TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
TxDOT/TTI 0258-1		

4. Title and Subtitle	5. Report Date
Benefits of the Texas Traffic Light Synchronization (TLS) Grant Program I: Volume I. Executive Summary and Appendices A-D	October 1992
	6. Performing Organization Code
7. Author (s)	8. Performing Organization Report No.
Daniel B. Fambro, Carlos A. Lopez, and Srinivasa R. Sunkari	
9. Performing Organization Name and Address	10. Work Unit No.
Texas Transportation Institute Texas A&M University College Station, Texas 77843-3135	11. Contract or Grant No. Contract No. IAC(92-93)0029
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
The Texas Department of Transportation Division of Maintenance and Operations 125 East 11th Street, File D-18 Austin, Texas 78701-2483	Final - June 1989 October 1992
	14. Sponsoring Agency Code

15. Supplementary Notes

Program Title: Texas Traffic Light Synchronization (TLS) Grant Program I
This program was conducted in cooperation with the Texas Governor's Energy Office and the U.S. Department of Energy.

16. Abstract

The Texas Department of Transportation (TxDOT) was the administering agency for the Traffic Light Synchronization (TLS) Program, which was funded with Oil Overcharge funds made available by the Governor's Energy Office. The TLS Program was approved by the United States Department of Energy (DOE) as part of a package of transportation related programs with the objective of reducing energy consumption. This grant program provided the sum of $5.2 million to local city governments across the state for the optimization of traffic signal timing plans and the replacement of outdated signal controller equipment. As stated previously, the program's objective was to reduce traffic congestion and facilitate the flow of traffic, with the goal of achieving more efficient use of energy resources.

With 166 completed projects, the TLS Program has seen results that will pay for the cost of the program many times over. These results were estimated from the required "Before" and "After" studies that were submitted by the cities. These studies document the major goals of the TLS Program -- reductions in fuel consumption and unnecesary delay and stops. All projects were evaluated using the same unit costs. The TLS Program resulted in 2,243 signals in 44 cities being retimed; the expenditure of $7.9 million of program funds and local matches; and annual reductions in fuel consumptions, delay, and stops of 9.1 percent (30 million gallons), 24.6 percent (43 million hours), and 14.2 percent (1.7 billion stops), respectively. The total savings to the public in the form of reduced fuel, delay, and stops will be approximately $485 million in the next year alone. In regard to fuel savings, Texas motorists are realizing $3.81 in savings for every dollar spent, and if stops and delay are included, Texas motorists are realizing $62 in savings for every dollar spent. These savings will continue to accrue in future years without any additional expenditures; therefore, the benefits to the public will be even greater.

This report is in three volumes. The other volumes are:
Benefits of the Texas Traffic Light Synchronization (TLS) Grant Program I: Volume II. Appendix E
Benefits of the Texas Traffic Light Synchronization (TLS) Grant Program I: Volume III. Appendices F and G

17. Key Words	18. Distribution Statement
Traffic Signal Improvements, Fuel Consumption, Traffic Signal Retiming, PASSER, TRANSYT	No restrictions. This document is available to the public through the National Technical Information Service, 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	76	

Form DOT F 1700.7 (8-69)

BENEFITS OF THE TEXAS TRAFFIC LIGHT SYNCHRONIZATION (TLS) GRANT PROGRAM I

VOLUME I. EXECUTIVE SUMMARY AND APPENDICES A - D

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Report No: 0258-1
Contract No. IAC(92-93)0029
Program Title: Traffic Light Synchronization (TLS)
Grant Program I

Sponsored by
The Texas Department of Transportation
and
The Texas Governor's Energy Office

October 1992

Texas Transportation Institute
Texas A&M University
College Station, Texas 77843-3135

METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	2.54	centimetres	cm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
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ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
MASS (weight)				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3

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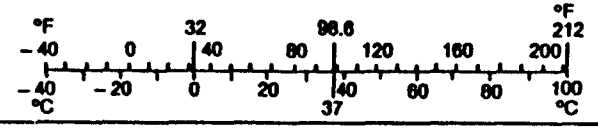

These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

ABSTRACT

The Texas Department of Transportation (TxDOT) was the administering agency for the Traffic Light Synchronization (TLS) Program, which was funded with Oil Overcharge funds made available by the Governor's Energy Office. The TLS Program was approved by the United States Department of Energy (DOE) as part of a package of transportation-related programs with the objective of reducing energy consumption. This grant program provided the sum of $5.2 million to local city governments across the state for the optimization of traffic signal timing plans and the replacement of outdated signal controller equipment. As stated previously, the program's objective was to reduce traffic congestion and facilitate the flow of traffic, with the goal of achieving more efficient use of energy resources.

With 166 completed projects, the TLS Program has resulted in benefits that will pay for the cost of the program many times over. These benefits were estimated from the required ""Before" and "After" studies that were submitted by the cities. These studies document the major goals of the TLS Program -- reductions in fuel consumption and unnecessary delay and stops. All projects were evaluated using the same unit costs. The TLS Program resulted in 2,243 signals in 44 cities being retimed; the expenditure of $7.9 million of program funds and local matches; and annual reductions in fuel consumption, delay, and stops of 9.1 percent (30 million gallons), 24.6 percent (43 million hours), and 14.2 percent (1.7 billion stops), respectively. The total savings to the public in the form of reduced fuel, delay, and stops will be approximately $485 million in the next year alone. In regard to fuel savings, Texas motorists are realizing $3.81 in savings for every dollar spent, and if stops and delay are included, Texas motorists are realizing $62 in savings for every dollar spent. These savings will continue to accrue in future years any without additional expenditures; therefore, the benefits to the public will be even greater.

Besides the intuitive benefits of reducing unnecessary vehicle stops, delays, fuel consumption and emissions, the TLS Program brought together the diverse transportation community of city staffs, consultants, TxDOT personnel and researchers to improve traffic operations at the state's signalized intersections. The program also has increased the signal timing expertise of transportation professionals in Texas and created a traffic data base that can be used for additional transportation projects. Most importantly, perhaps, the TLS Program has enhanced the image of the transportation professional by improving of quality of traffic flow on arterial streets in Texas, and is helping to change the driver perspective of always stopping at a "red" light to going at a "green" light.

ACKNOWLEDGEMENTS

The results reported herein were accomplished as a result of a program entitled "Traffic Light Synchronization (TLS) Grant Program I." The program was administered by the Texas Department of Transportation and sponsored by the Governor's Energy Office in cooperation with the U.S. Department of Energy. Training and technical assistance for the program were provided by the Texas Transportation Institute and Texas Engineering Extension Service at Texas A&M University and the McTrans Center at the University of Florida. Program managers/supervisors were Mr. Robert L. Otto, P.E., with the Governor's Energy Office, Mr. Carlos A. Lopez, P.E., with the Texas Department of Transportation and Dr. Daniel B. Fambro, P.E., with the Texas Transportation Institute. The authors wish to acknowledge the contributions of the many people that helped make this program a success.

The Texas Department of Transportation secured the funding, prepared the grant manual, and were responsible for all contractual and administrative matters. TxDOT staff members making significant contributions to the TLS Program include:

Mr. Ron Barnes	Mr. Victor J. Holubec	Ms. Cindy Metzler
Mr. Byron C. Blaschke	Ms. Anna M. Isbell	Mr. Henry A. Thomason
Ms. Connie Bohuslav	Mr. Ernest W. Kanak	Mr. Gary K. Trietsch
Mr. Herman Haenel	Mr. Michael J. McAndrew	Mr. Roger G. Welsch
Mr. Bob G. Hodge	Mr. Wilbur Mehaffey	Ms. Brenda Yocum

The training manuals, related materials, and documentation of benefits were prepared by the Texas Transportation Institute and Texas Engineering Extension Service at Texas A&M University, and the McTrans Center at the University of Florida. Staff members from these organizations that made significant contributions to the TLS Program include:

Ms. Laura L. Arabie	Mr. Gilmer D. Gaston	Mr. Srinivas M. Sangineni
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DISCLAIMER

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CHAPTER ONE

INTRODUCTION

It has been estimated that approximately one-fifth of the total daily U.S. oil consumption is used by vehicles traveling in urban areas through signalized intersections. A significant portion of this consumption is wasted due to poor signal timing. In street networks with poorly timed traffic signals, the fuel consumed by vehicles stopping and idling at traffic signals accounts for approximately 40 percent of network-wide vehicular fuel consumption. Improving traffic signal timing improves the quality of traffic flow 24 hours per day, 7 days per week with no sacrifice required on the part of the individual driver. Driving is made faster and easier for all cars, trucks, and buses using the street system (1).

It also has been estimated that of the approximately 240,000 urban signalized intersections in the United States, 148,000 need upgrading of physical equipment and signal timing optimization, while another 30,000 are in need of signal timing optimization only. These types of improvements generally provide noticeable improvements in traffic flow on arterial streets for relatively small costs (2). For example, past projects have reported benefit/cost ratios between 20 to 1 and 30 to 1 (1). More significantly, however, an average of 10 gallons of fuel was saved for each dollar that was spent on signal retiming projects. Signal timing optimization projects are extraordinary cost effective - saving an estimated 20 to 30 gallons of fuel for each project dollar invested; i.e., only about 4 cents in project costs for each gallon saved (3).

In recognition of these potential savings and as a result of the Oil Overcharge Restitutionary Act, the Texas Department of Transportation (TxDOT) in conjunction with the Governor's Energy Office secured funding and developed the Texas Traffic Light Synchronization (TLS) Program for retiming traffic signals and replacing outdated equipment on city streets. The objective of this program was to reduce traffic congestion and facilitate the flow of traffic, with the goal of achieving more efficient use of energy resources. The objective was accomplished by:

1. Selecting projects and administering grants;
2. Training local staff/consultants in the use of computer technology for timing traffic signals;
3. Providing technical assistance in the use of computer models;
4. Providing technical assistance in collecting data and retiming signals; and
5. Providing for the replacement of outdated equipment.

The following sections describe the Texas TLS Program in greater detail.

Program Description

The Texas Department of Transportation (TxDOT) was the administering agency for the Traffic Light Synchronization (TLS) Program, which was funded with Oil Overcharge funds made available by the Governor's Energy Office. The TLS Program was approved by the United States Department of Energy (DOE) as part of a package of transportation-related programs with the objective of reducing energy consumption. This grant program provided the sum of $5.2 million to local city governments across the state for the optimization of traffic signal timing plans and the replacement of outdated signal controller equipment. As stated previously, the program's objective was to reduce traffic congestion and facilitate the flow of traffic, with the goal of achieving more efficient use of energy resources.

Besides the intuitive benefits of reducing unnecessary vehicle stops, delays, fuel consumption and emissions, the TLS program brought together the diverse transportation community of city staffs, consultants, TxDOT personnel and researchers to improve traffic operations at the state's signalized intersections. The program also has increased the signal timing expertise of transportation professionals in Texas and created a traffic data base that can be used for additional transportation projects. Most importantly, perhaps, the TLS Program has enhanced the image of the transportation profession by improving of quality of traffic flow, and helping to change the driver's perspective of always stopping at a "red" light to going at a "green" light.

Funding Distribution

TLS funds were expended through contracts administered by TxDOT on signal retiming projects proposed by local city governments. There were three major funding categories: large cities (cities with populations over 200,000), medium-sized cities (cities with populations ranging between 50,000 and 200,000), and small cities (cities with populations under 50,000). The approved program of work is shown in Table 1 - 44 cities, 166 arterial and network signal system projects, and 2,243 of the state's approximately 13,000 traffic signals.

Fifty percent of available funds were expended in large cities, with each of the eight Texas cities presently over 200,000 population assigned an allotment proportional to its population; 17 medium and 19 small cities received 35 percent and 15 percent, respectively, of available funds. This distribution of funds helped to achieve one of the goals of the TLS program -- a widespread, geographic distribution of funds which allowed indirect restitution to a large segment of the population that was overcharged by the oil companies.

Selection Criteria

Projects were recommended for funding using the following criteria, which was developed by an advisory panel composed of local government officials and TxDOT personnel:

1. **Operational Characteristics of the Traffic Signal System** - operational characteristics such as delay, average travel speed, average daily traffic, etc., were considered to determine the amount of benefit improved signal timing could produce.

2. **Availability of Local Staff to Implement Timing Plans** - having local staff available allows the knowledge gained through the required technical training to be retained and encourages future retiming efforts to be undertaken by local city governments.

3. **Average Signal Spacing** - the greater the concentration of signals, the more important synchronization and optimal signal timing become. A signal must have been no further than one mile from an adjacent signal for it to be considered part of a signal system.

4. **Other Criteria such as Recent Growth in the Project Area, Date of Last Retiming Effort, Level of Expansion Over Current Effort, and Certification that TLS Funds will supplement and not Supplant Existing Funds** - this criteria aided in determining where the need for TLS funds was greatest and where maximum benefit could be achieved.

Table 1. Traffic Light Synchronization Program of Work

Funding Category	Cities	Systems	Signals
Large Cities	8	102	1,487
Medium Cities	17	38	523
Small Cities	19	26	233
Totals	44	166	2,243

Reimbursement Guidelines and Eligibility

Up to 75 percent of project costs were eligible for reimbursement. If a project was funded, the local government or TxDOT paid a minimum 25 percent of the total direct costs of the project in matching funds and/or in-kind services. TxDOT provided a local match when a project contained traffic signals that were maintained and operated by TxDOT, unless the local government and TxDOT agreed otherwise.

Costs eligible for reimbursement under the program included training local staff and/or consultants in the use of computer technology for the retiming of traffic signals; providing technical assistance in the use of computer models; providing technical assistance in collecting data and retiming of signals; and replacing outdated signal controller equipment. TLS Program funds could not be used to supplant or replace existing funds earmarked for specific signal retiming projects. That is, if existing funds were authorized for signal retiming expenditures, those funds could not be released and then replaced by TLS funds.

The TLS Program targeted traffic control systems (four signals minimum) currently coordinated and/or controlled in a manner that permitted implementation of multiple coordinated timing plans; i.e., timing plans that match traffic needs at different times of day. By focusing on traffic signal systems that currently have coordination capabilities, maximum energy savings could be realized with the available funds.

Signal systems included in the program ranged from those with sophisticated computer-controlled units to fixed-time electromechanical dial units. Many projects coordinated signals that were not presently a part of a coordinated system. Coordination is being supplied to previously isolated intersections by time-based (as opposed to hard-wire interconnect) methods. Signal controller equipment being purchased through a TLS project was, in general, either providing for coordination of a previously uncoordinated group of signals, adding signals to a currently coordinated system, or providing optimum signal timing capabilities.

Training and Technical Assistance

One of the program's major objectives was to train local staff in the use of the PASSER II, PASSER III, and TRANSYT-7F signal timing computer models to facilitate ongoing maintenance of efficient timing plans. Local governments awarded a grant were required to have local project staff and/or their consultant attend specialized training workshops that were offered at the onset of the program. TxDOT secured the services of the Texas Transportation Institute (TTI) to provide computer model training and technical assistance to cities during project development. The McTrans Center at the University of Florida and the Texas Engineering Extension Service (TEEX) at Texas A&M University assisted TTI in the computer model training phase of the program. TTI also provided in-depth analysis of "Before" and "After" studies submitted by cities and prepared the Final Report for submission to the Governor's Energy Office documenting reductions in fuel consumption, stops and delay accomplished as a result of the TLS Program.

Seven training courses (4 PASSER, 3 TRANSYT) were offered through the TLS Program. Through these courses, 108 transportation professionals were trained (listing shown in Appendix A). Also, each of the participating cities were furnished copies of the PASSER and TRANSYT computer software. This training of city, consultant and TxDOT personnel helped achieve another TLS goal - providing statewide expertise in signal retiming techniques so that these efforts can continue long after the last TLS dollar is spent.

TLS General Facts

The following general facts relate to the TLS Program:

o	Program Cost:	$7,889,879
o	Date Started:	June 28, 1989 - Request for Proposals issued; November 22, 1989 - TxDOT Commission approves Program of Work.
o	Number of Cities Participating:	44 (8 large, 17 medium, 19 small - listing and funding amounts shown in Appendix B)
o	Population of Participating Cities:	7,731,361
o	Number of Projects:	148 of the 152 projects submitted were funded. The four projects not selected were projects submitted by large cities which had already received their allotment.
o	Number of Signal Systems:	166
o	Number of Signals Retimed:	2,243 (2,328 city, 106 state); this total represents approximately 1/6 of all the signals in the state.
o	Date Completed:	October 30, 1992 - Final Report submitted to TxDOT and the Governor's Office.

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CHAPTER TWO

RESULTS

As mentioned in Chapter One, previous traffic signal retiming projects have reported benefit/cost ratios of 20 to 1 to 30 to 1 and an average fuel savings of approximately 10 gallons per dollar spent (1). It should be noted that ultraconservative values for time were used in computing these benefits, and if more realistic values had been used, the resultant benefit/cost ratios would have been much greater. The two signal retiming programs cited most often in the literature are the Federal Highway Administration's (FHWA's) National Signal Timing Optimization Project (1) and California's FETSIM (Fuel Efficient Traffic Signal Management) Program (3). In both programs, TRANSYT-7F was used to estimate motorist benefits as the hourly difference in fuel consumption and delay between the before and after retiming conditions. These differences were converted to annual differences and then multiplied by unit costs for fuel consumption and vehicular delay to obtain an estimate of annual benefits. The estimated improvements were validated with arterial travel time data from field studies during the before and after conditions. The same procedure for estimating benefits was followed in the TLS Program.

The benefits from the FETSIM Program (3) through 1988 were substantial - with an average first year reduction of 14 percent in stops and delay, 7.5 percent in travel time, and 8.1 percent in fuel use. Reductions in fuel usage in the first year were four times the program cost, and the first year benefit to cost ratio was 16 to 1. The state cost per signal, including retiming, training, and technical assistance was approximately $1,500 per intersection. Similar to the TLS Program, expenditures were allowed for all aspects of signal timing: data collection, data processing, timing plan development, implementation, and field evaluation. Unlike the TLS Program, however, expenditures were not allowed for replacing outdated equipment. Thus, the state cost per signal in the TLS Program will probably be slightly higher than in the FETSIM Program.

The preceding discussion demonstrates the range of benefits that have been obtained from other signal retiming projects, and serves as a basis for comparison for the TLS Program. The following sections describe the results of the TLS Program in more detail and compare those results to other signal retiming programs.

Program Results

With 166 projects completed, the TLS Program has seen results that will pay for the cost of the program many times over. These results were estimated from the required "Before" and "After" studies that were submitted by the cities. These studies document the major goals of the TLS program - reductions in fuel consumption and unnecessary delay and stops. All projects

were evaluated using the same unit costs. The cost for fuel was based on current prices ($1.00 per gallon) and costs for delay and stops were based on values suggested by AASHTO ($10 per vehicle-hour of delay and 1.4 cents per stop). A summary of the results as of August 1992 follows:

- 166 projects completed;
- 2,243 signals in 44 cities have been retimed;
- Approximately $7.9 million of program funds and local matches have been expended (several cities expended more than the required local match);
- 30 million gallons of fuel will be saved within the next year alone;
- In fuel savings alone, Texas motorists are realizing $3.81 in savings for every program dollar spent;
- Reductions in fuel consumption, delay, and stops were 9.1, 24.6, and 14.2 percent, respectively;
- The total savings to the public in the form of reduced fuel, delay and stops will be approximately $485 million within the next year alone; and
- TLS Program benefit to cost (b/c) ratio is 62 to 1; in other words, Texas motorists are realizing $62 in savings for every program dollar spent.

The expected benefits during the first year after implementation of the signal timing improvements are summarized in Table 2. As expected, the bulk of the benefits occurred in the large cities where population and traffic volumes are highest. Note, however, that substantial benefits also occurred in the medium and small cities, and that the average benefit to cost ratio for projects in small cities was 65 to 1.

Table 2. TLS Program Annual Benefits

	Stops	Delay	Fuel	Savings	Cost
Large Cities	1,283,099,850	30,621,657	22,180,341	346,360,309	2,885,302
Medium Cities	239,633,625	6,926,004	4,491,237	77,106,148	4,032,313
Small Cities	198,936,150	5,696,696	3,409,146	63,171,212	972,264
Total	1,721,669,625	43,245,357	30,080,724	486,637,668	7,889,879

Annual Benefits

The annual benefits estimated for each project were calculated on the basis of a 300-day year and a 10- to 15-hour day, depending on local traffic conditions. These hour per day values were used in order **not** to claim benefits when traffic volumes were low; i.e, retiming probably will not benefit weekend or late night traffic. In other words, an intentional effort was made to **not** overestimate benefits. Furthermore, field data from the required "Before" and "After" arterial travel time runs were used to verify the benefits that were being estimated. These travel time improvements should have been comparable to the fuel, delay, and stop reductions. For example, in four City of Austin projects, travel time was reduced by an average of one to two minutes on each arterial street, and in one City of Austin project, travel time was reduced by 5½ minutes (62 percent of the before travel time).

Annual benefits and changes in measures of effectiveness are illustrated in Tables 3 and 4 for each of the 44 cities in the program. Note that the bulk of the benefits were in the large city category; however, significant benefits also occurred in the medium and small city categories. Given that higher traffic volumes are generally found in the larger cities, this result was expected. When interpreting this table, one should not try to compare between cities, as the number of retimed signals and the types of projects varied greatly between the cities. Generally, the more intersections that were retimed, the larger the improvements. For example, Austin retimed 271 intersections whereas Corpus Christi only retimed 18 intersections. As expected, the savings in Austin were greater than the savings in Corpus Christi. The percentage improvement in stops, delay, and fuel consumption in Corpus Christi, however, was comparable to that in Austin.

Type of signal retiming project also had an impact on the estimated benefits. Generally, coordinating a previously uncoordinated system resulted in large improvements. Midland and Temple are examples of cities with projects of this type. Also, projects that involved the purchase of new hardware or arterial streets with relatively low traffic volumes resulted in low benefit to cost ratios. Corpus Christi is an example of a city with projects involving new equipment purchases, and Mineral Wells and Taylor are examples of cities with low traffic volumes. Finally, note that there were five cities with projects that resulted in increases in fuel consumption. With the exception of Lubbock, these increases were a result of increases in side street delay in order to provide better flow along the arterial. These increases in fuel consumption were negligible, in the range of one to two percent, and in all four cities, decreases in stops and delay on the arterial streets produced positive benefit to cost ratios. In the case of Lubbock, the increase in fuel consumption was the result of a major construction project within the network and significant changes in travel patterns. This project is expected to reduce fuel consumption after the new construction is completed. That date, however, is beyond the ending time for the TLS Program and thus those results were not available for this report.

The cost side of the benefit to cost (b/c) ratios reflect the time spent by local staff in developing and implementing timing plans and the total equipment costs. Even though the equipment installed under a TLS project will most likely last several years, the total equipment costs (not an amortized value) was used in the calculation of the b/c ratios. Furthermore, the

Table 3. Annual Benefits By City

Cities	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	Range of B/C Ratio(s)
Arlington	125	136,872,300	11.2	9,644,700	31.0	6,455,850	17.0	2.64 to 3026.24
Austin	271	335,361,375	16.8	9,210,909	34.3	3,899,370	9.4	32.51 to 971.26
Corpus Christi	18	23,136,225	23.1	407,550	33.2	472,425	18.9	14.79
Dallas	344	163,156,500	13.1	3,223,782	28.0	3,084,111	9.6	2.95 to 244.2
El Paso	209	182,115,600	14.1	1,707,312	14.4	4,903,671	13.5	-83.68 to 2030.74
Fort Worth	33	15,786,150	11.8	136,290	15.7	439,335	15.1	3.27 to 23.07
Houston	236	310,164,900	20.1	5,632,314	34.8	1,414,029	4.3	6.97 to 2144.72
San Antonio	251	116,506,800	16.8	658,800	14.8	1,511,550	8.1	5.65 to 186.49
Total	1,487	1,283,099,850	15.6	30,621,657	26.1	22,180,341	9.9	-83.6 to 2144.7
Amarillo	86	4,632,750	2.8	45,039	5.1	17,064	1.0	2.8
Beaumont	33	7,687,800	9.5	343,575	28.4	85,950	4.0	70
Brownsville	35	15,021,600	9.3	191,160	14.1	160,920	6.1	2.49 to 34.67
Denton	7	17,574,600	37.2	185,040	50.2	243,480	26.9	40.95
Galveston	30	2,077,200	3.9	50,910	14.9	46,740	5.5	3.22
Garland	122	77,075,400	13.9	1,061,700	18.3	1,880,493	12.2	3.47 to 8.23
Grand Prairie	14	14,337,600	20.5	2,325,000	64.8	568,200	19.2	8.2 to 9.3
Harlingen	16	3,786,600	7.1	58,440	15.8	3,972	0.5	3.62 to 77.7
Longview	21	5,734,800	9.1	108,240	24.1	(23,040)	-1.4	1.51 to13.8
Lubbock	10	(12,372,300)	-16.5	109,560	18.1	(1,068,330)	-57.2	53
McAllen	15	5,937,600	8.2	104,640	17.9	155,040	12.7	13.31
Midland	16	45,801,150	15.8	1,410,066	37.5	2,007,858	24.3	33.31 to 162.06
Odessa	17	31,844,250	24.6	556,800	31.6	57,300	2.4	102.85
Port Arthur	22	4,345,800	13.2	60,270	21.2	27,510	3.1	13.09
San Angelo	39	8,180,400	7.3	73,704	8.9	127,590	4.6	1.61 to 3.31
Victoria	16	347,400	0.3	135,300	14.6	41,640	1.5	7.04 to 14.91
Waco	24	7,620,975	4.3	106,560	10.1	158,850	5.4	4.21 to 24.59
Total	523	239,633,625	9.3	6,926,004	18.0	4,491,237	5.7	1.5 to 162
Addison	22	13,667,205	11.0	1,571,727	53.4	478,233	12.5	192.83
Brownwood	5	2,086,980	12.7	7,026	7.7	26,376	9.5	3.19
Corsicana	14	9,600	0.2	828	2.3	(735)	-0.9	0.13
Del Rio	6	11,790,000	23.4	155,160	37.5	69,120	5.6	42.72
DeSoto	7	6,097,950	18.6	78,426	31.2	117,195	13.7	17.53
Duncanville	7	173,940	3.5	(1,578)	-3.6	(384)	-0.4	2.06
Euless	6	2,368,650	12.7	130,740	50.9	330,765	37.5	58.61
Highland Park	13	8,676,900	11.1	370,512	28.7	298,683	15.9	50
Hurst	13	2,052,900	4.6	18,627	5.6	8,796	0.7	2.65 to 3.85
Marble Falls	7	8,856,300	28.7	42,000	26.5	116,289	23.0	21.79
Mineral Wells	8	1,623,000	11.7	16,698	18.3	19,458	7.2	5.91
Orange	9	20,170,500	71.5	913,320	96.0	355,998	64.9	313.72
Round Rock	6	7,871,625	23.6	107,955	40.1	144,030	15.7	109.77
San Marcos	24	8,568,600	9.4	1,045,500	41.9	324,000	12.1	261.45
Taylor	9	3,284,100	11.4	1,455	1.2	25,539	5.8	1.41
Temple	41	69,273,975	23.1	895,884	37.2	823,356	10.1	-54.06 to 2660.19
Texarkana	10	3,881,175	7.2	26,916	6.3	18,477	1.6	8.92
University Park	20	15,317,400	6.2	11,100	0.2	(23,100)	-0.4	0.61 to 9.22
West Lake Hills	6	13,165,350	52.6	305,400	62.2	277,050	39.9	31.8
Total	233	198,936,150	16.1	5,697,696	29.3	3,409,146	11.9	-54 to 2660
Grand Total	2,243	1,721,669,625	14.2	43,245,357	24.6	30,080,724	9.1	-83.6 to 2660

Table 4. Annual Change in Measures of Effectiveness

Cities	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal)		Range of B/C Ratio(s)
		Before	After	Before	After	Before	After	
Arlington	125	1,221,810,300	1,084,938,000	31,154,700	21,510,000	38,070,450	31,614,600	2.64 to 3026.24
Austin	271	1,996,068,525	1,660,707,150	26,857,908	17,646,999	41,555,688	37,656,318	32.51 to 971.26
Corpus Christi	18	100,018,050	76,881,825	1,226,100	818,550	2,504,775	2,032,350	14.79
Dallas	344	1,242,564,825	1,079,408,325	11,518,779	8,294,997	32,112,234	29,028,123	2.95 to 244.2
El Paso	209	1,292,736,600	1,110,621,000	11,823,552	10,116,240	36,304,524	31,400,853	-83.68 to 2030.74
Fort Worth	33	133,585,950	117,799,800	866,880	730,590	2,917,707	2,478,372	3.27 to 23.07
Houston	236	1,543,088,100	1,232,923,200	16,167,366	10,535,052	32,782,806	31,368,777	6.97 to 2144.72
San Antonio	251	692,227,500	575,720,700	4,437,300	3,778,500	18,557,100	17,045,550	5.65 to 186.49
Total	1,487	8,222,099,850	6,939,000,000	104,052,585	73,430,928	204,805,284	182,624,943	-83.6 to 2144.7
Amarillo	86	164,040,825	159,408,075	890,664	845,625	1,690,830	1,673,766	2.8
Beaumont	33	80,910,900	73,223,100	1,210,950	867,375	2,137,230	2,051,280	70
Brownsville	35	161,916,600	146,895,000	1,355,700	1,164,540	2,648,040	2,487,120	2.49 to 34.67
Denton	7	47,306,400	29,731,800	368,400	183,360	905,040	661,560	40.95
Galveston	30	53,673,000	51,595,800	341,100	290,190	850,800	804,060	3.22
Garland	122	554,056,200	476,980,800	5,814,300	4,752,600	15,436,800	13,556,307	3.47 to 8.23
Grand Prairie	14	69,883,200	55,545,600	3,589,800	1,264,800	2,962,800	2,394,600	8.2 to 9.3
Harlingen	16	53,686,800	49,900,200	370,800	312,360	849,072	845,100	3.62 to 77.7
Longview	21	63,178,200	57,443,400	450,060	341,820	1,600,620	1,623,660	1.51 to13.8
Lubbock	10	74,838,000	87,210,300	606,330	496,770	1,868,970	2,937,300	53
McAllen	15	72,100,800	66,163,200	586,080	481,440	1,217,040	1,062,000	13.31
Midland	16	290,649,300	244,848,150	3,761,769	2,351,703	8,248,302	6,240,444	33.31 to 162.06
Odessa	17	129,682,200	97,837,950	1,764,300	1,207,500	2,411,550	2,354,250	102.85
Port Arthur	22	32,952,600	28,606,800	284,220	223,950	897,750	870,240	13.09
San Angelo	39	112,082,100	103,901,700	825,642	751,938	2,765,982	2,638,392	1.61 to 3.31
Victoria	16	102,456,600	102,109,200	928,020	792,720	2,752,740	2,711,100	7.04 to 14.91
Waco	24	178,971,000	171,350,025	1,057,425	950,865	2,949,825	2,790,975	4.21 to 24.59
Total	523	2,242,384,725	2,002,751,100	24,205,560	17,279,556	52,193,391	47,702,154	1.5 to 162
Addison	22	124,335,720	110,668,515	2,943,021	1,371,294	3,815,484	3,337,251	192.83
Brownwood	5	16,443,330	14,356,350	91,371	84,345	277,749	251,373	3.19
Corsicana	14	6,387,600	6,378,000	35,454	34,626	79,113	79,848	0.13
Del Rio	6	50,292,900	38,502,900	413,910	258,750	1,242,000	1,172,880	42.72
DeSoto	7	32,713,800	26,615,850	251,625	173,199	855,315	738,120	17.53
Duncanville	7	5,020,650	4,846,710	44,328	45,906	109,389	109,773	2.06
Euless	6	18,715,200	16,346,550	256,665	125,925	880,995	550,230	58.61
Highland Park	13	78,290,400	69,613,500	1,292,715	922,203	1,880,745	1,582,062	50
Hurst	13	44,530,050	42,477,150	333,345	314,718	1,210,947	1,202,151	2.65 to 3.85
Marble Falls	7	30,892,200	22,035,900	158,700	116,700	506,076	389,787	21.79
Mineral Wells	8	13,930,500	12,307,500	91,074	74,376	268,473	249,015	5.91
Orange	9	28,223,100	8,052,600	951,330	38,010	548,613	192,615	313.72
Round Rock	6	33,306,150	25,434,525	269,205	161,250	919,050	775,020	109.77
San Marcos	24	91,518,300	82,949,700	2,496,000	1,450,500	2,682,600	2,358,600	261.45
Taylor	9	28,692,300	25,408,200	124,095	122,640	436,608	411,069	1.41
Temple	41	299,749,050	230,475,075	2,411,394	1,515,510	8,138,850	7,315,494	-54.06 to 2660.19
Texarkana	10	54,096,300	50,215,125	429,660	402,744	1,168,278	1,149,801	8.92
University Park	20	246,297,900	230,980,500	5,389,200	5,378,100	6,042,000	6,065,100	0.61 to 9.22
West Lake Hills	6	25,048,800	11,883,450	491,100	185,700	694,650	417,600	31.8
Total	233	1,228,484,250	1,029,548,100	18,474,192	12,776,496	31,756,935	28,347,789	-54 to 2660
Grand Total	2,243	11,692,968,825	9,971,299,200	146,732,337	103,486,980	288,755,610	258,674,886	-83.6 to 2660

benefits are assumed to last only one year, when in reality some measure of the benefits will be realized over several years. Thus, the true benefits to Texas drivers were probably two to three times greater than the values reported in this report.

Benefits Per Intersection

Annual benefits and changes in measures of effectiveness per intersection are illustrated in Tables 5 and 6 for each of the 44 cities in the program. Note that on the average, more than 13,400 gallons of gasoline (9 percent), 19,200 hours of delay (24 percent), and 760,000 stops (14 percent) per intersection were reduced as a result of this program. The values reported in these tables are somewhat easier to compare between cities and could be used to estimate a range of potential benefits from retiming a certain number of signalized intersections; however, the discrepancy between different traffic volumes and types of projects in each of the participating cities still exists.

Note that the average benefits per intersection are similar for the large and small city categories. The range of benefits per intersection within each city size category, and in some cases, an overlap between categories is primarily a result of different types of projects. For example, coordinating a series of isolated intersections, generally produced greater benefits than retiming an existing system. In other words, how bad or good the before condition was had a great deal to do with the benefits that could be obtained. Benefits for 12 different types of signal retiming project are presented in Appendix C.

Comparison With Other Programs

The estimated benefits from the Texas TLS Program are consistent with those reported by other statewide signal retiming programs. TLS reduced fuel, delay and stops by 9.1, 24.6, and 14 percent, respectively. California's FETSIM Program reduced fuel consumption by 8.1 percent and stops and delay by 14 percent. Texas motorists realized $3.81 in fuel savings for every program dollar spent, whereas California motorists realized $4.00 in fuel savings for every program dollar spent. It should be noted, however, that FETSIM used a slightly higher cost per gallon for fuel in their analysis. In terms of average annual fuel savings per intersection, TLS and North Carolina's Traffic Signal Timing Optimization Program (4) estimated savings per intersection of 13,400 gallons and 13,900 gallons, respectively.

First year benefit to cost ratios were 62 to 1 for TLS and 16 to 1 for FETSIM; however, different delay costs were used by the two programs. Thus, the reported benefit to cost ratios are not easily comparable. Because the benefits of the two programs in terms of percent reductions in fuel, delay, and stops were essentially the same and the costs were higher for TLS because of equipment purchases ($3,500 per intersection in TLS and $1,500 per intersection in FETSIM), the comparable benefit to cost ratios for TLS were probably slightly lower for the TLS Program than they were for FETSIM.

Table 5. Annual Benefits Per Intersection By City

Cities	Number of Intersections	Stops per Intersection	Percent	Delay per Inter. (hrs)	Percent	Fuel Cons. per Inter. (gal)	Percent	Range of B/C Ratio(s)
Arlington	125	1,094,978	11.2	77,158	31.0	51,647	17.0	2.64 to 3026.24
Austin	271	1,237,496	16.8	33,989	34.3	14,389	9.4	32.51 to 971.26
Corpus Christi	18	1,285,346	23.1	22,642	33.2	26,246	18.9	14.79
Dallas	344	474,292	13.1	9,371	28.0	8,965	9.6	2.95 to 244.2
El Paso	209	871,367	14.1	8,169	14.4	23,463	13.5	-83.68 to 2030.74
Fort Worth	33	478,368	11.8	4,130	15.7	13,313	15.1	3.27 to 23.07
Houston	236	1,314,258	20.1	23,866	34.8	5,992	4.3	6.97 to 2144.72
San Antonio	251	464,171	16.8	2,625	14.8	6,022	8.1	5.65 to 186.49
Average		862,878	15.6	20,593	26.1	14,916	9.9	
Amarillo	86	53,869	2.8	524	5.1	198	1.0	2.8
Beaumont	33	232,964	9.5	10,411	28.4	2,605	4.0	70
Brownsville	35	429,189	9.3	5,462	14.1	4,598	6.1	2.49 to 34.67
Denton	7	2,510,657	37.2	26,434	50.2	34,783	26.9	40.95
Galveston	30	69,240	3.9	1,697	14.9	1,558	5.5	3.22
Garland	122	631,766	13.9	8,702	18.3	15,414	12.2	3.47 to 8.23
Grand Prairie	14	1,024,114	20.5	166,071	64.8	40,586	19.2	8.2 to 9.3
Harlingen	16	236,663	7.1	3,653	15.8	248	0.5	3.62 to 77.7
Longview	21	273,086	9.1	5,154	24.1	(1,097)	-1.4	1.51 to13.8
Lubbock	10	(1,237,230)	-16.5	10,956	18.1	(106,833)	-57.2	53
McAllen	15	395,840	8.2	6,976	17.9	10,336	12.7	13.31
Midland	16	2,862,572	15.8	88,129	37.5	125,491	24.3	33.31 to 162.06
Odessa	17	1,873,191	24.6	32,753	31.6	3,371	2.4	102.85
Port Arthur	22	197,536	13.2	2,740	21.2	1,250	3.1	13.09
San Angelo	39	209,754	7.3	1,890	8.9	3,272	4.6	1.61 to 3.31
Victoria	16	21,713	0.3	8,456	14.6	2,603	1.5	7.04 to 14.91
Waco	24	317,541	4.3	4,440	10.1	6,619	5.4	4.21 to 24.59
Average		458,190	9.3	13,243	18.0	8,587	5.7	
Addison	22	621,237	11.0	71,442	53.4	21,738	12.5	192.83
Brownwood	5	417,396	12.7	1,405	7.7	5,275	9.5	3.19
Corsicana	14	686	0.2	59	2.3	(53)	-0.9	0.13
Del Rio	6	1,965,000	23.4	25,860	37.5	11,520	5.6	42.72
DeSoto	7	871,136	18.6	11,204	31.2	16,742	13.7	17.53
Duncanville	7	24,849	3.5	(225)	-3.6	(55)	-0.4	2.06
Euless	6	394,775	12.7	21,790	50.9	55,128	37.5	58.61
Highland Park	13	667,454	11.1	28,501	28.7	22,976	15.9	50
Hurst	13	157,915	4.6	1,433	5.6	677	0.7	2.65 to 3.85
Marble Falls	7	1,265,186	28.7	6,000	26.5	16,613	23.0	21.79
Mineral Wells	8	202,875	11.7	2,087	18.3	2,432	7.2	5.91
Orange	9	2,241,167	71.5	101,480	96.0	39,555	64.9	313.72
Round Rock	6	1,311,938	23.6	17,993	40.1	24,005	15.7	109.77
San Marcos	24	357,025	9.4	43,563	41.9	13,500	12.1	261.45
Taylor	9	364,900	11.4	162	1.2	2,838	5.8	1.41
Temple	41	1,689,609	23.1	21,851	37.2	20,082	10.1	-54.06 to 2660.19
Texarkana	10	388,118	7.2	2,692	6.3	1,848	1.6	8.92
University Park	20	765,870	6.2	555	0.2	(1,155)	-0.4	0.61 to 9.22
West Lake Hills	6	2,194,225	52.6	50,900	62.2	46,175	39.9	31.8
Average		853,803	16.1	24,454	29.3	14,632	11.9	
Overall Mean		767,575	14.2	19,280	24.6	13,411	9.1	

Table 6. Annual Changes in Measures of Effectiveness Per Intersection By City

Cities	Number of Intersections	Stops per Intersection		Delay per Intersection (hrs)		Fuel Cons. per Intersection (gal)		Range of B/C Ratio(s)
		Before	After	Before	After	Before	After	
Arlington	125	9,774,482	8,679,504	249,238	172,080	304,564	252,917	2.64 to 3026.24
Austin	271	7,365,567	6,128,071	99,107	65,118	153,342	138,953	32.51 to 971.26
Corpus Christi	18	5,556,558	4,271,213	68,117	45,475	139,154	112,908	14.79
Dallas	344	3,612,107	3,137,815	33,485	24,113	93,350	84,384	2.95 to 244.2
El Paso	209	6,185,343	5,313,976	56,572	48,403	173,706	150,243	-83.68 to 2030.74
Fort Worth	33	4,048,059	3,569,691	26,269	22,139	88,415	75,102	3.27 to 23.07
Houston	236	6,538,509	5,224,251	68,506	44,640	138,910	132,919	6.97 to 2144.72
San Antonio	251	2,757,878	2,293,708	17,678	15,054	73,933	67,911	5.65 to 186.49
Average		5,529,321	4,666,443	69,975	49,382	137,731	122,814	
Amarillo	86	1,907,451	1,853,582	10,357	9,833	19,661	19,462	2.8
Beaumont	33	2,451,845	2,218,882	36,695	26,284	64,765	62,160	70
Brownsville	35	4,626,189	4,197,000	38,734	33,273	75,658	71,061	2.49 to 34.67
Denton	7	6,758,057	4,247,400	52,629	26,194	129,291	94,509	40.95
Galveston	30	1,789,100	1,719,860	11,370	9,673	28,360	26,802	3.22
Garland	122	4,541,444	3,909,679	47,658	38,956	126,531	111,117	3.47 to 8.23
Grand Prairie	14	4,991,657	3,967,543	256,414	90,343	211,629	171,043	8.2 to 9.3
Harlingen	16	3,355,425	3,118,763	23,175	19,523	53,067	52,819	3.62 to 77.7
Longview	21	3,008,486	2,735,400	21,431	16,277	76,220	77,317	1.51 to13.8
Lubbock	10	7,483,800	8,721,030	60,633	49,677	186,897	293,730	53
McAllen	15	4,806,720	4,410,880	39,072	32,096	81,136	70,800	13.31
Midland	16	18,165,581	15,303,009	235,111	146,981	515,519	390,028	33.31 to 162.06
Odessa	17	7,628,365	5,755,174	103,782	71,029	141,856	138,485	102.85
Port Arthur	22	1,497,845	1,300,309	12,919	10,180	40,807	39,556	13.09
San Angelo	39	2,873,900	2,664,146	21,170	19,280	70,923	67,651	1.61 to 3.31
Victoria	16	6,403,538	6,381,825	58,001	49,545	172,046	169,444	7.04 to 14.91
Waco	24	7,457,125	7,139,584	44,059	39,619	122,909	116,291	4.21 to 24.59
Average		4,287,542	3,829,352	46,282	33,039	99,796	91,209	
Addison	22	5,651,624	5,030,387	133,774	62,332	173,431	151,693	192.83
Brownwood	5	3,288,666	2,871,270	18,274	16,869	55,550	50,275	3.19
Corsicana	14	456,257	455,571	2,532	2,473	5,651	5,703	0.13
Del Rio	6	8,382,150	6,417,150	68,985	43,125	207,000	195,480	42.72
DeSoto	7	4,673,400	3,802,264	35,946	24,743	122,188	105,446	17.53
Duncanville	7	717,236	692,387	6,333	6,558	15,627	15,682	2.06
Euless	6	3,119,200	2,724,425	42,778	20,988	146,833	91,705	58.61
Highland Park	13	6,022,338	5,354,885	99,440	70,939	144,673	121,697	50
Hurst	13	3,425,388	3,267,473	25,642	24,209	93,150	92,473	2.65 to 3.85
Marble Falls	7	4,413,171	3,147,986	22,671	16,671	72,297	55,684	21.79
Mineral Wells	8	1,741,313	1,538,438	11,384	9,297	33,559	31,127	5.91
Orange	9	3,135,900	894,733	105,703	4,223	60,957	21,402	313.72
Round Rock	6	5,551,025	4,239,088	44,868	26,875	153,175	129,170	109.77
San Marcos	24	3,813,263	3,456,238	104,000	60,438	111,775	98,275	261.45
Taylor	9	3,188,033	2,823,133	13,788	13,627	48,512	45,674	1.41
Temple	41	7,310,952	5,621,343	58,814	36,964	198,509	178,427	-54.06 to 2660.19
Texarkana	10	5,409,630	5,021,513	42,966	40,274	116,828	114,980	8.92
University Park	20	12,314,895	11,549,025	269,460	268,905	302,100	303,255	0.61 to 9.22
West Lake Hills	6	4,174,800	1,980,575	81,850	30,950	115,775	69,600	31.8
Average		5,272,465	4,418,661	79,288	54,835	136,296	121,664	
Overall Mean		5,213,094	4,445,519	65,418	46,138	128,736	115,325	

CHAPTER THREE

CONCLUSIONS

The TxDOT experience in administering the TLS Program has been very positive. The working relationship between TxDOT and city transportation professionals has been enhanced and Texas motorists have benefited from improved operation on many arterials. These benefits will extend well beyond the life of the TLS Program. Several cities have received positive press coverage as a result of improvements made through the TLS Program. Sample newspaper articles are included in Appendix D. Partial program results were presented at the 1991 Summer Meeting of the Texas Section of the Institute of Transportation Engineers in Arlington, Texas, during one of the most well attended sessions at the meeting. The results were part of an overall session on TLS which also included perspectives on the program from the consultant, city and TxDOT district office viewpoints. Final program results are being shared with all 44 of the participating cities.

With 166 projects completed, the TLS Program has seen results that will pay for the cost of the program many times over. These results were estimated from the required ""Before" and "After" studies that were submitted by the cities. These studies document the major goals of the TLS Program -- reductions in fuel consumption and unnecessary delay and stops. All projects were evaluated using the same unit costs. The TLS Program resulted in 2,243 signals in 44 cities (166 separate projects) being retimed; the expenditure of $7.9 million of program funds and local matches; and annual reductions in fuel consumption, delay, and stops of 9.1 percent (30 million gallons), 24.6 percent (43 million hours), and 14.2 percent (1.7 billion stops), respectively. Individual project summaries are presented in Appendices E, F, and G.

The total savings to the public in the form of reduced fuel, delay, and stops will be approximately $485 million in the next year alone. In regard to fuel savings, Texas motorists are realizing $3.81 in savings for every dollar spent, and if stops and delay are included, Texas motorists are realizing $62 in savings for every dollar spent. These savings will continue to accrue in future years without any additional expenditures; therefore, the benefits to the public will be even greater.

Benefits besides those that can be given a dollar value have been realized through the TLS Program. The bringing together of the entire transportation community (local, state, and private) to try to reach a common goal has been rewarding. In the area of traffic signal retiming, the technical expertise of more than 100 transportation professionals has been enhanced. The driver perspective of the "stop" light or the "red" light is starting to change to that of the "green" light. In fact, the City of Port Arthur announced the completion of its project by telling its citizens to "think green." And probably best of all, as was experienced by a City of Houston employee who spoke of the program on television, the public is talking about government actually doing something that is **saving** public dollars instead of spending them.

As a result of the success of this program, DOE and the Governor's Energy Office has provided an additional $5 million in Oil Overcharge funds to TxDOT to undertake a second TLS Program. This second program, which will run from January 1992 until August 1993, should allow the benefits of improved signal timing to be realized in more areas of the state.

Overall, the TLS Program has been developed, funded and implemented on a multi-jurisdictional basis (local city governments and state agencies). The program has had a significant visible and positive effect on actual operation on a large part of the transportation system, as well as on the citizens' perception of the system. The direct savings in fuel consumption and delay represents significant increased efficiency, resulting in a more economical transportation system.

REFERENCES

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3. Deakin, E.A., A. Skabardonis, and A.D. May, "Traffic Signal Timing as a Transportation Management Measure: The California Experience," in *Transportation Research Record 1081: Urban Traffic Management*, Transportation Research Board, National Research Council, Washington, D.C. (1986) pp. 59-65.

4. North Carolina Department of Transportation and the Institute for Transportation Research and Education, "North Carolina's Traffic Signal Management Program for Energy Conservation," *ITE Journal* (December 1987) pp. 35-38.

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APPENDIX A

PROGRAM PARTICIPANTS

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TLS Participants Trained in PASSER and/or TRANSYT

- Joe A. Adams
  Signal Technician
  City of Beaumont
- Jim L. Alves
  Planner I
  TxDOT-San Angelo
  Representing the City of Del Rio
- Gary L. Anderson
  City Engineer
  City of Corsicana
- Rajiv K. Arya
  Traffic Designer
  City of Houston
- Kevin N. Balke
  Engineer I
  City of Austin
- Philip M. Ball
  City Engineer
  City of Texarkana
- Mark D. Barnes
  Signal Tech. II
  City of Midland
- Wayne D. Baumbach
  City Electrician
  City of Temple
- Abel Beltran
  Designer
  City of McAllen
- Richard A. Berry
  Project Manager
  DeShazo, Starek & Tang, Inc.
- Lee Bohlen
  Traffic Analyst
  City of Waco
- Keith R. Bonds
  Associate Engineer
  City of Texarkana
- Scott C. Booker
  Engineer
  City of Fort Worth
- Douglas H. Box
  Field Operations Supt.
  City of DeSoto
- Paul M. Boyer
  Asst. City Engineer
  City of Victoria
- Leroy J. Broussard
  Electrical & Paint Supt.
  City of Port Arthur
- Joel E. Brundrett
  Engineer Assistant
  Traffic Engineers, Inc.
- Brian D. Burk
  Engineer Asst.
  TxDOT
  Representing the Cities of Marble Falls, Round Rock, San Marcos, Taylor & West Lake Hills
- Lourdes Cardenas
  Traffic Engineer Assoc. II
  City of El Paso
- Jorge Cervantes
  Traffic Engineering Assoc. I
  City of El Paso

- Larry W. Cervenka
  Asst. Director of Transp.
  City of Garland
- Richard W. Charlton
  Traffic Operations Manager
  City of Waco
- Ted E. Clay
  Engineering Tech. IV
  TxDOT
  Representing the City of Orange
- James C. Cline, Jr.
  Traffic Engineer
  City of Beaumont
- Cary G. Cox
  Electronic Signal Tech.
  City of Odessa
- Thomas J. Cronick
  Acting Division Head
  City of Odessa
- Bill Dake
  Assistant to City Manager
  City of Temple
- Terry J. Dearing
  Signal Tech. III
  City of Midland
- Richard W. Denney, Jr.
  Signal Systems Engineer
  City of San Antonio
- Richard F. Dickinson
  Electrician II
  City of Port Arthur
- Robert A. Dimas
  Engineering Tech.
  City of San Antonio
- Kassem M. Elkhalil
  Engineer Assistant
  City of Dallas
- Eutiquio Flores
  Journey Men (Signals)
  City of McAllen
- Mike A. Flores
  Electrician II
  City of Port Arthur
- Jeff W. Gann
  Traffic Signal Tech.
  City of Denton
- David M. Garcia
  Traffic Supervisor
  City of Brownsville
- Juan F. Garcia
  Engineering Tech.
  City of Austin
- Placido J. Garcia, Jr.
  City Engineer
  City of Brownsville
- Ruben S. Garcia
  Traffic Signal
  City of Brownsville
- Jacob George
  Transportation Planner
  City of Galveston
- David G. Gerard
  Manager Transp. Engeering
  City of Austin
- Donald R. Glenn
  Engineer Asst.
  Traffic Engineers, Inc.
- Don M. Griffin
  Shop Foreman
  Town of Highland Park
- Donald R. Hatcher
  Dir. of P/W City Engineer
  City of Brownwood

- William E. Hensch
  Director
  City of Pasadena
- Victor M. Hernandez
  Senior Clerk
  Representing the City of McAllen
- Mark A. Horelica
  Traffic Engineering Supv.
  City of Beaumont
- John W. Hudson
  President
  Traffic Engineer, Inc.
- Paul C. Hugon
  Engineering Tech. IV
  TxDOT
  Representing the City Orange
- Paul C. Iwuchukwu
  Traffic Engineer
  City of Denton
- Robert W. Jenkins
  Vice President
  Traffic Engineers, Inc.
- Michael W. Jennings
  Electronic Signal Tech.
  City of Odessa
- Andrew Johnston
  City Engineer
  City of Longview
- Rex M. Jones
  Electrician II
  City of Port Arthur
- Ron Kennedy
  Traffic Tech.
  City of Pasadena
- Richard R. Larkins
  Asst. Dir. of Public Works
  City of Grand Prairie
- D. Ray Latham, Jr.
  Draftsman
  City of Corpus Christi
- Jihng-Yuu Jerry Luor
  Traffic Engineer
  City of Arlington
- Janet K. Manley
  Engineer Asst. III
  TxDOT
  Representing the City of Orange
- Teodoro Marquez
  Traffic Engineer IV
  City of El Paso
- Kenneth R. Marshall
  Senior Associate
  Barton-Aschman Associates, Inc.
- J. Mark Mathis
  Engineering Tech. II
  City of Grand Prairie
- Mike T. Mazzola
  Draft Tech.
  City of San Antonio
- Harold A. McDaniel
  Traffic Engineer
  City of Amarillo
- John M. McInturff
  Vice President
  Traffic Engineers, Inc.
- James W. McKanna
  Project Engineer
  City of Euless

- Buddy H. Lackey
  Signal Technician
  City of San Angelo
- Federico J. Mendoza
  Project Manager
  Traffic Engineers, Inc.
- Steven C. Miller
  Asst. Dir. of Public Works
  City of Duncanville
- Charles M. Mitchell
  Signal Technician
  Street Dept.
  Town of Addison
- Carl W. Mock
  Signal System Supervisor
  City of San Angelo
- Samileh Mozafari
  Engineering Assoc. III
  City of Austin
- Ali A. Mozdbar
  Traffic Signal Engineer
  City of Arlington
- Ronald L. Nation
  Traffic Tech.
  City of DeSoto
- Angie M. Ortegon
  Traffic Engineer
  TxDOT
  Representing the City of Del Rio
- Bob Otto
  Transportation Coordinator
  Office of the Governor
- Leslie E. McMahen
  City Engineer
  City of Port Arthur
- Lalo Ramirez
  Designer
  City of McAllen
- David M. Rasco
  Signal Timing Tech.
  City of Fort Worth
- Lee Jane Ream
  Traffic Engineer
  City of Houston
- David E. Redmon
  Engineering Tech.
  City of Beaumont
- George Byron Reeves
  Adm. Asst./Traffic Eng. Tech.
  TxDOT
  Representing the City of Lake Worth
- Gloria E. Rocha
  Area Signal Engineer
  City of Houston
- Daniel A. Rogers
  Engineering Asst. III
  TxDOT
  Representing the Cities of Marble Falls, Round Rock, San Marcos, Taylor, & West Lake Hills
- John W. Roscher
  Supv. Traffic Operations
  City of Austin
- Robert E. Ross
  Lead Traffic Signal Tech.
  City of Austin

- Dorman R. Purdy
  Signal Tech. II
  City of Midland
- John H. Russell
  Traffic Supt.
  City of Longview
- Patrick D. Ryan
  Asst. Traffic Signal Eng.
  City of Dallas
- Jose Sanchez, Jr.
  Traffic Signal Maint. Supv.
  City of Harlingen
- Edward G. Schroeder
  Traffic Signal Supv.
  TxDOT
  Representing the Cities of Marble Falls, Round Rock, San Marcos, Taylor, & West Lake Hills
- David V. Seiler
  City Traffic Engineer
  City of Corpus Christi
- Mary B. Shanks
  Senior Traffic Control Tech.
  City of Odessa
- Brian K. Shewski
  Associate
  Barton-Aschman Associates
- Glen D. Siecko
  Electrician II
  City of Beaumont
- Sergio S. Silva
  Signal Technician
  City of McAllen
- John L. Sodek
  Traffic Analyst
  City of Waco
- Pioquinto A. Ruiz, Jr.
  Traffic Signal System Tech.
  City of Lubbock
- Charles V. Stierhoff
  Traffic System Supv.
  City of Dallas
- John T. Thomson
  Asst. Engineer
  City of Dallas
- David W. Timbrell
  Engineering Asst.
  City of Garland
- Mark A. Titus
  Engineer Assistant
  City of Dallas
- Daniel N. Troxel
  Traffic Signal Tech.
  City of Longview
- Bob E. Whaling
  City Engineer
  City of University Park
- Roy D. Wileman
  Estimator
  City of Houston
- Russ Wiles
  Traffic Engineer
  City of Fort Worth
- Denton Zebrowski
  Sr. Engineering Tech.
  City of Austin
- James B. Sparks
  Civil/Traffic Engineer
  City of Hurst

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APPENDIX B

PROGRAM OF WORK

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TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS Funds)		Local Match		Total Project Cost	Number of Signals Retimed
	1st	2nd	City	State		
LARGE CITIES						
HOUSTON						
WEST ALABAMA	69,753.00		23,665.00		93,418.00	16
WEST BISSONNET	10,985.00		3,662.00		14,647.00	6
EAST BISSONET	74,761.00		24,731.00		99,492.00	11
BROADWAY	30,823.00		10,192.00		41,015.00	7
CULLEN	32,018.00		10,910.00		42,927.00	10
EL DORADO	30,510.00		35,910.00		66,420.00	4
NORTH DURHAM	18,410.00		6,094.00		24,504.00	7
SOUTH DURHAM	4,595.00		1,532.00		6,127.00	4
GESSNER	16,701.00		39,000.00		55,701.00	6
LITTLE YORK	26,151.00		39,000.00		65,151.00	7
MLK/CALHOUN	83,426.00		27,700.00		111,126.00	15
S. SGT. MACARIO GARCIA	6,892.00		2,297.00		9,189.00	6
NORTH BRAESWOOD	26,750.00		8,750.00		35,500.00	8
NORTH SHEPHERD	18,285.00		6,219.00		24,504.00	7
SOUTH SHEPERD	5,743.00		1,914.00		7,657.00	5
WAYSIDE	5,743.00		1,914.00		7,657.00	5
WESTHEIMER	37,742.00		12,797.00		50,539.00	15
WAUGH	6,892.00		2,297.00		9,189.00	6
BELLFORT		46,839.00	15,589.00		62,428.00	13
BRIAR FOREST		11,930.00	3,977.00		15,907.00	12

TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS) Funds		Local Match		Total Project Cost	Number of Signals Retimed
	1st	2nd	City	State		
LARGE CITIES						
HOUSTON						
CAVALCADE		34,664.00	11,254.00		45,918.00	13
WEST ELGIN		39,200.00	12,870.00		52,070.00	16
EAST ELGLILN		28,776.00	9,510.00		38,286.00	7
GRIGGS LONG/PARK PLACE		35,771.00	11,705.00		47,476.00	13
HARRISBURG		28,305.00	9,313.00		37,618.00	12
NORTH JENSON		15,238.00	5,200.00		20,438.00	8
LONG POINT		18,841.00	6,380.00		25,221.00	14
SOUTH BRAESWOOD		14,933.00	4,978.00		19,911.00	13
QUITMAN		12,376.00	4,136.00		16,512.000	9
STELLA LINK		20,414.00	6,819.00		27,233.00	7
TELEPHONE		17,318.00	5,654.00		22,972.00	6
HOUSTON TOTALS	506,180.00	324,605.00	365,968.00		1,196,753.00	288
DALLAS						
VARIOUS SIGNAL SYSTEMS						
OUTSIDE THE CENTRAL						
BUSINESS DISTRICT						
(1 LARGE PROJECT SUBMITTED)	450,000.00		3,528,515.00		3,978,515.00	452
SIGNAL SYSTEMS:						
FERGUSON						16

TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS) Funds		Local Match		Total Project Cost	Number of Signals Retimed
	1st	2nd	City	State		
BUCKNER						39
SCYENE						4
EAST GRAND/HASKELL						18
COLUMBIA/MAIN						21
BUS SYSTEM						47
KINGSLEY/PLANO						9
ABRAMS/SKILLMAN/GREENVILLE						53
MONTFORT						8
LOWER N DALLAS GRID						28
MARSH						6
WALNUT HILL/HARRY HINES/ROYAL						27
OAKLAND						29
COLE/MCKINNEY						17
SYLVAN						6
CORINTH/LAMAR						13
OAK CLIFF AREA						49
HAMPTON						14
WESTMORELAND						5
WEST DAVIS						7
KIEST/POLK						10
MARSALIS						4

TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS Funds)		Local Match		Total Project Cost	Number of Signals Retimed
	1st	2nd	City	State		
LEDBETTER/LANCASTER						17
ILLINOIS/KIEST						5
DALLAS TOTALS	450,000.00		3,528,515.00		3,978,515.00	452
SAN ANTONIO						
WEST SIDE	163,250.72		63,369.13		226,619.85	69
BROADWAY	31,600.90		23,264.86		54,865.76	17
FLORES	10,283.57		13,123.04		23,406.61	23
SAN PEDRO		155,390.25	59,768.51		215,158.76	38
SOUTHEAST		42,591.15	17,033.37		59,624.52	55
BLANCO		7,600.90	5,264.86		12,865.76	17
WALZEM		2,682.67	1,858.19		4,540.86	6
PERRIN-BEITEL		7,600.90	5,264.86		12,865.76	17
WEST		3,576.90	2,477.58		6,054.48	8
SAN ANTONIO TOTALS	205,135.19	219,442.77	191,424.40		616,002.36	250
EL PASO						
MESA-RESLER	10,210.20		3,403.40		13,613.60	20
SUNLAND PARK/SHADOW MT	4, 594.59		1,531.53		6,126.12	9
COTTON	4,594.59		1,531.53		6,126.12	9
PIEDRAS-RAYNOR	6,636.63		2,212.21		8,848.84	13
COPIA-PERSHING	6,126.12		2,042.04		8,168.16	12
EAST MONTANA	4,003.80		1,334.60		5,338.40	5
WEST MONTANA	14,804.79		4,934.93		19,739.72	29

TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS) Funds)		Local Match		Total Project Cost	Number of Signals Retimed
	1st	2nd	City	State		
DYER	4,084.79		1,361.36		5,445.44	8
FRED WILSON/AIRPORT	6,636.63		2,212.21		8,848.84	13
AIRWAY	3,063.06		1,021.02		4,084.08	6
HAWKINS/VISCOUNT	6,636.63		2,212.21		8,848.84	13
MCRAE	4,084.08		1,361.36		5,445.44	8
GATEWAY NORTH AND SOUTH	5,105.10		1,701.70		6,806.80	10
DONIPHAN		3,063.06	1,021.02		4,084.08	6
ALABAMA		3,573.57	1,191.19		4,764.76	7
NORTH DYER		5,615.61	1,871.87		7,487.48	11
MCCOMBS		3,063.06	1,021.02		4,084.08	6
YARBROUGH		3,063.06	1,021.02		4,084.08	6
LEE TREVINO		5,105.10	1,701.70		6,806.80	10
GEORGE DIETER		2,552.55	850		3,403.40	5
ALAMEDA		9,699.69	3,233.23		12,932.92	19
EL PASO TOTALS	80,580.30	35,735.70	38,772.00		155,088.00	225
AUSTIN						
CENTRAL/LAMAR/UT AREA	54,324.00		18,108.00		72,432.00	62
S LAMAR/AUDITORIUM AREA	56,646.00		18,882.00		75,528.00	59
N LAMAR/RUNDBERG/RUTLAND	43,835.25		14,611.75		58,447.00	18
BURNET/BRAKER/KRAMER	22,959.00		7,653.00		30,612.00	11
NORTH LAMAR	12,891.00		4,297.00		17,188.00	9
BURNET/ANDERSON	19,344.75		11,417.25		30,7S62.00	23

TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS) Funds		Local Match		Total Project Cost	Number of Signals Retimed
	1st	2nd	City	State		
CBD		62,231.25	20,743.75		82,975.00	84
CAMERON		39,824.25	13,274.75		53,099.00	10
AUSTIN TOTALS	210,000.00	102,055.50	108,987.50		421,043.00	276
FORT WORTH						
EAST LANCASTER	51,700.35		17,202.36		68,902.71	8
CAMP BOWIE	39,889.15		13,305.56		53,194.71	6
28TH	49,434.25		16,544.45		65,978.70	8
NORTH MAIN	48,948.06		16,314,84		65,262.90	11
FORT WORTH TOTALS	189,971.81		63,367.21		253,339.02	33
CORPUS CHRISTI						
STAPLES	120,000.00		121,448.00		241.448.00	18
ARLINGTON						
COLLINS	31,227.00		10,534.00		41,811.00	23
LAMAR	15,476.00		5,162.00		20,638.00	11
FIELDER	16,876.00		5,662.00		22,538.00	12
DIVISION	18,876.00		6,101.00		24,378.00	14
COOPER	15,476.00		5,162.00		20,638.00	12
RANDOL MILL	2,800.00		960.00		3,760.00	5
MATLOCK	7,077.00		2,384.00		9,461.00	5
PARK ROW	2,741.00		6,720.00		9,461.00	5
DOWNTOWN		15,784.00	5,273.00		21,057.00	12
LITTLE/GREEN OAKS		14,154.00	4,724.00		18,878.00	10

TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS Funds)		Local Match		Total Project Cost	Number of Signals Retimed
	1st	2nd	City	State		
Bowden/Pioneer/Park Row		28,076.00	9,350.00		37,426.00	13
ARLINGTON TOTALS	110,000.00	58,014.00	62,032.00		230,046.00	122
LARGE CITY TOTALS	1,871,867.30	739,852.97	4,480,514.11		7,092,234.38	1664
MEDIUM CITIES						
AMARILLO						
CENTRAL BUSINESS DIST		95,000.00	34,836.00		129,836.00	84
BEAUMONT						
COLLEGE SYSTEM, ETC		65,000.00	39,400.00		104,400.00	30
BROWNSVILLE						
CENTRAL		26,480.61	8,826.87		35,307.48	5
INTERNATIONAL		31,661.54	10,553.85		42,215.39	10
BOCA CHICA		34,922.26	11,640.75		46,563.01	12
PALM		30,050.73	10,016.91		40,067.64	8
BROWNSVILLE TOTALS		123,115.14	41,038.38		164,153.52	35
DENTON						
BELL		37,470.54	12,490.18		49,960.72	9
GALVESTON						
PORT INDUSTRIAL, ETC		93,750.00	31,250.00		125,000.00	45
GARLAND						
SOUTH SUBNETWORK	32,100.00		610,700.00		642,800.00	29
NORTH SYSTEM	39,300.00		813,110.00		852,410.00	40
CENTRAL SYSTEM	48,525.00		816,175.00		864.700.00	43
GARLAND TOTALS	119,925.00		2,239,985.00		2,359,910.00	112

TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS Funds) 1st	2nd	Local Match City	State	Total Project Cost	Number of Signals Retimed
GRAND PRAIRIE						
JEFFERSON/MAIN		81,600.00	109,276.76		190,876.76	14
SH 303		52,500.00	43,127.76		95,627.76	7
GREAT SOUTHWEST		52,500.00	43,127.76		95,627.76	7
GRAND PRAIRIE TOTALS		186,600.00	195,532.28		382,132.28	28
HARLILNGEN						
COMMERCE		15,476.16	5,158.71		20,634.87	7
LOOP 448		6,000.00	2,64.63		8,164.63	5
FIRST		5,140.00	1,679.51		35,619.01	4
HARLINGEN TOTALS		26,616.16	9,002.85		35,619.01	16
LONGVIEW						
JUDSON		22,020.15	7,340.05		29,360.20	4
HIGH		60,962.80	20,320.93		81,283.73	13
MOBERLY		35,986.13	11,995.37		47,981.50	7
LONGVIEW TOTALS		118,969.08	39,656.35		158,625.43	24
LUBBOCK						
SOUTH LOOP 289, ETC		65,000.00	69,741.00		134,741.00	13
MCALLEN						
US 83		82,500.00	27,500.00		110,000.00	15
MIDLAND						
BIG SPRING/GARFIELD	74,104.54		24,701.51		98,806.05	12
MIDKIFF/ANDREWS	93,724.54		31,241.51		223,772.10	16

TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS Funds)		Local Match		Total Project Cost	Number of Signals Retimed
	1st	2nd	City	State		
MIDLAND TOTALS	167,829.08		55,943.02		223,772.10	28
ODESSA						
CENTRAL BUSINESS DISTRICT	44,270.99		14,756.83		59,027.82	39
PASADENA						
RICKEY, ETC	5,350.00		8,739.20		14,089.20	14
PORT ARTHUR						
MEMORIAL/GULFWAY		78,833.33	26,277.78		105,111.11	23
SAN ANGELO						
BRYANT		87,120.64	105,187.76		192,308.40	17
CENTRAL BUSINESS DISTRICT		105,000.00	115,259.80		220,259.80	26
SAN ANGELO TOTALS		192,120.64	220,447.56		412,568.20	43
VICTORIA						
NAVARRO		65,331.27	21,915.50		87.246.77	9
RIO GRANDE/HOUSTON		51,719.92	17,239.97		68,959.89	7
VICTORIA TOTALS		117,051.19	39,155.47		156,206.66	16
WACO						
17TH/18TH		27,750.00	9,250.00		37,000.00	23
WACO DRIVE		34,L887.00	11,629.00		46,516.00	17
25TH/26TH		31,125.00	10,375.00		41,500.00	7
WACO TOTALS		93,762.00	31,254.00		125,016.00	47
MEDIUM CITY TOTALS	333,375.07	1,375,788.08	3,137,005.90		4,850,169.05	621

TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS) Funds)		Local Match		Total Project Cost	Number of Signals Retimed
	1st	2nd	City	State		
SMALL CITIES						
ADDISON						
ENTIRE SIGNAL SYSTEM		61,206.20	20,400.00		81,606.20	22
BROWNWOOD						
CENTRAL BUSINESS DIST		33,496.00	6,556.00	4,609.00	44,661.00	9
CORSICANA						
CENTRAL BUSINESS DIST		45,578.08	15,1912.70		60,770.78	14
DEL RIO						
US 90	27,007.71			9,002.57	36,010.28	7
DESOTO						
HAMPTON	40,710.00		13,570.00		54,280.00	6
DUNCANVILLE						
SANTA FE	17,114.28		5,704.76		22,819.04	7
EULESS						
MAIN	22,160.00		4,620.00	2,770.00	29,550.00	8
HIGHLAND PARK						
MOCKINGBIRD/PRESTON		42,225.00	14,075.00		56,300.00	14

TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS Funds)		Local Match		Total Project Cost	Number of Signals Retimed
	1st	2nd	City	State		
HURST						
HURST BLVD	35,127.80			11,715.00	46,842.80	7
PIPELINE	19,440.00		6,480.13		25,920.13	5
HURST TOTALS	54,,567.80		6,480.13	11,715.00	72,762.93	12
LAKE WORTH						
SH 199		17,198.00		5,732.00	22,930.00	4
MARBLE FALLS						
US 281, ETC		26,460.00	1,000.00	13,149.24	40,609.24	7
MINERAL WELLS						
CENTRAL BUSINESS DIST	35,247.00			11,029.00	46,276.00	8
ORANGE						
GREEN		64,989.00	16,247.00		81,236.00	9
ROUND ROCK						
US 79		8,632.00	709.66	2,595.00	11,936.66	5
RM 620		8,632.00	809.66	3,741.78	13,183.44	5
ROUND ROCK TOTALS		17,164.00	1,519.32	6,336.78	25,120.10	10
SAN MARCOS						
CENTRAL BUSINESS DISTRICT	30,240.00		1,521.71	16,960.68	48,960.68	24

TRAFFIC LIGHT SYNCHRONIZATION (TLS) PROGRAM OF WORK

City/Project	*Funding Cycle (TLS Funds)		Local Match		Total Project Cost	Number of Signals Retimed
	1st	2nd	City	State		
TAYLOR						
SH 95, ETC		34,020.00		44,013.94	78,033.94	9
TEMPLE						
AVENUE M	5,782.72		1,928.40		7,711.12	4
31ST	6,654.37		2,219.45		8,873.82	9
1ST/3RD	12,700.80		4,234.94		16,935.74	11
57TH	10,284.88		3,429.44		13,714.32	5
AVENUE H	5,625.24		1,876.54		7,501.78	4
CENTRAL	15,942.37		5,315.45		21,257.82	16
TEMPLE TOTALS	56,990.38		19,004.22		75,994.60	49
TEXARKANA						
US 82	27,500.00		9,276.00		36,776.00	10
UNIVERSITY PARK						
PRESTON		31,760.00	10,587.00		42,347.00	10
HILLCREST		31,760.00	10,587.00		42,347.00	10
UNIVERSITY PARK TOTALS		63,520.00	21,174.00		84,694.00	20
WEST LAKE HILLS						
BEE CAVES	18,900.00			9,919.14	28,819.14	6
SMALL CITIES TOTALS	295,190.17	441,203.28	156,340.84	135,237.35	1,027,971.64	255
GRAND TOTALS	**2,504,432.54**	**2,556,844.33**	**7,773,860.85**	**135,237.35**	**12,970,375.07**	**2540**

*Cities which have projects funded during the first cycle will have grant agreements tendered to them in December 1989.
Cities which have projects funded during the second cycle will have grant agreements tendered to them in July 1990.

The total amount of TLS funds that will be obligated to cities during both funding cycles is $5,061,276.87.

APPENDIX C

BENEFITS BY TYPE OF TRAFFIC SIGNAL TIMING IMPROVEMENT

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List of Tables

Table C-1. Annual Benefits when Optimizing Uncoordinated Arterial with Existing Equipment.

Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Arlington	Park Row Drive	6	2,965,800	12	(3,900)	(3)	22,500	5	2.64
	Randol Mill Road	6	(2,629,500)	(4)	206,400	15	179,100	10	586.47
Medium Cities									
Beaumont	College Street	7	2,216,550	11	134,775	33	18,090	3	N/A
	Dowlen Road	6	2,755,500	12	7,875	3	26,505	5	N/A
	Highland Avenue	4	707,400	11	(765)	(4)	4,770	4	N/A
	Lucas Street	5	(88,200)	(1)	9,945	6	3,240	1	N/A
	Major Drive	6	1,529,100	10	15,840	11	23,355	6	N/A
	Washington Boulevard	5	567,300	11	175,905	72	9,990	5	N/A
Grand Prairie	Great Southwest Parkway	7	2,469,600	8	99,000	15	85,800	6	9.29
	SH 303	7	11,868,000	29	2,226,000	76	482,400	31	193.26
Harlingen	Loop 448	5	1,741,200	10	37,680	27	240	0	77.7
Longview	High Street	11	2,922,000	10	50,520	25	87,960	12	7.32
Total		75	27,024,750	10	2,959,275	24	943,950	8	2.6 to 586

Table C-2. Annual Change in MOEs when Optimizing Uncoordinated Arterial with Existing Equipment.

Cities	Projects	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		B/C Ratio(s)
			Before	After	Before	After	Before	After	
Large Cities									
Arlington	Park Row Drive	6	24,343,500	21,377,700	153,600	157,500	496,200	473,700	2.64
	Randol Mill Road	6	67,657,200	70,286,700	1,375,950	1,169,550	1,869,150	1,690,050	586.47
Medium Cities									
Beaumont	College Street	7	20,697,600	18,481,050	412,830	278,055	570,600	552,510	N/A
	Dowlen Road	6	23,139,000	20,383,500	236,655	228,780	580,005	553,500	N/A
	Highland Avenue	4	6,169,500	5,462,100	20,925	21,690	121,725	116,955	N/A
	Lucas Street	5	10,436,400	10,524,600	154,170	144,225	277,290	274,050	N/A
	Major Drive	6	15,468,300	13,939,200	141,975	126,135	378,765	355,410	N/A
	Washington Boulevard	5	4,999,800	4,432,500	244,395	68,490	208,845	198,855	N/A
Grand Prairie	Great Southwest Parkway	7	29,362,800	26,893,200	643,200	544,200	1,420,800	1,335,000	9.29
	SH 303	7	40,520,400	28,652,400	2,946,600	720,600	1,542,000	1,059,600	193.26
Harlingen	Loop 448	5	17,533,200	15,792,000	139,140	101,460	447,240	447,000	77.7
Longview	High Street	11	29,605,200	26,683,200	203,220	152,700	757,560	669,600	7.32
Total		75	289,932,900	262,908,150	6,672,660	3,713,385	8,670,180	7,726,230	2.6 to 586

Table C-3. Annual Benefits when Optimizing Uncoordinated Network with Existing Equipment.

Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Dallas	S9 - Montfort	7	8,781,000	13.7	95,067	13.0	141,171	9.1	244.20
	S17 - OakCliff (Jefferson)	49	894,900	3.1	21,663	12.0	9,195	1.4	2.95
San Antonio	San Pedro	38	11,856,900	10.3	118,800	15.6	184,500	5.8	7.37
Medium Cities									
Galveston	Galveston System	30	2,077,200	3.9	50,910	14.9	46,800	5.5	3.22
Garland	North Area System	43	63,506,100	18.7	235,500	7.6	554,700	7.8	3.47
	South Subnetwork System	34	2,806,500	2.7	713,325	40.3	979,500	19.7	8.23
Waco	S. 17th/S. 18th Streets	23	2,732,400	8.5	46,575	17.7	43,950	5.7	21.73
Small Cities									
Euless	Main Street	6	2,368,800	12.7	130,740	50.9	330,765	37.5	58.61
Total		230	95,023,800	8	1,412,580	18	2,290,581	8	2.95 to 244.2

Table C-4. Annual Change in MOEs when Optimizing Uncoordinated Network with Existing Equipment.

Cities	Projects	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		
			Before	After	Before	After	Before	After	B/C Ratio(s)
Large Cities									
Dallas	S9 - Montfort	7	64,004,250	55,223,250	730,272	635,205	1,550,475	1,409,304	244.20
	S17 - OakCliff (Jefferson)	49	28,806,600	27,911,700	181,224	159,561	641,154	631,959	2.95
San Antonio	San Pedro	38	114,656,700	102,799,800	760,800	642,000	3,200,100	3,015,600	7.37
Medium Cities									
Galveston	Galveston System	30	53,673,000	51,595,800	341,100	290,190	850,800	804,000	3.22
Garland	North Area System	43	338,927,400	275,421,300	3,095,100	2,859,600	7,145,700	6,591,000	3.47
	South Subnetwork System	34	103,342,800	100,536,300	1,768,605	1,055,280	4,982,700	4,003,200	8.23
Waco	S. 17th/S. 18th Streets	23	32,152,200	29,419,800	263,325	216,750	777,225	733,275	21.73
Small Cities									
Euless	Main Street	6	18,715,200	16,346,400	256,665	125,925	880,995	550,230	58.61
Total		230	754,278,150	659,254,350	7,397,091	5,984,511	20,029,149	17,738,568	2.95 to 244.2

Table C-5. Annual Benefits when Optimizing Uncoordinated Arterial with New Equipment.

Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Dallas	S15- Sylvan	6	3,370,200	18.8	13,089	14.0	55,671	17.0	79.92
	S22- Marsalis	4	4,572,900	34.8	5,655	13.0	14,226	6.1	18.38
Fort Worth	28th	8	8,349,600	21.8	50,400	22.9	241,956	36.3	17.94
	Camp Bowie	6	1,444,500	7.0	3,510	3.2	162,390	39.9	5.43
Medium Cities									
Brownsville	Central Boulevard	5	2,304,000	11.6	20,280	11.2	25,860	4.9	6.52
	Palm Boulevard	8	3,411,600	16.9	9,420	6.9	13,920	4.6	2.49
Longview	Judson Road	4	1,070,400	4.7	44,580	26.2	(32,400)	(5.6)	13.8
	Mobberly Avenue	6	1,742,400	16.0	13,140	17.1	(78,600)	(29.6)	1.51
Midland	Big Spring St/ Garfield St	10	7,278,300	10.3	194,025	25.5	242,739	11.1	33.31
	Midkiff Rd/ Andrews Hwy	6	38,523,000	17.5	1,215,897	40.5	1,765,071	29.1	162.06
San Angelo	Bryant Boulevard	17	6,714,300	9.8	21,153	3.9	77,733	3.9	1.61
Victoria	Rio Grande Street	7	2,838,600	6.6	40,800	10.8	17,220	1.5	7.04
Small Cities									
Duncanville	Santa Fe	7	173,700	3.5	(1,578)	-3.6	(384)	(0.4)	2.06
Orange	Green Avenue (BU 90Y)	9	20,170,500	71.5	913,320	96.0	355,998	64.9	313.72
Total		103	101,964,000	18	2,543,691	21	2,861,400	14	2.06 to 313.70

Table C-6. Annual Change in MOEs when Optimizing Uncoordinated Arterial with New Equipment.

Cities	Projects	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		
			Before	After	Before	After	Before	After	B/C Ratio(s)
Large Cities									
Dallas	S15 - Sylvan	6	17,886,600	14,516,400	93,333	80,244	327,726	272,055	79.92
	S22 - Marsalis	4	13,121,700	8,548,800	43,341	37,686	231,831	217,605	18.38
Fort Worth	28th	8	38,284,800	29,935,200	220,095	169,695	666,300	424,344	17.94
	Camp Bowie	6	20,657,100	19,212,600	109,485	105,975	407,334	244,944	5.43
Medium Cities									
Brownsville	Central Boulevard	5	19,923,600	17,619,600	181,080	160,800	523,860	498,000	6.52
	Palm Boulevard	8	20,137,200	16,725,600	137,340	127,920	299,400	285,480	2.49
Longview	Judson Road	4	22,669,800	21,599,400	169,860	125,280	577,620	610,020	13.8
	Mobberly Avenue	6	10,903,200	9,160,800	76,980	63,840	265,440	344,040	1.51
Midland	Big Spring St/ Garfield St	10	70,613,700	63,335,400	760,425	566,400	2,180,748	1,938,009	33.31
	Midkiff Rd/ Andrews Hwy	6	220,035,600	181,512,600	3,001,200	1,785,303	6,067,500	4,302,429	162.06
San Angelo	Bryant Boulevard	17	68,792,100	62,077,800	539,667	518,514	1,997,949	1,920,216	1.61
Victoria	Rio Grande Street	7	42,939,000	40,100,400	377,280	336,480	1,153,800	1,136,580	7.04
Small Cities									
Duncanville	Santa Fe	7	5,020,500	4,846,800	44,328	45,906	109,389	109,773	2.06
Orange	Green Avenue (BU 90Y)	9	28,223,100	8,052,600	951,330	38,010	548,613	192,615	313.72
Total		103	599,208,000	497,244,000	6,705,744	4,162,053	15,357,510	12,496,110	1.61 to 313.72

Table C-7. Annual Benefits when Optimizing Uncoordinated Network with New Equipment.

Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Dallas	S21 - Kiest/Polk	10	15,875,700	28.9	34,500	14.5	153,009	18.3	55.07
San Antonio	Perrin-Beitel	17	37,662,600	39.9	82,800	16.2	535,200	20.1	186.49
Medium Cities									
Amarillo	Central Business District	86	4,632,900	2.8	45,039	5.1	17,064	1.0	2.8
Denton	Bell	7	17,574,600	37.2	185,040	50.2	243,480	26.9	40.95
Garland	Central Area System	45	10,762,500	9.6	112,956	11.9	946,317	28.6	4.92
Lubbock	Central Business District	10	(12,372,300)	(16.5)	109,560	18.1	(1,068,330)	(57.2)	N/A
Waco	N. 25th/N.26th Streets	7	2,609,700	24.8	11,025	15.8	24,000	13.3	4.21
	Waco Drive	17	5,011,200	5.9	95,535	19.3	90,900	4.6	24.59
Small Cities									
Addison	Addison System	22	13,667,100	11.0	1,571,727	53.4	478,233	12.5	192.83
Brownwood	Brownwood CBD	5	2,087,100	12.7	7,026	7.7	26,376	9.5	3.19
Corsicana	Corsicana CBD	14	9,600	0.2	828	2.3	(735)	(0.9)	0.13
DeSoto	Hampton	7	6,098,100	18.6	78,426	31.2	117,300	13.7	17.53
Marble Falls	US 281	7	8,856,600	28.7	42,000	26.5	116,289	23.0	21.97
Mineral Wells	Central Business District	8	1,623,000	11.7	16,698	18.3	19,458	7.2	5.91
San Marcos	Central Business District	24	8,568,600	9.4	1,045,500	41.9	324,000	12.1	261.45
Taylor	SH 95 System	9	3,284,100	11.4	1,455	1.2	25,539	5.8	1.41
University Par	Hillcrest Road System	10	9,922,200	17.9	18,600	6.3	(48,600)	(7.3)	9.22
	Preston Road System	10	5,395,200	2.8	(7,500)	(0.1)	25,500	0.5	0.61
West Lake Hill	RM 2244	6	13,165,500	52.6	5,400	1.1	277,050	39.9	31.8
Total		321	154,434,000	11.2	3,456,615	16.3	2,302,050	8.8	0.13 to 261

Table C-8. Annual Change in MOEs when Optimizing Uncoordinated Network with New Equipment.

Cities	Projects	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		
			Before	After	Before	After	Before	After	B/C Ratio(s)
Large Cities									
Dallas	S21 - Kiest/Polk	10	54,926,100	39,050,400	237,300	202,800	834,381	681,372	55.07
San Antonio	Perrin-Beitel	17	94,432,200	56,769,600	510,900	428,100	2,658,000	2,122,800	186.49
Medium Cities									
Amarillo	Central Business District	86	164,040,900	159,408,000	890,664	845,625	1,690,830	1,673,766	2.8
Denton	Bell	7	47,306,400	29,731,800	368,400	183,360	905,040	661,560	40.95
Garland	Central Area System	45	111,785,700	101,023,200	950,733	837,777	3,308,400	2,362,083	4.92
Lubbock	Central Business District	10	74,838,000	87,210,300	606,330	496,770	1,868,970	2,937,300	N/A
Waco	N. 25th/N.26th Streets	7	10,523,400	7,913,700	69,675	58,650	180,450	156,450	4.21
	Waco Drive	17	84,223,800	79,212,600	493,875	398,340	1,992,150	1,901,250	24.59
Small Cities									
Addison	Addison System	22	124,335,600	110,668,500	2,943,021	1,371,294	3,815,484	3,337,251	192.83
Brownwood	Brownwood CBD	5	16,443,300	14,356,200	91,371	84,345	277,749	251,373	3.19
Corsicana	Corsicana CBD	14	6,387,600	6,378,000	35,454	34,626	79,113	79,848	0.13
DeSoto	Hampton	7	32,713,800	26,615,700	251,625	173,199	855,300	738,000	17.53
Marble Falls	US 281	7	30,892,200	22,035,600	158,700	116,700	506,076	389,787	21.97
Mineral Wells	Central Business District	8	13,930,500	12,307,500	91,074	74,376	268,473	249,015	5.91
San Marcos	Central Business District	24	91,518,300	82,949,700	2,496,000	1,450,500	2,682,600	2,358,600	261.45
Taylor	SH 95 System	9	28,692,300	25,408,200	124,095	122,640	436,608	411,069	1.41
University Park	Hillcrest Road System	10	55,501,200	45,579,000	296,700	278,100	666,900	715,500	9.22
	Preston Road System	10	190,796,700	185,401,500	5,092,500	5,100,000	5,375,100	5,349,600	0.61
West Lake Hills	RM 2244	6	25,048,800	11,883,300	491,100	485,700	694,650	417,600	31.8
Total		321	1,258,336,800	1,103,902,800	16,199,517	12,742,902	29,096,274	26,794,224	0.13 to 261

Table C-9. Annual Benefits when Optimizing Partially Coordinated Arterial with Existing Equipment.

Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Arlington	Collins Street	20	(14,660,400)	(5.4)	714,450	10.2	627,150	6.8	180.96
	Cooper Street	12	8,988,300	9.7	67,500	8.0	136,500	5.8	45.42
Austin	North Lamar	17	72,013,950	30.4	672,240	14.3	998,088	20.0	676.97
El Paso	Alabama	7	3,558,600	20.7	26,280	29.4	12,636	2.0	69.09
	Cotton	8	472,200	1.3	7,140	3.4	1,728	0.4	15.58
	Dyer	8	7,400,400	22.3	92,520	36.7	221,580	18.8	286.65
	East Montana	6	5,135,400	12.3	33,690	12.1	278,838	13.8	88.08
	Gateway North and South	5	(334,800)	(2.5)	11,040	14.5	3,696	0.9	23.21
	George Dieter	6	(4,369,800)	(13.6)	(27,420)	(16.0)	(13,896)	(0.9)	-83.68
	McCombs	6	2,494,200	12.6	8,280	12.2	8,166	1.3	31.51
	Sunland Park/ Shadow Mt.	9	9,017,400	20.5	136,776	30.4	138,486	11.4	98.44
Houston	Briar Forest	12	20,685,000	19.8	329,430	23.5	74,529	3.4	628.16
	Broadway	7	3,924,300	13.4	62,160	22.0	15,942	3.6	25.07
	East Elgin	6	7,192,500	20.5	54,390	28.3	23,181	5.7	41.26
	Long Point	14	18,428,400	19.6	152,280	26.2	48,093	2.2	216.81
	North Jenson	8	8,970,300	21.4	105,810	34.9	44,430	4.5	203.67
	Quitman	9	1,421,100	8.6	5,970	7.9	4,014	1.2	14.23
	S. Sgt. Macario Garcia	6	1,559,100	9.2	11,460	10.2	10,449	2.5	15.98
	South Braeswood	10	56,936,700	34.4	1,608,810	59.4	239,547	7.1	2144.72
	South Durham	4	9,597,000	29.5	450,240	86.5	130,086	22.7	778.01
	South Shepherd	5	3,450,900	10.3	21,678	5.2	21,678	5.2	155.20
	Waugh	6	8,516,700	28.9	170,700	61.0	76,281	16.7	207.04
	Wayside	6	1,335,000	5.5	10,020	6.7	3,138	0.5	16.74
San Antonio	Blanco	17	5,943,300	11.5	73,500	22.3	102,300	7.7	90.81
Small Cities									
Temple	1st/3rd	11	11,912,100	21.7	36,645	12.7	11,958	0.7	45.97
	31st Street	9	28,598,100	29.2	563,940	53.0	142,659	6.5	2660.19
	57th Street	5	1,965,750	9.1	(67,560)	(93.9)	2,487	0.4	-54.06
	Avenue H	4	3,055,200	12.7	4,530	3.3	7,608	1.0	17.33
	Avenue M	4	10,159,350	35.5	81,945	40.2	48,177	3.9	198.95
	Central/ Adams	8	13,583,625	18.7	276,399	42.7	310,467	18.7	314.68
Texarkana	Highway US 82	10	3,881,175	7.2	26,916	6.3	18,507	1.6	8.92
Total		265	310,831,050	6.41	5,721,759	8.52	3,748,503	2.84	

Table C-10. Annual Change in MOEs when Optimizing Partially Coordinated Arterial with Existing Equipment.

Cities	Projects	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		B/C Ratio(s)
			Before	After	Before	After	Before	After	
Large Cities									
Arlington	Collins Street	20	269,022,600	283,683,000	7,014,750	6,300,300	9,220,500	8,593,350	180.96
	Cooper Street	12	92,658,000	83,669,700	842,400	774,900	2,341,200	2,204,700	45.42
Austin	North Lamar	17	236,659,125	164,645,175	4,699,965	4,027,725	4,978,128	3,980,040	676.97
El Paso	Alabama	7	17,226,000	13,667,400	89,460	63,180	617,580	604,944	69.09
	Cotton	8	37,168,800	36,696,600	208,440	201,300	458,922	457,194	15.58
	Dyer	8	33,124,200	25,723,800	252,000	159,480	1,177,020	955,440	286.65
	East Montana	6	41,699,400	36,564,000	278,880	245,190	2,016,354	1,737,516	88.08
	Gateway North and South	5	13,473,000	13,807,800	76,260	65,220	411,666	407,970	23.21
	George Dieter	6	32,216,400	36,586,200	171,720	199,140	1,517,496	1,531,392	-83.68
	McCombs	6	19,815,600	17,321,400	67,980	59,700	615,768	607,602	31.51
	Sunland Park/ Shadow Mt.	9	44,083,200	35,065,800	449,808	313,032	1,216,134	1,077,648	98.44
Houston	Briar Forest	12	104,669,700	83,984,700	1,403,250	1,073,820	2,187,528	2,112,999	628.16
	Broadway	7	29,323,500	25,399,200	282,690	220,530	445,590	429,648	25.07
	East Elgin	6	35,127,000	27,934,500	192,180	137,790	407,799	384,618	41.26
	Long Point	14	94,061,100	75,632,700	582,210	429,930	2,235,114	2,187,021	216.81
	North Jenson	8	41,933,400	32,963,100	303,060	197,250	992,580	948,150	203.67
	Quitman	9	16,567,800	15,146,700	75,690	69,720	338,577	334,563	14.23
	S. Sgt. Macario Garcia	6	16,976,100	15,417,000	112,200	100,740	414,021	403,572	15.98
	South Braeswood	10	165,647,700	108,711,000	2,710,620	1,101,810	3,375,105	3,135,558	2144.72
	South Durham	4	32,563,200	22,966,200	520,380	70,140	572,265	442,179	778.01
	South Shepherd	5	33,429,300	29,978,400	420,090	398,412	420,090	398,412	155.20
	Waugh	6	29,501,400	20,984,700	279,810	109,110	457,197	380,916	207.04
	Wayside	6	24,388,200	23,053,200	149,190	139,170	589,794	586,656	16.74
San Antonio	Blanco	17	51,488,400	45,545,100	330,300	256,800	1,326,000	1,223,700	90.81
Small Cities									
Temple	1st/3rd	11	55,013,400	43,101,300	287,910	251,265	1,686,198	1,674,240	45.97
	31st Street	9	97,860,000	69,261,900	1,063,890	499,950	2,184,453	2,041,794	2660.19
	57th Street	5	21,505,950	19,540,200	71,985	139,545	596,607	594,120	-54.06
	Avenue H	4	24,028,500	20,973,300	136,800	132,270	767,040	759,432	17.33
	Avenue M	4	28,608,300	18,448,950	203,670	121,725	1,244,097	1,195,920	198.95
	Central/ Adams	8	72,732,900	59,149,275	647,139	370,740	1,660,458	1,349,991	314.68
Texarkana	Highway US 82	10	54,096,300	50,215,125	429,660	402,744	1,168,308	1,149,801	8.92
Total		265	1,866,668,475	1,555,837,425	24,354,387	18,632,628	47,639,589	43,891,086	-83 to 2660

Table C-11. Annual Benefits when Optimizing Partially Coordinated Network with Existing Equipment.

Large Cities									
Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Dallas	S6- Bus System	49	6,823,650	4.2	71,439	5.8	100,854	2.5	42.16
	S8A-Mockingbi	27	13,112,100	7.4	956,700	37.2	834,600	16.2	734.65
El Paso	Fred Wilson/ Al	12	225,000	0.3	309,078	29.6	738,144	20.7	73.91
San Antonio	Broadway	17	1,109,400	3.1	74,400	30.1	43,050	5.9	11.94
Total		105	21,270,150	4.4	1,411,617	20.5	1,716,648	8.7	11 to 734

Table C-12. Annual Change in MOEs when Optimizing Partially Coordinated Network with Existing Equipment.

Large Cities									
		Number of	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		
Cities	Projects	Intersections	Before	After	Before	After	Before	After	B/C Ratio(s)
Large Cities									
Dallas	S6 - Bus System	49	162,593,100	155,769,450	1,236,438	1,164,999	4,009,320	3,908,466	42.16
	S8A - Mockingbird/Central/Gree	27	176,051,100	162,939,000	2,575,200	1,618,500	5,156,100	4,321,500	734.65
El Paso	Fred Wilson/ Airport	12	80,104,800	79,879,800	1,045,158	736,080	3,567,156	2,829,012	73.91
San Antonio	Broadway	17	35,708,400	34,599,000	247,500	173,100	731,400	688,350	11.94
Total		105	454,457,400	433,187,250	5,104,296	3,692,679	13,463,976	11,747,328	11 to 734

Table C-13. Annual Benefits when Optimizing Partially Coordinated Arterial with New Equipment.

Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Dallas	S2a- Buckner	34	12,930,600	9	594,081	39	194,133	4	106.46
	S19- Westmoreland	5	2,352,900	17	12,468	22	24,177	7	15.54
	S20- West Davis	6	322,275	2	5,436	9	21,651	6	6.44
Houston	Alabama	16	7,623,300	12	69,870	16	13,515	1	15.80
	Bellfort	12	6,080,400	10	26,310	5	13,707	1	12.80
	Cavalcade	13	11,529,600	22	17,430	5	24,435	2	15.69
	Cullen	9	830,400	7	(138,060)	(167)	9,702	3	6.97
	East Bissonnet	11	27,723,900	31	581,190	54	109,170	7	155.74
	El Dorado	4	4,835,700	26	47,220	33	27,012	6	37.12
	Gessner	6	8,321,100	14	73,776	14	32,736	7	69.54
	Griggs Long/Park Place	11	7,495,500	17	73,830	21	19,275	2	60.57
	Harrisburg	11	6,110,700	18	85,110	30	14,415	1	61.07
	Little York	6	15,772,200	27	372,900	37	64,065	5	193.82
	MLK/ Calhoun	13	12,075,900	26	183,270	40	51,975	3	35.12
	North Braeswood	6	7,507,500	13	299,910	26	95,655	6	145.91
	North Durham	7	1,091,100	3	15,600	14	5,106	1	12.01
	North Shepherd	7	9,135,900	21	184,800	51	47,943	7	130.42
	Stella Link	7	9,054,300	20	80,580	16	29,316	4	80.50
	Telephone	6	5,252,700	19	42,240	20	19,803	4	54.71
	West Bissonnet	6	11,220,300	19	280,740	39	99,738	8	291.05
	West Elgin	16	2,847,300	8	26,310	14	9,990	3	16.29
	Westheimer	15	13,640,100	18	173,220	25	32,136	2	61.61
Medium Cities									
Harlingen	Commerce Street	7	1,997,400	7	19,380	11	2,940	1	15.61
Victoria	Navarro Street	9	(2,491,200)	(4)	94,500	17	24,420	2	14.91
Small Cities									
Del Rio	US 90-Avenue	6	11,790,000	23	155,160	37	69,120	6	42.72
Total		249	195,049,875	15	3,377,271	18	1,056,135	3	6 to 291

Table C-14. Annual Change in MOEs when Optimizing Partially Coordinated Arterial with New Equipment.

Cities	Projects	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		
			Before	After	Before	After	Before	After	B/C Ratio(s)
Large Cities									
Dallas	S2A - Buckner	34	150,000,000	137,069,400	1,529,286	935,205	5,342,151	5,148,018	106.46
	S19 - Westmoreland	5	13,454,700	11,101,800	57,552	45,084	322,728	298,551	15.54
	S20 - West Davis	6	14,527,650	14,205,375	58,137	52,701	344,460	322,809	6.44
Houston	Alabama	16	63,077,700	55,454,400	441,480	371,610	1,324,536	1,311,021	15.80
	Bellfort	12	58,184,700	52,104,300	488,820	462,510	2,040,096	2,026,389	12.80
	Cavalcade	13	51,368,400	39,838,800	321,840	304,410	1,340,637	1,316,202	15.69
	Cullen	9	11,104,500	10,274,100	82,470	220,530	302,697	292,995	6.97
	East Bissonnet	11	89,623,800	61,899,900	1,081,500	500,310	1,573,623	1,464,453	155.74
	El Dorado	4	18,861,900	14,026,200	145,050	97,830	451,044	424,032	37.12
	Gessner	6	59,529,000	51,207,900	538,356	464,580	466,626	433,890	69.54
	Griggs Long/Park Place	11	42,962,400	35,466,900	352,980	279,150	1,210,713	1,191,438	60.57
	Harrisburg	11	34,742,100	28,631,400	286,140	201,030	1,145,472	1,131,057	61.07
	Little York	6	58,440,000	42,667,800	1,018,050	645,150	1,353,636	1,289,571	193.82
	MLK/ Calhoun	13	46,925,700	34,849,800	457,200	273,930	1,505,445	1,453,470	35.12
	North Braeswood	6	58,852,800	51,345,300	1,138,860	838,950	1,573,518	1,477,863	145.91
	North Durham	7	39,704,400	38,613,300	113,130	97,530	670,428	665,322	12.01
	North Shepherd	7	43,495,800	34,359,900	359,100	174,300	701,820	653,877	130.42
	Stella Link	7	46,308,000	37,253,700	497,340	416,760	820,818	791,502	80.50
	Telephone	6	28,260,900	23,008,200	214,470	172,230	475,272	455,469	54.71
	West Bissonnet	6	57,817,200	46,596,900	723,480	442,740	1,316,544	1,216,806	291.05
	West Elgin	16	33,808,500	30,961,200	184,290	157,980	358,728	348,738	16.29
	Westheimer	15	75,831,900	62,191,800	691,440	518,220	1,715,526	1,683,390	61.61
Medium Cities									
Harlingen	Commerce Street	7	27,089,400	25,092,000	182,580	163,200	311,580	308,640	15.61
Victoria	Navarro Street	9	59,517,600	62,008,800	550,740	456,240	1,598,940	1,574,520	14.91
Small Cities									
Del Rio	US 90-Avenue	6	50,292,900	38,502,900	413,910	258,750	1,242,000	1,172,880	42.72
Total		249	1,233,781,950	1,038,732,075	11,928,201	8,550,930	29,509,038	28,452,903	6 to 291

Table C-15. Annual Benefits when Optimizing Partially Coordinated Network with New Equipment.

Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Dallas	S3 - Scyene	4	4,354,200	21	35,817	28	52,179	11	70.53
	S5 - Columbia/Main	23	7,431,000	15	222,588	35	217,191	16	71.39
	S23 - Ledbetter/Marsalis	18	11,399,250	18	61,485	17	106,686	5	26.30
	S24 - East Illinois	5	1,055,250	9	15,741	21	20,163	8	36.70
Total		50	24,239,700	16	335,631	26	396,219	11	26 to 71

Table C-16. Annual Change in MOEs when Optimizing Partially Coordinated Network with New Equipment.

Cities	Projects	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		B/C Ratio(s)
			Before	After	Before	After	Before	After	
Large Cities									
Dallas	S3 - Scyene	4	21,024,600	16,670,400	125,874	90,057	492,261	440,082	70.53
	S5 - Columbia/Main	23	48,238,500	40,807,500	640,854	418,266	1,325,223	1,108,032	71.39
	S23 - Ledbetter/Marsalis	18	62,833,800	51,434,550	365,409	303,924	1,944,162	1,837,476	26.30
	S24 - East Illinois	5	11,557,050	10,501,800	75,045	59,304	268,539	248,376	36.70
Total		50	143,653,950	119,414,250	1,207,182	871,551	4,030,185	3,633,966	

Table C-17. Annual Benefits when Optimizing Coordinated Arterial with Existing Equipment.

Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Arlington	Division Street	14	70,081,500	25	2,864,100	37	2,634,600	27	1,323.19
	Fielder Road	14	13,213,200	15	1,077,300	52	456,150	20	506.39
	Lamar Boulevard	12	22,814,400	18	1,628,250	55	1,314,150	36	868.07
	Matlock Road	6	20,215,500	20	2,761,200	48	733,200	26	3,026.24
Corpus Christi	Staples Street	18	23,136,000	23	407,550	33	472,425	19	14.79
Dallas	S4 - East Grand	10	2,237,700	10	121,317	54	69,600	17	213.18
El Paso	Airway	5	5,211,000	9	153,960	27	407,082	31	602.52
	Alameda	19	8,643,000	11	74,052	16	39,870	2	80.65
	Doniphan	6	2,754,600	11	33,822	22	43,434	5	96.26
	Hawkins/Viscount	14	4,456,800	5	87,174	12	502,800	26	148.06
	Lee Trevino	10	39,421,200	36	1,195,242	67	1,388,904	35	2,030.74
	McRae	7	14,754,600	26	207,606	42	228,045	17	126.40
	Mesa-Resler	21	23,516,400	14	105,924	8	794,814	15	66.32
	North Dyer	11	19,889,400	19	(1,326,006)	-120	157,518	6	754.75
	Yarbrough	6	7,972,200	14	319,560	35	115,542	10	911.04
San Antonio	Walzem	6	(2,155,800)	-10	36,300	19	(2,100)	-0	94.95
Medium Cities									
Port Arthur	Memorial Dr./Gulfway Dr.	22	4,345,800	13	60,270	21	27,510	3	13.09
Total		201	280,507,500	16	9,807,621	23	9,383,544	17	13 to 3026

Table C-18. Annual Change in MOEs when Optimizing Coordinated Arterial with Existing Equipment.

Cities	Projects	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		B/C Ratio(s)
			Before	After	Before	After	Before	After	
Large Cities									
Arlington	Division Street	14	283,169,100	213,087,600	7,821,600	4,957,500	9,846,600	7,212,000	1,323.19
	Fielder Road	14	88,048,200	74,835,000	2,063,250	985,950	2,232,900	1,776,750	506.39
	Lamar Boulevard	12	123,946,800	101,132,400	2,941,650	1,313,400	3,678,000	2,363,850	868.07
	Matlock Road	6	100,823,100	80,607,600	5,741,700	2,980,500	2,841,300	2,108,100	3,026.24
Corpus Christi	Staples Street	18	100,017,900	76,881,900	1,226,100	818,550	2,504,775	2,032,350	14.79
Dallas	S4 - East Grand	10	21,404,700	19,167,000	225,714	104,397	415,800	346,200	213.18
El Paso	Airway	5	56,032,800	50,821,800	575,580	421,620	1,302,450	895,368	602.52
	Alameda	19	75,219,000	66,576,000	452,820	378,768	2,276,880	2,237,010	80.65
	Doniphan	6	24,405,600	21,651,000	151,662	117,840	841,104	797,670	96.26
	Hawkins/Viscount	14	89,830,200	85,373,400	726,942	639,768	1,918,182	1,415,382	148.06
	Lee Trevino	10	110,530,200	71,109,000	1,779,618	584,376	3,933,312	2,544,408	2,030.74
	McRae	7	55,722,000	40,967,400	490,458	282,852	1,362,378	1,134,333	126.40
	Mesa-Resler	21	163,509,600	139,993,200	1,380,972	1,275,048	5,165,646	4,370,832	66.32
	North Dyer	11	103,715,400	83,826,000	1,102,140	2,428,146	2,428,146	2,270,628	754.75
	Yarbrough	6	56,155,200	48,183,000	904,320	584,760	1,179,708	1,064,166	911.04
San Antonio	Walzem	6	21,545,700	23,701,500	188,400	152,100	614,700	616,800	94.95
Medium Cities									
Port Arthur	Memorial Dr./Gulfway Dr.	22	32,952,600	28,606,800	284,220	223,950	897,750	870,240	13.09
Total		201	1,507,028,100	1,226,520,600	28,057,146	18,249,525	43,439,631	34,056,087	13 to 3026

Table C-19. Annual Benefits when Optimizing Coordinated Network with Existing Equipment.

Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Arlington	Bowen/Pioneer/Park Row	13	8,058,900	11	(6,300)	(1)	70,800	3	3.22
	Downtown System	12	7,188,300	18	113,100	30	142,800	17	65.43
	Green Oaks Blvd/Little Road	10	(984,000)	(2)	222,600	12	138,900	6	125.74
Austin	Burnet/ Anderson	24	19,311,300	12	616,740	31	79,692	2	245.50
	Burnet/Braker/Kramer	12	68,028,300	33	624,708	26	529,626	10	971.26
	Cameron Road	12	9,371,400	10	351,099	39	289,914	12	76.96
	Central Business District	74	72,014,100	30	2,497,560	53	998,088	20	32.51
	Central Lamar	65	29,101,500	7	277,800	6	355,080	4	71.39
	N. Lamar/ Rundberg/ Rutland	17	72,014,100	30	2,497,560	53	998,088	20	395.74
	South Lamar/ Auditorium	58	44,817,900	9	1,340,790	22	571,689	5	229.45
El Paso	Copia-Pershing	10	3,264,000	13	23,412	13	14,646	2	46.21
	Piedras-Raynor	13	2,701,200	7	24,120	10	11,400	3	32.86
	West Montana	20	25,932,600	15	211,080	18	2,810,268	86	148.35
San Antonio	Southeast	56	4,974,300	6	101,400	18	85,200	4	20.58
	South Flores	23	1,316,400	2	160,800	29	123,600	7	74.59
	West Side	69	54,828,000	25	9,300	1	419,700	8	5.65
Small Cities									
Highland	Mockingbird/Preston	13	8,676,900	11	370,512	29	298,683	16	50
Total		501	430,615,200	15	9,436,281	22	7,938,174	12	3.2 to 971

Table C-20. Annual Change in MOEs when Optimizing Coordinated Network with Existing Equipment.

Cities	Projects	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		
			Before	After	Before	After	Before	After	B/C Ratio(s)
Large Cities									
Arlington	Bowen/Pioneer/Park Row	13	74,377,200	66,318,300	986,700	993,000	2,316,900	2,246,100	3.22
	Downtown System	12	39,588,900	32,400,600	378,900	265,800	825,300	682,500	65.43
	Green Oaks Blvd/Little Road	10	58,175,400	59,159,400	1,834,200	1,611,600	2,402,400	2,263,500	125.74
Austin	Burnet/ Anderson	24	167,434,800	148,123,500	2,001,690	1,384,950	3,548,385	3,468,693	245.50
	Burnet/Braker/Kramer	12	205,305,600	137,277,300	2,369,349	1,744,641	5,237,100	4,707,474	971.26
	Cameron Road	12	94,002,600	84,631,200	888,999	537,900	2,419,584	2,129,670	76.96
	Central Business District	74	236,659,200	164,645,100	4,699,965	2,202,405	4,978,128	3,980,040	32.51
	Central Lamar	65	444,226,500	415,125,000	4,305,525	4,027,725	8,570,229	8,215,149	71.39
	N. Lamar/ Rundberg/ Rutland	17	236,659,200	164,645,100	4,699,965	2,202,405	4,978,128	3,980,040	395.74
	South Lamar/ Auditorium	58	523,070,400	478,252,500	6,149,820	4,809,030	10,469,472	9,897,783	229.45
El Paso	Copia-Pershing	10	25,989,000	22,725,000	187,092	163,680	611,736	597,090	46.21
	Piedras-Raynor	13	41,057,400	38,356,200	230,280	206,160	434,100	422,700	32.86
	West Montana	20	171,658,800	145,726,200	1,201,980	990,900	3,252,774	442,506	148.35
San Antonio	Southeast	56	85,546,200	80,571,900	558,000	456,600	2,191,500	2,106,300	20.58
	South Flores	23	58,936,200	57,619,800	549,900	389,100	1,814,100	1,690,500	74.59
	West Side	69	215,708,400	160,880,400	1,228,800	1,219,500	5,593,200	5,173,500	5.65
Small Cities									
Highland	Mockingbird/Preston	13	78,290,400	69,613,500	1,292,715	922,203	1,880,745	1,582,062	50
Total		501	2,756,686,200	2,326,071,000	33,563,880	24,127,599	61,523,781	53,585,607	3.2 to 971

Table C-21. Annual Benefits when Optimizing Coordinated Arterial with New Equipment.

Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Fort Worth	East Lancaster	8	(1,033,500)	(3)	15,585	6	14,313	1	3.27
	North Main	11	7,025,400	19	67,995	24	20,658	3	23.07
Medium Cities									
Brownsville	Boca Chica Boulevard	12	7,156,200	10	121,440	18	112,860	9	34.67
	International Boulevard	10	2,749,800	5	41,820	12	8,280	1	13.89
Harlingen	First Street	4	48,000	1	1,380	3	792	1	3.62
McAllen	Loop 374	15	5,934,600	8	104,640	18	155,040	13	13.31
Small Cities									
Hurst	Hurst Boulevard	8	1,473,300	5	10,542	4	(1,995)	(0)	2.65
	Pipeline Road	5	579,600	4	8,085	12	10,791	4	3.85
Orange	Green Avenue (BU 90Y)	9	20,170,500	71	913,320	96	355,998	65	313.72
Total		82	44,103,900	14	1,284,807	23	676,737	12	3.2 to 313

Table C-22. Annual Change in MOEs when Optimizing Coordinated Arterial with New Equipment.

Cities	Projects	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		B/C Ratio(s)
			Before	After	Before	After	Before	After	
Large Cities									
Fort Worth	East Lancaster	8	37,476,900	38,510,400	249,660	234,075	1,202,301	1,187,988	3.27
	North Main	11	37,166,700	30,141,300	287,640	219,645	641,757	621,099	23.07
Medium Cities									
Brownsville	Boca Chica Boulevard	12	71,524,800	64,368,600	685,980	564,540	1,211,640	1,098,780	34.67
	International Boulevard	10	50,331,000	47,581,200	353,100	311,280	613,140	604,860	13.89
Harlingen	First Street	4	9,064,200	9,016,200	49,080	47,700	90,252	89,460	3.62
McAllen	Loop 374	15	72,100,800	66,166,200	586,080	481,440	1,217,040	1,062,000	13.31
Small Cities									
Hurst	Hurst Boulevard	8	31,032,000	29,558,700	264,780	254,238	945,408	947,403	2.65
	Pipeline Road	5	13,497,900	12,918,300	68,565	60,480	265,539	254,748	3.85
Orange	Green Avenue (BU 90Y)	9	28,223,100	8,052,600	951,330	38,010	548,613	192,615	313.72
Total		82	350,417,400	306,313,500	3,496,215	2,211,408	6,735,690	6,058,953	3.2 to 313

Table C-23. Annual Benefits when Optimizing Coordinated Network with New Equipment.

Cities	Projects	Number of Intersections	Stops	Percent	Delay (hrs)	Percent	Fuel Cons. (gal)	Percent	B/C Ratio(s)
Large Cities									
Dallas	S7- Kingsly/Plano/Audelia	7	3,561,300	10	29,193	16	50,754	6	56.70
	S13- Lemmon/Oaklawn	29	43,598,100	23	442,485	28	665,523	16	108.00
	S14- Cole/McKinney	21	7,242,675	13	205,743	25	69,720	5	182.00
	S16- Corinth/Grand Lamar	16	5,693,100	19	54,900	30	55,800	8	18.34
	S18- Hampton	14	7,548,000	11	225,198	38	230,100	13	196.01
Medium Cities									
Odessa	Central Business District	17	31,844,250	25	556,800	32	57,300	2	102.85
San Angelo	CBD System	22	1,466,100	3	52,551	18	49,557	6	3.31
Total		126	100,953,525	15	1,566,870	27	1,178,754	9	3 to 196

Table C-24. Annual Change in MOEs when Optimizing Coordinated Network with New Equipment.

Cities	Projects	Number of Intersections	Overall Stops		Overall Delay (hrs)		Overall Fuel Consumption (gal.)		B/C Ratio(s)
			Before	After	Before	After	Before	After	
Large Cities									
Dallas	S7 - Kingsly/Plano/Audelia	7	35,957,400	32,396,100	182,037	152,844	832,989	782,235	56.70
	S13 - Lemmon/Oaklawn	29	187,950,600	144,352,500	1,570,290	1,127,805	4,248,213	3,582,690	108.00
	S14 - Cole/McKinney	21	57,723,375	50,480,700	818,649	612,906	1,329,633	1,259,913	182.00
	S16 - Corinth/Grand Lamar	16	30,156,300	24,463,200	180,600	125,700	663,900	608,100	18.34
	S18 - Hampton	14	70,346,100	62,798,100	592,137	366,939	1,831,200	1,601,100	196.01
Medium Cities									
Odessa	Central Business District	17	129,682,200	97,837,950	1,764,300	1,207,500	2,411,550	2,354,250	102.85
San Angelo	CBD System	22	43,290,000	41,823,900	285,975	233,424	768,033	718,476	3.31
Total		126	555,105,975	454,152,450	5,393,988	3,827,118	12,085,518	10,906,764	3 to 196

APPENDIX D

NEWSPAPER ARTICLES

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Plan to synchronize traffic signals gets green light, $300,000 grant

By Scott W. Wright
American-Statesman Staff

Commuters frustrated by Austin's occasionally car-clogged streets should have one less thing to fume about in the near future: City engineers have begun retiming signal lights to improve traffic flow.

Using a $300,000 state grant, traffic engineers will synchronize roughly half of the city's 554 signal lights over the next year so motorists on main thoroughfares can more easily go through a series of lights without stopping.

"We're trying to make sure the signal lights are operating as efficiently as possible, what with all the competing demands from traffic coming in all the different directions," said David Gerard of the Public Works and Transportation Department.

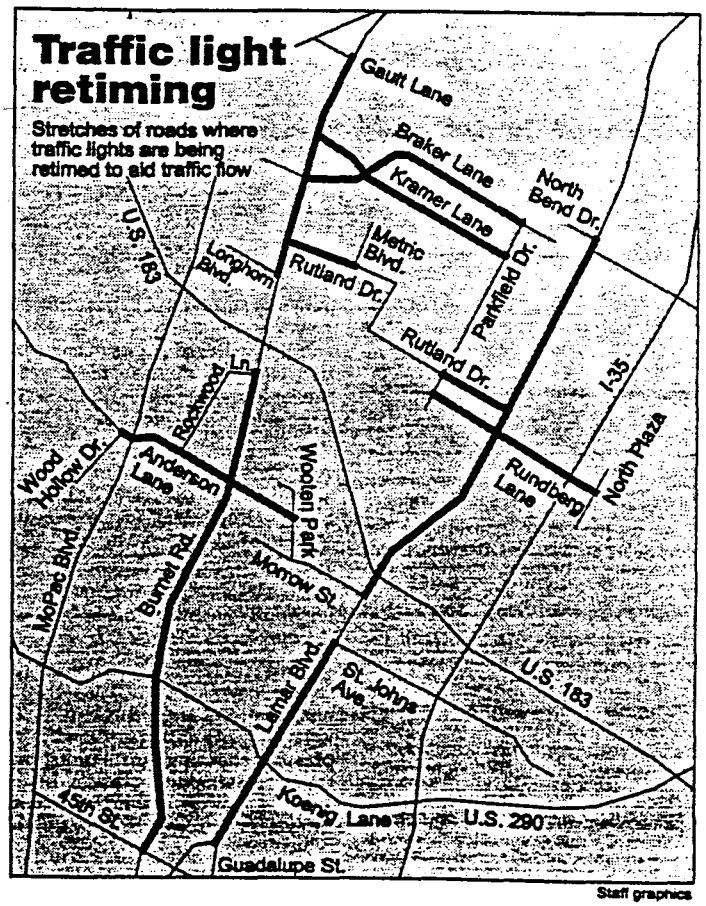
"You'll never be able to make it so that every car can make it through every signal without stopping," he said, "but we are trying to allow the most number of cars through."

Engineers so far have retimed more than 60 signal lights in four heavily traveled areas of North Austin. The changes cut travel time by an average of 1 to 2 minutes, and in some instances, by as much as 5½ minutes, Gerard said.

The areas included a strip of North Lamar Boulevard from Guadalupe Street to St. Johns Avenue; North Lamar Boulevard near Anderson and Rundberg lanes; Burnet Road from West 45th Street to Rockwood Lane; and Burnet Road near Braker and Kramer lanes.

Based on information gathered at those sites, city transportation officials say motorists could save about $7.4 million in fuel costs each year when the project is completed.

In addition, studies have shown that the time saved between starts and stops at traffic lights in those four areas alone may save motorists another $45 million a year because traffic delays can cost anywhere from $1 to $10 an hour per motorist, Gerard said.



Staff graphics

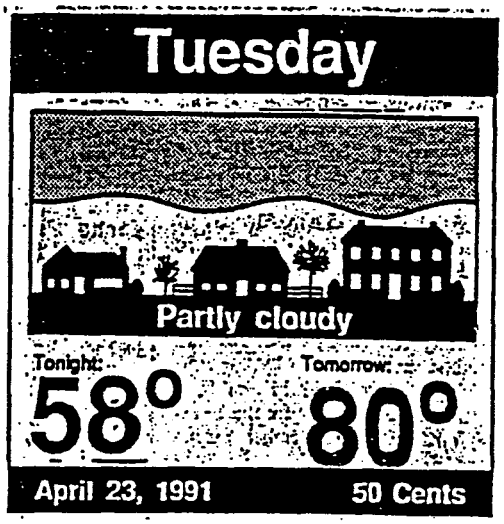
More than 120 other traffic lights along Lamar Boulevard from the University of Texas area southward to West Gate Boulevard will be retimed in the next two months, Gerard said.

Engineers also will synchronize signal lights in the downtown business district and on Cameron Road from Rundberg Lane to East 51st Street by the beginning of next year, he said.

Despite the savings in fuel consumption and travel time, retiming traffic lights doesn't solve everything. The city still will have some traffic woes, Gerard said.

And some drivers will continue to be miserable while waiting for red lights, which normally keep them stalled for 50 seconds to two minutes.

"There is a limit to what we can do," he said. "We try to make the system as efficient as possible, but you'll still see some congestion and delay because in some areas there just isn't enough lane capacity for all the cars."



Downtown signals given 'green light'

By GENE DEASON
Bulletin Managing Editor

Brownwood Public Works Director Donald Hatcher hopes that after the city upgrades downtown traffic signals later this year, motorists will think "green light," instead of red.

Meanwhile, drivers will not only enjoy fewer traffic frustrations, but will also realize fuel savings by not having to spend as much time idling in front of repeated "stop lights."

The Brownwood City Council earlier this month awarded a $21,095 low bid to Naz-Tech of Sugarland for five new traffic signal controllers to be installed in the downtown business district along with 12 loop detectors, which will be connected and retimed with four state-maintained and operated signals. Delivery of the signals is expected by July 1, with a project completion date set for Aug. 31.

When operational, a vehicle traveling through the downtown business district just under the posted speed limit should not be required to stop at more than one traffic signal, Hatcher said.

The project is a result of a grant request submitted in September 1989 to the State Department of

See SIGNALS on page 10

SIGNALS

Continued from page 1

Highways and Public Transportation for a traffic light synchronization program. In July 1990, the city executed an agreement to accept a grant for a $44,661 project, with approximately $6,500 (not quite 15 percent of the cost) funded by the city — partially through kind services.

Approximately 10 percent or $4,600 is funded by the state highway department, while 75 percent (almost $33,500 will come from State Oil Overcharge Funds designated for this type of work. The fund was established from monies collected as a result of petroleum price overcharges.

The purpose of the grant fund is to finance projects that will increase energy efficiency in the movement of vehicular traffic.

In October 1990, Hatcher participated in two computer modeling training courses, as part of the grant requirements. Last December, the city contracted with Barton-Aschman Associates Inc. to furnish technical and professional assistance to the project.

The city is assisting in two required traffic surveys, a "before" field evaluation report offering travel time and simulation statistics, plus an "after" field evaluation report including travel time and simulation statistics after the installation and calibration of the new equipment and timing plans.

"The 'before' study was recently submitted to the state highway department, Hatcher said. "Analyses were made using a computer model called Transyt-7F, by inputting traffic data taken on Jan. 23 and 24 of this year," he explained. "The existing conditions at each of the nine intersections were analyzed with respect to fuel consumption, total delay and the number of stops."

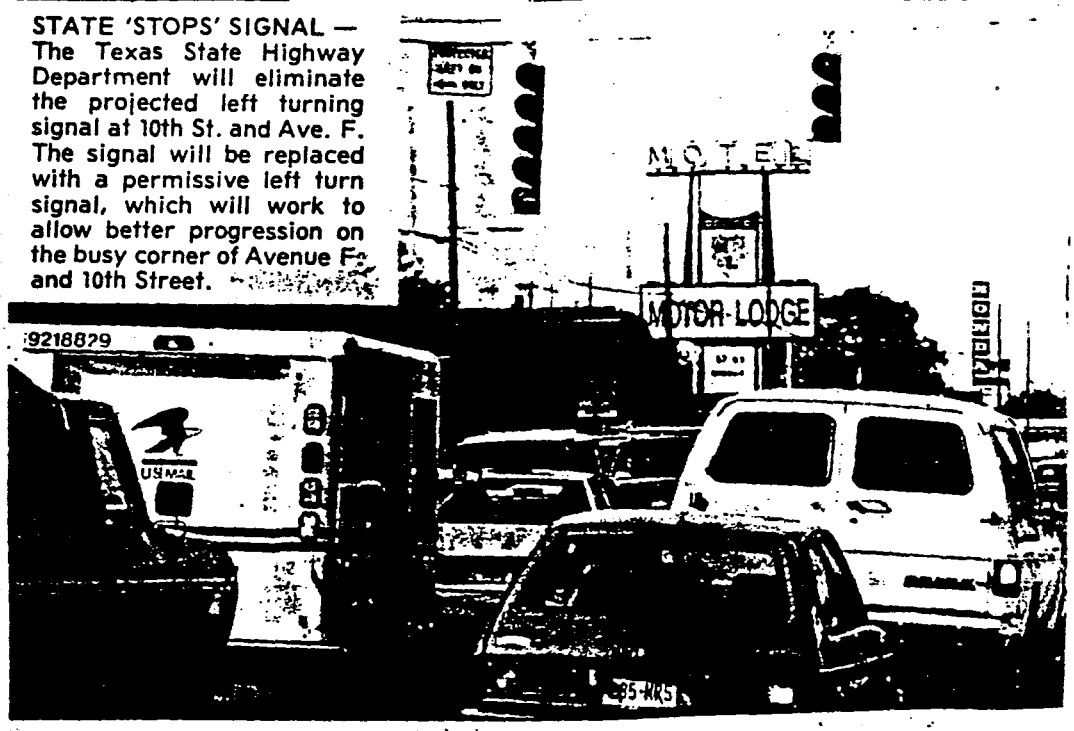
Cost assumptions used included that of fuel at $1 per gallon, with delays at $10 per vehicle hour and 14 cents per stop. Costs were analyzed over a period of 300 days, with each day assumed to be 12 hours. Hatcher said the "before" report shows the annual operating costs for vehicular traffic movement in the central business district to be approximately $1,300.

That information was used to qualify the existing conditions and to calibrate the computer model so that an accurate before and after comparison can be made in the final report, Hatcher said.

"In addition to upgrading our equipment and increasing energy efficiency, we hope to change the attitude of some drivers that by having responsive traffic signals, they will think green light, not red light."

Del Rio News-Herald

Tuesday, October 16, 1990 7



STATE 'STOPS' SIGNAL — The Texas State Highway Department will eliminate the projected left turning signal at 10th St. and Ave. F. The signal will be replaced with a permissive left turn signal, which will work to allow better progression on the busy corner of Avenue F and 10th Street.

Avenue F traffic signals to change

Motorists in Del Rio will notice some changes in traffic signal operations on Avenue F beginning Sunday, Oct. 21.

The State Department of Highways and Public Transportation will activate some new controllers and time the traffic signals to provide progression on Avenue F. Signals involved include the intersections with 6th, 7th, 10th, 15th streets, Cantu Drive and Chevrolet Drive.

To provide progression, the existing protected left turn signal at 10th Street will be eliminated. The intersections at 6th, 7th, 10th and 15th streets will have a permissive left turn. This means traffic turning left must yield to all oncoming traffic before making their turn.

Traffic on Avenue F turning left onto Cantu Drive will continue to have a protected left turn on a green arrow and permissive left turn when there are no oncoming vehicles.

At Chevrolet Drive, motorists will continue to be provided protected left turns on green arrows for both Chevrolet Drive and Avenue F.

The cycle length will be increased from 60 seconds to 90 seconds. From 11:30 p.m. to 5:30 a.m., all these signals on Avenue F will be in the flashing mode. Yellow will be flashing on Avenue F and red flashing on the side streets.

This work is being done under the Traffic Light Synchronization Program. The program was approved by the Governor's Energy Management Center and the U.S. Department of Energy. The purpose of the program is to reduce unnecessary vehicle stops and delays through more efficient traffic signal timing. This should result in significant fuel savings and a reduction in vehicle emissions.

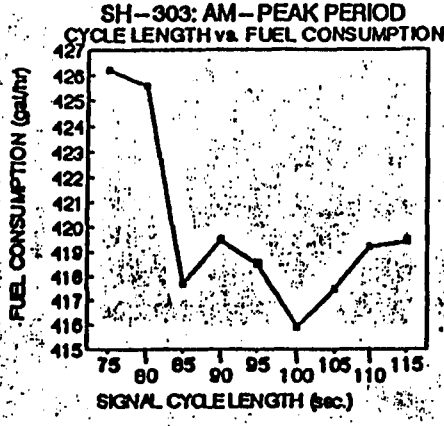
The Highway Department has proposed plans to further upgrade the traffic signals on Avenue F next year, according to Angie Ortegon, P.E., traffic engineer with the department. Most arm installations will be installed at the intersections with 6th, 7th, 10th and 15th streets.

TRAFFIC LIGHT SYNCHRONIZATION GRANT PROGRAM

In January, 1990 Grand Prairie was awarded $161,150.00 for improving traffic signal timing under the Traffic Light Synchronization Grant program. The grant is administered by the Texas Department of Transportation (TxDOT) under the Oil Overcharge Restitutionary Act. The funds for this Act are from Federal Court settlements of lawsuits against major oil companies for the overpricing of petroleum products during the 1970's.

The Traffic Light Synchronization (TLS) Grant is a matching grant program to assist Cities in developing coordinated traffic signal timing along certain major roadways. Grand Prairie was awarded grant monies to purchase new, microprocessor based traffic signal controllers and develop new timing plans along the following roadways:

- Great Southwest Pkwy.:
  from I.H. – 20 to Sherman St.
- State Highway 303:
  from Grt. Southwest Pk. to SE 14th St.
- Jefferson St. & Main St. :
  from SW 23rd St. to SE 14th St.



The goal of this program is to minimize stops and delays, and to provide a progressing band of green lights for the major roadway. Some of the benefits of this improved signal timing include:

- reducing fuel consumption,
- lowering polluting emmissions,
- lowering vehicle operating cost.

Another benefit is improved roadway safety. By improving the flow of vehicles, there is less desire to travel above the speed limit or to try to 'beat' the red light.

The new signal timing has been developed by City staff from vehicle count, delay and travel time studies, and computer software that simulates traffic conditions with mathematical models. But what looks good on the computer screen may not work so well at the real intersection. Therefore some 'after' studies and adjusting will be needed.

During the next three months, December, January and February, City staff and contractors will be installing new traffic control equipment, as well as implementing and fine tuning the new signal timing.

So please be alert to the changing traffic signals and traffic conditions during the next few months. It is our hope that our citizens start referring to traffic signals as "green lights" rather than "red lights."

TRANSPORTATION SERVICES
DEPARTMENT
P.O. BOX 530011
GRAND PRAIRIE, TEXAS 75053–0011

Council discusses traffic light placement, welcome signs

By LINDA B. FARRIS
Staff Reporter

Traffic lights and welcome signs dominated discussions at the Orange City Council meeting at 9 a.m. today.

Mayor Dan Mohon said that during a test period of shrouded traffic signals and replacement stop signs on Green Avenue, he has received few complaints about the elimination of lights, but numerous complaints about activation of the traffic signal at 13th Street on Green.

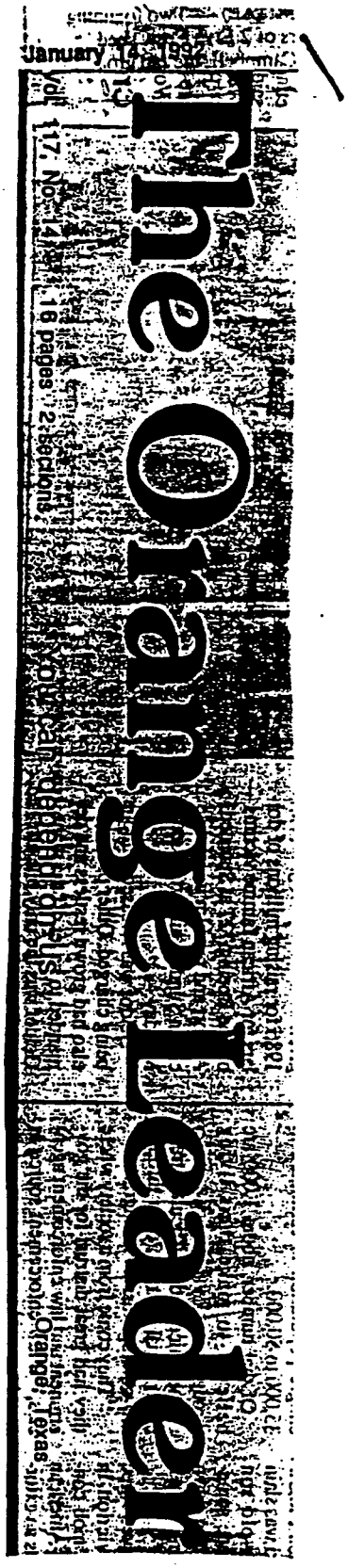
Citizens, he said, see no reason for that light to be fully operable, since there is little cross traffic there, particularly since the West Orange-Stark High School East Campus on Green was closed.

Texas Department of Transportation Resident Engineer Frank James said the light was activated to enhance progression between traffic signals on Green Avenue, to capture traffic coming from the 16th Street intersection and group it. This grouping of traffic at signals along the street helps the flow of side traffic, he said.

James said, however, that because the city is not happy with the 13th Street signal, he will request that a new study be done. He also said that that signal and others may soon be reworked so that they will remain green on the busy street longer, stopping that traffic only when vehicles cross sensors when approaching the signal on the side street.

James and Orange Director of

Please see TRAFFIC, page 2A


January 14, 1992
Vol. 117, No. 14, 16 pages, 25 cents
Orange Leader

•Traffic light location discussed

Continued from page 1A

Public Safety Jerry Penick told the council that city and state studies indicate that the new stop-sign system at the intersections of Green Avenue with Eighth Street, Second Street and Simmons Drive are working and traffic signals there can be safely removed.

Penick said Orange Police Department studies show there has been a 20-percent reduction of traffic flow on Fifth Street at Green since the signals there have been turned off. He said there were a few more traffic accidents there in the last couple of months of 1991 than there were in the same period of 1990, but none were serious.

Penick and James recommended further study of the Fifth Street intersection, and removal of the other three shrouded sets of signals.

Councilman Ron Sigler stated strong objections to any further consideration of removing traffic signals at Fifth and Green. He pointed out that visibility for drivers southbound on Fifth is very bad and traffic signals are needed.

"Unless you've got really good eyesight and conditions are just right, it's tough to see if anything's coming," he said, because of the close proximity of a church and an old retail business building to Green Avenue on either side of Fifth.

On a less controversial note, Penick provided sketches and snapshots of design ideas for "Welcome to Orange" signs to be posted under the 16th Street overpass of Interstate 10.

Councilmen agreed that the idea of placing such signs on the 16th Street medians — one on either side of the roadway to be visible to traffic arriving from all directions — was a good one. They agreed to study designs and select one.

Mohon said he did not believe it would be necessary to use property tax funds for the project. Because the signs would enhance tourism, he said, the money for them probably could come from the hotel-motel tax which state law required be spent to promote tourism and the arts.

Mohon said he wanted to remind citizens, many of whom seem confused about the matter, that hotel-motel taxes — collected from visitors at local motels — are used by the city to help finance the Orange Convention and Visitors Bureau of the Greater Orange Area Chamber of Commerce, and various arts and cultural projects and organizations.

Money for those purposes never comes out of city tax funds, he said. And all money brought in by the hotel-motel tax must, by state law, be spent as designated by state law.

"We couldn't use that money for anything else," he said. "Even if we were broke and really needed it."

SAN ANGELO STANDARD-TIMES—Thursday, June 15, 1989—

Traffic light funding announc

San Angelo hopes to use money for synchronization equipm

From Associated Press
and staff reports

AUSTIN — The governor's office on Wednesday announced a new, $5.2 million program to speed up stalled motorists — and save fuel · · by synchronizing traffic lights around the state.

Texas cities will compete for a share of the money under guidelines being written by the state highway department, with the funds used to supplement up to 75 percent of a city's costs, officials said.

The $5.2 million is being made available through the governor's Energy Management Center and the synchronization program will be handled by the Texas Department of Highways and Public Transportation.

San Angelo Assistant City Manager Don Abell said Wednesday if the funds can be used for equipment purchases, "that would be fantastic."

However, he said, San Angelo would have little use for the money if it is solely for "theoretical planning."

"We already have a good plan that was done for us last year by Traffic Engineers Inc.," he said, "and we're ready to implement it if we ever have the money."

Equipment would cost about $643,400, he said, including some traffic signals, about 50 controllers — the computerized systems that make the signals work — and a number of mast-arms to replace Central Business District on-the-ground lights.

Additional funds would be needed for engineering work tying together the computerized systems and to have the work done by a private contractor.

"My four people (in the signal department) could no way [illegible] this work. We'd have to bid it out," he said.

The plan would synchronize traffic lights in the Central Business District and along Bryant Boulevard, Johnson Street, 19th Street, Knickerbocker Road and from Beauregard Avenue through Sherwood Way.

Abell will present details of the plan and its financial requirements to the San Angelo City Council during the upcoming June 30-July 2 retreat in Kimble County.

He has been aware of the state proposal since December 1987. "It's been kicking around that long," he said.

"We're just waiting for the highway department to come up with the guidelines and tell us what we can do," he said.

He added that San Angelo would have a good chance of winning some of the money, since it is likely to be allocated according to geographic areas covering individual highway department districts, "and San Angelo is the only city of any consequence in this district except for Del Rio."

The money for the program comes from oil overcharge funds which have been refunded to Texas as settlement of alleged oil company price control violations between 1973 and 1981.

"This common sense approach to traffic management can save Texans both time and money by improving the flow of traffic in cities and towns all across our state," Gov. Bill Clements said in announcing the project.

The governor said fewer than half the estimated 13,000 traffic lights in Texas are timed for maximum driving efficiency, and he noted that autos and trucks burn more fuel per mile in traffic than on the open road.

"In fact, it has been estimated that between 30 percent and 40 percent of fuel burned in high traffic is burned while idling at red lights," he said.

SAN ANGELO STANDARD-TIMES—Monday, July 9, 1990

All signs are go for traffic improvements

By LE KILLGORE
Political Affairs Editor

The green light is on for a trio of traffic-control improvements over the coming year in San Angelo.

Assistant City Manager Don Abell said there are three signal-light installations and systems in various stages of development:

- Two sets of traffic lights will be installed by the end of July at the multi-access intersection of Pecos and Howard streets and Sherwood Way. Mast-arm poles for this installation cost $15,421.
- Traffic lights will be installed at Christoval Road and Chadbourne Street and at Paint Rock Road and Kearney Boulevard — at Goodfellow Air Force Base — in about three months. The eight mast-arm assemblies for these lights cost $14,519.
- A $410,000 program jointly funded by the state and the city for new computer-operated traffic lights and synchronized controls to smooth out traffic flow along Bryant Boulevard and within the Central Business District will be in place in about a year.

The San Angelo City Council on Tuesday will take final action on a contract with Traffic Engineers Inc. for designing the two synchronized systems.

Pecos-Howard-Sherwood Way

Abell said work on the Pecos-Sherwood-Howard intersection includes boring six holes for the traffic-light standards, cutting into the street surface to install electric conduits, erecting the poles and hanging the lights.

The lights will operate on a "demand" basis, Abell said, turning green as soon as enough cars drive over timing devices set under the street surface.

Timing the multiple-access area presents a major challenge, he said, "because it's a tight, narrow intersection to work with."

Because there's not much room for eastbound cars to stack up on Pecos before getting to the Pecos-Howard intersection, the Pecos signal will have the longest green light, "so in theory, there won't be many cars backing up waiting to proceed east."

But cars driving south on Howard "can't get out at all now, so these lights will be timed to give them a break," Abell said.

The lights also will be synchronized to match signals at Sherwood Way and Johnson and Sherwood Way and Beauregard.

Christoval-Chadbourne, Paint Rock-Goodfellow

The San Angelo City Council approved the Paint Rock Road light last summer, and the Christoval-Chadbourne light earlier this year.

The equipment, ordered in June, will arrive in about 10 to 12 weeks. "That means we'll install them in about three months, or whenever we get the equipment."

He said the Texas Department of Highways and Public Transportation has informally approved the Paint Rock Road light, but must follow that with formal written approval before actual installation can be accomplished.

Bryant Boulevard—downtown

Traffic-light synchronization has been done on a few major streets in the past, Abell noted, but last summer city administrators asked the council to consider a massive — and expensive — program that would tie together several of the city's systems.

With available funds shrinking at an alarming rate, council members decided to pick two systems they believed would have the greatest impact on the greatest number of drivers: Bryant Boulevard, running the full stretch of the city from north to south; and the Central Business District.

To accomplish this, they issued $250,000 worth of certificates of obligation — a method of borrowing money often used by municipalities.

The city's share will be augmented by a traffic management grant from the highway department: $87,120 from the state and $109,169 from the city for Bryant Boulevard; and $105,000 from the state and $109,107 from the city for the Central Business District.

The state grants come from $5.2 million refunded to Texas as settlement of alleged oil-company price-control violations between 1973 and 1981.

Abell said highway department officials are expected to approve San Angelo's grants this month and sign contracts in early fall.

Once the contracts are signed, he said, the city has one year to complete the work.

Traffic Engineers Inc. of Fort Worth has conducted traffic surveys for the two synchronized areas, Abell said, and the contract to be considered Tuesday will be for the final design phase.

The first phase, which cost $20,000 and focused on the highest-risk intersections in the city, was approved by the council in June 1989.

Once the state money is in hand, he said, the City Council will award contracts for the equipment: 22 controllers and a master computer for the CBD; and 17 controllers and a master computer for Bryant Boulevard.

The computers will be at the city-school shop complex on St. Ann Street, where malfunctions can be noted immediately and crews dispatched to make repairs.

"The one I'm looking forward to is the CBD. We've got some controllers there that were installed in 1946, with the same setting day in and day out," Abell said.

With the new system, he said, "we can have some flexibility." At night, for example, people traveling through the downtown often must stop at one red light after another even though there's no other traffic on the road.

"This way, we may be able to flash some of those lights at night, so you don't have to stop at every intersection," he said.

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Council talks of traffic flow

By LE KILLGORE
Political Affairs Editor

San Angelo City Council talked about traffic flow and traffic access during discussions Tuesday.

The traffic-flow issue related to a grant awarded San Angelo by the Texas Department of Highways and Public Transportation to synchronize traffic-light systems along Bryant Boulevard and in the Central Business District.

Council members awarded two contracts for the work: one to Barton-Aschman Associates Inc. for $9,302 to furnish technical and professional assistance; and for $386,404.50 to Traffic Maintenance and Construction Inc. to install the equipment.

Assistant City Manager Don Abell said the work, which should be finished by the end of August, including replacing downtown traffic lights in place since 1948.

With the new system, he said, downtown lights can be changed to accommodate the heavier traffic of morning and evening hours and the lighter volumes during the hours in between.

Later in the meeting, council members listened to comments from Northbank developer Dick Fausset and City Planning Director David Thurbon on Fausset's proposed multi-use, 900-acre-plus development and golf course at Pulliam Street and Loop 306.

The council took no formal action.

Fausset said he realized that discussing the development before formally presenting a preliminary subdivision plat is "putting the cart before the horse."

He said, however, that his group is anxious to get the golf course completed and opened for play by late this year or early next year.

"Doing that, we have taken significant (financial) risks . . . but we want to do this so we don't lose this year," he said.

Fausset said he and his backers initially were going to ask the city to share to some extent in the golf course development, but decided to go ahead with totally private financing.

But there is still the likelihood his group will ask the city to form a Public Utility District through which the private group can issue bonds to finance street and utility work.

"But I would rather not discuss a PID or whatever other financing vehicle might be available until we have the experts here to answer questions about it," he said.

City Planning Director David Thurbon told the council that in his opinion, Fausset's plan to extend Rio Concho Drive east and Smith Boulevard south through the tract would not provide adequate traffic flow.

He proposed extending Harris Avenue eastward through the tract.

"I feel the development goes against conventional wisdom for street access," Thurbon said, citing other San Angelo subdivisions with as many as 10 access roads.

Angelo will synchronize signals

State, city crews to revamp roads

By LE KILLGORE
Political Affairs Editor

State and city crews will be out in force this week, starting on $1 million worth of fix-up and modernizing projects on two major San Angelo traffic centers.

The projects involve synchronizing traffic controls along Bryant Boulevard and in the Central Business District, and also resurfacing Beauregard Avenue and Sherwood Way.

Work begins Monday on the four-month-long project to synchronize the traffic signals.

Assistant City Manager Don Abell said the contractor, Traffic Maintenance and Construction Co. of Houston, will do the work.

The work will cost $360,755. The state awarded the city a grant of $192,120 from its fuel-overcharge fund for a portion of the costs — $105,000 for the Central Business District (CBD) and $87,120 for the Bryant Boulevard portion.

The $168,635 balance will be paid out of city funds.

When the work is completed in late August, Abell said, "We're hoping to have better traffic-control synchronization for our streets.

"We hope to get a better flow in and out of the downtown area. Now, the CBD lights are set in an unchangeable schedule. Everything is tied into Bryant Boulevard, and it takes an 80-second cycle to get traffic through it, and that's a long time to wait for a light.

"With the new system," he said, "we'll be able to do some changes on it."

All signal lights will be controlled from a central computer system in the city shop building on St. Ann Street, Abell explained.

Any time a signal malfunctions, it will trigger a message via telephone lines to the central computer.

Maintenance people then will address the problem at the computer, "change the settings or the timing, things like that," he said.

In some cases, of course, crews will still have to go "down in the field to fix something," he said.

The first phase of the project involves installing conduit and signal loops, "and folks won't see much in those early phases unless they spot somebody on a pole."

The project also involves installing new controller cabinets on 17 traffic signals along Bryant Boulevard and 22 signals in the CBD; and new mast arms and signal lights at Bryant Boulevard and Beauregard Avenue and Bryant Boulevard and Harris Avenue.

By the first week of July, Abell said, passers-by will begin noticing work in progress as crews start changing out the controller boxes that govern the signals at individual intersections.

While that work is going on, Jascom Inc. of Uvalde will continue the $747,538 Texas Department of Highways and Public Transportation project repairing the Beauregard Avenue bridge and resurfacing Beauregard Avenue.

That project should be completed in late June.

Gene Hirschfelt, spokesman for the highway department, said Jascom crews have finished working on the underside of the bridge and will start Tuesday working on the top.

As a result, he said, two of the four lanes across the bridge will be closed. "There will be two-way traffic, but it will be on one side of the median."

The work will take two or three weeks, he said, with the two-lane traffic flow shifted as necessary from one side of the median to the other.

Reece Albert Inc. of San Angelo is the subcontractor for putting down a new road surface along Beauregard Avenue from Koenigheim to the Beauregard-Sherwood "Y" intersection, and then along Sherwood Way to Arden

Computer work likely to signal easier driving

By LE KILLGORE
Political Affairs Editor

Traffic lights downtown and along Bryant Boulevard are being treated this summer with a stiff dose of computer wisdom that by late August should make driving a bit easier.

Carl Mock, supervisory traffic signal technician with the city's signal control division, said Friday the traffic synchronization project should be completed "in about three weeks."

The work, which began in late April, will cost $360,755. Of the total, $192,120 comes from a grant awarded to San Angelo from the state's fuel overcharge fund.

When everything is in place, traffic lights at 39 intersections — 18 along Bryant and 21 in the Central Business District (CBD) — will be synchronized according to the traffic demands of each area and varied according to the time of day, with the goal of smoothing traffic flow.

But Mock warned people "not to think new timing is a magic cure-all for everything, because it is not.

"Even if the lights are perfectly synchronized, we still will have problems that cannot be remedied by signal timing," he said.

Consider the CBD, Mock said, with pedestrian traffic, angle parking, no separate left-turn lanes and a number of drivers who are inclined to travel well below the speed limit.

"Where there is no left-turn bay, you may not be able to move (on a green light) because of having to wait for the left-turner," Mock said.

"And some people drive 20 miles an hour, so if you time the lights for 30 miles an hour, half the time you won't make it because of the traffic; and if you time it for 20 miles an hour you will overdrive it," he said.

"We can look for better results on Bryant Boulevard," he said, "because people are more inclined to drive through there, where people who go downtown very seldom drive straight through."

Overall, each system — the CBD and Bryant Boulevard — is called a grid.

The new system involves a central computer in the City-School Shop Complex at 1627 St. Ann St., a master controller at the intersection of Harris and Main streets and individual secondary controllers at all intersections that are part of one of the two grids.

Attached to the computer is a modem — a telephone line that links one computer with another computer or with a computer terminal.

The computer is linked with the master controller, which in turn sends and receives signals from the secondary controllers.

Mock said new controllers have been installed at 36 of the 39 intersections, computer hookups have been established between the main computer and the CBD grid, and work on the Bryant grid is "about 99 percent complete."

The project also includes installation of six new 40-foot-long mast arms — the old ones were 30 feet — at Bryant and L, Bryant and 29th, Abe and Beauregard, Koenigheim and Beauregard, Harris and Abe and Harris and Koenigheim.

Another change will be a left-turn lane on Harris Avenue between Abe and Koenigheim, accomplished by banning on-street parking on both sides of Harris.

Mock said people who find they cannot drive through the downtown area as easily as they used to are absolutely right: The timing was set heavily in favor of traffic traveling along Harris and Beauregard avenues; now it has been changed to give more time for traffic moving along Twohig, Concho, Randolph, Irving and Oakes.

Those changes won't be permanent, he emphasized: "The timing plan is in a kind of in-between state."