# Los Angeles Congestion Reduction Demonstration (Metro ExpressLanes) Program

## National Evaluation: Traffic System Data Test Plan

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16. Abstract
This report presents the Traffic System Data Test Plan for the national evaluation of the Los Angeles County Congestion Reduction Demonstration (CRD) under the United States Department of Transportation (U.S. DOT) Urban Partnership Agreement (UPA) Program. The Los Angeles County CRD projects focus on reducing congestion by employing strategies consisting of combinations of tolling, transit, telecommuting/travel demand management (TDM), and technology, also known as the 4Ts. Tolling (pricing) strategies include converting high occupancy vehicle (HOV) lanes on the two freeway corridors to variably-priced high-occupancy toll (HOT) lanes, adding a second HOT lane to portions of one corridor, and implementation of a downtown L.A. intelligent parking management system featuring demand-based pricing and real-time parking availability information. Transit improvements include increased bus service, transit station security improvements, expansion of two transit stations, creation of an El Monte Busway/Union Station connector, and the expansion of downtown L.A. transit signal priority. TDM strategies aim to establish 100 new registered vanpools. This Traffic System Data Test Plan is one of ten test plans being developed. The other nine test plans consist of the following: tolling; transit; ridesharing; safety; environmental; surveys, interviews and workshops; cost-benefit, content analysis; and exogenous factors. Each test plan is based on the Los Angeles County CRD National Evaluation Plan. This test plan summarizes the data sources, data availability, data analysis and possible risks associated with the data. The schedule and responsibilities for collecting, analyzing, and reporting the data are also presented.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| 4Ts | Tolling, Transit, Telecommuting, and Technology |
| ADT | Average Daily Traffic |
| ATMS | Advanced Traffic Management System |
| ATSAC | Automated Traffic Surveillance and Control |
| BRT | Bus-Rapid Transit |
| Caltrans | California Department of Transportation |
| CHP | California Highway Patrol |
| CRD | Congestion Reduction Demonstration |
| ExpressLanes | Component of LA CRD, pilot converted HOT lanes |
| FHWA | Federal Highway Administration |
| FTA | Federal Transit Administration |
| HOT | High-occupancy tolling |
| HOV | High-occupancy vehicle |
| I-10 | Interstate 10 (El Monte Busway between Alameda St and I-605) |
| I-110 | Interstate 110 (Harbor Transitway between Adams Blvd and Harbor Gateway Transit Center) |
| IPM | Intelligent Parking Management |
| L.A. | Los Angeles |
| LA CRD | Los Angeles Congestion Reduction Demonstration |
| LADOT | Los Angeles Department of Transportation |
| LA ExpressPark | Component of LA CRD, pilot LA parking management system |
| Metro | Los Angeles County Metropolitan Transportation Authority |
| Metrolink | Southern California Regional Rail Authority |
| MPH | Miles Per Hour |
| PATH | Partnership for Advanced Technology on the Highways |
| PeMS | Performance Measurement System |
| PMT | Person-Miles of Travel |
| SBCCOG | South Bay Cities Council of Governments |
| SCAG | Southern California Association of Governments |
| SGVCOG | San Gabriel Valley Council of Governments |
| TDM | Travel Demand Management |
| TTI | Travel Time Index |
| UPA | Urban Partnership Agreement |
| U.S. DOT | U.S. Department of Transportation |
| VHT | Vehicle-Hours of Travel |
| VMT | Vehicle-Miles Traveled |

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# 1.0 INTRODUCTION

This report presents the test plan for collecting and analyzing traffic system data for the national evaluation of the Los Angeles (L.A.) Congestion Reduction Demonstration (Metro ExpressLanes) Program under the United States Department of Transportation (U.S. DOT) Congestion Reduction Demonstration (CRD) program. The LA CRD (Metro ExpressLanes) is one of several large field deployments around the United States that are receiving U.S. DOT funding and which are intended to demonstrate congestion pricing and supporting strategies. The LA CRD (Metro ExpressLanes) Program national evaluation will address the four primary U.S. DOT evaluation questions shown in Table 1-1.

**Table 1-1. U.S. DOT National Evaluation "Objective Questions"**

| | |
|---|---|
| **Objective Question #1** | How much was congestion reduced in the area impacted by the implementation of the tolling, transit, technology, and telecommuting strategies? It is anticipated that congestion reduction could be measured by one of the following measures, and will vary by site and implementation strategy:<br>• reductions in vehicle trips made during peak/congested periods;<br>• reductions in travel times during peak/congested periods;<br>• reductions in congestion delay during peak/congested periods; and<br>• reductions in the duration of congested periods. |
| **Objective Question #2** | What are the associated impacts of implementing the congestion reduction strategies? It is anticipated that impacts will vary by site and that the following measures may be used:<br>• increases in facility throughput during peak/congested periods;<br>• increases in transit ridership during peak/congested periods;<br>• modal shifts to transit and carpools/vanpools;<br>• traveler behavior change (e.g., shifts in time of travel, mode, route, destination, or forgoing trips);<br>• operational impacts on parallel systems/routes;<br>• equity impacts;<br>• environmental impacts;<br>• impacts on goods movement; and<br>• effects on businesses. |
| **Objective Question #3** | What are the non-technical success factors with respect to the impacts of outreach, political and community support, and institutional arrangements implemented to manage and guide the implementation? |
| **Objective Question #4** | What are the overall costs and benefits of the deployed set of strategies? |

**Source:** "Urban Partnership Agreement Demonstration Evaluation – Statement of Work," United States Department of Transportation, Federal Highway Administration, November 2007.

The questions shown in Table 1-1 will be addressed by carrying out the following 11 "evaluation analyses" described in the LA CRD (Metro ExpressLanes) Program National Evaluation Plan[1]: tolling, technology, transit, travel demand management (TDM), congestion, safety, equity,

[1] Los Angeles County Congestion Reduction Demonstration National Evaluation Plan, January 13, 2010, U.S. DOT.

environment, business impacts, non-technical success factors, and cost benefit. Each of these 11 analyses relies upon various evaluation measures of effectiveness.

“Test plans” are the evaluation planning documents that describe how specific data will be collected and processed to yield the evaluation measures of effectiveness required for the various analyses. Whereas evaluation analyses are categorized according to related evaluation questions or types of impacts, for example all equity-related impacts are addressed in the equity analysis, test plans are categorized according to common data types or sources. For example, the “Traffic System Data Test Plan” collects and processes all of the traffic data required for the national evaluation. There are a total of ten test plans for the LA CRD (Metro ExpressLanes) Program national evaluation. In addition to this Traffic System Data Test Plan, there are test plans focusing on the following types of data: tolling; transit system; exogenous factors; ridesharing; safety; environment; content analysis; surveys, interviews, and workshops; cost benefit.

The relationship between test plans and evaluation analyses is discussed in Section 1.2. In short, analyses describe the evaluation questions and hypotheses to be investigated and the test plans describe how the data and measures of effectiveness needed to support the evaluation will be collected and processed. Most test plans collect data and provide measures of effectiveness that will be used in multiple analyses and most analyses rely upon data and measures developed through several different test plans.

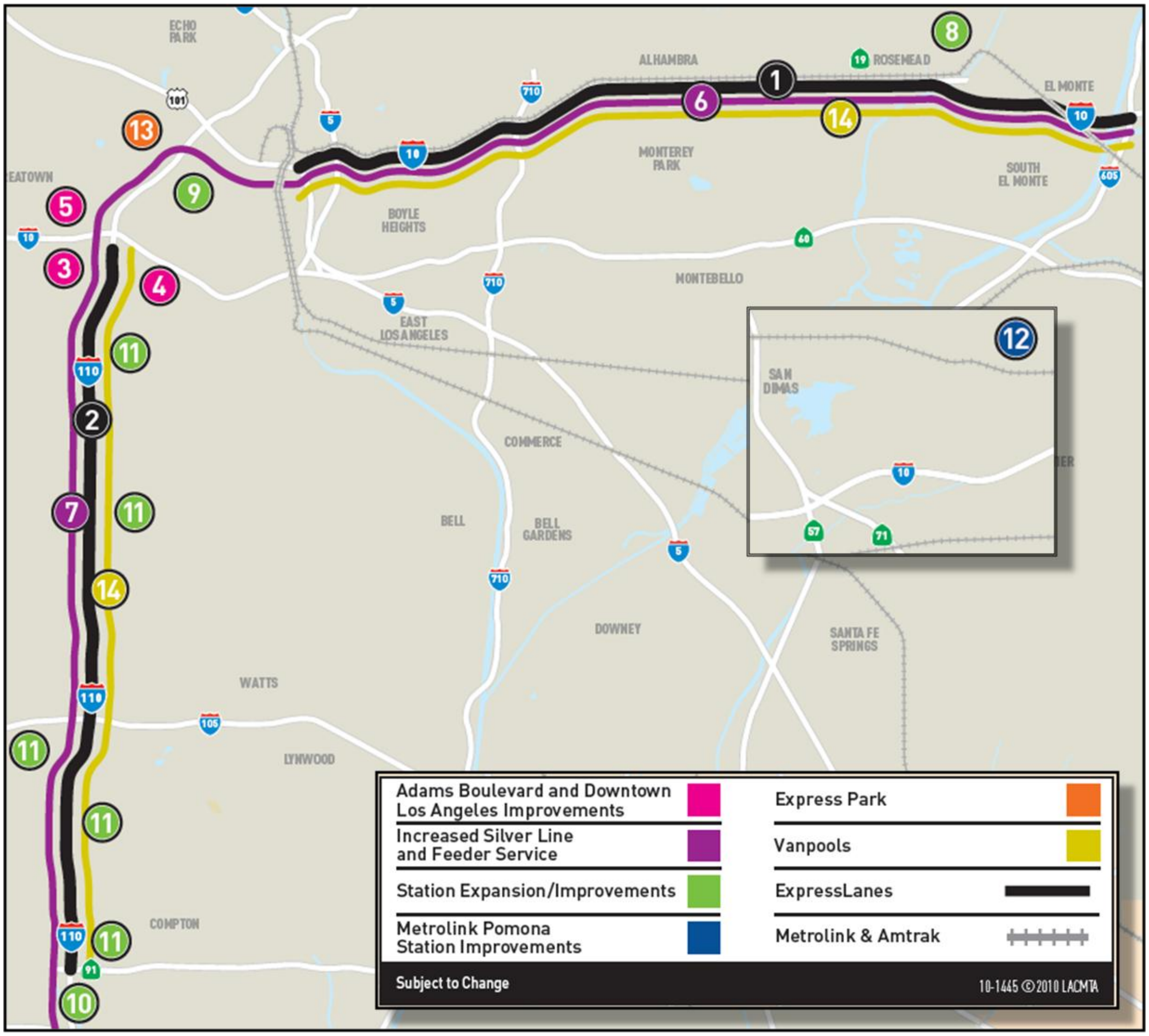
The remainder of this introduction chapter identifies the LA CRD (Metro ExpressLanes) Program deployments and elaborates on the relationship between test plans and evaluation analyses. The remainder of the report is divided into three sections. Chapter 2.0 presents the data sources, availability, and risks associated with data collected through this Traffic System Data Test Plan. Chapter 3.0 discusses how the traffic system data will be conducted and used in the national evaluation. Chapter 4.0 presents the schedule and responsibilities for conducting the traffic system data analysis.

## 1.1 The LA CRD (Metro ExpressLanes) Program Projects

The LA CRD (Metro ExpressLanes) Program was selected by the U.S. DOT as an Urban Partner to implement projects aimed at reducing congestion based on four complementary strategies known as the 4Ts: Tolling, Transit, Telecommuting/TDM, and Technology. Under contract to the U.S. DOT, a national evaluation team led by Battelle is assessing the impacts of the projects in a comprehensive and systematic manner in Los Angeles (L.A.) County and other sites. The national evaluation will generate information and produce technology transfer materials to support deployment of the strategies in other metropolitan areas. The national evaluation will also generate findings for use in future Federal policy and program development related to mobility, congestion, and facility pricing.

The LA CRD (Metro ExpressLanes) Program effort is led by the Los Angeles County Metropolitan Transportation Authority (Metro). The CRD projects are being implemented with the assistance of a number of supporting agencies especially the California Department of Transportation (Caltrans); and the Los Angeles Department of Transportation (LADOT). Other participating agencies include the Southern California Association of Governments (SCAG); the San Gabriel Valley Council of Governments (SGVCOG); the South Bay Cities Council of

Governments (SBCCOG); the Southern California Regional Rail Authority (Metrolink); Foothill Transit; the California Highway Patrol (CHP); and the Los Angeles County Sheriff's Department. The LA CRD (Metro ExpressLanes) Program projects are intended to reduce congestion, promote throughput, and enhance mobility in the Interstate-10 (I-10) and Interstate-110 (I-110) corridors, and in downtown Los Angeles. Figure 1-1 shows the location of the LA CRD (Metro ExpressLanes) Program projects and Figure 1-2 provides short summaries of the numbered projects on Figure 1-1.




Derived from Metro ExpressLanes project map

**Note**: See Figure 1-2 for the explanation of each numbered project on this map.

**Figure 1-1. LA CRD (Metro ExpressLanes) Program Project Locations**

Derived from Metro ExpressLanes project map.

**1 EXPRESSLANES ON I-10**

This project will convert existing HOV lanes on the I-10 from Alameda Street/Union Station to I-605 into ExpressLanes (44 lane miles). The budget will cover the toll technology, toll infrastructure and operational improvements required to complete the conversion. This project will also provide additional ExpressLanes capacity on the El Monte Busway between I-710 and I-605 through re-striping and buffer changes. No general purpose lanes are taken away to create the second ExpressLane between I-710 and I-605.

**2 EXPRESSLANES ON I-110**

This project will convert existing HOV lanes on the I-110 from 182nd Street/Artesia Transit Center to Adams Boulevard into ExpressLanes (38 lane miles). The budget will cover the toll technology, toll infrastructure and operational improvements required to complete the conversion.

ExpressLanes is a one-year demonstration project. Buses, motorcycles, vanpools, and carpools that currently use HOV lanes will not be charged a toll. General purpose lanes will continue to remain toll-free. The following projects will provide additional access and capacity to the I-10 and I-110 ExpressLanes, to encourage movement of more people rather than more vehicles.

## ADAMS BOULEVARD AND DOWNTOWN LOS ANGELES IMPROVEMENTS

**3 I-110 ADAMS/FIGUEROA FLYOVER STUDY**

The Adams/Figueroa Flyover Study will investigate how the construction of a new structure – connecting the I-110 northbound HOV lane off-ramp directly to Figueroa Street – could improve traffic flow at the end of the I-110 HOV lane.

**4 ADAMS BOULEVARD STREET WIDENING**

Adams Boulevard will be widened between the Harbor Freeway off-ramp and Flower Street – adding an additional westbound right-turn-only lane to the HOV bypass connecting to Figueroa Street. Re-striping will also add one extra lane to the HOV off-ramp approaching Adams Boulevard to increase capacity.

**5 TRANSIT SIGNAL PRIORITY IN LOS ANGELES**

This project will install bus-signal priority technology on Figueroa Street between Wilshire Boulevard and Adams Boulevard (15 signals), and Flower Street between Wilshire Boulevard and Olympic Boulevard (5 signals) to enhance transit operations. It will also extend the existing AM peak-period northbound bus-only lane on Figueroa Street between 23rd Street and 4th Street to cover the PM peak-period.

## INCREASED SILVER LINE AND FEEDER SERVICE

**6 NEW BUSES FOR THE I-10 EL MONTE BUSWAY CORRIDOR**

Before adding ExpressLanes to the corridor, Metro and its transit partner – Foothill Transit – will purchase 30 new buses and increase Silver Line and feeder service on the I-10 El Monte Busway, with a goal of providing service every three to seven minutes during rush hour.

**7 NEW BUSES FOR I-110 HARBOR TRANSITWAY CORRIDOR**

Before adding ExpressLanes to the corridor, Metro and its transit partners – Torrance Transit and Gardena Transit – will purchase 29 new buses to improve Silver Line and feeder service on the I-110 Transitway, with a goal of providing service every three to seven minutes during rush hour.

## STATION EXPANSION/IMPROVEMENTS

**8 EL MONTE TRANSIT STATION EXPANSION**

The El Monte Station is the eastern terminus of the El Monte Busway, and is currently the busiest bus terminal west of Chicago. Given that the El Monte Station will now also be the eastern terminus of the ExpressLanes, expansion of the terminal will be required to accommodate additional high-capacity buses, passenger parking and bike lockers.

**9 PATSAOURAS PLAZA/UNION STATION CONNECTION**

A new Union Station stop will be created for the El Monte Busway, allowing direct access to the station's Patsaouras Transit Plaza. This will eliminate the long walks, operational delays and insufficient lighting and information displays passengers currently have to contend with when transferring at Alameda Street to Metro's Red and Gold lines, Metrolink and Amtrak.

**10 IMPROVED ARTESIA TRANSIT CENTER SECURITY**

Improvements at the largest transit center on the I-110 Harbor Transitway include bike lockers to promote non-motorized access and a law enforcement substation to assist with station security.

**11 I-110 HARBOR TRANSITWAY PARK & RIDE AND TRANSIT STATION IMPROVEMENTS**

Improvements to these facilities will include enhanced signage, lighting and security. Other benefits to customers include new bus stops under Slauson and Manchester stations for Lines 108/115, and improved signage and security for existing Harbor Transitway Park and Ride lots at Slauson, Manchester, Harbor Green Line, Rosecrans, Artesia, Carson, PCH and Harbor/Beacon in San Pedro.

## METROLINK POMONA STATION IMPROVEMENTS

**12 ADDITIONAL COMMUTER RAIL CAPACITY**

This station on Metrolink's San Bernardino Line will undergo several improvements, including the addition of 143 new parking spaces and the expansion of platforms to accommodate longer eight-car trains.

## EXPRESS PARK

**13 DOWNTOWN PARKING MANAGEMENT**

This project will use new parking technology to provide motorists alternative payment options and real-time parking availability information for nearly 13,000 on-street and off-street parking spaces in Downtown Los Angeles. The information will aid motorists in understanding their parking options and will guide them to available parking spaces – eliminating the need to search for parking and reducing traffic congestion.

New parking meters will be installed at approximately 5,500 on-street metered parking spaces in the downtown area. These meters will be capable of charging motorists demand-based parking rates – which change depending on the time of day and traffic congestion levels. They will also provide alternative payments options, allowing motorists to pay for parking using their credit card or cell phone and to receive a text message when their paid parking time is about to expire.

## VANPOOLS

**14 I-10/I-110 COMMUNITY-BASED VANPOOL FORMATION**

This program will provide vanpool formation services to any community where ExpressLanes are implemented. This includes a dedicated vanpool representative that will actively train community groups to form vanpools and provide support to ensure that vanpools are created and retained.

In addition to receiving the incentive of free access to the new ExpressLanes, vanpoolers along those corridors will also be eligible for vanpool start-up assistance, which may cover the cost of driver and back-up driver training and exams, as well as special training on how best to keep existing vanpools together.

**Figure 1-2. LA CRD (Metro ExpressLanes) Program Project Descriptions**

The U.S. DOT is allocating $210.6 million in Federal grant funding for the LA CRD (Metro ExpressLanes) Program projects, drawn from the Federal Transit Administration (FTA) 5309 Bus and Bus Facilities Program. The LA CRD (Metro ExpressLanes) Program projects consist of the following:

- **Transit Improvements** to increase the frequency of Metro bus rapid transit service through the acquisition of 59 new clean fuel expansion buses (30 buses in the I-10 El Monte Busway corridor and 29 buses in the I-110 Harbor Transitway corridor) and increased service: to one bus every seven minutes along the I-10 corridor and to one bus every ten minutes along the I-110 corridor. Various security upgrades will be made to the Harbor Gateway Transit Center (better lighting, new security cameras, bicycle lockers and a new L.A. County Sheriff's substation). Expansion of the El Monte Transit Center includes reconstruction of the existing transit passenger terminal, additional surface parking, and a new administration facility. A new El Monte Busway stop will be created at Union Station that will allow for direct pedestrian access to Union Station's Patsaouras Transit Plaza and thus promote transfers to/from the El Monte Busway and other transit services. Expansion of the Pomona (North) Metrolink station includes 143 new parking spaces and extended platforms to accommodate additional rail cars for the San Bernadino Line. Improvements to Harbor Transitway Park-and-Ride lots and Transit Stations include enhanced signage, lighting, and closed-circuit television cameras for existing lots at Slauson, Manchester, Harbor Green Line, Rosecrans, and Harbor Gateway as well as the relocation of bus stops for Lines 108 and 115 to the Slauson and Manchester Transitway stations. The $37^{th}$ Street Station will also be fitted with translucent and architectural sound attenuation panels to reduce noise levels for waiting customers on the Harbor Transitway. Implementation of transit signal priority technology on Figueroa Street (15 signals between Wilshire Boulevard and Adams Boulevard) and Flower Street (5 signals between Wilshire Boulevard and Olympic Boulevard) in downtown Los Angeles. Lastly, to facilitate HOT traffic movement where the I-110 freeway enters downtown Los Angeles, Adams Boulevard will be widened and the Adams Boulevard off ramp will be restriped, both providing an additional lane of high occupancy vehicle (HOV) capacity.
- **High Occupancy Toll (HOT) Lanes** ("ExpressLanes") to expand freeway capacity by permitting toll-paying, single occupancy vehicles or those that do not meet the carpool occupancy requirement to use slack, HOT lane capacity on the I-10 and I-110 freeways. ExpressLanes will be created by converting existing HOV lanes into HOT lanes along the I-10 (from I-605 to Alameda Street) and along the I-110 (from $182^{nd}$ Street to Adams Boulevard). In addition, a second HOT lane will be created (via restriping; no loss of general purpose lanes will occur) on I-10 from I-605 to I-710 where there is no slack HOV lane capacity during peak periods. All vehicles will pay to use the HOT lanes with the exception of transit vehicles, motorcycles and multiple-occupant private vehicles (three or more occupants on I-10 during peak hours, two or more all other times; two or more occupants on I-110). All tolls will be collected electronically, requiring all toll-paying vehicles entering HOT lanes to be equipped with a transponder. Vehicles satisfying the ExpressLane occupancy requirements and therefore eligible to use the lane free of charge will "self declare" by setting a switch on their transponders. ExpressLane enforcement will be carried out manually through on-site law enforcement observation.

Tolls will range from a minimum $0.25 per mile to a maximum $1.40 per mile depending on congestion levels. When travel speeds in the HOT lanes fall below 45 mph for more than ten minutes, the ExpressLanes have reached capacity. At this point, the lanes will revert to HOV lanes and vehicles that do not meet the carpool occupancy requirements will not be permitted to "buy" their way into the lanes. Low income commuters[2] will receive cost reductions through the Equity Account Discount, consisting of a $25 discount for toll account set-up and waiver of the $3 non-usage maintenance fee.

- **Intelligent Parking Management (IPM)** ("LA ExpressPark") consists of a variable, demand-based parking pricing system coupled with a parking guidance system that will include real-time parking availability information. The IPM is intended to reduce traffic congestion, reduce air pollution, and improve transit efficiency by reducing parking search times by achieving 10 to 30 percent parking availability for on-street parking. The LA ExpressPark system will cover approximately 13,500 City of Los Angeles-owned or operated parking spaces (about 6,000 on-street, metered spaces and about 7,500 off-street spaces in an area of downtown Los Angeles bounded by the I-10 and I-110 freeways, Alameda Street and Adams Boulevard. The project area is shown in Figure 1-3.
  LA ExpressPark meter capabilities include demand-based parking rates based on time of day and length of stay; alternate payment options (coins, credit card, smart phone, cell phone); and increased convenience (text messages when paid parking time is about to expire). Vehicle sensors placed in the on-street metered parking spaces provide real-time occupancy and parking duration information. Parking conditions and availability in off-street parking locations will be determined using vehicle sensors, cordon counting systems and/or advanced revenue control systems. The parking guidance component of the IPM will provide information via a limited number of on-street dynamic message signs when not in use for active traffic management, an Internet web site, mobile phones using the regional 511 interactive voice response system, smart phones and, pending industry support, in-vehicle navigation systems.
- **Ridesharing Promotion (travel demand management)** to increase the number of registered vanpools (with a goal of 100 new vanpools on the I-10 and I-110 corridors), and major employer-based ridesharing through the use of promotional methods including subsidies to travelers and vanpool operators and promotional outreach to major employers. In addition, a Metro ExpressLanes Carpool Loyalty Program is being developed which will incentivize vanpool trips by offering monthly drawings for gift cards on each corridor. Vanpools will be automatically entered into the drawing every time they use the Metro ExpressLanes and the toll system detects their FasTrak at the 3+ setting.

[2] The Equity Account Discount defines low income commuters as Los Angeles residents with an annual household income (family of 3) of $35,000 or less.

Derived from "ExpressPark Intelligent Parking Management: Downtown" Los Angeles Department of Transportation Pamphlet http://ladot.lacity.org/pdf/PDF217.pdf

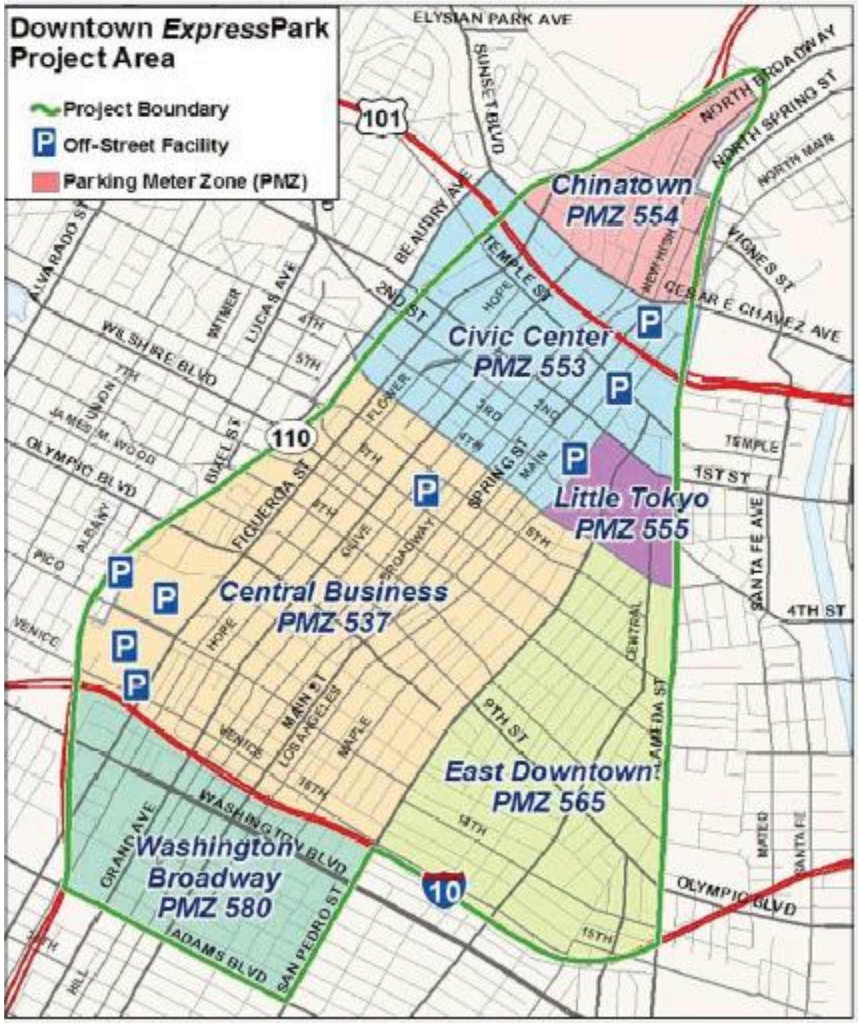
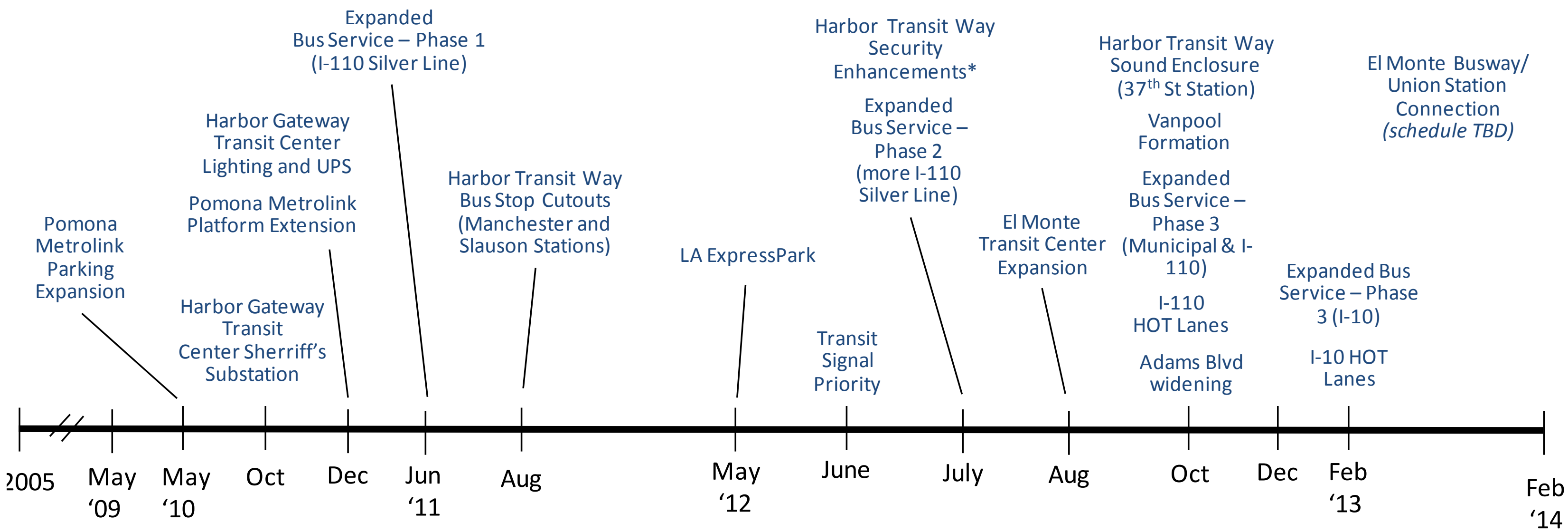



**Figure 1-3. LA ExpressPark Project Area**

**Schedule for the LA CRD (Metro ExpressLanes) Program Projects.** As shown in Figure 1-4, the LA CRD (Metro ExpressLanes) Program projects will become operational in a phased manner. Tolling on I-110 is scheduled to begin in October 2012, and tolling on I-10—the last project to be completed—is scheduled to begin in February 2013. Most of the LA CRD (Metro ExpressLanes) Program projects will be coming on line in advance of I-110 and I-10 tolling. One project will come on line after tolling begins on the I-10.

Based on information provided by Metro; July 2012.




**Stations: Slauson, Manchester, Harbor Green Line, Rosecrans, Harbor Gateway*

**Figure 1-4. LA CRD (Metro ExpressLanes) Program Project Completion ("Go Live") Schedule**

## 1.2 LA CRD (Metro ExpressLanes) Program National Evaluation Plan and the Use of Data from the Traffic Congestion Analysis

Table 1-2 shows which of the various LA CRD (Metro ExpressLanes) Program test plans will contribute data to each of the evaluation analyses. The “flow” between test plans is “one way” in the sense that test plans feed data and measures to the analyses rather than the reverse. The solid circles show where data from a given test plan constitutes a major input to an analysis; the open circles show where data from a given test plan constitutes a supporting input to an analysis. As shown in Table 1-2, the Traffic System Data Test Plan provides major input to the tolling, congestion, safety, environmental, and cost-benefit analyses and supporting input to the transit and equity analyses.

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**Table 1-2. Relationships Among Test Plans and Evaluation Analyses**

| LA CRD (Metro ExpressLanes) Program Test Plans | Evaluation Analyses | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tolling | Technology | Transit | Travel Demand Management (TDM)* | Congestion | Safety | Environmental | Equity | Business Impact | Non-Technical Factors | Cost-Benefit |
| Traffic System Data Test Plan | ● | | ○ | ○ | ● | ● | ● | ○ | | | ● |
| Tolling Test Plan | ● | ● | | | ○ | | ○ | ○ | ○ | | ● |
| Transit System Data Test Plan | ○ | | ● | ○ | ○ | | ○ | ○ | | | ● |
| Ridesharing Test Plan | | | | ● | | | | ○ | | | ○ |
| Safety Test Plan | | | | | ○ | ● | | ○ | | | ● |
| Environmental Data Test Plan | | | | | | | ● | ○ | | | ○ |
| Surveys, Interviews, Workshops Test Plan | ● | ● | ● | ● | ○ | ○ | ○ | ● | ● | ● | |
| Content Test Plan | | | | | | | | | | ● | |
| Cost Benefit Test Plan | | | | | | | | | | | ● |
| Exogenous Factors Test Plan | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | |

**Source:** Battelle, August 2012.

● — Test Plan Data Constitutes a Major Input to the Evaluation Analysis

○ — Test Plan Data Constitutes a Supporting Input to the Evaluation Analysis

* The only Travel Demand Management (TDM) element included in the LA CRD are those related to ridesharing and therefore what is called the TDM Analysis in the evaluation plan documents for some of the other UPA and CRD sites is referred to as the Ridesharing Analysis in the LA CRD evaluation documents.

Within each test plan, data are grouped by type into various “data elements.” Table 1-3 lists the type of traffic system data to be used to evaluate the hypotheses/questions for related evaluation analyses.

**Table 1-3. Summary of Traffic System Data Needs for LA UPA National Evaluation**

| Los Angeles Traffic System Data Element | Los Angeles CRD Measure of Effectiveness | Los Angeles CRD Hypothesis/ Questions |
|---|---|---|
| 1. Traffic Volume and Lane Occupancy | ▪ Increase in vehicle throughput (number of vehicles) on I-10 and I-110<br>▪ Increase in person throughput (vehicle occupants) on I-10 and I-110<br>▪ Improved Level of Service on I-10 and I-110<br>▪ Traffic Density of I-10 and I-110 | LATolling-1 |
| | ▪ Corridor Mode Split (%) | LA Transit-3 |
| | ▪ Percent change in the number of vehicles serviced<br>▪ Percent change in the total number of people serviced | LACong-4 |
| | ▪ Change in incidents per Vehicle-Miles Traveled (VMT) in treatment corridors is comparable to that occurring in control corridors | LASafety-1 |
| | ▪ Decreased VMT-based estimates of air emissions in treatment corridors | LAEnvir-1 |
| | ▪ Decreased VMT-based estimates of fuel consumption in treatment corridors | LAEnvir-2 |
| 2. Traffic Speed | ▪ Percent change in number of lane miles per analysis period that HOV/HOT operating in congested conditions<br>▪ Percent change in number of minutes per analysis period that HOV/HOT operating in congested conditions | LACong-11 |
| | ▪ Percent change in number of lane miles per analysis period that GP lanes operating in congested conditions<br>▪ Percent change in number of minutes per analysis period that GP lanes operating in congested conditions | LACong-12 |
| | ▪ Percent change in lane miles per analysis period that arterial paralleling operating at LOS E or F<br>▪ Percent change in minutes per analysis period arterial paralleling operating at LOS E or F | LACong-13 |
| | ▪ Decrease VMT-based estimates of air emissions in treatment corridors | LAEnvir-1 |
| | ▪ Decrease VMT-based estimates of fuel consumption in treatment corridors | LAEnvir-1 |

**Table 1-3. Summary of Traffic System Data Needs for LA UPA National Evaluation (Continued)**

| Los Angeles Traffic System Data Element | Los Angeles CRD Measure of Effectiveness | Los Angeles CRD Hypothesis/ Questions |
|---|---|---|
| 3. Travel Times | ▪ Travel times in the HOT lanes | LATolling-3 |
| | ▪ Percent change in trip travel times in GP lanes (I-10 and I-110) | LACong-1 |
| | ▪ Percent change in trip travel times in HOV/HOT lanes (I-10 and I-110)<br>▪ Percent change in trip travel time on arterial paralleling I-10 and I-110<br>▪ Percent change in person trip times<br>▪ Percent change in travel-time index | |
| | ▪ Percent change in the variability of trip travel times in GP lanes<br>▪ Percent change in the variability of trip travel times in HOV/HOT lanes<br>▪ Percent change in the variability of trip travel times on arterial paralleling I-10 and I-110<br>▪ Percent change and change in variability of the Buffer Index<br>▪ Percent change and change in variability of the Planning Index | LACong-2 |
| | ▪ Travel time savings on HOV/HOT lane compared to GP lanes<br>▪ Difference in Planning Index (HOV/HOT to GP) | LACong-9 |
| | ▪ Median travel time in traffic traveling in HOV/HOT lane compared to baseline<br>▪ Variability in travel time in traveling in HOV/HOT lane<br>▪ Planning Index of traffic traveling in HOV/HOT lane | LACong-10 |
| 4. Vehicle Occupancy (Vehicle Occupant Counts) | ▪ Increase in person throughput (vehicle occupants) on I-10 and I-110<br>▪ Increase average vehicle occupancy in HOT and GP lanes | LATolling-1 |
| | ▪ Percent change in person trip times | LACong-1 |
| | ▪ Percent change in total number of people services | LACong-4 |

**Source:** Battelle, August 2012.

# 2.0 DATA SOURCES, AVAILABILITY, AND RISKS

This chapter identifies the data sources for the traffic system data and discusses the availability of those data and any potential risks associated with collecting and processing them for use in the evaluation. Table 2-1 summarizes the data requirements for the Traffic System Data Test Plan.

Because of the sequencing of improvements in the I-110 corridor, the analyses of the traffic system data for the I-110 corridor will be divided into three intervals. The first interval will be designated as the "Before" period and represents travel conditions prior in the corridor prior to the first wave of transit expansion. This analysis period will be from June 2010 through May 2011.

The second interval will be from July 2011 to September 2012 and is intended to capture any significant changes in travel conditions in the I-110 corridor as a result of the first wave of transit service expansion. This interval will be designated as the "After Initial Transit Service Expansion" analyses period. For this analysis period, the National Evaluation Team plans to focus on assessing the degree to which the first wave of transit service improvement affected traffic demands and throughput on I-110. This will be done by examining the throughput at select traffic sensors on the I-110. If changes in travel demands are detected at these stations, the more detailed traffic speed and volume data will be provided to the Air Quality assessment; however, if not significant changes in traffic volumes are detected, then this evaluation period will not be included in the Air Quality Assessment.

The third analyses period will from November 2012 through October 2013 – after tolling operation commences in the HOV lane. This analyses period will be designated as the "After Tolling" analysis period. For this analysis period, the National Evaluation Team will assess the impacts of beginning HOT operations on not only traffic demands and throughput in the I-110 corridor but also travel time and travel time reliability. The Congestion Analysis will utilize data from this period for the assessment.

The details associated with source, timing and other particulars are discussed in the sections that follow.

## 2.1 Data Sources

A number of sources of traffic system data exist in the I-10/I-110 corridors that will be used by the national evaluation to the various analyses. Sources of data include the following:

- Freeway Traffic System Data
- Manual Studies
- Arterial Traffic System Data
- Parking System Data

### 2.1.1 Freeway Traffic System Data

Three major types of data from the freeway system will be used to in the evaluation of converting the HOV lane on both I-10 and I-110 to HOT operations:

- Volume, and Occupancy data from freeway detector systems
- Probe-based travel times
- Vehicle Occupancy counts

The following describes the sources from which the evaluation team is expecting to obtain this information about the freeway performance system:

***Caltrans District 7 Advanced Traffic Management System (ATMS).*** Caltrans District 7 was one of the first agencies in the United States to deploy a freeway management system. This system uses a combination of loop detectors installed in the freeway approximately every ½ mile and video surveillance cameras to monitor traffic flow and detect incidents on the freeway system in Los Angeles areas. Loop detectors have been installed in the main lanes and the HOV lanes of both I-10 and I-110 and provide 30-second traffic counts (i.e., the number vehicle crossing each loop detector ) and occupancy (the average fraction of time a vehicle was present over the loop during that 30-second interval). While not measured directly, average travel speed in each lane at each detector station can be estimated using volume and occupancy measures.

Caltrans has deployed loop detectors in both the HOV and each main lane of both I-10 and I-110, although part of I-10 is under construction during the pre-deployment period. Caltrans expects to have data available from their ATMS system for at least 3-month in the baseline, or "before" period (i.e., before the conversion of the HOV lanes to HOT lanes) and for a full year in post-deployment, or "after" period, on I-10. Caltrans expects that a full-year of data will be available in both the baseline period and post-deployment period on I-110. The evaluation team accepts that data may not be available from every detector station during the evaluation period as detector and communication malfunctions may occur. Although there are no traffic detectors on the viaduct section of I-110, the evaluation team has agreed with Caltrans and U.S. DOT that data from adjacent detectors will suffice. Appendix B lists the detector stations from which traffic data will be used in the evaluation.

***Caltrans Portable Traffic Sensor Station.*** Because of the lack of ATMS detection data on I-10 due to the construction activities, Caltrans is proposing to supplement the ATMS collected data with data from two portable traffic sensor stations. These portable sensor stations are radar-based sensors and can measure speed and volume. Caltrans has only a limited number of locations where these sensors can be located safely. The national evaluation team recommends that Caltrans use these sensor stations to collect additional traffic volume and speed data from the I-10 HOV/HOT lane. The national evaluation team recommends that these sensors be located as close as possible to the locations where vehicle occupancy counts will be performed on the I-10 HOV/HOT lane (i.e., at or near Jackson and at or near Warwick).

## Table 2-1. Traffic Data Needs for LA UPA Evaluation

| Data Element | Data Sub-Element | Location | Termini | Granularity | Data Collection Sampling Frequency | | Data Collection Timing | | | | Data Reporting Frequency | A "New" (Add'l) Data Collection Activity for the Local Partners? | Responsible Agency (Data Source) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cont. (Auto.) | Periodic (Freq.) | Baseline | | Post Deployment | | | | |
| | | | | | | | Begin | End | Begin | End | | | |
| 1. Traffic Volume and Lane Occupancy | 1.1 Freeway | I-10 | I-605 to Downtown | 5-min | X | – | Nov 2012 | Jan 2013 | Feb 2013 | Jan 2014 | Quarterly | No | Caltrans (ATMS) |
| | 1.2 Freeway | I-10 (HOV) | Warwick Jackson | 5-min | X | | Feb 2012 | Oct 2012 | - | - | Quarterly | New | Caltrans (Portable) |
| | 1.3 Freeway | I-110 | Harbor Gateway Transit Center to Adams | 5-min | X | – | Oct 2011 | Sep 2012 | Oct 2012 | Sep 2013 | Quarterly | No | Caltrans (ATMS) |
| | 1.4 Arterial (Volume Only) | I-10 Corridor | Garvey Valley | 15 - min | | Quarterly | Apr 2012<br>Jul 2012<br>Oct 2012<br>Jan 2013 | | Apr 2013<br>Jul 2013<br>Oct 2013<br>Jan 2014 | | Quarterly | Yes | LA METRO (Counts) |
| | 1.5 Arterial (Volume Only) | I-110 Corridor | Vermont<br>Figueroa<br>Grand<br>Broadway<br>Main St.<br>Western | 15-min | X | – | Oct 2011 | Sep 2012 | Oct 2012 | Sep 2013 | Quarterly | No | LA County (RIITIS) |
| 2. Traffic Speed | 2.1 Freeway | I-10 | I-605 to Downtown | 5-min | X | – | Nov 2012 | Jan 2013 | Feb 2013 | Jan 2014 | Quarterly | No | Caltrans (ATMS) |
| | 2.2 Freeway | I-110 | Arterial Transit Center to Adams | 5-min | X | – | Oct 2011 | Sep 2012 | Oct 2012 | Sep 2013 | Quarterly | No | Caltrans (ATMS) |
| | 2.3 Arterial | I-110 Corridor | Vermont<br>Figueroa<br>Grand<br>Broadway<br>Main St.<br>Western | 15-min | X | | Oct 2011 | Sep 2012 | Oct 2012 | Sep 2013 | Quarterly | No | LA County (RIITIS) |

**Table 2-1. Traffic Data Needs for LA UPA Evaluation (Continuted)**

| Data Element | Data Sub-Element | Location | Termini | Granularity | Data Collection Sampling Frequency | | Data Collection Timing | | | | Data Reporting Frequency | A "New" (Add'l) Data Collection Activity for the Local Partners? | Responsible Agency (Data Source) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Cont. (Auto.) | Periodic (Freq.) | Baseline | | Post Deployment | | | | |
| | | | | | | | Begin | End | Begin | End | | | |
| 3. Travel Times | 3.1 Freeway | I-10 | I-605 to Downtown | - | - | Four Days each data period | Feb 2012 | May 2012 | Feb 2013 | May 2013 | Upon Completion | New | Caltrans (Probe) |
| | 3.2 Freeway | I-110 | Harbor Gateway Transit Center to Adams | - | X | Four days each data period | Feb 2012 | May 2012 | Feb 2013 | May 2013 | Upon Completion | New | Caltrans (Probe) |
| | 3.3 Arterial | I-10 Corridor | Various | Per Trip | X | | Feb 2012 | Jan 2013 | Feb 2013 | Jan 2014 | Quarterly | NO | LA Metro (BRT GPS) |
| 4. Vehicle Occupancy | 4.1 Freeway | I-10 | Warwick Jackson | 15-min | – | X | Oct 2011 | May 2012 | Feb 2013 2012 | May 2013 | Semi-Annually | New | Caltrans (Veh. Occ Study) |
| | 4.2 Freeway | I-110 | Slauson Adams (NB AM peak only) | 15-min | – | X | Oct 2011 | May 2012 | Oct/Nov 2012 | May 2013 | Semi-Annually | New | Caltrans (Veh. Occ Study) |
| 5. Parking Information Sign Logs | 5.1 Information Logs | Downtown | Various | | | X | - | - | Oct 2012 | Sept 2013 | Quarterly | New | LA DOT |

**Source:** Battelle, August 2012.

### 2.1.2 Manual Studies

A series of manual studies are also planned to collect data that will be used by the national evaluation team. These include probe-based travel times studies and manual vehicle occupancy counts. The methodologies to be used to collect these data are described below.

***Caltrans Probe-Based Travel Time Studies.*** Vehicle travel time and travel time reliability are key evaluation performance measures. Caltrans plans to provide probe-based travel time data on both I-10 and I-110. The proposed limits of these travel time runs are as follows:

- I-110 from the Harbor Gateway Transit Center/SH 91 through Adams Boulevard
- I-10 from I-605 through Alameda St.

In these studies, Caltrans plans to conduct average car travel time measures studies to measure end-to-end travel times in the corridor. All travel time data will be collected using a GPS-based system. CalTrans will be collecting travel time data twice (once in February and once in May) during both evaluation periods (before and after) on each route (I-10 and I-110). Travel time data will be collected from approximately 5 am to 9 pm (free-flow to free-flow) for a total of 4-days in each data collection period. Travel time data will be collected on both the general purpose and the HOV/HOT lanes.

***Vehicle Occupancy Study.*** Data on the average number of occupants per vehicle class are needed in several of the UPA evaluation analyses. Vehicle occupancy data are needed for both the general purpose lanes and HOV/HOT lanes for both directions of the both I-10 and I-110. The anticipated types of vehicle classes from which these data are needed include passenger vehicles, HOV vehicles (carpools and vanpools) and transit. Vehicle occupancy levels are critical in computing passenger throughput at both the facility and corridor levels.

Caltrans plans to provide the evaluation team with vehicle occupancy counts from the same locations that that are used to collect for the data Caltrans District 7 HOV Annual report. Vehicle occupancy data will be collected at the following locations:

- I-10 at Jackson
- I-10 at Warwick
- I-110 at Slauson
- I-110 Adams Blvd (northbound in the AM Peak only)

These locations are shown in Figure 2-1. During discussions conducted as part of the development of this draft test plan, Caltrans agreed to consider adding an additional vehicle occupancy data collection location on the I-110 at Adams Boulevard. A final decision from Caltrans will be reflected in the final version of this test plan.

The evaluation team recommends Caltrans perform two vehicle occupancy counts–one count in the spring and one count in the fall – at each location during both the baseline and post-deployment periods. With the exception of the I-10 at Adams Blvd location, vehicle occupancy counts will be performed for both directions of travel in both the AM and PM peak periods (6:30am to 8:30am in the AM peak and 3:00pm to 5:30pm in the PM peak. The evaluation team recommends Caltrans collect the following vehicle occupancy counts:

- The number of vehicles carrying only 1 occupant
- The number of vehicles carrying 2 occupants
- The number of vehicles carrying 3 occupants
- The number of vehicle carrying 4 occupants
- The number of vehicles carrying 5 occupants
- The number of vehicles carrying 6 occupants
- The number of multi-passenger vans carrying 6 or more occupants
- The number of motorcycles
- The number of buses estimated to be fully occupied
- The number of buses estimated to be half occupied
- The number of buses estimated to be a quarter occupied

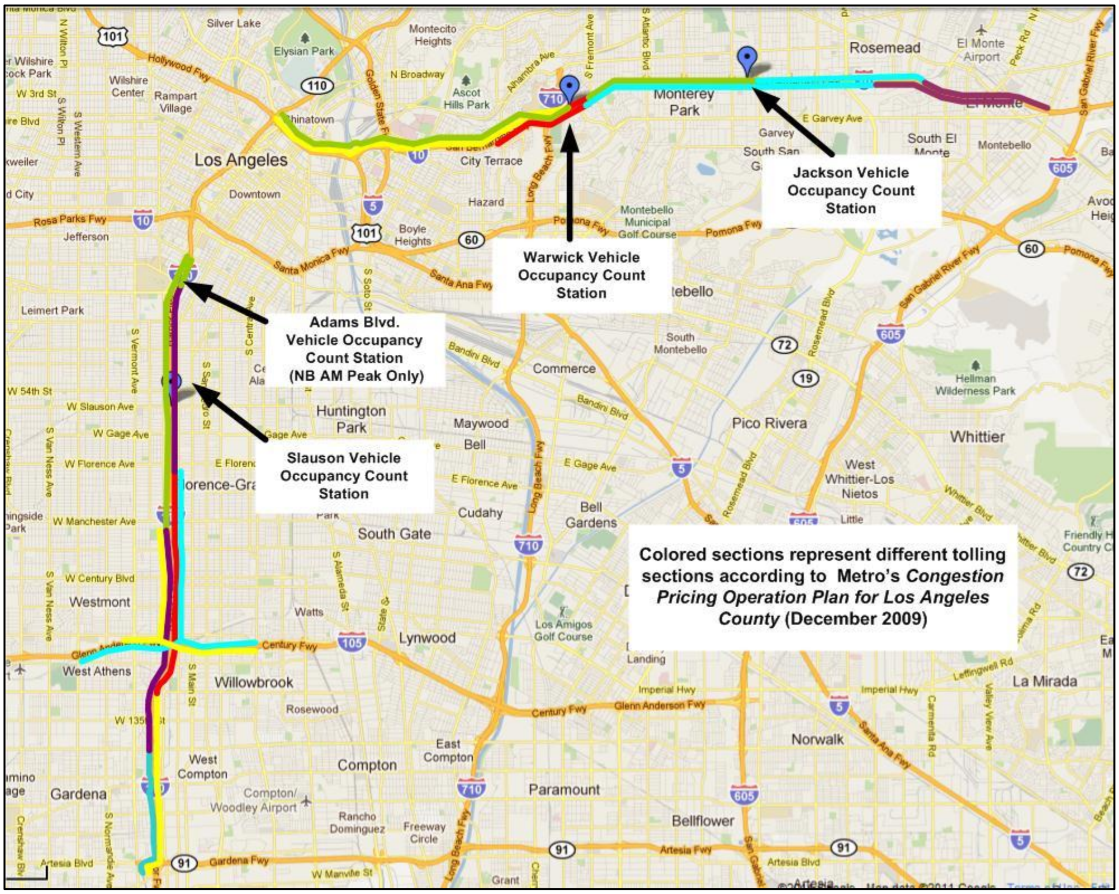


**Figure 2-1. Proposed Locations for Vehicle Occupancy Count Studies**

Counts will be performed for both the general purpose and the HOV/HOT lanes in both the before and after deployment periods for both direction of travel (with the exception of the count on I-110 at Adams Blvd which will be a AM count in the northbound direction only).

### 2.1.3 Arterial Traffic System Data

A number of data sources are being considered for obtaining arterial traffic system performance data including the following:

- City of Los Angeles' Automated Traffic Surveillance and Control (ATSAC) system
- Periodic screenline traffic counts
- Probe-travel times studies

**City of Los Angeles ATSAC Detector Logs**. The City of Los Angeles' ATSAC system could also be used a source of traffic system data. ATSAC is a computer-based traffic signal control system that monitors traffic conditions and system performance and implements appropriate signal timing strategies in response to changing traffic conditions. The system records loop volume and occupancy from intersection detectors. Approach speeds are then estimated using these data.

ATSAC system data is available primarily in the I-110 corridor. Most of the I-10 corridor is outside the coverage area of the ATSAC system. The data from the ATSAC system will be used to examine changes in volume on the following arterial paralleling I-110:

- Vermont Blvd
- Figueroa St
- Grand Ave
- Broadway Ave
- Main St.
- Western Ave.

**Quarterly Screenline Traffic Counts**. Because no automated source of traffic volume data is readily available in the I-10 corridor, quarterly screenline average daily traffic (ADT) counts will need to be performed to assess the impact of converting the I-10 HOV lane to an HOT lane is impacting traffic on paralleling arterial streets. These data will also be used in the air quality analysis. Screen line counts can be performed using tube counters, temporary wireless sensors, or other similar types of technologies. Figure 2-2 show suggested locations for performing screenline traffic counts in the I-10 corridor.


**Figure 2-2. Proposed Screenline Volume Counts for Arterial Paralleling I-10**

**GPS-Equipped Bus-Rapid Transit (BRT) Vehicles.** Travel time information from the arterial streets is needed in determining whether converting the HOV lanes on I-10 and I-110 to HOT pulls latent demand on the arterial streets to these facilities. Arterial travel time information will also be needed to assess the congestion reduction benefits of implementing the intelligent parking technologies. On many of the arterials, Metro Transit operates several BRT routes. Because BRT buses do not stop as frequently as local transit routes, it has been suggested that these vehicle would experience similar trip behavior as normal vehicles. As these vehicles are equipped with GPS-locating systems, the potential exist to use these vehicles as probes traveling in the traffic stream on the routes where BRT service is being provided.

The local partners have purposed using this method to obtain travel times the arterial streets paralleling the I-10. Data from GPS-equipped buses traveling on the following Metro Transit Express routes will be used to compare arterial travel times in the I-10 corridor:

- #745 on Broadway from I-105 to MLK
- #754 on Vermont from I-105 to MLK
- #757 on Western from I-105 to MLK

## 2.2 Data Availability

Most of the traffic system data from the freeway system is readily available either from Caltrans directly or through the PeMS system. PeMS (which stands for Performance Measurement System) is a software system developed by Caltrans, the University of California at Berkeley, and the Partnership for Advanced Technology on the Highways (PATH) designed as a traffic data collection, processing, and analysis tool to assist in assessing the performance of the freeway system. PeMS extracts information for a number of real-time and historical traffic data sources stores this information in a database that various entities (both public and private) can use to compute performance measures. The PeMS software performs the following steps:

- Performs diagnostics on the data to determine if the loop detector is faulty;
- Aggregates the raw loop lane-by-lane loop detector data into 5-minute values;

- Calculates the speed for each lane based on individual g-factors for each loop detector in the system;
- Imputes for any missing data;
- Aggregates the lane-by-lane value for flow, occupancy, and speed across all lanes at each detector station;
- Computes performance measures;
- Aggregates across geographical boundaries.

PeMS does allow some performance measures to be computed automatically from the database. The types of performance measures that can be computed include the following:

- Flow
- Occupancy
- Speed
- Vehicle-Miles Traveled (VMT)
- Vehicle-Hours of Travel (VHT)
- Travel Time Index (TTI)

The PeMS system can also estimate truck volumes at each detector station based on the measured 5-minute, lane-by-lane values of flow and occupancy. The PeMS algorithm attempts to break down the total flow into passenger cars and large trucks. While the system cannot classify trucks into the 13 classes as defined by FHWA, it can estimate the proportion of trucks in each lane and when aggregated over multiple days and detector stations, can capture overall trends in truck volumes. When analyzing and reporting the results of PeMS data it will be important for the evaluation team to identify any instances where data gap-filling or other internal PeMS methodologies may impact the evaluation conclusions. Data from the arterial street system is not as readily available. Where possible, the evaluation team plans to use data from the City of Los Angeles' ATSAC system, which provides volume and occupancy information from signalized intersections. The ATSAC data is primarily available in the I-110 corridor. Much of the data that are needed for the evaluation in the I-10 corridor will need to be collected through special studies. These special studies are needed to obtain both travel time and volume information from the arterial paralleling I-10. The National Evaluation Team recommends that these special studies be conducted at least quarterly both before and after the conversion of the HOV lanes.

## 2.3 Potential Risks

Considerable risks exist with the collection of some of the traffic system data. At the time of writing of this test plan, no traffic volume data was available from Caltrans' ATMS sensor on I-10 in the evaluation corridor due to construction. While Caltrans expects to construction to be completed three months before the HOT operations is to begin, it is unknown at this time how many of the detector stations will be operational after construction is complete. Furthermore, any delays that many occur in completing the construction activity might reduce the amount of data available during the baseline period. Caltrans has taken steps to reduce these risks by proposing to collect probe-based travel times in both the baseline and post-deployment period, and by installing portable sensors in the HOV/HOT lane at key locations to supplement the existing ATMS detection systems.

Risks also exist due to the high potential of detector failures in both the I-10 and I-110 corridor. Many of the detectors stations in both the I-110 and I-10 corridors have history of malfunctions. The sources of these malfunctions vary considerably for loss of communications to bad sensors in the pavement.  Due to funding constraints, Caltrans is often unable to repair malfunctioning sensors in a timely fashion.  Malfunctioning or inoperable sensors often create holes in the data which can reduce the power of the analyses.  Again, Caltrans' plan to conduct probe-based travel time runs in the both evaluation corridors reduces this risk.

Risks also exist with the strategies devised to obtain arterial performance data.  The traffic systems to be used to derive the performance measures are not specifically designed to collect the type of data needed for the evaluation.  While LADOT's ATSC system reports a speed measurement, it is not known how closely the speed measures accurately reflect actual running speeds in the corridor.  Likewise, it is not known how accurate travel times produced by using BRT travel times are to running speeds of regular traffic on the evaluation corridors.  There is no plan to calibrate these surrogate measures to actual arterial travel conditions.

# 3.0 DATA ANALYSIS

This chapter contains the processes and procedures used by the national evaluation team to analyze the traffic system data. The analysis that will be used consists of the following three elements:

- Checking the data for errors and "cleaning" the data to ensure that it reflects actual conditions as much as reasonably possible;
- Aggregating data, both spatially and temporally, and controlling for atypical conditions which may affect the consistency of the data; and
- Calculating the measures of effectiveness to be utilized in the various evaluation analyses.

## 3.1 Data Cleaning/Error Checking

Although data quality checks are performed on the Caltrans detector data before it is archived into PeMS, the national evaluation team will also perform quality assurance/quality control checks on the data before analyzing it for the national evaluation. After downloading the detector data, the national evaluation team will perform a series of quality control checks and screening procedures to identify any suspect or invalid data that may exist in the traffic sensor data. The evaluation team will use the quality control checks recommended in NCHRP's *Guide to Effective Freeway Performance Measurement*. Suspect data will be "flagged" for possible exclusion from the performance measure calculations. The national evaluation team will review flagged data to determine its validity and inclusion in the final data set. A "bad data" list will be compiled that includes dates, times, and road section that have failed a quality control check. "Bad data" will be excluded from valid weekdays on a section-by-section basis. Incident-affected data will also be excluded where the affected data can be reasonably identified via matching of detector data with recorded times and locations of lane-blocking incidents. If necessary, the national evaluation team will follow accepted procedures estimating and/or replacing missing or erroneous data.

## 3.2 Data Aggregation and Control for Atypical Conditions

To compute the performance measures, the national evaluation team will aggregate the traffic sensor data, both spatially and temporally. In addition, the data will be assessed for the influence of incidents and other atypical traffic conditions.

**Spatial Aggregation of Freeway Sensor Data.** Figure 3-1 illustrates the process that the national evaluation team will follow to aggregate the data spatially. The PeMS system allows speed and volume data to be extracted already aggregated across all lanes in each direction to yield detector station values. Volume data from lane detectors will be summed to provide a detector station volume. An average station speed will be developed by computing a volume-weighted speed across all lanes.

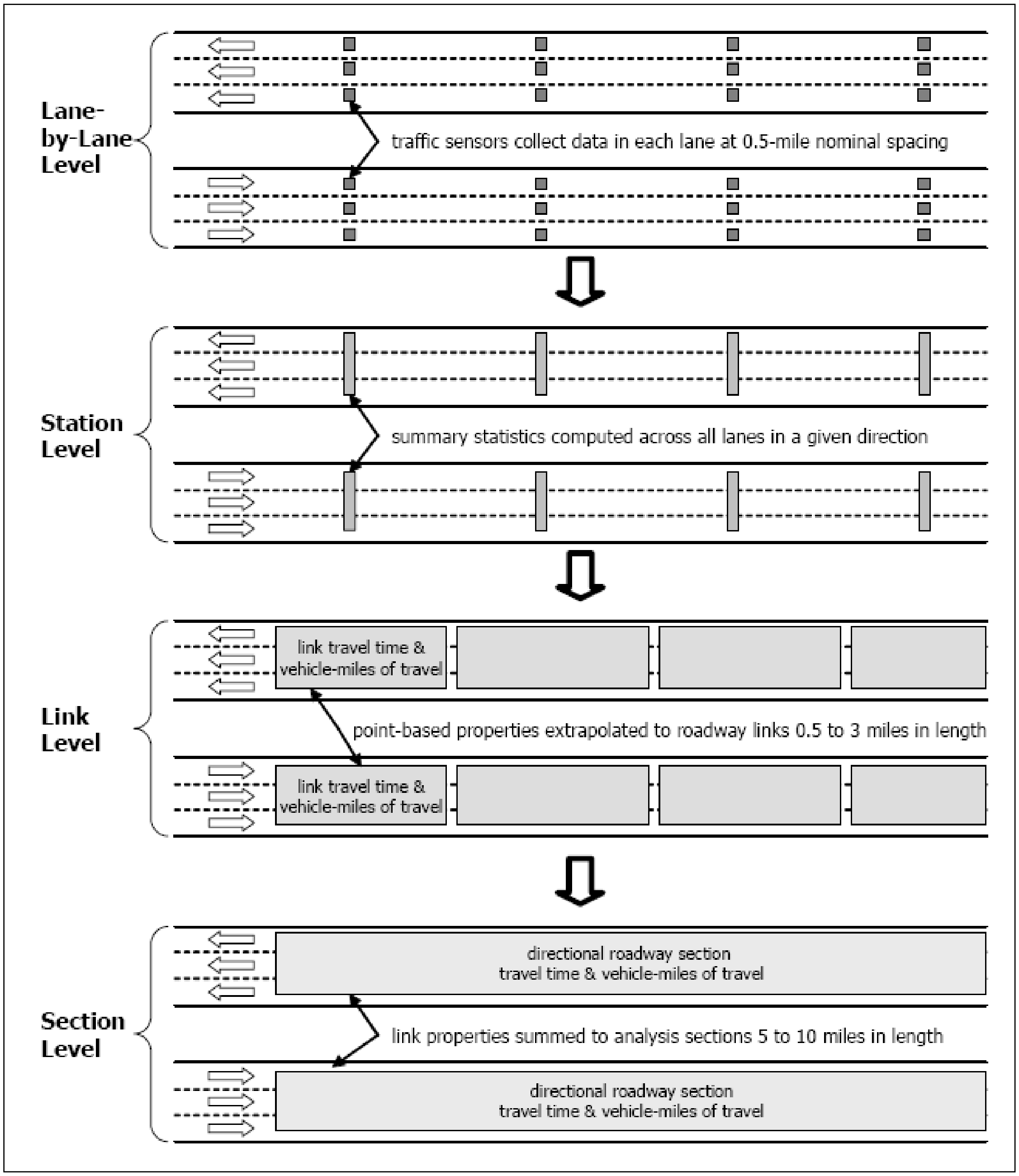


**Figure 3-1. Roadway Data Spatial Aggregation Scheme**

Next, detector station data will be aggregated to link-level data. At this level, a "zone of influence" will be assigned for each detector station. This zone of influence will be equivalent to one-half the distance to the nearest upstream and downstream sensors. Link travel times will be computed by applying the average detector station speed over the zone of influence for each detector station.

**Temporal Aggregation of Freeway Sensor Data.** In addition to aggregating the data spatially, data and performance measures will be aggregated temporally. For the purpose of the LA CRD national evaluation, performance measures will be computed for peak hours, and the peak period.

Peak hour statistics provide an indication of corridor performance when congestion is at its worst. The evaluation will use two methods to define the peak hour. The first method is the traditional method of determining the peak hour by applying the Highway Capacity Manual's definition of peak hour, which is the one-hour period experiencing the highest hourly traffic volume. Typically, this is the one-hour period when throughput is at its maximum, just before congestion forms; however, because the CRD projects are intended to lessen the impacts of congestion, the evaluation will also use an alternative definition to determine the peak hour. This definition is the one-hour period when travel speeds are at their lowest. This alternative definition defines when congestion is at its worst. Typically, the peak hour based on lowest speeds lags the peak hour based on highest volumes by 30 to 60 minutes. The evaluation team will compute performance statistics for both morning and afternoon peak hour using both definitions.

In addition to computing peak hour statistics, the national evaluation will also compute peak period performance statistics. The peak period is a time period that extends beyond the peak hour. It not only includes the peak hour but also incorporates the shoulders of the peak hour when traffic congestion is building and dissipating. For the purposes of this evaluation, a.m. and p.m. peak periods are defined to be from 6:00 a.m. to 9:00 a.m. and from 3:00 p.m. to 7:00 p.m., respectively.

For the purposes of this evaluation, only data from non-holiday weekdays will be included in the analysis. Data from the weekends and from Federal and state holidays will be excluded from the analysis as traffic conditions are not typical on these days. The data may also exhibit significant seasonal variations, such as summer versus winter and times when schools are in and out of session. While the national evaluation team does not envision needing to conduct separate analysis for different seasons, data will be examined to determine if significant seasonal variations exist that might influence the overall analysis.

**Atypical Conditions.** The focus of the LA CRD projects is primarily on addressing the effects of typical, or recurring, congestion on traffic operations. However, "atypical" (or non-recurring) conditions such as incidents are also a major source of congestion in most metropolitan areas and some of the CRD projects are intended, at least in part, to reduce incident related congestion. For these reasons, it will be important both to isolate and separately analyze traffic data associated with incidents and other atypical conditions, including work zones, adverse road-weather conditions, demand fluctuations, special events, traffic control devices, and inadequate base capacity. The effects of the following atypical conditions will be examined in the evaluation:

- **Incidents.** Incidents are a source of travel time variability in the evaluation corridor. An incident is any event that unexpectedly and temporarily reduces capacity of the freeway and roadways. Incidents can range in nature from debris on the roadway to stalled vehicles blocking travel lanes, to major collisions. Those periods when traffic flow is severely impeded by incidents will be flagged in the data and their impacts will be analyzed separately from those days when traffic operations are "normal." Incident data collected via the Exogenous Factors Test Plan will be used as the primary source of information to determine when incident conditions exist in the both the I-10 and I-110 corridors.

- **Inclement Weather.** Because weather can significantly impact freeway performance, the analysis will also attempt to identify those dates, time and locations were inclement weather occurred. Those data will be collected via the Exogenous Factors Test Plan and utilized in the analysis of the traffic data. Inclement weather would include days experiencing significant fog, ice, rainfall, or snowfall events.
- **Roadway Construction and Maintenance.** Roadway construction and maintenance can be a source of congestion. It will be important to exclude from the "typical" day analyses those days when performance of the roadway is severely impacted by roadway construction and maintenance. Those data will be considered separately in the analysis of incident-related conditions. Caltrans will identify for the evaluation team when and where construction and maintenance activities in the evaluation corridors impacted operations. Those logs will be collected via the Exogenous Factors Test Plan.

**Control Sites.** The national evaluation team will monitor the exogenous factors to determine their impact on overall network performance. Data from freeway sensors within the evaluation network will be compared to traffic data from freeway sensors outside the evaluation network to determine if overall travel patterns in the network have changed dramatically between evaluation periods. If traffic patterns appear to have shifted radically, the evaluation team will examine how factors such as construction, economic conditions, changes in land-use development, etc. have impacted travel conditions between evaluation periods and between evaluation facilities.

The local partners have indicated that there are few, if any, good control corridor candidates to use as control corridors in the region – "good" candidates being those without corridor-specific major construction or other corridor-specific influences that make them poor indicators of the influence of more general exogenous factors (like economic conditions) on travel. However, for analyzing the traffic data, several control locations in the region have been identified based on the following criteria:

- Not on corridors so overly-congested during the peak that any change in demand leading to reduced traffic levels will likely be compensated by latent demand,
- Fairly similar economic and employment demographics as the CRD corridor,
- Not on the fringe of the urban area where they might be directly impacted by local land-use development and local growth during the evaluation period, and
- Adequate traffic data available from Caltrans' ATMS system.

Based on these criteria, seven control locations have been identified. The following locations will serve as the traffic data controls:

- I-10 near La Brea Ave. (EB Station No. 717024 and WB Station No. 717026)
- I-405 near Inglewood (NB Station No. 717760 and SB Station No. 718277)
- I-710 near Del Amo (NB Station No. 718319 and SB Station No. 717960)
- I-710 near Florence (NB Station No. 718147 and SB Station No. 718002)
- I-605 near Slauson (NB Station No. 717888 and SB Station No. 717887)
- I-605 near Carson (NB Station No. 717836 and SB Station No. 717838)
- SR-60 near Findlay (EB Station No. 76844 and WB Station No. 717281)

Figure 3-2 shows the approximate location of the proposed control sites with respect to the evaluation corridors. This control analysis will consist of comparing ADT values obtained from these locations to ADT from the evaluation corridors.

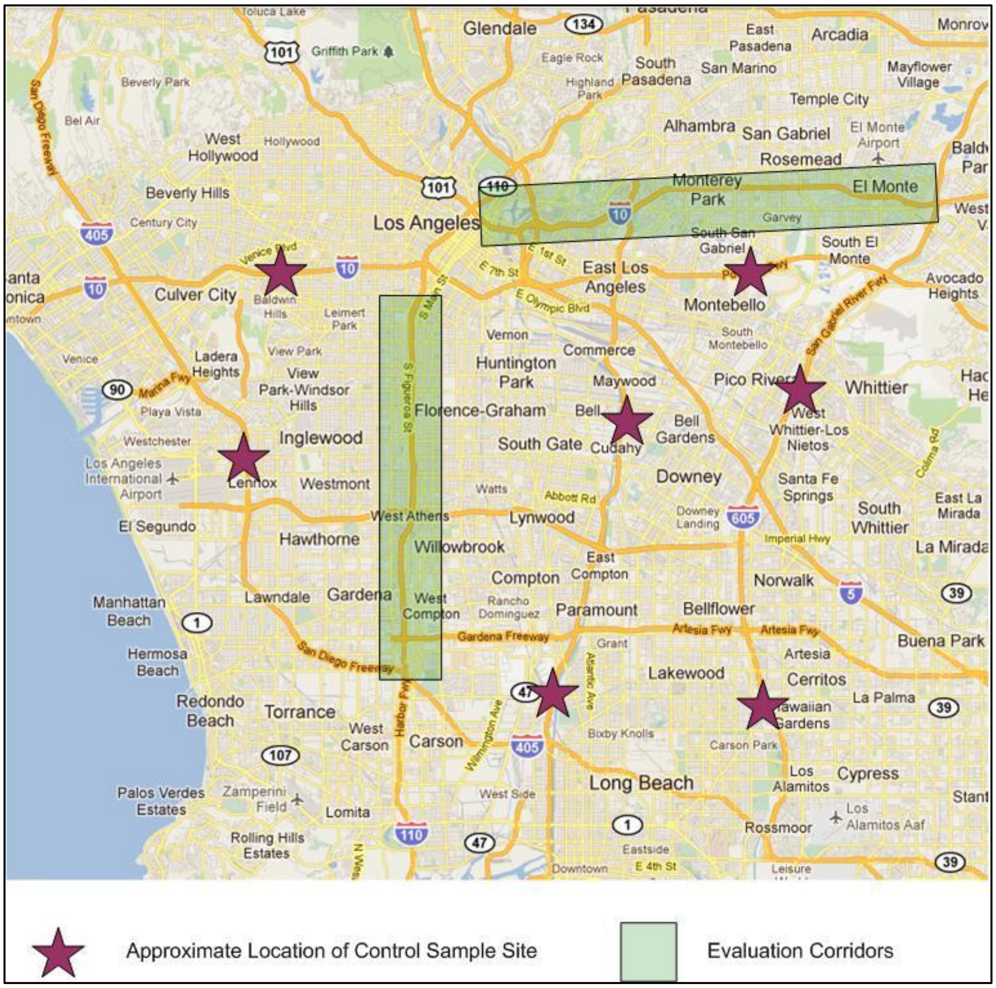


**Figure 3-2. Proposed Control Site Locations to be used in Exogenous Factor Analysis**

## 3.3 Performance Measure Calculation Procedures

The input data and procedures for calculating the primary performance measures using traffic system data are described in this section. The measures presented include travel time, vehicle throughput, person throughput, VMT, person-miles of travel (PMT), the travel time index, the planning time index, the buffer index, hours of congestion, and the number of congested links.

**Travel Time and Travel Speed.**

*Travel Speed*. Link travel speed is a base measure of performance used in the evaluation. Link travel speed is the average of the individual lane-by-lane speeds at an individual detector station, weighted by the lane volume measured at each detector at a station. It is computed using the following equation:

$$Average\ Link\ Speed\ (mph)\ = \frac{\sum_1^n (\mu_n * v_n)}{\sum_1^n v_n}$$

Where,

n = the number of detectors at each detection station,
μ = speed (mph) measured by individual detector n, and
$v$ = volume measured by individual detector n.

*Travel Time*. Many of the analyses use performance measures that are derived from travel time, which is the amount of time required to traverse the length of a predefined section of a corridor or roadway. Caltrans is planning to collect vehicle travel times using an average vehicle technique (where the data collection vehicle travels like an average vehicle in the traffic stream). Travel times will be collected using a GPS-equipped system.

After the data have been collected by Caltrans, the national evaluation will compute an average travel time for the morning and evening analysis periods for both the general purpose lanes and the ExpressLanes. Peak period and peak hour travel times will be analyzed separately in the evaluation.

For those links where the data exists (i.e., I-110), travel times will be determined using the detector data from the Caltrans' PeMS. Both link and segment travel times will be computed. Link travel times (i.e., the travel time between detector stations) are computed using the following equation:

$$Link\ Travel\ Time\ (minutes) = \frac{Link\ Length\ (miles)}{Average\ Link\ Speed\ (mph)} * \frac{60\ minutes}{1\ hour}$$

*Travel Time Index*. Travel Time Index is the ratio of the average peak period travel time to the off-peak (or free flow) travel time. The Travel Time Index is commuted using segment travel times. It will be computed using the following equation:

$$Travel\ Time\ Index\ (TTI) = \frac{Average\ Travel\ Time}{Free\ Flow\ Travel\ Time}$$

The free flow travel time will be computed based on the posted speed limit for each section of the evaluation corridor.

**Throughput.** Throughput is the amount of demand that is served over a period of time and is measured as the passage of persons or vehicle past a given point on the roadway. Vehicle-based measures of throughput provide insight to how the facility is operating, while person-based measures of throughput provide the capability to compare different modes of travel. Three primary measures of throughput will be used by the national evaluation team:

- Vehicle throughput,
- Person throughput, and
- Vehicle-miles traveled.

Traffic volume and throughput measures will be evaluated at analysis locations established in the corridor. These analysis locations provide a reference point for evaluating traffic volume-related measures (such as vehicle throughput, person throughput, etc.) These analysis locations will coincide with Caltrans ATMS traffic sensor locations. Proposed analysis locations are shown in Figure 3-3.

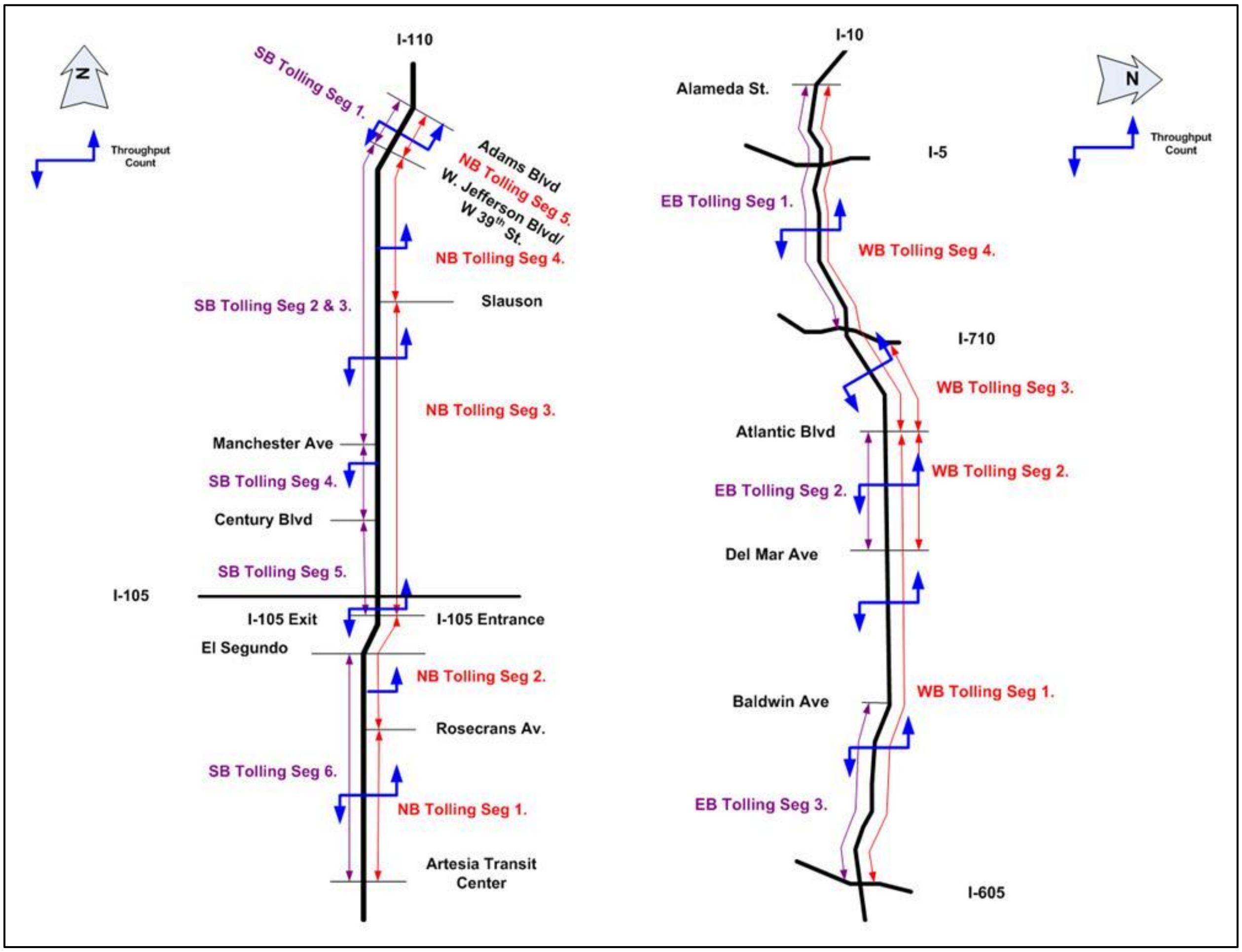


**Figure 3-3. Suggested Analysis Locations for Vehicle Throughput Measurements**

Vehicle volumes from each detector station will be multiplied by link length to produce a VMT measure for the link. Section and corridor level VMT will be computed by totaling the VMT measures from each link.

*Vehicle Throughput*. Vehicle throughput is a measure of the number of vehicles that are serviced in one direction of a facility during the analysis period. Data from Caltrans' ATMS detectors measure the vehicle throughput at the evaluation screenlines shown in Figure 3-3. Total vehicle throughput is the sum of all types of vehicle traversing the roadway during the analysis period (peak hour, and peak period).

*Person Throughput*. Person throughput, or person volume, is the total number of people served at the reference screenlines in the corridor during the analysis period. Changes in total person throughput are possible as a result of each of the main categories of CRD projects:

- Person throughput changes attributed to CRD transit improvements, and
- Person throughput changes due to converting the HOV lane to HOT operations.

As shown in the equation below, person throughput is the average vehicle occupancy multiplied by the volumes of vehicles within the corridor.

$$Person\ Throughput\ (PT) = Vehicle\ volume\ (V) *\ Average\ Vehicle\ Occupancy\ (AVO)$$

The analysis will compare the total person throughput at these locations. The equations below shows how total person throughout will be computed for these locations:

$$PT_{Total} = PT_{Transit} + PT_{SOV} + PT_{HOV2} + PT_{HOV3} + PT_{HOV4+} + PT_{Vans} + PT_{Trucks} + PT_{Motorcylces}$$

*Vehicle Miles Traveled*. VMT is a common measure of throughput. It is the product of the number of vehicles traveling over a roadway segment and the length of the segment. It is computed using the following equations:

$$Vehicle - Miles\ of\ Travel\ (VMT)_{Link} = Volume\ (V)_{Link}\ X\ Link\ Length$$

$$VMT_{Total} = \sum VMT_{Link}$$

The total station volume data for each link will be used to compute VMT. Station volume data will be multiplied by the segment length. Segment level and corridor level VMT measures will be calculated by summing link-level VMT measures. Peak hour, peak period, and daily VMT will be calculated using this approach.

**Spatial and Temporal Extent of Congestion.** The LA CRD National Evaluation Plan also calls for traffic system data to be used to compute the spatial and temporal extent of congestion. For the purposes of the LA CRD evaluation, a freeway link will be defined as "congested" when the reported 5-minute average speed drops below 30 mph. The following spatial and temporal congestion measures will be evaluated:

- Change in the percentage of general purpose and Express Lane-miles operating in a congested conditions (i.e., Average 5-minute speeds per detector station less than 30 mph),
- Change in the number of peak period minutes the general purpose and Express Lanes operating in a congested condition (i.e., Average, 5-minute speed per detector station than 30 mph).

*Percent of Congested Lane Miles*. The percent of congested lane miles measures the spatial extent of congestion. This measure is the lane miles of roadway where the average travel speed is less than a defined threshold (45 mph and 30 mph in this study). For each 5-minute time period during the analysis period, the average link travel speed is compared to the threshold values. If the actual link travel speed is less than the threshold value, then the link will be defined as congested. The performance measure, which is the percentage of congested roadways, is calculated as the ratio of congested lane miles to the total lane miles. Days where incidents have occurred, inclement weather, or maintenance and/or construction activities are present will be analyzed separately from typical workdays.

*Number of Peak Period Minutes of Congested Operation*. This measure is intended to measure the temporal extent of congestion. It is the average length of time each period and/or day that a particular facility is operating in a congested state (below 45 mph and below 30 mph in this study). Hours of congestion will be computed using Caltrans ATMS data. The uncongested and congested links in the corridor will be counted by each 5-minute time period and the percentage of congested links will be computed. If the percentage of congested links in the corridor exceeds 20 percent, the corridor will be identified as being congested for that 5-minute time period and day. For each weekday in the month, the number of congested 5-minute periods will be used to determine the total duration of congestion during the peak period. Only time periods between 6:00 a.m. and 9:00 a.m. and between 3:00 p.m. and 7:00 p.m. will be included in this analysis.

## 3.4 Use of Traffic System Data in Evaluation Analyses

The traffic system data are used as data inputs into the following evaluations being performed by the national evaluation team:

- Congestion analyses,
- Tolling analyses,
- TDM analysis,
- Technology analysis,
- Safety analysis,
- Environmental analysis,
- Goods movement analysis, and
- Cost benefit analysis.

This section describes how traffic system data will be used in each of these analyses. Traditional statistical testing, such as comparison of means and analysis of variance, will be performed to determine whether or not changes in congestion levels differed statistically during the pre- and post-deployment time periods. All statistical comparisons will be performed using standard statistical procedures and conducted at a 95$^{th}$ percentile confidence level.

**Congestion Analysis.** The primary user of traffic system data is the congestion analyses. Most of the performance measures used in the congestion analyses are derived directly from the traffic system data. Data from control locations will be used to account for changes caused in exogenous factors, such as changes in economic conditions. For example, traffic volume counts and speed will be used to compare the following:

- Changes in travel time, and travel speed of users
- Changes in travel time reliability experienced by users in the corridor
- Total vehicle throughput, both daily and during the peak-periods, using the facilities in the corridor
- Total person throughput, both daily and during peak periods, using the facilities in the corridor
- Changes in the temporal and spatial extent of congestion.

Travel time and travel time reliability measures will be derived using travel speeds measured in the corridor. Vehicle throughput will be derived using traffic volume data collected by Caltrans ATMS sensors.

**Tolling Analysis.** The tolling analysis uses traffic system data in assessing the direct impacts of converting the HOV lane to HOT operations. Specifically, the tolling analysis will be investigating whether or not converting the HOV lane to HOT operations increased vehicle throughput and improved travel times. In the tolling analysis, the national evaluation team will be comparing vehicle throughput after converting the HOV lane to HOT operations to vehicle throughput that occurred when the lane was reserved for HOV vehicles exclusively. The tolling analysis will also compare travel times before and after the conversion. The tolling analysis will use vehicle occupancy data to examine how changing the way the HOV lane operates affected the composition of the traffic stream.

**Travel Demand Management Analysis.** In the TDM analysis, vehicle occupancy data will be used to assess how the CRD improvements help promote commuting alternatives in the corridor. Conversion of the HOV lane to HOT operations and change from HOV2+ to HOV3+ may encourage higher vehicle occupancy levels, and the data on the vehicle occupancy levels will indicate whether the number of two-person, three-person, and four or more person carpools increased. Traffic system data will also be used in this analysis to assess the relative contribution of TDM strategies on the number vehicle trips and vehicle miles traveled in the evaluation corridors.

**Safety Analysis.** The safety analysis is examining how the rate of incidents changes as a result of the CRD improvements in the corridor, and traffic system data will be used as a secondary measure in support of this analysis. More specifically, VMT data will be used to compute the rate at which incidents occur, as the incidents need to be normalized for the volume of traffic.

**Environmental Analyses.** The environmental analyses use performance measures derived from the traffic system data –specifically average travel speeds and VMT. Changes in average travel speeds and vehicle miles traveled will be used to calculate changes in emissions derived from implementing all of the CRD improvements. Similarly, changes in VMT will be used to assess the combined impact of all the CRD improvements on energy consumption. Both the air quality and energy consumption analyses will use the traffic system data one year prior to and one year following start of operation of the Express Lanes.

**Goods Movement Analysis.** It is hypothesized that commercial vehicle operators in the corridor will experience a reduction in travel time by reduced congestion on the general purpose lane as a result of the CRD improvements. While this analysis will not examine the travel times of commercial vehicles specifically, travel times derived from traffic sensor data will be used to determine the degree to which travel times in the general purpose lanes improved as a result of implementing the CRD improvements. Vehicle occupancy data (which will provide a sampling of the composition of the traffic stream) will be used determine the relative percentage of trucks in the traffic stream. These two pieces of traffic system data will then be used to infer the degree to which commercial vehicles benefited from the CRD improvements in the evaluation corridor.

**Cost-Benefit Analysis.** The cost-benefit analyses will use traffic system data as a primary input for the analyses, including VMT, vehicle occupancy rates, number of vehicles, and travel times. These data will be used in monetizing the costs and benefits of the CRD improvements.

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# 4.0 SCHEDULE AND RESPONSIBILITY

The majority of the analyses requiring traffic system data are "before and after" comparisons. For the national evaluation, the local partners are responsible for providing the data used in the analyses. As of the September 2011 ExpressLane Status report prepared by Metro, the "Go Live" dates for the project primary being evaluated using traffic system data are as follows:

- I-110 ExpressLane in 10/2012
- Express Park in 10/2012
- I-10 ExpressLane in 2/2013

Using these dates as starting points, the national evaluation team has identified the schedule and responsible party for collecting the needed traffic system data for the various analyses. Table 4-1 shows the data collection schedule and responsible agency. Caltrans is shown as the "responsible agency" in Table 4-1 in so much as they own the data. However, at the request of the LA CRD local partners, the national evaluation team will be responsible for pulling the ATMS Detector data from the PeMS system. Therefore, the data that will be used in the evaluation will reflect the quality of the data in PeMS.

**Table 4-1. Schedule and Agency Responsible for Providing Traffic System Data**

| Source of Traffic System Data | Responsible Agency | Data Collection Period | |
|---|---|---|---|
| | | Baseline | Post-Deployment |
| Probe-based Travel Time<br>• I-110<br>• I-10 | • Caltrans<br>• Caltrans | (A total of 4 days each month)<br>• Feb 2012, May 2012<br>• Feb 2012, May 2012 | (A total of 4 days each month)<br>• Feb 2013, May 2013<br>• Feb 2013, May 2013 |
| ATMS Detector Data<br>• I-110<br>• I-10 | • Caltrans<br>• Caltrans | • 10/2011 – 9/2012<br>• 11/2012 – 1/2013 | • 10/2012 – 9/2013<br>• 2/2013 – 1/2014 |
| Supplemental Traffic Counts<br>• I-10 (HOV lane only) | • Caltrans | • 2/2012 – 11/2012 | • NA |
| Vehicle Occupancy Studies<br>• I-110<br>• I-10 | • Caltrans<br>• Caltrans | • Oct 2011, May 2012<br>• Oct 2011, May 2012 | • Oct/Nov 2012 May 2013<br>• Feb 2013, May 2013 |
| Arterial Travel Times<br>• I-10 (BRT GPS Logs)<br>• I-110 Parallel Routes (ATSAC Speed) | • LA Metro<br>• LA DOT | • 10/2011 – 9/2012<br>• 11/2012 – 1/2013 | • 10/2012 – 9/2012<br>• 2/2013 – 1/2014 |
| Arterial Traffic Counts<br>• I-10 Parallel Routes (Quarterly Counts)<br>• I-110 Parallel Routes (ATSAC Volume) | • LA Metro<br>• LA DOT | • Apr 2012, July 2012, Oct 2012, Jan 2013<br>• 10/2011 – 9/2012 | • Apr 2013, July 2013, Oct 2013, Jan 2014<br>• 10/2012 – 9/2013 |

**Source:** Battelle, August 2012.

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# APPENDIX A – HYPOTHESIS/QUESTIONS FROM THE L.A. COUNTY CRD NATIONAL EVALUATION PLAN

| Evaluation Analysis | Hypothesis/ Question Number | Hypothesis/Question |
|---|---|---|
| Congestion | LACong-1 | Deployment of the CRD improvements will reduce the travel time of users in the I-10 and I-110 corridors. |
| | LACong-2 | Deployment of the CRD improvements will improve the reliability of user trips in the I-10 and I-110 corridors. |
| | LACong-3 | Deployment of the Downtown L.A. Intelligent Parking Management Project will reduce congestion in the downtown. |
| | LACong-4 | Deploying the CRD improvements will result in more vehicles and persons served in the I-10 and I-110 corridors during peak periods. |
| | LACong-5 | Will surveyed travelers perceive a noticeable reduction in travel times in the treatment corridors? |
| | LACong-6 | Will surveyed travelers perceive a noticeable improvement in trip-time reliability in the treatment corridors? |
| | LACong-7 | Will surveyed travelers perceive a noticeable reduction in the duration of congested periods in the treatment corridors? |
| | LACong-8 | Will surveyed travelers perceive a noticeable reduction in the length of peak congestion periods in the treatment corridors? |
| | LACong-9 | Relative travel times for HOV/HOT lanes vs. general purpose lanes will either remain the same or (more likely) improve for HOV/HOT travelers as a result of the CRD deployments. |
| | LACong-10 | The introduction of tolled SOV traffic into the HOT lanes in the deployment corridors will not negatively impact HOV or transit traffic in terms of average travel times or travel reliability. |
| | LACong-11 | The CRD deployment will not cause traffic congestion to increase in the HOV/HOT lanes. |
| | LACong-12 | Because of latent demand in the deployment corridors, the CRD deployments are not likely to impact in traffic congestion on the general purpose lanes. |
| | LACong-13 | Because of the CRD deployments, congestion on the arterials streets paralleling the corridors will be reduced. |

| Evaluation Analysis | Hypothesis/ Question Number | Hypothesis/Question |
|---|---|---|
| Tolling | LATolling-1 | The HOT lanes will regulate vehicular access to the I-10 and I-110 and improve their operation. |
| | LATolling-2 | Some general-purpose lane travelers will shift to the HOT lanes, while HOV lane travelers will continue to use them after they are converted to HOT. |
| | LATolling-3 | After ramp-up, the HOT lanes on I-10 and I-110 pricing maintains operating improvements on I-10 and I-110 after the initial ramp-up period. |
| | LATolling-4 | The downtown IPM project will result in 70-90% of the parking spaces on each block occupied throughout the day. |
| | LATolling-5 | The downtown IPM project may increase parking revenues that can be used to fund system expansion in other high-demand areas. |
| | LA Tolling-6 | Implementing the HOT lanes will reduce the HOV violation rate. |
| Transit | LATransit-1 | CRD projects will enhance transit performance within CRD corridors through reduced travel times, increased service reliability, and increased service capacity. |
| | LATransit-2 | User perceptions of security at transit stations/park-and-ride lots will be improved by CRD projects. |
| | LATransit-3 | CRD projects will increase ridership and facilitate a mode shift to transit within CRD corridors. |
| | LATransit-4 | Increased ridership and mode shift to transit will contribute to increased person throughput, congestion mitigation, and transit cost-effectiveness within CRD corridors. |
| | LATransit-5 | What was the relative contribution of each CRD project element to increased ridership/ transit mode share/person throughput? |
| Ridesharing | LARideshare-1 | CRD vanpool promotion will result in at least 100 new Metro-registered vanpools. |
| | LARideshare-2 | Which factors were most effective in stimulating new vanpool formation? |
| Technology | LATech-1 | Travelers will access the IPM website and telephone information system. |
| | LATech-2 | IPM will improve L.A.DOT's ability to reconfigure parking restrictions and rates. |
| | LATech-3 | IPM will improve L.A.DOT's ability to enforce parking regulations. |
| Safety | LASafety-1 | The collective impacts of CRD improvements[3] will be safety neutral or safety positive. |
| | LASafety-2 | The addition of transition zones will not increase incidents. |
| | LASafety-3 | Will boundary jumping cause incidents? |
| | LASafety-4 | Will HOT infrastructure changes affect the time needed to respond to or clear accidents? |
| | LASafety-5 | Will adjusted enforcement procedures affect the number of incidents? |

[3] Relevant UPA changes include narrower lanes on portions of the I-10 freeway, new signage, new HOT procedures, new enforcement procedures, and reduced congestion (i.e., faster flowing traffic).

| Evaluation Analysis | Hypothesis/ Question Number | Hypothesis/Question |
|---|---|---|
| Equity | LAEquity-1 | What is the socio-economic and spatial distribution of the direct social effects of the CRD projects? |
| | LAEquity-2 | Are there any differential environmental impacts on certain socio-economic groups? |
| | LAEquity-3 | Will the potential HOT and IPM net revenues be reinvested in an equitable manner? |
| Environmental | LAEnvironmental-1 | Vehicle-related air emissions will decrease in the treatment corridors. |
| | LAEnvironmental-2 | Users of the two corridors will perceive improvements in air quality as a result of the CRD projects. |
| | LAEnvironmental-3 | Vehicle-related fuel consumption will decrease in the treatment corridors. |
| Business Impacts | LABus-Imp-1 | How will the downtown IPM project affect retailers and similar businesses that rely on customers' ability to access their stores? |
| Non-Technical Success | LANon-Tech-1 | What role did factors related to these five areas play in the success of the deployment?<br>1. People: Sponsors, champions, policy entrepreneurs, neutral conveners, legislators<br>2. Process: Forums (including stakeholder outreach), meetings, alignment of policy ideas with favorable politics and agreement on nature of the problem), legislative and Congressional engagements<br>3. Structures: Networks, connections and partnerships, concentration of power & decision making authority, conflict mgt. mechanisms, communications strategies, supportive rules and procedures<br>4. Media: Media coverage, public education<br>5. Competencies: Cutting across the preceding areas: persuasion, getting grants, doing research, technical/technological competencies; ability to be policy entrepreneurs; knowing how to use markets |
| | LANon-Tech-2 | Does the public support the CRD strategies as effective and appropriate ways to reduce congestion? |
| Cost Benefit | LACostBenefit-1 | Will the LA CRD (Metro ExpressLanes) Program projects have a net societal benefit? |

**Source:** Battelle, August 2012.

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# APPENDIX B– LISTING OF CALTRANS ATMS DETECTOR STATIONS

**Table B-1. Caltrans Detector Stations in Each CRD Tolling Section – I-110 Northbound**

| Tolling Section | Section Limits[a] | Caltrans Detector Station | | | | |
|---|---|---|---|---|---|---|
| | | Name | ATMS Detector Station ID | | Operational Status (June 16, 2011) | |
| | | | Main | HOV | Main | HOV |
| NB #1 | Harbor GatewayTransit Center/91 Frwy to N. of El Segundo | S of 91 | 763663 | - | Good | - |
| | | Gardena | 716484 | - | Good | - |
| | | Redondo Beach | 763626 | - | Good | - |
| | | Rosecrans 2 | 763361 | - | Good | - |
| | | 137th | 716490 | 772078 | Good | Good |
| | | El Segundo | 763367 | - | Good | - |
| NB #2 | N. of El Segundo to S. of Florence | 126th | 716493 | - | Good | - |
| | | Imperial 1 | 763304 | - | Good | - |
| | | Imperial 2 | 763372 | - | Good | - |
| | | FM RT 105 | 763720 | - | Good | - |
| | | Century | 763384 | - | Good | - |
| | | 94th | 716498 | - | Good | - |
| | | Manchester 1 | 763392 | 763389 | Good | Good |
| | | Manchester 2 | 763400 | 763397 | Good | Good |
| | | 76th | - | 763280 | - | Marginal |
| NB #4 | S. of Florence to Jefferson | Florence | 763408 | 763405 | Good | - |
| | | Gage | 763419 | 763416 | Good | - |
| | | Slauson | 718164 | 762508 | Good | - |
| | | 51st | 763424 | - | Good | - |
| | | Vernon | 763800 | - | Good | - |
| | | King | 763434 | - | Good | - |
| NB #5[b] | 39th St to Adams | Exposition2 | 763439 | 763444 | Good | Off-line |
| | | Adams[c] | 764032 | 766286 (HOV Off Ramp) | Off-line | - |

**Source:** Battelle, August 2012.

[a] Based on Appendix D of ExpressLane Concept of Operation Document

[b] Viaduct Section

[c] May NOT be located on I-110HOV connector ramp

**Table B-2. Caltrans Detector Stations in Each CRD Tolling Section – I-110 Southbound**

| Tolling Section | Section Limits[a] | Caltrans Detector Station | | | | |
|---|---|---|---|---|---|---|
| | | Name | ATMS Detector Station ID | | Operational Status (June 16, 2011) | |
| | | | Main | HOV | Main | HOV |
| SB #1 | S. of 28th St to S. of Manchester | Adams[b] | 764037 | - | Off-line | - |
| | | Exposition2 | 763447 | 764427 | Good | Off-line |
| | | Exposition 1 | 763246 | 763243 | Good | Marginal |
| | | King Blvd | 718041 | - | Good | - |
| | | Vernon | 763251 | - | Good | - |
| | | Slauson | 763259 | 763256 | Good | Good |
| | | Gage | 763267 | | Good | Marginal |
| | | Florence | - | 763413 | - | Good |
| | | 76th | 763275 | 763272 | Good | Marginal |
| | | Manchester 2 | 763286 | 763283 | Marginal | Good |
| | | Manchester 1 | 763294 | 763291 | Good | Marginal |
| SB #3 | S. of Manchester to Rosecrans | 94th St | 716500 | 772076 | Marginal | Good |
| | | Imperial 2 | 763377 | - | Good | - |
| | | FM 105EB | 759416 | 763718 | Good | Off-line |
| | | 126th | 716494 | - | Good | - |
| | | El Segundo | 763309 | - | Good | - |
| | | 137th | 716491 | 771223 | Good | Good |
| | | Rosecrans | 763314 | - | Good | - |
| SB #4 | Rosecrans to Harbor Gateway Transit Center | Redondo Beach | 763621 | 771232 | Good | Marginal |
| | | Gardena | 716485 | - | Good | - |
| | | N of 91 | 766988 | - | Good | - |

**Source:** Battelle, August 2012.

[a] Based on Appendix D of ExpressLane Concept of Operation Document

[b] May NOT be located on I-110HOV connector ramp

**Table B-3. Caltrans Detector Stations in Each CRD Tolling Section – I-10 Westbound**

| Tolling Section | Section Limits[a] | Caltrans Detector Station | | | | |
|---|---|---|---|---|---|---|
| | | Name | ATMS Detector Station ID | | Operational Status (June 16, 2011) | |
| | | | Main | HOV | Main | HOV |
| WB #1 | Maxson Ave to W of San Anita | Durfee Rd | 717157 | 718331 | Off-line | Off-line |
| | | Stewart | 767329 | 768752 | Off-line | Off-line |
| | | Valley | 717154 | 768746 | Off-line | Off-line |
| | | Peck | 717150 | 768741 | Off-line | Off-line |
| | | Santa Anita | 717142 | 768738 | Off-line | Off-line |
| WB #2 | W. of San Anita to Del Mar Entrance Merge | Baldwin | 717139 | 762470 | Off-line | Off-line |
| | | Temple City | 717135 | 762504 | Off-line | Off-line |
| | | Flair | 717134 | 762468 | Off-line | Off-line |
| | | Rosemead 2 | 717129 | 768720 | Off-line | Off-line |
| | | Rosemead 1 | 717125 | 762502 | Off-line | Off-line |
| | | Walnut Grove | 717121 | 762500 | Off-line | Off-line |
| | | San Gabriel 2 | 717119 | 768718 | Off-line | Off-line |
| | | San Gabriel 1 | 717116 | 762498 | Off-line | Off-line |
| | | Del Mar 2 | 717112 | - | Off-line | - |
| | | Del Mar 1 | 717108 | | Off-line | Off-line |
| WB #3 | Del Mar Entrance Merge to S. Primrose Ave. | New 2 | 717101 | - | Off-line | - |
| | | New 1 | 717095 | 762494 | Off-line | Off-line |
| | | Almansor | 716101 | 762491 | Off-line | Off-line |
| | | Garfield 2 | 717091 | - | Off-line | - |
| | | Garfield 1 | 717087 | 762488 | Off-line | Off-line |
| | | Atlantic 2 | 717081 | - | Off-line | - |
| | | Atlantic 1 | 717079 | 768724 | Off-line | Off-line |
| | | Marengo | 716091 | 762486 | Off-line | Off-line |
| WB #4 | S. Primrose Ave to E. of I-710 | Hellman | 717073 | 762484 | Off-line | Off-line |
| | | Warwick | 716088 | 762482 | Off-line | Off-line |

**Table B-3. Caltrans Detector Stations in Each CRD Tolling Section – I-10 Westbound (Continued)**

| Tolling Section | Section Limits[a] | Caltrans Detector Station | | | | |
|---|---|---|---|---|---|---|
| | | Name | ATMS Detector Station ID | | Operational Status (June 16, 2011) | |
| | | | Main | HOV | Main | HOV |
| WB #5 | E. of I-710 to Alameda St. (via El Monte Busway) | Winthrope | 717071 (HOV 762480) | -[b] | Off-line (Off-line) | -[b] |
| | | RT 710 CN | 768972 (HOV 762476) | -[b] | Off-line (Off-line) | -[b] |
| | | W of 710 | 716084 | -[b] | Off-line | -[b] |
| | | Campus | 737345 | -[b] | Off-line | -[b] |
| | | Eastern | 717065 (HOV 762436) | -[b] | Off-line (Off-line) | -[b] |
| | | Miller | 718332 (HOV 762432) | -[b] | Off-line (Off-line) | -[b] |
| | | Herbert | 718020 (HOV 762432) | -[b] | Off-line (Off-line) | -[b] |
| | | Indiana | 716076 (HOV 762423) | -[b] | Off-line (Off-line) | -[b] |
| | | Tremont | 717060 (HOV 762413) | -[b] | Off-line (Off-line) | -[b] |
| | | Soto | 717055 (HOV 717056) | -[b] | Off-line (Off-line) | -[b] |
| | | St. Louis | 717052 (HOV 762409) | -[b] | Off-line (Off-line) | -[b] |
| | | State | 737329 (HOV 762405) | -[b] | Off-line (Off-line) | -[b] |
| | | Echandia | 717047 (HOV 762405) | -[b] | Off-line (Good) | -[b] |
| | | E of Macy | 764941 | -[b] | Good | -[b] |
| | | Alameda (SR 101-N) | 769118 | -[b] | Off-line | -[b] |

**Source:** Battelle, August 2012.

[a] Based on Appendix D of ExpressLane Concept of Operation Document

[b] El Monte Busway runs parallel to I-10 at this point. No detection in El Monte Busway.

**Table B-4. Caltrans Detector Stations in Each CRD Tolling Section – I-10 Eastbound**

| Tolling Section | Section Limits[a] | Caltrans Detector Station | | | | |
|---|---|---|---|---|---|---|
| | | Name | ATMS Detector Station ID | | Operational Status (June 16, 2011) | |
| | | | Main | HOV | Main | HOV |
| EB #1 | Alameda to E of I-710 (Via El Monte Busway) | E of Macy | 737320 | -[b] | Off-line | -[b] |
| | | Echandia | 716028 (HOV 762404) | -[b] | Good (Good) | -[b] |
| | | State | 716067 | -[b] | Off-line | -[b] |
| | | Saint Louis | 716069 (HOV 762408) | -[b] | Off-line (Off-line) | -[b] |
| | | Soto | 716072 (HOV 765207) | -[b] | Off-line (Off-line) | -[b] |
| | | Tremont | 717059 (HOV 762410) | -[b] | Off-line (Off-line) | -[b] |
| | | Indiana | 716075 (HOV 762422) | -[b] | Off-line (Off-line) | -[b] |
| EB #2 | Herbert St. to Fremont Ave.(Via HOV lane) | Herbert | 716078 | 765508 | Off-line | Off-line |
| | | Miller | 765098 | - | Off-line | - |
| | | Eastern | 716081 | 762435 | Off-line | Off-line |
| | | Campus | 737344 | 762441 | Off-line | Off-line |
| | | W of 710 | 717070 | 762445 | Off-line | Off-line |
| | | Warwick[c] | 716087 | 762447 | Off-line | Off-line |
| EB #3a | Fremont Ave. to Del Mar Exit | Fremont | 765451 | - | Off-line | - |
| | | Marengo | 716092 | 762449 | Off-line | Off-line |
| | | Atlantic 1 | 717077 | - | Off-line | - |
| | | Atlantic 2 | 717075 | 762451 | Off-line | Off-line |
| | | Garfield 1 | 717089 | - | Off-line | - |
| | | Garfield 2 | 717083 | 762453 | Off-line | Off-line |
| | | Almansor | 717083 | 762492 | Off-line | Off-line |
| | | New 1 | 717093 | - | Off-line | - |
| | | New 2 | 717097 | 762455 | Off-line | Off-line |
| EB #3b | Del Mar Exit to Rio Hondo Blvd | Del Mar 1 | 717105 | - | Off-line | - |
| | | Del Mar 2 | 717110 | 762457 | Off-line | Off-line |
| | | San Gabriel 1 | 717114 | - | Off-line | - |
| | | San Gabriel 2 | 718445 | 762459 | Off-line | Off-line |
| | | Walnut Grove | 717123 | 762461 | Off-line | Off-line |
| | | Rosemead 1 | 717127 | - | Off-line | - |
| | | Rosemead 2 | 717131 | 762463 | Off-line | Off-line |

**Table B-4. Caltrans Detector Stations in Each CRD Tolling Section – I-10 Eastbound (Continued)**

| Tolling Section | Section Limits[a] | Caltrans Detector Station | | | | |
|---|---|---|---|---|---|---|
| | | Name | ATMS Detector Station ID | | Operational Status (June 16, 2011) | |
| | | | Main | HOV | Main | HOV |
| EB #4 | Rio Hondo Blvd. to Lansdale Blvd. | Flair | 717133 | 762467 | Off-line | Off-line |
| | | Temple City | 717136 | 768426 | Off-line | Off-line |
| | | Baldwin | 716126 | 717140 | Off-line | Off-line |
| | | Santa Anita | 717146 | 717148 | Off-line | Off-line |
| | | Valley | 707052 | 768743 | Off-line | Off-line |
| | | Stewart | 717155 | 768751 | Off-line | Off-line |
| | | Durfee | 717156 | 717158 | Off-line | Off-line |

**Source:** Battelle, August 2012.

[a] Based on Appendix D of ExpressLane Concept of Operation Document

[d] El Monte Busway runs parallel to I-10 at this point. No detection in El Monte Busway.

[c] First Station downstream of merge of El Monte Busway and HOV lane

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