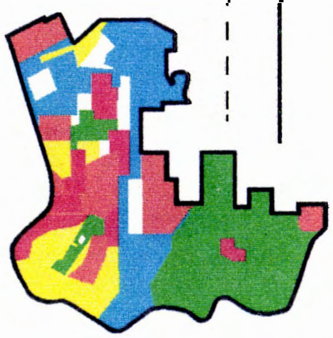
Los Angeles County
Metropolitan Transportation Authority

Draft Final Report

Conceptual Design Study of Traffic Signal System Improvements in the South Bay Area of Los Angeles County



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July 1993

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1. INTRODUCTION

This report documents the results of a study for the Los Angeles County Metropolitan Transportation Authority (LACMTA) to identify and evaluate the opportunities and constraints for the short-term and long-term improvements in the South Bay traffic signal system. The South Bay Traffic Signal System Improvement project is consistent with the Transportation Systems Management (TSM) element of MTA's 30-Year Plan, which proposes to utilize TSM measures on the arterial highway system including signal synchronization, peak hour parking restrictions, and automated traffic surveillance and control systems. By applying communications upgrade, traffic operations improvements and installation of CCTV's and system loops to South Bay area intersections, the South Bay Traffic Signal System Improvement project will strive to meet the goals of MTA's 30-Year Plan highway planning efforts.

This report is divided into the following sections:

1. *Introduction*: This introductory section describes the report outline, study background and objectives.

2. *Existing Conditions:* Describes the existing traffic signal operations for each jurisdiction, the development of the GIS and database software systems, the existing controllers and provides information on various types of controllers, as well as, describes the existing traffic control systems for Caltrans, County of Los Angeles and other agencies. It also provides an overview of the existing signal operation and maintenance procedures in the South Bay area.

3. *Analysis of Opportunities and Constraints:* This section identifies the opportunities and constraints in formulating the conceptual improvement plan. It analyzes the primary traffic flow pattern, the existing equipment compatibilities, analysis of various traffic operation systems, and institutional issues and agreement opportunities.

4. *Conceptual Plan:* This section presents a Two-Year plan (short-term) and Year 3 through 10 (long-term) conceptual improvement plans for the South Bay area. A detailed analysis and description of the short-term recommended improvements is presented in this section.

5. *Implementation and Schedule:* This section describes the phasing for short-term and long-term program and introduces the step-by-step plan and scheduled program for implementation.

1.1 BACKGROUND

The South Bay area encompasses a wide range of urbanized area within Los Angeles County and includes the cities of Carson, Culver City, El Segundo, Gardena, Hawaiian Gardens, Hawthorne, Hermosa Beach, Inglewood, Lawndale, Lomita, Long Beach, Los Angeles, Manhattan Beach, Palos Verdes Estates, Santa Monica, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, Signal Hill, Torrance, and the unincorporated areas of Los Angeles County. Although the City of Santa Monica is geographically designated within the South Bay area, for improvement programs it is included in the Westside area, and therefore is not directly included in this study. Caltrans maintains the traffic signals along the majority of state routes within the study area. Exhibit 1.1 shows the South Bay study area boundary and jurisdictions involved. It also indicates the four primary routes—the focus of the first two years of improvements and Pilot Project 1 (see page 70).

The South Bay area is both large and complex in that many jurisdictions have responsibilities for funding, designing, improving, constructing and maintaining the traffic signal system. Most of the agencies have their own ongoing signal timing and coordination improvement programs, equipment upgrade and routine maintenance programs. Each agency focuses on their own network, although coordination between traffic signals already exists at some intersections which share jurisdictional boundaries.

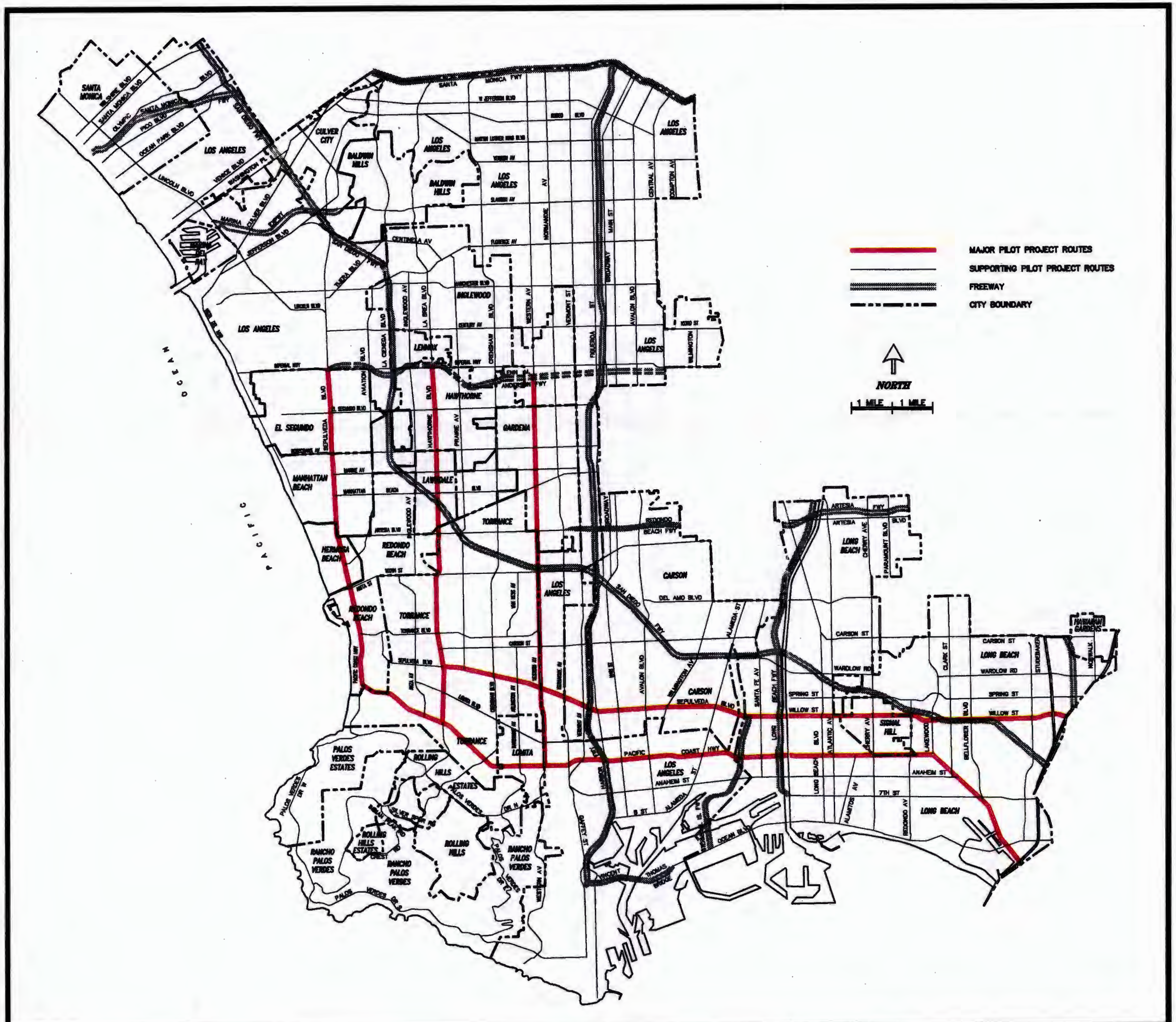
Approximately 2,500 traffic signals exist in the study area with a mixture of traffic control systems (such as Bitrans QuicNet, VMS 220, UTCS Enhanced and Econolite Closed Loop), traffic controllers (such as Type 170, NEMA, and electromechanical) and communication systems (such as twisted pair, fiber optics, and wireless) within the South Bay area. The City of Gardena has recently installed a new traffic control system which controls the operations of the City's 56 traffic signals.

The County of Los Angeles and Caltrans primarily provide coordination between traffic signals along major routes including Pacific Coast Highway, Artesia Boulevard (SR 91), County-maintained arterials and other major arterials within the South Bay area. These coordinations are all arterial signal coordination which synchronize the offsets through a common time reference, typically WWV receivers. The County of Los Angeles has played an active role in these coordination activities. Table 1.1 shows the Los Angeles County current and planned coordination improvement projects.

1.2 STUDY OBJECTIVES

The overall objectives of the South Bay Signal System Improvement Study were to identify and evaluate the opportunities and constraints and to develop a conceptual plan for short and long-term signal system improvements. To accomplish these goals the following activities were specified:

1. Inventory of existing systems.
2. Analysis of the traffic pattern, equipment, control systems and strategies and institutional issues.
3. Development of conceptual plan alternatives.
4. Development of an implementation and schedule program for the recommended conceptual plan.



SOUTH BAY TRAFFIC SIGNAL SYSTEM IMPROVEMENTS

LACMTA

Los Angeles County Metropolitan Transportation Authority

South Bay Study Area

Exhibit 1.1

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TABLE 1.1

COUNTY OF LOS ANGELES CURRENT AND PLANNED TRAFFIC SIGNAL SYNCHRONIZATION PROGRAMS IN THE SOUTH BAY AREA (TSSP)

	Segment	Status
Imperial Hwy.	I-405 to Budlong Ave. and Mona Blvd. to 1st Ave.	Proposed: Second Five-Year Program*
El Segundo Blvd.	Illinois St. to Douglas St. Isis Ave. to Vermont Ave.	Proposed: Second Five-Year Program* Operational
Rosecrans Ave.	Highland Blvd. to Budlong Ave. and from Broadway to Santa Gertrudes	In Design: First Five-Year Program, to be advertised 6/93.
Manhattan Beach Blvd.	Manhattan Ave. to Van Ness Ave.	Proposed: Second Five-Year Program*
Redondo Beach Blvd./ Compton Blvd./ Sommerset Blvd.	Freeman Ave./Amie Ave. to Berendo Ave. and Broadway to Woodruff Ave.	Proposed: Second Five-Year Program*
Carson St.	Del Amo Mall to Cabrillo Ave. and from Harbor Hospital to Wilmington Ave. and from Paramount Blvd. to Bloomfield Ave.	Proposed: Second Five-Year Program*
Sepulveda Blvd./ Willow St.	Palos Verdes Blvd. to Western Ave. and from Normandie Ave. to Studebaker Rd.	Proposed: Second Five-Year Program*
Lomita Blvd.	Pennsylvania Ave. to Walnut Ave.	Proposed: Second Five-Year Program*
Aviation Blvd.	118th St. to Prospect Ave.	Design Complete: First Five-Year Program, to be advertised 5/93.
Inglewood Ave.	104th St. to Manhattan Beach Blvd.	Under construction
Hawthorne Blvd.	104th St. to Manhattan Beach Blvd. and from 244th St. to Palos Verdes Drive West	Under Construction: Second Five-Year Program - est. completion 1993-94.
Prairie Ave.	118th St. to Redondo Beach Blvd.	Under construction
Crenshaw Blvd.	Northrup Gate 16 to Crestridge Rd.	Under construction
Normandie Ave.	228th St. to Lomita Blvd.	Proposed: Second Five-Year Program*
Avalon Blvd.	El Segundo Blvd. to Sepulveda Blvd.	Proposed: Second Five-Year Program*
Atlantic Blvd./Ave.	70th St. to Ocean Ave.	Proposed: Second Five-Year Program*
Cherry Ave./ Garfield Ave.	70th St. to Ocean Ave.	Proposed: Second Five-Year Program*
Bellflower Blvd.	Del Amo Blvd. to Anaheim St.	Proposed: Second Five-Year Program*

* Second Five-Year Program to begin 1994-1995.

Note: Sepulveda Boulevard/Willow Street and Hawthorne Boulevard are two of the four primary routes.

2. EXISTING CONDITIONS

A wide range of traffic signal controller types, systems and communications equipment exist within the South Bay area. The purpose of this section is to summarize the existing conditions with respect to traffic signals, traffic control systems, communications and operating and maintenance procedures.

2.1 JURISDICTIONAL AND INTERSECTION INVENTORY

All 23 jurisdictions in the South Bay area were contacted to update available information regarding traffic signals and signal systems within their supervision. Two types of inventory activities were conducted:

1. Jurisdictional inventory, which included elements pertinent to the operational characteristics of each jurisdiction in general, such as coordination strategies, multijurisdictional coordination and agreements, types of systems and database; and

2. Intersection inventory which describes each specific signalized intersection being inventoried.

Approximately 600 intersections along major arterials were inventoried. The following sections summarize the results of the jurisdictional and signal inventory activities.

2.2 OVERVIEW OF THE EXISTING TRAFFIC SIGNAL OPERATIONS

Caltrans: Caltrans currently operates and maintains the majority of traffic signals along Pacific Coast Highway (SR 1), Artesia Boulevard (SR 91), Lakewood Avenue (SR 19) and a portion of Hawthorne Boulevard (SR 107) and Western Avenue (SR 213). Caltrans' policy for new and existing traffic signals along state highways states that only the microprocessor (Type 170) traffic signal controller assemblies should be installed on the State Highway System. Caltrans also plans to install fiber optics along the South Bay freeway system, which will provide capabilities of two-way communication between a Traffic Operations Center (TOC) and the regional facilities to establish an advanced transportation system management by integration of freeways, state routes and major arterials.

Currently, the communication and interconnect system between traffic signals at intersections along state routes are provided predominately through hardwire underground cables. Caltrans owns and maintains approximately 400 traffic signals within the South Bay area.

Los Angeles County: The Los Angeles County Department of Public Works is currently operating and maintaining the majority of signals along County owned routes and several of the major arterials owned by various cities within the South Bay area. The County maintains approximately 200 signals of which 40 are located in unincorporated portions of Los Angeles County. The County has played an active role in initiating, designing and implementing synchronization projects for many corridors through the five-year TSSP program. The projects include replacement of electromechanical and old controllers with more sophisticated solid state NEMA and Type 170 controllers. In all of these projects, the coordination of traffic signals is achieved through time base coordination units and common time reference (WWV) receivers installed in on-street masters and individual controllers.

City of Carson: The City of Carson does not have a central traffic control system or any working hardwire interconnect network. There are 126 traffic signals of which 22 along Avalon Boulevard are coordinated through time base coordination (TBC) units. However, there are 4 signals along Avalon Boulevard which belong to Caltrans and the County, and are not coordinated with other signals. The City of Carson has separate agreements with the County of Los Angeles, as well as the cities of Compton, Los Angeles and Long Beach for its shared signals.

City of Culver City: Culver City has a VMS central system which controls 12 signals. Thirty-four signals are coordinated through Automated Traffic Surveillance and Control (ATSAC) as part of the "Smart Corridor" program. The City has a total of 84 signals. The general plan is to upgrade all signals to ATSAC 170's.

City of El Segundo: The City of El Segundo has no central traffic control system. El Segundo uses Type 170 and Econolite NEMA controllers. Major arterials are controlled and maintained by either Caltrans, the County, or the City of Los Angeles. There are a total of 52 signalized intersections within the City of El Segundo.

City of Gardena: The City of Gardena uses a QuicNet central traffic control system which controls the operations of 56 traffic signals. There are a total of 73 signals within the city boundaries. All of the controllers are Type 170 which are interconnected by aerial and underground hardwire network. Fifty-four of the signals are coordinated and operate on 100-second cycle lengths.

City of Hawaiian Gardens: The City does not have a traffic control system. All 12 signals located within the City are currently maintained by the County of Los Angeles.

City of Hawthorne: The City of Hawthorne has an Econolite (Zone Monitor IV) Central Traffic Signal Monitoring System, with upgraded controllers at the majority of the City's intersections. The signals along Inglewood Avenue, Prairie Avenue, Crenshaw Boulevard and El Segundo Boulevard are coordinated with WWV Radio and Time Base units. Prairie Avenue also has telephone interconnect for communication to City Hall. There are a total of 75 signalized intersections within the City of Hawthorne.

City of Hermosa Beach: Hermosa Beach has 15 signalized intersections. The intersection of Aviation/Prospect will be coordinated with other signals along Aviation Boulevard by the County of Los Angeles, as part of the County's first 5-year program. The majority of controllers are Type 170. Routine maintenance of the signals is provided every six months. The City has existing signal coordination with Redondo Beach and Caltrans signals.

City of Inglewood: The City of Inglewood has a UTCS/QuicNet central traffic signal control system which operates 138 of the intersections owned by the City. There are a total of 154 signalized intersections in the City of which 106 signals are coordinated. All of the City's controllers are Type 170 with underground hardwire cable interconnect. The City's interconnect system is about 20 years old and needs to be upgraded. The City has agreements for operation and maintenance of shared intersections with the City of Los Angeles and Los Angeles County.

City of Lawndale: The City of Lawndale does not have a traffic signal control system. There are a total of 32 signals of which 21 will be coordinated by County projects. The traffic signals in Lawndale are primarily operated and maintained by Los Angeles County. The City has maintenance and coordination agreements with the County and shared use agreements with its neighboring cities of Hawthorne, Redondo Beach and Torrance.

City of Lomita: The City of Lomita has seven uncoordinated signals which are City maintained within the city limits. All other signals within the City of Lomita are operated and maintained by the City of Torrance or Caltrans.

City of Long Beach: The City of Long Beach maintains a total of 494 signals of which 473 are within the City boundaries and 21 are located in the City of Signal Hill. All of these signals are coordinated via hardwire network or time base coordination units. The City possesses a QuicNet central traffic control system which currently communicates with 230 signals throughout the City. The existing communication/interconnect system includes hardwire, radio, and microwave. All of the controllers on-line are Type 170 controllers. The majority of hardwire equipment at critical intersections along Pacific Coast Highway are upgraded and the signals are coordinated. Traffic signals along Lakewood Boulevard north of Willow Street are coordinated and operated by Caltrans.

City of Los Angeles: The City of Los Angeles has approximately 885 signalized intersections and three projects/corridors within the South Bay area. In the vicinity of the Los Angeles Airport, the ATSAC system consists of 95 signals and includes a portion of Imperial Highway west of the San Diego Freeway. The majority of controllers are Type 170. The City of Los Angeles also has an ATSAC project along Pacific Coast Highway, from Western Avenue to Alameda Street. Within this project, the signals are interconnected mainly by hardwire. The information is then sent to San Pedro via telephone line and microwave to the Los Angeles TOC. In addition, the City has 14 signals along Western Avenue, from 182nd Street to 190th Street which are integrated, but are not an active system. However, the City has expressed interest in connecting these signals to the City of Gardena. All controllers along Western Avenue are either Type 170 or NEMA with the exception of three Eagle pretimed controllers.

City of Manhattan Beach: The City of Manhattan Beach does not currently have a traffic signal control system. Signals along Sepulveda Boulevard and Artesia Boulevard (16 signals) in Manhattan Beach are controlled and maintained by Caltrans. A total of 17 signals are maintained by the County of Los Angeles. The City has a total of approximately 47 signalized intersections of which 20 are shared with adjacent cities. The number of signals reflected in Table 2.1 shows those signals which are not shared with other cities.

Cities of Palos Verdes Estates, Rancho Palos Verdes, Rolling Hills and Rolling Hills Estates: The signals within these cities generally are not coordinated. However, the County of Los Angeles is completing a synchronization program for the portion of Crenshaw Boulevard between Rolling Hills Road and Crestridge Road. The County of Los Angeles also has plans to synchronize the traffic signals along Hawthorne Boulevard from 244th Street to Palos Verdes Drive West.

City of Redondo Beach: The City has a total of 101 signals of which it owns and maintains 65. There are 51 signals coordinated via TBC. Controllers are generally Type 90 NEMA (Econolite) controllers. The City has maintenance and coordination agreements with the County and State and shared use agreements with its neighboring cities of Torrance and Hawthorne.

City of Signal Hill: The City of Signal Hill has 21 signals of which 12 are interconnected using either direct wire or leased telephone/radio interconnect. All controllers are Type 170 controllers. The City of Long Beach is responsible for all maintenance and operation of signals located within the City of Signal Hill.

City of Torrance: The City of Torrance has an Econolite (zone master IV) central traffic signal control system with upgraded controllers at the majority of the City's 159 signalized intersections. Along 190th Street, there are eight signals interconnected by hardwire which are coordinated. There are 12 signals along Torrance Boulevard and five along Sepulveda Boulevard connected with hardwire underground cables which are also coordinated. The interconnect system throughout the City has been upgraded, except for a segment on Sepulveda Boulevard east of Crenshaw Boulevard.

2.3 DEVELOPMENT OF GIS AND DATABASE SYSTEM

2.3.1 Overview

Upon compiling inventory of South Bay cities traffic signals, a Geographical Information System (GIS) and database system was developed. The South Bay Signal Inventory database contains information on traffic signal hardware and operations in the South Bay area. The primary purpose of the database is to develop a more comprehensive, coordinated inventory of signal operational data. The database is maintained by the cooperative effort of the South Bay jurisdictions and LACMTA. The database is built on the SYSTEM II GIS/database software developed by JHK & Associates for transportation planning and operations applications. The database system is referenced to the street network, enabling data to be displayed graphically on the screen. The census Topologically Integrated Geographic Encoding and Referencing (TIGER) file serves as the street network to which the data are referenced. The network consists of the South Bay region only. The primary capabilities of the system include:

- Graphical display of the street network, signal locations and signal operations attributes.
- Independent maintenance of the individual city datasets, with the capability of merging new or modified information into the centralized dataset.
- Output reports with several sort options and the capability of output files for importing to other systems.

2.3.2 Description of the Software

SYSTEM II is a comprehensive software system for transportation planning and transportation database management. In addition to travel demand forecasting capabilities, SYSTEM II components are well-suited to a wide range of data management and analysis tasks, roadway inventories, intersection inventories, level of service analysis, and regional emission inventories.

The Interactive Graphics Editor included in SYSTEM II is called GEDIT. GEDIT presents information from the SYSTEM II databases as a color-coded map of the transportation network. It enables the user to interact with several databases simultaneously and visualize the spatial relationships between demographics and transportation facilities. GEDIT uses a layering concept that assigns each database to a different layer. The signal inventory database uses a unique layer reserved explicitly for the signal data. Provisions are made for four other layers of data as well. The user has full control over the ordering, hierarchy, and meaning of each layer. At any given time, only one layer is "active". All editing, selection, and query functions operate on the active layer. Street names appear on the screen at the appropriate zoom level. In addition to the signal inventory layer, the available layers are:

- Network Link Database
- Network Node Database
- Code Name Database
- Intersection Level of Service Database (Including volumes and intersection geometry)

2.3.3 Signal Inventory Database

The graphical interface with the TIGER file network is not necessary to edit the data. The data can be referenced independently from GEDIT. Running the database only (i.e. without graphics) may be the most convenient option for the smaller cities with few signals and more limited computer availability. The database without graphics may be run on a computer with less power than would be required to efficiently run the graphics editor. An IBM-compatible 386/33 machine or higher will be adequate to run the graphical interface, however, at least a 486/25 is recommended for optimum performance.

It is important to note that if a signal were to be added to the database without activation of the graphical interface, the geographic reference to the network will not be created. Cities intending to enter new signal locations into the database themselves will need to have the graphical interface program or will need to submit the information to LACMTA, where the new signal location can be added and properly referenced to the network.

2.3.4 Obtaining Output

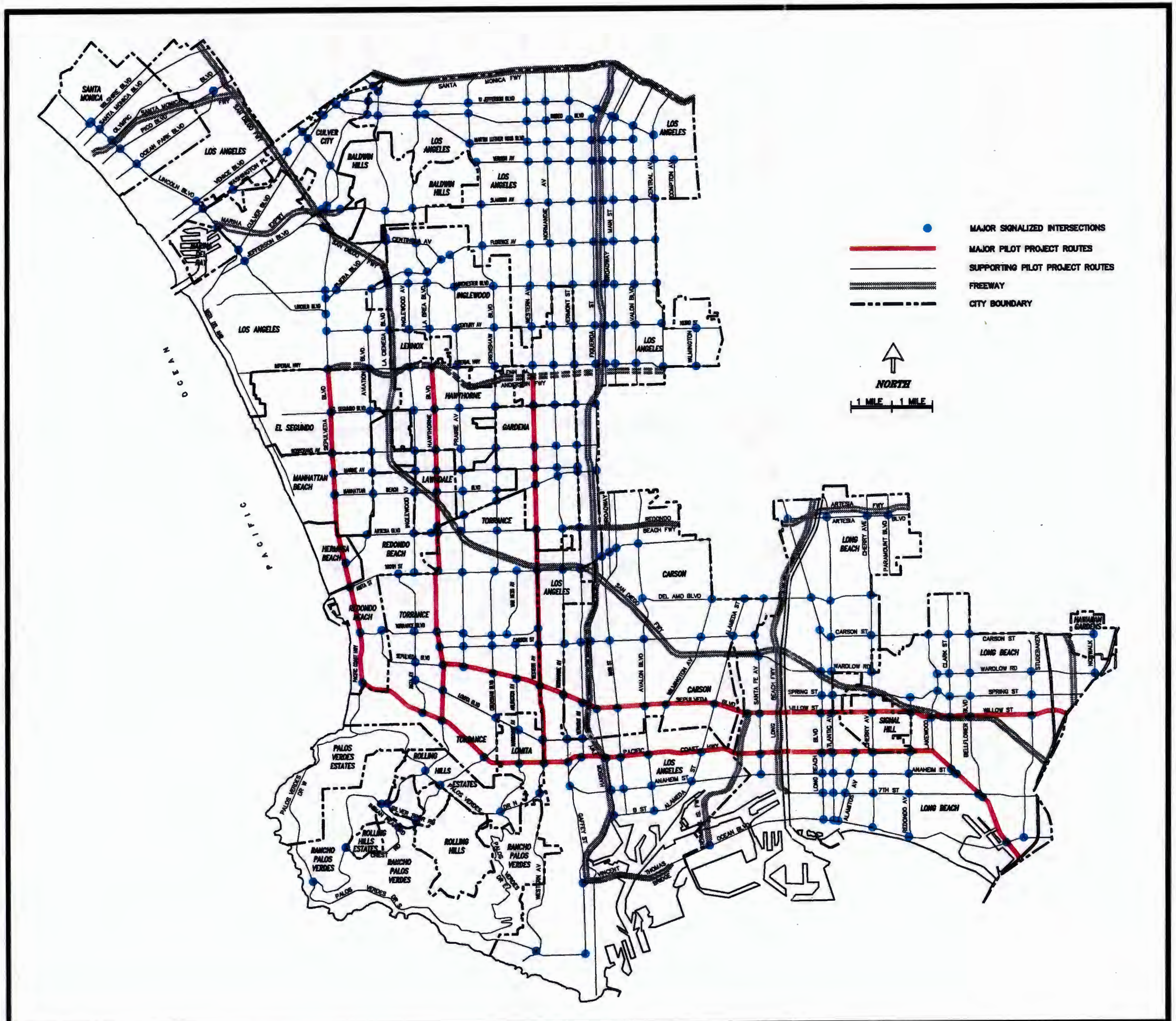
The output functions allow the printing of all data in a format of multiple records per page. Several types of sorts are available for the output, or a subset of the data can be created in a separate file. Thus, Caltrans or a local jurisdiction could request a subset of the database screened according to a particular characteristic. The user may also print a single page directly from the computer screen. The output function is provided as a separate utility program. All print and output file creation functions are handled through utility programs.

2.3.5 Operational Strategy for Using the Database

The suggested operational strategy for maintaining the individual city databases and the centralized database involves several steps. Agencies would maintain the information and provide updates to LACMTA, who would merge the new data into the central database. Old records from the jurisdiction would be deleted, and new records would be added. For jurisdictions opting not to use the graphical interface, information on new signals would need to be sent to LACMTA, who would input the data properly referenced to the network. Updates would be conducted annually or semi-annually. New datasets would be distributed back to Caltrans and the jurisdictions. Jurisdictions would receive either the entire dataset or relevant portions, depending on how much data they want to keep on their own system. When updates are conducted by LACMTA, only the portions of the dataset within a given jurisdiction may be updated by that jurisdiction.

2.4 SIGNALIZED INTERSECTIONS

There are approximately 2,500 signalized intersections contained within the study area boundaries. These intersections include 354 intersections of major arterials which are shown in Exhibit 2.1, as well as, intersections along other supporting streets. There are 214 traffic signals along the four primary routes. Table 2.1 shows the total number of signalized intersections and the intersections along the four primary routes within each jurisdiction.



SOUTH BAY TRAFFIC SIGNAL SYSTEM IMPROVEMENTS

LACMTA

Los Angeles County Metropolitan Transportation Authority

Major Signalized Intersections

Exhibit 2.1

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2.5 CONTROLLERS

There are three main types of controllers used throughout the South Bay area. They are: electromechanical, NEMA and Type 170 controllers. Section 3.2 of this report describes major characteristics and features of these three types of controllers. The NEMA controllers and Type 170 controllers are the most commonly used controllers at signalized intersections in the South Bay area. Caltrans installs Type 170 controllers exclusively at all of their signal locations including those along the routes within the South Bay Area. The signals along state routes are coordinated also by 170 master controllers.

In addition to state routes, county routes are also predominately equipped with Type 170 controllers. Other jurisdictions within the South Bay area have other types of controllers. The cities of El Segundo, Hawthorne and Torrance have NEMA controllers. There are, however, a number of electromechanical controllers spread throughout the area which do not have adequate capabilities and are not compatible with other upgraded equipment.

There are approximately 242 electromechanical controllers currently in use at signalized intersections. NEMA controllers are in use throughout the South Bay area with the majority lying in the cities of Los Angeles, El Segundo, Carson and Hawthorne. There are approximately 644 NEMA controllers used at signalized intersections. Type 170 controllers are the predominant type in the South Bay area with approximately 1637 in use. Caltrans, Long Beach, City of Los Angeles, Los Angeles County, Inglewood and Gardena are the major users of Type 170 controllers.

Table 2.2 shows the quantity of each type of controller within the South Bay jurisdictions. Exhibit 2.2 presents the number of various controllers at major intersections.

2.6 EXISTING TRAFFIC CONTROL SYSTEMS

There are currently several traffic control systems throughout the South Bay area. A brief summary of each system follows.

2.6.1 Caltrans System

As mentioned in Section 2.2, Caltrans installs Type 170 controllers exclusively at all of their signal locations. The signals are coordinated by Type 170 master controllers. The majority of freeways in District 7 jurisdictions contain mainline detectors, ramp detectors, and ramp meters. Data from detectors and ramp meter are transmitted via telephone lines to the TOC to be summarized by the District's Semi-Automatic Traffic Management System (SATMS). Additionally, existing changeable message signs and closed circuit television cameras are controlled by the TOC via phone lines. The 10-Year Caltrans

TABLE 2.1

SIGNALIZED INTERSECTIONS

Jurisdiction	Number of Signals[1]	Number of Signals Along Four Pilot Routes				
		Pacific Coast Highway	Sepulveda Blvd./ Willow St.	Hawthorne Blvd.	Western Ave.	Total Number of Signals Along Pilot Routes
Caltrans	--[2]					
Carson	126		13			13
Culver City	84					0
El Segundo	52	8				8
Gardena	73				13	13
Hawaiian Gardens	12					0
Hawthorne	75			10		10
Hermosa Beach	15	7				7
Inglewood	154					0
Lawndale	32			10		10
Lomita	7	6				6
Long Beach	473	28	17			45
Los Angeles	885	13	1		13	27
Los Angeles County	40		3		3	6
Manhattan Beach	27	8				8
Palos Verdes Estates	0					0
Rancho Palos Verdes	10					0
Redondo Beach	101	15		1		16
Rolling Hills	0					0
Rolling Hills Estates	19					0
Santa Monica	160					0
Signal Hill	21		7			7
Torrance	159	11	8	16	3	38
Total	**2,525**	**96**	**49**	**37**	**32**	**214**

1 Number of signals are signals within the boundaries of each jurisdiction regardless of who owns or maintains. Shared signals have been counted in one jurisdiction only.

2 There are approximately 400 signals within the South Bay area which are owned by Caltrans, although located in local jurisdictions. To prevent double counting, these signalized intersections are only listed and counted as part of the local agency traffic signals.

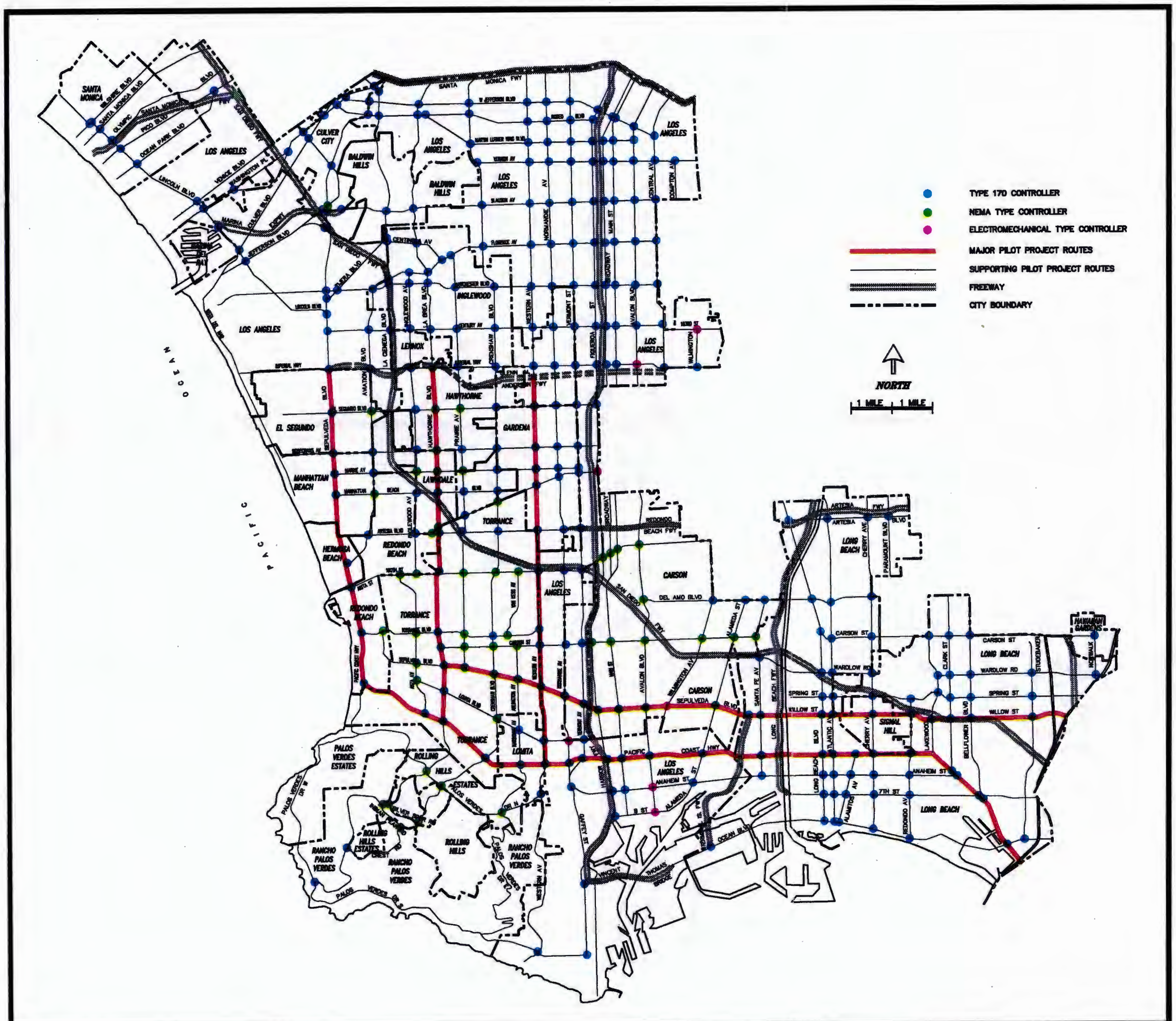
TABLE 2.2

CONTROLLER CHARACTERISTICS IN SOUTH BAY

Jurisdiction	[1]Number of Signalized Intersections	Type of Controller			Comments
		Type 170	NEMA	Electro-mechanical	
Caltrans	--[2]				
Carson	126	43	73	10	
Culver City	84	36	48	0	
El Segundo	52	32	8	12	
Gardena	73	73	0	0	73 signal on-line
Hawaiian Gardens	12	9	3	0	
Hawthorne	75	24	44	7	
Hermosa Beach	15	8	7	0	
Inglewood	154	154	0	0	105 signal on-line
Lawndale	32	24	7	1	
Lomita	7	4	3	0	
Long Beach	473	473	0	0	230 signals on-line
Los Angeles	885	460	221	204	255 signals on-line
Los Angeles County	40	40	0	0	
Manhattan Beach	27	16	7	4	
Palos Verdes Estates	0				No signals in city
Rancho Palos Verdes	10	8	2	0	
Redondo Beach	101	45	56	0	
Rolling Hills	0				No signals in city
Rolling Hills Estates	19	1	18	0	
Santa Monica	160	120	40	0	
Signal Hill	21	21	0	0	
Torrance	159	48	107	4	Mainly KMC-8000
Total	**2,525**	**1,639**	**644**	**242**	

[1] *Number of signalized intersections within the boundaries of each jurisdiction regardless of who owns or maintains.*

[2] *There are 400 signals within the South Bay area which are owned by Caltrans and are all type 170 controllers.*



SOUTH BAY TRAFFIC SIGNAL SYSTEM IMPROVEMENTS

LACMTA

Los Angeles County Metropolitan Transportation Authority

Existing Controller Type

Exhibit 2.2

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Master Plan shows that approximately 25 CMS and 110 CCTV cameras are expected to be installed along the state routes within the South Bay area. The proposed communication lines will link all freeway surveillance equipment, ramp metering, CCTV and CMS with the TOC and will consist of a fiber optic trunk line with sophisticated electronics at field-located communication hubs.

Caltrans TOC currently has interties with the City of Los Angeles ATSAC in the South Bay area and Pasadena in the San Gabriel Valley. Additionally, as the Caltrans TOC-TMC Intertie block diagram in Exhibit 2.3 shows, the City of Anaheim in Orange County as well as the Caltrans District 12 Management Operation Center have interface links with the Caltrans District 7 Operation Center.

2.6.2 Los Angeles County System

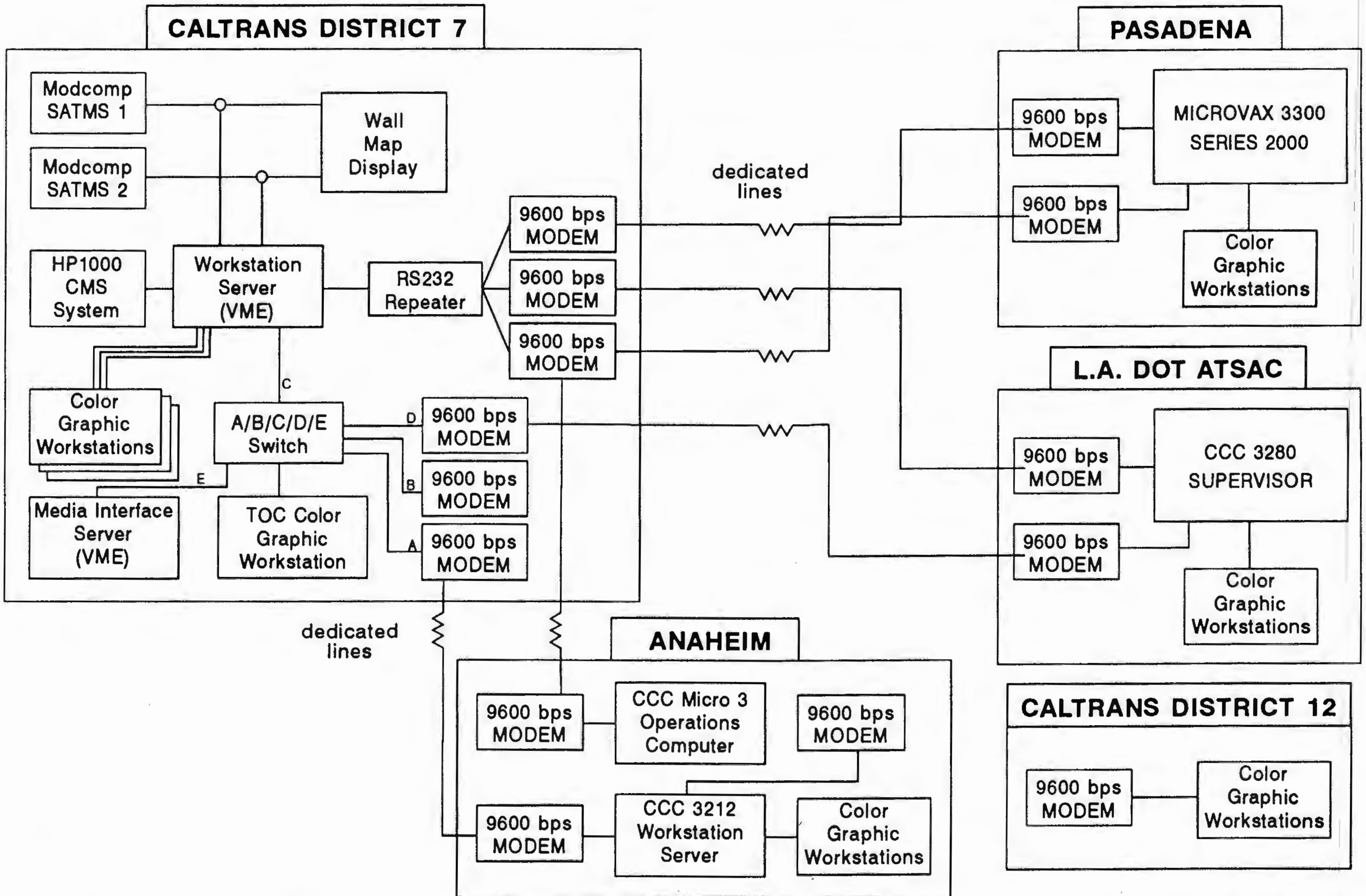
The County of Los Angeles controls or maintains approximately 200 signals along arterials within the South Bay area. The County, under a comprehensive synchronization project, achieves coordination of traffic signals along arterials only (open network). Arterial street control controls signals along an arterial street to give major consideration to the provision of progressive traffic flow along the arterial. The County uses Type 170 controllers as the on-street masters for this control. Table 1.1, which was previously introduced, shows those arterial streets which are coordinated or planned to be coordinated by Los Angeles County.

2.6.3 AUTOMATED TRAFFIC SURVEILLANCE AND CONTROL (ATSAC)

In The City of Los Angeles, ATSAC was first put into operation in June 1984 in preparation for the Summer Olympic Games. The initial installation included 118 signalized intersections and 396 detectors covering four square miles in the Los Angeles Coliseum area. Today more than 850 signalized intersections are controlled by ATSAC. By 1998, all 4,000 signalized intersections in the City of Los Angeles are scheduled to be within the ATSAC System.

Because of its advanced design, ATSAC has been selected as a research site for several National Cooperative Research Program studies. Some of the distinguishing features of the system include:

- Extensive use of detectors to obtain data
- Color graphic monitors to display real-time traffic information at various levels of detail
- Critical intersection control (CIC), providing traffic adaptive signal timing, at all major intersections outside of the Central Business District (CBD)
- Automation of the development of updated areawide signal timing plan using the 1.5 Generation, UTCS-Enhanced Software Package
- Real-time computation of traffic flow measures to evaluate system performance
- Use of fiber optics for trunk communications
- Standardized use of Type 170 controllers for all intersections



Source: jhk & Associates

Meyer, Mohaddes Associates, Inc.
Traffic Engineering o Transportation Planning

Caltrans District 7 TOC-TMC Interties
Inter-System Links
South Bay Signal System Improvement Plan

EXHIBIT 2.3

- Downloading of backup timing plans to local controllers
- Networking of area computers under overall control of the supervisory computer through Ethernet interface

Since the initial implementation, nine other subsystems have been added (CBD, Westwood, West Los Angeles, Los Angeles Airport, Ventura Boulevard, Harbor Freeway Corridor, Pacific Coast Highway, Pathfinder, and along the Light Rail Transit Blue Line. Each subsystem is controlled by a separate minicomputer--either a Concurrent Computer Systems 3230 or Micro 5 configured with 10 megabytes of main memory. One subsystem area computer can control up to 400 intersections and 1,600 detectors. The area computers communicate with each local controller once every second. Fiber optic cable is used to transmit both surveillance data and video pictures.

The City of Los Angeles has currently installed CCTV cameras at major critical intersections for surveillance purposes which are connected to the ATSAC. These intersections include two cameras along Figueroa Street at Exposition Boulevard and at Washington Boulevard; two cameras west of Sepulveda at the airport control tower; two along Sepulveda Boulevard at 96th Street and south of the San Diego Freeway; and three along La Cienega Boulevard, north of Century Boulevard and south of Centinela Avenue.

2.6.4 Smart Corridor Project

The Smart Corridor project focuses on the Santa Monica Freeway and encompasses five parallel and 15 perpendicular arterial streets within the cities of Los Angeles, Culver City and Beverly Hills. A number of signals in the City of Santa Monica will also be connected to the Smart Corridor and the ATSAC. Additionally, there are several other agencies that have been integrated or linked together through the project, including Caltrans, the Los Angeles Police Department and the Southern California Rapid Transit District.

System elements that gather and manage information include: inductive loop detectors; closed circuit television; changeable message signs; highway advisory radio; call-in services; media communications; digital broadcasting; and teletext. There are a few features that will be used to provide operational support for the combined decision made by the various agencies in real-time. They will include: a combined information database, shared data among agencies (including video images), decision support mechanisms, strategies to influence route choice, and adaptation of the network to conditions in real-time.

2.6.5 Local Systems

As mentioned in Section 2.2, several cities in the South Bay area currently manage, monitor or control their traffic signals through a computerized traffic control system. In addition, some cities have system masters which control the signals along a given arterial. Table 2.3 indicates the type of traffic control systems in operation in the South Bay area. Exhibit 2.4 illustrates the existing systems.

2.6.6 Geographical Subsystems

A subsystem or subarea contains a group of traffic signals within a traffic signal system which have similar characteristics and are located adjacent to each other. An important consideration in subsystem control is the definition of the control area boundaries and the groupings of signals that will operate within these boundaries. The major objective when designing a geographical subsystem is to allow for the effective coordination of as many traffic signals as possible within the subsystem. With the successful implementation of proper geographical subsystems and timing plans, spread out vehicles can be joined together to form vehicle platoons which aid in smoother traffic flow while maintaining speed.

System Control

Once the decision to form subsystems has been completed, the next step is to decide which type of subsystem to form. There are two main subsystems which are proven to work effectively in their respective environments. They are Arterial and Grid Networks.

Arterials: Arterial control is used where one street, usually a regionally significant arterial surrounded by smaller collector streets, is experiencing large volumes of traffic. Under this scenario, an agency would want to coordinate this facility to maximize the progressive movement of traffic. First, the agency could coordinate the entire facility as one entity, however, depending on the length and desired outcome, it could prove beneficial to define smaller subsystems.

1. Basic factors when creating arterial subsystems along arterials include the following:

    a. Distance between signalized intersections - The spacing of signalized intersections on an arterial street may range from 150 feet to more than 5,000 feet. The need to operate the facility as one unit usually increases as the distance between signalized intersections decreases. Although optimum operation can be achieved with greater distances between signalized intersections, the *Traffic Control System Handbook* suggests that any two or more intersections which are less then one-half mile apart or within a cycle length of travel time (which may be more than one-half mile on high speed roads) should be coordinated.

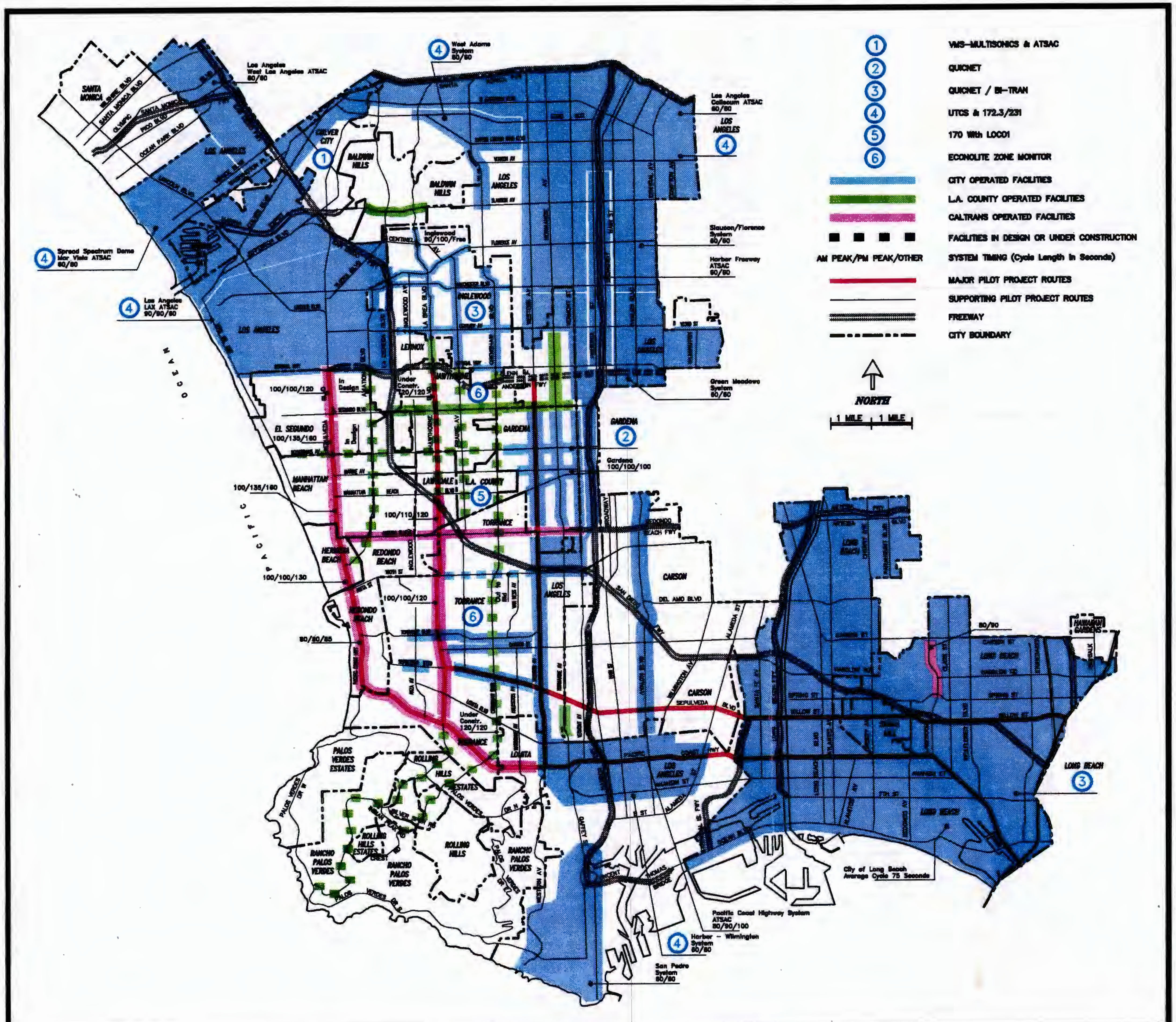
    b. Street Operations - One-way streets usually lend themselves to better progressive movement and system control.

    c. Signal Phasing - Some intersections may be simple two-phase operation while surrounding signalized intersections may be six or eight-phase operation.

TABLE 2.3

EXISTING TRAFFIC CONTROL SYSTEMS

Jurisdiction	Control System Name/Vendor	Control System Type
Caltrans	May procure QuicNet for subsystems	
Carson	None	
Culver City	VMS (Multisonics) & ATSAC	Central
El Segundo	Sonex (inactive)	
Gardena	QuicNet	Central/Distributed
Hawaiian Gardens	None	
Hawthorne	Zone Monitor IV (Econolite KMC 10,000)	Distributed
Hermosa Beach	None	
Inglewood	QuicNet/UTCS	Central
Lawndale	None	
Lomita	None	
Long Beach	QuicNet (Bi-Trans-II)	Central
Los Angeles	UTCS (with 172.3/231 controller software designed by Bi-Trans)	Central/distributed
Los Angeles County	170 with LOCO-I/III	Distributed
Manhattan Beach	None	
Palos Verdes Estates	None	
Rancho Palos Verdes	None	
Redondo Beach	None	
Rolling Hills	None	
Rolling Hills Estates	None	
Santa Monica	Econolite Zone Monitor IV	
Signal Hill	None	
Torrance	Econolite Zone Monitor IV	Central/Distributed



SOUTH BAY TRAFFIC SIGNAL SYSTEM IMPROVEMENTS

LACMTA

Los Angeles County Metropolitan Transportation Authority

Existing Traffic Signal Systems and Subsystems

Exhibit 2.4

Meyer, Mohaddes Associates, Inc.
Traffic Engineering • Transportation Planning

6-25-93

d. Volume Characteristics - A large link volume usually implies a greater need for coordination between adjacent traffic signals.

e. Arrival Characteristics - The arrival characteristics of traffic approaching the signalized intersection are very important. If approaching traffic is random or high side friction is evident, then some form of control must be implemented to form vehicle platoons in order to assist in progressive movement. Sources of random arrivals include the following:

- Substantial distance between signalized intersections.
- High volumes of traffic created by mid-block sources (i.e., shopping centers).
- High volumes of traffic generated by turning vehicles from minor intersecting streets.
- Fluctuations in traffic volume due to time-of-day variation.

f. Geographical Relationships - Intersection should be adjacent to each other without being affected by natural and artificial boundaries, such as rivers, railroads, and freeways.

2. The control area boundaries for arterial subsystems are affected by the following factors:

- System boundaries should be chosen in such a way that there will be minimum disruption to traffic flow at the interface between subsystems because of lack of coordination.

- Boundary location should be chosen where traffic volumes or patterns change drastically, such as heavy left-turn-only movements.

- Political considerations - Place boundary locations where different goals and objectives may require different types of control.

- Existing communications systems - Boundary locations should be placed where adequate interconnect does not exist.

- Change in speed.

Grid Networks: The concept of closed or grid network control is where two intersecting streets are experiencing high congestion levels and low progression. Each street needs to be coordinated and the common reference point would be the intersection where both facilities meet. Under this scenario, not only will a common cycle length need to be used for each street, they need to work together as an entity. Timing plans need to be developed for each using the intersection point of both streets as the common reference point. This process continues as the network becomes larger as more streets are added to the network.

Once a grid network has been created, it is possible to alter the physical structure of the network by removing some signalized intersections or streets from the timing plans, thus creating an open system (arterial control). This could prove beneficial, especially when dealing with peak period travel direction.

There are a number of different factors which should be considered when defining sectional or grid control. They are:

- There should be uniformity either in traffic and travel patterns or timing plans throughout the section.
- Section boundaries should be chosen in such a way that there will be minimal disruption to traffic flow at the intersection of two separate subsystems or subgroups due to lack of coordination.
- Political considerations - Places where differing goals and objectives may require different types of control.
- Geographical limitations in creating one control system.
- Existing communication systems.

Exhibit 2.4 shows existing geographical subsystems and background coordination cycle length for the South Bay area. Section 3.4 of this report provides discussion of arterial and grid system application in the South Bay area including recommendations regarding location and boundary for the systems.

2.6.7 Communications

The communication between signals within the existing subsystems and on-street masters and the local traffic control centers are currently provided through a mixture of jurisdictional owned twisted pair, leased telephone lines, fiber optics, radio and microwave throughout the South Bay area. Table 2.4 indicates the various types of communication media currently used along major arterials. Exhibit 2.5 illustrates the existing communications systems.

TABLE 2.4 (Continued)

CHARACTERISTICS OF MAJOR ARTERIALS

Arterial Name	Segment	Jurisdiction	Existing Interconnect	Controller Type	Responsible Agency
Western Ave.	I-10 - Century Blvd.	LA City	Twisted pair/telephone (ATSAC)	170	LA City
	Century Blvd.-Imperial Hwy.	LA County	—	170	LA County
	Imperial Hwy. - El Segundo Blvd.	LA City	—	170	LA City
	132nd St.-169th St.	Gardena	6 pr. non-figure 8	170	Gardena
	182nd St.-190th St.	Gardena/LA City/Torrance	TBC	170	LA City
	195th St.-Del Amo Blvd.	LA City/Torrance	Free ?	NEMA	Torrance
	Torrance Blvd.-223rd St.	LA City/Torrance	7 wire	170	LA City
	238th St.-253rd St.	LA City/Torrance	7 wire	NEMA/170 Electro-mechanical	LA City
	PCH-Summerland Ave.	LA City	—	170	LA City
	Summerland Ave.-25th St.	LA City	Radio/telephone	170	LA City
Normandie Ave.	Anaheim St.-Sepulveda Bl.	LA City	----	170	LA City
	Sepulveda Blvd. - Artesia Blvd.	County	----	170	LA County
	166th St. - Gardena Blvd.	Gardena	6 pair twisted	170	Gardena
	Gardena Blvd. - 139th St.	Gardena	12 pair twisted	170	Gardena
	139th St. - 132nd St.	Gardena	6 pair twisted	170	Gardena
	132nd St. - Imperial Hwy.	County	-----	170	LA County
	Imperial Hwy. - Century Bl.	LA County	----	170	LA County
	Century Bl.-Vernon Ave.	LA City	Telephone/7-wire	170	LA City
	Vernon Ave. - I-10	LA City	Twisted pair (ATSAC)	170	LA City

TABLE 2.4 (Continued)

CHARACTERISTICS OF MAJOR ARTERIALS

Communications and Controller Conditions					
Arterial Name	Segment	Jurisdiction	Existing Interconnect	Controller Type	Responsible Agency
Vermont Ave.	Normandie Ave.-Sepulveda Bl.	LA City	----	170	LA City
	Sepulveda Blvd.- 190th St.	LA City	----	Varies	LA City
	190th St.-Artesia Blvd.	LA County	----	170	LA County
	168th St.-135th St.	Gardena	6 pair twisted	170	Gardena
	135th St.-Imperial Hwy.	LA County	----	170	LA County
	Imperial Hwy.-Manchester Bl.	LA City	Telephone/7-wire	170	LA City
	Manchester Bl.-Florence Ave.	LA City	Twisted pair	170	LA City
	Florence Ave.-Vernon Ave.	LA City	Telephone/7-wire	170	LA City
	Vernon Ave. - I-10	LA City	Twisted pair (ATSAC)	170	LA City
Venice Blvd.	Abbot Kinney Bl.-Centinela Ave.	LA City	Telephone/7-wire	170	LA City
	Centinela Ave. - I-10 Fwy.	LA City	Twisted pair (ATSAC)	170	LA City
Washington Blvd.	Abbot Kinney Bl.-Centinela Ave.	LA City	Radio	170	LA City
	Centinela Ave. - I-10 Fwy.	Culver City	Radio	170	LA City
Culver Blvd.	Jefferson Bl.-Sepulveda Bl.	LA City	Radio	170	LA City
	Sepulveda Bl.-Washington Bl.	Culver City	Hardwire	170	LA City
Jefferson Blvd.	Culver Blvd.-Sepulveda Blvd.	LA City	Radio	170	LA City
	Sepulveda Blvd.-National	Culver City	----	170	LA City
	National-Normandie Ave.	LA City	Twisted pair (ATSAC)	170	LA City
	Normandie Ave.-Avalon Bl.	LA City	Twisted Pair (ATSAC)	170	LA City
Rodeo Rd.	Washington Bl.-Normandie Ave.	Culver City/LA City	Telephone/7-wire	170	LA City
	Normandie Ave.-Figueroa St.	LA City	7-wire	170	LA City
ML King Blvd.	Rodeo Rd.-Leimert Bl.	LA City	Telephone/7-wire	170	LA City
	Leimert Bl.-Western Ave.	LA City	TBC	170	LA City
	Western Ave.-Normandie Ave.	LA City	Twisted pair (ATSAC)	170	LA City
	Normandie Ave.-Avalon Bl.	LA City	7-wire/Twisted pair (ATSAC)	170	LA City
Vernon Ave.	Crenshaw Blvd.-Normandie Ave.	LA City	----	170	LA City
	Normandie Ave.-Avalon Blvd.	LA City	7-wire/Twisted pair (ATSAC)	170	LA City

TABLE 2.4

CHARACTERISTICS OF MAJOR ARTERIALS

Communications and Controller Conditions					
Arterial Name	**Segment**	**Jurisdiction**	**Existing Interconnect**	**Controller Type**	**Responsible Agency**
Lincoln Bl.	Sepulveda Bl.-Hughes Terr.	LA City	Twisted pair (ATSAC)	170	LA City
	Hughes Terr.-Commonwealth	LA City	Radio/ telephone	170	LA City
Sepulveda Blvd. /Pacific Coast Highway	Jefferson - I-405	Culver City	Twisted pair (ATSAC)	170	LA City/ Culver City
	I-405 - Imperial Hwy.	Los Angeles	Twisted pair (ATSAC)	170	LA City
	Imperial Hwy.-El Segundo Blvd.	El Segundo	25 #19 hardwire	170	Caltrans
↑ Sepulveda Blvd. / ↓ Pacific Coast Hwy.	Hughes Way-21st St.	El Segundo/ Manhattan Beach/ Hermosa Beach	25 #19 hardwire	170	Caltrans
	Pier Ave.-Irena Ave.	Hermosa Beach/ Redondo Beach	7 #14 and 25 #19 hardwire	170	Caltrans
	Beryl St.-Anza Ave.	Redondo Beach/ Torrance	25 #19 hardwire	170	Caltrans
	Hawthorne Blvd.-Crenshaw Blvd.	Torrance	12 #19 hardwire	170	Caltrans
	Rolling Hills Plaza Dwy.-Walnut Ave.	Lomita	12 #19 hardwire	170	Caltrans
	Western Ave.-Alameda St.	LA City	Microwave/twisted pair telephone to San Pedro	170	LA City
			Microwave/twisted pair telephone to LA City Hall		
	Santa Fe Ave.-Termino Ave.	Long Beach/Signal Hill	12 #19 hardwire	170	Long Beach
	Ximeno Ave.-Studebaker Rd.		12 #19 hardwire	170	Long Beach
		Long Beach	12 #19 hardwire		
Aviation Blvd.	Westchester Bl.-Arbor Vitae Bl.	Inglewood	----	170	Inglewood
	Arbor Vitae Bl.-Imperial Hwy.	LA City	Twisted pair (ATSAC)	170	LA City
	Imperial Hwy.-Pacific Coast Hwy.	El Segundo/LA County/Manhattan Beach/Redondo Beach/Hawthorne /LA City	Future WWV/TBC (1994)	170	LA County

TABLE 2.4 (Continued)

CHARACTERISTICS OF MAJOR ARTERIALS

Communications and Controller Conditions					
Arterial Name	Segment	Jurisdiction	Existing Interconnect	Controller Type	Responsible Agency
La Cienega Bl.	Washington-Stocker St.	LA City/LA County/Inglewood	----	170	LA City/ LA County/ Inglewood
	Fairview Bl. - Centinela Ave.	LA City	Twisted pair (ATSAC)	170	LA City
	Florence Ave.-Century Bl.	Inglewood	12 twisted pair	170	Inglewood
	Century Bl.-Imperial Hwy.	LA City	----	170	LA City/LA County
La Brea Blvd./ Hawthorne Blvd.	I-10 - Don Richard Dr.	LA City	Telephone/Twisted pair (ATSAC)	170	LA City
↑ La Brea Blvd.	Don Richard Dr.-64th St.	LA County	----	170	LA County
----------	64th St.-104th St.	Inglewood	12 twisted pair	170	Inglewood
↓ Hawthorne Blvd.	104th St.-Imperial Hwy.	LA County	Future WWV/TBC (1994)	170	LA County/ Hawthorne
	Imperial Hwy.-Manhattan Beach Blvd.	Hawthorne/ Lawndale	----	170/90	LA County
		Lawndale/ Torrance			
	I-405 NB off-ramp - 177th St.	Torrance	12 #19 hardwire	170	Caltrans
	186th St. - Lomita Blvd.	Rolling Hills Est./ Rancho Palos Verdes	25 #19 hardwire	170	Caltrans
	PCH - Palos Verdes Dr. S.		Future WWV/TBC (1994)	170/90	Rolling Hills Est/ Rancho Palos Verdes
Prairie Ave.	Florence Ave.-Imperial Hwy.	Inglewood	12 twisted pair	170	Inglewood
	118th St.-Redondo Beach Blvd.	Hawthorne/Lawndale/ LA County	TBC-WWV	170/90	LA County
Crenshaw Blvd.	I-10 - Imperial Hwy.	LA City/Inglewood	Twisted pair/ ATSAC	170	LA City/ Inglewood
	Imperial Hwy.-Marine Ave.	Hawthorne/Gardena/Inglewood/LA County	TBC-WWV	170/90	LA County
	Marine Ave.-PCH	Torrance/LA County/Gardena/ Lomita	TBC-WWV	170/90	LA County
	Maricopa St.-Sepulveda Blvd.	Torrance	Hardwire installed by Torrance	NEMA	LA County
	235th St.-Skypark Dr.	Torrance	Hardwire installed by Torrance	NEMA	LA County
	PCH - Crestridge Rd.	Rolling Hills Est/ Rancho Palos Verdes	TBC-WWV	170/90	LA County

TABLE 2.4 (Continued)

CHARACTERISTICS OF MAJOR ARTERIALS

Communications and Controller Conditions					
Arterial Name	**Segment**	**Jurisdiction**	**Existing Interconnect**	**Controller Type**	**Responsible Agency**
Slauson Ave.	I-10 Fwy. at Slauson Ave.	LA City	Twisted pair (ATSAC)	170	LA City
	I-10 Fwy. - Bristol Pkwy.	LA County	Hardwire	170	LA County
	Bristol Pkwy.-Angelus Vista	LA City	TBC	170	LA County
	Angelus Vista-Crenshaw Blvd.	LA City	-----	170	LA City
	Crenshaw Blvd.-Central Ave.	LA City	Radio/telephone	170	LA City
Centinela Ave.	I-405 Fwy. - Florence Ave.	LA County/Inglewood	-----	170	LA County/ Inglewood
La Tijera Blvd.	Sepulveda Blvd.-Centinela Ave.	LA City	Twisted pair (ATSAC)	170	LA City
Florence Ave.	LA Cienega Blvd.-Western Ave.	Inglewood/LA City	Twisted pair (ATSAC)	170	Inglewood/L A City
	Western Ave.-Central Ave.	LA City	Telephone/7-wire /Twisted pair (ATSAC)	170	LA City
Manchester Blvd.	Pershing Dr.-Van Ness Ave.	LA City/Inglewood	Twisted pair (ATSAC) /hardwire	170	LA City/ Inglewood
	Van Ness Ave.-Western Ave.	LA City	Telephone/7-wire	170	LA City
	Western Ave.-Central Ave.	LA City	7-wire/Twisted pair (ATSAC)	170	LA City
Century Blvd.	Sepulveda Blvd.-La Cienega Bl.	LA City	Twisted pair (ATSAC)	170	LA City
	La Cienega Bl.-La Brea Ave.	Inglewood	-----	170	Inglewood
	La Brea Ave.-Van Ness Ave.	Inglewood	Hardwire	170	Inglewood
	Van Ness Ave.-Western Ave.	LA City	-----	170	LA City
	Western Ave.-Figueroa St.	LA County/LA City	Radio/telephone	170	LA City
	Figueroa St.-Main St.	LA City	7-wire/Twisted pair (ATSAC)	170	LA City
	Main St.-Central Ave.	LA City	Radio/telephone	170	LA City

TABLE 2.4 (Continued)

CHARACTERISTICS OF MAJOR ARTERIALS

Communications and Controller Conditions					
Arterial Name	**Segment**	**Jurisdiction**	**Existing Interconnect**	**Controller Type**	**Responsible Agency**
Imperial Hwy.	Main St.-Aviation Blvd.	El Segundo/ LA City	ATSAC/hardwire	170	LA City/Caltrans
	Inglewood Ave.-Prairie Ave.	Hawthorne/ Inglewood	----	Econolite	LA County
	Prairie Ave.-Van Ness Ave.	Inglewood	Hardwire	170	Inglewood
	Western Ave.-Vermont Ave.	LA County	----	170	LA County
	Vermont Ave.-Central Ave.	LA City	7wire/telephone /Twisted pair (ATSAC)	170	LA City
El Segundo Blvd.	Sepulveda Blvd.-Aviation Blvd.	El Segundo	Sonex (not working)	170	LA County
	Isis Ave.-Vermont Ave.	El Segundo/ Hawthorne/ LA County/Gardena	TBC-WWV	170	LA County
	Vermont Ave.-Figueroa St.	LA City	Twisted pair (ATSAC)	170	LA City
Rosecrans Ave.	Sepulveda Blvd.-Crenshaw Blvd.	El Segundo/ Hawthorne/Lawndale/ LA County/Manhattan Beach	----	170	LA County
	Van Ness Ave.-Vermont Ave.	Gardena	6 & 12 twisted pair	170	Gardena
	Vermont Ave.-Figueroa St.	LA City	Twisted pair (ATSAC)	170	LA City
Marine Ave.	Sepulveda Blvd. to Van Ness Ave.	Manhattan Beach/ Lawndale/LA County	----	170	County
	Van Ness Ave.-Vermont Ave.	Gardena	6 pair twisted	170	Gardena
Manhattan Beach Blvd.	Sepulveda Blvd.-Crenshaw Blvd.	Manhattan Beach/ Redondo Beach/ Lawndale/LA County/Gardena	----	170	LA County
Redondo Beach Blvd.	Artesia Blvd.-Van Ness Ave.	Torrance/Lawndale /Gardena	----	170	LA County
	Van Ness Ave.-Vermont Ave.	Gardena/Torrance /LA City	6 pair non-twisted 8	170	Gardena
	Vermont Ave.-Figueroa St.	LA City	TBC	170	LA City
Artesia Blvd.	Prospect Ave.-Felton Lane	Manhattan Beach/ Hermosa Beach /Redondo Beach	12 #19 & 20 #18 hardwire	170	Caltrans
	Inglewood Ave.-Grevillea Ave.	Lawndale/Redondo Beach	12 #19 hardwire	170	Caltrans
	Prairie Ave.-Vermont Ave.	Torrance/Gardena	12 #19 hardwire	170	Caltrans

TABLE 2.4 (Continued)

CHARACTERISTICS OF MAJOR ARTERIALS

Communications and Controller Conditions					
Arterial Name	**Segment**	**Jurisdiction**	**Existing Interconnect**	**Controller Type**	**Responsible Agency**
190th St.	Pacific Coast Hwy.-Hawthorne Blvd.	Redondo Beach /Torrance	----	Econolite	Redondo Beach
	190th St. at Western Ave.	LA City	TBC	170	LA City
	Prairie Ave.-Gramercy Ave.	Torrance	6 pair #19	KMC-8000	Torrance
Victoria St.	Vermont Ave.-Wilmington Ave.	Carson	----	NEMA	Carson
Torrance Blvd.	Pacific Coast Hwy.-Earl St.	Redondo Beach/ Torrance	----	NEMA	Redondo Beach/ Torrance
	Torrance Bl. at Western Ave.	LA City	----	170	LA City
	Earl St.-Cabrillo	Torrance	6 #19	KMC-8000	Torrance
Carson St.	Madrona Ave.-Cabrillo Ave.	Torrance	6 #19	KMC-8000	Torrance
	Western Ave.-Santa Fe Ave.	LA City/Carson	----	NEMA	LA City/Carson
	Long Beach Bl.-Clark St.	Long Beach	TBC	170	Long Beach
	Clark St. - I-605 Fwy.	Long Beach	Radio/telephone	170	Long Beach
Sepulveda Blvd./ Willow St.	Palos Verdes Bl.-Anza Ave.	Torrance	6 pair #19	KMC-8000	Torrance
	Del Amo Cir. East-Crenshaw Bl.	Torrance	6 pair #19	KMC-8000	Torrance
	Western Ave.-I-110 NB Ramps	Torrance/LA City /LA County	----	Varies	LA City/ LA County
	Figueroa St.-Alameda St.	Carson	----	Varies	Carson
	Terminal Isl. Fwy.-Studebaker Rd.	Long Beach/Signal Hill	12 #19/microwave	170	Long Beach
Gaffey St.	25th St.-22nd St.	LA City	Radio/telephone	170	LA City
	22nd St.-19th St.	LA City	Hardwire	170	LA City
	19th St.-1st St.	LA City	Radio/telephone	170	LA City
	1st St. - I-110 Fwy.	LA City	Hardwire	170	LA City
	I-110 Fwy. - Anaheim St.	LA City	Radio/telephone	170	LA City
Pacific Ave./ John Gibson Blvd.	Paseo Del Mar - I-110 Fwy.	LA City	Radio/telephone	170	LA City
	I-110 Fwy. - B St.	LA City	----	170	LA City
Figueroa St.	Anaheim St.-Gardena Blvd.	LA City/Carson	----	170/NEMA	LA City/Carson
	Gardena Blvd.-Redondo Bch. Bl.	LA City	TBC	170	LA City
	Redondo Bch. Bl.- I-10 Fwy.	LA City	Twisted pair (ATSAC)	170	LA City

TABLE 2.4 (Continued)

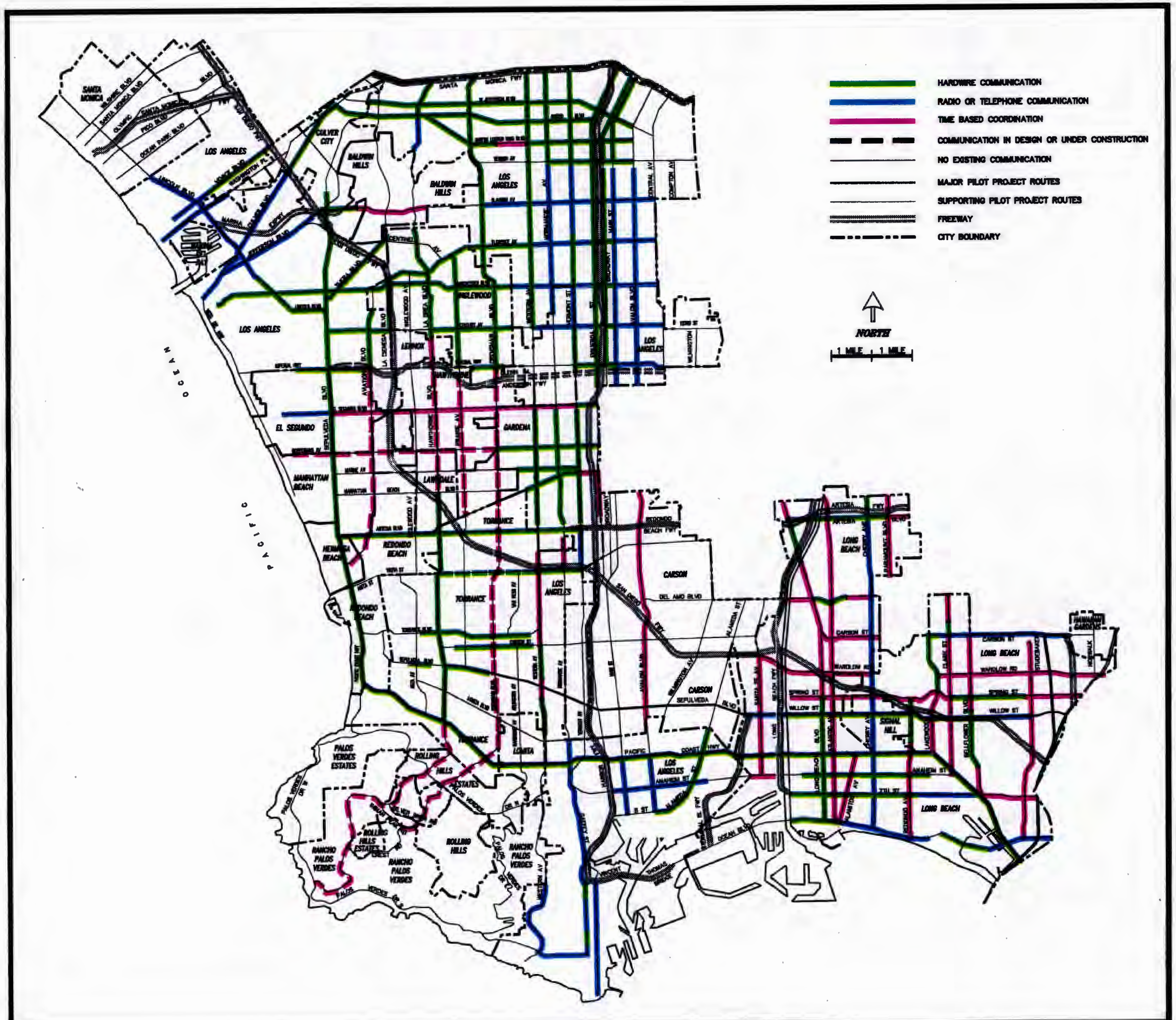
CHARACTERISTICS OF MAJOR ARTERIALS

Arterial Name	Segment	Jurisdiction	Existing Interconnect	Controller Type	Responsible Agency
Broadway	Main St.-Alondra Blvd.	Carson	-----	NEMA	Carson
	Imperial Hwy.-Vernon Ave.	LA City	Twisted pair (ATSAC)	170	LA City
	Vernon Ave. - I-10 Fwy.	LA City	Hardwire (ATSAC)	170	LA City
Main St.	B St.-Alondra Blvd.	LA City/Carson	-----	NEMA/170	Carson/LA City
	Imperial Hwy.-Vernon Ave.	LA City	Radio/telephone	170	LA City
	Vernon Ave. - I-10 Fwy.	LA City	Hardwire (ATSAC)	170	LA City
Avalon Blvd.	B St.-Lomita Blvd.	LA City	-----	170	LA City
	Lomita Blvd.-Alondra Blvd.	Carson	TBC	NEMA	Carson
	Imperial Hwy.-Vernon Ave.	LA City	Radio/telephone	170	LA City
	Vernon Ave. - I-10 Fwy.	LA City	-----	170	LA City
Central Ave.	Imperial Hwy. - I-10 Fwy.	LA City	-----	170	LA City
Wilmington Ave.	Lomita Blvd.-Del Amo Blvd.	Carson	-----	NEMA	Carson
Alameda St.	B St.-Lomita Blvd.	LA City	Telephone/Twisted pair (ATSAC)	170	LA City
	Lomita Blvd.-Del Amo Blvd.	Carson	-----	NEMA/elect.	Carson
Santa Fe Ave.	Anaheim St.-Wardlow Rd.	Long Beach	TBC	170	Long Beach
	Wardlow Rd.-Del Amo Blvd.	Carson	-----	NEMA	Carson
Long Beach Blvd.	Ocean Ave.-Spring St.	Long Beach	12 #19 twisted pair	170	Long Beach
	Spring St.-70th St.	Long Beach	TBC	170	Long Beach
Atlantic Ave.	Ocean Ave.-70th St.	Long Beach	TBC	170	Long Beach
Alamitos Ave.	Ocean Ave.-Pacific Coast Hwy.	Long Beach	TBC	170	Long Beach
Cherry Ave.	Ocean Ave.-Artesia Blvd.	Long Beach/ Signal Hill	Radio/telephone	170	Long Beach
	Artesia Blvd.-70th St.	Long Beach	12 #19 twisted pair	170	Long Beach
Paramount Blvd.	South St.-70th St.	Long Beach	TBC	170	Long Beach
Redondo Ave.	Ocean Ave.-Pacific Coast Hwy.	Long Beach	TBC	170	Long Beach
	Pacific Coast Hwy.-Spring St.	Long Beach/ Signal Hill	12 #19 twisted pair	170	Long Beach
Lakewood Blvd.	Pacific Coast Hwy.-Spring St.	Long Beach	TBC	170	Long Beach
	Spring St.-Arbor Rd.	Long Beach	Hardwire	170	Caltrans
Clark St.	Pacific Coast Hwy.-Carson St.	Long Beach	TBC	170	Long Beach
	Carson St.-Arbor Rd.	Long Beach	TBC/twisted pair	170	Long Beach

TABLE 2.4 (Continued)

CHARACTERISTICS OF MAJOR ARTERIALS

Communications and Controller Conditions					
Arterial Name	**Segment**	**Jurisdiction**	**Existing Interconnect**	**Controller Type**	**Responsible Agency**
Bellflower Blvd.	Pacific Coast Hwy.-Atherton Ave.	Long Beach	TBC	170	Long Beach
	Atherton Ave.-Spring St.	Long Beach	12 #19 twisted pair	170	Long Beach
	Spring St.-Arbor Rd.	Long Beach	TBC	170	Long Beach
Studebaker Rd.	Westminster Ave.-Carson St.	Long Beach	TBC	170	Long Beach
Norwalk Blvd.	Wardlow Rd.-Carson St.	Hawaiian Gardens	-----	170	Hawaiian Gardens
Wardlow Rd.	Santa Fe Ave.-Cherry Ave.	Long Beach	TBC	170	Long Beach
	Lakewood Blvd.-Norwalk Blvd.	Long Beach	TBC	170	Long Beach
Spring St.	San Francisco Ave.-Clark St.	Long Beach	TBC	170	Long Beach
	Clark St.-Studebaker Rd.	Long Beach	Hardwire	170	Long Beach
Anaheim St.	Gaffey St.-Figueroa St.	LA City	-----	170	LA City
	Figueroa St.-Henry Ford St.	LA City	Telephone/7-wire	170	LA City
	Henry Ford St.- I St.	LA City	-----	170	LA City
	I St.-Redondo St.	Long Beach	12 #19 twisted pair	170	Long Beach
	Redondo St.-Pacific Coast Hwy.	Long Beach	-----	170	Long Beach
7th St.	I-710 Fwy.-Redondo Ave.	Long Beach	12 #19 twisted pair	170	Long Beach
	Redondo Ave.-Pacific Coast Hwy.	Long Beach	Radio/telephone	170	Long Beach
	Pacific Coast Hwy.-Pepper Tree Ln.	Long Beach	12 #19 twisted pair	170	Long Beach
Ocean Blvd./ Ave.	Vincent Thomas Brdg.-Magnolia Ave.	Long Beach	-----	170	Long Beach
	Magnolia Ave.-Alamitos Ave.	Long Beach	12 #19 twisted pair	170	Long Beach
	Alamitos Ave.-Redondo Ave.	Long Beach	Radio	170	Long Beach
	Sorrento Dr.-Appian Way	Long Beach	12 #19 twisted pair	170	Long Beach
	Marina-Studebaker Rd.	Long Beach	Radio	170	Long Beach



SOUTH BAY TRAFFIC SIGNAL SYSTEM IMPROVEMENTS

LACMTA

Los Angeles County Metropolitan Transportation Authority

Existing Communication Method

Exhibit 2.5

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2.7 SURVEILLANCE ELEMENTS

The surveillance elements currently in use within the South Bay area are system loops and CCTV cameras. System loops are installed sporadically throughout the cities of Long Beach, Inglewood and Los Angeles. Several CCTV cameras are installed along major arterials at critical intersections or near the major activity centers. The City of Los Angeles has CCTV cameras in the following locations:

- Century Boulevard west of Sepulveda Boulevard
- Century Boulevard and La Cienega Boulevard
- Sepulveda Boulevard and 96th Street
- La Cienega Boulevard at La Tijera Boulevard
- Sepulveda Boulevard and Higuera Parkway
- Olympic Boulevard and Bundy Drive
- Wilshire Boulevard and Barrington Avenue
- Exposition Boulevard and Figueroa Street
- Figueroa Street and Washington Boulevard

2.8 SIGNAL OPERATION/MAINTENANCE PROCEDURES

The jurisdictional inventory forms sent to each jurisdiction, contained questions regarding the existing signal operating and maintenance procedures. Most of the South Bay agencies perform routine maintenance. The frequency of maintenance varies from monthly to bi-annually. Many agencies have employed outside contractors for maintaining their signals. The County maintains more than 200 signals within the unincorporated areas and within some of the cities' boundaries in the South Bay area. Table 2.5 presents a summary of maintenance types, frequency and number of maintenance staff and jurisdictional desires for additional staff.

2.9 PLANNED JURISDICTIONAL IMPROVEMENTS

The jurisdictional inventory forms contained questions regarding the jurisdictional planned improvements, traffic signal equipment and system upgrade. The forms also contained questions to provide information on jurisdictional desires. Responses to these questions were used to prioritize the recommended improvements contained in the 10-Year Plan. Table 2.6 indicates the jurisdictional targeted traffic signal equipment and system upgrade and provides a list of jurisdictional desires associated with signal system improvements.

TABLE 2.5

SIGNAL MAINTENANCE TYPE AND FREQUENCY

Jurisdiction	Maintenance Type	Frequency of Maintenance	Number of Maintenance Staff
Caltrans	Routine/Preventative/ Emergency	As Needed	Adequate
Carson	Routine	Monthly	Contract: Compton, Los Angeles County, Long Beach
Culver City	Routine/Preventative/ Emergency	Monthly	4 (inc. street lights and building maintenance)
El Segundo	Routine/Preventative/ Emergency	As needed	0; County, Manhattan Beach and Los Angeles provide required staff
Gardena	Routine/Preventative/ Emergency	Monthly	2
Hawaiian Gardens	Routine/Preventative/ Emergency	Every 6 Weeks	LA County
Hawthorne	Routine	Monthly	Contracted: LA County and SMI Company
Hermosa Beach	Routine/Emergency	Every 6 Months	2
Inglewood	Routine/Preventative/ Emergency	Every 6 Months	6
Lawndale	Routine/Preventative/ Emergency	Every 6 weeks (goal) As needed for emergency	LA County
Lomita	Routine/Preventative/ Emergency	Monthly	Contractor
Long Beach	Routine/Preventative/ Emergency	Quarterly/ Semi-Annual/ Annually	18
Los Angeles	Routine/Preventative/ Emergency	As Staff is Available	4 for South Bay area
Los Angeles County	Routine/Preventative/ Emergency	Every 6 weeks (goal) As needed for emergency	County has 8 districts - 4 people are handling the South Bay
Manhattan Beach	Routine/Preventative Emergency	Monthly	Adequate

TABLE 2.5 (continued)

SIGNAL MAINTENANCE TYPE AND FREQUENCY

Jurisdiction	Maintenance Type	Frequency of Maintenance	Number of Maintenance Staff
Palos Verdes Estates	N/A	N/A	No signals
Rancho Palos Verdes	Not available	Not available	Not available
Redondo Beach	Routine	Quarterly	1½
Rolling Hills			
Rolling Hills Estates			
Santa Monica	N/A	N/A	N/A
Signal Hill	Routine/Preventative/ Emergency	Quarterly/ Semi-Annual/ Annually	Included in 18 Long Beach staff
Torrance	Routine	Every 6 Months	2

TABLE 2.6

JURISDICTIONAL TARGETED IMPROVEMENTS AND DESIRES

Agency	Targeted Traffic Signal Equipment and System Upgrade	Jurisdictional Desires
Caltrans	Upgrading the existing hardwire along state routes and tie into freeway fiber optic trunk Upgrading the system	A regional center which can monitor all signals in the South Bay area as well as other areas. Implementation of CCTV, CMS, HAR and fiber optics communications and their integration with new Traffic Operations Center.
Carson	TBC only along major arterials	More staff for traffic operational tasks. For City of Carson, which does not include regionally significant arterials, multijurisdictional coordination is not to the community's benefit.
Culver City	Upgrade all signals to 170 controllers	Increase staffing and funding. Change VMS to 170's and ATSAC. Coordinate all signals with City of Los Angeles.
El Segundo	No report	Increase staffing. Coordinate all City's signals.
Gardena	Update traffic signals, mast arms, poles, and wiring	Increase staffing. Fund hardware improvements. Upgrade intersection hardware.
Hawaiian Gardens	No report	The County of Los Angeles provides maintenance and operation for signals within the City.
Hawthorne	Upgrade communications by adding WWV Upgrade to Econolite Zone Monitor IV	Increase staffing. Government funding is needed.
Hermosa Beach	No Report	Increase staffing.

TABLE 2.6 (continued)

JURISDICTIONAL TARGETED IMPROVEMENTS AND DESIRES

Agency	Targeted Traffic Signal Equipment and System Upgrade	Jurisdictional Desires
Inglewood	Upgrade to fiber optic Install new version of QuicNet software	Need more government funding to improve existing traffic signals systems, update data and equipment. Upgrade/replace the City's 20 year old interconnect.
Lawndale	See *Los Angeles County*	Coordination of signals along the City's major arterials.
Lomita	No report	Have a good progression in the City.
Long Beach	Upgrade system to include hardwire, microwave, and fiber optic Complete LACMTA software modifications for QuicNet system; complete Citywide system	Additional technicians Increase maintenance budget Communication equipment, CCTV, new larger control center
Los Angeles	Various mediums of communications including fiber optic, microwave, telephone, leased line, 7-wire, twisted pair, infrared, radio based, and spread spectrum. FHWA grant for spread spectrum, replaces 7-wire with twisted pair, fiber optic trunkline.	More staff for operations and maintenance Replace NEMA and electromechanical timers with 170's Interconnect signals Provide surveillance and interconnect control elements wherever possible

TABLE 2.6 (continued)

JURISDICTIONAL TARGETED IMPROVEMENTS AND DESIRES

Agency	Targeted Traffic Signal Equipment and System Upgrade	Jurisdictional Desires
Los Angeles County	TBC along major arterials	**Countywide Desires:** More fine tuning and timing More Staff Keep Hardware Delete telephone interconnect Use of video detection systems in data gathering (Counts) such as Autoscope Introduce WWV and keep TBC potential **Jurisdictional Desires:** More funding needed More maintenance crew More synchronization implementation
Manhattan Beach	No report	Future traffic Central System
Palos Verdes Estates	No signals in City	Signal synchronization along Hawthorne Boulevard from Pacific Coast Highway to Palos Verdes Drive will positively impact the City's traffic operations
Rancho Palos Verdes	No report	Signal synchronization along Hawthorne Boulevard from Pacific Coast Highway to Palos Verdes Drive will positively impact the City's traffic operations

TABLE 2.6 (continued)

JURISDICTIONAL TARGETED IMPROVEMENTS AND DESIRES

Agency	Targeted Traffic Signal Equipment and System Upgrade	Jurisdictional Desires
Redondo Beach	No report	The City is supportive of multijurisdictional coordination Numerous intersection improvements (refer to Jurisdictional Inventory sheet)
Rolling Hills	No signals in City	Signal synchronization along Hawthorne Boulevard from Pacific Coast Highway to Palos Verdes will positively impact the City's traffic operations
Rolling Hills Estates	No report	Signal synchronization along Hawthorne Boulevard from Pacific Coast Highway to Palos Verdes will positively impact the City's traffic operations
Torrance	Interconnect 190th Street - Gramercy Pl. to Prairie Ave. - KMC 10000 Master	Upgrade of interconnect system for a segment of Sepulveda Blvd. east of Crenshaw Blvd.
Signal Hill	See *Long Beach*	The City of Long Beach is maintaining the signals within the City

3. ANALYSIS OF OPPORTUNITIES AND CONSTRAINTS

This section generally provides a brief discussion of the traffic flow and congestion patterns. It also presents an analysis of available controllers and communication media systems, and covers the opportunities and constraints for developing relationships between the various agencies. These relationships will be necessary throughout the design and implementation of improvement projects and for proposing and funding traffic signal system improvements.

3.1 PRIMARY TRAFFIC FLOW PATTERN

Existing Roadway Network

The South Bay study area is presently served by eight freeways. The San Diego Freeway (I-405) runs in a northwest-southeast direction throughout the study area, from Santa Monica on the north to Long Beach on the south. The Harbor Freeway (I-110) runs in a north-south direction, from downtown Los Angeles south to its terminus within the San Pedro area. The Long Beach Freeway (I-710) is a north-south freeway which parallels the Los Angeles River and terminates in Long Beach. The Santa Monica Freeway (I-10) runs in an east-west direction along the northern boundary of the study area. The Marina Freeway (SR 90) is a short east-west freeway connecting Culver City and the San Diego Freeway with the Marina del Rey area. The Redondo Beach-Artesia Freeway (SR 91) is an east-west facility serving the northern portions of Carson and Long Beach. The Terminal Island Freeway (SR 47) serves the port areas of Long Beach and Los Angeles, consisting of two separate parts: the Vincent Thomas Bridge from San Pedro to Terminal Island, and an approximately three mile segment connecting Terminal Island to the north. The San Gabriel River Freeway (I-605) runs north-south along a small portion of the eastern boundary of Long Beach and the study area. In addition, the Glenn Anderson Freeway (I-105) is currently under construction and scheduled to open in 1993, and will run in an east-west direction terminating at Los Angeles International Airport.

Throughout much of the study area, the arterial roadway system is generally a grid system with a north-south/east-west orientation. Major exceptions to this typically occur as a result of topographic features, such as the Palos Verdes Peninsula in the southwest corner of the study area, the Baldwin Hills in the northwest section of the study area, and the harbor areas of Long Beach and Los Angeles.

Most of the arterials serving the study area provide four or six through lanes of traffic (two or three in each direction) during peak traffic periods. Portions of Hawthorne Boulevard in Torrance and Sepulveda Boulevard in El Segundo provide eight travel lanes (four in each direction).

Existing Traffic Volumes

Existing traffic volume data were collected from a variety of sources, including traffic flow maps and count data provided by a number of cities in the study area, the 1991 Caltrans *Traffic Volume Book*, the 1991 Los Angeles County *Traffic Volume Book*, and previous studies conducted in the area (see source list at the end of this report). Existing average daily traffic (ADT) volumes at locations for which data were available are illustrated on Exhibit 3.1.

Many of the arterials within the study area carry high traffic volumes. For example, the following streets carry ADT volumes in excess of 60,000:

North-South Streets
- Sepulveda Boulevard - in the vicinity of Los Angeles International Airport and in the Cities of El Segundo, Manhattan Beach and Redondo Beach
- La Cienega Boulevard - in the City of Los Angeles north of the Baldwin Hills
- Hawthorne Boulevard - in the Cities of Lawndale and Torrance

East-West Streets
- Century Boulevard - in the vicinity of Los Angeles International Airport

In addition, portions of the following streets carry ADT volumes of between 40,000 and 60,000:

North-South Streets
- Lincoln Boulevard - in Santa Monica and Los Angeles
- Sepulveda Boulevard - in the Westchester area of Los Angeles and in Hermosa Beach
- La Cienega Boulevard - in Inglewood
- Hawthorne Boulevard - in Inglewood, Hawthorne and Lawndale
- Prairie Avenue - in Inglewood and in Torrance
- Crenshaw Boulevard - in Los Angeles and in Torrance
- Gaffey Street - in the San Pedro area of Los Angeles
- Lakewood Boulevard - in Long Beach

East-West Streets
- Venice Boulevard - in Los Angeles and Culver City
- Slauson Avenue - in Culver City
- Florence Avenue - in Inglewood and south central Los Angeles
- Manchester Boulevard - in south central Los Angeles
- Century Boulevard - in Inglewood
- Imperial Highway - in El Segundo, Hawthorne and Inglewood

East-West Streets (continued)

- El Segundo Boulevard - in El Segundo, Hawthorne and Gardena
- Rosecrans Avenue - in El Segundo/Manhattan Beach, Lawndale, Hawthorne and Gardena
- Artesia Boulevard - in Redondo Beach, Torrance and Gardena
- 190th Street - in Torrance
- Sepulveda Boulevard - in Torrance and the Harbor Gateway area
- Pacific Coast Highway - in Torrance, Lomita, Los Angeles and Long Beach
- 7th Street - in Long Beach
- Ocean Boulevard - on Terminal Island
- 2nd Street/Westminster Avenue - in the Naples area of Long Beach

It is of interest to note that three of the four streets carrying greater than 60,000 ADT are north-south streets in the western portion of the study area (Sepulveda, La Cienega, and Hawthorne Boulevards), and two (Sepulveda and Century Boulevards) are in the vicinity of LAX. Also, almost every major east-west arterial in a band from Inglewood on the north to north Torrance on the south carries greater than 40,000 ADT. However, in the latter case, it should be noted that the opening of the Glenn Anderson Freeway in 1994 could be expected to relieve traffic volumes on many of the parallel east-west streets in the Inglewood/Hawthorne/Gardena area. The Final Environmental Impact Statement prepared for the Glenn Anderson Freeway concluded that traffic volumes on parallel arterial streets would initially drop substantially (up to 50% for arterials immediately adjacent to the freeway and about 20% for the corridor as a whole from Florence Avenue on the north to Artesia Boulevard on the south) upon completion of the freeway and would then gradually increase in the future, although future volumes with the freeway would remain substantially less than those projected without the freeway. The four pilot projects include two of the three most heavily-travelled routes—Sepulveda Boulevard and Hawthorne Boulevard.

Portions of the study area in which most or all of the streets are relatively less travelled compared to the above (i.e., 40,000 ADT or less) include the Palos Verdes Peninsula, the Wilmington area of Los Angeles, the Carson and North Long Beach areas, and most streets in the south central area of Los Angeles.

Existing Congestion Levels

Data regarding existing traffic operating levels and congestion levels at major arterial intersections in the study area were compiled from information provided by certain cities as part of the signal system inventory stage of this study, from the *Congestion Management Program* and the *Congested Corridors Action Plan* prepared by the Los Angeles County Transportation Commission (now the Los Angeles County Metropolitan Transportation Authority) and from previous studies conducted in the area (see source list at the end of this report). Information was collected regarding typical weekday morning and afternoon peak commute period operating conditions at major arterial intersections in the study area. An attempt was also made to collect information regarding operating conditions during non-commute peak periods, such as midday, evening, weekend and seasonal peaks. However, little quantitative data was available for these atypical peak periods.

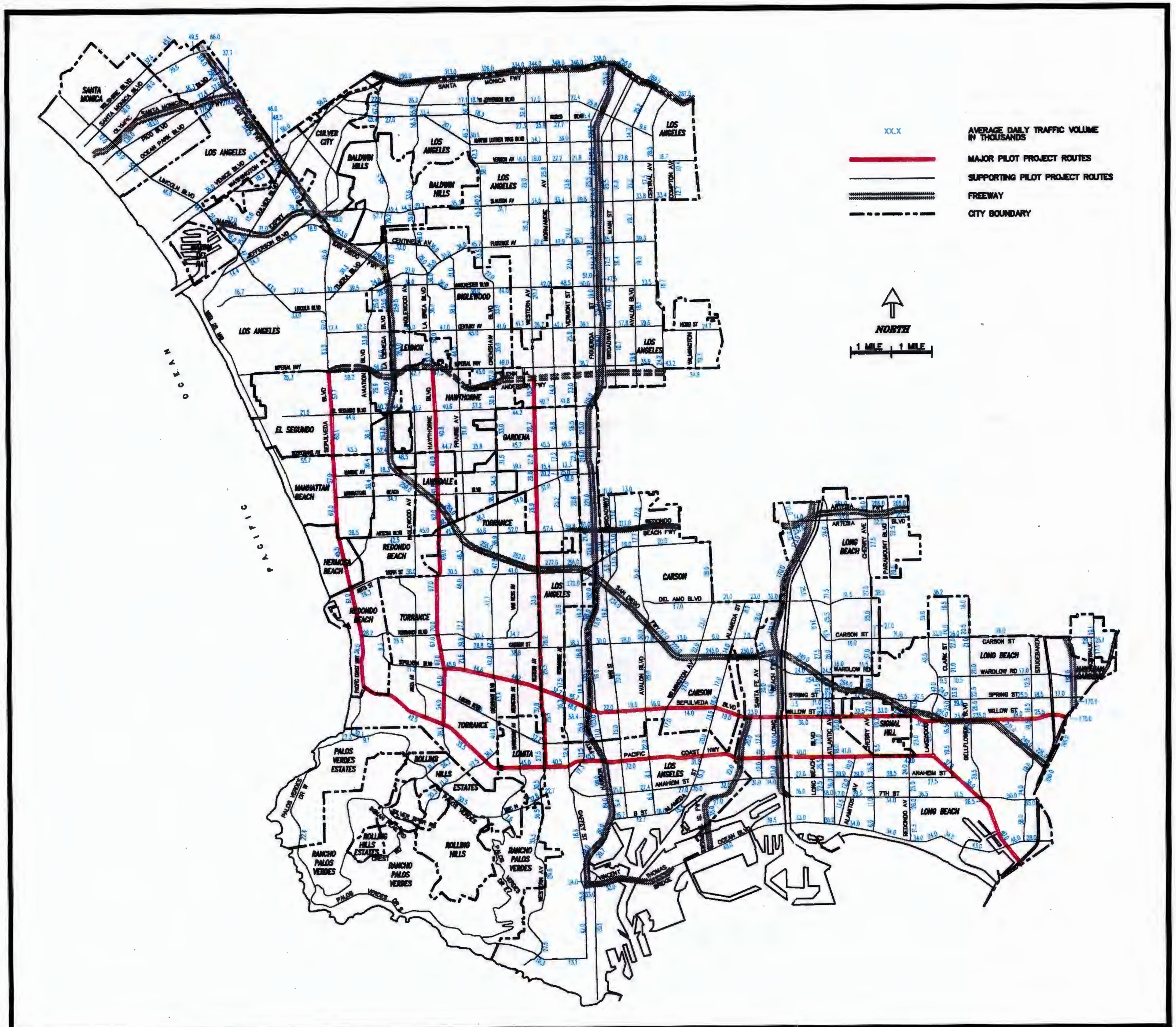
Level of service is a measure used to describe the conditions of traffic flow, ranging from excellent conditions at level of service (LOS) A to overloaded conditions at LOS F. Level of service definitions for signalized intersections are provided in Table 3.1. For the purposes of this study, three congestion level categories were defined based on level of service, as follows:

Congestion Level	Level of Service
Low	A or B
Medium	C or D
High	E or F

Weekday Commute Peak Periods. Exhibit 3.2 illustrates the existing weekday peak period congestion levels at the major arterial intersections for which data were available. The exhibit identifies those locations experiencing high congestion levels in the morning and/or afternoon commute peak periods. Typical morning peak occurs between 7:00 and 9:00 AM and afternoon peak between 4:00 and 6:00 PM. A review of the exhibit indicates that high congestion levels are experienced at most of the major intersections throughout a large portion of the study area.

The major portions of the study area in which the available data suggests that peak period congestion levels are not predominantly high include the Palos Verdes Peninsula, the port area, and portions of south central Los Angeles. The available data suggests that high congestion levels are experienced along most of the major arterial corridors in the rest of the study area. This includes the four pilot project routes (Pacific Coast Highway/Sepulveda Boulevard between the eastern Long Beach city limits and Los Angeles International Airport, Willow Street/Sepulveda Boulevard between the eastern Long Beach city limits and Hawthorne Boulevard, Western Avenue between Pacific Coast Highway and the future Glenn Anderson Freeway, and Hawthorne Boulevard between Pacific Coast Highway and the future Glenn Anderson Freeway) as well as many of the other arterial corridors.

Seasonal Variation and Special Generators. Although little quantitative data is available, some general observations can be made regarding atypical traffic peaks in the study area. The "beach" cities (including Manhattan Beach, Hermosa Beach, Redondo Beach, the coastal area of Torrance, the Belmont Shore area of Long Beach, the Marina del Rey area, the Venice area of Los Angeles, and Santa Monica) experience seasonal traffic congestion during summer months, particularly on peak summer weekend days.



SOUTH BAY TRAFFIC SIGNAL SYSTEM IMPROVEMENTS

LACMTA

Los Angeles County Metropolitan Transportation Authority

Existing Average Daily Traffic Volumes

Exhibit 3.1

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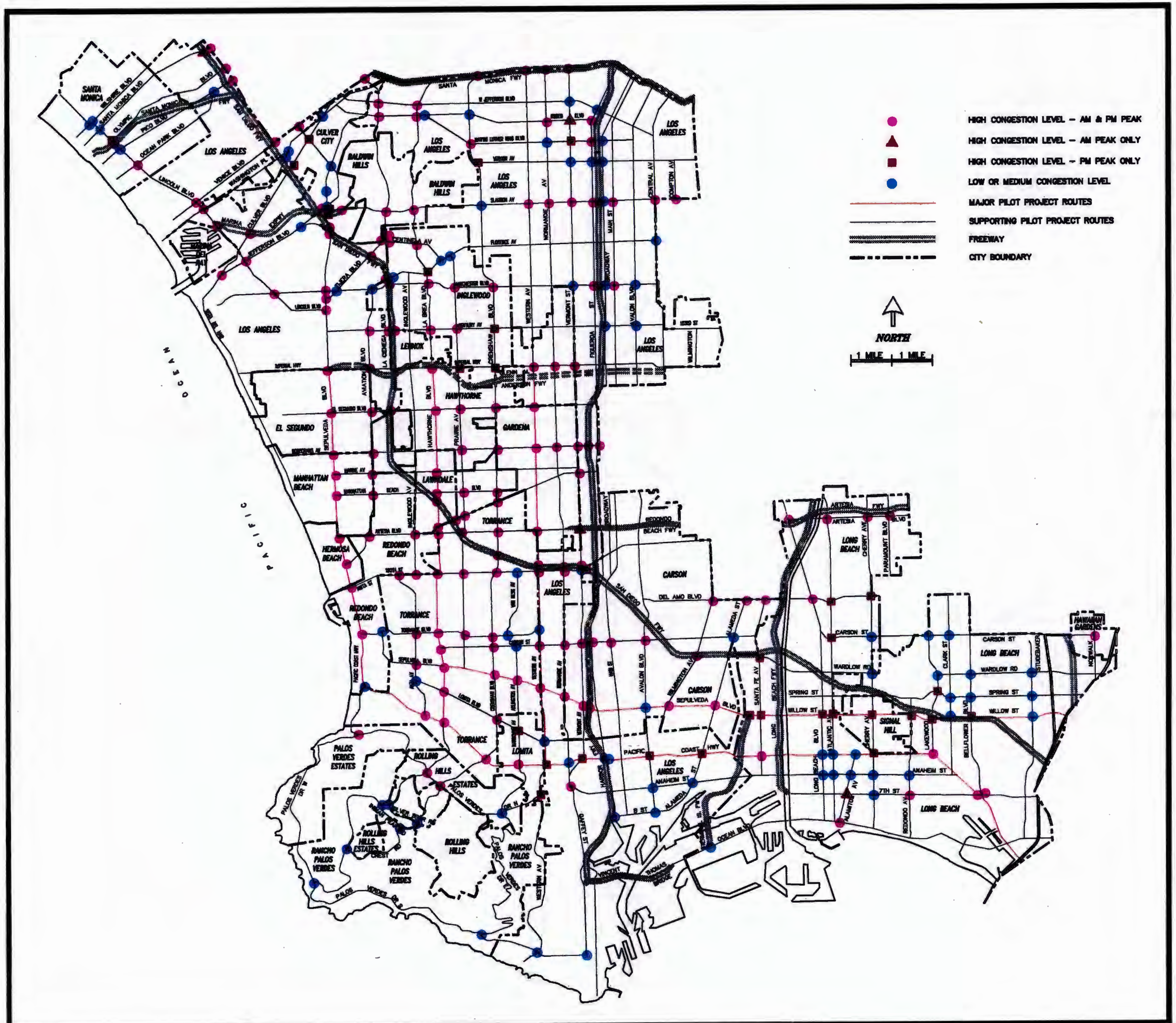

SOUTH BAY TRAFFIC SIGNAL SYSTEM IMPROVEMENTS

LACMTA

Los Angeles County Metropolitan Transportation Authority

Existing Weekday Peak Period Congestion Levels

Exhibit 3.2

Meyer, Mohaddes Associates, Inc.
Traffic Engineering • Transportation Planning

6-29-93

There are a number of major special generators within the study area which attract trips from throughout the Southern California region as well as within the study area. These include:

- Los Angeles International Airport
- Long Beach Municipal Airport
- Long Beach and Los Angeles Harbors (which generate high volumes of truck and rail traffic)
- Long Beach Convention and Entertainment Center complex (and the annual Long Beach Grand Prix)
- Long Beach Community College
- Hollywood Park and The Forum in Inglewood
- Los Angeles Coliseum and Exposition Park in Los Angeles
- University of Southern California
- California State University, Dominguez Hills in Carson
- California State University, Long Beach

These special generators often contribute to or create congestion in their vicinity, particularly during special events (e.g., events at the Coliseum, Forum or Hollywood Park) or unique peak periods of the generator (e.g., holiday travel periods in the vicinity of LAX). Exhibit 3.3 shows major activity centers within the South Bay area.

3.2 CONTROLLER ANALYSIS

As mentioned in Table 2.2, the three main types of controllers used at signalized intersections in the South Bay area are Type 170, NEMA and Electromechanical. A brief comparison of these controllers is presented in this Section.

NEMA Controllers

NEMA controllers are solid-state, fully-actuated type units manufactured in accordance with standards published by the National Electrical Manufacturers Association (NEMA), 1983. The standards cover the following:

- Definitions for function and hardware
- Environmental requirements and test procedures
- Interface requirements
- Physical and functional requirements
- Peripheral equipment to complete the controller assembly, such as land switches, conflict monitors, detector amplifiers, flasher switches, electrical terminals and facilities, and power supply

NEMA standards cover fully-actuated operation ranging from two-phase to eight-phase, with overlaps.

SOUTH BAY TRAFFIC SIGNAL SYSTEM IMPROVEMENTS

LACMTA

Los Angeles County Metropolitan Transportation Authority

Major Activity Centers

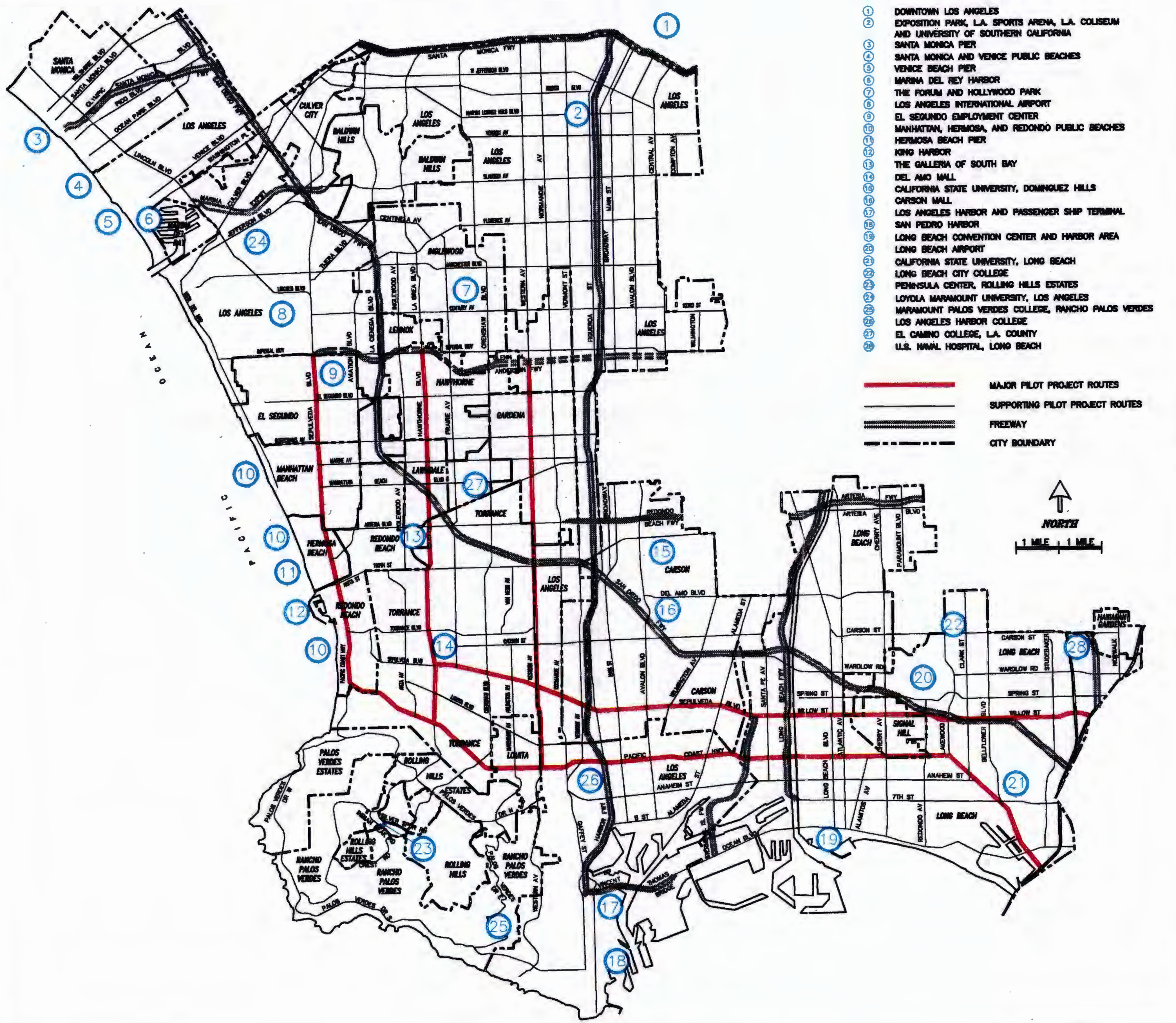

Exhibit 3.3

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Type 170 Controllers

Type 170 controllers are general purpose microprocessor-based units manufactured in accordance with the Type 170 specifications. The specifications were jointly developed by the states of California and New York in coordination with the Federal Highway Administration (FHWA); but unlike NEMA standards, the Type 170 specifications do not cover control functions. Each manufacturer designs controllers in accordance with the specifications. The concepts of the states of California and New York are to purchase the controllers and to then add the necessary discrete software to respective units for implementation of desired control functions. Software for the 170 controllers can also be provided and integrated with respective controller units by consultants or suppliers, or by the manufacturer of the controller.

If appropriate software is installed, the Type 170 controller will functionally duplicate NEMA units and vice versa. The standardized versions of the Type 170 software could be modified to accommodate a variety of traffic control applications.

The conceptual approach of the Type 170 system is based on hardware standardization, and structure of the controller assembly as a package consisting of standardized modules, complementary hardware and wiring harnesses, all housed within a standard cabinet enclosure.

Comparison of NEMA and Type 170 Controllers

The concepts of the NEMA and Type 170 controllers are quite different. NEMA controller units are designed and manufactured in various electronic arrays, but all must conform functionally to the NEMA standards. Certain physical requirements for auxiliary and ancillary equipment must also be met to maintain compatibility between certain components. Many manufacturers of NEMA units use the microprocessor concept, satisfying the NEMA functional requirements, and also provide a means for programming special additional functions by the user. Type 170 controller units, on the other hand, are microprocessors conforming to the *Type 170 Hardware Specifications* which describes the physical performance and mechanical requirements of the unit. As manufactured, the Type 170 unit is not capable of performance as a traffic signal controller. The user must provide (or procure from other sources) a software program and install it in the traffic PROM module of the unit. This program provides the brain necessary for the microprocessor to perform as a signal controller unit.

Table 3.2 lists some items for a comparison of likenesses/differences in the Type 170 and NEMA controller concepts.

TABLE 3.2

COMPARISON OF NEMA AND TYPE 170 CONTROLLER UNITS

Basis for Comparison	NEMA	Type 170
Design	Usually microprocessor-based, but must functionally conform to NEMA Standards of operation for traffic signal controller	Microprocessor-based, but functions are a result of the specific software program installed in Programmable Read-Only Memory (PROM) module
Standards/ Specifications	Not hardware specific a. Define functional, environmental, physical and interface b. Objectives - Attain compatibility and interchangeability of equipment c. Provide for standard operation and performance as traffic signal controller	Hardware oriented a. Define environmental, physical, self-diagnostics, and interface b. Objectives - Interchangeability, minimized costs for procurement, simplified maintenance c. User and/or vendor are responsible for operation and software programming-coding
User Access	Usually via keyboard - some units employ thumbwheels,Diamond Interchange Program (DIP) switches, or program pins	Via keyboard - some units employ hexadecimal system for programming-coding
Software	Tested and supplied by vendor	Vendor or user (or other source) may supply
Adaption for Special Use	Difficult, since Standards define functions and PROM is "fixed" by vendor to carry out tailored program per NEMA	Standards do not cover functions; specific PROM can be installed so that virtually any mode or application can be carried out
Maintenance and Trouble Shooting	Microprocessor-based in most controller units, but oriented to function by phase, sequence, or interval. Easy to trouble shoot.	Oriented to microprocessor addressor database; requires more advanced electronics knowledge. Is difficult to maintain because assigned output may be different with each controller.
Input/Output (I/O) Interface	Inputs and outputs are function specific by pin assignment	Software used directly assigns inputs and outputs, by pin, on some models. Others have feature which reassigns individual I/O pins from keyboard by user
Cabinets	Not standardized in size or component placement within, from one manufacturer's product to another	Standard size wiring layout and component placement within cabinet specified for uniformity

Electromechanical Controllers

Electromechanical controllers are an older generation of traffic control device where a synchronous motor drives a timing dial and advances a motor-drive camshaft for signal lamp switching. The majority of these controllers have been gradually replaced with either NEMA or Type 170 controllers.

3.3 COMMUNICATIONS

Data communications can take place over a variety of media such as :

- Twisted pair cable
- Coaxial cable
- Fiber optics
- Radio
- Microwave link
- Infrared laser
- VSAT

Jurisdiction-owned twisted pair cable is one of the most widely used communications media for traffic control systems. Twisted pair cable provides a voice-grade transmission link between a central computer or master and each intersection. Jurisdiction-owned interconnect typically is installed in conduit underground (Caltrans) or is strung aerially on poles (Gardena).

The alternative to jurisdiction owned cable is a leased communication network such as telephone company circuits or cable TV. Telephone intertie is a preferred medium in situations where the intersections to be controlled are remote from the master and no existing conduit or cable provides the necessary connections.

The extremely high bandwidth potential of fiber optics and the decreasing cost of both cable and communications terminal equipment makes fiber optics today's preferred alternative for high speed data network. Caltrans has plans to install fiber optics along the freeways within the entire South Bay area. The City of Los Angeles has fiber optic backbone in place for its ATSAC system along the Harbor Freeway and Santa Monica Freeway.

Many of the cellular telephone companies offer services to provide communications between locations where physical cable installation is not practical. Spread spectrum radio, as a medium for communication, is an alternative which is still under research and evaluation. Spread spectrum radio communication can be used to transmit both data and voice between intersections and the master controller if line of sight is available.

Microwave links could be used for both short and long distance communications, if line of sight is available, with high capacity. However, the most economical systems are limited in distance to a few miles. In addition, the operating frequencies are within the radio band requiring FCC licensing.

Infrared laser communications provides many of the advantages of microwave, without the requirement for licensing. These systems, however, provide lower speed communications and are limited in distance to a few miles, depending on the laser power and capabilities of the transmitter and receiver.

VSAT (Very Small Aperture Terminals) provides a cost-effective means for many users to share a single channel on a satellite communications system. It is recommended that fiber optic cable be used for trunk line due to wide band requirements for transmission, such as CCTV. Use of microwave and radio could be applied where appropriate. Traditional use of twisted pair is still adequate for data and voice transmissions, although with compression techniques, video can also be transmitted.

3.4 SYSTEM BOUNDARY ANALYSIS

Discussion: Section 2.6.6 provided a framework by which arterial and grid subsystems are designed, and described the associated criteria such as travel characteristics, travel speeds, spacing between traffic signals, traffic volumes, etc. This section focuses on these elements within the South Bay area and provides recommendations for consideration.

Currently, there are several arterials which are coordinated in different segments with different cycle lengths. The main reason for the difference in cycle length is that the facility runs through several jurisdictions and generally each jurisdiction employs different cycle lengths.

Due to the diversity of travel characteristics in the South Bay area, both arterial and grid systems seem appropriate for various areas. This approach is currently in place in The City of Long Beach. Portions of the City of Los Angeles are in a grid system and the County of Los Angeles is coordinating major arterials in an arterial system progression method.

The similar traffic characteristics and signal spacings along several arterials suggest that a common cycle length could be employed in coordinating the traffic signals along portions of the facility. In addition, grid network coordination could be achieved for the central South Bay area which contains evenly spaced signals. The recommendations for arterial and grid progression presented here should be complemented with additional, more focussed study in order to determine the exact boundary locations and common cycle lengths. These recommendations are primarily concentrated within the central portion of the South Bay area. Although the northern and southern/eastern portion of the South Bay area is also included. The northern portion of the area is primarily under the cities of Inglewood and Los Angeles (ATSAC and non-ATSAC) control. They have both grid and arterial control for appropriate areas. For the area east of the Harbor Freeway within the southern portion of the South Bay area, the majority of which contains the cities of Carson and Long Beach, arterial progression method should be employed for major arterials since the spacing between traffic signals is significant and grid network is not applicable.

Recommendation: Two types of progression recommendations, grid and arterial, are presented below.

1) *Grid Network*: The area south of Glenn M. Anderson Freeway, north of Artesia Boulevard and the San Diego Freeway, east of Hawthorne Boulevard and west of Harbor Freeway, is suggested for the grid network. Within this area, signals are evenly spaced along arterials and traffic volumes are uniform. A range of 40,000 to 45,000 ADT is identified along much of these corridors. Currently, cycles lengths ranging from 100 to 120 seconds are employed for operation (Exhibit 2.4). Obviously a common cycle length is necessary for operation of this grid system. Many of the controllers are Type 170, although several NEMA controllers are currently operating at several intersections. In order to synchronize both controller types, a common time clock will be necessary. This area encompasses the following major east-west and north-south arterials:

- El Segundo Boulevard, Rosecrans Avenue, Marine Avenue, Manhattan Beach Boulevard, and Artesia Boulevard between Hawthorne Boulevard and the Harbor Freeway.

- Hawthorne Boulevard, Prairie Avenue, Crenshaw Boulevard, Western Avenue, Normandie Avenue, and Vermont Avenue between Glenn Anderson Freeway and San Diego Freeway.

Special attention should be given to the determination of the system boundaries to integrate the last signals within this grid network with continuation of arterial progression.

In the northern portion of the South Bay area several systems are currently in operation, including the Los Angeles systems (Green Meadows, Slauson/Florence, L.A. Coliseum, Adams West, LAX, Harbor Freeway Corridor, West L.A., and Westwood). Inglewood is operating several arterial systems as discussed later in this section.

The Los Angeles systems primarily operate on 60 second cycles, except for the LAX system. This common cycle length provides an opportunity for better integration of the various subsystems. Several of these systems are not currently in ATSAC control. It is recommended that for better integration and monitoring they ultimately be connected to the ATSAC system.

In the southern portion of the South Bay area, it is recommended that the PCH/Harbor Wilmington system be integrated with traffic signals along Pacific Coast Highway and Lomita Boulevard, from Crenshaw Boulevard to the west and Santa Fe Boulevard to the east.

In the city of Long Beach additional traffic signals north of downtown are recommended to be included in the downtown grid system especially along the north-south corridors, such as Atlantic Boulevard and Long Beach Boulevard.

2) *Arterial Progression*: Arterial progression method is recommended to be applied for major arterials primarily within the central and southern portions of the area. Some of these arterials, as Exhibit 2.4 shows, are already coordinated or planned to be coordinated. However, the coordination should provide progression throughout the facility with a common cycle length to the extent possible. The similar traffic characteristics of the following arterials in particular, suggest that a common cycle length may be employed in conjunction with the grid network recommended for the central area:

East - West Arterials:

- El Segundo Boulevard from Sepulveda Boulevard to Hawthorne Boulevard. This segment has an average daily traffic of approximately 42,000 vehicles.

- Rosecrans Avenue from Vista Del Mar Boulevard to Hawthorne Boulevard. This segment has an average daily traffic of approximately 50,000 vehicles.

- Marine Avenue from Sepulveda Boulevard to Hawthorne Boulevard. This segment has an average daily traffic of approximately 20,000 vehicles.

- Manhattan Beach Boulevard from Sepulveda Boulevard to Hawthorne Boulevard. This segment has an average daily traffic of approximately 35,000 vehicles.

- Artesia Boulevard from Sepulveda Boulevard to Hawthorne Boulevard. This segment has an average daily traffic of approximately 40,000 vehicles per day.

North - South Arterials:

- Aviation Boulevard from Imperial Highway to Pacific Coast Highway. This segment has an average daily traffic of approximately 36,000 vehicles.

- Hawthorne Boulevard from Imperial Highway to Pacific Coast Highway. This segment has an average daily traffic of approximately 65,000 vehicles.

- Prairie Avenue from Artesia Boulevard to Sepulveda Boulevard. This segment has an average daily traffic of approximately 40,000 vehicles.

- Crenshaw Boulevard from Artesia Boulevard to Pacific Coast Highway. This segment has an average daily traffic of approximately 42,000 vehicles.

- Western Avenue from Artesia Boulevard to Pacific Coast Highway. This segment has an average daily traffic of approximately 31,000 vehicles.

- Normandie Avenue from Artesia Boulevard to Pacific Coast Highway. This segment has an average daily traffic of approximately 17,000 vehicles.

- Vermont Avenue from Artesia Boulevard to Pacific Coast Highway. This segment has an average daily traffic of approximately 19,000 vehicles.

In the northern part of the South Bay, integration of several arterials is recommended including:

- Crenshaw Boulevard between Slauson Avenue (West Adams system) and Manchester Boulevard in the city of Inglewood.

- Century Boulevard between La Cienega Boulevard and Western Avenue in the city of Inglewood is recommended to be tied into both the LAX system on the west and the Green Meadows system to the east. Similarly, Manchester Boulevard is recommended to be tied into both LAX and Green Meadows systems. Although currently the LAX system and Green Meadows systems are operating on different cycle lengths (90 seconds and 60 seconds), opportunities should be investigated for possible revised boundary locations.

In the southern/southeast portion of the South Bay area the following recommendations are presented for consideration.

- Sepulveda Boulevard east of Western Avenue to Wilmington Avenue should be considered for arterial progression.

- The city of Long Beach currently has approximately 320 intersections in the system. It is recommended that much of the remaining traffic signals (170) within the city be considered for inclusion into the system, especially along the major arterials such as Atlantic Boulevard and Long Beach Boulevard.

In summary, the communication improvements along with controller replacement, WWV clocks, and the system wide coordination plan indicated in the Concept Plan (Section 5) will aid in overall system improvement in the South Bay. In addition as discussed in Section 4, the multijurisdictional boundaries recommended should provide a framework for overall coordination and interface strategies in the South Bay area.

3.5 INSTITUTIONAL ISSUES AND SIGNAL COORDINATION

This topic covers any issues of relevance to the practical implementation of a fully coordinated traffic control system for the South Bay Area. It is concerned with the opportunities and practical constraints for developing close working relationships between agencies, such that broader goals and benefits can be realized.

This discussion is organized as follows:

1. The existing institutional arrangements for proposing and funding signal coordination projects in the South Bay Area.

2. A section which considers multi-jurisdictional cooperation in general. This includes defining the scope of work and considers the likely content of formal agreements between agencies related to signal coordination.

3.5.1 Institutional Structure

The South Bay area is both large and complex in terms of the many institutions which have responsibilities for improving, designing, funding, constructing and maintaining the signal system. Exhibit 3.4 below shows the relationships of the institutions and the emerging working structure.

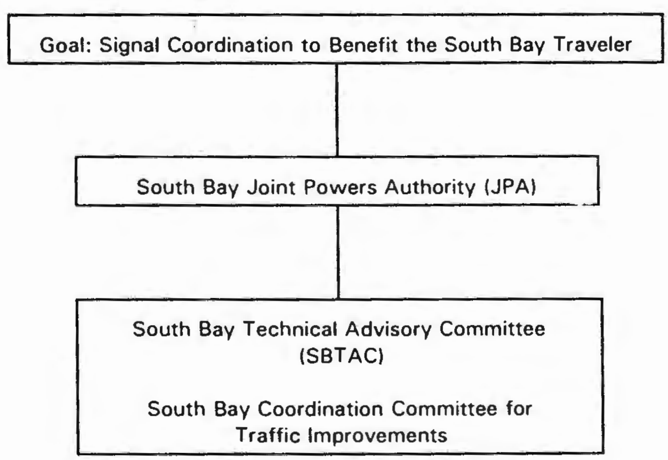


Exhibit 3.4 South Bay Signal Coordination Institutions

Table 3.3 which follows, shows the membership of the committees which are identified.

TABLE 3.3

THE SOUTH BAY AREA INSTITUTIONAL STRUCTURE FOR IMPROVING SIGNAL COORDINATION

The South Bay Joint Powers Authority (JPA)	Non JPA Members Included/Involved in the Project	Technical Advisory Committee of the JPA (TAC)	South Bay Coordination Committee For Signal Improvements
		All JPA Members	All JPA members plus all others involved in the project
City of Carson	City of Culver City		
City of El Segundo	City of Long Beach		
City of Gardena	City of Signal Hill		
City of Hawthorne	City of Hawaiian Gardens		
City of Hermosa Beach	Caltrans		
City of Inglewood	Los Angeles County		
City of Lawndale	LACMTA		
City of Lomita			
City of Los Angeles			
City of Manhattan Beach			
City of Palos Verdes Estates			
City of Rancho Palos Verdes			
City of Redondo Beach			
City of Rolling Hills			
City of Rolling Hills Estates			
City of Torrance			

The above table shows the institutional structure for improving signal coordination in the South Bay area. The South Bay Joint Powers Authority (JPA) has overall responsibility and authority for promoting policies and programs for improving signal coordination within the area. The interests of both JPA members and non-members at a technical level are considered within the context of the Technical Advisory Committee (TAC) of the JPA. Within this committee, an ad hoc group is convened regularly to consider proposals for signal improvements which will benefit the South Bay area. This group is called the South Bay Coordination Committee for Signal Improvements and its members include both JPA and non-JPA institutions. It reports via the TAC to the South Bay Joint Powers Authority. Pilot Project 1, which is the first initiative of the JPA, will benefit all of the parties indicated in the institutional structure.

3.5.2 Multi-jurisdictional Funding Applications

The JPA supported by the Technical Advisory Committee, is the conduit through which the first funding application is being made for monies in support of Pilot Project 1, a multi-agency signal coordination project. The JPA is proposed as the general oversight and decision making body for all such purposes. Projects supported by the JPA should benefit by being identified as:

1. Projects with political multi-agency support

2. Can be placed within the context of the Concept Plan for the whole South Bay traffic signal coordination program.

3. Can be identified with regional rather than single agency benefits.

All of the above should be beneficial in promoting the case for signal coordination funding within the South Bay Area. If the initial application proves successful, agencies which are not currently members of the JPA may wish to give consideration to the merit of formal membership of the JPA. Given the current good informal working relationships this may be considered to be unnecessary.

3.5.3 General Considerations for Multi-Jurisdictional Cooperation

The JPA and the TAC are responsible for approving projects to go forward for funding applications. MTA staff, however, will take the responsibility for overall coordination of projects where this is deemed appropriate. In many instances, the practical implementation of projects will require the establishment of close working relationships between groups of agencies. Effectively this will mean that sub-area (working groups) within the South Bay will work cooperatively on projects. This process will be greatly helped if for each sub-area project clear understandings are reached at the beginning of the cooperative effort.

Each project will need to be clearly defined and at a minimum will require the following:

- Clear goals and objectives agreed by all the participating agencies
- Identification of the intersections within the scope of the project(s)
- A basic outline understanding of the existing controllers and methods of communication used by all of the participating agencies
- A discussion of the alternatives available for pursuing coordination, including likely sub-systems
- A review of current resources within each agency, e.g to help with an evaluation of the manpower available to work on the detailed definition of the project(s)
- An estimate of man hours required to manage the project and insure close agency oversight
- First estimates of capital and annual operating costs of the project
- An outline of the inter-jurisdictional agreements for project implementation.

3.5.4 Considerations for Multi-Jurisdictional Agreements

There are two levels at which agreements are required:

1. Cooperative work on project design and implementation
2. Formal Agency Agreements on Operations and Maintenance

Project Design and Implementation

The following are some of the questions which need to be addressed:

Which agency(ies) will take the lead on the following:

- Project Management
- Finance and tracking of project finances
- Coordination/administration of meetings, minutes and feedback

- Be responsible for insuring the formalizing of agreements
- How will the system be maintained? Centrally or by the individual participating agencies.

An issue which was raised as a result of jurisdictional inventory was the concerns of many agencies for the need for additional staff to support signal coordination projects. This is an issue of importance since effective project design and implementation requires considerable active staff participation for the agencies involved. Lack of sufficient commitment of staff resources can result in many difficulties which delay progress and potentially undermine the achievement of the expected multi-jurisdictional benefits.

Formal Agency Agreements

Existing Agreements

As a part of the data collection for this study, agencies were asked about the type of agreements that they had with other agencies. Many of the cities have maintenance agreements and in some cases multiple agreements with other agencies. An example of a comprehensive agreement on maintenance is given in Appendix A. This example is for a maintenance agreement between the State and the City of Los Angeles for State Highways located within the City boundaries. The agreement details special responsibilities in general. It then specifies each level of maintenance, e.g., under electrical "Maintenance of the "designed" timing is the responsibility of the CITY. Timing records shall be kept in both CITY Maintenance and State Traffic Branches". In this example, the agreement covers signs, emergency operation of traffic signals, drainage and slopes, litter and debris, bridge and pump, maintenance and pavement, approval for storm repairs, the submission of bills and charges. Traffic signal coordination agreements however call for an even wider range of issues to be covered.

Traffic Signal Coordination Agreements

If agencies are to cooperate much more closely in signal coordination projects they will need agreements suitable for traffic signal synchronization, operation and maintenance. A useful resource is a JHK document written for the County of Los Angeles, Traffic Reduction and Free Flow Interagency Committee. This is included in Appendix B. This is a series of sample draft agreements. While it is obvious that no one single set of agreements will answer all of the needs of the South Bay agencies, nevertheless, they offer an extremely useful starting point for consideration of the issues to be addressed and methods of resolving certain types of difficulties.

1. Generic Operations and Maintenance Agreement

This agreement covers:

1. Signal Construction Plans
2. Signal Timing Plans
3. Equipment
4. Construction
5. Maintenance
6. Technical Support
7. Public Interface
8. Coordinating committee
9. Cost Sharing
10. Records
11. Notification
12. Arbitration
13. Liability
14. Integration and Modification
15. Governing Law

As can be seen from the above list of items included in the agreement, the outline agreement seeks to expose all likely issues of contention and to regulate the working arrangements between the parties in clear and simple language. In this instance, one agency is responsible for the signal construction plans, whereas signal timing plans shall be the subject of mutual agreement between parties, to be agreed in writing by the Traffic Engineer of each agency. The necessary plans, specifications and estimates for the installation of the agreed upon timing plans is then made the responsibility of one party. Throughout the agreement the clear assignment of responsibilities, definitions and understandings is set out. Provision is made for a coordinating committee to oversee and review the operation of the system in the long term such than any modifications to the system can be considered as necessary but also to insure that the system is maintained. By regulating frequent formal discussions and notification procedures in the event of breakdowns this agreement seeks to create the atmosphere of full knowledge and understanding on the part of all concerned and thereby fosters a climate of understanding and good working relationships.

2. Signals Maintenance (General)

The second example in Appendix B with the title, "Example Traffic Signal Maintenance Agreement, Signal Maintenance (General)", covers signal maintenance. This agreement covers:

1. Regular Maintenance
2. Emergency Maintenance

3. Coordinating Committee
4. Costs
5. Records
6. Notification
7. Arbitration
8. Liability
9. Integration and Modification
10. Governing Law
11. Termination

As with the first example, this is a comparatively simple form of regulating traffic signal and hardwire interconnect maintenance such that all parties have a clear understanding of responsibilities, costs and liability. A coordinating committee of both parties is regulated to oversee the correct working of the agreement.

Experiences with Multi-Agency Agreements

It is useful to consider the experiences of other agencies in the actual implementation of signal coordination projects. The following is a brief description of a project which involved cooperation between seven agencies.

Katella Avenue, Orange County - An interjurisdictional signal coordination project involving the Cities of Anaheim, Stanton, Los Alamitos, Garden Grove, and Cypress plus Caltrans and the County of Orange. Agreements used for this project were:

- A Memorandum of Understanding (a non-binding agreement by each of the agencies to participate in the project)

- A signal coordination agreement

- An operations and maintenance agreement

Two lead agencies emerged in the process: Anaheim being responsible for the expansion of their own system and Los Alamitos which was responsible for the implementation of a Traconex closed loop system.

Multiple agreements were used to regulate issues between all of the agencies. This approach was used to try and speed the process of closing agreements. The alternative would have been to hammer out one agreement for all parties to sign. This approach was rejected as being too time consuming. Caltrans in particular indicated that their procedures for reaching such agreements were prolonged. The project took 40 months to complete between pre-proposal and implementation.

An important issue was liability agreements. In particular this came down to liability for personal injury and property damage. The agreements contain a "hold harmless" provision relieving a city from the responsibility for the acts of another city and state that each agency agrees to indemnify the other cities from its own negligent acts. An early recommendation to purchase a combined insurance policy was rejected on the grounds of prohibitive cost.

Several important points should be noted from this experience:

1. It takes a considerable amount of time to try and get multiple signatures to a single agreement. If possible it may be a simpler procedure to work with multiple two party agreements.

2. The amount of time devoted to agreements should not be underestimated. The necessary staff time should be budgeted into projects.

3. In practice it may not be necessary for only one agency to assume sole responsibility for coordinating an entire project even if this seems desirable in theory. Where a large group of agencies are seeking to cooperate it may be desirable for different agencies to take the lead on certain elements thereby sharing the work load.

Area-wide Control of Signal Coordination by a Joint Powers Authority

The consultant team was asked to consider whether a joint powers authority arrangement could be used to manage signal coordination projects for the South Bay Area. Again it is worthwhile to consider a working example of such an arrangement.

Las Vegas - LVACS (Las Vegas Area Computer Traffic System) - This coordinated traffic system is composed of four prime agencies: City of Las Vegas, Clark County, North Las Vegas and the Nevada Department of Transportation. It currently coordinates signals for 421 intersections. LVACS has its own central location, computer equipment and staff but maintenance for the on street system is still dealt with by each jurisdiction separately. The agreement has the form of a joint powers authority. LVACS was actually established through the Nevada Legislature. The original funding for the project came from largely Federal Funds. The building and equipment are the property of the Nevada Department of Transportation. LVACS staff are paid through the City of Las Vegas. The system is governed by a five person management committee which has four voting members plus a non-voting representative of the Regional Transportation Commission.

The costs of operating the system are divided up between the four agencies on the basis of the number of signals operated by the system. If an agency has 32% of the signals they pay 32% of the operating cost excluding maintenance.

With regard to liability issues the inter-agency agreement has "hold harmless" provisions similar to the Katella Avenue example above.

The system manager holds the view that the single drawback with the current arrangement is the lack of a central maintenance shop. He considers that a dedicated signal engineering staff would greatly benefit the efficiency and coordination of the system.

There are some obvious advantages in using a JPA structure to manage large scale signal coordination projects. Perhaps the most important is the lack of competing priorities and ability to concentrate on a single mission. A problem with establishing such an arrangement would be funding for office space equipment and staff. The Las Vegas operation benefitted from Federal funding for its start up costs.

In the absence of such funding it seems reasonable to conclude that the South Bay area should seek to utilize the resources of current agency staff, including the valuable resource of MTA staff. If necessary staff can be supplemented with consultant assistance or contract staff. However, the consultant proposes working further with the JPA, the TAC and MTA staff to arrive at agreement on a management plan prior to the implementation of the proposals contained in this report.

4. CONCEPTUAL PLAN ANALYSIS AND RECOMMENDATIONS

A 10-year Conceptual Improvement Plan was developed as a result of inventory, analysis of opportunities and constraints and jurisdictional needs and desires stated earlier in this report.

This section introduces the short-term and long-term conceptual improvement plans recommended for the first two years and the following years 3 through 10 implementation schedule, respectively. It begins with a general discussion of multilevel computer interface, jurisdictional, areawide and regional improvement strategies, followed by a short description of Pilot Project 1 which was recommended as part of the South Bay Conceptual Plan for the funding of the first two years improvement program. Finally, the short-term and long-term improvements are discussed. For the short-term improvements, detailed descriptions and implementation plans are provided.

4.1 MULTILEVEL COMPUTER INTERFACE

The objective of the multilevel computer interface strategy for the South Bay area is to maximize the surveillance, monitoring and information gathering capabilities of individual jurisdictions in order to improve the timing and operational efficiencies of their signal systems.

Multilevel computer interface/data and information sharing can be classified as the following three levels.

Level 1 - At this level, individual jurisdictions have no communication link with their neighboring jurisdictions. Often these cities do not have a traffic control center to control or even monitor the operation of traffic signals within the city and, even if a centrally computerized traffic control center is available, there is no intertie with other neighboring cities for information and data sharing.

Except for the City of Los Angeles and Culver City, which share some of their database and information together, the cities within the South Bay area are at Level 1 of information and data sharing.

Level 2 - At this level, the database and traffic operation in adjacent cities may be tied together to form a multijurisdictional information/data sharing or even control center. Multijurisdictional intertie is a form of areawide cooperation where one jurisdiction can utilize the capabilities of other jurisdictions in order to obtain relevant information on traffic flow patterns and surveillance. Depending on the desired level of jurisdictional independence, the organizational structure of multijurisdictional cooperation can be either an intertie without provision for jurisdictional monitoring, or control in which only one control master system supervises and coordinates traffic signals in the entire area. Overall direction, management, and guidance may be provided by a committee comprised of representatives from all affected agencies.

Under this scheme, each jurisdiction would have the ability to either monitor and obtain information via a personal computer or control the intersections within its boundaries with access to the central computer.

For the South Bay area jurisdictions, a computer interface/data and information sharing interlink is proposed to be accomplished as a longer term improvement strategy. Several jurisdictions in the vicinity of Gardena are willing to utilize the capabilities of the Gardena traffic control center and database as the clearinghouse for information sharing. The following multijurisdictional interties are recommended for implementation:

1. Los Angles, Inglewood, Culver City, Los Angeles County (partial)
2. Gardena, El Segundo, Hawthorne, Lawndale, Manhattan Beach, Los Angeles (partial), Los Angeles County (partial), Redondo Beach (partial)
3. Torrance, Lomita, Hermosa Beach, Palos Verdes Estates, Rancho Palos Verdes, Rolling Hills, Rolling Hills Estates, Los Angeles County (partial), Redondo Beach (partial)
4. Long Beach, Carson, Signal Hill, Hawaiian Gardens, Los Angeles County (partial)

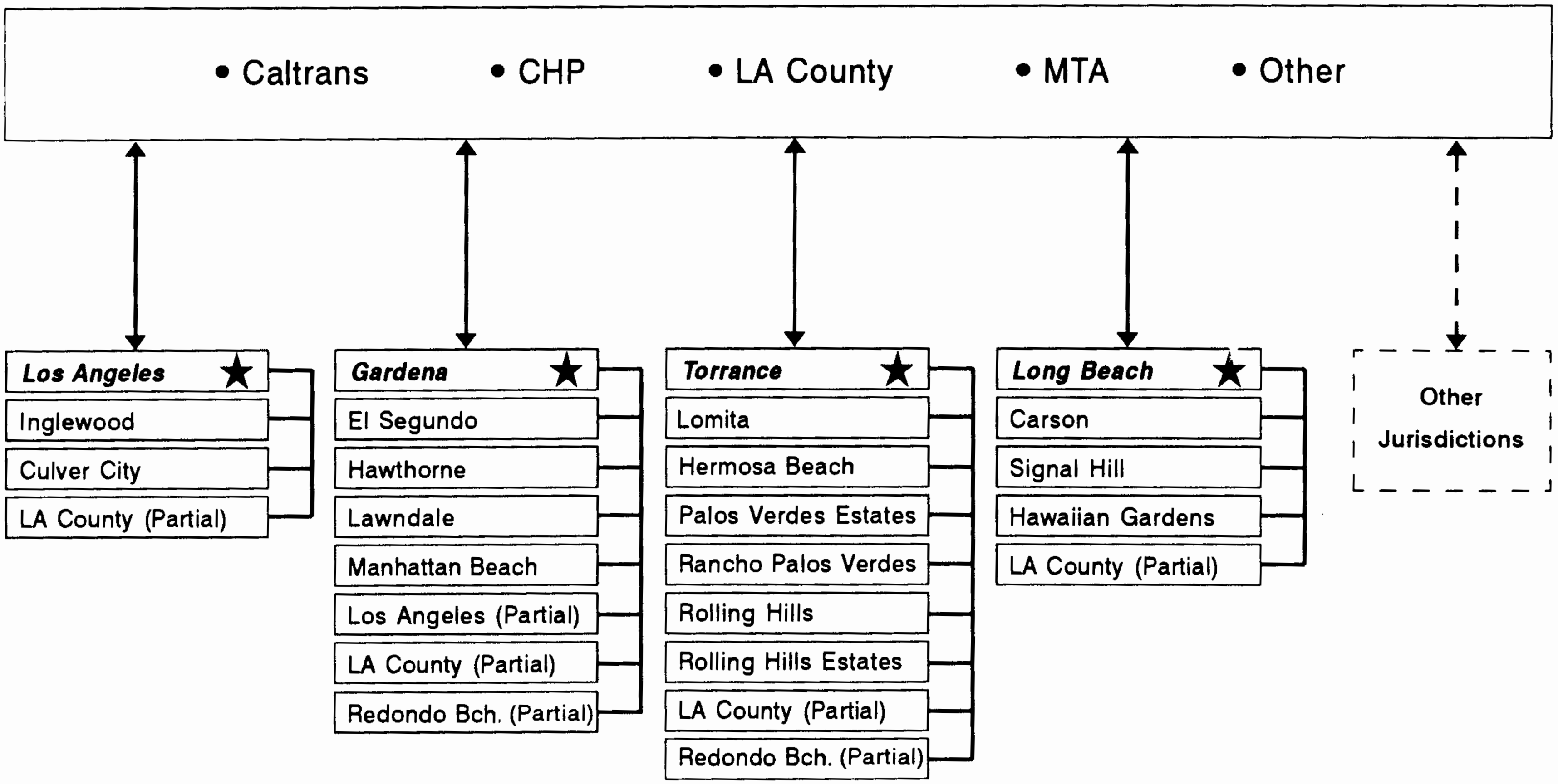
It should be noted that some of the jurisdictions are included in more than one regional interface due to their geographical and operational settings.

Level 3 - This level provides integration of Level 2 systems with a regional management center. Caltrans already has intertie with the City of Los Angeles in the South Bay area and with Pasadena in the San Gabriel Valley. The center at Level 3 could monitor the traffic operations of the jurisdictions and fully transmit information on traffic flow to the jurisdictions under Level 2 scheme.

Level 3 interlink may also include California Highway Patrol (CHP), the County of Los Angeles operations, MTA and other pertinent agencies. The concept of the multilevel interface system is illustrated in Exhibits 4.1 and 4.2.

The interface of multiple jurisdictions requires that a process and supporting mechanism be defined and implemented that simplifies, controls and speeds data and information sharing among the jurisdictions. The following outlines the high level requirements upon such a system. The requirements fall into two categories:

- Conceptual - format, content of data and information to be shared
- Physical - computer, data storage devices and communications needed to implement the logical information exchange



Level 1 - Individual Jurisdiction
Level 2 - Multijurisdictional Interface
Level 3 - Regional Interface
★ - Host Computer Agency

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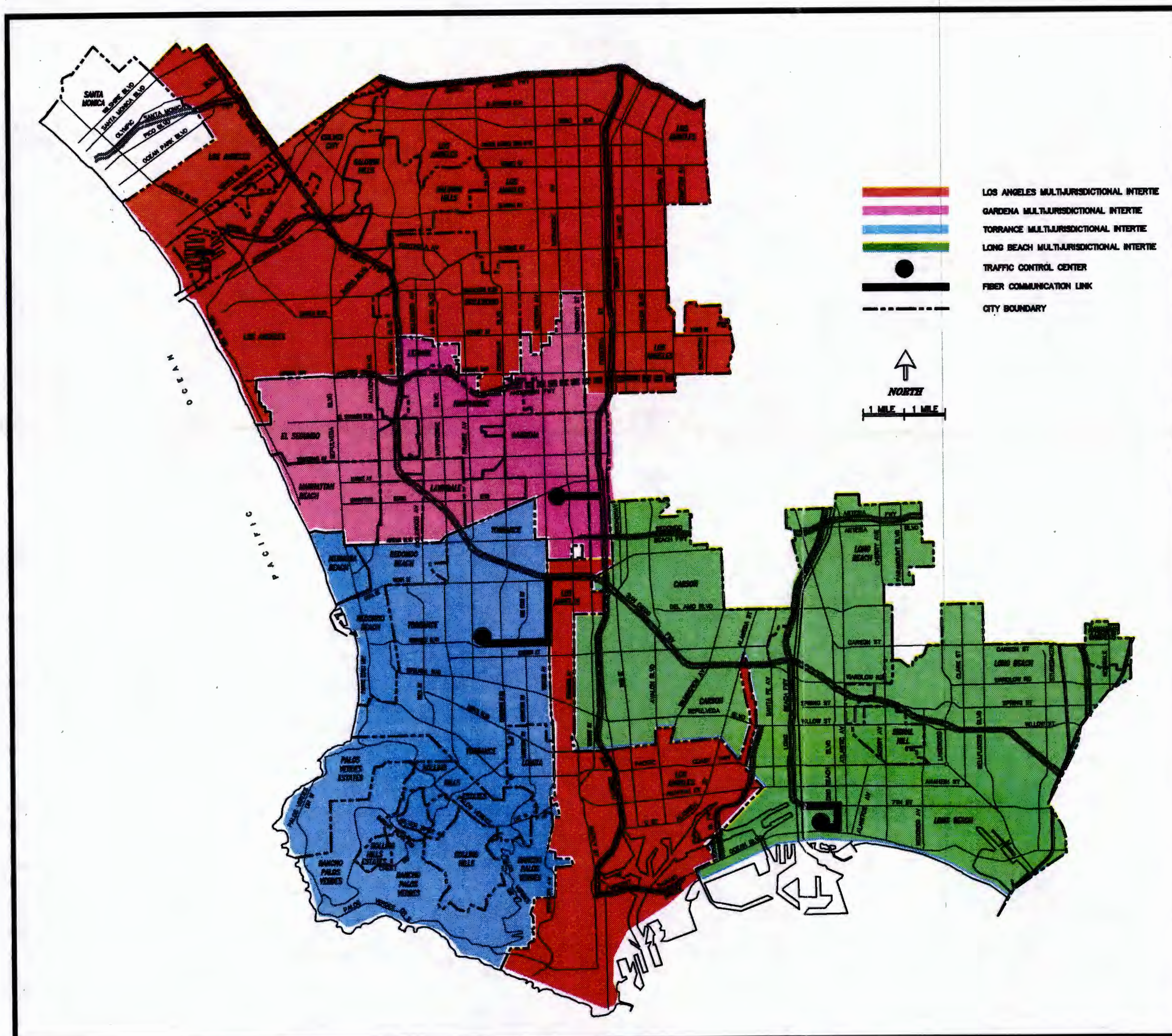
Traffic Engineering • Transportation Planning

South Bay Multi-Level Interface System
South Bay Traffic Signal Systems Improvement Plan

EXHIBIT
4.1



SOUTH BAY TRAFFIC SIGNAL SYSTEM IMPROVEMENTS

LACMTA

Los Angeles County Metropolitan Transportation Authority

Multi-Level Interface Concept Plan

Exhibit 4.2

Meyer, Mohaddes Associates, Inc.
Traffic Engineering • Transportation Planning

6-25-93

Conceptual Interface

In order to build a multiple layer traffic management system, the following must occur:

- Determine information that a jurisdiction must supply to a multijurisdictional center
- Determine information that a multijurisdictional center must supply to a regional center
- For each data group, define a format in which the information must be supplied
- Identify which information must be supplied on a periodic basis, and determine the period
- Each entity shall be able to provide the required data in the specified format.
- The external information exchange interface shall not constrain internal operations of any entity.

The information sharing requires that data be stored in a manner accessible by all parties. This database shall be able to:

- Store and retrieve large volumes of data
- Provide a standard mechanism to store and retrieve data
- Provide a query language in which predefined and ad hoc queries may be formatted
- Retrieve data at a rate not less than a specified number of bytes per second. The requirement is based on the combination of software and hardware chosen to implement the common database.
- Provide for data security--allow multi-level security access

In addition to the common database, there must be a mechanism for transferring other data and information on request. Ninety percent of the information should be available via the common database. A procedure to allow direct requests needs to be set up. It could take the form of telephone calls, database queries, or video information. The following steps should be taken:

- Policies and procedures defined that govern special requests: when the request should occur, who may make them, what information is available to each class of user
- Message format defined which should include
  - Message organization
  - Message destination(s)
  - Request--a final specific definition of what is being requested
  - Format--how return information should be formatted
- Determine expected volume of special requests
- Assure that procedures do not imply requirements on internal data storage and format. A jurisdiction that does not have a traffic operation center should be able to receive and send information, if only over telephone lines.

Physical Interface

The physical interface shall be capable of supporting the logical information sharing process. It should be capable of:

- Storing and returning large volumes of data
- Transferring data between entities at a rate not less than a specified number of bytes per second.
- Switching data between any two entities
- Transferring video information between entities
- Provide multiple paths for data transfer
- Broadcasting information to a defined group of entities
- Have bit error rate not greater than a specified rate per million bits sent

The details of the requirements on the physical interface will be determined once the logical data sharing requirements have been finalized.

4.2 PILOT PROJECT 1

Introduction

As part of the South Bay Traffic Signal Improvements project, the South Bay Technical Advisory Committee (SBTAC) has identified "Pilot Project 1" as one of the overall South Bay Concept Plan projects for evaluation. As described in detail later in this report, the focus of the pilot project was to identify short-term improvements (within four years). SBTAC applied for funding for improvements identified for the first two years. Pilot Project 1 is aimed at achieving multi-agency cooperation to enhance mobility through improved interagency signal coordination, operation and maintenance. Participating agencies include:

- Caltrans
- County of Los Angeles
- City of Carson
- City of El Segundo
- City of Gardena
- City of Hawaiian Gardens
- City of Hawthorne
- City of Hermosa Beach
- City of Inglewood
- City of Lawndale

- City of Lomita
- City of Long Beach
- City of Los Angeles
- City of Manhattan Beach
- City of Palos Verdes Estates
- City of Rancho Palos Verdes
- City of Redondo Beach
- City of Rolling Hills
- City of Rolling Hills Estates
- City of Signal Hill
- City of Torrance

Objectives

The primary goal of Pilot Project 1 is to achieve coordinated operation of signals within and across jurisdictional boundaries of all the involved agencies to provide needed improvements for the integrated management of arterials. Cross-boundary coordination will benefit all cities, as well as the South Bay region. Motorists will benefit by the reduction in delay and stops and the improvement in air quality.

This Pilot Project is aimed at achieving the following specific objectives:

- Decrease congestion and vehicular delay
- Cost savings (via fuel and reduction in stops and delay)
- Optimum use of existing traffic signal system
- Consensus between all the involved agencies
- Compatibility with the overall South Bay concept plan

The project's objectives can be accomplished through the implementation of various improvement projects, such as corridor, jurisdictional, and areawide improvements.

Project Description

The following arterials are the approximate geographical boundaries of the project area:

- Pacific Coast Highway/Sepulveda Boulevard (SR 1) between the eastern city limits of Long Beach and Los Angeles International Airport.
- Willow Street/Sepulveda Boulevard between the eastern city limits of Long Beach and Hawthorne Boulevard.
- Western Avenue between Pacific Coast Highway and the future Glenn M. Anderson Freeway (SR 105).

- Hawthorne Boulevard between Pacific Coast Highway and the future Glenn M. Anderson Freeway (SR 105).

The project, generally located along the San Diego Freeway (I-405) corridor, includes the most regionally significant arterials in the South Bay area. The signal system improvements along Pilot Project 1 will relieve traffic congestion along the San Diego Freeway corridor.

In addition to the above mentioned four major routes, the following supporting arterials are also included for evaluation in this Pilot Project area, due to their significant relationship with the four major arterials:

- Imperial Highway between Sepulveda Boulevard and Western Avenue
- El Segundo Boulevard between Sepulveda Boulevard and Western Avenue
- Rosecrans Avenue between Sepulveda Boulevard and Western Avenue
- Marine Avenue between Sepulveda Boulevard and Western Avenue
- Inglewood Avenue between 104th Street and Manhattan Beach Boulevard
- Manhattan Beach Boulevard between Sepulveda Boulevard and Crenshaw Boulevard
- Artesia Boulevard between Pacific Coast Highway and Western Avenue
- Redondo Beach Boulevard between Artesia Boulevard and Western Avenue
- 190th Street between Pacific Coast Highway and Western Avenue
- Torrance Boulevard between Pacific Coast Highway and Western Avenue
- Carson Street between Hawthorne Boulevard and Western Avenue
- Pacific Coast Highway between Hawthorne Boulevard and Torrance Boulevard
- Lomita Boulevard between Hawthorne Boulevard and eastern city limits of Los Angeles
- Aviation Boulevard between Imperial Highway and Pacific Coast Highway
- Prairie Avenue between Imperial Highway and Sepulveda Boulevard
- Crenshaw Boulevard between Imperial Highway and Pacific Coast Highway
- Normandie Avenue between Sepulveda Boulevard and Pacific Coast Highway
- Vermont Avenue between Sepulveda Boulevard and Pacific Coast Highway
- Figueroa Street between Sepulveda Boulevard and Pacific Coast Highway
- Main Street between Sepulveda Boulevard and Pacific Coast Highway
- Avalon Boulevard between Sepulveda Boulevard and Pacific Coast Highway
- Wilmington Avenue between Sepulveda Boulevard and Lomita Boulevard
- Alameda Street between Sepulveda Boulevard and Pacific Coast Highway
- Santa Fe Avenue between Willow Street and Pacific Coast Highway
- Long Beach Boulevard between Willow Street and Pacific Coast Highway
- Atlantic Boulevard between Willow Street and Pacific Coast Highway
- Cherry Avenue between Willow Street and Pacific Coast Highway
- Redondo Avenue between Willow Street and Pacific Coast Highway
- Lakewood Avenue between Willow Street and Pacific Coast Highway
- Bellflower Boulevard between Willow Street and Pacific Coast Highway

- Studebaker Road between Willow Street and Pacific Coast Highway
- Anaheim Street between Vermont Avenue and Terminal Island Freeway

Characteristics of the Four Identified Major Routes of Pilot Project 1

1. **Pacific Coast Highway/Sepulveda Boulevard between the Los Angeles International Airport (LAX) to the north and the eastern city limits of Long Beach.**

Pacific Coast Highway runs through the cities of El Segundo, Manhattan Beach, Hermosa Beach, Redondo Beach, Torrance, Lomita, Torrance, Redondo Beach, Los Angeles, and Long Beach. Pacific Coast Highway changes names within the City of Manhattan Beach and continues north as Sepulveda Boulevard. There are a total of 95 signals along Pacific Coast Highway between Los Angeles International Airport (LAX) and the eastern city limits of Long Beach. These signals are operated and maintained by Caltrans, except for 13 signals located within the City of Los Angeles, which are part of the ATSAC system, operated and maintained by the City of Los Angeles, and 27 signals maintained and located in the City of Long Beach. All controllers along Pacific Coast Highway are Type 170. There are nine coordinated subsystems along the route, with cycle lengths ranging from 80 seconds to 160 seconds. The interconnect along Pacific Coast Highway consists mainly of two interconnect sizes all owned by Caltrans; north of Hawthorne Boulevard 25 twisted pair cable and south of Hawthorne Boulevard 12 twisted pair cable.

2. **Hawthorne Boulevard between the future Glenn M. Anderson Freeway to the north and Pacific Coast Highway to the south.**

Hawthorne Boulevard traverses the cities of Hawthorne, Lawndale, Redondo Beach, and Torrance. There are 38 signals located along Hawthorne Boulevard. The City of Hawthorne and Los Angeles County operate and maintain 14 signals between Imperial Highway and Manhattan Beach Boulevard. The Los Angeles County operates signals along Hawthorne Boulevard which are currently uncoordinated, however, this portion has been designed and will be completed in 1993 with coordination via timed based WWV. The controllers are Type 170 and NEMA (ASC 8000) and those that are not will be replaced during the reconstruction. Caltrans currently operates and maintains 24 signals between the northbound I-405 off-ramp and Lomita Boulevard. All controllers are Type 170. There are two coordinated subsystems within this segment, however, both use the same background cycle length ranging from 100 seconds to 120 seconds. The interconnect along the Caltrans portion of Hawthorne Boulevard consists of 12 twisted pair cable north of 177th Street and 25 twisted pair cable south of 186th Street.

3. **Western Avenue between the future Glenn M. Anderson Freeway to the north and Pacific Coast Highway to the south.**

Western Avenue runs through Los Angeles County, Gardena, and Los Angeles. There are 34 signals located along Western Avenue. Los Angeles County maintains three signals between Imperial Highway and El Segundo Boulevard which are not coordinated, however, this segment is proposed as a second five-year proposed project. The City of Gardena operates the 11 signals between 132nd Street and 166th Street and all are coordinated using Type 170 controllers. The City of Gardena currently has six pair figure 8 interconnect along this segment. The City of Los Angeles operates the remaining 20 signals south of Artesia Boulevard. The signals from 182nd Street to 190th Street currently do not operate as a coordinated system but the City of Los Angeles is willing to connect this portion to Gardena, if the opportunity arises. The City of Los Angeles does have two functioning subsystems along Western Avenue from Torrance Boulevard to 223rd Street and 238th Street to 253rd Street. Controllers within each coordinated subsystem are mainly Type 170 with the exception of two or three electromechanical controllers. The City of Los Angeles is currently using 7-wire interconnect for each of these subsystems.

4. **Sepulveda Boulevard/Willow Street between Hawthorne Boulevard to the west and the eastern city limits of Long Beach to the east.**

Sepulveda Boulevard/Willow Street runs through Torrance, Harbor City, Los Angeles County, Carson, Long Beach, and Signal Hill. Sepulveda Boulevard changes names within the City of Long Beach and continues east as Willow Street. There are a total of 46 signals along Sepulveda Boulevard/Willow Street. The City of Torrance currently operates and maintains 7 signals along Sepulveda Boulevard from Madrona Avenue to Cabrillo Avenue. All controllers are KMC-8000 or equivalent. Torrance operates one coordinated system from Madrona Avenue to Hickory Avenue with six twisted pair interconnect. The 15 signals between Western Avenue and Watson Intermodal Way are neither interconnected nor coordinated. All controllers in this segment vary greatly from Type 170 to TRA290. The next operational coordinated system is within the City of Long Beach from the Terminal Island Freeway to Studebaker Road. All 24 signals in this segment are operated and maintained by the City of Long Beach and use Type 170 controllers with a 90 second background cycle length. The interconnect type for this portion is hardwire between Long Beach Boulevard and Woodruff Avenue and microwave between Terminal Island Freeway and Long Beach Boulevard, and between Woodruff Avenue and Studebaker Road.

A number of improvement projects were identified and proposed for Pilot Project 1. These improvements are redefined as the short-term improvements in the conceptual plan. Generally, the recommended improvements include controller replacement, communication upgrade, intersection traffic operational improvements, systemwide coordination, surveillance, common time reference, computer interface/data sharing, and traffic control center for the City of Long Beach. Appendix D includes a complete analysis and recommendations of Pilot Project 1.

Management of the Proposed Pilot Project 1

Assuming that the Pilot Project 1 for the South Bay area is funded, it will be necessary to establish a management structure for the various elements. These proposals center upon the work that would need to be undertaken in the first two years of the project. The elements under consideration are as follows:

- Installation of one traffic control center at the City of Long Beach
- Surveillance: installation of CCTV cameras within the jurisdictions of Long Beach, City of Los Angeles, Caltrans (PCH)
- Systemwide coordination, common time reference and controller replacement
- Communications upgrades and traffic operations improvements.

Management strategies are proposed to meet the needs of the four sets of improvements. Guiding these recommendations was a desire to propose structures that are practical, recognizing three elements, i.e., political, fiscal and technical responsibilities. They assume the use of existing staff resources, supplemented as necessary with consultant assistance.

Management Structure for the Upgrade of the Traffic Control Center at the City of Long Beach

The first element is relatively straightforward because only one agency is involved as a location for the work. Exhibit 4.3 illustrates the proposed division of responsibilities. The following are assumed:

- Final oversight of the project is the responsibility of the South Bay JPA as the formal promoters of the project.
- The MTA staff and TAC membership will be responsible for approval of consultant selection and the review of progress and completion of the project
- MTA staff will be responsible for budget oversight
- City of Long Beach Staff will take lead responsibility for the technical specification of the work to be performed by the consultant and technical oversight of the work .

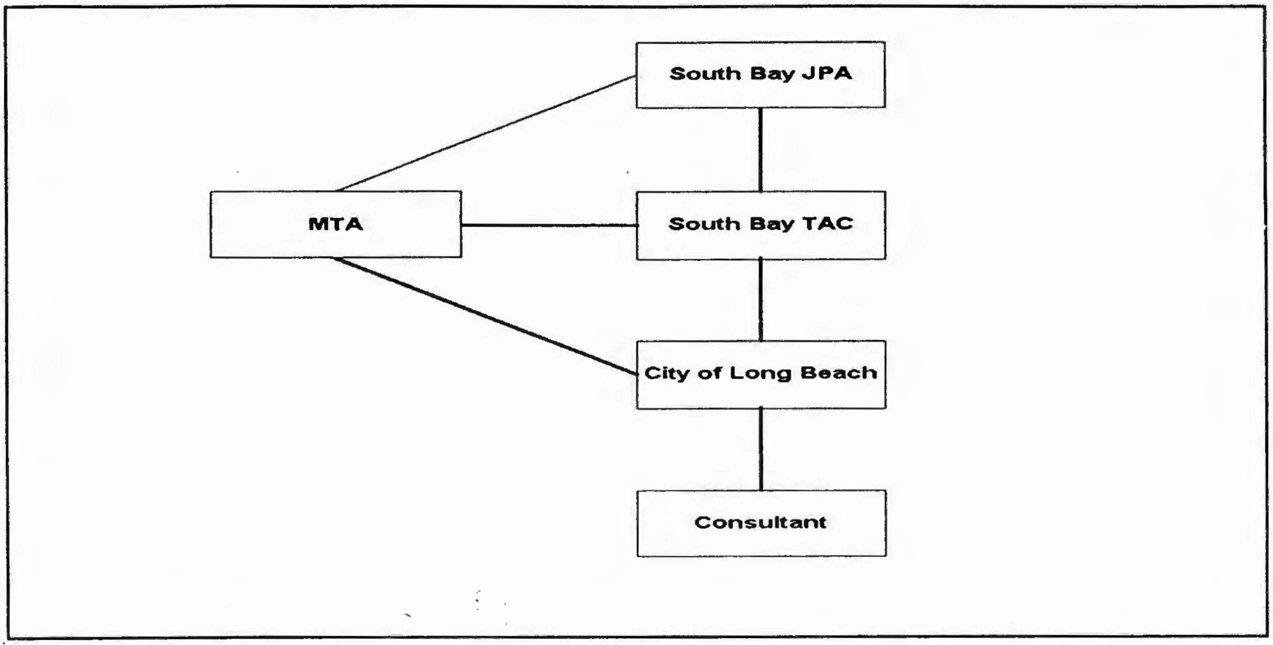


Exhibit 4.3 Upgrade of the Traffic Control Center at the City of Long Beach

This would seem to present a fair balance of responsibility relative to political, financial and technical issues.

Surveillance: Installation of CCTV cameras

This second element is also relatively straightforward. The responsibilities are illustrated by Exhibit 4.4. The following are assumed:

- Final oversight of this element and all elements is the responsibility of the JPA as formal promoters of the project
- MTA staff and TAC membership will review progress and completion of the project
- One of the three agencies will assume lead responsibility. The three agencies plus MTA will approve consultant/vendor selection

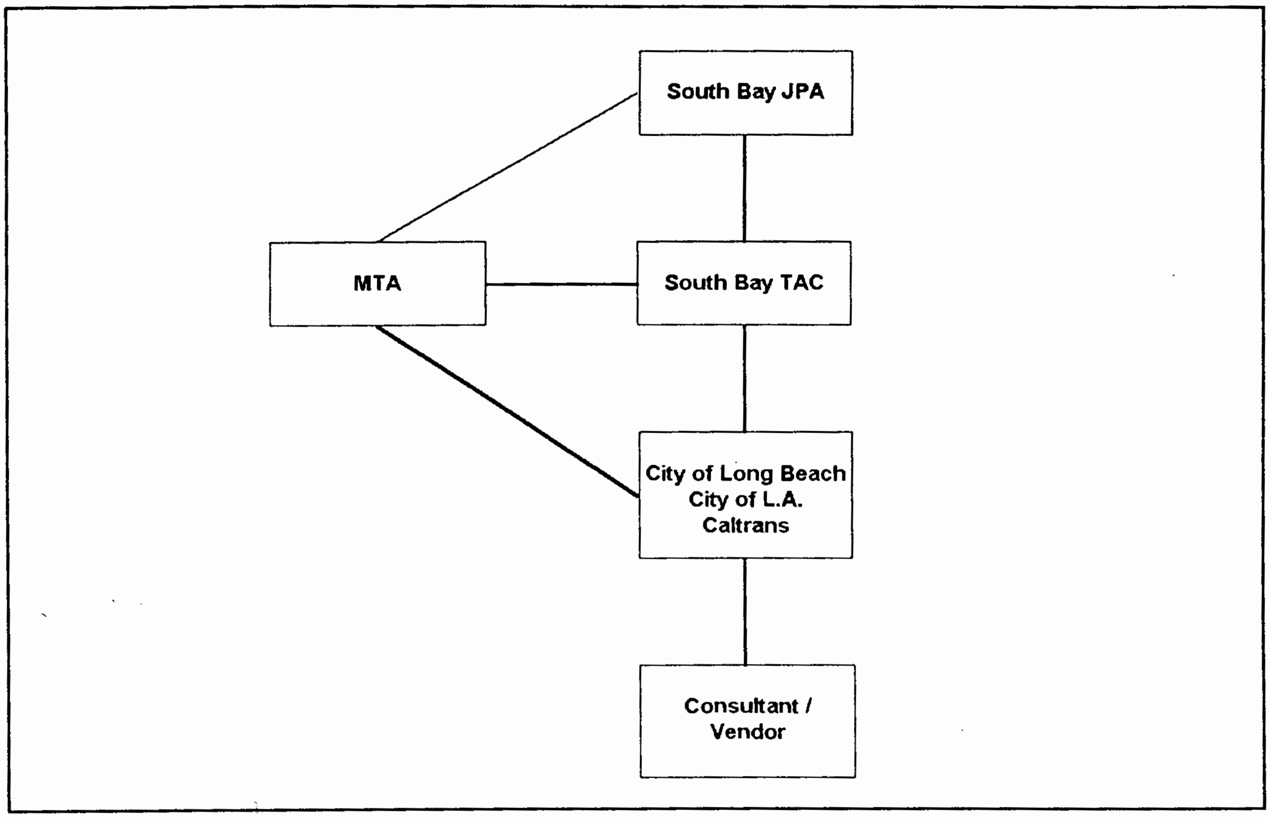


Exhibit 4.4 Surveillance, Installation of CCTV Cameras, Long Beach, LA and Caltrans

Systemwide Coordination, Common Time Reference and Controller Replacement

This combination of three elements of the pilot project is more complex because it involves many agencies. Exhibit 4.5 illustrates the responsibilities as proposed. The following are assumed:

- Final oversight remains with the South Bay JPA
- Since many agencies are involved the TAC and the MTA staff(probably with considerable support from the Signal Support Group) will be responsible for consultant selection and management.

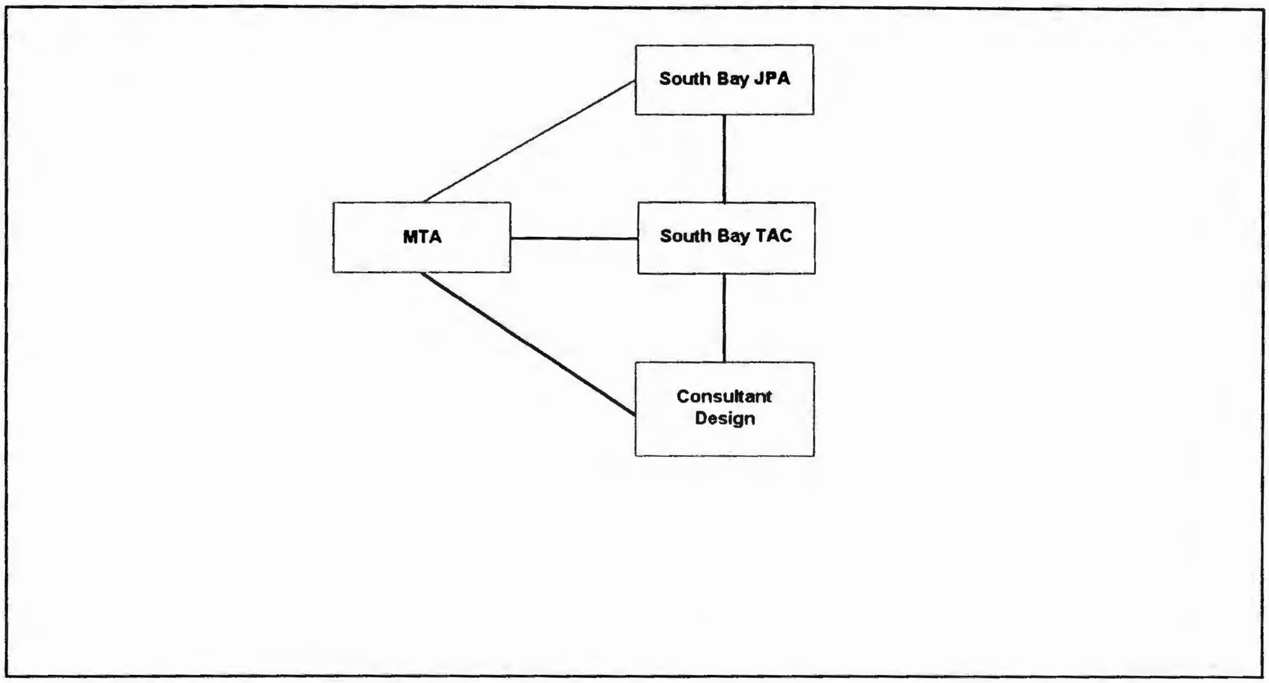


Exhibit 4.5 Systemwide Coordination, Common Time Reference and Controller Replacement

- This management structure would be modified as this part of the project moves tot implementation and maintenance phases. At this point the sub-area groupings referred to in Section 3 of this discussion of institutional issues would become of greater relevance. Simple items like controller replacement would of course be the responsibility of individual agencies.

Communications Upgrade and Traffic Operations Improvements

These two topics effect all 23 agencies and will require a great deal of management effort. On this occasion it seems that a number of alternatives are available and these are indicated in Exhibit 4.6.

The assumptions in this management structure are as follows:

- Final oversight remains with the South Bay JPA

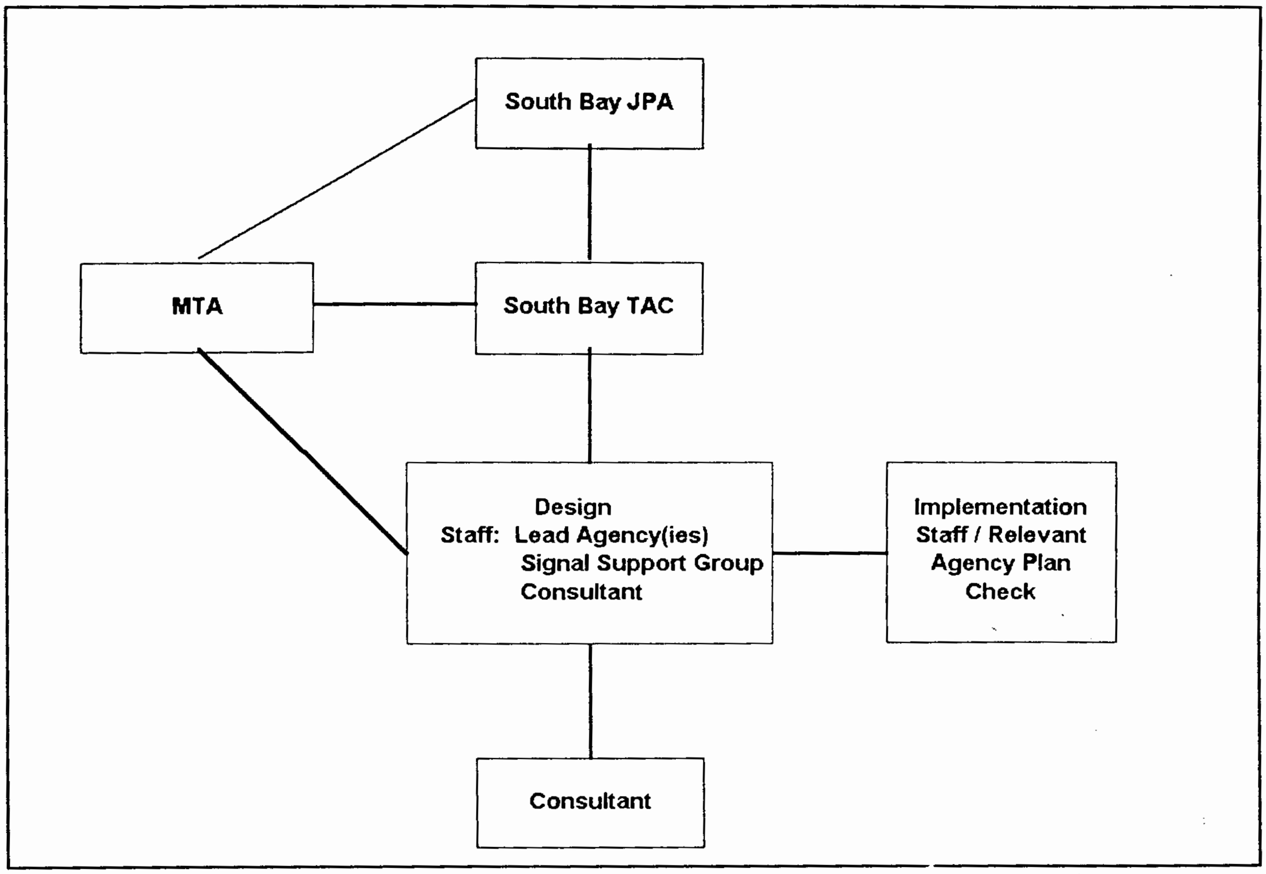


Exhibit 4.6 Communications Upgrades and Traffic Operations Improvements

- The TAC and MTA will review and maintain oversight of the project in terms of progress and approval of consultant selection.

- Detailed project management work in both the design and implementation phases could be staffed by one of the following:

  - A lead agency or agencies
  - Signal Support Group Staff
  - A consultant

- In the implementation phase it seems appropriate to recommend that staff from each relevant agency would be responsible for plan check work.

4.3 PROPOSED IMPROVEMENTS

Three levels of improvements are identified as part of the South Bay concept plan of improvements -- jurisdictional, areawide and regional improvements. Jurisdictional improvements refer to the improvements within each jurisdiction at either isolated intersections or along major arterials. Operational improvements and signal upgrade, controller replacement and communication upgrade along arterials are the jurisdictional improvements included in the conceptual plan which would improve the Level 1 control within the South Bay area. Areawide improvements refer to the improvements which benefit a wider area than individual jurisdictions. These improvements include systemwide coordination (timing), areawide surveillance, multijurisdictional coordination and traffic control centers. Regional improvements refer to the improvements which benefit the entire South Bay area and the immediate jurisdictions. A summary of the improvements identified below is also included in the Concept Plan chapter of this report and illustrated in Exhibit 5.5.

*A. **Traffic Operational Improvements:*** These improvements include signal hardware upgrade at local intersections which may include one or all of the following elements:

- detection loop
- left-turn phasing where warranted
- removal of left-turn phasing
- split phasing removal
- right-run loop delay
- turn prohibition
- peak hour parking restrictions
- right-turn overlap
- intersection reconfiguration
- other operational considerations

Traffic Operational Improvements have been identified for both short-term and longer-term implementation.

A total of 64 intersections are identified for short-term operational improvements. The location of the intersections listed below are identified, but the exact location of the remaining 24 intersections which are spread throughout the South Bay area and along Sepulveda/Willow from Hawthorne Boulevard to the eastern city limit of Long Beach will be identified during design. It is estimated that a total of $1,880,000 will be the cost of these improvements.

INTERSECTIONS IDENTIFIED FOR OPERATIONAL IMPROVEMENTS

Intersection	Agency	Improvement	Cost
Rosecrans/Vermont	Gardena	Signal modification	30K
Redondo/Vermont	Gardena	Signal modification	30K
Gardena/Vermont	Gardena	Signal modification	30K
Redondo/Western	Gardena	Signal modification	30K
Redondo/Normandie	Gardena	Signal modification	30K
Rosecrans/Budlong	Gardena	Signal modification	30K
Rosecrans/Gramercy	Gardena	Signal modification	30K
Marine/Western	Gardena	Signal modification	30K
Redondo Beach/Berendo	Gardena	Signal modification	30K
Redondo Beach/Budlong	Gardena	Signal modification	30K
Redondo Beach/Raymond	Gardena	Signal modification	30K
Western/Torrance	Los Angeles	Signal modification	40K
Western/223rd St.	Los Angeles	Signal modification	30K
Western/Anaheim	Los Angeles	Signal modification	30K
PCH/Vermont	Los Angeles	Restriping	20K
PCH/Redondo	Caltrans	Phasing	30K
PCH/Cherry	Caltrans	Phasing	30K
Sepulveda/Vermont	Carson	Signal modification	30K
190th/Rindge	Redondo Beach	Phasing	30K
190th/Meyer Lane	Redondo Beach	Phasing	30K
190th/Anza	Redondo Beach	Phasing	30K
190th/Inglewood	Redondo Beach	Phasing	30K
Manhattan Beach/Dow	Redondo Beach	Loops	20K
PCH/190th	Redondo Beach	Phasing	30K
Torrance/PCH	Redondo Beach	Phasing	30K
Western: south of Redondo Beach Blvd. intersections; total of 15 intersections	Los Angeles	Signal Modification	26K each
Total Other Intersections - 24 intersections			$758,000
Total Cost			$1,880,000

The following intersections are included in the long-term improvement plan:

- Intersections along Carson Street from Hawthorne Boulevard to Alameda Street
- Intersections along Redondo Beach Boulevard from Hawthorne Boulevard to Normandie Avenue
- Intersections along Manhattan Beach Boulevard
- Intersections along Imperial Highway east of I-405 to Normandie Avenue
- Intersections along Lomita Boulevard from Crenshaw Boulevard to eastern city limits of Los Angeles

It is assumed that approximately 100 intersections will need traffic operation improvements for an average cost of $40,000 for a total of $4,000,000. These intersections may include those which may already be considered for funding through MTA. In this case, the total improvement cost will be reduced accordingly.

B. Controller Replacement: Up to 50 electromechanical and outdated controllers are identified for replacement with either newer versions of NEMA or Type 170 controllers. These are the controllers identified for replacement during the first two years of the Conceptual Plan. The total cost of replacement is estimated to be approximately $394,000. Twenty-three of these controllers are currently identified and illustrated below. The other 27 controllers should be identified during the design phase of the project as part of the system wide coordination and controller replacement/common time reference improvements.

CONTROLLERS IDENTIFIED FOR REPLACEMENT

Intersection	Jurisdiction
Wilmington Ave./103rd St.	LA City
Wilmington Ave./Sepulveda Blvd.	Carson
Central Ave./Imperial Hwy.	LA City
Avalon Blvd./Imperial Hwy.	LA City
Avalon Blvd./Anaheim St.	LA City
Avalon Blvd./B St.	LA City
190th St./Rindge Lane	Redondo Beach
190th St./Meyer Lane	Redondo Beach
190th St./Mary Ann Dr.	Redondo Beach
190th St./Anza Ave.	Redondo Beach

CONTROLLERS IDENTIFIED FOR REPLACEMENT (continued)

Intersection	Jurisdiction
190th St./Flagler Lane (currently four-way stop)	Redondo Beach
Manhattan Beach Blvd./Dow Ave.	Redondo Beach
182nd St./Western Ave.	LA City
Western Ave./223rd St.	LA City
Western Ave./247th St.	LA City
Redondo Beach Blvd./Ainsworth Ave.	Torrance
Manhattan Beach Blvd./Redondo Ave.	Manhattan Beach
Carson St./Dolores	Carson
Carson St./Figueroa St.	Carson
Carson St./Alameda St.	Carson
Carson St./Martin	Carson
Carson St./Moneta	Carson
Main St./192nd St.	Carson

As discussed earlier, it is important that various jurisdictions share data and possibly interface at the regional level (Level 3). For example, the City of Long Beach may desire to know the conditions along a section of the freeway experiencing an incident and the conditions of on/off-ramps. It is conceivable that this information could be accessed both with data/graphics and perhaps CCTV surveillance cameras. It may also be the desire of Caltrans to observe conditions of a freeway at nearby arterials and associated ramps. Furthermore, it is ideal that the motorist could be informed comprehensively relative to conditions of both freeways and arterials in a harmonious way.

Considering a useful life of approximately 15 years for the existing controllers at major intersections, it is proposed that all 354 controllers at the intersections of major arterials, except LA County's intersections, be upgraded within the next 10 years as part of the long-term improvement plan. The cost of this improvement is estimated to be approximately $1,127,000

*C. **Communication Upgrade:*** Throughout the study area, a total of approximately 80 miles of interconnect improvements are identified. These include those routes which the signals are coordinated currently via time base coordination and those which do not have any means of communication. A total of 10 miles of communication upgrade is assumed for the first two years. A feasibility analysis should be performed to assess the most appropriate means of interconnect between the signals on Sepulveda/Willow route from Crenshaw Boulevard to Terminal Island Freeway and from Studebaker

Road to the eastern city limits of Long Beach, for a total of approximately 7 miles. Additionally, the three signals along Western Avenue between Imperial Highway and El Segundo Boulevard, for a length of approximately 2500 feet, are identified for interconnect. Along Western Avenue, between 182nd Street and 190th Street, is also identified for short-range interconnect for a length of approximately 3000 feet, and 7-wire interconnect improvement south of Torrance Boulevard to Sepulveda Boulevard for a length of approximately 6000 feet. A total of one additional mile of interconnect is also recommended for implementation throughout the South Bay as the short-term interconnect improvements. It is estimated that short-term communication improvement will cost approximately $1,150,000.

A total of approximately 65 miles of additional interconnect improvements is identified for long-term improvements. These improvements should be analyzed for applicability of various types of communication such as hardwire or wireless communication. Table 4.1 shows some of the identified segments. For the purpose of cost calculation, interconnect upgrade is assumed to be twisted pair cable @ $18.00/ft. plus engineering costs and contingency, for a total of $7,475,000.

D. Systemwide Coordination Plan: As a result of the system wide coordinator analysis performed earlier, a comprehensive signal timing plan for the short term is recommended to include approximately 300 signals within Pilot Project 1. The signal timing plans should be evaluated periodically and revised as needed. This improvement will benefit the entire area of Pilot Project 1 and will be implemented within the first two years with an approximate cost of $401,000.

The signal timing plan for the longer term will include a total of 1,000 signals and needs to be reevaluated every three years after implementation. These signals generally are located along major arterials and their immediate supporting routes. The design and implementation of the long-term signal timing plans will be started at the beginning of the third year as is shown in Exhibit 5.5 and will be reevaluated after three years. Total cost is estimated to be approximately $3,081,000.

TABLE 4.1

COMMUNICATION NEEDS

Arterial Name	Segment		Distance (Miles) Segment	Total
Sepulveda Blvd. /Pacific Coast Hwy.	Pier Ave.-Irena Ave.			
		Redondo Beach	0.17	
		Hermosa Beach	0.73	
				.90
Aviation Blvd.	Imperial Hwy.-Pacific Coast Hwy.			
		El Segundo	0.51	
		Hermosa Beach	0.45	
		Redondo Beach	0.62	
		El Segundo/L.A.	0.11	
		Redondo Beach/Manhattan Beach	1.58	
		Manhattan Beach/Haw.	0.45	
		El Segundo/Hawthorne	0.68	
		El Segundo/LA County	0.68	
				5.08
Hawthorne Blvd.	Imperial Hwy.-Manhattan Beach Blvd.			
		Hawthorne	1.97	
		Lawndale	0.96	
				2.93
Prairie Ave.	Imperial Hwy.-Redondo Beach Blvd.			
		Lawndale/LA County	1.18	
		Hawthorne	1.97	
		Hawthorne/Lawndale	0.56	
				3.71
Crenshaw Blvd.	Imperial Hwy.-Marine Ave.			
		Inglewood	0.45	
		Hawthorne	0.45	
		Hawthorne/Gardena	0.73	
		Gardena/LA County	0.68	
	Marine Ave.-PCH			
		LA County	0.45	
		Gardena/LA County	0.28	
		Torrance	5.52	
		Torrance/Lomita	0.79	
				**7.37
Western Ave.	Imperial Hwy. - El Segundo Blvd.			
		LA County	0.90	
	182nd St.-190th St.			
		L.A.	0.45	
	195th St.-Del Amo Blvd.			
		Torrance/L.A.	0.51	
	Torrance Blvd.-223rd St.			
		Torrance/L.A.	0.90	
	238th St.-253rd St.			
		L.A.	0.96	
				3.72

TABLE 4.1 (continued)

COMMUNICATION NEEDS

Arterial Name	Segment	Distance (Miles) Segment	Total
Normandie Ave.	Sepulveda Blvd. - Artesia Blvd.		
	L.A. County/L.A.	2.36	
	Gardena	0.11	
	Gardena/L.A. County	0.34	
	L.A.	0.56	
	LA County	0.60	
	Lomita Blvd. - Anaheim St.		
	L.A.	1.00	
			4.97
Vermont Ave.	Sepulveda Blvd. - 190th St.		
	LA County	2.48	
	L.A.	0.56	
	LA County/L.A.	0.45	
	190th St. - Artesia Blvd.		
	L.A./Gardena	0.39	
	L.A.	0.45	
	135th St. -Imperial Hwy.		
	LA County/L.A.	0.51	
	L.A./Gardena	0.45	
			5.29
Imperial Hwy.	Inglewood Ave.-Prairie Ave.		
	Hawthorne	1.01	
	Prairie Ave.-Van Ness Ave.		
	Hawthorne/Inglewood	0.68	
	Inglewood	0.79	
	Western Ave.-Budlong Ave.		
	LA County	0.68	
			3.16
El Segundo Blvd.	Sepulveda Blvd.-Aviation Blvd.		
	El Segundo	1.01	
	Isis Ave.-Vermont Ave.		
	Hawthorne/LA County	0.68	
	Hawthorne	2.03	
	Hawthorne/Gardena	1.01	
			4.73
Rosecrans Ave.	Sepulveda Blvd.-Crenshaw Blvd.		
	Manhattan Beach/El Segundo	0.96	
	Hawthorne	1.91	
	Hawthorne/Gardena	0.90	
			3.77
Marine Ave.	Sepulveda Blvd. to Van Ness Ave.		
	Hawthorne/LA County	0.45	
	LA County	0.45	
	Manhattan Beach	0.90	
	Hawthorne/Redondo Beach	0.68	
	Redondo Beach/Lawndale	0.23	
	Lawndale	0.51	
	LA County/Gardena	0.45	
			3.67
Manhattan Beach Blvd.	Sepulveda Blvd.-Crenshaw Blvd.		
	Manhattan Beach	0.90	
	Redondo Beach	0.90	
	Lawndale	1.01	
	LA County	1.01	
			3.82

TABLE 4.1 (continued)

COMMUNICATION NEEDS

Arterial Name	Segment	Distance (Miles) Segment	Total
Redondo Beach Blvd.	Artesia Blvd.-Van Ness Ave.		
	Redondo Beach/Lawndale	0.17	
	Torrance	1.01	
	Torrance/Lawndale	0.51	
	Torrance/Gardena	0.56	
			2.25
190th St.	Pacific Coast Hwy.-Hawthorne Blvd.		
	Redondo Beach	0.68	
	Redondo Beach/Torrance	1.41	
			2.09
Sepulveda Blvd./ Willow St.	Palos Verdes Bl.-Anza Ave.		
	Torrance	0.28	
	Western Ave.-I-110 NB Ramps		
	LA County	0.79	
	L.A.	0.68	
	Figueroa St.-Alameda St.		
	Carson	2.93	
			4.68
Anaheim St.	Vermont Ave. - Terminal Island Fwy.		
	L.A.	4.20	
			4.20
Figueroa St.	Pacific Coast Hwy.- Sepulveda Blvd.		
	Carson	0.68	
	L.A.	0.56	
			1.24
Main St.	Pacific Coast Hwy.- Sepulveda Blvd.		
	Carson	0.68	
	L.A.	0.56	
			1.24
Avalon Blvd.	Pacific Coast Hwy.- Sepulveda Blvd.		
	Carson	0.23	
	L.A.	0.90	
			1.13
Wilmington Ave.	Pacific Coast Hwy.- Sepulveda Blvd.		
	Carson/L.A.	0.34	
	L.A.	0.28	
			0.62
Alameda St.	Pacific Coast Hwy.- Sepulveda Blvd.		
	Carson	0.56	
	L.A.	0.68	
			1.24
Santa Fe Ave.	Pacific Coast Hwy.- Willow St.		
	Long Beach	1.01	
			1.01
Redondo Ave.	Pacific Coast Hwy.- Willow St.		
	Long Beach	0.23	
	Signal Hill	0.73	
			0.96
Lakewood Blvd.	Pacific Coast Hwy.- Willow St.		
	Long Beach	0.90	
			0.90

TABLE 4.1 (continued)

COMMUNICATION NEEDS

Arterial Name	Segment	Distance (Miles) Segment	Total
Clark Ave.	Pacific Coast Hwy.- Willow St. Long Beach	1.35	1.35
Bellflower Blvd.	Pacific Coast Hwy.- Willow St. (Partial) Long Beach	1.01	1.01
Studebaker Rd.	Pacific Coast Hwy.- Willow St. Long Beach	3.04	3.04
Total Mileage For Communication		**80.08 Miles**	

*** Torrance has installed hardwire from Maricopa to Sepulveda Blvd. and from 235th St. to Skypark Dr. along Crenshaw Blvd., this number has been reduced by 1.98 miles to account for this existing hardwire.*

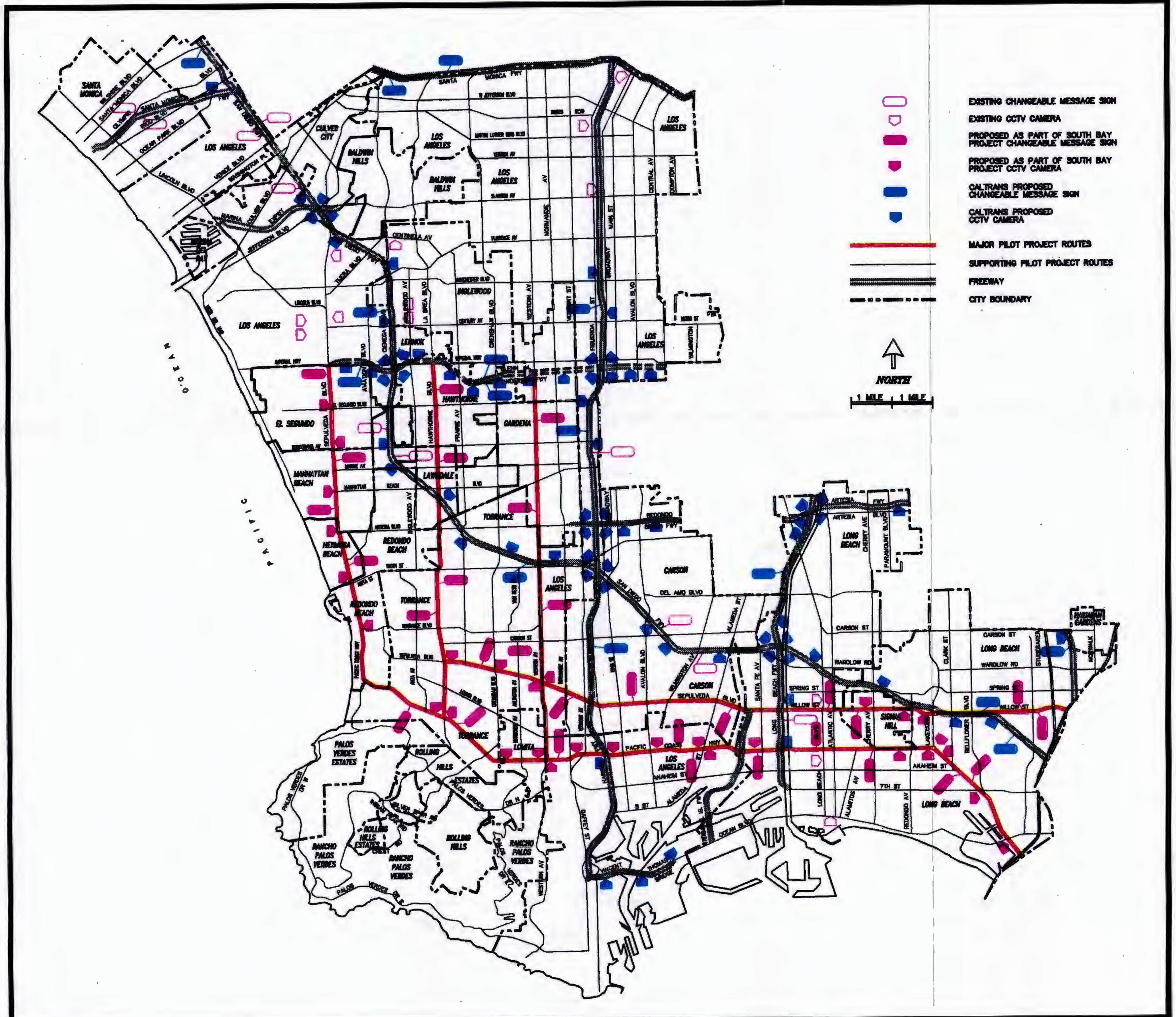
E. Areawide Surveillance: Closed circuit television (CCTV) systems are recommended to be installed for some of they key intersections or bottlenecks to enhance the detection and monitoring capabilities in observing traffic conditions and taking appropriate measures. Additionally, system loops are recommended to be installed at major intersections. A total of 13 CCTV cameras and 50 system loops are included for implementation as the short-term improvement and a total of 30 cameras are recommended for the longer term improvement plan (Exhibit 4.7). The locations of the proposed short-term surveillance elements are as follows:

- Redondo Avenue/Pacific Coast Highway
- Lakewood Boulevard/Pacific Coast Highway (roundabout)
- 7th Street/Pacific Coast Highway
- Westminster Avenue/Pacific Coast Highway
- Santa Fe Avenue/Pacific Coast Highway
- Cherry Avenue/Willow Street
- Redondo Avenue/Willow Street
- Lakewood Boulevard/Willow Street
- Rosecrans Avenue/Hawthorne Boulevard
- Pacific Coast Highway/Harbor Freeway
- Pacific Coast Highway/Western Avenue
- Pacific Coast Highway/Alameda Street
- Pacific Coast Highway/Long Beach Boulevard

A total of 50 system loops at the major intersections along Sepulveda Boulevard/Willow Street is also proposed to be installed during the first two years of the implementation plan. Total cost is estimated to be approximately $917,000.

Twenty CCTV cameras are recommended to be located along Pacific Coast Highway at critical intersections. The exact locations should be identified in cooperation with Caltrans staff. System loops are also recommended to be installed at all the remaining major intersections along PCH, Western Avenue, Hawthorne Boulevard, and Sepulveda Boulevard/Willow Street. The cost of camera installation and intertie is estimated to be approximately $1,079,000.

F. Common Time Reference: Under this areawide improvement, on-street masters and controllers should use a common time reference to establish the time of day. The time reference which is used in most jurisdictions throughout the country is WWV time broadcast via radio from Colorado. In the case of centralized systems, a single time reference (WWV receiver) at the central computer can synchronize the entire system. In the case of on-street masters, the on-street masters must be equipped with WWV receivers and appropriate interface to be master unit.



SOUTH BAY TRAFFIC SIGNAL SYSTEM IMPROVEMENTS

LACMTA

Los Angeles County Metropolitan Transportation Authority

Surveillance

Exhibit 4.7

Meyer, Mohaddes Associates, Inc.
Traffic Engineering • Transportation Planning

6-25-93

In the case of coordinated systems which use time base coordination units, in addition to a WWV receiver at each controller, a software modification might be required at some locations to enable each controller to be synchronized with the WWV receiver.

A total of 100 WWV receivers are assumed to be installed at on-street masters and controllers along Western Avenue and Sepulveda Boulevard/Willow Street routes during the first two years with an estimated cost of approximately $242,000. It is assumed that all other controllers and on-street masters will be replaced during the long-term plan strategies, as appropriate. Cost estimate has not been provided for this improvement since many of the intersections are anticipated to be linked through direct communication with each other, resulting from the communication upgrade task.

G. Computer Interface/Data and Information Sharing: Under this improvement, every jurisdiction procures a computer with which to share information on all the adjacent signal systems. Those corridors/systems that currently do not have a computer interface with their field units will also establish a computer interface such as a closed loop system. El Segundo, for example, which has several agencies controlling its signals, could get information from all of them and have oversight of what is going on. The information sharing could be in the form of data or graphic display. Each city can only observe the conditions of other cities without being able to change or control the operation of traffic signals in those cities. As an extension of this improvement, the project provides common areawide graphics and partial integration of the systems and provides on interactive user interface. The host computer containing the data bank and processing will be placed at the control centers.

This improvement requires communication capabilities between each group of cities. Surveillance loops should also be installed for data sharing. Additionally, software modification, database integration and upgrade and common time reference should be implemented.

Another type of improvement for multijurisdictional coordination is common central control. Under this scenario, certain corridors might be logical to be controlled by a central/distributed system. All or certain signals of City B, therefore, will be connected to the control center of City A. This might require controller replacement or development of software to integrate the existing or planned systems with each other. This also requires jurisdictional agreements for both control and maintenance. In the South Bay area, this arrangement may not be appropriate at this time. However, computer interface and data sharing is strongly recommended. After implementation of such improvements, the committee could discuss if any common central control opportunities are available in certain areas.

The implementation of computer interface/data and information sharing is recommended for the following cities for longer term of the improvement plan:

- Gardena (host)
- El Segundo
- Hawthorne
- Lawndale
- Manhattan Beach
- Northern portion of Redondo Beach

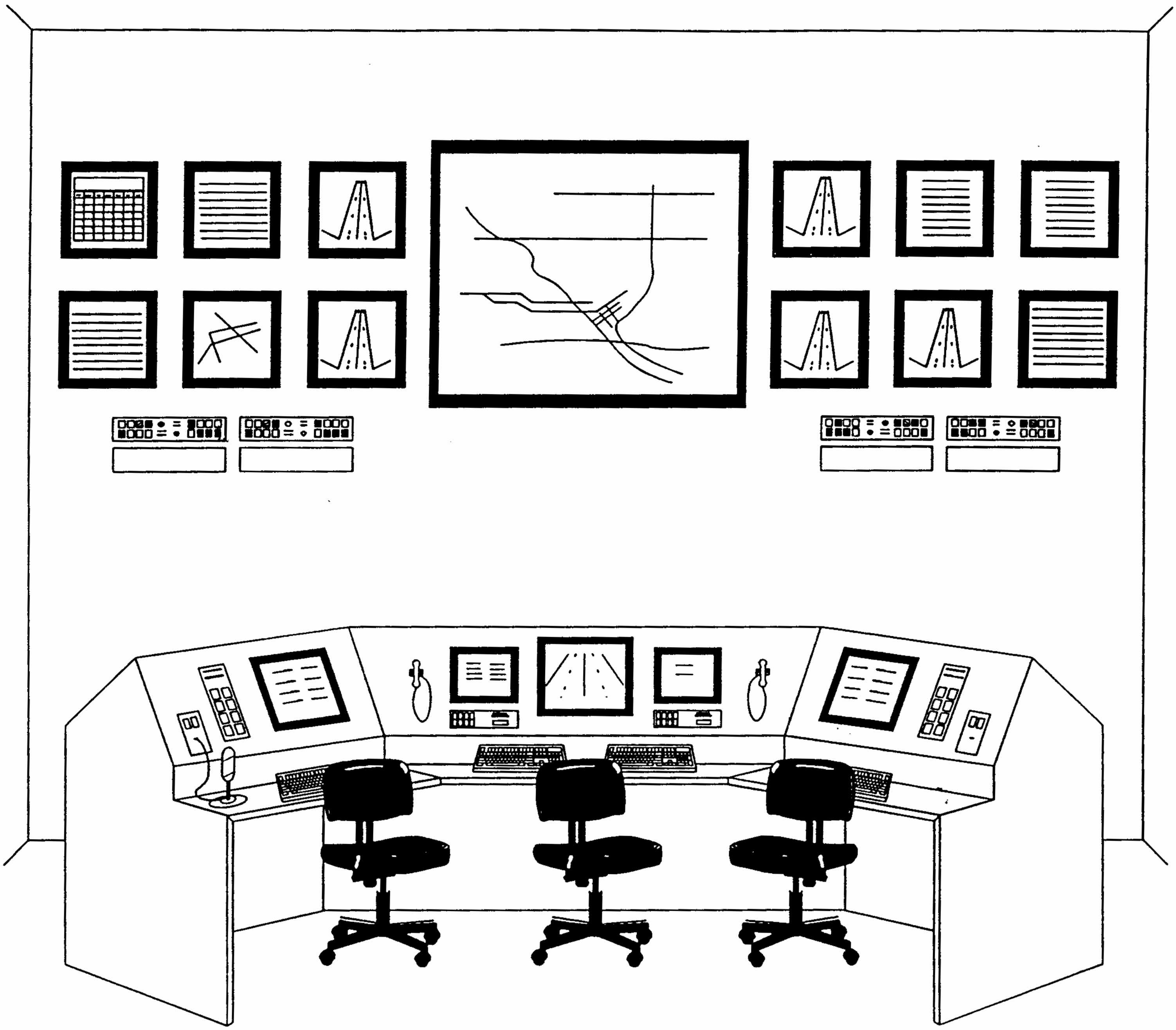
The cost of this implementation is estimated to be about $842,000.

Exhibit 4.1, which was previously introduced, shows the recommended division of the South Bay cities for the implementation of the longer-term computer interface strategy. The cities of Los Angeles, Gardena, Torrance and Long Beach will serve as the host cities housing the main computer containing the data and information bank. Much of the activity will be afforded through the computer interface process developed during the short-term plan, although modifications will be necessary for tailoring for each of the remaining centers. The cost of this longer term improvement is estimated to be about $300,000.

*H. **Traffic Control Center:*** A traffic control center (TCC) normally hosts the control processing and monitoring of traffic conditions. It acts as the focal point for data management and system control. Several components are included in a TCC, although depending on functional and physical desires of jurisdictions, certain elements may vary. In general, a typical control center may include (Exhibit 4.8)

COST OF A TYPICAL CONTROL CENTER

Element	Approximate Cost
Console	15K
2-4 computers and supporting utility software	20K
Large screen graphic display unit	35K
4-12 color video monitors	10K
Lighting, furniture, work stations, heating, air conditioning, c- 200Kabling, terminal panel, floor, ceiling, structural and architectural work	100K - 150K
Design and integration	40K - 70K
Contingency	50K - 100K
Total	**270K - 400K**



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Typical Traffic Control Center

Exhibit 4.8

In the South Bay area, control centers could serve both the jurisdiction which it is located, and also serve as the host for the database computer as discussed earlier (computer interface/data and information sharing). As included in Pilot Project 1, the City of Long Beach is recommended for control center upgrade. The City of Long Beach already has a signal system and is expanding their monitoring and surveillance capabilities. The Cost of this upgrade is estimated to be about $378,000.

Since the cities of Torrance and Gardena are recommended to host the database computers, it is further recommended that a control center be installed at the City of Torrance at a cost of $300,000. The City of Gardena currently has a small traffic control center, therefore it is recommended for upgrade for expansion at a cost of $150,000. Graphic workstations for the cities of Los Angeles and Inglewood will be needed when tied to ATSAC and Gardena, respectively, at a cost of approximately $50,000.

I. Data, graphics and video intertie with Caltrans via fiber optic trunk: This longer-term concept would provide a framework for regional integration and information sharing. Several components should be studied in detail, design and implementation, including:

- Architecture, format, size, protocol and speed of data
- Characteristics and type/format of graphics
- Magnitude, protocol and speed of video
- Location for intertie to fiber and the necessary equipment. In addition, type of communication between the hubs and jurisdictional control centers should be further investigated. One scenario could include fiber optic link between the three major control centers (Long Beach, Torrance, and Gardena) to tie with the closest Caltrans hub near the freeway. This concept is illustrated in Exhibit 4.2.

The cost for this effort includes approximately $500,000 for a detailed study and PS&E. In addition, software development cost of $200,000 to $1,000,000 depending on the status and availability of Caltrans and San Gabriel software activities. Also, implementation cost (construction and integration) will be approximately $1,000,000. Additional trunking will be necessary along certain routes. Caltrans is preparing their 10-year plan of communication that will include a study of trunking along major Caltrans arterials such as Western Avenue between I-405 and Pacific Coast Highway. For the purpose of this concept plan, it is assumed that fiber optic trunk between I-405 and Pacific Coast Highway will cost approximately $500,000 for design and construction. In addition, provision of 20 miles of trunk is recommended at a cost of $1,500,000.

J. Development of a Comprehensive Traveller Information System: This longer-term concept includes providing current, real-time information to travellers related to conditions of the transportation system. The information may be related to traffic congestion, construction and maintenance activities, weatherrelated or hazardous environmental conditions, and other pertinent, trip advisory information. This information will be disseminated through freeway and surface street changeable message signs (CMS), highway advisory radio (HAR) and information kiosks at activity centers. In addition, much of this information could be presented at-home or at-office. For the purpose of this concept plan, the following components have been identified as stepping stones for an overall traveller information system with a total cost of about $2,950,000. Possible locations of CMS are illustrated in Exhibit 4.7.

TRAVELLER INFORMATION SYSTEM COMPONENTS

Element	Approximate Cost
Total of 30 surface CMS along the four identified major routes. This will be This intertied with the fiber optic trunk.	$1,500,000
HAR along the four major routes for 15 stations	$450,000
Information kiosks at 20 activity center	$1,000,000

K. Development of "Smart Corridors" along the Harbor, Glenn Anderson, San Diego and Long Beach Freeways: The Statewide Smart Corridor Study[1] addresses the concept of Smart Corridors and typical involved agencies. It defines such corridors which all facilities, including freeways and surface streets, are used at their maximum efficiency during both normal periods of congestion and when an incident has occurred. This will normally involve freeway surveillance and control, ramp metering, improved traffic signals control, incident detection and response, motorist service patrols and other traffic management features. Also, a Smart Corridor actively involves the motorist by providing drivers with the information needed to make intelligent decisions on the best route to travel, given the existing conditions.

Much of these types of opportunities and improvements were discussed in the prior two concepts (data, graphics and video intertie and the traveller information system). The concentration of the Smart Corridor concept will be along and near the freeway facilities, while the former two concepts will focus on major arterials and activity centers throughout the South Bay area.

[1]*Smart Corridor Statewide Study, Final Report.* JHK & Associates, June 1990.

The statewide study has identified three categories of corridors for consideration as "Smart Corridors". They are as follows:

- Category 1 - Corridors with benefit cost ratio of over 3:1
- Category 2 - Corridors with benefit cost ratio of between 1:1 and 3:1
- Category 3 - Corridors with benefit cost ratio with positive value under current conditions.

In Los Angeles County, a total of 17 corridors have been identified for all three categories. In the South Bay and vicinity, the following corridors are identified:

POTENTIAL SMART CORRIDORS

Corridor	B/C Ratio	Implementation Cost
I-405 between I-110 and I-10	9.94	$17.4 million
I-110 between I-405 and I-10	3.93	$14.3 million
I-405 between I-110 and I-605	1.03	$15.7 million
Total Cost		$47.4 million

It is recommended that the Glenn Anderson (I-105) Freeway be studied for opportunities relative to Smart Corridors at an initial study cost of $150,000. It is further recommended that the identified "Smart Corridors" be included in the South Bay 10-year concept plan for analysis, design and implementation.

The implementation cost of the three recommended Smart Corridors which sums to a total of $47,550,000 may decrease due to several factors including the current work in process throughout Los Angeles County, such as the East San Gabriel Valley project, Santa Monica Smart Corridor project, the proposed Pasadena Smart Project, and other potential projects similar to the South Bay project which may occur in the next 10 years.

5. IMPLEMENTATION PROGRAM AND SCHEDULE

Proposed improvements for the South Bay area were divided into short-term and long-term plans. Both short-term and long-term plans are formulated based on current and expected future needs with no budget constraint. In other words, the recommended improvements which are summarized in Exhibit 5.5 represent an unconstrained 10-year Conceptual Plan which may be refined depending upon the funding and budget availabilities. The short-term plan includes recommended improvements for the first two years while the long-term plan includes those improvements to be implemented during the last eight years of the 10-year Conceptual Plan. The implementation program and scheduling of both short-term and long-term plans are presented in this section.

5.1 SHORT TERM (TWO YEAR) PLAN

For management purposes, and in order to design and implement related improvements together, the short-term improvement elements recommended as part of the South Bay Conceptual Plan are classified into four sets of improvements. Each set of improvements includes one or more of the improvement specified in the 10-year Conceptual Plan of Exhibit 5.5, and are to be designed and implemented during the first two years of the Plan. The improvements under considerations are as follows:

- **Improvements A and C** - Intersection traffic operations improvements and communications upgrade
- **Improvements B, D and F** - Controller replacement, systemwide coordination and common time reference
- **Improvements E** - Surveillance: installation of CCTV cameras and system loops
- **Improvements F** - Upgrading the traffic control center at the City of Long Beach

Management strategies are proposed to meet the needs of these improvements to be implemented in the first two years. It is intended to present each improvements in a "stand alone" arrangement for ease of implementation. The implementation and scheduling set of are presented below.

IMPLEMENTATION AND SCHEDULING FOR INTERSECTION TRAFFIC OPERATIONS AND COMMUNICATIONS UPGRADE (IMPROVEMENTS A AND C)

This plan includes individual intersection improvements and communication upgrade. Intersection improvements may include the following elements:

- detection loop
- left-turn phasing where warranted
- removal of left-turn phasing
- split phasing removal
- right-run loop delay
- turn prohibition
- peak hour parking restrictions
- right-turn overlap
- intersection reconfiguration
- other operational considerations

A total of 64 intersections are identified for operational improvements.

A total of 10 miles of interconnect improvements is also an element of this task. The following segments are considered:

- Sepulveda/Willow from Crenshaw Boulevard to Terminal Island Freeway
- Sepulveda/Willow from Studebaker Road to the eastern city limits of Long Beach
- Western Avenue between Imperial Highway and El Segundo Boulevard
- Western Avenue between 182nd Street and 190th Street
- Western Avenue south of Torrance Boulevard to Sepulveda Boulevard

Cost Estimate:

A. Intersections Improvements: Intersection improvements vary between 10K to 60K, depending upon the extent of needed improvements. A total of $10,000 has been assumed for minor restriping; $20,000 for minor modifications; $30,000 for phasing modifications; and $40,000 for relatively moderate modifications.

Total $1,880,000

C. Communications Upgrade at approximately $18 per fit	$950,000
Design cost	95,000
Contingency	105,000
Total	$1,150,000
Total Improvements A and C Cost	$3,030,000

Schedule: The design and implementation schedule for Improvements A and C is shown in Exhibit 5.1.

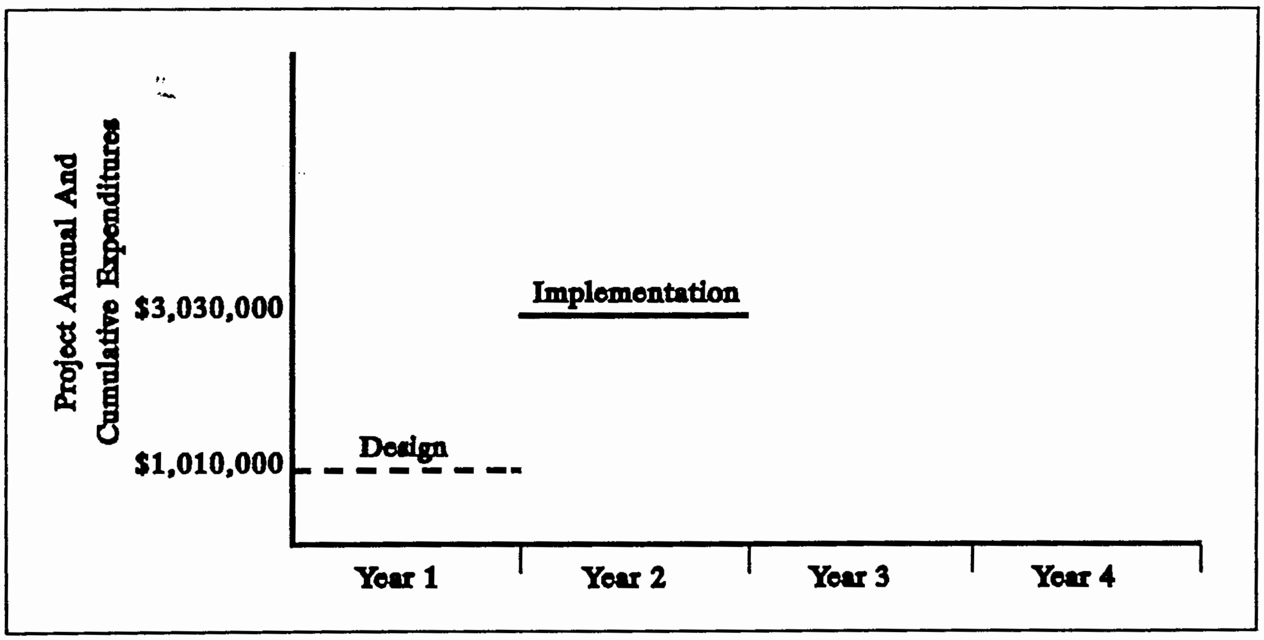

Exhibit 5.1 Improvements A and C Schedule

Management: The following management structure is proposed for Improvements A and C:

- Final oversight remains with the South Bay JPA
- The TAC and MTA will review and maintain oversight of the project in terms of progress and approval of consultant selection.
- Detailed project management work in both the design and implementation phases could be staffed by one of the following:
  - A lead agency or agencies
  - Signal Support Group staff
  - A consultant
- In the implementation phase, it seems appropriate to recommend that staff from each relevant agency would be responsible for plan check work.

IMPLEMENTATION AND SCHEDULING FOR CONTROLLER REPLACEMENT, SYSTEMWIDE COORDINATION AND COMMON TIME REFERENCE (IMPROVEMENTS B, D AND F)

Improvements B, D and F include systemwide coordination through a comprehensive signal timing plan, implementation of common time references (WWV receivers), and controller replacement.

The signal timing plan will use traffic volume and geometric data and utilize timing optimization techniques such as PASSER-II and TRANSYT-7F to coordinate a grid of signals throughout the South Bay area. The plan would cover approximately 300 intersections along Sepulveda Boulevard/Willow Street, Pacific Coast Highway, Hawthorne Boulevard, Western Avenue and crossing major arterials. This improvement will benefit the vast majority of the South Bay area and will include intersection turning volume count task, analysis, optimization, fine tuning and after study tasks.

In conjunction with the timing plan, implementation of a common time reference for the coordinated signals is proposed. Under this areawide improvement, on-street masters and controllers will use a common time reference to establish the time of day. The time reference is WWV time broadcast via radio from Colorado. A total of 100 WWV receivers are assumed, at this stage, to be installed. The exact location of the controllers or on-street masters for installation of WWV receivers will have to be identified during the initial task of the design phase. In the case of existing coordination systems which use time base coordination units, in addition to a WWV receiver at each controller, software modification might also be required to enable each controller to be synchronized with the WWV receiver.

The majority of the 100 WWV receivers are assumed to be installed at on-street masters and controllers along the Western Avenue and Sepulveda Boulevard/Willow Street routes.

Up to 50 electromechanical and outdated controllers are assumed to be replaced as part of this improvement.

Cost Estimate:

B.	Controller Replacement	
	50 controllers @ $6,500 each*	$325,000
	Design	33,000
	Contingency	36,000
	Total	$394,000
D.	Systemwide Coordination	
	$1,200 per intersection including	$720,000
	- turning movement counts for AM, PM and off-peak period	
	- optimization and design	
	- fine tuning	
	- after study	
	Contingency	74,000
	Training	10,000
	Total	$802,000
F.	Common Time Reference	
	100 controllers	$150,000
	Software modification	50,000
	Design	20,000
	Contingency	22,000
	Total	$242,000
Total Improvements B, D and F Cost		$1,438,000

* *It is assumed that, for most cases, the existing foundation and cabinet will remain and only the controller will be replaced.*

Schedule: The design and implementation schedule for Improvements B, D and F is shown in Exhibit 5.2.

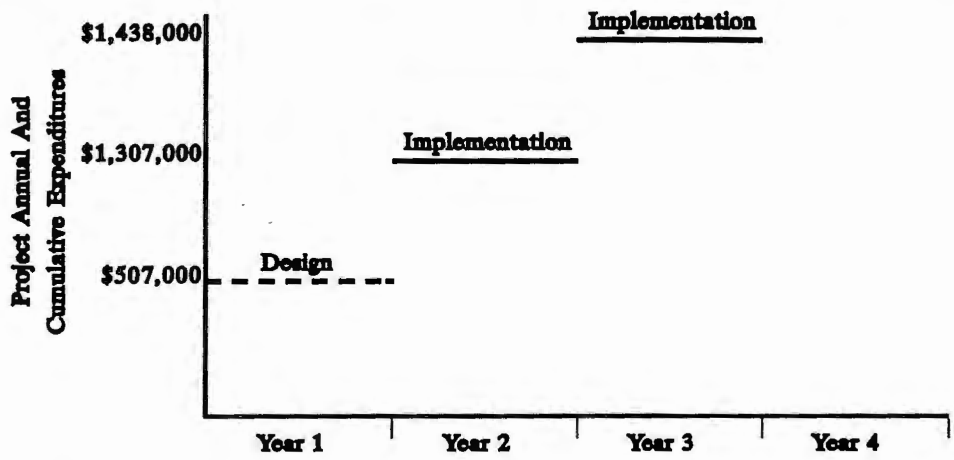

Exhibit 5.2 Improvements B, D and F Schedule

Management: The following management structure is proposed for Improvements B, D and F:

- Final oversight remains with the South Bay JPA
- The TAC and MTA will review and maintain oversight of this task in terms of progress and approval of consultant selection.
- Detailed project management work in both the design and implementation phases could be staffed by one of the following:
  - A lead agency or agencies
  - Signal Support Group staff
  - A consultant
- Consistent and common design criteria should be developed by representatives of various agencies before the design phase of the tasks starts.
- In the implementation phase, it seems appropriate to recommend that staff from each relevant agency would be responsible for plan check work.

IMPLEMENTATION AND SCHEDULING FOR SURVEILLANCE (IMPROVEMENT E)

CCTV systems are recommended to be installed at 13 locations along Pacific Coast Highway and within the cities of Long Beach and Los Angeles at the following locations:

- Pacific Coast Highway/Redondo Avenue
- Pacific Coast Highway/Lakewood Boulevard
- Pacific Coast Highway/7th Street
- Pacific Coast Highway/Westminster Avenue
- Pacific Coast Highway/Santa Fe Avenue
- Willow Street/Cherry Avenue
- Willow Street/Redondo Avenue
- Willow Street/Lakewood Avenue
- Two intersections in Los Angeles
- Pacific Coast Highway/Western Avenue
- Pacific Coast Highway/Alameda Street
- Pacific Coast Highway/Harbor Freeway
- Pacific Coast Highway/Long Beach Boulevard

The exact location and placement consideration for the proposed cameras should be determined during the design phase of the project, through field review and appropriate line of sight investigation.

Elements of Improvement E: The elements of the CCTV system included in the project are the camera installation, communication and intertie with Caltrans TOC. The recommended CCTV system will improve the surveillance capabilities of Caltrans and individual jurisdictions, in order to view and verify the potential incidents for traffic diversion implementation.

Improvement E also includes installation of a total of 50 system loops to provide traffic flow information at critical intersections. System loops are proposed to be installed at all legs of the intersections. These intersections should be selected in cooperation with the involved jurisdictions and Caltrans. Recommended intersections are along Pacific Coast Highway and Sepulveda Boulevard/Willow Street.

Cost Estimate: The estimated cost for the design and implementation of this improvement includes the cost of field equipment and communication system.

The general elements are as follows:

- CCTV camera and housing
- CCTV cabinet and communication equipment
- Communication link

- Central display equipment

A total of approximately $30,000 is assumed for each camera location to include the elements and installation costs. The elements of the cost are as follows:

CCTV camera and housing, CCTV cabinet and communication equipment, communication link and control display equipment	$360,000
Caltrans intertie	75,000
Installation of 50 system loops	375,000
Design Cost	80,000
Contingency	27,000
Total	$917,000

Schedule: The design and implementation schedule for Improvement E is shown in Exhibit 5.3.

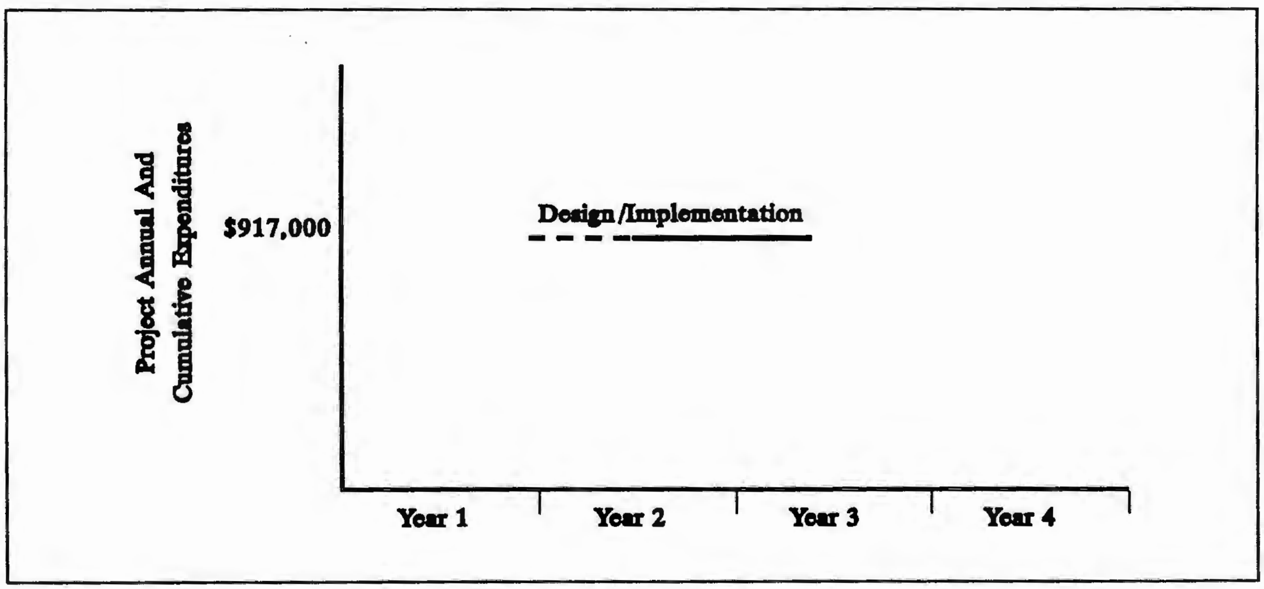

Exhibit 5.3 Improvement E Schedule

Management: Management of this improvement is relatively straightforward. The management of the project is proposed as follows:

- Final oversight of this element and all elements is the responsibility of the JPA as formal promoters of the project
- MTA staff and TAC members will review progress and completion of the project
- One of the three agencies will assume lead responsibility. The three agencies plus MTA will approve consultant/vendor selection.

IMPLEMENTATION AND SCHEDULING FOR TRAFFIC CONTROL CENTER (IMPROVEMENT H)

The City of Long Beach currently has a traffic control center which monitors and operates approximately 230 signals of the city's 500 traffic signals. The City has identified the needs for expanding the capabilities of the existing system and a new traffic control center in order to better monitor and manage the traffic within the city.

Elements of Improvement H: The following elements are assumed to be included for this improvement. These elements should be finalized in cooperation with City staff during the planning and design phases of the project.

- Console
- Two computers and supporting utility software
- Large screen graphic display unit
- Four color video monitors
- A furnished control center including related elements such as lighting, furniture, work stations, heating, air conditioning, cabling, terminal panel, floor, ceiling, structural and architectural.

Cost Estimate:

Console	$15,000
Computers/software	15,000
Large screen graphic display	35,000
Color monitors	10,000
Architectural design and construction of the traffic center room	200,000
Design, integration and training	70,000
Contingency	33,000
Total	$378,000

Schedule: The design and implementation schedule for Improvement H is shown in Exhibit 5.4.

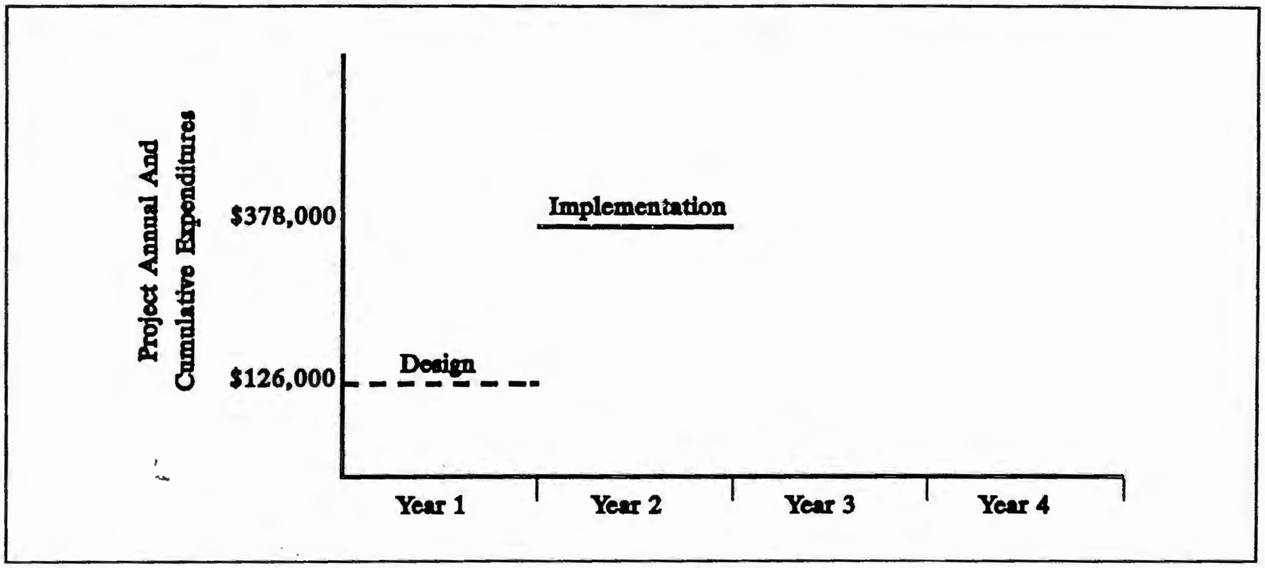

Exhibit 5.4 Improvement H Schedule

Management: The following management structure is proposed for Improvement H:

- Final oversight of the project is the responsibility of the South Bay JPA
- The MTA staff and TAC members will be responsible for approval of consultant selection and the review of progress and completion of the project
- City of Long Beach staff will take lead responsibility for the technical specifications of the work to be performed by the consultant and technical oversight of the work.

5.2 LONG TERM PROGRAM AND SCHEDULE

As illustrated in Exhibit 5.5, all recommended improvements are included in the 10-Year Conceptual Plan. Annual expenditures for each type of improvement is presented. This plan contains a series of improvements which are recommended for implementation in case that sufficient funding could be granted. It is recognized that due to the limited budget, the plan may be revised or some improvements be deferred to the later years for implementation. In addition, as technology evolves, both the improvement strategies and cost may change or be modified.

Improvements	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
A. Traffic Operational Improvements	$627K	$1,253K			$1,000K	$1,000K	$1,000K	$1,000K			$5,880K
B. Controller Replacement	$131K	$263K			$282K	$282K	$282K	$281K			$1,521K
C. Communication Upgrade	$383K	$767K	$1,150K	$2,300K	$1,006K	$1,006K	$1,006K	$1,007K			$8,625K
D. Systemwide Coordination	$134K	$267K	$401K		$670K	$670K			$670K	$670K	$3,482K
E. Surveillance		$917K		$1,079K							$1,996K
F. Common Time Reference	$242K										$242K
G. Computer Interface			$281K	$561K	$150K	$150K					$1,142K
H. Traffic Control Center	$126K	$252K			$250K	$250K					$878K
I. Data, Graphics and Video Intertie					$1,500K	$1,500K	$1,500K				$4,500K
J. Travellers Info. System					$738K	$738K	$738K	$736K			$2,950K
K. "Smart Corridors"					$3,000K	$5,000K	$8,000K	$10,516K	$10,516K	$10,518K	$47,550K
Budget	$1,643K	$3,719K	$1,832K	$3,940K	$8,596K	$10,596K	$12,526K	$13,540K	$11,186K	$11,188K	$78,766K
Cumulative Budget	$1,643K	$5,362K	$7,194K	$11,134K	$19,730K	$30,326K	$42,852K	$56,392K	$67,578K	$78,766K	

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Exhibit 5.5

Concept Implementation Plan and Schedule (10 Year)
(Unconstrained Plan)

Much of the proposed improvements during the first four years concentrate on the basis and practical improvements within the jurisdictions and also coordination of traffic signals within and between appropriate agencies. Year 5 through 10 are intended to focus on two types of projects:

1. Continuation on extension of the first four year projects, such as additional communication and signal coordination improvements; and

2. Application of state-of-the-art technology in transportation to provide better mobility for the travellers in the South Bay area. These improvements include design and implementation of "Smart Corridors" and a comprehensive traveller's information system.

5.3 FUNDING SOURCES FOR CONCEPTUAL PLAN

A total 10-Year budget of $78,766,000 is proposed for the recommended improvements. This budget includes $47,550,000 for "Smart Corridor" improvements plus $31,216,000 for other improvements recommended in Exhibit 5.5. The plan is based on expected needs of the proposed improvements under an unconstrained budgetary assumption. Given the current budget constraints, it is envisioned that modifications to the plan's schedule will be made as deemed necessary. A variety of funding sources should be explored to secure the needed budget for the plan implementation, including the following:

- Federal ISTEA funds
- State TSM Funds
- Local TSM Funds
- Proposition C - Discretionary and Local Return
- Local Surface Transportation Program Fund

It should also be noted that some of these projects, such as the "Smart Corridors" are already in process of preparation for funding application.

5.4 ACTION PLAN FOR THE FIRST TWO YEARS

The short-term plan improvements focus primarily on Pilot Project 1 along the identified four major corridors and supporting arterials submitted to the LACMTA for potential funding. The plan was evaluated under the current budget constraints and was recommended for implementation with some modifications. Exhibit 5.6 shows the modified (constrained) two-year plan expenditure for implementation as was submitted by LACMTA staff for approval.

It should be noted that the recommended budget for the first two years is $3,185,000. Since this budget is less than the amount identified in the Concept Plan ($5,362,000), some of the projects in part will be deferred to later years for implementation.

5.5 SIGNAL SUPORT GROUP

In 1992 the Los Angeles County Transportation Commission authorized and funded the establishment of a unit called the Signal Support Group (SSG). The SSG now operates within the Metropolitan Transportation Authority (MTA).

The primary role of the Signal Support Group is to assist in the development and implementation of multi-jurisdictional projects to improve the regional coordination of traffic signals. Other objectives of the SSG include developing multi-jurisdictional traffic signal operation and maintenance procedures and policies, developing training programs for local traffic engineering and signal operation personnel, establishing project application funding and project implementation standards, and working on Intelligent Vehicle and Highway Systems (IVHS).

5.5.1 Role Of Signal Support Group In The South Bay Project

The Signal Support Group will assist the South Bay area team in monitoring the South Bay project and provide technical support and management assistance as it does for other signal synchronization and coordination projects under way in different areas of the County.

The SSG will assist the South Bay Area Team to establish working groups of traffic engineers for the implementation of different elements of the project. The forums would actually be smaller working groups of the South Bay cities which would work under the direction of the South Bay TAC and JPA.

The SSG will assist the area team project manager to define the scope of services for the upcoming implementation phases of the project, and participate in the evaluation of qualified firms for the design, management and implementation of the projects. They will also provide technology transfer from other

EXHIBIT 5.6

RECOMMENDED IMPLEMENTATION PROGRAM AND SCHEDULE FOR FIRST TWO YEARS (CONSTRAINED)

Task	Year 1 Recommended	Year 2 Recommended	Total 2-Year Recommended	Comments
Tasks A and C				
A: Traffic Operational Improvements	410,000	815,000	1,225,000	Figure represents 45 of the intersections requested as part of the Conceptual Plan
C: Communications Upgrade	180,000	365,000	545,000	This budget will cover approximately 10 miles of communications upgrade
Total Tasks A and C	590,000	1,180,000	1,770,000	
Tasks B, D and F				
B: Controller Replacement	131,000	263,000	394,000	
D: Systemwide Coordination	134,000	267,000	401,000	Estimated $1,200 per intersection
F: Common Time Reference	242,000	0	242,000	
Total Tasks B, D and F	507,000	530,000	1,037,000	
Task H				
H: Long Beach Control Center Upgrade	126,000	252,000	378,000	
Total Task H	126,000	252,000	378,000	
TOTAL	**1,223,000**	**1,962,000**	**3,185,000**	

MTA signal efforts in the County.

The SSG will assist the Area Team in the development and execution of the MOU and necessary working agreements among cities, and in the determination of lead agencies for each portion of the project.

Upon completion of each element of the project, the SSG will work with the Area Team to evaluate the project, and transfer the proven technology and experience gained to future projects throughout Los Angeles County.

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