Executive Summary
RTSRP Phase III

Prepared for:
North Central Texas Council of Governments

Prepared by:
HDR
17111 Preston Road
Dallas, Texas 75248
(972) 960-4400

Prepared in cooperation with the Regional Transportation Council, NCTCOG, and the Texas Department of Transportation.

Contact:
Leslie Pollack, P.E., PTOE
Texas PE # 101285

HDR
Texas Registration #F-754

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STATE OF TEXAS
LESLIE D. POLLACK
101285
LICENSED
PROFESSIONAL ENGINEER

1.0 Introduction

The North Central Texas Council of Governments (NCTCOG) contracted HDR, Inc. to provide assistance to local agencies to coordinate traffic signal timing for 298 traffic signals along various corridors within the Metroplex. This summary covers traffic signals operated by North Richland Hills, Frisco, Hurst, Denton, Flower Mound, Lewisville, and the Fort Worth and Dallas Districts of the Texas Department of Transportation. Figure 1 illustrates the locations of these traffic signals. This project has improved progression along these arterial streets without regard to jurisdictional boundaries.

2.0 Project Scope

The assigned intersections were grouped into designated corridors that ranged in size from 7 to 22 intersections. For each corridor, the scope included the following tasks:

- A baseline assessment to document the conditions as of the beginning of the project.
- Development, implementation, and fine-tuning of the new signal timing plans.
- An after assessment to quantify and document the project results.

3.0 Data Collection

The project included extensive data collection:

- For all intersections, peak-hour turning movement counts were made either by human observers who used electronic count boards or video data recorders to document the number of vehicles by approach direction and by movement (i.e., left turn, straight through, or right turn).

- Bi-directional machine counts were made with pneumatic tube-type counters that digitally record the number of vehicles in 15-minute increments, totaled on an hourly basis. These included seven-day counts, 24-hour counts, and vehicle classification counts.

- As one means of measuring the benefits of the project, travel time runs were made with an instrumented vehicle. The software electronically recorded the vehicle's speed, the distance traveled, and the number and elapsed time of each stop.

4.0 Signal Timing Plans

For all corridors, new timing plans were developed for the AM and PM peaks plus the weekday midday peak. In some cases, separate versions of the AM and midday plans were required for times when school speed zones are in operation. Some corridors required timing plans for other periods such as the Saturday afternoon peak or weekday afternoon off-peak. After the new timing plans were operational, extensive "fine-tuning" was performed to improve actual on-street performance.

5.0 Project Results

5.1 Travel Time Runs

The project results were measured quantitatively through the travel time runs made with an instrumented vehicle traveling at the pace set by other traffic. The "before" runs were made at the start of the project prior to any changes in the previous signal timing. Later, after the new signal timing plans had been installed and fine-tuned, the "after" runs were made. A comparison of the "before" and "after" travel time runs determined that the following reductions had been attained in travel time, stops, and delay:

- Travel Time
    - Weekday
        - 6 percent overall reduction
        - 5,510 seconds (92 minutes) reduction per day
        - 2,910 vehicle-hours reduction per day
    - Saturday
        - 10 percent overall reduction
        - 910 seconds (15 minutes) reduction per day
        - 390 vehicle-hours reduction per day
- Stops
    - Weekday
        - 14 percent overall reduction
        - 140 stops reduction per day
        - 232,180 vehicle-stops reduction per day
    - Saturday
        - 19 percent overall reduction in number of stops
        - 14 stops reduction per day
        - 18,420 reduction per day

Some corridors experienced an increase in travel time, stops, and delay during the "after" travel time runs including SH 26, Bedford Euless, Pipeline, Hurst, FM 1171, and BU 67.

5.1.1 SH 26

SH 26 experienced an increase in travel time, stops, and delay during the AM and PM peak periods. Before travel time runs were completed in February of 2015 while after travel time runs were completed in April of 2018, three years later. The increased volumes on the corridor resulted in deteriorating measures of effectiveness. The interchange at SH 26 and NE Loop 820 is over capacity and cannot accommodate the additional demand. The improvements needed at this interchange cannot be achieved through signal timing alone. It is recommended that further study be initiated to evaluated capacity increases at this interchange.

5.1.2 Bedford Euless

Bedford Euless experienced an increase in travel time, stops, and delay during all peak periods. Because the two eastern intersections are uncoordinated (free) and the intersections to the west are coordinated separately from Precinct Line Road and Irwin Drive, results from travel time runs on this corridor varied due to random arrivals. Additionally, pedestrian walk and clearance times at intersections along Bedford Euless Road were updated to comply with guidance in the Texas Manual on Uniform Traffic Control Devices (TMUTCD). In most instances, updating pedestrian interval timing required increasing the minor street splits at intersections. This reduced the major street split time, and thus also contributed to increased delays on the major street.

5.1.3 Pipeline

Pipeline showed an increase in travel time due to the travel time increase in the midday peak period. Pedestrian walk and clearance times at intersections along Pipeline Road were updated to comply with guidance in the TMUTCD. In most instances, updating pedestrian interval timing meant increasing the cycle time given to pedestrians, and therefore increasing the time required for the minor street at each intersection. This reduced the major street split time, and thus also contributed to increased delays on the major street. Furthermore, increased delay experienced during the midday peak stems partly from stopped time at Precinct Line Road, where the cycle length was increased to 132 seconds in order to coordinate with the North Precinct Line Road corridor.

5.1.4 Hurst

Hurst showed an increase in overall delay due to the increase in delay during the PM peak period travel time run. The team observed travel time and operations in the PM peak period on three occasions. Field operations generally remained comparable to existing conditions on travel observation days. After travel time runs were not reflective of the conditions observed in the field.

5.1.5 FM 1171

FM 1171 showed an increase in travel time, stops, and delay during the weekend peak period. This is due to increased side-street splits at Old Orchard Lane, Civic Circle, Valley Parkway, and the High School Driveway over existing conditions. The increased splits on the side street reduce delay for traffic on the minor streets during peak periods of demand, but result in slightly increased stops and delay on FM 1171 during the weekend peak period.

5.1.6 BU 67

BU 67 showed an overall increase in travel time due to the increase in travel time during the AM and Midday peak periods. Although there was an average increase in delay during these peak periods, the travel time and delay were decreased for the peak direction (WB).

5.1.7 Loop 288

Loop 288 showed an increase in travel time, stops, and delay. This can be attributed to the 3 year time difference between “before” and “after” travel time runs, resulting in an increase in traffic volumes and surrounding development. The diamond intersection at IH 35E and Loop 288 does not provide sufficient capacity, resulting in poor operations with the increase in traffic volumes. Construction is planned for the diamond to increase capacity in the near future, and it is recommended that the signal timing be revisited at the southern end of the corridor once construction is complete.

5.1.8 University

The eastern portion of University Boulevard showed an increase in travel time, stops, and delay, while the western portion of University Boulevard showed an increase in delay. Limiting geometry along the corridor resulted in queuing and spillback at the IH 35 diamond interchange, the Loop 288 diamond interchange, as well as at major cross-streets with short turn-lane bays. Signal timing throughout the corridor was generally increased, with a maximum increase of 40 seconds in cycle length, in order to accommodate heavy volumes on the corridor. The resulting cross-street and left-turn queuing was addressed by shifting through movement green time to movements with significant queuing. A break in signal coordination was also placed along the corridor to increase the cycle length at the eastern portion of the corridor to accommodate heavier volumes. The Loop 288 diamond is characterized by insufficient frontage road storage and requires a significant portion of the cycle to prevent queue spillback onto the mainlanes. The IH 35E diamond signal timing proved challenging to implement, and the clearance intervals were not operating. Once the signal timing is corrected, the increased northbound and southbound green time may allow additional green time to be shifted to University Drive. A review of after travel time run videos revealed that the corridor was not operating according to the proposed signal timing, and several stops occurred that were not expected. Travel time runs completed during signal timing implementation had travel time durations less than those documented by after travel time runs. It is recommended that the signal timing along University Drive is reviewed and adjusted as needed to match the splits and offsets in the proposed signal timing for all peaks.

5.2 Synchro™ Version 9 Measures of Effectiveness

The project results were also estimated from the Synchro™ Version 9 models that were used to develop the new traffic signal timing plans. For each corridor, the calibrated model of the before timing was compared with the calibrated model of the final timing. The measures of effectiveness (MOEs) that were compared included total signal delay and fuel consumption along with three categories of emissions (CO, NOx, and VOC). The following improvements were estimated by the Synchro™ Version 9 comparison:

- Signal Delay
  - Weekday
    - 5,340 overall vehicle-hour reduction per day
  - Saturday
    - 2,250 overall vehicle-hour reduction per day

- Fuel Consumption
  - Weekday
    - 5,170 overall gallon reduction per day
  - Saturday
    - 2,020 overall gallon reduction per day
- Emissions
  - Weekday
    - VOC reduction of approximately 97,760 grams per day
    - CO reduction of approximately 361,400 grams per day
    - NOx reduction of approximately 70,350 grams per day
  - Saturday
    - VOC reduction of approximately 32,720 grams per day
    - CO reduction of approximately 141,080 grams per day
    - NOx reduction of approximately 27,480 grams per day

5.3 Estimated Economic Benefits

The following rationale was used to estimate the daily user savings from the new timing plans for most corridors:

- On each weekday there will be:
  - Two hours of benefit from the AM peak period timing plan
  - Two hours of benefit from the PM peak period timing plan
  - Five hours of benefit from the midday peak period timing plan
  - To be conservative, no benefit is assumed from other hours of the day even though most of the corridors operate the new timing plans for at least 12 hours per day.
- On Saturday, there will be four hours of benefit from the timing plan.

The following rationale was used to estimate the daily user savings from the new timing plans for corridors in Denton:

- On each weekday there will be:
  - Two hours of benefit from the AM peak period timing plan
  - Two hours of benefit from the PM peak period timing plan
  - Three hours of benefit from the midday peak period timing plan
  - Two hours of benefit from the off-peak period timing plan

For the purpose of economic analysis of transportation improvements, the Texas A&M Transportation Institute's 2015 Urban Mobility Scorecard estimated congestion value is $23.43 per vehicle-hour of delay for 2018 (considering inflation).

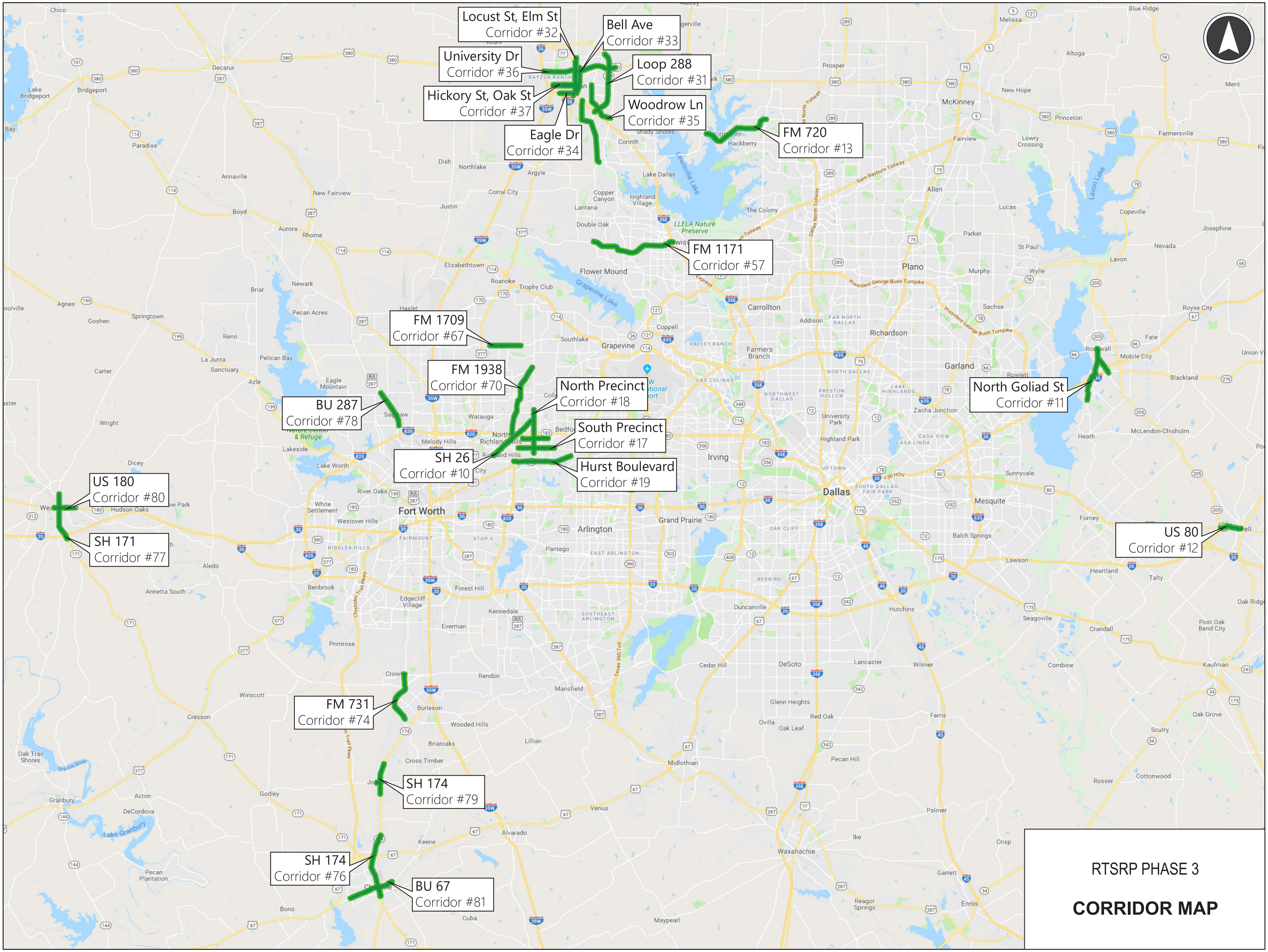
For each corridor, the "before" and "after" Synchro™ Version 9 models were compared for each of the timing plans. Considering the composite total signal delay for all corridors and using the above-described rationale, the estimated user benefit is $125,120 per weekday. Assuming 248 weekdays per year, this equates to an annual savings of approximately $31 million.

The attached Table 1 provides a summary of the project benefits. The data provided include the following statistics per travel time route: number of signals, average daily traffic volume, and project benefits (reductions in travel time, stops, and delay). Also provided were the following statistics per corridor: number of signals, project benefits as derived from the Synchro™ Version 9 models (reductions in total signal delay, stops, travel time, fuel consumed, and emissions). Daily user savings are calculated using $23.43 per vehicle-hour of delay and total signal delay (veh-hours) from the Synchro™ Version 9.

The greatest per-intersection improvements were attained in the following corridors:

- Corridor 11 (North Goliad)
- Corridor 18 (North Precinct)
- Corridor 57 (FM 1171)
- Corridor 77 (SH 171)
- US 180 (Corridor 80)

These corridors saw daily delay savings of more than $700 per intersection. These benefits were realized through improved phasing, adjusted cycle lengths, and improved coordination between intersections.



RTSRP PHASE 3

CORRIDOR MAP

Table 1
Summary of Project Benefits

	Corridor	Type	Contract Number of Signals	Average Daily Traffic	Benefits: From Travel Time Runs[A]: Travel Time (seconds)	Stops	Delay (seconds)	From Synchro: Total Signal Delay (veh-hours)	Stops	Total Travel Time (veh-hours)	Fuel Consumed (gallons)	VOC Emissions (grams)	CO Emissions (grams)	NOx Emissions (grams)	Daily User Savings[B]: Corridor Total	Per Intersection
10	SH 26	Weekday	14	22,339	187	1.2	195	-17	1,519	-35	-44	-750	-3,160	-620	$398.31	$28.45
	North Goliad (SH 205)	Weekday	11		-719	-12.7	-694									
11	North Goliad (FM 740 - 1)	Weekday	6	40,948	-201	-2.9	-201	-390	-12,039	-388	-416	-6,790	-29,080	-5,630	$9,137.70	$830.70
	North Goliad (FM 740 - 2)	Weekday	4		-25	-0.9	-22									
12	US 80	Weekday	8	33,087	-231	-5.2	-226	-146	-9,746	-151	-193	-3,200	-13,720	-2,690	$3,420.78	$427.60
13	FM 720	Weekday	10	27,007	-324	-4.4	-110	11	-5,951	-43	-198	-3,150	-13,800	-2,680	-$257.73	-$25.77
		Saturday		32,964	-332	-4.8	-332	0	-5,524	-48	-156	-2,560	-11,080	-2,160	$0.00	$0.00
	Precint Line	Weekday		19,762	-37	-4.2	-39									
17	Bedford Euless	Weekday	22	12,088	195	2.6	195	-14	-8,713	6	-56	-890	-3,780	-710	$328.02	$14.91
	Pipeline	Weekday		28,214	14	-11.1	-193									
18	North Precinct	Weekday	9	32,087	-127	-7.0	-153	-446	-18,443	-522	-406	-6,590	-28,500	-5,540	$10,449.78	$1,161.09
19	Hurst Boulevard	Weekday	12	29,256	-118	-3.3	70	-37	-8,915	-35	-159	-2,580	-11,270	-2,220	$866.91	$72.24
31	Loop 288	Weekday	10	39,960	511	14.5	569									
32	Locust/Elm	Weekday	19	39,961	-262	-10.5	-264									
33	Bell	Weekday	10	39,962	-109	-4.4	-55									
34	Eagle	Weekday	7	39,963	-140	-6.6	-162	-268	-18,580	621	741	12,010	51,920	10,070	$6,279.24	$78.49
35	Woodrow	Weekday	8	39,964	-387	-6.4	-390									
36	University (East)	Weekday	17	39,965	242	8.1	149									
	University (West)	Weekday			-59	-0.4	78									
37	Hickory/Oak	Weekday	9	39,966	-36	-6.9	-36									
57	FM 1171	Weekday	21	47,535	-423	-13.5	-426	-2,764	-18,668	-2,660	-2,023	-32,780	-141,640	-27,550	$64,760.52	$3,083.83
		Saturday		42,280	192	4.4	172	-2,108	-11,560	-2,056	-1,584	-25,680	-110,720	-21,560	$49,390.44	$2,351.93
67	FM 1709 (Keller Parkway)	Weekday	7	39,576	-330	-3.5	-290	59	2,054	70	82	1,350	5,640	1,110	-$1,382.37	-$197.48
70	FM 1938	Weekday	14	35,399	-169	-0.2	-212	1	4,844	68	-80	-1,320	-5,660	-1,100	-$23.43	-$1.67
74	FM 731	Weekday	9	20,002	-481	-9.1	-365	-181	-8,404	-174	-225	-3,640	-15,770	-3,010	$4,240.83	$471.20
		Saturday		15,526	-228	-5.6	-236	-40	-3,956	-40	-72	-1,120	-4,880	-960	$937.20	$104.13
76	SH 174 (Cleburne)	Weekday	15	28,113	-277	-5.6	-277	-157	-17,149	-152	-326	-5,230	-22,580	-4,340	$3,678.51	$245.23
77	SH 171	Weekday	12	23,482	-907	-12.5	-905	-391	-28,540	-393	-491	-22,246	-34,150	-6,630	$9,161.13	$763.43
		Saturday		23,841	-332	-4.8	-336	-40	-9,764	-40	-104	-1,680	-7,240	-1,400	$937.20	$78.10
78	BU 287	Weekday	8	38,989	-679	-14.9	-645	-125	-19,986	-96	-408	-6,500	-28,300	-5,650	$2,928.75	$366.09
79	SH 174 (Joshua)	Weekday	8	25,248	-198	-5.6	-157	52	-5,772	57	-39	-600	-2,630	-530	-$1,218.36	-$152.30
80	US 180	Weekday	10	19,865	-504	-6.9	-499	-311	-19,222	-303	-373	-5,780	-25,900	-5,020	$7,286.73	$728.67
		Saturday		13,127	-208	-3.6	-208	-60	-7,084	-60	-104	-1,680	-7,160	-1,400	$1,405.80	$140.58
81	BU 67	Weekday	18	17,371	24	-2.7	-23	-216	-45,442	-225	-559	-9,070	-39,020	-7,610	$5,060.88	$281.16
Average		Weekday			-197	-4.8	-184	-297	-13175	-242	-287	-5431	-20078	-3908	$6,950.90	$454.22
		Saturday			-182	-2.9	-188	-450	-7578	-449	-404	-6544	-28216	-5496	$10,534.13	$534.95
Total		Weekday			-5512	-134.6	-5165	-5340	-237153	-4355	-5173	-97756	-361400	-70350	$125,116.20	$8,175.88
		Saturday			-908	-14.4	-940	-2248	-37888	-2244	-2020	-32720	-141080	-27480	$52,670.64	$2,674.74

Note A: Based on the following hours of benefit per weekday from the three timing plans: 2 hours per weekday for AM Peak plan; 5 hours per weekday for the Midday plan; and 2 hours per weekday for PM Peak plan

Note B: Corridors 31-37 based on the following hours of benefit per weekday from the three timing plans: 2 hours per weekday for AM Peak plan; 3 hours per weekday for the Midday plan; 2 hours for the OP Peak plan; and 2 hours per weekday for PM Peak plan

Note C: Based on $23.43 per hour of Synchro™ total signal delay