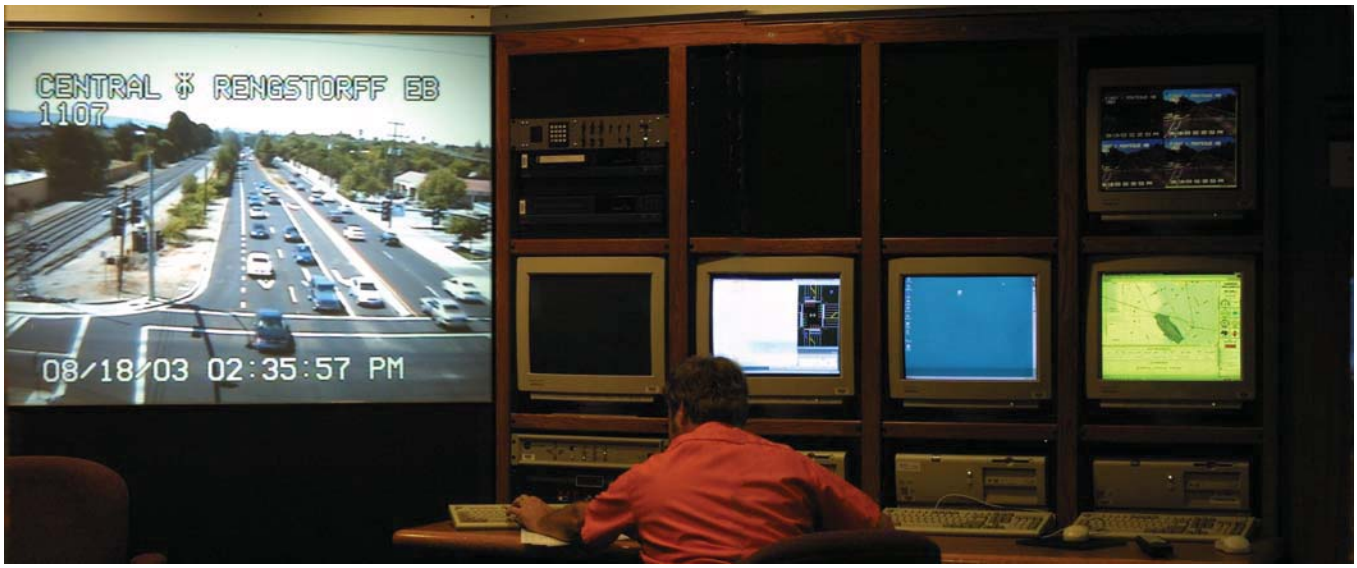
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SECTION FOUR

SIGNALS & TRAFFIC OPERATIONS SYSTEM (TOS) ELEMENT

Traffic signals play a key role in the efficient functioning of the expressways. They regulate traffic flow on the expressways and help balance the mobility needs of users of the expressways and cross streets. Survey respondents have consistently rated timing of lights and synchronizing signals as very important improvements. In many instances, signal timing changes and new signal technologies can alleviate congestion problems as traffic demand grows. For this reason, adjustments to signal operations were considered a key part of the overall improvement strategy.

This element provides a description of current traffic signal operations along the expressways and the funded expressway Traffic Operations System (TOS) Program. It then documents the recommendations and costs for enhancing signal operations and TOS, including capital improvements and operations/maintenance. The costs of the recommended capital projects are incorporated in the Capacity/Operational Improvement Element, while operating costs are folded into the Maintenance and Operations Element.

Current Traffic Signal Synchronization Practice

There are 134 signalized intersections along the eight expressways. Figure 4-1 shows the current groupings of synchronized traffic signals. Intersections that are not included in a group are operating in isolation from other traffic signals. Typically, breaks in the signal groupings occur where the travel patterns change or the signals are controlled by Caltrans, such as at freeway interchanges and El Camino Real. The signals at the western end of Central Expressway and the First Street area of Montague Expressway operate without synchronization due to frequent train pre-emption of the signals.

The goal of synchronization along expressways is to give priority to through traffic on the expressways. It's designed to progress large volumes of through traffic in the peak direction, especially during the peak hour periods, from one end of each group to another. Thus, delays and stops on the expressway are relatively low while delays and stops are relatively high for side street movements.

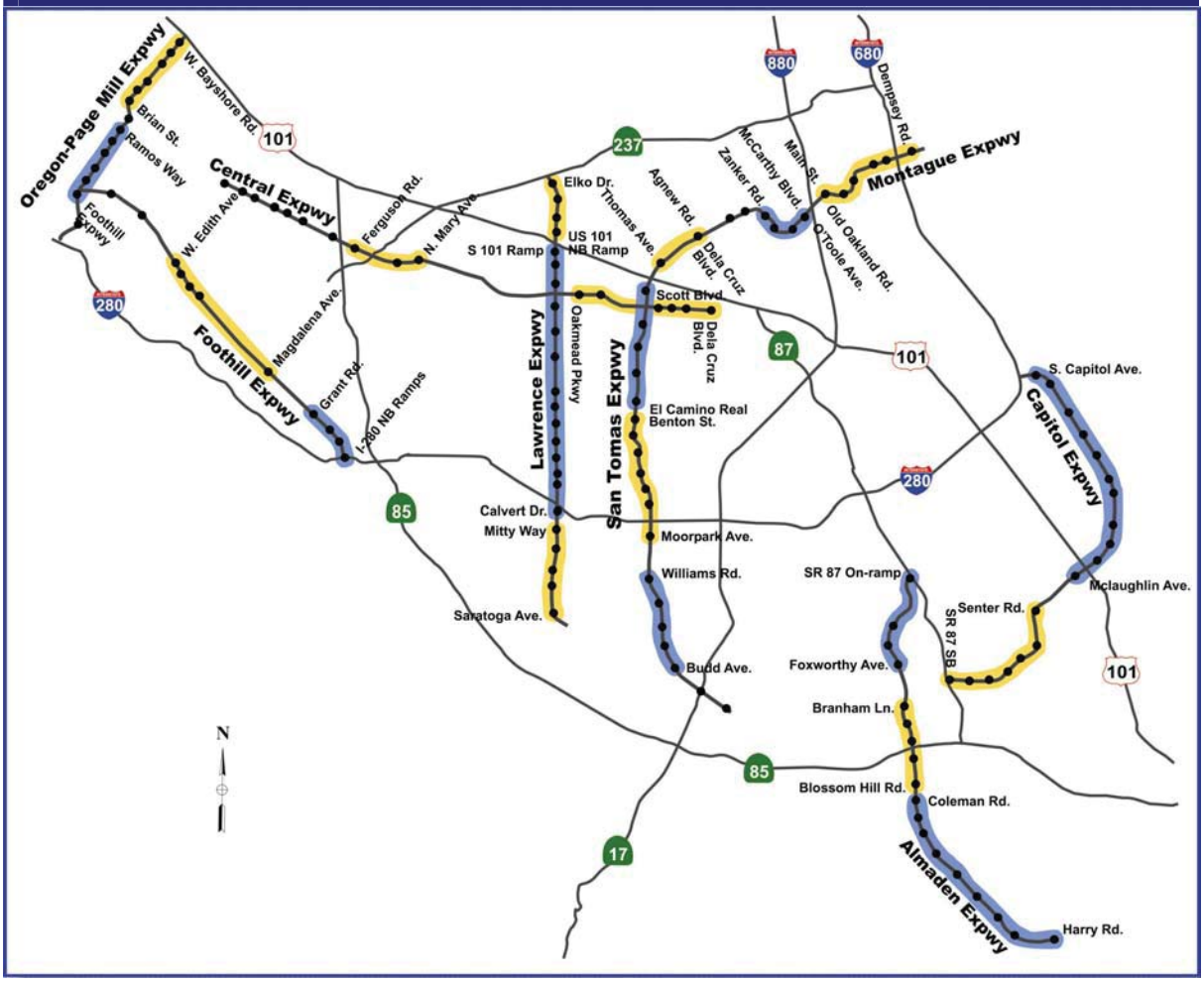
All expressway signal groups are coordinated in the weekday AM and PM peak periods for the commute direction. The exact peak period varies by expressway depending on travel patterns. Some of the expressway signal groups are coordinated for weekday mid-day periods and during the weekends. When not coordinated, the signals are free-running and responsive to the left turns and cross-street activation by approaching vehicles. Current practice is to conduct signal timing studies and re-time the signals as funding allows, which is generally limited to responding to specific requests from cities and the public.

Traffic Operations System Program

TOS is an operational system for managing and operating transportation systems with technologies. It is a system made up of various Intelligent Transportation System (ITS) components such as surveillance (loop detectors, closed-circuit TV, etc.), monitoring equipment, highway advisory radio, and changeable message signs (CMS).

In the mid-1990s, the County embarked on a cooperative effort with other agencies to study the Silicon Valley Smart Corridor along I-880 and State Route (SR) 17. A Smart Corridor is one where various public agencies' traffic management activities are coordinated to more

Figure 4-1: Current Traffic Signal Coordination Grouping



effectively manage traffic in that corridor. These are typically achieved using advanced technologies or ITS while partnerships between jurisdictions are necessary to develop procedures and measures for coordination. The first phase of the I-880/SR 17 Smart Corridor project was deployed in 2000 and included improvements on San Tomas and Montague Expressways. The project's components enable local and regional agencies to respond to traffic incidents and to better manage traffic operations in the corridor. Initial installations included intersection and freeway cameras, changeable message signs, a new traffic data collection station, a new highway advisory radio transmitter, and central traffic signal system enhancements.

The County has also developed a TOS Master Plan that includes $42 million in TOS improvements along the expressways. The 1996 Measure B Sales Tax Program allocated $24.5 million for expressway TOS allowing implementation of over half of the TOS Master Plan. Funded improvements include traffic management center upgrades, new loop and video sensors along the various expressways, and fiber optic interconnect between traffic signals. As the first step, a countywide review of traffic signal equipment and operations, including synchronization, was completed in 2000. Construction of initial TOS improvements on Central and Lawrence Expressways is now underway, and construction of improvements on Oregon-Page Mill, Foothill, and Almaden Expressways is scheduled over the next two years.

Additionally, a demonstration Traffic Adaptive System project is in progress along Lawrence Expressway between Oakmead Parkway and Kifer Road intersections. The adaptive module optimizes the timing split based on current conditions. If all the cars in a phase do not make it through the intersection, then a set amount of time is automatically added to that phase in the next cycle. If significant gaps develop in the flow of cars, then a set amount of time is removed from that phase in the next cycle.

Recommended Signal Operations/TOS Projects

Table 4-1 summarizes the funded TOS projects and the recommended signal operations and TOS improvement projects that will require additional funding.

Signal Operations Projects

The following projects totaling $6.7 million have been included in the Tier 1A capacity/operational improvements list. These projects were selected because they have the potential to improve LOS problems and facilitate traffic flow along specific expressway segments as described below:

- Foothill operational corridor improvement ($1.5 million) - Signalized intersections along Foothill between Edith Avenue and El Monte Avenue are closely spaced with the adjacent local intersections in the City of Los Altos. This project includes upgrading signal controllers at the local intersections, providing communication

between the expressway and local signals, and developing timing plans to facilitate traffic flow within the corridor.

Table 4-1: Signal Operations and TOS Project Summary

Category	Status/ Recommended Tier		Project Description	Cost (millions)
Capital Improvements (Funded)	Measure B Program		TOS improvements including traffic management center upgrades, new loop and video sensors along the expressways, and fiber optic interconnect between traffic signals	$23.0
			Traffic Adaptive System implementation along Lawrence between Oakmead and Kifer	$1.5
	Total Funded			$24.5
Capital Improvements – Signal Operations (Unfunded)	Listed as Tier 1A Capacity/ Operational Improvement Projects		Foothill operational corridor improvements between Edith and El Monte including adjacent side street intersections & at Grant/St. Joseph	$1.5
			Lawrence/I-280/Stevens Creek: optimize signal phasing and timing plans including City of Santa Clara signals at Stevens Creek and County's signal at Lawrence/Calvert/I-280 SB on-ramp	$0.1
			Lawrence-Saratoga corridor signal optimization between Prospect and SR 85	$0.1
			Oregon corridor improvements, including replacing signal standards and re-timing accordingly	$5.0
	Total Tier 1A Signal Operations Projects			$6.7
Capital Improvements – TOS (Unfunded)	Included in TOS Master Plan but not funded	1A	Traffic information outlets such as electronic information signs, advisory radio, cable TV feeds, and a web page	$5.0
		1A	Install equipment to coordinate expressway signals with city signals on perpendicular streets	$10.0
		1A	Install equipment to connect with Sunnyvale, Palo Alto, Mountain View, and Los Altos traffic signal interconnect systems	$2.5

Table 4-1: Signal Operations and TOS Project Summary (continued)

Category	Status/ Recommended Tier		Project Description	Cost (millions)
Capital Improvements – TOS (Unfunded) (continued)	Additional TOS projects	1A	Upgrade traffic signal system to allow automatic traffic count collection	$0.5
		1C	Adaptive traffic signal system for selected or all expressways based upon further feasibility study	$10-12
		2	New technology/ITS update over the next 30 years	$55-75
	Total Unfunded TOS			$83-105
Operations/Maintenance	Conducted by Expressway Study		Update signal timing plans along the following three expressway corridors: • Oregon between El Camino Real and Indian • Foothill from Magdalena to Edith • San Tomas from Moorpark to Scott • San Tomas from Hamilton to Budd and coordination with Hamilton system	N.A
	Potential needs		Annual maintenance of TOS equipment	$0.5 annually
			Develop & update multiple timing plans for different times of days and days of week for all expressways	$1.0 annually
	Total Operations/Maintenance			$1.5 annually

- Lawrence/I-280/Stevens Creek signal optimization study ($0.1 million) - This study will develop optimal signal phasing and timing plans for operations during different times of the day and/or different days of the week to facilitate traffic flow in the interchange area. The study will include three traffic signals along Stevens Creek Boulevard being operated by the City of Santa Clara and the County's signal at Lawrence/Calvert/I-280 southbound on-ramp.
- Lawrence-Saratoga corridor signal operations study ($0.1 million) - This study will develop multiple timing plans to facilitate traffic flow between SR 85 and Lawrence Expressway during the peak hour periods.
- Oregon corridor improvement project ($5.0 million) - This study includes replacing and relocating the traffic signal standards at signalized intersections between El Camino Real and US 101, constructing pedestrian ramps when the standards are relocated, potentially adding a southbound left-turn lane at Middlefield Road for 8-phase signal operations, studying operational/safety improvements at the unsignalized intersections at Waverley Street, Ross Road, and Indian Drive, and developing new timing plans based on the corridor improvements.

TOS Improvements

A total of $83-105 million has been identified for continuous update of the expressway TOS using available and new technologies over the next 30 years.

As shown in Table 4-1, the unfunded items of the current TOS Master Plan ($17.5 million) and upgrades to the County's standard signal controllers to allow for automatic traffic count collection ($0.5 million) are recommended as Tier 1A projects. The automated count collection system can help identify trouble spots in the signal operations/TOS and aid in future design.

The County is already deploying a trial installation of a fully adaptive system on three intersections on Lawrence Expressway. Depending on the success of this trial, the adaptive module can be added to the current County signal timing toolbox. Depending on the feasibility and the number of intersections, implementation of a more extensive adaptive signal system would cost $10-12 million. This project has the potential to provide

operational improvements in the longer term and is, therefore, prioritized as a Tier 1C project.

Additionally, $55-75 million has been estimated and prioritized in Tier 2 to provide TOS enhancements and update the system as new technologies become available over the next 30 years. The availability and cost of new technologies over a 30-year period cannot be predicted with any accuracy. To arrive at a reasonable cost estimate as a placeholder, it was assumed that a sum equal to the current TOS project recommendations (approximately $55 million including both funded and unfunded elements) will be needed to replace the TOS over the 30-year period. Another $20 million has been added to account for further enhancements to the current TOS, such as incident management and communications with systems in other agencies.

Operations and Maintenance

Currently, the County adjusts the signal timing plans along the expressways in response to requests or complaints from the local agencies and the public and as monies allow. During the Expressway Study, it became clear that a more proactive approach to adjusting signal timing was desired and needed. Traffic conditions are constantly changing in response to the economy and new land uses. These changes affect the length and times of peak period flows, cross-street traffic demand, and the overall volume of traffic. Most of all, they affect signal synchronization, which requires regular timing adjustments for maximum effectiveness.

In response to concerns expressed regarding signal timing on specific expressway segments, four signal timing studies were initiated as part of the Expressway Study. The scope and purpose of these studies are as follows:

- Oregon between El Camino Real and Indian Drive - Validate the need to include the Caltrans operated El Camino Real signal for coordination with the Page Mill system in the PM peak hours and with the Oregon system in the AM peak hour to facilitate traffic flow along Oregon-Page Mill during the commute peak hours. Coordination is required with Caltrans and the City of Palo Alto staff.

- Foothill from Magdalena Avenue to Edith Avenue - Facilitate traffic flow between El Monte Avenue and San Antonio Road and balance this movement with the through traffic flow on Foothill Expressway during the commute peak hours.
- San Tomas from Moorpark Avenue to Scott Boulevard - Optimize timing plans to balance expressway and side street delays during the peak hours.
- San Tomas between Budd Avenue and Hamilton Avenue - Optimize timing plans for this coordinated system and provide coordination with the City of Campbell's signal system on Hamilton Avenue.

These studies address currently identified problem areas. To develop a regularly scheduled signal retiming program for the entire expressway system, a total of $1.5 million annually is needed for signal operations and maintenance. The estimated cost includes $1.0 million to develop and optimize variable timing plans for different times of the day and days of the week for all expressways annually and another $0.5 million to operate and maintain the TOS.

Inter-Agency Signal Coordination

As shown on Figure 4-1, the expressway signal synchronization system is disrupted by Caltrans-operated signals along the expressways and by train crossings receiving signal pre-emption. Currently, there are railroad crossings on Montague Expressway and light rail transit (LRT) crossings on Montague, Lawrence, and Central Expressways.

Traffic flow along local streets and on the expressways can also be impaired when there are city-controlled signals at local intersections closely spaced with expressway signals. Several of the signal projects listed in this element involve improved coordination between the County's and other agencies' signals and/or incorporating the other agencies' signals into the expressway signal system.

In addition, VTP 2020 recommends broader countywide planning efforts to define and develop new ITS projects. These efforts require ongoing multi-agency partnerships. The expressways, as major travel corridors, will likely play key roles in new Smart Corridor ITS projects.

Specific recommendations for continuing to improve inter-agency signal coordination include:

- Work with Caltrans to bring more Caltrans-operated signals along the expressways into the expressways' synchronized signal system.
- Work with Caltrans on optimal ramp meter operations to ensure ramp queues do not negatively impact expressway operations.
- Explore additional opportunities to increase coordination between city-operated signals on major cross streets with expressway signals to help optimize traffic flow on both roadways.
- Continue coordination efforts with rail operators to minimize expressway traffic impacts, and where appropriate, support grade separation of the facilities. A potential instrument for expressway coordination with LRT operations would be a joint operation agreement to optimize peak commute operations for users of the crossing, both on the expressway and LRT.
- Continue to participate in VTA's ITS planning efforts and in the Silicon Valley (SV)-ITS Program Partnership. VTP 2020 recommends that the SV-ITS partnership be expanded to implement three additional ITS projects in Santa Clara and Southern Alameda Counties.


VTA