ITEM 15 - Information
November 16, 2005

Briefing on the Implementation of
Traffic Signal Optimization in the Region

Staff Recommendation: Receive briefing on the implementation of traffic signal optimization in the region, one of the three priority areas identified for the 2005 CLRP update.

Issues: None

Background: The briefing on this topic was deferred from the October 19 TPB meeting. In 2002, the TPB adopted a regional traffic signal optimization Transportation Emissions Reduction Measure (TERM), setting the goal of the optimization of approximately 900 additional signals in the region by 2005.

The attached memorandum presents the results of the TERM, describes the aims of optimizing traffic signals, and provides an overview of other signal operations and activities within the region.

National Capital Region Transportation Planning Board

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MEMORANDUM

TO: Transportation Planning Board

FROM: Andrew J. Meese, AICP
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DATE: November 10, 2005

SUBJECT: Briefing on the Implementation of Traffic Signal Optimization in the Region

Background

This memorandum will examine:

- What goals were set in the TPB's adopted Traffic Signal Optimization Transportation Emissions Reduction Measure (TERM), what were the baseline conditions, and what were the results?
- What does it mean for a signal to be optimized? How do we know it is optimized?
- Traffic signals activities and operations in general.

Goals of the Signal Optimization TERM

On July 31, 2002, the Transportation Planning Board adopted a regional signal optimization TERM, setting the goal of the optimization of approximately 900 additional traffic signals in the region by 2005. The departments of transportation and the participating local jurisdictions agreed to implement their portions of this TERM in addition to maintaining signals already optimized as of June 2002.

Signal optimization is a traffic engineering concept whereby traffic signals (often groups of signals in corridors) are (re-)timed to reduce delay for vehicles on the roadway system while ensuring safety. Engineers use a combination of traffic volume counts, in-car and in-field travel time observations, and computer analysis to determine signal timings given the complex interactions of traffic flows. The results for any one driver on any one trip may not appear to be "optimal", due to high traffic loads, cross-traffic, and other factors, but overall system delay should be reduced. An engineering rule-of-thumb recommends checking signal timing at least every three years because traffic patterns evolve.

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Conservative air quality benefits were assumed. Technical bases for the TERM included a common optimization methodology, "before and after" field observations, and self-reporting of results by implementing agencies.

Results

The Washington region met and, in fact, exceeded the goal put forth in the 2002 signal optimization TERM. According to the region's traffic signal agencies, approximately an additional 1,100 signalized intersections were optimized in the three-year period ending June 2005, exceeding the original 900 goal by 200. In percentage terms, the region progressed from about 45% of its signals optimized to about 68%. Table 1 shows the overall optimization results.

Table 1. Regional Signal Optimization TERM Goals and Reported Results

Total Signalized Intersections*	Optimized Intersections June 2002	Number of Signals to Be Optimized According to Original TERM Commitment		Signals Optimized as of June 2005 (Reported Actual Results)		Percentage of Signalized Intersections Optimized	
		Increment	Total	Increment	Total	Jun '02	Jun '05
4,700	2,100	900	3,000	1,100	3,200	45%	68%
*All totals approximate. Signals newly installed since 2002 not included in totals.							

Costs and Benefits

At the outset of the TERM, the cost of optimization was estimated at about $3,000 per intersection. Implementing agencies reported that this estimate was accurate, spending about $3,000 per optimized intersection during the TERM.

Efforts were aimed at reducing delays, frequency of stops at red lights, or overall travel time. Results around the region varied from essentially no improvement to quite significant improvements (on the order of 50% reductions in stops, delays, or travel times), though the most common results were improvements in the range of 5% to 20%.

Georgia Avenue in Maryland and the District of Columbia provides an example. In Maryland, State Route 97 (Georgia Avenue) from Gold Mine Road in Olney to State Route 410 near the District of Columbia boundary covers a distance of approximately fourteen (14) miles. After optimization, travel time for the morning southbound trip in the corridor from beginning to end was reduced from an estimated 35 minutes 20 seconds "before" to 33 minutes 28 seconds "after", a 5% reduction in travel time. The Maryland State Highway Administration's analysis estimated a benefit of about $10 in time and fuel savings for each $1 spent on optimization. In the District of Columbia, the approximate five-mile length of Georgia Avenue/Seventh Street N.W. from the Maryland boundary to the edge of the downtown area at Rhode Island Avenue N.W. also was retimed. The morning southbound travel time was reported to have been reduced from 32 minutes 20 seconds "before" to 28 minutes 7 seconds "after", a 12% reduction in travel time.

Additionally, the original TERM was for air quality purposes. TPB staff reanalyzed the TERM using the latest adopted methods according to air quality rules, and the results appear to have met and exceeded the originally projected air quality benefits. The estimated benefit of retiming 1,100 signals was a reduction of 0.62 tons/day of NOx by 2005 (versus the original projection of 0.27), and reduction of 0.72 tons/day of volatile organic compounds by 2005 (versus the original projection of 0.67). Overall impacts were better both because the number of signals retimed was greater than projected (1,100 versus 900), and because the impact per signal is greater than originally projected after federally-mandated methodology updates since 2002 for such air quality analysis.

What Does It Mean for Signals to Be "Optimized"?

Traffic signals allot time at intersections for safety, traffic flow, pedestrians, and other factors. An individual signal's timing needs to be balanced for traffic loads, cross traffic, left and right turns, and pedestrians. Multiple nearby signals can be analyzed as a system to coordinate timings. Under certain conditions, a corridor with a predominating flow and direction can be timed for "progression", reducing delays for traffic in that flow. Signals generally have three or more timing plans, usually including morning peak period, midday, and evening peak period, and frequently additional plans such as weekend or overnight plans.

"Optimized", however, does not mean "without delay". The driver may still experience delays even after signal or corridor optimization, especially:

- Places with high traffic volumes
- Places where cross-traffic or left and right turn volumes are high
- Travel routes that cross or are in the opposite direction of predominant flow
- Places with competing demands, such as emergency vehicles, or places fortunate enough to have high pedestrian volumes.

It is overall system delay, not necessarily the delay experienced by a given individual driver, which is minimized in optimization.

What is the Process of Optimization?

Once the signal, corridor, or area to be optimized has been identified, engineers generally go through the following steps:

1. "Before" field observations are taken by technicians, including travel time runs, current signal timings, and traffic volumes (including cross traffic and left and right turns).
2. Data are entered for computer analysis with specialized software, outputting suggested timings and estimated benefits.
3. Engineers interpret and adjust the computer results, and fine-tune and implement the new set of timings. Professional judgment based on experience is used in adjusting signal timings, not relying solely on the raw computer output.

4. "After" field observations are undertaken for the retimed signals, with readjustments if necessary.
5. Over time, engineers undertake ongoing observations spot-checking for problems and adjustments, and investigate timings in response to public inquiries or complaints.

An engineering rule-of-thumb recommends that signals be reanalyzed for optimization about once every three years on average, more often for critical signals and less often for more isolated signals. Traffic patterns evolve quickly, and equipment must be maintained in proper mechanical working order.

Involved Agencies

The District Department of Transportation, Maryland State Highway Administration, Virginia Department of Transportation, and numerous local government transportation agencies in the region were involved in this optimization TERM. These agencies strive to maintain a regular program of optimization. Note that the TERM was not just a one-time effort – these agencies view optimization and traffic signals maintenance in general as ongoing needs to which they devote staff and resources to the extent possible.

Signal Optimization in the Context of Other Signals Operations and Activities

Optimization activities and investments take place within a context of a variety of traffic engineering activities in the region, including development of timing plans, maintenance of existing equipment, and upgrading to new technologies. Certain specialized timing plans have been developed around the region, including those for emergencies, and, in the case of VDOT, for holiday shopping traffic near major Northern Virginia shopping facilities. Agencies perform systems monitoring and maintenance, respond to public complaints and inquiries, and undertake problem spot-checks. Some of the region's signals systems have the ability to be controlled and changed from a central facility, such as District of Columbia, Montgomery County, and VDOT systems, and are adjusted on a regular basis. Note that all agencies have expressed a strong, ongoing commitment to the maintenance of their signals. And new signals are installed where deemed necessary; about 250 new signals were installed in the region since the mid-2002 adoption of the signals optimization TERM.

Agencies have also looked at emerging technologies, such as upgraded traffic detection or traffic-adaptive systems, though technical difficulties have proved challenging in some cases. The installation of pedestrian "countdown" signals in many portions of the region has proven to be popular. Traffic signal priority treatment for transit buses is undergoing pilot implementation in two corridors in the region (U.S. 1 in southern Fairfax County and Columbia Pike in Arlington County), and will be analyzed for lessons learned for the future of bus rapid transit in the region. Emergency preparedness concerns since 9/11 has brought calls for electric power backup systems for signal (either battery backups or portable generators), so signals may continue to function even when there have been power failures. Conversely, agencies have examined and implemented alternatives to traffic signals, notably modern roundabouts, which, under the correct conditions, can

enjoy less delay than a signalized intersection. The traffic engineer's toolbox holds a number of tools for consideration for the best solution to the problems of traffic management.

Traffic signals personnel also are involved in regional and interagency collaboration and outreach. The TPB's MOITS Task Forces have a Traffic Signals Working Group to discuss issues of regional interest, and to help provide the connections between TPB planning and signal operations. Subregional groups in Suburban Maryland and Northern Virginia help shepherd interjurisdictional coordination in those locations. Washington area signals professionals will join their Baltimore metropolitan counterparts for the second annual Regional Traffic Signals Forum this year, December 14 in Linthicum Heights, Maryland. Overall, the region's agencies are committed to continuing to work for the best use of resources for traffic signals and other means for transportation management in the region.

Outlook

Agencies in the Washington region responsible for traffic signal timing and maintenance have reported general satisfaction with the computerized tools now available to retime signals, and hope to maintain and increase their optimization efforts in the future. In many cases, specialist consulting firms are brought under contract to perform this work, which has aided timeliness and affordability of such activities. Most agencies also have dedicated in-house staff to support this work, as well as to support everyday technical maintenance of signals. Continued investment of resources in this area will ensure maintenance of the benefits of optimization.