Technical Report Documentation Page

| 1. Report No. | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| TX-95/2903-2 | | |

| 4. Title and Subtitle | 5. Report Date |
|---|---|
| CONGESTION-RELIEF ROUTE FEASIBILITY STUDY FOR FALFURRIAS, TEXAS | October 1995 |
| | 6. Performing Organization Code |

| 7. Author(s) | 8. Performing Organization Report No. |
|---|---|
| Kelley S. Klaver and Russell H. Henk | Research Report 2903-2 |

| 9. Performing Organization Name and Address | 10. Work Unit No. (TRAIS) |
|---|---|
| Texas Transportation Institute<br>The Texas A&M University System<br>College Station, Texas 77843-3135 | 11. Contract or Grant No.<br>Study No. 7-2903 |

| 12. Sponsoring Agency Name and Address | 13. Type of Report and Period Covered |
|---|---|
| Texas Department of Transportation<br>Research and Technology Transfer Office<br>P. O. Box 5080<br>Austin, Texas 78763-5080 | Interim:<br>September 1993 - August 1995 |
| | 14. Sponsoring Agency Code |

15. Supplementary Notes

Research performed in cooperation with the Texas Department of Transportation.
Research Study Title: Planning, Design, and Operation of Transportation Facilities in the Pharr District

16. Abstract

This report documents the procedures and findings associated with a feasibility assessment of a congestion relief route for U.S. 281 through Falfurrias, Texas. Researchers examined both short- and long-term improvements. The analyses conducted in this study indicate that immediate adjustments in signal timing and minor geometric changes can significantly improve progression through Falfurrias.

The results of these analyses also indicated that planned short-term improvements to Railroad Street would be cost-effective. Conservative benefit-cost (B/C) analyses produced an estimated B/C ratio of 5:1. Finally, this report recommends the construction of a congestion relief route east of existing U.S. 281 as a long-term improvement.

| 17. Key Words | 18. Distribution Statement |
|---|---|
| Signal Timing, Progression, Congestion, Benefit- Cost Analysis | No restrictions. This document is available to the public through NTIS:<br>National Technical Information Service<br>5285 Port Royal Road<br>Springfield, Virginia 22161 |

| 19. Security Classif.(of this report) | 20. Security Classif.(of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | 48 | |

# CONGESTION-RELIEF ROUTE FEASIBILITY STUDY FOR FALFURRIAS, TEXAS

by

Kelley S. Klaver
Assistant Research Scientist
Texas Transportation Institute

and

Russell H. Henk, P.E.
Assistant Research Engineer
Texas Transportation Institute

Research Report 2903-2
Research Study Number 7-2903
Research Study Title: Planning, Design, and Operation of Transportation Facilities in the Pharr District

Sponsored by
Texas Department of Transportation

October 1995

TEXAS TRANSPORTATION INSTITUTE
The Texas A&M University System
College Station, Texas 77843-3135

## IMPLEMENTATION STATEMENT

This research report documents the operational analysis and assessment of a congestion-relief route for U.S. 281 through Falfurrias, Texas. Traffic traveling to and from South Texas via U.S. 281 is currently subjected to unnecessary delays at several traffic signals in Falfurrias. The results from this study can be used in the development of detailed drawings for the construction of a limited access congestion-relief route east of existing U.S. 281.

## DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation. This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. This report was prepared by Russell H. Henk, P.E. #74460.

# TABLE OF CONTENTS

Page

# LIST OF FIGURES

## LIST OF TABLES

# SUMMARY

Researchers performed a comprehensive delay study in Falfurrias by assessing the existing and projected operations of the five signalized intersections along U.S. 281. The results of the study showed a delay reduction, based on signal timing and geometric improvements (to existing U.S 281) alone, with a corresponding discounted 20-year delay benefit of approximately $0.6 million.

Tests also revealed that significant safety benefits could be gained by improving existing operations in Falfurrias. Assuming the implementation of the proposed signal and geometric improvements (including the extension of Railroad Street and construction of the bypass), these benefits would be approximately $41 million. In addition, a study of the trip patterns through Falfurrias indicated that any significant adverse economic impacts were or would be unlikely.

Because several other sources of benefits were quantifiable, a more comprehensive assessment of two improvement alternatives (short-term and long-term) was also performed using the MicroBENCOST program. This assessment included not only delay benefits, but also vehicle operating and accident reduction benefits. The results of the MicroBENCOST analyses showed a benefit-cost ratio of 8:1 for the Railroad Street expansion project (assumed to be complete by 1997) and a benefit-cost ratio of 5:1 for the congestion relief route (assumed to be complete by 2005).

# I. INTRODUCTION

Falfurrias is located along U.S. 281 approximately 137 kilometers (85 miles) north of the United States-Mexico Border in the South-Texas Valley. U.S. 281 is a major north-south route for international trade with Mexico; therefore, it carries not only international traffic, but also a large number of trucks to and from the border. The Valley has experienced significant growth over the past decade, and one result of this growth is a considerable increase in traffic. Further, the location of international bridges in the vicinity of U.S. 281 and the onset of the North American Free Trade Agreement (NAFTA) will significantly increase traffic through Falfurrias.

It would be desirable to curtail the growing traffic problems in Falfurrias by adding capacity to U.S. 281. However, adjacent development along U.S. 281 in Falfurrias restricts significantly increasing capacity of the facility through the city. Due to the limitations in expanding U.S. 281 through Falfurrias, the continued growth of the area, and the probability of increasing truck traffic due to NAFTA, it has become necessary to assess alternative solutions to the developing congestion problems. One proposed alternative is the provision of a congestion relief route around Falfurrias. This report outlines the analysis procedure used to assess the feasibility of this alternative.

## BACKGROUND

Falfurrias stretches approximately one mile along U.S. 281 (Figure 1). There are five signalized intersections along U.S. 281 through the city. Through Falfurrias, U.S. 281 is a four-lane facility (i.e., two lanes in each direction) with parking lanes/shoulders in both directions. The cross streets of four of the five signalized intersections in Falfurrias are two-lanes with no left- or right-turn bays. At the intersection of U.S. 281, SH 285 is two lanes on the east-side approach to the intersection and four-lanes on the west-side approach to the intersection.

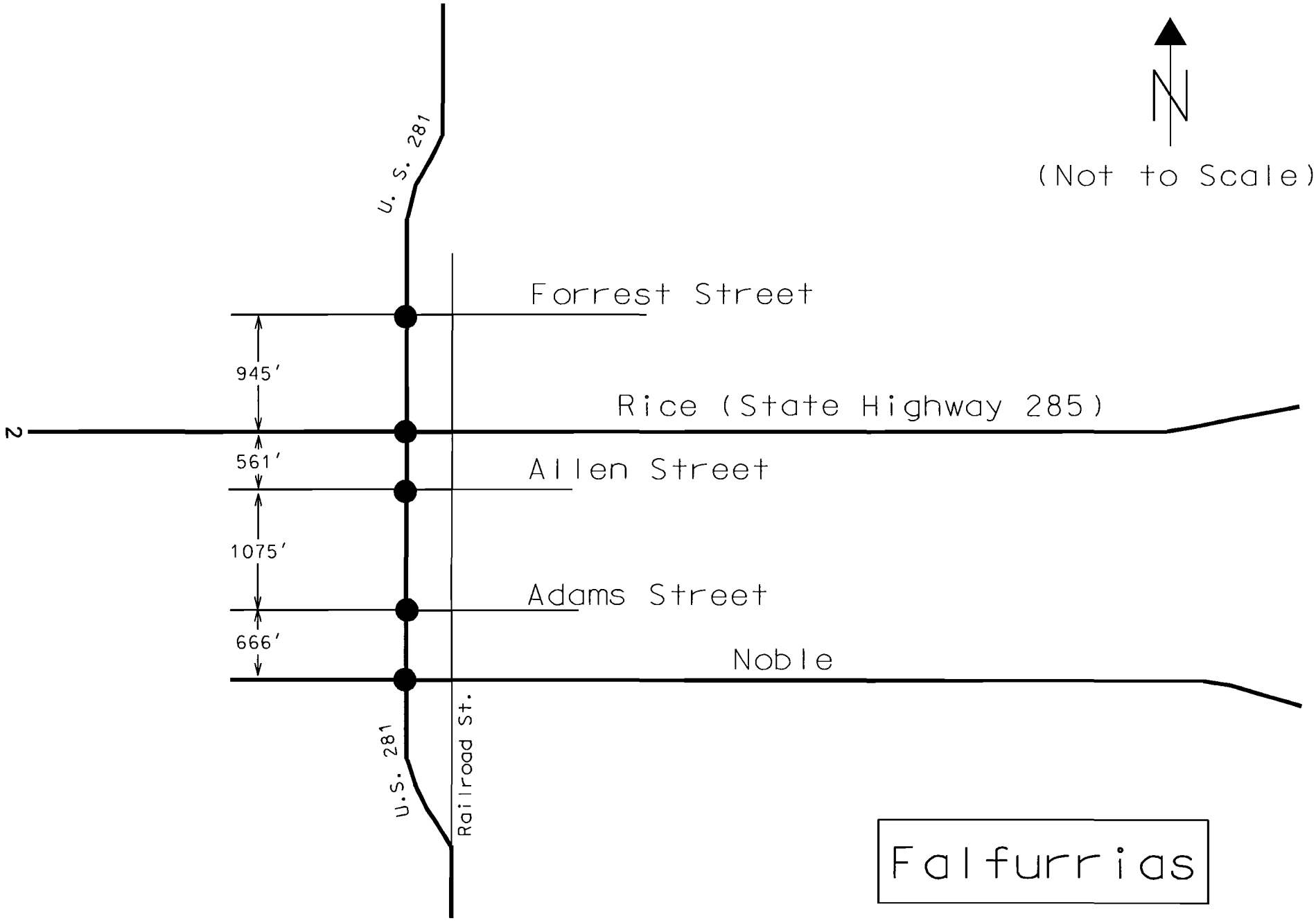


**Figure 1. Vicinity Map for Falfurrias**

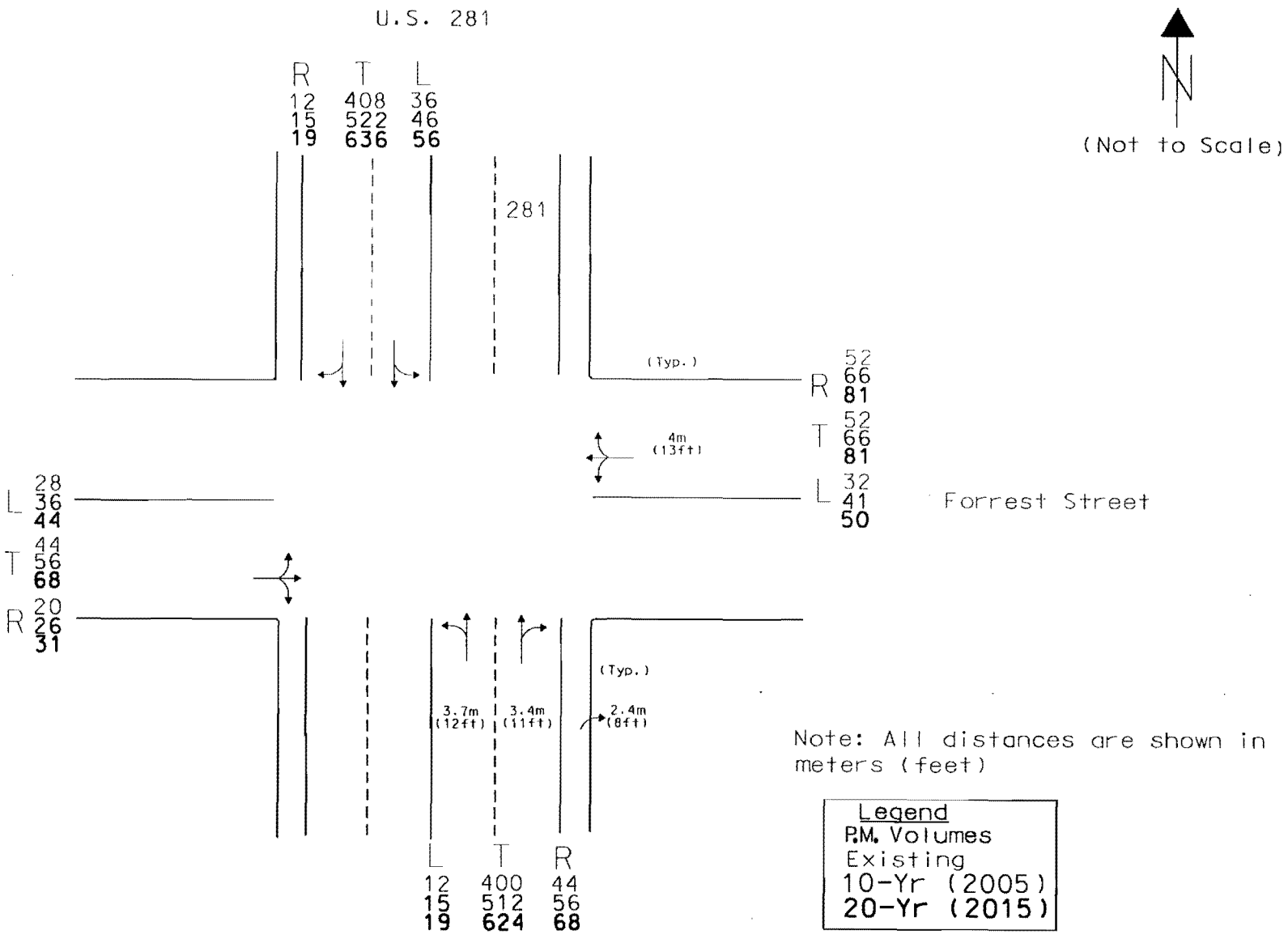


**Figure 2. Traffic Volumes for U.S. 281 and Forrest, Evening Peak Hour**

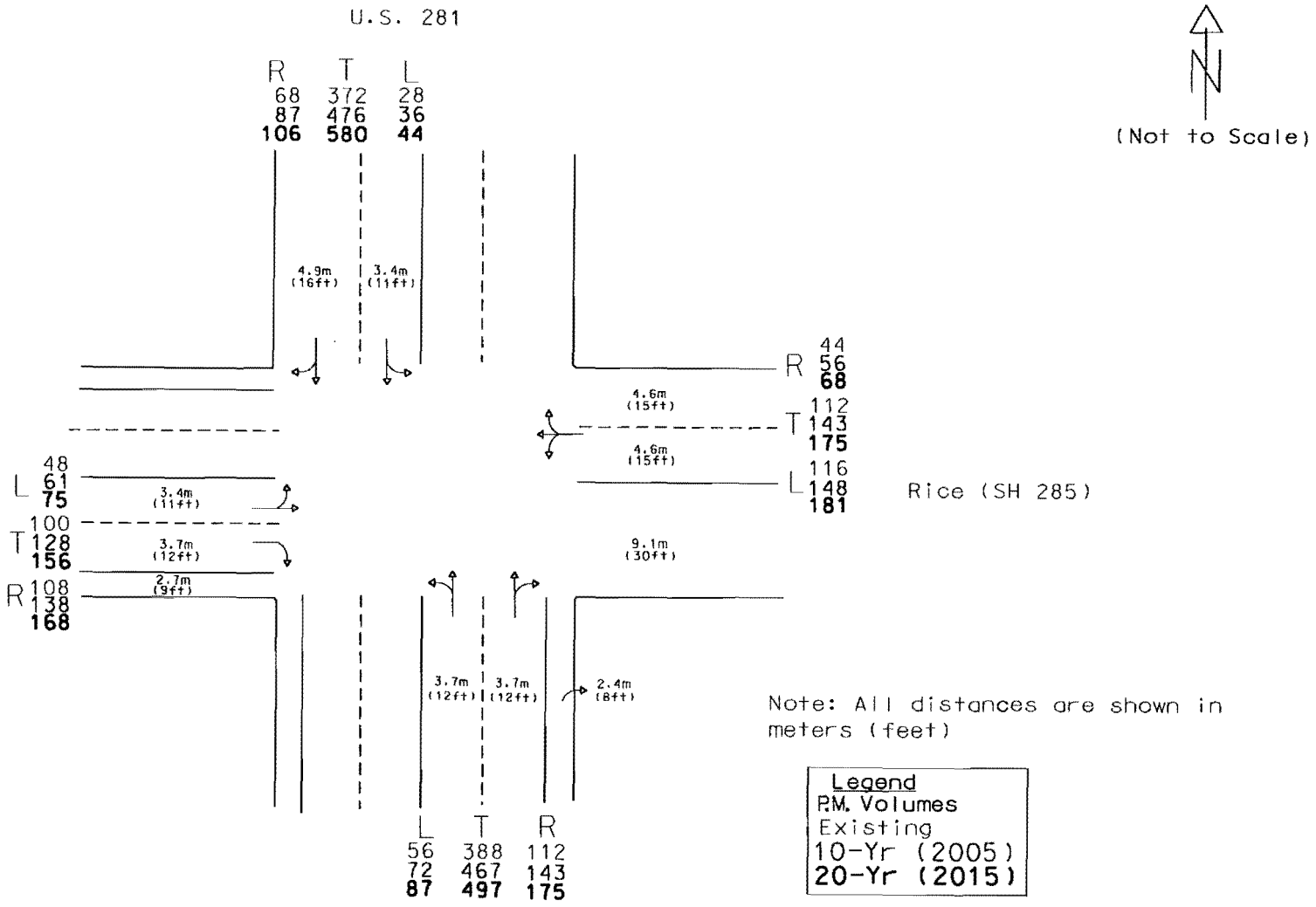


**Figure 3. Traffic Volumes for U.S. 281 and SH 285, Evening Peak Hour**

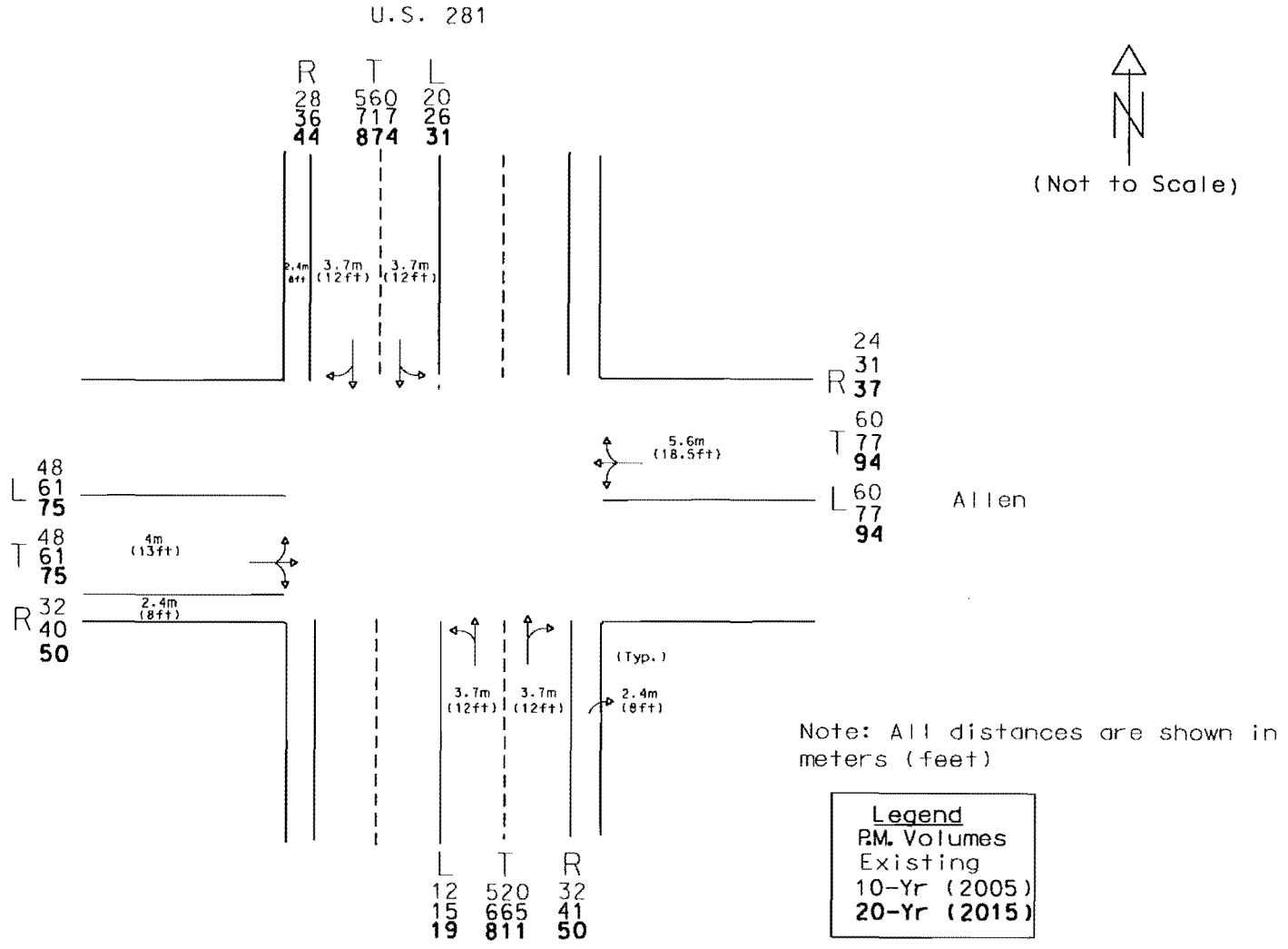


**Figure 4. Traffic Volumes for U.S. 281 and Allen, Evening Peak Hour**

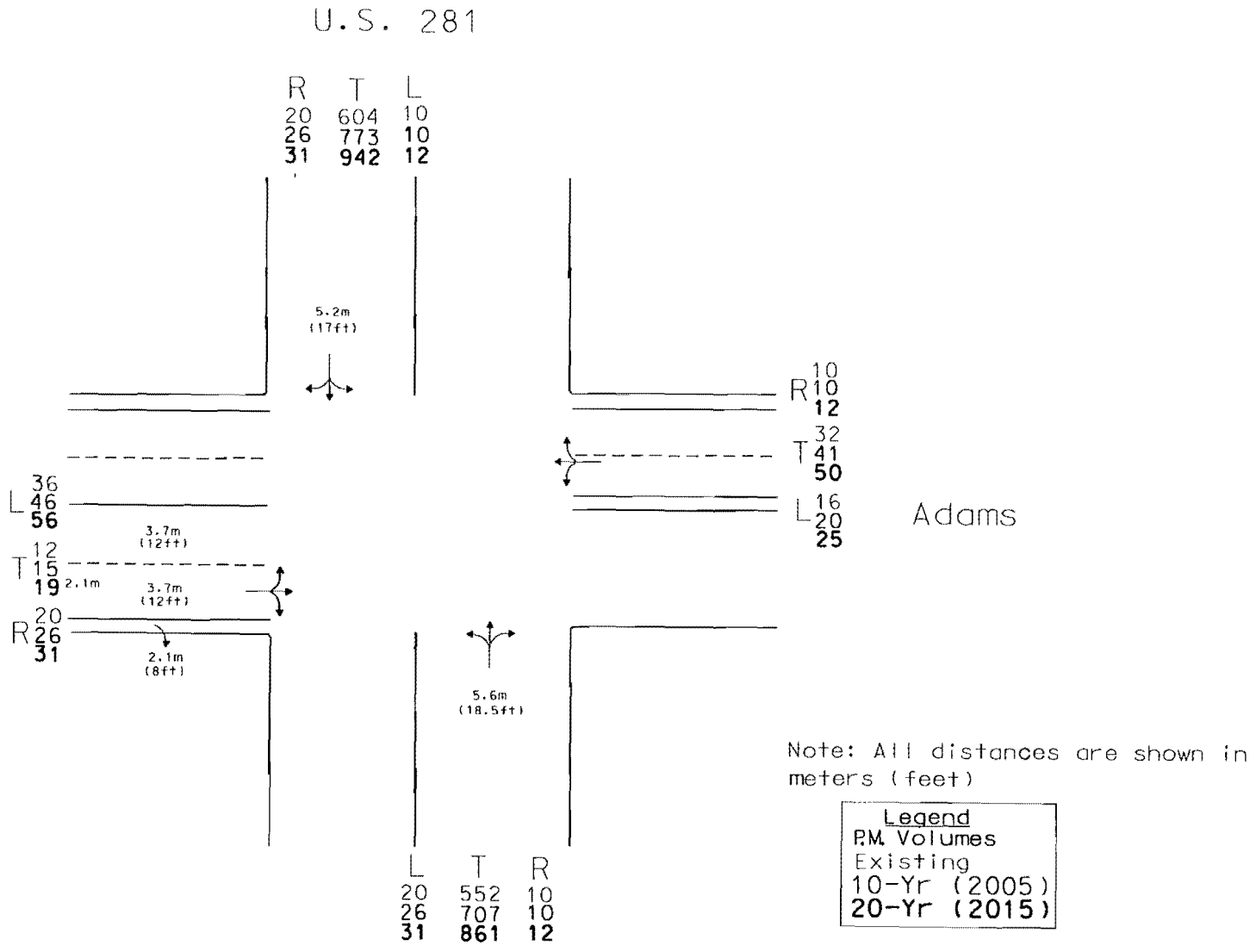


**Figure 5. Traffic Volumes for U.S. 281 and Adams, Evening Peak Hour**

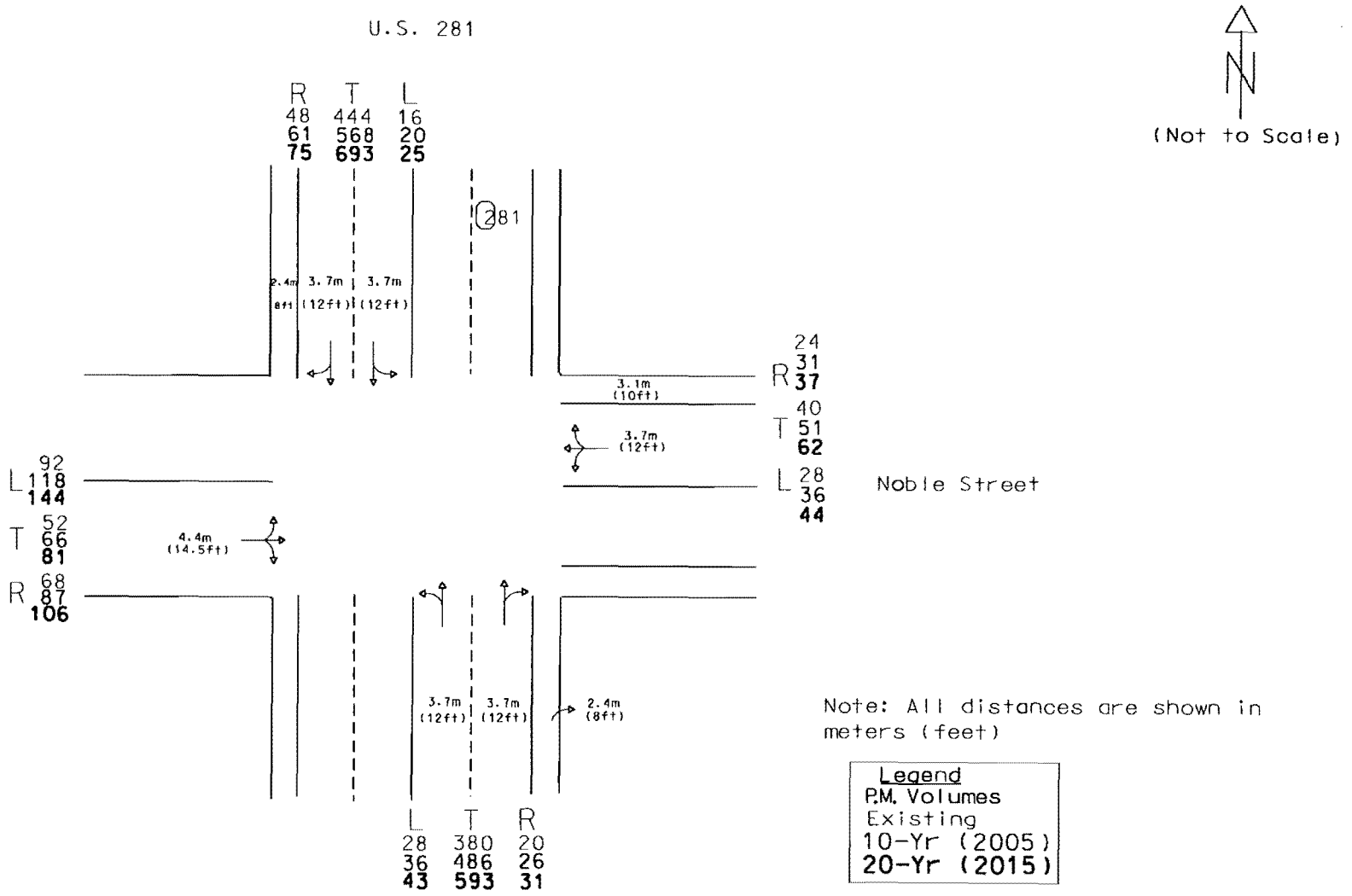


**Figure 6. Traffic Volumes for U.S. 281 and Noble, Evening Peak Hour**

# II. EVALUATION OF TRAFFIC OPERATIONS

Before researchers evaluated current or projected traffic operations in Falfurrias they collected data at all intersections. They performed turning movement counts from 7:00 a.m. to 9:00 a.m. and from 4:00 p.m. to 6:00 p.m. at each of the five intersections (Figures 2-6). All geometric information (e.g., number of lanes, lane widths, allowable turning movements, etc.) and signal timing information were recorded for each intersection. Finally, video cameras placed at each end of Falfurrias recorded the license tags of all vehicles entering and leaving town.

In the first step in assessing the feasibility of a bypass around Falfurrias the collected data simulated and optimized the existing traffic operations through the city. Next, 10- and 20-year traffic operations were assessed assuming optimized signals but no geometric improvements. Ten- and 20-year traffic operations with feasible geometric improvements in Falfurrias were then assessed. If future traffic operations were expected to be unacceptable with geometric improvements to U.S. 281, then operations with a bypass would be assessed by diverting the through traffic from town to a U.S. 281 relief route. However, if projected traffic operations did not show considerable traffic delay, the need for a congestion-relief route could not be justified on the basis of delay savings alone. In this case, a more detailed analysis would be required to asses the bypass's feasibility.

## EXISTING AND PROJECTED TRAFFIC OPERATIONS

Existing peak-hour volumes and geometric information served as input data for the PASSER II-90 (PII-90) model. This model simulated the existing traffic operations and optimized existing and projected traffic operations along U.S. 281 in Falfurrias. PII-90 optimized cycle length and green splits by minimizing delay, but the model did not directly evaluate actuated signal operations so researchers had to estimate cycle lengths, green splits, and offsets between the signals. Historical traffic volume data indicated an average

annual growth rate of 2.5 percent over the past five years. These analyses, therefore, reflect a growth rate of 2.5 percent. The results are presented in Table 1.

**Table 1. Existing and Projected Traffic Operations Along U.S. 281 in Falfurrias**

| Condition | Cycle Length (seconds) | Total System Stopped Delay (veh-hrs/hr) | Average Stopped Delay (seconds/veh) | LOS | System Stops (hourly) | Green Band (sec) |
|---|---|---|---|---|---|---|
| Existing AM | 50 | 11 | 18 | C | 3900 | - |
| Existing-Optimized AM | 50 | 10 | 16 | C | 4200 | 13 |
| 10-Year AM | 50 | 14 | 17 | C | 5800 | 13 |
| 20-Year AM | 50 | 25 | 25 | D | 7700 | 13 |
| Existing PM | 50 | 14 | 22 | C | 5000 | - |
| Existing-Optimized PM | 50 | 12 | 19 | C | 5200 | 12 |
| 10-Year PM | 50 | 20 | 24 | C | 7600 | 12 |
| 20-Year PM | 50 | 71 | 71 | F | 12000 | 12 |

These analyses did not consider any geometric improvements to U.S. 281 or the cross-street intersections or any changes to the existing phasing schemes at the intersections. Optimization of the signals involved only changes in green splits and cycle length. Therefore, by simply optimizing the green splits and cycle lengths along the existing facility, engineers expect traffic operations to be at LOS C now and past 10 years into the future. It is anticipated that operations during the AM peak will reach LOS D and that operations for the PM peak will be at LOS F by 2015.

## EXISTING AND PROJECTED TRAFFIC OPERATIONS WITH SIGNAL PHASING AND GEOMETRIC IMPROVEMENTS

Researchers subsequently assessed existing and projected traffic operations with signal phasing and geometric improvements along U.S. 281 in Falfurrias. Various alternatives were analyzed, including the alteration of the phasing pattern at the SH 285 intersection from four-phase to two-phase operation. Though there were possible delay

reduction benefits to through vehicles using two-phase operations, the existing four-phase scheme was preserved for safety (especially given the heavy vehicle volumes at this intersection) and to facilitate left turns at this intersection. Geometric improvements examined included either: 1) re-striping U.S. 281 through Falfurrias as four 3.7 meter (12-foot) lanes and a 4.9 meter (16-foot) two-way center left-turn lane; or 2) flaring the intersections to provide left-turn bays at each signalized intersection on U.S. 281 except SH 285. These options are the same in the signal analyses; however, the first option is more expensive and provides a separate lane for all left turns. The second option, although less expensive, provides a left-turn bay only at the signalized intersections.

Also, re-striping alternatives were examined for the intersection with SH 285. Currently, SH 285 has two lanes in each direction west of U.S. 281 and one lane in each direction east of U.S. 281. Geometric limitations and tight turning radii at the intersection make it infeasible to add lanes or bays at the intersection. However, there is side-of-street parking on both sides of SH 285 east of U.S. 281. The parking was "removed" for this analysis and the space used for an additional travel lane in each direction east of U.S. 281. Table 2 illustrates the results of the proposed signal and geometric alternatives.

**Table 2. Existing and Projected Traffic Operations Along U.S. 281 in Falfurrias with Signal Phasing and Geometric Improvements**

| Condition | Cycle Length (seconds) | Total System Stopped Delay (veh-hrs/hr) | Average Stopped Delay (seconds/veh) | LOS | System Stops (hourly) | Green Band (sec) |
|---|---|---|---|---|---|---|
| Existing-Optimized AM | 55 | 10 | 15 | B | 4300 | 15 |
| 10-Year AM | 55 | 14 | 17 | C | 5600 | 14 |
| 20-Year AM | 55 | 21 | 21 | C | 6700 | 12 |
| Existing-Optimized PM | 55 | 11 | 18 | C | 5400 | 18 |
| 10-Year PM | 55 | 17 | 21 | C | 7000 | 15 |
| 20-Year PM | 55 | 37 | 37 | D | 9900 | 11 |

The change in signal timing at all of the intersections, the provision of left turn bays along U.S. 281 at each intersection (except SH 285), and the restriping of SH 285 east of U.S. 281 to two lanes in each direction combined to provide acceptable levels of service past the twenty-year time horizon.

PII-90 optimizes the signal splits at each intersection to minimize delay and it optimizes the offsets between the intersections to maximize progression. Because U.S. 281 is a major thoroughfare, the through traffic on that highway deserves priority in cities such as Falfurrias to minimize the delay and number of stops for the through traffic, especially the heavy vehicle traffic that has the potential to reduce pavement life and disrupt traffic flows. Therefore, every effort was made during the analysis to provide maximum progression along U.S. 281, with the secondary objective of minimizing delay to all traffic in the U.S. 281 corridor in Falfurrias.

The results of the PII-90 signal optimizations are presented in Tables 3 through 8. System-wide signal operations included a 4-second yellow clearance interval and a 1-second all-red clearance interval. For simplicity, the green splits are shown including the yellow and all-red clearance times.

**Table 3. Signal Timing Information for Maximum Bandwidth with Minimum Delay Existing, Morning Peak Hour**

| Intersection with U.S. 281 | Cycle Length (seconds) | Left-Turn Phasing | U.S. 281 Green (seconds) | Cross-Street Green (seconds) | Offset from Master Controller[1,2] (seconds) |
|---|---|---|---|---|---|
| Noble | 55 | Permitted only | 25 | 30 | NA |
| Adams | 55 | Permitted only | 39 | 16 | 48 |
| Allen | 55 | Permitted only | 35 | 20 | 23 |
| SH 285 | 55 | Protected-NB,WB<br>Permitted-SB,EB | 28, 10 sec leading left NB | 27, 10 sec leading left WB | 51 |
| Forrest | 55 | Permitted only | 36 | 19 | 20 |

[1]Master controller is located at intersection of U.S. 281 and Noble.
[2]All offsets are measured from the beginning of the U.S. 281 green split at Noble to the beginning of the U.S. 281 green split at the downstream intersections.

For the existing morning peak hour, the optimized bandwidth northbound and southbound through Falfurrias was 15 seconds, a bandwidth efficiency of 27 percent.

**Table 4. Signal Timing Information for Maximum Bandwidth with Minimum Delay Existing, Evening Peak Hour**

| Intersection with U.S. 281 | Cycle Length (seconds) | Left-Turn Phasing | U.S. 281 Green (seconds) | Cross-Street Green (seconds) | Offset from Master Controller[1,2] (seconds) |
|---|---|---|---|---|---|
| Noble | 55 | Permitted only | 34 | 21 | NA |
| Adams | 55 | Permitted only | 42 | 13 | 47 |
| Allen | 55 | Permitted only | 35 | 15 | 25 |
| SH 285 | 55 | Protected-NB,WB<br>Permitted-SB,EB | 29, 10 sec leading left NB | 26, 10 sec leading left WB | 1 |
| Forrest | 55 | Permitted only | 37 | 18 | 24 |

[1]Master controller is located at intersection of U.S. 281 and Noble.
[2]All offsets are measured from the beginning of the U.S. 281 green split at Noble to the beginning of the U.S. 281 green split at the downstream intersections.

For the existing evening peak hour, the optimized bandwidth northbound and southbound through Falfurrias was 18 seconds, a bandwidth efficiency of 33 percent.

**Table 5. Signal Timing Information for Maximum Bandwidth with Minimum Delay Projected Ten-Year, Morning Peak Hour**

| Intersection with U.S. 281 | Cycle Length (seconds) | Left-Turn Phasing | U.S. 281 Green (seconds) | Cross-Street Green (seconds) | Offset from Master Controller[1,2] (seconds) |
|---|---|---|---|---|---|
| Noble | 55 | Permitted only | 25 | 30 | NA |
| Adams | 55 | Permitted only | 38 | 17 | 48 |
| Allen | 55 | Permitted only | 32 | 23 | 24 |
| SH 285 | 55 | Protected-NB,WB Permitted-SB,EB | 28, 10 sec leading left NB | 27, 10 sec leading left WB | 51 |
| Forrest | 55 | Permitted only | 35 | 20 | 21 |

[1]Master controller is located at intersection of U.S. 281 and Noble.
[2]All offsets are measured from the beginning of the U.S. 281 green split at Noble to the beginning of the U.S. 281 green split at the downstream intersections.

For the projected ten-year morning peak hour, the optimized bandwidth northbound and southbound through Falfurrias was 14 seconds, a bandwidth efficiency of 25 percent.

**Table 6. Signal Timing Information for Maximum Bandwidth with Minimum Delay Projected Ten-Year, Evening Peak Hour**

| Intersection with U.S. 281 | Cycle Length (seconds) | Left-Turn Phasing | U.S. 281 Green (seconds) | Cross-Street Green (seconds) | Offset from Master Controller[1,2] (seconds) |
|---|---|---|---|---|---|
| Noble | 55 | Permitted only | 29 | 26 | NA |
| Adams | 55 | Permitted only | 42 | 13 | 46 |
| Allen | 55 | Permitted only | 32 | 23 | 26 |
| SH 285 | 55 | Protected-NB,WB Permitted-SB,EB | 30, 10 sec leading left NB | 25, 10 sec leading left WB | 53 |
| Forrest | 55 | Permitted only | 35 | 20 | 24 |

[1]Master controller is located at intersection of U.S. 281 and Noble.
[2]All offsets are measured from the beginning of the U.S. 281 green split at Noble to the beginning of the U.S. 281 green split at the downstream intersections.

For the projected ten-year evening peak hour, the optimized bandwidth northbound and southbound through Falfurrias was 15 seconds, a bandwidth efficiency of 28 percent.

**Table 7. Signal Timing Information for Maximum Bandwidth with Minimum Delay Projected Twenty-Year, Morning Peak Hour**

| Intersection with U.S. 281 | Cycle Length (seconds) | Left-Turn Phasing | U.S. 281 Green (seconds) | Cross-Street Green (seconds) | Offset from Master Controller[1,2] (seconds) |
|---|---|---|---|---|---|
| Noble | 55 | Permitted only | 25 | 30 | NA |
| Adams | 55 | Permitted only | 36 | 19 | 48 |
| Allen | 55 | Permitted only | 28 | 27 | 26 |
| SH 285 | 55 | Protected-NB,WB<br>Permitted-SB,EB | 28, 10 sec leading left NB | 27, 10 sec leading left WB | 51 |
| Forrest | 55 | Permitted only | 32 | 23 | 24 |

[1]Master controller is located at intersection of U.S. 281 and Noble.
[2]All offsets are measured from the beginning of the U.S. 281 green split at Noble to the beginning of the U.S. 281 green split at the downstream intersections.

For the projected twenty-year morning peak hour, the optimized bandwidth northbound and southbound through Falfurrias was 12 seconds, a bandwidth efficiency of 22 percent.

**Table 8. Signal Timing Information for Maximum Bandwidth with Minimum Delay Projected Twenty-Year, Evening Peak Hour**

| Intersection with U.S. 281 | Cycle Length (seconds) | Left-Turn Phasing | U.S. 281 Green (seconds) | Cross-Street Green (seconds) | Offset from Master Controller[1,2] (seconds) |
|---|---|---|---|---|---|
| Noble | 55 | Permitted only | 25 | 30 | NA |
| Adams | 55 | Permitted only | 40 | 15 | 47 |
| Allen | 55 | Permitted only | 27 | 28 | 27 |
| SH 285 | 55 | Protected-NB,WB Permitted-SB,EB | 32, 10 sec leading left NB | 23, 10 sec leading left WB | 47 |
| Forrest | 55 | Permitted only | 33 | 22 | 24 |

[1]Master controller is located at intersection of U.S. 281 and Noble.
[2]All offsets are measured from the beginning of the U.S. 281 green split at Noble to the beginning of the U.S. 281 green split at the downstream intersections.

For the projected twenty-year peak hour, the optimized bandwidth northbound and southbound through Falfurrias was 11 seconds, a bandwidth efficiency of 20 percent.

In a congestion-relief route study, the through traffic would normally be removed from the intersections in the signal operational analyses to predict the future operational LOS of the signalized intersections with a relief route. In this case, however the 20-year evening peak conditions were expected to be at a LOS C (with the minor signal timing and geometric improvements). An operational LOS C is often used for design purposes so an not to "over design" a facility. In this case, the through traffic was not removed. With operations at LOS C, the removal of the through traffic will result in minimal additional delay savings assuming historical growth trends continue into the foreseeable future.

# III. DELAY BENEFITS

The delay benefits along U.S. 281 in Falfurrias were a result of all the improvements considered along U.S. 281. These improvements included signal timing and geometric improvements at each of the signalized intersections and the bandwidth optimization which minimized delay to through traffic.

## GEOMETRIC IMPROVEMENT BENEFITS

Geometric improvements in Falfurrias included the restriping of SH 285 east of U.S. 281 and the provision of left-turn bays at all the signalized intersections along U.S. 281 (except SH 285). The restriping of SH 285 east of U.S. 281 from one lane to two lanes in each direction provides more capacity and, to some degree, separates turning traffic from through traffic. With only one lane in each direction, left turning vehicles that approached the intersection after the protected left turn arrow "timed out" blocked the entire intersection approach. With two lanes in each direction, the left turning vehicles that did not make it through the protected left turn phase are safely stored in the left lane while the right lane remains open for through and right-turning vehicles.

Although the delay savings resulting from a center left-turn lane or left-turn bays along U.S. 281 are minimal at current traffic volume levels, they will become increasing important as traffic volumes grow over the years. If no left-turn treatments are provided by 2005, the left-turn traffic from U.S. 281 onto the cross streets will inhibit effective traffic operations along U.S. 281. Removing permissive left-turn movements from the through lanes will not only reduce delay to through vehicles, but it will help reduce the potential for rear-end accidents.

## SIGNAL OPTIMIZATION BENEFITS

There were no delay savings resulting from the signal split optimization at the intersections along U.S. 281. The signals are currently actuated and are operating at minimum delay. Unfortunately, fully-actuated operations do not allow a progression band along arterial streets; therefore, the through traffic currently experiences an unnecessary proportion of the total system delay. Optimizing the offsets (offsets shown in Tables 3 through 8) between the signalized intersections and utilizing semi-actuated operation (or fixed-cycle time operation) creates and preserves a progression band for the through traffic. It is the presence of a progression band in the optimized signal settings that provides a delay reduction along U.S. 281 for the current, 10 and 20 year traffic volume.

## SUMMARY OF DELAY BENEFITS

The delay savings along U.S. 281 (based on signal timing and geometric improvements) in 10 and 20 years were extrapolated over a 20-year analysis period. The total discounted delay benefit of the signal timing and geometric improvements was $0.6 million during the A.M. and P.M. peak hours alone. Additional benefits due to progression will occur, including delay reduction during all hours of the day along U.S. 281, reduced accidents, reduced queuing, a reduction in stops along U.S. 281, and lower system fuel consumption.

The removal of the through traffic would result in a slightly higher figure; however, this figure alone would still be far too small to make the congestion-relief route a feasible project. Although this benefit would not cover the cost of constructing a relief route around Falfurrias, it does illustrate the delay benefits based on a comprehensive study of the traffic operations in the city. The study also shows that there are some immediate, relatively inexpensive improvements that can be made along U.S. 281 in Falfurrias to improve the efficiency of the signal operations.

In many cases, the benefits resulting from a delay study (such as this) will justify an improvement project. However, delay benefits are not the only benefits upon which the feasibility of a project can be based. Other factors such as accidents, fuel consumption, and vehicle operating costs could result in user benefits, and they could be considered in a feasibility study. This report subsequently discusses an assessment of all potential safety benefits.

# IV. SAFETY BENEFITS

An analysis of accident data for the Falfurrias area was also conducted as a part of this study. This analysis indicated that the average accident rate for Falfurrias is 3.02 accidents per million vehicle-kilometers (MVK) of travel. This rate compares poorly with the average accident rate of 1.14 accidents/MVK (1.83 accident/million vehicle miles (MVM)) for South Texas cities of similar size (e.g., Edinburg, Freer, Raymondville, and Rio Grande City/ Roma). Closer examination of the cause of the accidents revealed that approximately 43 percent of the accidents in Falfurrias are associated with traffic control and/or left turns. This figure is also well above the average of 20-25 percent for similar South Texas cities.

Assuming (conservatively) that safety could be improved (i.e., accidents reduced) to a level of 1.55 accident/MVK (2.5 accidents/MVM), these benefits would translate into approximately $3 million per year. Further, assuming a 20-year life for respective geometric and/or signal improvements, the net present worth of these benefits would translate into approximately $41 million.

# V. DETAILED ASSESSMENT

MicroBENCOST is a computer program for analyzing benefits and costs of a wide range of highway improvements. It compares the motorist costs in the existing situation, the "without improvement" alternative, to the motorist costs if the improvement is implemented, the "with improvement" alternative. The improvement benefits can be expressed in terms of delay benefits only or total user benefits, depending on the user's discretion. Delay benefits include only the benefits associated with a time savings. Total user benefits, on the other hand, include a reduction in vehicle operating costs (costs of fuel, oil, tires, maintenance and repair, depreciation, and vehicle miles of travel), delay costs (costs for the value of time lost, stopping discomfort, congestion discomfort, and rough pavement), and accident costs (costs for property damage only, injury, and fatal accidents).

MicroBENCOST allocates traffic to routes so as to equilibrate the average trip cost per vehicles on each route based on the previously listed costs. As stated above, the trip costs can be based solely on delay costs or can be based on total user costs. Since a comprehensive study of delay costs/benefits for a Falfurrias relief route had already been completed, total user costs were used for assessing two improvement alternatives in Falfurrias--short-term and long-term improvements.

## SHORT-TERM IMPROVEMENT PROJECT--RAILROAD STREET EXPANSION

The first project evaluated was the expansion and widening of Railroad Street through Falfurrias to provide a more efficient route for through traffic. For an added capacity project such as this, MicroBENCOST assumes there is an existing route and an available alternate route, each of which has local traffic and through traffic. For this project, U.S. 281 was assumed to be the existing route, with existing Railroad Street as the alternate route. The route data for U.S. 281 and Railroad Street are shown in Tables 9

and 10, respectively. Ten percent truck traffic was assumed for U.S. 281 and Railroad Street. Figure 7 illustrates the existing U.S. 281 and Railroad Street segments.

**Table 9. Existing Route Data--Existing U.S. 281**

| Segment Number | Segment Length, km. (miles) | Local AADT[1] (veh/day) | Thru AADT[1] (veh/day) | Average Speed, kph. (mph) | Number of Signals |
|---|---|---|---|---|---|
| 1 | 1.61 (1.00) | 2,000 | 3,000 | 64 (40) | 0 |
| 2 | 1.37 (0.85) | 8,000 | 3,000 | 56 (35) | 2 |
| 3 | 0.72 (0.45) | 10,000 | 3,000 | 48 (30) | 3 |
| 4 | 1.13 (0.70) | 8,000 | 3,000 | 56 (35) | 0 |
| 5 | 1.61 (1.00) | 8,000 | 3,000 | 64 (40) | 0 |
| **TOTALS** | 6.44 (4.00) | -- | -- | -- | 5 |

[1]Base year assumed to be 1994.

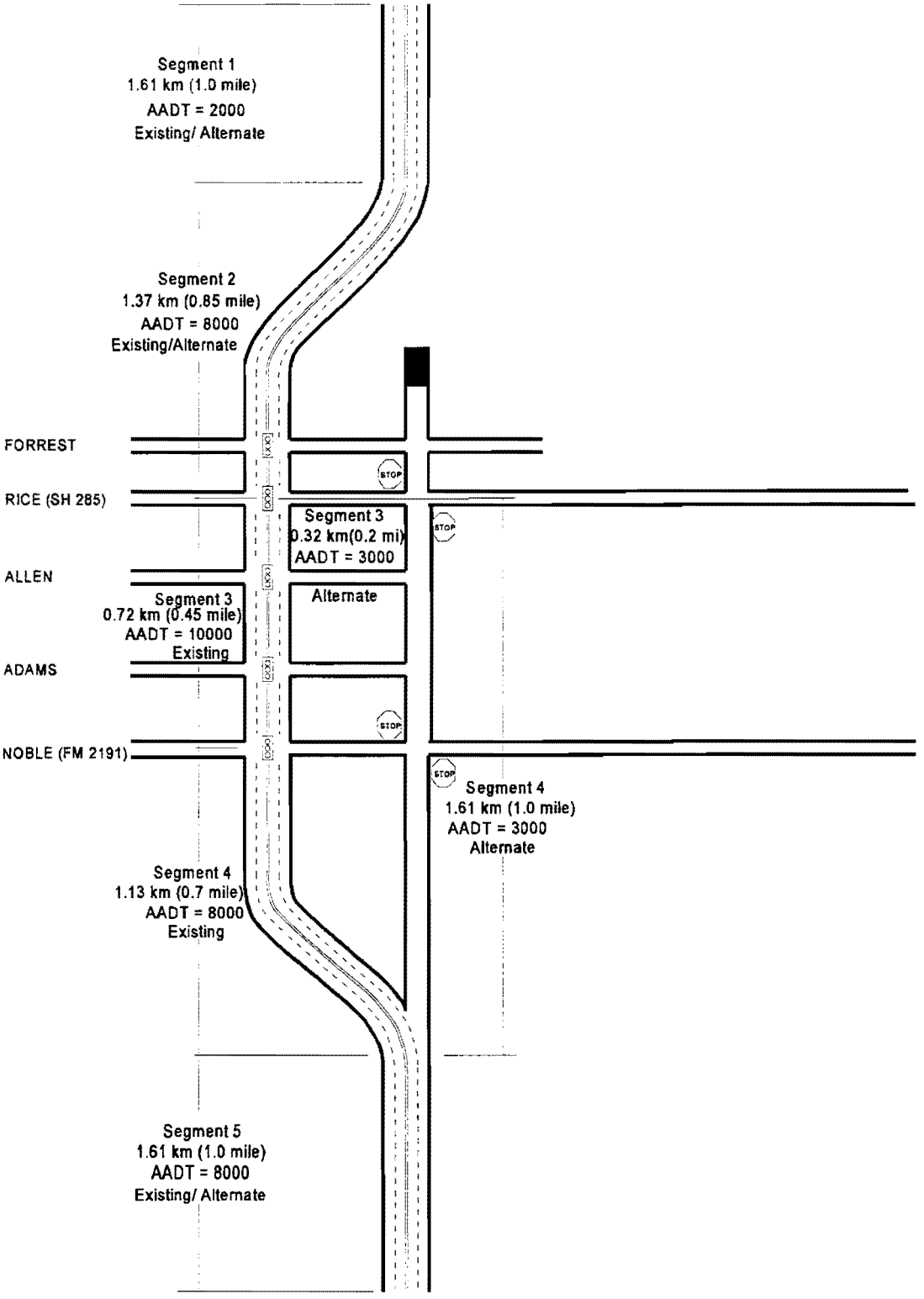


**Figure 7. Existing U.S. 281 and Railroad Street Segments**

**Table 10. Existing Alternate Route Data--Railroad Street**

| Segment Number | Segment Length, km. (miles) | Local AADT[1] (veh/day) | Thru AADT[1] (veh/day) | Average Speed, kph.(mph) | # of Traffic Controlled Intersections | Number of Thru Lanes (each direction) |
|---|---|---|---|---|---|---|
| 1 | 1.61 (1.00) | 2,000 | 800 | 64 (40) | 0 | 2 |
| 2 | 1.37 (0.85) | 8,000 | 800 | 48 (30) | 2 | 2 |
| 3 | 0.32 (0.20) | 3,000 | 800 | 48 (30) | 0 | 1 |
| 4 | 1.61 (1.00) | 3,000 | 800 | 48 (30) | 2-way stop | 1 |
| 5 | 1.61 (1.00) | 8,000 | 800 | 64 (40) | 0 | 2 |
| **TOTALS** | 6.52 (4.05) | -- | -- | -- | 3 | -- |

[1]Base year assumed to be 1994.

The proposed expansion of Railroad Street was assumed to be a four-lane arterial with a signal at each end of Falfurrias connecting it to U.S. 281 and two additional signalized intersections in the city. The Railroad Street expansion was assumed to be a one-year project, complete in 1997, at a cost of approximately $2 million. Figure 8 illustrates the proposed route segments. Other proposed route data are shown in Table 11. Results of the economic assessment of the total user benefits and costs for the expansion of Railroad Street showed a benefit-cost ratio of 8:1.

**Table 11. Proposed Route Data--Proposed Improvements to Railroad Street**

| Segment Number | Segment Length, km. (miles) | Local AADT[1] (veh/day) | Thru AADT[1] (veh/day) | Average Speed, kph (mph) | Number of Signals |
|---|---|---|---|---|---|
| 1 | 1.61 (1.00) | 2,000 | 3,300 | 64 (40) | 0 |
| 2 | 1.29 (0.80) | 3,000 | 3,300 | 56 (35) | 2 |
| 3 | 1.61 (1.00) | 2,000 | 3,300 | 56 (35) | 2 |
| 4 | 1.61 (1.00) | 8,000 | 3,300 | 64 (40) | 0 |
| **TOTALS** | 6.12 (3.80) | -- | -- | -- | 4 |

[1]Base year assumed to be 1994.

## LONG-TERM IMPROVEMENT PROJECT–FALFURRIAS CONGESTION-RELIEF ROUTE

The second project evaluated was a Falfurrias congestion-relief route to be constructed by the year 2005. For a project of this type, MicroBENCOST assumes there is an existing route and an available alternate route. For this project, it was assumed that in ten years, the Railroad Street expansion would be the existing route through Falfurrias, with U.S. 281 as an available alternative route. The route data for Railroad Street and U.S. 281 are shown in Tables 12 and 13, respectively (illustrated in Figure 9). Ten percent and 3 percent truck traffic were projected for Railroad Street and Business 281, respectively.

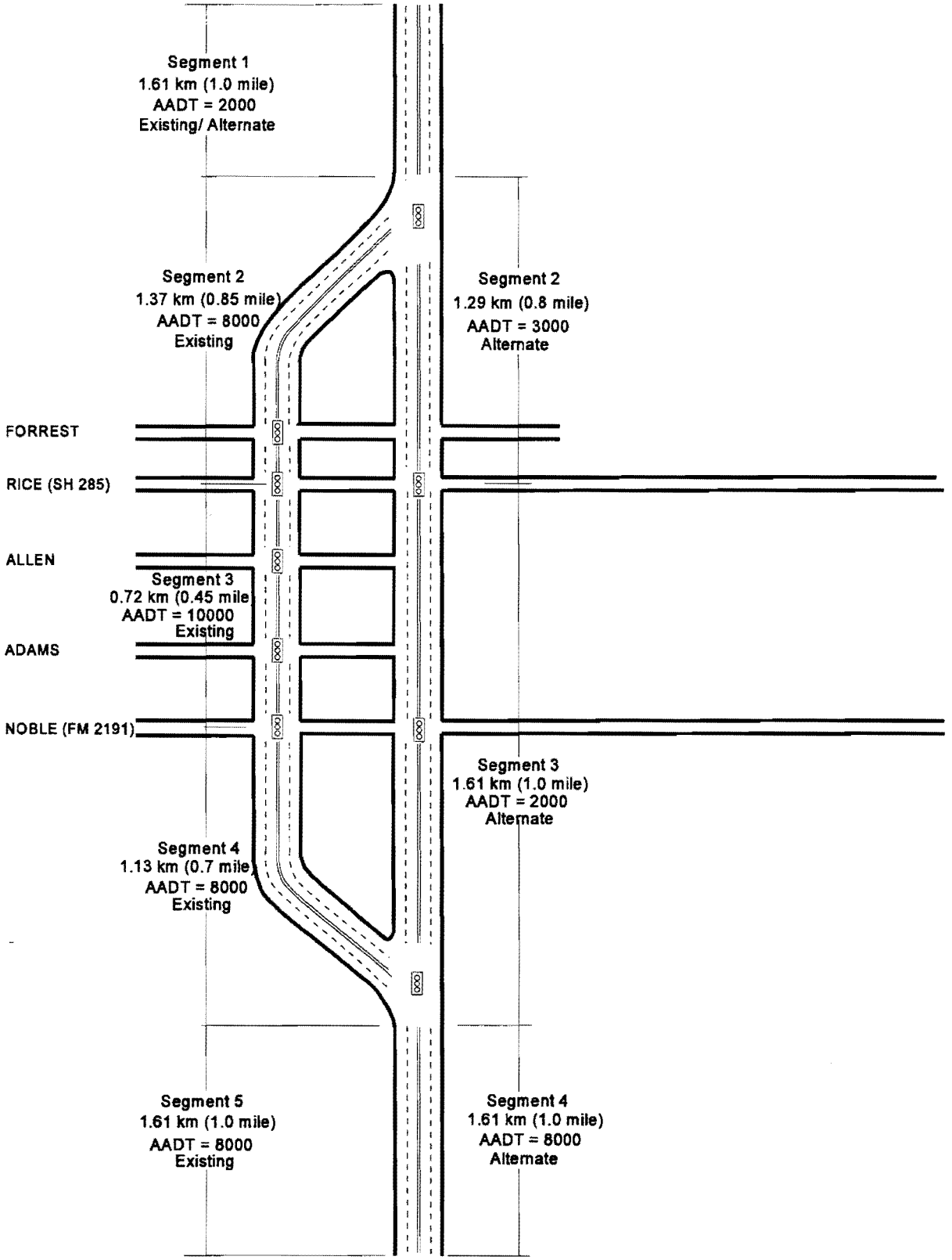


**Figure 8. Proposed Geometry - Railroad Street**
(Assumed Completion Date 1997)

**Table 12. Existing Route Data--Expanded Railroad Street**

| Segment Number | Segment Length, km. (miles) | Local AADT[1] (veh/day) | Thru AADT[1] (veh/day) | Average Speed, kph. (mph) | Number of Signals |
|---|---|---|---|---|---|
| 1 | 1.61 (1.00) | 2,700 | 5,000 | 64 (40) | 0 |
| 2 | 1.29 (0.80) | 4,100 | 5,000 | 56 (35) | 2 |
| 3 | 1.61 (1.00) | 2,700 | 5,000 | 56 (35) | 2 |
| 4 | 1.61 (1.00) | 11,000 | 5,000 | 64 (40) | 0 |
| **TOTALS** | 6.12 (3.80) | -- | -- | -- | 4 |

[1]Base year assumed to be 2003.

**Table 13. Alternate Route Data--Existing U.S. 281**

| Segment Number | Segment Length, km. (miles) | Local AADT[1] (veh/day) | Thru AADT[1] (veh/day) | Average Speed, kph. (mph) | Number of Signals |
|---|---|---|---|---|---|
| 1 | 1.61 (1.00) | 2,700 | 500 | 64 (40) | 2 |
| 2 | 1.37 (0.85) | 11,000 | 500 | 56 (35) | 2 |
| 3 | 0.72 (0.45) | 14,000 | 500 | 48 (30) | 3 |
| 4 | 1.13 (0.70) | 11,000 | 500 | 56 (35) | 0 |
| 5 | 1.61 (1.00) | 11,000 | 500 | 64 (40) | 0 |
| **TOTALS** | 6.44 (4.00) | -- | -- | -- | 7 |

[1]Base year assumed to be 2003.

The proposed U.S. 281 congestion-relief route was assumed to be a 7.2-kilometer (4.5-mile), four-lane facility with a grade separation north and south of Falfurrias connecting it to Business 281 and two additional grade-separated interchanges located in between. This project was assumed to be a two-year project complete in 2005 at an approximate cost of $15 million. An initial through average annual daily traffic (AADT) of 6,000 vehicles per day and 10 percent truck traffic were assumed for the facility. Figure 9 illustrates the proposed bypass segments.

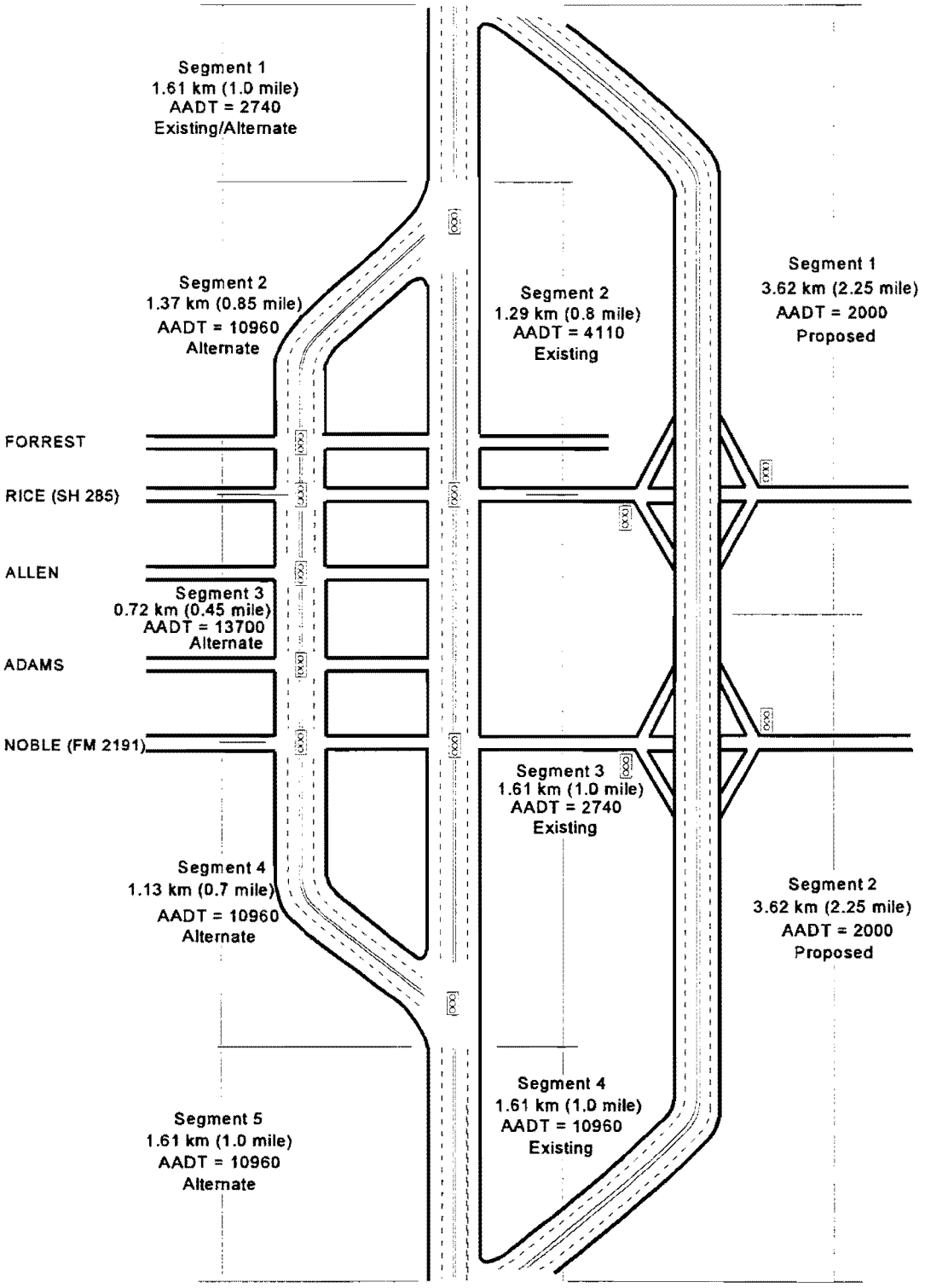


**Figure 9. Proposed Geometry - Congestion-Relief Route**
(Assumed Completion Date 2005)

Other proposed route data are shown in Table 14. The results of the economic assessment of the total user costs and benefits for the Falfurrias congestion-relief route project in 10 years showed a benefit-cost ratio of 5:1.

**Table 14. Proposed Route Data--U.S. 281 Congestion-Relief Route**

| Segment Number | Segment Length, km. (miles) | Local AADT[1] (veh/day) | Thru AADT[1] (veh/day) | Average Speed, kph. (mph) | Number of Interchanges |
|---|---|---|---|---|---|
| 1 | 3.62 (2.25) | 2,000 | 6,000 | 89 (55) | 2 |
| 2 | 3.62 (2.25) | 2,000 | 6,000 | 89 (55) | 2 |
| **TOTALS** | 7.24 (4.50) | -- | -- | -- | 4 |

[1]Base year assumed to be 2003.

For a city the size of Falfurrias (approximately 10,000 people), a common concern of constructing a congestion-relief route is the impact on the local economy. If diversion of a significant amount of traffic (to an alternative route) which frequently utilizes local merchants located along the existing through route occurs, a congestion-relief route may not be feasible due to adverse economic impacts. Therefore, a travel time study was done to determine what percentage of the through traffic on U.S. 281 is currently stopping at businesses located within Falfurrias.

For the travel time study, license tags and times were recorded for vehicles on the north and south ends of Falfurrias during the morning (7:00 a.m. to 9:00 a.m.) and evening (4:00 p.m. to 6:00 p.m.) peak periods for two days during the week. For practical purposes, a trip less than 10 minutes was assumed to be a non-stop trip, while trips more than 10 minutes in length were assumed to be trips with stops in Falfurrias.

Analysis of the travel time data showed a total of 678 through trips for the two morning and evening peak periods. Of the 678 through trips, 533 (79 percent) took less

than 10 minutes, with an average trip length of 4.5 minutes. The remaining 21 percent of the trips took longer than 10 minutes, with an average trip length of 22 minutes.

These results indicate that only about 20 percent of the through traffic in Falfurrias is actually stopping, and those that do stop are only doing so for a short period of time. Thus, the majority of the current business which would have a significant economic impact appears to be local in nature. Further, those that are currently stopping in Falfurrias will probably continue to do so with a congestion-relief route in place. The distance separating Falfurrias and the nearest city offering similar products or services is approximately 64 kilometers (40 miles) in the northbound direction to 97 kilometers (60 miles) in the southbound direction. These geographic characteristics, combined with the fact that the proposed location of the congestion-relief route is within a mile of existing U.S. 281, makes it very unlikely that a significant adverse economic impact would result from the construction of a congestion-relief route. Past experience with towns of similar size indicates that relief routes located in close proximity to existing business activity (along a current/historical route) have minimal adverse economic impacts.

# VI. CONCLUSIONS AND RECOMMENDATIONS

A comprehensive delay study of Falfurrias assessed the existing and projected operations of the five signalized intersections along U.S. 281. The results of the study showed a delay reduction, based on signal timing and geometric improvements (to existing U.S. 281) alone, with a corresponding discounted 20-year delay benefit of approximately $0.6 million during the peak hours of the day alone.

The study also found that significant safety benefits could be gained by improving existing operations in Falfurrias. Assuming the implementation of the proposed signal and geometric improvements (including the extension of Railroad Street and construction of the congestion-relief route) these benefits would be approximately $41 million. In addition, a study of the trip patterns through Falfurrias indicated that any significant adverse economic impacts are unlikely.

Because several other sources of benefits are quantifiable, a more comprehensive assessment of two improvement alternatives (short-term and long-term) was also performed using the MicroBENCOST program. This assessment included not only delay benefits, but also vehicle operating and accident reduction benefits. The results of the MicroBENCOST analyses showed a benefit-cost ratio of 8:1 for the Railroad Street expansion project (assumed to be complete by 1997) and a benefit-cost ratio of 5:1 for the congestion-relief route project (assumed to be complete by 2005).

Based upon the results of this analysis, it is recommended that immediate signal timing and minor geometric improvements be made along existing U.S. 281 in Falfurrias. At a minimum, left-turn bays should be provided along U.S. 281 at all signalized intersections except SH 285 to separate left-turning traffic from through traffic. These

improvements will not only reduce delay to through traffic, but will increase safety through the city until short-term improvements can be made to Railroad Street.

Additionally, it is recommended that SH 285 be restriped east of U.S. 281 to allow for two lanes in each direction. The current geometry includes one lane in each direction and side-of-street parking. By simply removing some of the parking on each side, an additional travel lane can be created in each direction. Functionally, the extra lane would provide capacity (which will be required given the anticipated traffic growth) and it would provide for the storage of left-turning vehicles so that they do not block through and right-turning vehicles from reaching the intersection.

The expansion and widening of Railroad Street through Falfurrias appears to be a cost-effective short-term solution to removing through traffic from existing U.S. 281 in Falfurrias. This expanded facility will provide a safer and more efficient route for through traffic by separating it from the existing local traffic on U.S. 281.

Finally, a U.S. 281 congestion-relief route around Falfurrias appears to be a cost-effective long-term solution for the traffic problems in Falfurrias. In 10 years, problems will have risen to a level that would be better handled by a limited-access facility such as the proposed relief route. By providing a freeway facility around Falfurrias by 2005, safe and efficient travel can be maintained in Falfurrias.