8%
4	0	0	1	0	0	0	0	1	0	0	0	0	2	2.4%

Question #4

"Which do you think is safer?"
Response 1: one-way frontage roads
Response 2: two-way frontage roads
Response 3: no difference/Equally safe
Response 4: no response

	Type of Business													
	1	2	3	4	5	6	7	8	9	10	13	14	Total	%
Response														
1	2	3	10	5	5	9	2	0	3	11	5	0	55	66.3%
2	0	0	3	0	1	1	0	0	0	0	0	1	6	7.2%
3	2	2	3	2	1	4	0	3	1	0	1	0	19	22.9%
4	0	0	1	0	0	0	0	1	1	0	0	0	3	3.6%

Question #5

"How has the conversion of the frontage roads to one-way operation affected your property/business/organization?"
Response 1: none
Response 2: hurt
Response 3: improved
Response 4: other
Response 5: no response

	Type of Business													
	1	2	3	4	5	6	7	8	9	10	13	14	Total	%
Response														
1	1	0	5	1	3	5	2	0	2	8	5	1	33	39.8%
2	3	5	12	6	3	9	0	3	2	1	1	0	45	54.2%
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
4	0	0	0	0	1	0	0	0	1	2	0	0	4	4.8%
5	0	0	1	0	0	0	0	1	0	0	0	0	1	1.2%

Responses from Follow-up Survey

Exhibit 4-43 lists the questions and responses in the follow-up survey, divided by land use category.

EXHIBIT 4-43 Follow-up Survey Questions and Responses

Question #1

"Does your site rely entirely on the frontage road for access, or does another road also serve your site?"
Response 1: solely on frontage road
Response 2: already had alternate access
Response 3: constructed alternate access after conversion
Response 4: no response

	Type of Business													
	1	2	3	4	5	6	7	8	9	10	13	14	Total	%
Response														
1	4	2	13	3	4	8	2	3	4	7	4	1	55	70.5%
2	0	2	1	2	2	3	0	0	0	4	1	0	15	19.2%
3	0	1	1	2	0	2	0	0	0	0	0	0	6	7.7%
4	0	0	0	0	0	0	0	1	0	0	1	0	2	2.6%

Question #2

"Before the frontage road was converted from two-way to one-way operation in October, 2002, I…"
Response 1: was for the conversion
Response 2: opposed the conversion
Response 3: had no opinion/undecided
Response 4: did not know the conversion was about to occur
Response 5: no response

	Type of Business													
	1	2	3	4	5	6	7	8	9	10	13	14	Total	%
Response														
1	0	0	1	0	0	0	0	0	0	0	0	0	1	4.3%
2	2	1	5	1	1	2	1	1	2	0	1	0	17	73.9%
3	1	0	0	0	0	1	0	0	0	1	0	0	3	13.0%
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
5	0	0	0	0	0	0	0	1	0	0	1	0	2	8.7%

Question #3

"Now that the conversion from two-way to one-way operation has occurred, I…"
Response 1: am for the conversion
Response 2: am opposed to the conversion
Response 3: have no opinion/undecided
Response 4: no response

	Type of Business													
	1	2	3	4	5	6	7	8	9	10	13	14	Total	%
Response														
1	1	1	5	2	1	3	0	0	0	9	2	1	25	32.1%
2	1	4	10	5	5	8	2	3	4	2	2	0	46	59.0%
3	2	0	0	0	0	2	0	0	0	0	1	0	5	6.4%
4	0	0	0	0	0	0	0	1	0	0	1	0	2	2.6%

Question #4

"Which do you think is safer?"
Response 1: one-way frontage roads
Response 2: two-way frontage roads
Response 3: no difference/Equally safe
Response 4: no response

	Type of Business													
	1	2	3	4	5	6	7	8	9	10	13	14	Total	%
Response														
1	2	3	8	5	4	7	2	1	2	8	3	0	45	57.7%
2	0	1	1	1	0	2	0	1	0	0	1	0	7	9.0%
3	2	1	5	1	2	4	0	1	2	2	1	1	22	28.2%
4	0	0	1	0	0	0	0	1	0	1	1	0	4	5.1%

Question #5

"How has the conversion of the frontage roads to one-way operation affected your property/business/organization?"

Response 1: none
Response 2: hurt
Response 3: improved
Response 4: other
Response 5: no response

	Type of Business													
	1	2	3	4	5	6	7	8	9	10	13	14	Total	%
Response														
1	1	0	4	1	0	5	1	0	0	8	2	1	23	29.5%
2	3	5	10	6	6	8	1	3	4	0	2	0	48	61.5%
3	0	0	0	0	0	0	0	0	0	1	0	0	1	1.3%
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
5	0	0	1	0	0	0	0	1	0	2	2	0	6	7.7%

Statistical Analysis of Survey Responses

Symmetry models were used to analyze the opinion data because the data were matched pairs. Methods that treat the two samples as independent were inappropriate. The method that was used compared categorical responses from two samples that are statistically dependent. The Deviance and Pearson chi-square tests were used to determine if the model fit the data. The null hypothesis was the symmetry model fits data. If the p-values were greater than α=0.10, the null hypothesis was not rejected, and it was concluded that the symmetry model fit the data. When it was found that the symmetry model fit the data, it was concluded that respondents either did not change their opinion, or the same number of respondents changed their opinion in one direction as the number of respondents changed their opinion in the opposite direction. Hence, it was concluded that there was not a significant change in public opinion.

Questions number one, three, four, and five were analyzed in this manner to determine if responses changed over a period of one year. Question number two was handled in a slightly different manner. If the same person interviewed in the initial survey was interviewed in the follow-up survey, this question was not asked. Therefore, questions two and three from the initial survey were modeled together to determine if opinions changed from just before conversion to just after conversion.

Exhibit 4-44 shows the frequency of responses to Question #1 from both the initial and follow-up surveys. This question did not test attitudes, but rather only determined the number of businesses that either already had alternate access, or built alternate access after conversion. Due to the fact that there were very few responses of "Constructed alternate access after conversion" and "No response" on both the initial and follow-up surveys, these were combined with the response "already had alternate access". This gave a straight comparison between businesses that relied solely on the frontage roads for access and those that had or constructed alternate access.

EXHIBIT 4-44 Responses to Question #1

Response Given in Initial Survey	Response Given in Follow-Up Survey 1	2, 3, and 4	Total
1	55	6	61
2, 3, and 4	0	17	17
Total	55	23	78

Results of the symmetry model found the p-value equaled 0.004, lower than α=0.10. From this, it was concluded that the data did not fit the symmetry model. This indicates that a statistically significant number of business owners felt it was necessary to construct alternate access. However, due to the nature of the question, a statistical test may not have been totally appropriate.

Inspection of the preceding exhibit found that only six of the 61 respondents, 9.8%, that initially answered they had only frontage road access, stated they built alternate access after conversion.

Exhibit 4-45 shows a symmetry model for questions #2 and #3 for the initial survey only. This tested whether attitudes about the frontage road changed immediately after the frontage road was converted.

EXHIBIT 4-45 Initial Survey Responses to Questions #2 and #3

Response Given in Initial Survey	Response Given in Follow-Up Survey 1	2	3	Total
1	18	4	0	22
2	4	28	2	34
3	9	10	2	21
Total	31	42	4	77

Since the p-value equaled 0.003, less than α=0.10, the null hypothesis was rejected, and the data did not fit the symmetry model. It was concluded that attitudes about the frontage road changed significantly immediately after conversion. Inspection of the previous exhibit revealed that 19 of the 21 respondents that stated they were neither for nor against the conversion changed their attitude. Of the 19 that changed their minds, nine stated they were for the conversion, while the remaining ten stated they were against the conversion. This indicates the change in attitude was about equally balanced.

Exhibit 4-46 shows the symmetry model for question #3. The initial survey responses were tested against the follow-up survey to determine if attitudes changed over a one-year period.

EXHIBIT 4-46 Response to Question #3

Response Given in Initial Survey	Response Given in Follow-Up Survey 1	2	3	Total
1	17	9	3	29
2	6	35	1	42
3	1	2	1	4
Total	24	46	5	75

Results of the test found the p-value equaled 0.59, greater than α=0.10, and the null hypothesis was not rejected. Therefore, the data fit the symmetry model. It was concluded that negative attitudes of the respondents towards conversion did not change significantly between 2002 and 2003.

Inspection of the data reveled that nine people developed a more negative attitude towards the conversion. However, it also reveled that six people found one-way frontage roads more favorable than two-way one year after conversion.

Exhibit 4-47 shows the symmetry model for question #4 from both the initial and follow-up surveys. This question asked the respondents which they thought was safer, one-way operation, two-way operation, or if they thought there was no difference how the frontage roads were operated.

EXHIBIT 4-47 Response to Question #4

Response Given in Initial Survey	Response Given in Follow-Up Survey 1	2	3	Total
1	37	3	9	49
2	2	1	3	6
3	4	3	10	17
Total	43	7	22	72

Results of the test found the p-value equaled 0.55, greater than α=0.10, and the null hypothesis was not rejected. Therefore, the data fit the symmetry model. It was concluded that attitudes of the respondents did not change significantly over the one-year period.

Inspection revealed that twelve people developed a more negative attitude towards safety of one-way frontage roads. Of the twelve, three of them reversed direction to state they thought two-way operation was safer, while the remaining nine thought that there was no difference between one-way and two-way operation. Five of six respondents developed a more positive attitude toward one-way operation one year after conversion.

Exhibit 4-48 shows the symmetry model for question #5. Due to the fact that very few owners gave a response of "improved" for this question, it was combined with the "no effect" response. Therefore, "no effect/improved", "hurt", and "other" were modeled for this question.

EXHIBIT 4-48 Responses to Question #5

Response Given in Initial Survey	Response Given in Follow-Up Survey			
	1 and 3	2	4	Total
1 and 3	18	11	0	28
2	4	35	0	39
4	2	2	0	4
Total	24	48	0	72

Results of the test found the p-value equaled 0.03, less than α=0.10, and the null hypothesis was rejected. Therefore, the data did not fit the symmetry model. It was concluded that a significant number of business owners felt the conversion hurt their business one year later.

Inspection revealed that 11 of the 28 owners who responded they felt no effect from the frontage road conversion changed their minds one year later and stated they thought the conversion hurt their business. Only four respondents that thought they were hurt immediately after conversion stated they thought there was no effect from the conversion on their business.

Summary of Business Owner Opinions

From question 1, less than 10% of the business owners surveyed felt the need and were able to construct alternate access to their property.

From the second and third questions from the initial survey, a significant number of business owners developed negative attitudes toward conversion immediately after it occurred. This is also illustrated by analysis of question 5, where a significant number of business owners felt their business was hurt by the conversion one year after conversion took place.

Comparing both surveys, question 3 responses indicate there was no significant change in business owner attitudes about being for or against the conversion after it occurred. Question 4 revealed that those business owners that felt two-way operation was safer than one-way did not change their minds.

CHAPTER 5
SUMMARY AND CONCLUSION

This chapter presents the conclusions from the study of data collected in the I-30 corridor. As stated in earlier chapters, data pertaining to volume, speed, travel time, collisions, land use, tax receipts, and public opinion were collected along the frontage roads in the I-30 corridor between the Sevier Street interchange in Benton, Arkansas, and the University Avenue interchange in Little Rock, Arkansas.

CONCLUSION FROM VOLUME DATA ANALYSIS

Exhibit 5-1 shows the results of the average daily volume analysis performed on data that were collected in the study corridor. Considering all of the volume recording stations on both the frontage roads and parallel roadways, overall average daily volume increased about 1.0% one year after conversion of the frontage roads to one-way operation.

EXHIBIT 5-1 Volume Analysis

Roadway	Volume Difference 2002-2003	Volume Difference 2002-2006
Frontage roads converted to one-way	-7.1%	1.3%
Frontage roads remaining two-way	-19.1%	-
Overpasses	4.0%	-
Parallel Roadways	15.2%	-
Overall	1.0%	-

NOTE: Frontage roads converted to one-way compares 36 locations from 2002 to 2003, compares 12 locations 2002 to 2006.

Volumes on Frontage Roads

Volumes on the frontage roads converted to one-way operation decreased by over 7% after conversion to one-way. This was a statistically significant decrease in volume. It is noteworthy that volumes on the two frontage road sections that remained two-way in 2003 decreased even more. From a smaller sample of locations, 2002 volumes on average had rebounded by 2006, although there is so much variation in the data that a clear pattern is not evident. Volumes did increase at the majority of these stations from 2003 to 2006.

Volumes on Overpasses

Overpass volumes were found to increase after conversion. However, the 4% increase was not statistically significant. With one-way frontage roads, some motorists must make more circuitous trips. That would cause drivers to have to use the overpasses more after the conversion. The additional travel necessitated by converting the frontage roads to one-way operation may have contributed to the increase.

The SH 183 overpass in Bryant showed a large increase in average daily volume that may have been affected by the timing of new commercial land development near the interchange. It may also reflect that some motorists used this overpass to travel from Bryant on the south side of the freeway to SH 5 on the north side, altering their routes to use SH 5 instead of I-30 to commute to Little Rock.

Volumes on Parallel Routes

The average daily volume was found to increase by about 15% on parallel roadways in the corridor. This was a statistically significant increase in volume. Almost all stations on parallel routes saw an increase in average daily volume in both directions. This may reinforce the fact that motorists used these parallel routes to commute as opposed to traveling on the frontage roads.

Comments About Volume

After converting the frontage roads to one-way operation, volumes on frontage roads decreased. This decrease may have been caused not only by the conversion to one-way operation, but also by the road construction activity. The I-30 main lanes were under total reconstruction and widening (with portions of the inside lane of the frontage roads closed due to this construction) during 2003. Most interchanges were being modified as well.

Commuters may have been using parallel routes instead of the frontage roads to travel between Little Rock and Saline County. This illustrates the importance of a developing a supporting roadway network, so motorists do not have to rely on the frontage roads for travel and circulation.

The average volume at stations along the frontage roads before conversion was 5712 vpd. From the literature review, Woods developed a warrant justifying conversion to one-way operation at a volume of 6000 vpd in intermediately developed areas (30% to 60% development), and at 5000 vpd in urban areas (60% to 100% development). Given the amount of development along the frontage roads in the study corridor and these warrants, conversion to one-way was justified according to Woods.

CONCLUSION FROM SPEED DATA ANALYSIS

From before conversion (2002) to after conversion (2003), spot speeds increased by roughly 5 mph. Speed data comparing 2002, 2003, and 2006 were available at seven frontage road locations. Although there was variation among recording stations, overall, the speeds taken in 2006 were less than those recorded in 2002 and 2003, and were less dispersed.

CONCLUSION FROM TRAVEL TIME DATA ANALYSIS

Travel time through the study corridor was compared in two different ways. First, same direction round trip data were compared to determine if travel times between nodes changed after conversion. Second, six routes for testing purposes were developed, and travel times for these routes before and after conversion were compared.

Same Direction Travel Time

The analysis showed that there was a statistically significant decrease in same direction travel times between nodes on the frontage roads. Almost all segments between nodes showed a decrease in travel time. It was concluded that the after conversion, travel times between nodes

on the one-way frontage roads were less than the travel times under two-way operation. From this, it was also inferred that since travel distance was the same, speed increased on the frontage road after conversion. This also suggests that traffic flows more freely, and delays along the frontage roads decreased as well.

Six of these segments did show an increase in same direction travel times. These stations were all east of the I-30/I-430 interchange in Little Rock where the heaviest construction activity took place. The inside lane was closed due to construction activity during "after" condition data collection at these six segments. Also, a temporary stop sign was placed on the frontage near an off-ramp while travel times were collected after conversion. These factors account for some of the same direction travel time increase on these six segments, and suggests that construction had a large influence on traffic that traveled through the study corridor.

Opposite Direction and Crossover Travel Times

Although individual segment travel time decreased after conversion, it was concluded from analysis of the six routes used to study trips that traversed the overpasses that these travel times increased. These increases in travel times were mainly due to the large increase in circuitous routes that motorists had to take after conversion. However, it was also shown that a newly opened overpass reduced some travel times. The importance of a well-developed surrounding roadway network was also shown to be vital so that motorists do not become too dependent on the frontage roads for travel through the corridor.

CONCLUSION FROM CRASH DATA ANALYSIS

After reviewing and reclassifying crash data, the study found that after the completion of freeway widening and converting the frontage roads to one-way operation, there were major decreases in the numbers of collisions. While there was an increase in the number of ramp collisions, the magnitude of this increase is insignificant when considering the decreases in freeway and frontage road collisions. From 2001 through 2003, there was not a great change in freeway volumes, but by 2006 volumes had grown considerably. Exhibit 5-2 shows the collision numbers.

EXHIBIT 5-2 Collision Analysis

	Freeway	Frontage road	Ramp
2000-2001	669	726	36
2005-2006	398	491	42
Change	-271	-235	6
% Change	-40%	-30%	20%

During the analysis of collision data, a sizeable number of the entries into the summary crash database raised questions. In many cases, the entries were seemingly incongruous. After consulting the original accident report, it appeared that anywhere from 1/5 to 2/5 of the accidents were incorrectly listed in the summary database. If the detailed review of individual accidents had not been conducted, the resulting analysis probably would have been misleading.

CONCLUSION FROM LAND USE DATA ANALYSIS

An inventory of land uses along both the frontage roads and along two segments of parallel routes in the study corridor were collected to asses the effect that conversion had on land use. The properties were placed into one of 14 land use categories, or vacant. Most of the categories were some form of commercial land use. Several statistical tests were conducted.

First, a statistical test was conducted to determine whether the distribution of the types of land use along the frontage roads was similar to the distribution along the parallel control roads. It was concluded that they did not have similar types of land use, so four of the original 14 land use categories were omitted from further comparisons so that results would not reflect a bias.

Then, statistical tests were conducted to determine if the land use had changed more on the frontage roads than on the control roads between 2002 and 2003 (i.e., before and after conversion). It was found that there was no statistically significant difference in land use change between the two roadways. A comparison of 2002 with 2006 data produced the same result of no significant difference. In other words, the changes along the frontage roads converted to one-way operation were essentially the same as the changes experienced along parallel control roads which continued to have two-way operation. Although there probably were some spot exceptions, it was concluded that the conversion had no overall impact on land use.

Finally, the frontage roads were divided into three sections (Benton, Bryant, Little Rock), and those three sections were compared with each other to determine if they were affected differently by the conversion. It was found that the land uses along the three segments did not experience the same proportions of types of changes. In general, the Benton and Bryant segments fared slightly better than did the Little Rock segment.

CONCLUSION FROM TAX DATA ANALYSIS

Tax data were collected for several restaurants and motels located in the Little Rock section of the study corridor. Statistical tests were conducted on these data to determine the economic impact conversion had on those types of businesses.

First, businesses located on the frontage road were compared to businesses located on the control roads. A statistical test indicted that there was no significant difference before and after conversion for businesses located on either type of roadway. It was concluded that the conversion had no economic impact on businesses in the study corridor, neither positive nor negative. It should be understood that the data used in these tests were incomplete and further analysis needs to be conducted to verify these conclusions.

A repeated measure ANOVA was conducted to determine if businesses with frontage road access only were impacted differently from businesses with frontage road and alternate access. It was concluded this from test that the conversion did not have a statistically significant impact on frontage road businesses regardless of the type of access the business had (i.e. frontage road access only, frontage road and alternate access).

Another repeated measure ANOVA proved that there was not a statistically significant difference after conversion for businesses with either type of access. It was concluded that businesses with alternate access were not affected any differently by the conversion than those businesses with frontage road access only. This test also showed that there was a statistically significant downward trend in sales for these businesses. An exhibit showed that this trend began before the conversion took place and continued through the duration of the study. This proves that the down swing in the overall economy was perhaps more to blame for declining sales than the conversion of the frontage roads. This contradicts remarks taken from business

owners who stated they felt the conversion had a negative impact on sales since this downward trend had began before the conversion took place.

This investigation of sales trends illustrates how decisions that transportation officials and engineers make effect more than just motorists, and the need for more efficient discussion and transfer of information and data between different state agencies. The conversion of the frontage road and construction activity has economic and land use impacts that need to be understood by officials from other state agencies.

CONCLUSION FROM OPINION ANALYSIS

A survey was administered to managers and owners of business located on the frontage road to determine if opinions about the conversion of the frontage road changed one year after conversion. Several statistical models were tested to determine if the conversion had either a positive or negative impact on business owner opinions. Exhibit 5-3 shows the results of the models that were tested.

EXHIBIT 5-3 Results of Public Opinion Analysis

Question	Result
#1	Significant number constructed alternate access
#2 and #3	Significant change in opinion
#3	No significant change in opinion
#4	No significant change in opinion
#5	Significant change in opinion

From these results several conclusions were made. From question number one, it was found that a number of businesses constructed an alternate access after conversion of the frontage road. It was concluded that those business owners who could construct alternate access found it advantageous to have alternate access as well as frontage road access.

Due to the nature of the survey conducted, question two had to be directly compared to question three in the initial survey. From a statistical test performed on these questions, it was concluded that opinions changed negatively immediately after conversion. More businesses changed their opinions from being “for” or “indifferent” about the conversion to “against” the conversion. It was concluded that although business owners may have wanted the frontage roads to be converted to one way, immediately after they were converted they did not like it.

From the results of tests on questions three and four, it was concluded that there was not a significant change in attitude one year after conversion. Question three showed that businesses’ attitudes were still the same one year after conversion: they did not care for one-way operation of the frontage roads. From question four, it was concluded that the majority of businesses still felt one year after conversion that one-way operation was safer than two-way. Due to the disagreement in attitudes, it was concluded that businesses felt that one-way was safer than two-way, but they did not want one-way operation because it might negatively affect their sales.

Results from the analysis of question five showed that attitudes concerning the impact that conversion had on businesses changed significantly. Business owners changed their opinion from “they thought that the conversion had no effect on sales” soon after conversion to “the

conversion hurt sales" one year later. It was concluded that businesses felt the conversion hurt their sales.

Some of the comments taken from those who were interviewed may better describe how businesses felt about the frontage road conversion. Perhaps the most frequently given comment by those who were interviewed was "One way frontage roads are very inconvenient." This negative opinion may be a result of operating the frontage road as two-way roads since they were opened to traffic over 40 years prior to conversion. It also reinforces the thought given by Stover et al. that the longer the frontage roads are operated as two-way roads, the more opposition to conversion to one-way there will be.

These same authors also expressed the need for state officials to work with local agencies to avoid business owners from developing a "the highway department is telling us what we will do" attitude. Although the AHTD expressed a desire to convert the frontage roads to one-way as far back as the early 1990s, perhaps greater assistance should be given to those businesses on the frontage road not only after conversion takes place, but well before. Perhaps sharing studies with business owners to show them that traveling on the frontage roads will be safer, traffic will flow more freely, and that the impact to their business may not be as severe as they perceive.

Many comments from the surveys showed that some business owners felt their business had dropped considerably (some owners stated a drop of 50% or more in sales) after conversion. Others stated that they felt sales dropped but they were not sure if it was due totally to the conversion of the frontage roads, or if the overall economy in the area was on a decline. One test showed that there was not a statistically significant difference before and after conversion. These results may support those that felt the overall economy had dropped and contradict those that believed a severe drop in business was solely due to the frontage road conversion.

A number of comments taken from the follow-up surveys that were administered one year after conversion showed that some business owners were more frustrated with the main lane and interchange construction activity than the conversion of the frontage roads. Comments such as "Wish the construction were over" and "Need to finish construction" show that some owners felt that the construction activity may have a bigger effect on business than conversion.

A big safety concern was revealed from the follow-up survey. Numerous comments revealed that some motorists were seen driving the wrong direction on the one-way frontage roads. Although the AHTD placed many new signs and orange barrels in the inside lane of the frontage road, and sent out numerous press releases and flyers to inform people of the impending conversion, some motorist were unaware of the change. Perhaps a longer "transition" period, where the orange barrels were used to close the inside lane of the frontage road, was needed to be sure all drivers understood that a change had taken place.

From the literature review, Stover et al. explained that although most people believe that one-way frontage roads are much safer than two-way, they do not comprehend the capacity and operational advantages of one-way frontage roads. The history of frontage road experience has shown that local governments may view a state-built frontage road as a welcome no-cost addition to their local street network, and therefore fail to plan and operate a supporting network of streets that will provide traffic circulation in the corridor. If the land along such a two-way frontage road develops, then the abutting owners will come to rely on two-way frontage road operation for all of their access and circulation needs. When such a scenario is allowed to evolve over the years, it should surprise no one that property owners vigorously object when safety concerns lead the transportation agency to contemplate conversion to one-way operation.

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APPENDIX A: Survey Form

I-30 Frontage Road Conversion to One-Way

Name of Surveyor ❒ Hanning ❒ Gattis Other _____ Date_____

Type of Business 1 motel 2 restaurant 3 vehicle, equipment sales

4 "small" retail shops 5 "large" retail (lumber, home) 6 specialty retail 7 other retail

8 gas station (w/ or w/o other services) 9 Repair shops 10 industrial (cons't, warehouse, trucking)

11 church, funeral home 12 institutional (hospital, nursing home) 13 professional, offices, services

14 other_____

Name of Person Interviewed enter

Business/Organization Name enter

Address enter

enter

enter

Phone Number enter

1. Does your site rely entirely on the frontage road for access, or does another road also serve your site?

1 solely on frontage road 2 already had alt. access 3 const. alt. access after conversion 4 nr

2. Before the frontage roads were converted from two-way to one-way operation in Oct. 2002, I…

1 was for the conversion 2 opposed the conversion

3 had no opinion/undecided 4 did not know the conversion was about to occur 5 nr

3. Now that the conversion from two-way to one-way operation has occurred, I …

1 am for the conversion 2 am opposed to the conversion 3 have no opinion/undecided 4 nr

4. Which do you think is safer?

1 One-way frontage roads 2 Two-way frontage roads 3 No difference/Equally safe 4 nr

5. How has the conversion of the frontage roads to one-way operation affected your property/business/organization? 1 None 2 Hurt 3 Improved 4 Other 5 nr