Traffic Signal Timing Strategies 3/2013

Option	Method	Pros	Cons
1.	Run signals independently at all times	*Shortest* side-street delay	Repeated stops on arterial streets; gridlock where signals are closely spaced (e.g. Legacy Park, Shops at Willow Bend, etc.); loss of coordination across municipal boundaries
2.	Run signals independently during off-peak periods and in coordination during peak periods	Short side-street delay	Side-street delays during peak periods; repeated stops on arterial streets; probable gridlock during off-peak periods and week-ends; loss of coordination across municipal boundaries
3.	Run minor intersections free at all times, coordinate signals between selected major intersections	Shorter side-street delay	Nearly as many repeated stops as option 1; gridlock where signals are closely spaced
4.	Operate signals using shorter cycle lengths, ***without*** traffic count input, and computer analysis	Shorter side-street delay	Longer lines of waiting traffic at major intersections; increased arterial travel time; loss of coordination across municipal boundaries;
5.	Operate signals using shorter cycle lengths, ***with*** traffic count input, and computer analysis	Shorter side-street delay; increased probability of arterial traffic not stopping	Waiting lines of traffic; **Requires turning movement count data at all intersections as input into computer model**; higher travel time on arterial streets; loss of coordination across municipal boundaries
6.	Run off-peak timing plans during peak periods	Reduced side-street delay during peak periods	Side-street delay during off peak periods; cycle failures at major intersections; possible gridlock where intersections are closely spaced
7.	Operate signals in coordination, with arbitrarily shorter cycle lengths for off-peak period only,	Reduced side-street delay during off-peak period only	Side-street delay during peak periods; increased arterial travel time during off peak periods, increased maintenance requirements
8.	Operate signals in full coordination, with arbitrarily shorter cycle lengths for the peak periods only	Somewhat reduced side-street delay during peak periods only	Probable cycle failures at major intersections; increased travel times; waiting traffic lines; No coordination across municipal boundaries; side-street delay during off-peak periods
9.	Deploy a traffic adaptive system	Reduced arterial travel time and side-street delay **along a corridor**;	Technology is not refined (system-wide application is limited); Expensive (approximately $32.00 per Plano resident); takes years to deploy; requires an extensive vehicle detection system; *substantially increased* maintenance requirements; Best applied to uniform road grids; technology is not available for **low cost** *system-wide* deployment (only corridor applications exist at this time)
10.	Balance side-street delay with progression on arterial streets (**The current practice**)	Minimizes arterial stops and travel time; Limited coordination across municipal boundaries; minimizes gridlock in congested areas	*Perception* of excessive delay on side-streets, excessive stops on arterials, increased maintenance requirements
11.	Operate side-streets in flash during off-peak periods	Reduced side-street delay;	Does not meet driver expectation; spurious complaints about flashing signals; increased delay and accidents where arterial street traffic is heavy or sight-distance is limited; increased risk exposure to Plano;

CITY of PLANO
TRAFFIC SIGNAL RETIMING PROJECT
ZONE 3 – Off Peak Period

10/30/12
Plano Transportation Engineering Division
L: Signals/Zone 3 off peak report 2012 rev a.doc

EXECUTIVE SUMMARY

The City of Plano long ago recognized the need for efficiently operated traffic signals. Efficiently operated traffic signals provide the benefits of reduced delay, stops, and fuel consumption, and as the City's population and traffic volumes have grown, the need to minimize these factors has increased in importance.

The City of Plano has used coordinated signal operation since the early 1990s, and the timing of traffic signals is optimized periodically in order to keep pace with the City's changing traffic patterns. The City has been regularly optimizing and updating traffic signal timing for some years. However, this is the first time the timing has been updated for Zone 3 for the off-peak period.

Due to the changes in traffic volumes on the City's streets, it is necessary to optimize the timing of traffic signals at regular intervals. In response to this need, City staff have optimized the off-peak timing in Zone 3, and the results of that effort are presented here.

The off-peak period is here defined as the period during and immediately before and after the mid-day meal time, and for the purposes of this study is considered to be from 11:30 AM to 1:30 PM.

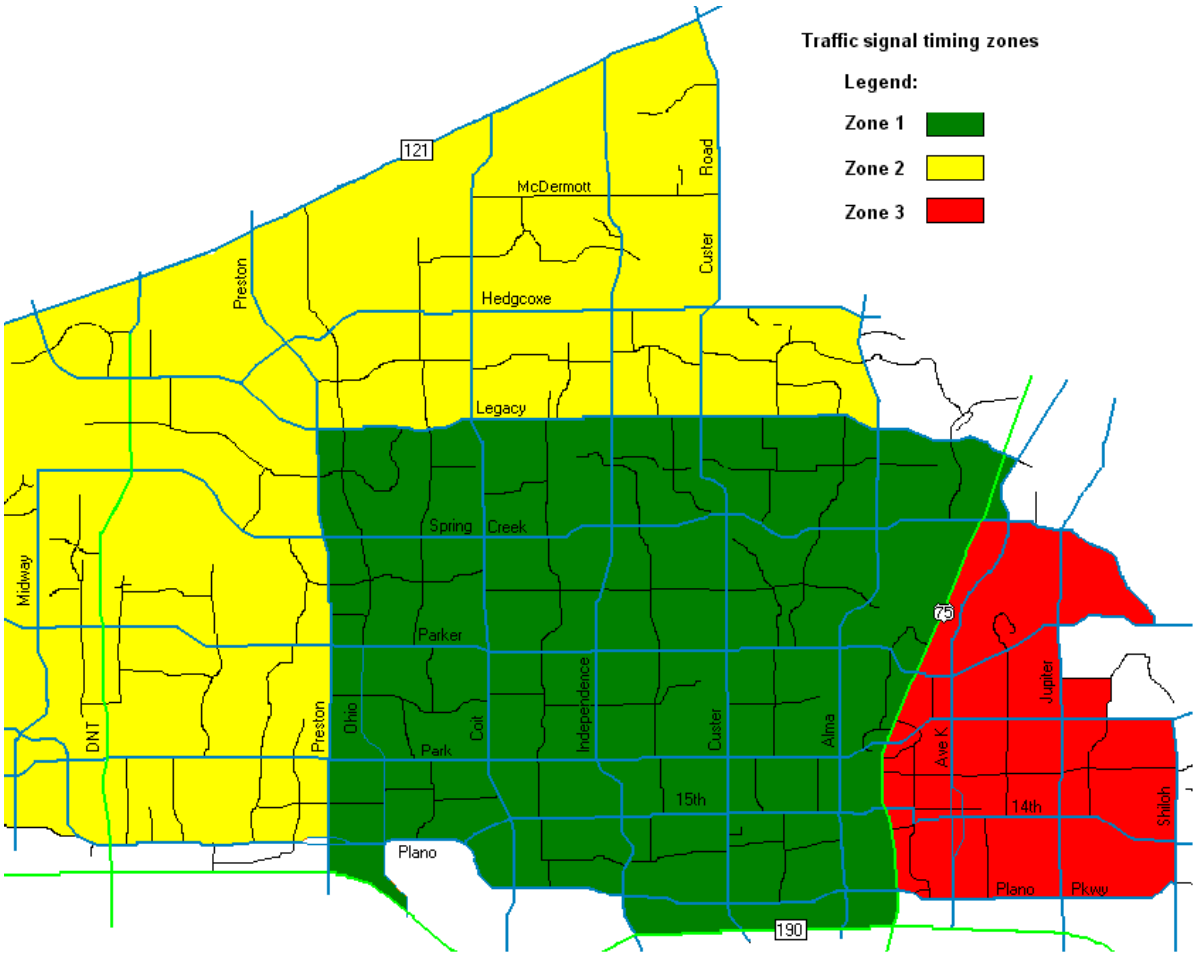
DISCUSSION

Zone 3 roughly comprises the portion of the City east of US 75. This area contains thirty-five of the City's 221 traffic signals. With funding assistance provided by the North Central Texas Council of Governments (NCTCOG), the City retained the services of a consulting firm to collect the traffic volume data from the intersections in the zone.

In addition, staff performed travel time measurements on major streets in this Zone 3 using a portable computer equipped with a global positioning sensor (GPS). These measurements establish the baseline conditions against which the effects of the new traffic signal timing could be compared. Staff then optimized and implemented the new signal timing. After implementation of the optimized timing, the travel times were measured again.

As with previous signal timing efforts, the goals of this effort were:

- Provide improved progression between traffic signals
- Demonstrate the effects of the new timing by directly measuring the travel times before and after optimizing the signal timing
- Reduce delay, stops, and fuel consumption at signalized intersections
- Quantify the effects of the revised traffic signal operation in terms of delay, travel time, and operating cost
- Present the results to City council and the public



Zone 3, the area included in this study, consists of the area east of US 75, as shown in the map above.

Transportation personnel, with the assistance of the consultant, gathered data at the signalized intersections in Zone 3. This data included turning movement counts, intersection geometry, arterial data and signal timing. While the former traffic signal timing plans were still operating, staff measured the actual travel times and signal-related delay along the major arterials in this zone.

Using sophisticated traffic analysis software called Synchro™, staff analyzed traffic patterns and optimized the traffic signal timing. Dozens of combinations of cycle lengths, phase sequences, green time and other options were considered before the plan was finalized. After deployment, the resulting traffic signal timing was quality-checked by City staff for several weeks. City staff identified intersections where traffic delays could be further reduced, and made additional improvements to the timing of these signals. After the new signal timing was implemented, the results were observed to verify the improvements. Where needed, signal timing was further revised to optimize traffic flow.

After fully implementing the new signal operation, staff again measured the travel times along the same arterials and compared the new travel times with the times using the old signal timing.

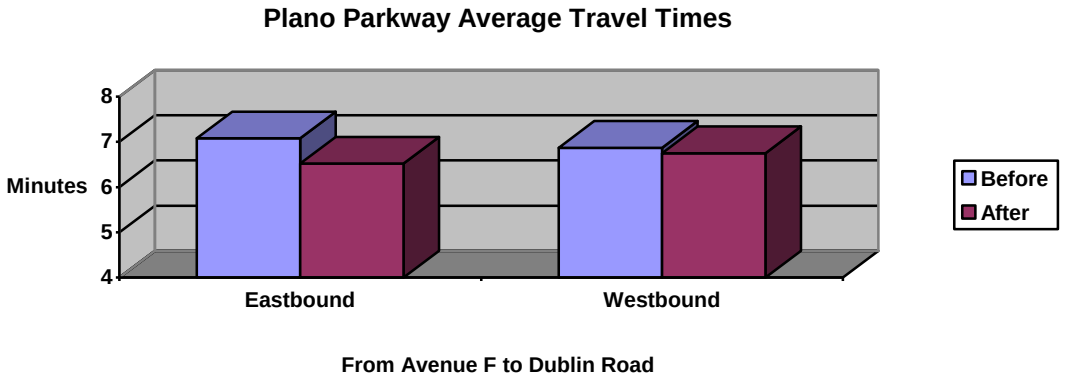
The Synchro™ traffic software used to optimize the traffic signal timing also provides the means to estimate the number of gallons of fuel consumed, the number of stops, and the total delay experienced by vehicles. The economic impact of these factors is presented below.

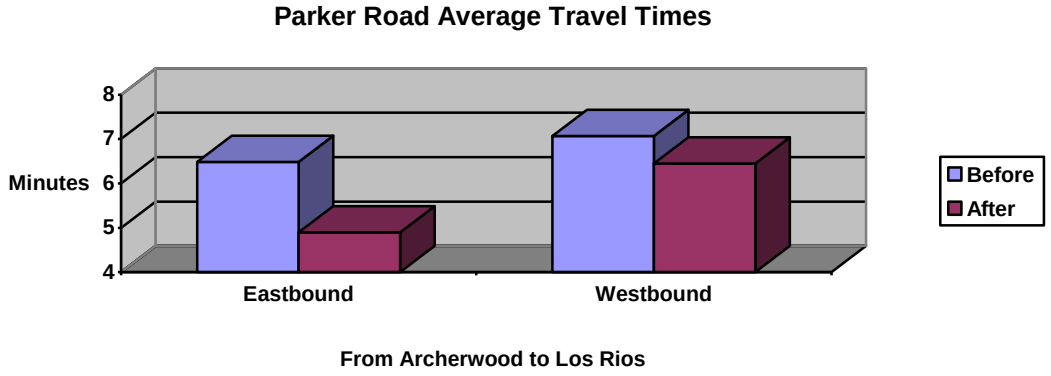
RESULTS

As noted above, staff measured and recorded the actual travel time on six major arterials in Zone 3 during the off-peak period, while the old traffic signal timing was still in effect. These times are shown in the following charts as the “before” measurements.

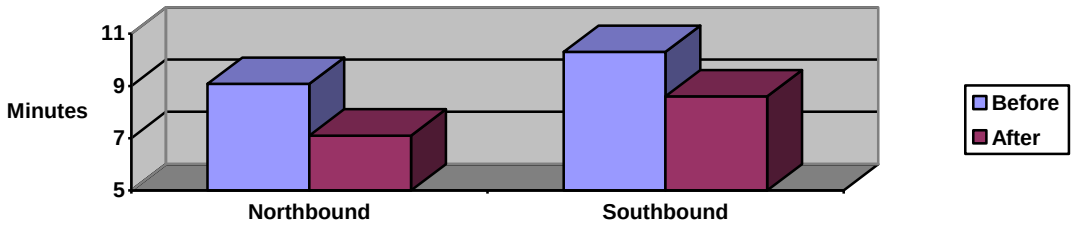
After staff implemented the new traffic signal timing, travel times were again measured. The travel time measurements using the new signal timing are shown as the “after” measurements.

The following charts summarizes the travel times before/after optimizing traffic signal timing.



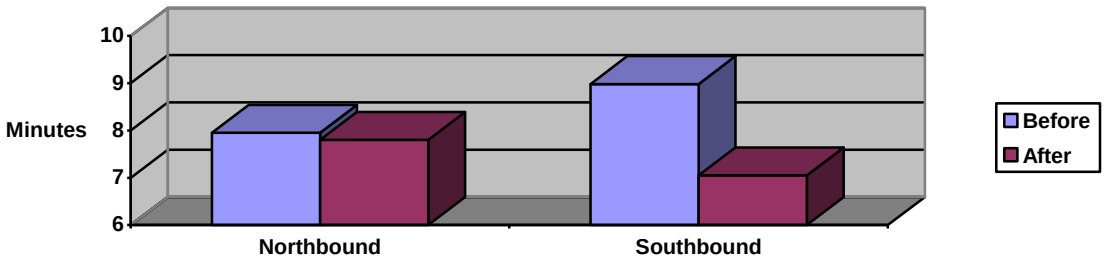


Jupiter Road Average Travel Times



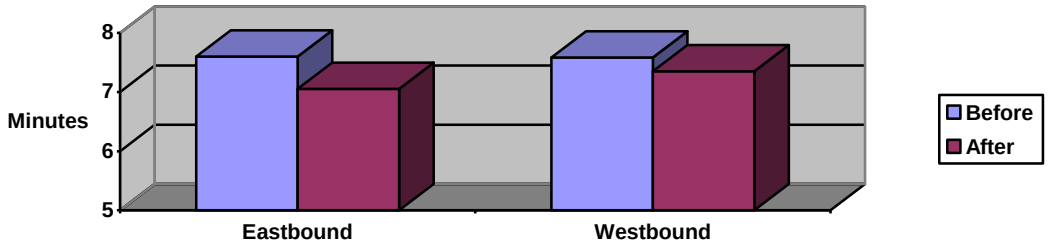
From Plano Parkway to Timberbrook Drive

Avenue K Average Travel Times

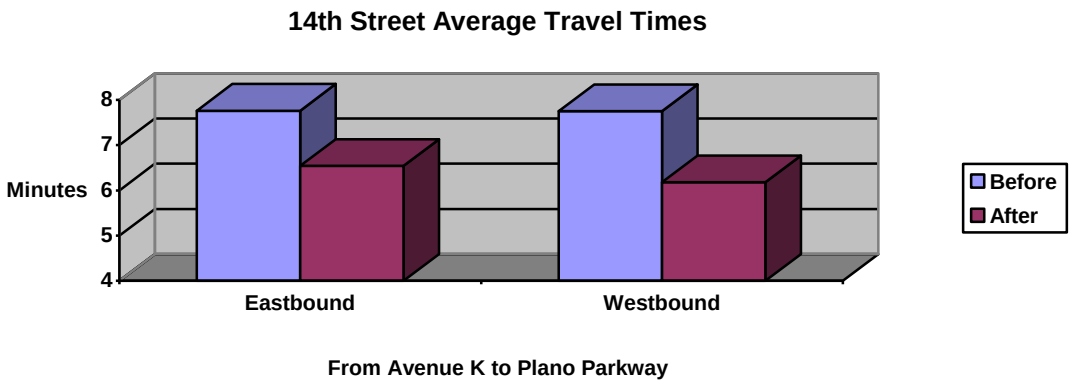


From Plano Parkway to Legacy Drive

Park Boulevard Average Travel Times



From Republic Drive to Los Rios



System-wide measurements

Fuel consumption, stops, and delay all contribute to the operating costs incurred by drivers as they pass through a network of roadways. Standing vehicles consume extra fuel while idling, and excessive vehicle stops add additional maintenance costs due to wear and tear on vehicular brake systems. And, because drivers value their personal time, the value of a driver's time while waiting in traffic (excess delay) also contributes to operating costs.

With the assistance of Synchro™ software, staff estimated the delay, stops and fuel consumption for both the "before" and "after" conditions. The methods used to calculate these costs are recognized by the Institute of Transportation Engineers (ITE) and Texas Transportation Institute (TTI) and provide the means to compare the benefits of traffic signal management options. The following monetary values reflect late 2007 economic conditions in Plano.

The costs assumed are:

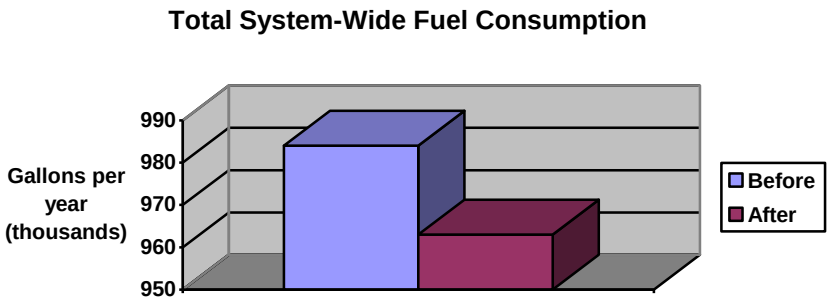
- $3.20 per gallon of fuel
- 1.8 cents per stop
- $16.50 per hour of vehicle delay

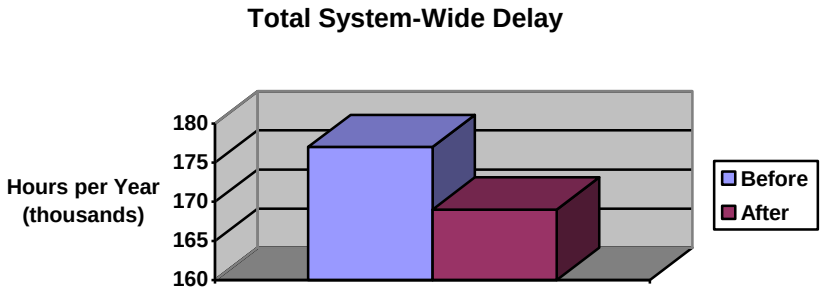
On weekdays, the Zone 3-off peak signal timing pattern operates 9 1/2 hours per day, from 6:00 AM to 6:30 AM, from 9:00 AM to 4:00 PM and from 7:00 PM to 9:00 PM. On weekends, this timing plan runs from 9:00 AM to 9:00 PM. However, because the data used to perform this study were collected only from 11:30 AM to 1:30 PM on weekdays, a period of only two hours, the operating costs in this report will be computed for this time period only. Accordingly, staff based the operating costs on 2.0 hours per day, five days per week, and fifty-two weeks per year.

The revised traffic signal timing has the following effects:

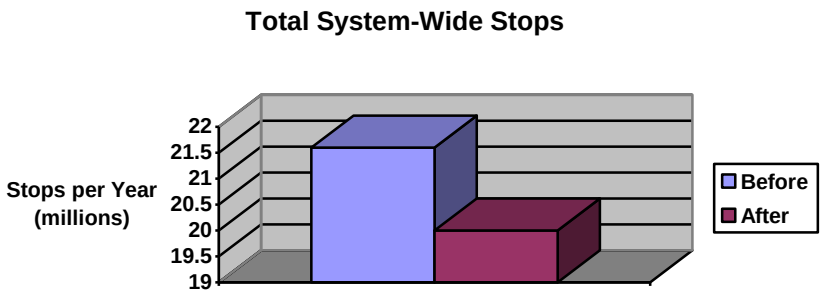
- Reduces fuel consumption by 21,000 gallons per year.
- Reduces stops by 1.4 million per year.
- Reduces delay by 7,500 hours per year
- Reduces operating costs by $215,943 per year.
- Reduces Carbon Monoxide (CO) emissions by 1.58 tons per year
- Reduces Nitrous Oxide (NOx) emissions by 0.31 tons per year
- Reduces Volatile Organic Compounds (VOC) emissions by 0.37 tons per year

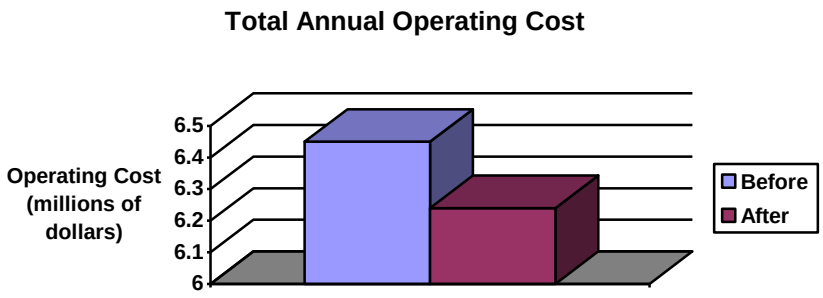
The following charts show the Measures of Effectiveness of the revised signal timing for the system as a whole.





Total delay is the total of the amount of delay experienced by all vehicles for all directions at all traffic signals.





In summary, the total benefits to the public are as follows:

- The amount of benefit returned to the public for this project is estimated to be $215,943.
- Labor costs incurred to implement the new timing were approximately $15,113.
- For every dollar spent on labor, $14.29 was returned to the public in benefits.
- Although calculated for a one-year period, the benefits of the zone 3 off peak period timing optimization can be expected for two to three years beyond the project's completion.

This is part of an on-going effort. Now that work is completed on the Zone 3 off peak period, staff will turn their attention to the Zone 1 morning peak period and perform a similar effort.

Comments

It should be noted that the benefit estimate stated above is extremely conservative and that the actual benefits of this project are probably much greater than stated here. As described in a previous section, the timing plans developed with this project operate for 9½ hours per weekday, and twelve hours per day on weekends, which is a total of 71.5 hours per week. The benefits described above apply to only ten of those hours, leaving the benefits of 61.5 hours per week unaccounted for in the measures of effectiveness mentioned above.

Because traffic count data was only acquired from the period from 11:30 AM to 1:30 PM on weekdays, it is not possible to quantify the estimated measures of effectiveness outside this time period. These measures, such as fuel consumption and total delay, require accurate traffic counts. Since traffic counts were not available outside the mid-day period, the measures of effectiveness shown in the last section pertain to the mid-day period only.

Even outside the mid-day period, the public still benefits from the travel time reductions shown in the charts of this document. For example, the approximate ninety-second reduction in eastbound travel time on Parker Road occurs at, ten o'clock in the morning, seven-thirty in the evening, or on weekends just as it would during the middle of an average weekday. It is possible that the benefits accrued for every hour of operation outside the mid-day period are less than those accrued during the mid-day period. If these benefits were half of what exists during the mid-day period, the total benefit for this project over 24 hours is $887,398.