SMART REGION

SACRAMENTO COUNTY

TECHNOLOGY IMPLEMENTATION PLAN

FINAL

February 2019

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List of Abbreviations

ATCMTD – Advanced Transportation and Congestion Management Technologies Deployment
ATMS – Advanced Traffic Management System
ATP – Active Transportation Program
ATSPM – Automated Traffic Signal Performance Measures
AVL – Automatic Vehicle Location
AVMS – Advanced Variable Message Signs
BUILD – Better Utilizing Investments to Leverage Development
CAD – Computer-Aided Dispatch
CCTV – Closed Circuit Television
CHP – California Highway Patrol
CIP – Capital Improvement Program
CMM – Capability Maturity Model
CMS – Changeable Message Signs
CV/AV – Connected Vehicle and Autonomous Vehicle
EMS – Extinguishable Message Signs
EVP– Emergency Vehicle Preemption
GHG – Green House Gas
GPS – Global Positioning System
HAR – Highway Advisory Radios
HSIP – Highway Safety Improvement Program
ICM – Integrated Corridor Management
INFRA – Infrastructure for Rebuilding America
IoT– Internet of Things
ITS – Intelligent Transportation Systems
MPA – Municipal Planning Area
O&M – Operations and Maintenance
P3 – Public/Private Partnerships
PeMS – Performance Measurement System
RMS– Ramp Metering System
RT– Sacramento Regional Transit
RTIP – Regional Transportation Improvement Program
RWIS – Road Weather Information Systems
SACOG – Sacramento Area Council of Governments
SB-1– Senate Bill 1
SCCP – Solutions for Congested Corridors Program
SCS – Sustainable Communities Strategy
SHA – State Highway Account
SHOPP – State Highway Operation and Protection Program
SR – State Route
STARNET – Sacramento Transportation Area Network
STBG – Surface Transportation Block Grant Program
STIP – State Transportation Improvement Program
TCEP – Trade Corridor Enhancement Program
TIFIA – Transportation Infrastructure Finance and Innovation Act
TIGER – Transportation Investment Generating Economic Recovery
TMC – Traffic Management Center
TMS – Traffic Management System
TNC – Transportation Network Carriers
TSP – Transit Signal Priority
V2I – Vehicle-to-Infrastructure
V2X – Vehicle-to-Everything

SMART REGION SACRAMENTO

Sacramento County TECHNOLOGY IMPLEMENTATION PLAN EXECUTIVE SUMMARY

February 2019

Transportation management is growing in terms of technology, software, and applications. The future of transportation includes connected vehicles, autonomous vehicles, decision-making based on performance metrics, and a committed focus on more effective operations and management of systems rather than just capital improvements. There is no way to build the way out of congestion, the only way to effectively improve mobility is to manage it better.

Sacramento County is one of eight agencies that is contributing to the Sacramento Area Council of Governments' (SACOG's) Smart Region Sacramento: Intelligent Transportation System (ITS) Architecture and Future Technology Project (referred to as Smart Region Sacramento). This Technology Implementation Plan provides Sacramento County with the framework necessary to proactively and positively affect how residents and all travelers move within and access the County transportation network. This framework and its resulting tools, if prioritized and managed well by the County, will assist with every aspect of County public service: mobility, incident response, efficient maintenance, and cost savings across the County's bottom line. Because technology investments are low-cost compared to capacity-related projects and offer potentially significant benefits to the broad transportation system and its users, prioritizing technology investments supports the vision of an integrated and reliable transportation system.

Goals and Objectives

Sacramento County participated in the development of this Technology Implementation Plan that follows the Smart Region mission statement intended to clearly define the path toward technology investments and resources moving forward from 2019.

SMART REGION MISSION STATEMENT: To improve system performance, safety, sustainability, and reliability by ensuring efficient investments in regional smart transportation projects.

The Smart Region Objectives include:

- Accommodate Different Communities Throughout the Region (Urban, Suburban, Rural, and Underserved)
- Adapt the Region to New Technology
- Achieve Consistency and Reliability for all Modes
- Increase Safety
- Improve Traveler Information Dissemination
- Improve Emergency/Disaster Preparedness

System Needs

The County is challenged with significant gaps that are inhibiting the system from addressing operational and management goals. The needs assessment process involved looking at existing documents and plans to map the different types of transportation technology most relevant to Sacramento County. These needs and gaps were organized into three (3) main sections: Infrastructure/Data, Operations, and Institutional. The outcome of this step was a list of needs and gaps to guide the types of upgrade strategies the County should focus on from new technologies to updated processes, policies, staffing, operations, and more.

Sacramento County has identified additional goals and objectives that support the regional objectives. These objectives were used to help prioritize strategies and project deployment phasing. The Sacramento County Smart Mobility Goals include:

- Replace the existing copper communications network backbone with fiber optics
- Connect all traffic signals to the County communications network to efficiently operate and maintain them
- Consider deployment of Dedicated Short Range Communications (DSRC), 5G, and/or Signal Phasing and Timing (SPaT) technology within the County
- Develop a comprehensive transportation infrastructure preventative maintenance and lifecycle replacement strategy to update the current process of replacing equipment upon failure
- Develop a prioritized list of transportation technology projects
- Configure existing transportation systems to provide alerts when equipment fails
- Develop/upgrade operations and maintenance policies and procedures
- Develop/upgrade and use performance metrics to improve operations
- Replace existing loop detection at intersections with new video detection
- Install CCTV cameras at all County intersections
- Plan for adequate staff to more effectively operate and maintain existing County transportation software systems, networks, and smart technologies
- Incorporate ICM concepts developed for US 50
- Enable regional and cross-agency management of transportation assets including traffic signals and ITS devices
- Enhance coordination and data sharing with regional transit partners
- Investigate possible TSP and/or queue-jumping projects with the Sacramento Regional Transit District

SMART REGION SACRAMENTO

Sacramento County TECHNOLOGY IMPLEMENTATION PLAN EXECUTIVE SUMMARY

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Determining the Path Forward

Traffic operations and management technology is constantly advancing and evolving, which makes it an important consideration during the formulation of implementation strategies. It is crucial that the implementation process takes full advantage of the existing ITS technologies available while also formulating strategies that align with where technological advancements may be heading. The following are current technology trends that were evaluated for applicability in addressing needs and gaps:

- *Big data* – more data collected from roads, vehicles, and other sources
- *Transportation network carriers* – rideshare services
- *Connected vehicles* – field infrastructure and policies for data sharing
- *Autonomous vehicles* – vehicle fleets, availability, additional data
- *Smart wayfinding and citizen engagement platforms* – smart kiosks
- *Adaptive traffic signal control* – signals that can retime themselves
- *Traffic signal performance metrics* – software that finetunes how traffic signal timing serves the traveling public
- *Vehicle-to-everything communications* – data exchange
- *Internet of things* – connected devices that communicate in new ways
- *Electrification* – electric vehicles and charging stations
- *Multi-modal considerations* – on-board and fleet transit technologies

Operations & Maintenance

The major elements of the future transportation network include:

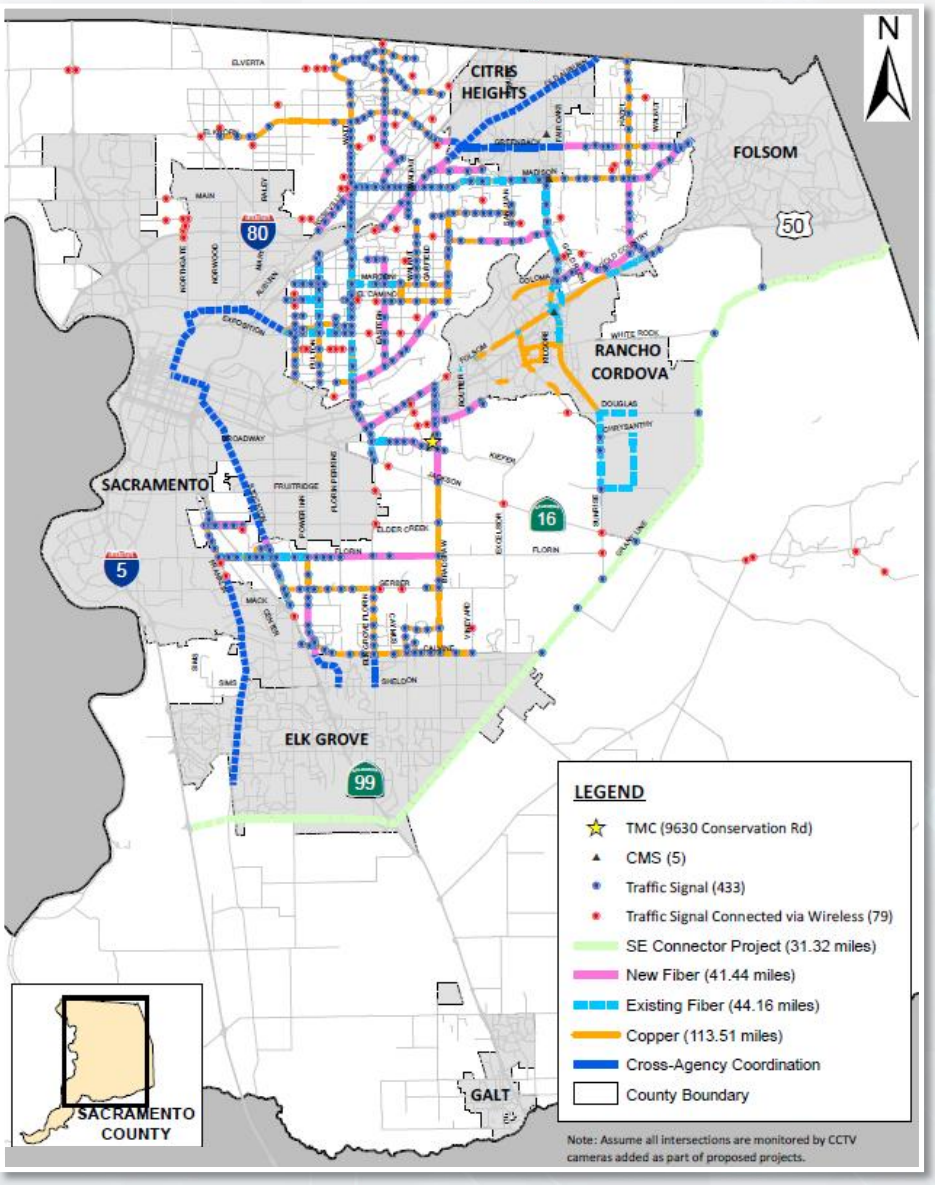
- 45 miles of fiber optic communications
- 419 traffic monitoring cameras
- 5 traffic information signs
- 229 upgraded traffic signal controllers
- 229 updated traffic signal timings
- 245 traffic detection devices

To effectively operate and maintain the various project elements and projects identified in this Implementation Plan, the County must be adequately staffed and prepared to sustain the system after it is deployed. Operations and maintenance procedures are essential to define the appropriate staffing levels, training, operational processes, and maintenance plans necessary to sustain an effective system. This Plan includes guidance for staffing resources necessary to support operations and maintenance activities recommended to maximize investment in assets.

Deployment Strategies

Strategies were developed and prioritized based on the County's conveyed needs and will aid in the phasing of future technology deployments and investments in the future of a Smart Region. Project corridors recommended to be outfitted with technology generally include enhanced communication infrastructure, deployment of vehicle video detection, installation of traffic monitoring cameras, installation of changeable message signs, installation of connected vehicle radio units, deployment of advanced traffic signal performance metrics, deployment of transit signal priority, and traffic signal controller upgrades. Other strategies were developed to improve processes, outline standard operating procedures, or prepare for a future of connected and autonomous vehicles.

Exhibit ES-1 – *Ultimate Traffic Signal and Communications Network*



INTRODUCTION

Why Pursue Strategic Investments in Smart Mobility

This Technology Implementation Plan provides the Sacramento County with the framework necessary to proactively and positively affect how residents and all travelers move within and access the County. This framework and its resulting tools, if prioritized and managed well by the County, will assist with every aspect of County public service: mobility, incident response, efficient maintenance, and cost savings across the County bottom line. Because Intelligent Transportation System (ITS) investments are low-cost compared to capacity-related projects and offer potentially significant benefits to the broad transportation system and its users, prioritizing ITS investments supports the vision that the County support the "most liveable region" in America.

Transportation management is growing in terms of technology, software, and applications. The future of transportation includes connected vehicles, autonomous vehicles, decision-making based on performance metrics, and a committed focus on more effective operations and management of systems rather than just capital improvements. There is no way to build the way out of congestion, the only way to effectively improve mobility is to manage it better. Continuing to build lanes and add capacity will become more and more restricted and ITS Programs will continue to mature in their capability to actively manage traffic (both reactive and proactive management), incidents, events, and work zones.

It is acknowledged that there is an expectation from travelers that a County's transportation system is equipped with the tools to move people as efficiently and safety as possible, yet the public rarely understands what is involved in implementing these tools. This Technology Implementation Plan provides the County with the opportunity to enhance their existing ITS Program with a solid foundation of strategic and necessary infrastructure enhancements, in combination with collaborative growth across the SACOG region, in operations and management capabilities.

This Plan is intended to be a strategic direction for the County to plan for capital and operational investments. External County stakeholders will see benefit in this Plan as providing a direction of where development, design standardization, and anticipated technologies and piloting innovation will be part of the County's investments.

Sacramento County Technology Implementation Plan

Sacramento County is one of eight agencies that is contributing to the Sacramento Area Council of Governments' (SACOG's) Smart Region Sacramento: ITS Architecture and Future Technology Project (referred to as Smart Region Sacramento). The eight partner agencies participating in this regional program are:

- City of Citrus Heights
- City of Elk Grove
- City of Folsom
- City of Rancho Cordova
- City of Sacramento
- El Dorado County
- **Sacramento County**
- Caltrans District 3

MISSION STATEMENT

To improve system performance, safety, sustainability, and reliability by ensuring efficient investments in regional smart transportation projects.

Development of the Smart Region plan follows a methodical Systems Engineering approach illustrated in **Figure 1**.

The initial discovery phase included a comprehensive review of adopted regional and local plans, existing transportation infrastructure, existing assets, and a definition of program needs. Gaps were identified within individual agencies based on the existing conditions and input received from agency stakeholders at one-on-one meetings and the Concept of Operations group workshop. These initial phases established a benchmark for what the County currently has, and defined the needs and deficiencies for the transportation system. This document culminates with a roadmap in the form of a list of implementable projects that close the gaps and fulfill the needs of the County.

On a separate but related path, the Concept of Operations was developed to document the parameters in which the system will function, define stakeholder roles and responsibilities, and outline data usage expectations.

Sacramento County participated in developing this plan and provided input to all stages of the Smart Region Sacramento program development. Information and details presented in this Technology Implementation Plan incorporate and build on the current infrastructure deployment projects and objectives to update the County's overall strategy going forward.

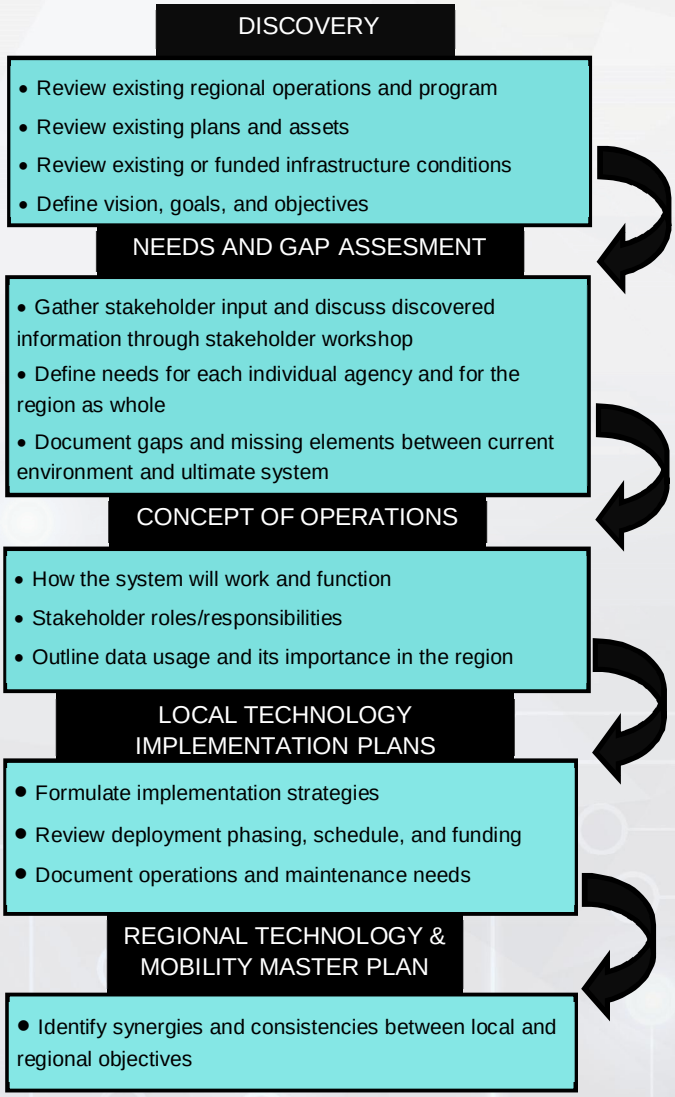


Figure 1 – Smart Region Sacramento Development Process

Additional background information was gathered from the County to enhance the previous work. This included the following:

- **One-on-one meeting** – At the one-on-one Kickoff Meeting conducted in March 2018, the County's existing transportation system and ITS infrastructure was discussed. County staff expressed their vision for the project:

  "*To enhance the transportation system and improve mobility within the County by selectively deploying new and emerging technologies that leverage existing infrastructure and allow staff to more proactively operate and maintain the system*."

At the meeting, County staff identified several challenges they currently face including a communications network that is primarily comprised of copper, lacks redundancy, and does not connect to a large number of existing traffic signals; aging or end-of-life ITS equipment (CCTV, CMS, and vehicle detection); insufficient operations and maintenance staff that lacks the necessary IT/networking expertise needed to manage the system; and a lack of configuration management policies and procedures. In addition to addressing these challenges, the County would like to develop a more proactive, as opposed to reactive, approach to transportation maintenance; improve traffic operations across agency boundaries; and enhance cooperation with regional transit partners and implement projects designed to increase transit ridership and improve transit reliability.

- **Documents/Plans** – A variety of documents and plans were gathered to support the background understanding of the County's current infrastructure, programs, and capabilities. The Sacramento County Transportation Improvement and Program Guide (TIPG) was reviewed to identify capital improvement projects that will be completed over the next five years as well as to obtain information on the County's operations and maintenance programs. Additional plans that were reviewed included the 2030 Sacramento County General Plan, the 2017-2018 Information Technology Plan, the 2007 Pedestrian Master Plan, and the 2011 Bicycle Master Plan. The County also provided documentation on existing traffic signal locations and equipment, the location of all ITS infrastructure including any CCTV camera locations, GIS maps, and communications network diagrams. Regional documents that impact Sacramento County were also collected, an example of which is the Caltrans US 50 ICM Regional Concept of Transportation Operations (RCTO). Software systems and applications used by the County were also evaluated.

Document Organization

This document includes the following primary sections:

- **Vision, Goals, and Objectives** – Summarizes the guiding principles for developing the Plan.
- **Existing Conditions** – Summarizes existing field devices, system performance, and operations and maintenance performance.
- **Needs and Gaps Assessment** – Discusses and tabulates Sacramento County's Needs and Gaps Assessment.
- **Determining the Path Forward** – Provides a link between needs and gaps assessment and how implementation projects were developed.
- **Implementation Project Development** – Describes the methodology for grouping strategy elements into implementable projects for delivery.
- **Deployment Prioritization** – Provides information on how projects are prioritized based on 10 criteria.
- **Funding** – Describes regional, state, and federal funding opportunities for ITS Projects.
- **Operations and Maintenance** – Describes strategies for staffing and ongoing maintenance.

- **Performance Metrics** – Describes evaluation and performance standards that will be used to evaluate transportation system performance, traffic signal operations, safety, and maintenance.
- **Next Steps** – Describes how to use the results of the Technology Implementation Plan to develop and deliver projects.

PROGRAM GOALS AND OBJECTIVES

The Smart Region Plan has six regional objectives that emerged as most critical throughout the project process, particularly during the strategy implementation phase. These six key objectives were crucial in guiding the strategy development process. The Smart Region objectives are:

- Accommodate Different Communities throughout the region (Urban, Suburban, Rural, Underserved)
- Adapt the region to New Technology
- Achieve Consistency and Reliability for all modes
- Increase Safety
- Improve Traveler Information Dissemination
- Improve Emergency/Disaster Preparedness

Sacramento County has identified additional goals and objectives that support the regional goals and objectives. By developing project objectives that are consistent with regional objectives, the agency can ensure that the strategies and projects developed for the County will improve the regional transportation system and enhance cooperation and coordination. It also helps create consistent guidelines for identifying projects and creating performance measures that can be used to evaluate program efficacy. These objectives were also used to help prioritize strategies and project deployment phasing, which is discussed in more detail later in this document.

- Replace the existing County copper communications network backbone with a fiber optic communications backbone;
- Connect all traffic signals to the County communications network to efficiently operate and maintain them;
- Consider deployment of Dedicated Short Range Communications (DSRC), 5G, and/or Signal Phasing and Timing (SPaT) technology within the County;
- Develop a comprehensive transportation infrastructure preventative maintenance and lifecycle replacement strategy to update the current process of replacing equipment upon failure;
- Develop a prioritized list of transportation technology projects;
- Configure existing transportation systems to provide alerts when equipment fails;
- Develop/upgrade operations and maintenance policies and procedures;
- Develop/upgrade and use performance metrics to improve operations;
- Replace existing loop detection at intersections with new video detection;

- Install CCTV cameras at all County intersections;
- Plan for adequate staff to more effectively operate and maintain existing County transportation software systems, networks, and smart technologies
- Incorporate ICM concepts developed for US 50;
- Enable regional and cross-agency management of transportation assets including traffic signals and ITS devices
- Enhance coordination and data sharing with regional transit partners; and
- Investigate possible TSP and/or queue-jumping projects with the Sacramento Regional Transit District.

The vision and objectives are important to consider throughout Smart Region development and implementation because they provide guidelines for identifying projects and creating performance measures to evaluate program efficacy. In addition, these objectives were helpful in determining strategy prioritization and deployment phasing priorities, which will be discussed in more detail later in this document.

EXISTING CONDITIONS

Traffic Signals

At the time of this report, the County owns, operates, and maintains 435 traffic signals in the unincorporated portions of the County. In addition to these 435 signals, the County also shares an additional 160 signals with neighboring agencies. The individual agencies that the County shares traffic signals with are summarized in **Table 1**.

Table 1 – Inventory of Existing Traffic Signals

Agencies	Number
Sacramento County	435
Sacramento County/Caltrans District 3	24
Sacramento County/City of Folsom	3
Sacramento County/City of Sacramento	18
Sacramento County/City of Citrus Heights	5
Sacramento County/Rancho Cordova	17
Sacramento County/City of Sacramento/Caltrans District 3	6
Sacramento County/City of Rancho Cordova/Caltrans	4
TOTAL County owned or shared	512
Maintained & Operated for Rancho Cordova	87
TOTAL Signals Maintained & Operated by County	599

In addition to the 512 traffic signals listed above, the County maintains 87 City of Rancho Cordova signals through maintenance agreement.

Traffic signals are interconnected on segments of major arterials in the County, including Elkhorn Boulevard, Watt Avenue, Madison Avenue, Hazel Avenue, Sunrise Boulevard, Bradshaw Road,

Fulton Avenue, Fair Oaks Boulevard, Arden Way, Calvine Road, Stockton Boulevard, Howe Avenue, Marconi Avenue, El Camino Avenue, Walnut Avenue, Walerga Road, Winding Way and Florin Road. The remaining non-interconnected signals are scattered between the major corridors. Interconnected signals are operated and managed through the County's Econolite Centracs traffic signal central management system software. The County currently has 39 intersections running on three Multisonics VMS 330 master systems with MS 820A controllers. These intersections are scheduled to be upgraded with a Highway Safety Improvement Program funded project in early 2019.

The Centracs Server-to-Server module allows the County and City of Rancho Cordova Centracs systems to share data and communicate with each other to facilitate cross-jurisdictional management. For redundancy, the County has the ability to operate City traffic signals by logging into their Centracs server through a City firewall which allows the County to monitor and manage the City traffic signals.

Exhibit 1 of **Appendix A** depicts the locations of all existing Sacramento County traffic signals. For each signalized intersection, Appendix A illustrates the intersection name and the type of traffic signal controller. Two-hundred and twenty-seven (227) signals operate on Econolite 2070 controllers and 219 signals operate on Multisonics 820/820A controllers. Other controllers include M/S 870 state specific, flasher, beacon, and fire station controllers. The traffic signal controller cabinets are a combination of Type 332, Type P, and Type M cabinets. The County recently changed the signal detection standard to video and radar detection, therefore many signals still operate with inductive loops.

Communications Network

The existing communications network consists of approximately 44 miles of fiber optic cable, 113 miles of copper signal interconnect, mostly 20 pair with some 12 pair and 6 pair and a limited amount of empty conduit. **Exhibit 2** of **Appendix A** depicts the locations of existing communications infrastructure. The County fiber optic network consists of 96- strand single mode fiber primarily located along segments of Arden Way, Fulton Avenue, Madison Avenue, Sunrise Boulevard, and Watt Avenue, with various smaller segments of fiber optic cable along adjacent routes. There are two hubs in the field – Sunrise Boulevard and Watt Avenue; neither are served by a full fiber ring. The fiber optic network provides 1 gigabit/second communications to the traffic signals and a 10 gigabit/second connection for Center-to-Center (C2C) communication between the County and the City of Rancho Cordova.

Table 2 below summarizes the County's existing communications network, including the type and length of the communications media.

Table 2 – Existing Communications Network Summary

Type	No. of Strands	Mode	Extent (Miles)
Fiber	96	Single	44
Copper	Mostly 20 pr w/	N/A	113

Closed Circuit Television (CCTV) Cameras

There are currently 93 existing Pan-Tilt-Zoom (PTZ) Closed Circuit Television (CCTV) cameras located at key intersections along Arden Way, Calvine Road, Fair Oaks Boulevard, Florin Road, Fulton Avenue, Hazel Avenue, Bradshaw Road, Howe Avenue, Madison Avenue, Watt Avenue and Sunrise Boulevard. The viewing and control of the CCTV cameras is through the County Centracs system. The County can also monitor and control 72 PTZ cameras in Rancho Cordova through the County Centracs system using a Federated Services module on the third party Omnicast software that Centracs uses for video integration. **Exhibit 3** of **Appendix A** depicts the locations of the existing CCTV cameras. County preference is to include a PTZ camera at each intersection. All new installations feature PTZ cameras.

Multi-sensor Video and Radar Detection

All County intersections have some form of detection on all approaches. The majority of existing detection is inductive loops. Sacramento County's current standard for vehicle detection is a multi-sensor hybrid utilizing video for stop bar and radar for advance detection. The standard includes a remote communications interface which allows for real-time viewing of the detection video with the capability to record video on the Omnicast CCTV server. The video detection feature includes vehicle, bike, and pedestrian count capability that are constantly being refined by the manufacturers. The radar detection feature of the multi-sensor units has the capability of collecting count and speed data. This data is readily available for performance measure analytics.

The County currently has 37 intersections with the multi-sensor detection on at least one approach, 33 of which are on the TOC network. All new signal installations and modifications to existing signals that upgrade to multi-sensor detection should ultimately have communication to the TOC.

Bluetooth Readers

Sacramento County currently has three Iteris Velocity Bluetooth readers on Watt Avenue at Jackson Highway, Folsom Boulevard and Fair Oaks Boulevard which communicate with a Velocity server located in the TOC over the DOT LAN. As more data is collected, the Department may want to add additional readers along the major corridors.

Changeable Message Signs (CMS)

Sacramento County owns 3 Changeable Message Sign (CMS). There are two signs in the median on a butterfly mounted pole for EB and WB Madison Avenue between Date Avenue and College Oak Avenue. There is one sign on the north side of Madison Avenue, east of Sunrise Boulevard for the WB direction. The County also maintains and operates one CMS the City of Rancho Cordova inherited from the County located on Sunrise Boulevard, south of Folsom Boulevard for NB traffic. The signs are from US Display Solutions but no are longer supported by the manufacturer. Communication and software issues have degraded sign operations and the County is currently only able to display messages on the EB Madison near Date CMS. **Exhibit 4** of **Appendix A** shows the location of the County-owned CMS.

Annual Daily Traffic (ADT) Vehicle Count Stations

There are 34 vehicle count station locations in Sacramento County, shown in **Exhibit 5** of **Appendix A**. The count stations store data collected by vehicle detector loops. The count data is retrieved from the count stations manually as they are not connected to the County TOC. These count stations are part of the County traffic count program that collects traffic data utilizing pneumatic hose counters, traffic signal detector loops, or staff field observations.

Traffic Management/Operations Center

The County's Traffic Operations Center (TOC) is located at 9630 Conservation Road in the County transportation complex. The TOC was opened in 2001 and was updated in 2011. The TOC consists of a self-contained structure with office space for approximately nine staff members, operations theater, and conference facilities. The operations theater has space for four operators at the console and a video wall for CCTV camera viewing. Real-time traffic cameras are used in the following transportation corridors: Arden Way, Calvine Road, Florin Road, Folsom Boulevard, Hazel Avenue, Howe Avenue, Madison Avenue, Sunrise Boulevard, and Watt Avenue. Staff monitors traffic in these corridors with CCTV cameras and can adjust traffic signals to improve the flow of traffic. TOC staff also respond to accidents, hazardous spills, and other emergencies by changing traffic signal timing when appropriate and posting information on CMS. Staff monitors the CHP CAD site for incidents in the unincorporated county as well as the Google maps traffic display for slowdowns in the region. The console is also equipped with an 800 MHz trunked radio console unit for monitoring public safety, emergency services, and transit channels. The hours of operation of the TOC are 6:30 am to 6:00 pm Monday - Friday.

System Performance

Interconnected traffic signals within the County are currently managed using Econolite's Centracs central management software. The application was last updated in 2011 and has been performing at an acceptable level. County personnel do not feel the application needs to be reviewed, or replaced, and they maintain an annual Software Maintenance Agreement (SMA) that keeps the Centracs and Genetec system at the latest version of software.

Operations & Maintenance

The Sacramento County Department of Transportation (SACDOT) Signal Operations section is responsible for the safe and efficient operation of the County signalized intersections and systems of intersections. Together with Signal Maintenance and Signal Design, it is the duty of the section to ensure that the operation of the signals utilizes the most current timing and design standards to maximize the capacity for the existing conditions in a manner that provides safe and comfortable passage of the traveling public. SACDOT Signal Operations staff are trained regarding Department policies and procedures that have been developed over the last 40 years. Most of these are still relevant but many pertaining to new technologies, ITS practices, and Incident Management need to be updated and/or developed to reflect the current industry standards. It is the goal of the Department to participate in regional transportation management and to work with the rest of the local

agencies to implement Intelligent Transportation Systems (ITS) technologies and techniques across jurisdictional boundaries.

Sacramento County's Traffic Signal Maintenance program maintains and monitors traffic signal infrastructure and operations for motorists, bicyclists, and pedestrians utilizing the County's road system. Maintaining safe and efficient traffic signal operation is a high priority in the County. The signal maintenance section provides coverage 7 days a week, 24 hours a day to ensure proper operation and timing of traffic signals for motorists, bicyclists, and pedestrians travelling in the County. The Signal Maintenance staff is also trained in house utilizing policies, procedures, and practices that have been developed over the past 40 years. Technicians are well versed in maintaining the existing signal traffic control infrastructure but there is still a learning curve for some of the new detection technologies. Network communications design and maintenance and ITS infrastructure maintenance is handled by a "Systems" sub-section which is staffed by Technicians and a Supervisor who have had to "learn on the job". Additional network and Information Technology (IT) training would be of benefit and/or a new classification that incorporates traffic signal and network communications knowledge would be of benefit.

PROJECT DEVELOPMENT PROCESS

To develop a list of projects to enhance Sacramento County's existing ITS network and help to prepare for the implementation of future technologies, a four-step process was utilized:

1. Needs and Gaps Assessment
2. Strategy Selection
3. List of Projects
4. Deployment Prioritization

Each of the steps and their intended outcomes are discussed in further detail below and in subsequent sections of this Plan.

NEEDS AND GAPS ASSESSMENT

The Sacramento County Needs and Gaps Assessment process was conducted using a combination of methods. Existing documents and plans related to transportation and technology relevant to the County and the region were thoroughly reviewed. These needs and gaps formed the foundation for identifying project solutions.

The needs and gaps were identified and categorized by the following distinctions:

- **Infrastructure/Data (D)** – field infrastructure, communications equipment, data, systems/software
- **Operations (O)** – operational enhancement projects and processes, staffing

- **Institutional (I)** – policies, agreements, funding/programming mechanisms, reporting/documenting, training

Table 3 summarizes Sacramento County's Needs and Gaps Assessment.

Table 3 – Sacramento County Needs and Gaps Summary

ID#	Need	Gap
	Infrastructure/Data (D)	
D1	Backbone communications infrastructure	The County is unable to communicate with approximately 250 county-managed traffic signals. The existing communications backbone is comprised of a combination of fiber and copper interconnect. The backbone should be upgraded to all fiber with a combination of fiber, wireless, and Ethernet over Copper on some existing copper is needed for last mile communications.
D2	Robust coverage to acquire real-time conditions	The County does not have ITS infrastructure installed along many county-managed roadways. Approximately half of the existing traffic signals do not have communications to send real-time data back to a central location.
D3	Reliable communications to prevent system downtime	Existing communications infrastructure is approximately one-third fiber and two-thirds copper and the network lacks redundancy. Single points of failure result in catastrophic loss of connectivity to infrastructure.
D4	Maintainable infrastructure and assets	Approximately half of County signal and ITS infrastructure is (close to) end-of-life, no longer supported by the vendor/manufacturer, and does not support newer technology or functionality
D5	Adequate bandwidth in communications to support data sharing	Several long runs of existing copper communications on the network do not have the necessary capacity (bandwidth) to support high resolution data or video transmission.
D6	Programmatic planning for assets and maintenance of assets	The County does not currently maintain adequate ITS equipment inventories for maintenance activities and maintenance is reactive rather than proactive. The County does not have documented maintenance policies or procedures for PTZ cameras, multi-sensor and video detection, communications switches and wireless communication devices.
D7	High-resolution traffic data for real-time operational decision making	Not all County traffic signal controllers support high resolution traffic data collection. The County does not have network connectivity to all traffic signals to support County-wide real-time operations. The County lacks the necessary ITS infrastructure along approximately half the County roadways to collect real-time traffic data.

ID#	Need	Gap
D8	Sharing of camera images to support pre-trip, en- route, and incident	The County does not currently have the ability to share CCTV camera images with partner agencies other than the City of Rancho Cordova, or with the general public.
D9	Reduce impact of light rail preemption on traffic mobility	Light rail preemption negatively impacts traffic signal system coordination and progression along a corridor that results in a reduction of capacity and additional user delays.
D10	Share data between agencies that share a corridor	Software and processes to share planned, real-time, or historic traffic data amongst agencies that share a corridor are insufficient and/or do not exist. Traffic operations by an individual agency along a shared corridor can negatively impact operations along the corridor in an adjacent jurisdiction. Operations along shared corridors are not as efficient as they could be with effective cross agency coordination.
D11	Encourage travel mode shift	There is a limited/insufficient amount of publicly available data for transit and alternate modes of transportation within the County. The County would like to increase transit and alternate transportation options within the County. There is a lack of TNC locations for last-mile transit connections.
D12	Real-time traveler information	There is a limited/insufficient amount of publicly available real-time traveler information within the County. The County has a limited amount of CMS to provide real-time traveler information.
D13	Interactive regional GIS- based inventory	The existing County GIS system has a limited ability to support operations.
D14	Use data to support planning purposes	The County has a limited amount of data to support planning activities. The County underutilizes a maintenance tracking system, Infor Public Sector v8.4.0, for transportation and ITS assets that can be used to more effectively and proactively plan maintenance
D15	CV/AV technology readiness	A large amount of the County's transportation infrastructure does not support CV/AV technologies. Existing County standards and design guidelines do not include any requirements/considerations for CV/AV readiness and/or technology.
D16	Leverage and bolster private sector traveler information services	The County would like to more effectively leverage privately available traveler information data. There is a large amount of third party traveler information available within the County but that data is located in disconnected systems that are unable to share information with one another.
Operations (O)		
O1	Integrate central systems and subsystems	Existing County central systems and applications are not integrated with other County systems and do not support sharing data, especially speed data, vehicle tracking information, and crash data. Existing County central systems and applications are not integrated with other agencies or regional systems.
O2	24/7 access to central systems	Many County central systems and applications are unavailable from outside the County network and do not support remote access. The County needs to be able to more effectively manage the transportation system from outside the TOC and when the TOC is not staffed.

ID#	Need	Gap
O3	Improve traffic operations	Existing County traffic operations staffing levels are insufficient to support traffic operations. The County does not have connectivity to approximately 250 traffic signals which prevents them from being able to remotely manage them.
O4	Trained staff to support maintenance	Existing County maintenance staffing levels are insufficient to support proactive system maintenance. Existing maintenance staff do not have the IT, networking, or systems management expertise required to manage the newer technologies being deployed by the County. There are insufficient training materials or opportunities available to County staff.
O5	Standard operating and maintenance procedures for traffic management	The County needs to update defined policies and documented procedures for traffic operations and maintenance activities including new policies and procedures for ITS infrastructure within the County.
O6	Standard operating and maintenance procedures for incident	The County lacks a set of standard operating procedures for managing traffic incidents. County staff do not effectively communicate and coordinate with other agencies for incident management purposes.
O7	Share regional operation and maintenance responsibilities	The County has shared facilities agreements with several neighboring agencies, however, a region-wide transportation maintenance program does not currently exist.
O8	Improve incident coordination across jurisdictions and with public safety	The County could do a better job coordinating incident response with other agencies and public safety personnel to reduce response times, reduce overall incident duration, reduce impacts to the traveling public, and improve responder safety. The County CAD system is not integrated with other agency CAD systems. The County TOC lacks sufficient staffing to coordinate incident response 24/7.
O9	Improve notification and alerts to travelers	Existing County traveler information systems and sources do not support robust notifications and/or alerts the can be easily or effectively disseminated to the traveling public.
Institutional(I)		
I1	Reliable network security	Existing County transportation personnel do not possess the IT security expertise required to manage existing and future field equipment and networks. More robust security policies and procedures are needed to protect the existing County transportation system and communications network.
I2	CV/AV policy readiness	Existing County policies, procedures, development standards and guidelines do not adequately cover CV/AV technologies.
I3	Funding strategy	The County does not have funding to support many of the Smart Region initiatives. The Sacramento region lacks a funding strategy and/or program to support Smart Region initiatives. The region does not have a technology procurement contract that can be used by individual agencies within the region.
I4	Expand Connected Corridor model	There is a lack of coordinated traffic management and operations along shared corridors within the region. Existing system integration and data sharing within the region are insufficient to support connected corridors.

ID#	Need	Gap
I5	Consistent CAD systems across public safety agencies	The County Sheriff's Department has a CAD system that is used by the County Sheriff, and the City of Rancho Cordova. Serveral other neighboring public safety agencies also have CAD systems that are likely not be integrated with one another.
I6	Shared access to radio communications	The County has access to the regional 800 MHz trunked radio communications but not with the CHP communications system used by other agencies in the region.

DETERMINING THE PATH FORWARD

There are many directions that the County and the region could move toward in implementing solutions to address the needs and gaps. While some gaps point to specific types of strategies that will directly and completely address that gap, other gaps are more difficult to solve and will require a combination of infrastructure, operations, and institutional processes to be implemented to completely address the gap.

Traffic operations and management technology is constantly advancing and evolving, which makes it an important consideration during the formulation of implementation strategies. It is crucial that the implementation process takes full advantage of the existing ITS technologies available while also formulating strategies that align with where technological advancements may be heading. The following are current technology trends that were evaluated for applicability in addressing needs and gaps as defined for the Smart Region Program:

- **Big Data** is becoming readily available as more data is acquired from connected field infrastructure on a near-real-time-basis as well as additional data-rich information from new sources such as probe vehicles, fleet vehicles, and connected vehicles becomes more mainstream. Big Data is about predictive analytics; or more simply, improving our ability to predict and anticipate outcomes. Historically, transportation data has been difficult and costly to obtain but as it becomes increasingly available through GPS, phone apps, and many other sources this is quickly changing. Big Data is already changing the way we plan, analyze, and operate our transportation, and big data will play a large role in affecting the evolution of the Sacramento Transportation Area Network (STARNET).
- **Transportation Network Carriers (TNCs)** – TNCs pair passengers with drivers who provide on-demand service, most often via websites or mobile apps. Services such as Uber and Lyft are examples of the sharing economy. Increasingly, transit providers, including Sacramento Regional Transit (RT), are beginning to provide on-demand transportation services to augment their systems. These services have the potential to address the long-standing challenge of first-mile, last-mile service to expand the reach of existing bus and light rail service.
- **Connected Vehicle (CV)** readiness, both in terms of infrastructure and institutions, was identified as a need and yet full connected vehicle CV deployment is gradually becoming a reality in the

industry. As a result, it is important that the partner agencies are equipped with the infrastructure and projects needed to adapt to those changes and needs. It is important to recognize the changing landscape of technology options with connected vehicles because the federal guidelines have not been finalized. Agency adoption of providing data to or collecting data from a connected vehicle will need to have benefits outlined and likely deployed on a scalable basis until more formal guidelines for adoption and expectations are defined.

- **Autonomous Vehicle (AV)** readiness, in terms of institutions and policies, was identified as a need as AVs are being tested on more and more roadways throughout the Country. Although functioning autonomously, there may be a variety of useful data that could be provided to the vehicle, collected by the vehicle, or shared between AVs that could require an agency role and responsibility.
- **Smart Wayfinding and Citizen Engagement Platforms –** Smart kiosks offer new, interactive ways for municipalities, business improvement districts, and marketing organizations to communicate with the public. Citizens and visitors use touchscreen displays to access a wide variety of information ranging from smart wayfinding and transit planning to locating nearby businesses and entertainment. Cities have the ability to broadcast important service announcements and relay emergency alerts enhancing public safety.
- **Adaptive Traffic Signal Control** enables traffic signals to proactively adjust signal timing parameters to accommodate unplanned variances in traffic demand. There are several adaptive systems in the market, each of which tends to accommodate specific corridor needs (e.g., maximize throughput, minimize side-street delay).
- **Automated Traffic Signal Performance Measures (ATSPM)** is a software module add-on to many traffic signal software applications that processes and analyzes traffic signal data to display and report performance metrics of an individual traffic signal, corridor, and/or across the traffic signal network. This feature enables agencies to proactively identify trouble areas, report on corridor performance, and facilitate efficient traffic management.
- **Vehicle-to-Everything (V2X) Communications** is becoming a highly-desirable system feature that establishes an exchange of data between vehicles and field infrastructure. One example includes Signal Phase and Timing data that enables subscribed vehicles to display when a downstream traffic signal will change. Another example is collecting vehicle location information for collision avoidance or for origin-destination analysis.
- **Internet of Things (IoT)** – Often referred to as “connected devices”, items are embedded with technology such that objects can exchange and collect data. From a streetlight bulb that notifies that it needs changing to roadway sensors that monitor traffic speeds, the opportunities to collect and use data to improve the maintenance and operations of the transportation system are rapidly expanding.
- **Electrification** – The transportation sector is responsible for approximately 36 percent of California’s Green House Gas (GHG) emissions (50 percent when you include refineries) and more than 80 percent of NOx and particulate emissions. In conjunction with the continued addition of renewable energy sources as the basis for electrification, the positive impact of air quality will be

significant. As the location of charging stations continues to expand, electric vehicles will also become increasingly easy to own and operate.

- **Multi-Modal Considerations –** Municipalities and transit providers are also faced with the challenge of embracing technological advancements. These technologies are aimed at improving bicycle and pedestrian safety and mobility, as well as maximizing the efficiency and convenience of transit service. Technological advancements that provide more meaningful real-time and situational awareness information for multi-modal users include detection techniques, minimizing conflicts at traffic signals, fleet management, mobile traveler information, and Automatic Vehicle Location (AVL), among other methods. Multi-modal transportation users are diverse in their ability to provide information as well as receive it, and service providers are already applying technology in equipment as well as systems to provide a greater experience for the user.

Determining the priority of which strategies are applicable to the County requires a careful evaluation of not only the existing conditions of the region (the infrastructure available, the data available, and the propensity for agencies to adopt certain technologies over others) but also the available technology trends that lend themselves toward potentially being solutions to the needs of the County.

IMPLEMENTATION PROJECT DEVELOPMENT

The next step in the project development process was to select strategies to implement with future construction projects. These strategies were created based on the results of the Needs and Gaps Assessment. In addition to the identified needs and gaps, additional deployment parameters were evaluated to help Sacramento County prepare for the transportation network of the future. These elements included:

- Key Emerging Technologies – Project includes provisions for CV/AV technology, multi-modal considerations (including transit), and other important initiatives in the region that are advancing innovative technology deployment.
- Emergency/Disaster Preparedness – Projects facilitate the ability to improve the effectiveness of emergency and disaster response.
- Data Availability – The type and quality of available data, how data set can be improved and/or expanded, and how data can be effectively leveraged once it has been analyzed.
- Project Dependencies – Certain project elements must be constructed before other elements can be advanced.
- Overlap with Other projects – Other projects within the same project area offer efficiencies for construction.
- Safety – Strategy contributes to improved safety.
- Context of Individual Agency – Specifically customized for applicability to each agency.

Strategy Development

Overarching project strategies have been developed to identify a broad set of technology solutions that will address infrastructure/data, operations, and institutional stakeholder needs and system gaps; and to satisfy this deployment criteria. The strategy summary format is provided below and is detailed for each strategy in **Appendix C – Strategy Summary Sheets**:

- **Strategy #** – This is the identification number of the strategy.
- **Title** – This is the title of the strategy.
- **Description** – This is a succinct description of the strategy for context.
- **Relation to Needs** – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.
- **Scope/Limits** – This is a succinct summary of what is included in the strategy and/or locations (if applicable) of where the strategy would be deployed.
- **Considerations** – This is a bullet listing of other strategy ID #'s and Titles that are relevant for the County to reference during implementation or that could be packaged together to be implemented as part of a larger project in a particular timeframe.
- **Prerequisite Dependencies** – This is a bullet list summary of the high-level steps required to implement the strategy.

When all of these strategies are constructed, Sacramento County will have established an overall communications network and field equipment deployment that enables staff to effectively monitor and manage traffic congestion. Infrastructure strategies, inclusive of communications media, CMS, CCTV cameras, detection, and traffic signal controllers, are visually presented in **Appendix B**, which shows the ultimate communication and ITS device deployment in the County.

LIST OF PROJECTS

A list of projects was developed through a comprehensive evaluation of existing County ITS elements (traffic signals, CCTV cameras, video detection cameras, controllers, controller cabinets, etc.). This evaluation included looking at existing gaps in the County communications network. These gaps focused on opportunities to improve reliability and throughput as well as future scalability. To visualize the existing gaps in terms of both intersections and overall corridors, all elements were plotted on GIS figures compiled in **Appendix B**. The GIS figures facilitated the process of looking at potential areas of coordination with Caltrans and other neighboring agencies as well as ways that individual upgrades could be grouped based on proximity. These project groups included upgrades to intersection equipment, traffic signal re-timing, upgraded communications networks and other elements as identified by the strategy worksheets.. All projects identified also included planning-level costs based on the elements to be upgraded. The projects included in this list are recommendations to the County but do not necessarily have to be implemented in the way in which they were grouped. The purpose of this project development process was to be fluid in the deployment of the strategies that were identified. By making the development process be fluid, the County has the opportunity to pick

elements that they would like to include as part of other projects or make certain upgrades within the project list independently of each other.

DEPLOYMENT PRIORITIZATION

After developing the various strategies, strategy element segments and locations are grouped into spcific deployment projects that will be prioritized for implementation. This results in a unique list of implementable projects tabulated in **Appendix D**. In general, strategy elements pertaining to ITS infrastructure improvements have been grouped based on a corridor or geographical location. Projects related to operational and institutional strategies will likely be deployed on a standalone basis.

Prioritization

Infrastructure projects are prioritized based on a set of 10 local and regional criteria and emphasize providing the infrastructure foundation; system and data integration to enhance functionality; and innovative advanced technology solutions when other critical elements are in place. Each criterion was weighted to represent some criteria being more important than others. The 10 local objectives and their weighting value are shown below:

1. **Extent that project achieves local objectives (14)** – project emphasizes addressing local needs
2. **Adaptable to new technology (13)** – can handle new technology without needing to be replaced
3. **Safety (13)**
4. **Addresses multijurisdictional networking (10)** – contributes to a multijurisdictional solution
5. **Improves reliability and consistency of driver trips (10)** – traveler information to drivers helps them make informed and real-time decisions
6. **Improves traveler information and dissemination (10)** – provides more and better information about roadway conditions and multimodal options
7. **Contributes to operational and institutional efficiency (10)** – enables staff to more efficiently manage the transportation network
8. **Enhances major corridors (10)** – corridors that serve more people than other corridors
9. **Emergency/disaster preparedness (5)** – better information to public and more robust system
10. **Other projects rely on this project (5)** – this project must be done before other projects can begin

Each project was given a subjective score of zero (0) to four (4) for each criterion based on its relevancy to the criteria. Project scores were totaled and ranked to identify the highest priority projects. As an example, Project #1 in **Table 4** was ranked using the following scores and weights:

1. Extent that project achieves local objectives (Weight 14): 2/4
2. Adaptable to new technology (Weight 13): 3/4
3. Safety (Weight 13): 3/4

4. Addresses multijurisdictional networking (Weight 10): 3/4
5. Improves reliability and consistence of driver trips (Weight 10): 3/4
6. Improves traveler information and dissemination (Weight 10): 2/4
7. Contributes to operational and instititutional efficiency (Weight 10): 2/4
8. Enhances major corridors (Weight 10): 3/4
9. Emergency/disaster preparedness (Weight 5): 2/4
10. Other projects rely on this project (Weight 5): 3/4

$$Overall\ Rank = \left(14 * \frac{2}{4}\right) + \left(13 * \frac{3}{4}\right) + \left(13 * \frac{3}{4}\right) + \left(10 * \frac{3}{4}\right) + \left(10 * \frac{3}{4}\right) + \left(10 * \frac{2}{4}\right) + \left(10 * \frac{2}{4}\right) + \left(10 * \frac{3}{4}\right) + \left(5 * \frac{2}{4}\right) + \left(5 * \frac{3}{4}\right) = 66.25$$

This Implementation Plan is intentionally structured to be agile and flexible in its implementation to enable the County to quickly identify a candidate project with a concise set of actions and next steps as funding becomes available and opportunities arise, or to reprioritize projects based on specific areas of emphasis.

Cost Estimations

Planning level cost estimations were prepared to reflect an order-of-magnitude cost for each project. A summary of specific costs and considerations related to implementing Smart Region elements is provided for each strategy where a cost can be reasonably estimated. **Appendix E – Cost Assumptions** summarizes the cost assumptions that were used to provide planning level cost estimations for each project, if applicable. These assumptions include a detailed breakdown of capital component costs and acknowledges the project development, design, construction, integration, and operations and maintenance costs associated with each project. The cost information is a planning-level estimate to deploy each project, based on available current (2018) pricing information for similar technology projects in the region.

Throughout development of projects, a distinction was made between projects that carry a cost and those that carry little to no cost. Projects that have costs may require initial capital investments and subsequent ongoing operations and maintenance (O&M) costs. Examples of these projects would be the deployment of new field infrastructure or upgrades to existing Traffic Operations System elements. No cost projects tend to fall into the institutional category and can be deployed with little to no cost and no future O&M costs. Examples of these projects would be the creation of a set of security guidelines, an interjurisdictional agreement, changes to a policy, or completing performance measurement analysis.

List of Prioritized Projects

Table 4 provides a summary of the prioritized strategies. Prioritization for infrastructure projects is presented in **Appendix D – Prioritization Summary**. **Appendix B** provides figures to show the limits and components of each project listed in **Table 4** at the County level. In addition, **Appendix B**

includes a future ITS Buildout figure for the County to help envision what the future of the County would look like if all projects are implemented. The recommendation is that these figures are used to implement projects as the County sees fit (i.e. new development, etc.).

Table 4 –Sacramento County Prioritized Strategy Summary

Priority No. (Score)	Project Corridor	Project Description	Planning Level Cost Estimate
1 (66.25)	Hazel Ave (County limit to Madison Ave); greenback Ln (Fair Oaks Blvd to Folsom city limit); Madison Ave (McKay St to Folsom city limit) **(*Project 1*)**	Project includes coordination across jurisdictional boundaries; connection to the TOC enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect, especially along transit corridors; deployment of vehicle video detection; installation of CCTV cameras; installation of CMS; study and implementation of updated signal timing.	$6,021,000
2 (64.25)	S Watt Ave (Folsom Blvd to Elder Creek Rd); Bradshaw Rd (Folsom Blvd to Jackson Rd); Old Placerville Rd (Bradshaw Rd to Systems Pkwy); Goethe Rd (Mayhew Rd to Bradshaw Rd); Kiefer Blvd (Thornhill Dr to past Bradshaw Rd); Mayhew Rd (Folsom Blvd to Goethe Rd) **(*Project 2*)**	Project includes connection to the TOC; enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination.	$4,836,000
3 (46)	Grant Line Rd (Jackson Rd to Calvine Rd); Jackson Rd (Excelsior Rd to city limit); Sunrise Blvd (Chrysanthy Blvd to Jackson Rd); at Douglas Rd and Sunrise Blvd **(*Project 3*)**	Project include updates in conjunction with the Southeast Connector Project; deployment of vehicle video detection; installation of CCTV cameras; installation of CMS; study and implementation of updated signal timing and coordination.	$592,000
4 (45.75)	El Camino Ave (Ethan Way to Fair Oaks Blvd); Cottage Way (Howe Ave to Watt Ave); Alta Arden Expy (Howe Ave to Watt Ave); Arden Way (Ethan Way from Fair Oaks Blvd); Hurley Way (Howe Ave to Watt Ave); Northrop Ave (Howe Ave to Watt Ave); Sierra Blvd (Howe Ave to Fulton Ave); Fair Oaks Blvd (Fulton Ave to El Camino Ave); Howe Ave (El Camino Ave to Fair Oaks Blvd); Fulton Ave (El Camino Ave to Fair Oaks Blvd); Watt Ave (El Camino Ave to Fair Oaks Blvd); at Tower Ave and Fulton Ave; at Walnut Ave and Cottage Way **(*Project 4*)**	Project includes coordination across jurisdictional boundaries; enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect, especially along transit corridors (what transit corridors); deployment of vehicle video detection; installation of CCTV cameras; installation of CMS; study and implementation of updated signal timing.	$6,948,000

Priority No. (Score)	Project Corridor	Project Description	Planning Level Cost Estimate
5 (45)	Hazel Ave (Madison Ave to Folsom Blvd); Sunrise Blvd (Gold Country Blvd to Coloma Rd); Gold Country Rd (Sunrise Blvd to Hazel Ave); Coloma Rd (Sunrise Rd to Gold Country Rd); Folsom Blvd (Hazel Ave to Folsom city limit); Grant Line Rd (Prairie City Rd to White Rock Rd) **(*Project 5*)**	Project include updates in conjunction with the Southeast Connector Project; enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect, especially along transit corridors; deployment of vehicle video detection; installation of CCTV cameras; installation of CMS; study and implementation of updated signal timing and coordination.	$6,685,000
6 (43.75)	N Loop Blvd (Elverta Rd to Don Julio Blvd); Elverta Rd (Dutch Haven Blvd to Antelope Rd); Antelope Rd (Watt Ave to Roseville Rd); Elkhorn Blvd (32nd St to Diablo Dr); Don Julio Blvd (Watt Ave to N Loop Blvd); Peacekeeper Way (Dudley Blvd to Watt Ave); Bell Ave (Winter St to Forcum Ave); Roseville Rd (Sacramento city limit to Watt Ave); Watt Ave (Center Ct Ln to Roseville Rd); Walerga Rd (Country Run Way to Madison Ave); at Roseville Rd and Daly Ave; at Dudley Blvd and Palm Ave; at Diablo Dr between Lancelot Dr and Woodforest Dr **(*Project 6*)**	Project includes coordination across jurisdictional boundaries; enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect, especially along transit corridors; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination.	$9,350,000
7 (41.75)	Elder Creek rd (S Watt Ave to Bradshaw Rd); Florin Rd (Power Inn Rd to Bradshaw Rd); Gerber Rd (Power Inn Rd to Bradshaw Rd); Calvine Rd (Power Inn Rd to Vineyard Rd); Elk Grove Florin Rd (Gerber Rd to Calvine Rd); Vintage Park Dr (Waterman Rd to Bradshaw Rd); Waterman Rd (Vintage Park Dr to Calvine Rd); Kingsbridge Dr (Vintage Park Dr to Calvine Rd); at Vineyard Rd and W Savona Dr **(*Project 7*)**	Project includes coordination across jurisdictional boundaries; enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect, especially along transit corridors; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination.	$5,264,000

Priority No. (Score)	Project Corridor	Project Description	Planning Level Cost Estimate
8 (40.5)	Watt Ave (Roseville Rd to Auburn Blvd); Madison Ave (Roseville Rd to Auburn Blvd); Auburn Blvd (Norris Ave to Citris Heights city limit); Greenback Ln (Diablo Dr to Citris Heights city limit); at Garfield Ave and Verner Ave **(*Project 8*)**	Project includes coordination across jurisdictional boundaries; enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect, especially along transit corridors; deployment of vehicle video detection; installation of CCTV cameras; installation of CMS; study and implementation of updated signal timing and coordination.	$4,729,000
9 (40)	Watt Ave (Fair Oaks Blvd to Folsom Blvd); Folsom Blvd (Watt Ave to Bradshaw Rd); at La Riviera Dr and Salmon Falls Dr; at American River Dr and Mills Rd **(*Project 9*)**	Project includes coordination across jurisdictional boundaries; enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect, especially along transit corridors; deployment of vehicle video detection; installation of CCTV cameras; installation of CMS; study and implementation of updated signal timing and coordination.	$4,435,000
10 (39.5)	Martin Luther King Jr Blvd (41st Ave to 47th Ave); 47th Ave (Franklin Blvd to Steiner Dr); Franklin Blvd (47th Ave to Elk Grove city limit); Florin Rd (Franklin Blvd to Power Inn Rd); 65th St (Florin Rd to Stockton Blvd); Stockton Blvd (Sacramento city limit to Elk Grove city limit); Gerber Rd (Stockton Blvd to Power Inn Rd); Power Inn Rd (Florin Rd to Elk Grove city limit); Calvine Rd (Elk Grove city limit to Power Inn Rd) **(*Project 10*)**	Project includes coordination across jurisdictional boundaries; enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect, especially along transit corridors; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination.	$5,154,000
11 (35.75)	Auburn Blvd (Bell St to Watt Ave); Marconi Ave (Howe Ave to Fair Oaks Blvd); Fulton Ave (Auburn Blvd to El Camino Ave); Whitney Ave (Watt Ave to Walnut Ave); Watt Ave (Auburn Blvd to El Camino Ave); Walnut Ave (Winding Way to El Camino Ave); Cypress Ave (Walnut Ave to Fair Oaks Blvd); Fair Oaks Blvd (Lincoln Ave to El Camino Ave); Eastern Ave (Whitney Ave to Marconi Ave); at Howe Ave between Shaw St and Burney Way; at Mission Ave and Donnie Lyn Way **(*Project 11*)**	Project includes enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect, especially along transit corridors; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination.	$3,345,000

Priority No. (Score)	Project Corridor	Project Description	Planning Level Cost Estimate
12 (30.75)	Walnut Ave (Auburn Blvd to Winding Way); Coyle Ave (Auburn Blvd to Dewey Dr); Madison Ave (Auburn Blvd to Fair Oaks Blvd); Winding Way (Garfield Ave to Sunrise Blvd); Fair Oaks Blvd (Wayside Ln to Sunrise Blvd); Sunrise Blvd (Madison Ave to Fair Oaks Blvd); at Dewey Dr and Linda Sue Way; at Dewey Dr between St. James Dr and Will Rogers Dr; at Fair Oaks Blvd and Via de Palmas Ln **(*Project 12*)**	Project includes enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect; deployment of vehicle video detection; installation of CCTV cameras; installation of CMS; study and implementation of updated signal timing and coordination.	$6,059,000
13 (18.75)	Elkhorn Blvd (Marysville Blvd to 16th St); Northgate Blvd (N Market Blvd to Sacramento city limit); N Market Blvd (Gateway Park Blvd to Northgate Blvd); at Dry Creek Rd and G St; at Rio Linda Blvd and M St; at Del Paso Rd and Blackrock Dr **(*Project 13*)**	Project includes enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect, especially along transit corridors; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination.	$1,354,000

FUNDING

Implementation of many of the projects identified by this Plan are contingent upon acquiring additional funding. The following are potential funding opportunities for ITS infrastructure and systems that are described in additional detail below:

- Local Funding Programs
- SACOG Funding Programs
- State Funding Programs
- Federal Funding Programs
- Grants/Pilot Programs
- Other Funding Types

Local Funding Programs

Sacramento County has a Transportation Improvement and Program Guide (TIPG) that provides a range of information including regional, federal, and state funding opportunities. This Plan serves as a reference for basic funding information. In general, this document is updated yearly and projected out five-years. Local projects typically need to be included in this regional document to receive funding.

SACOG Funding Programs

SACOG offers a variety of different annual funding programs for public agencies within the region. The funding programs relevant to ITS projects are shown in **Table 5**.

Table 5 – SACOG Funding Programs

Program	Funding Amount	Criteria	Performance Outcomes Measured for Selection
Regional Program	$92,586,000 Amount given and to how many projects will vary depending on applicants	• Eligible for CMAQ, RSTP or STIP funds • Listed in recent MTP/SCS or fit within a lump-sum project category • Must match 11.47% of award with non-federal funds • Begin construction or operation before April 2025	• Reduce regional VMT per capita • Increase multi-modal or alternative travel choices • Provide long term benefits, sustaining both rural and urban economies • Improve movement of goods, in and through the region • Improve safety and security • Maintain and improve upon the existing transportation system

Program	Funding Amount	Criteria	Performance Outcomes Measured for Selection
Green Region	$11,760,000 Amount given and to how many projects will vary depending on applicants	• Eligible for CMAQ, RSTP or STIP funds • Must match 11.47% of award with non-federal funds • Begin construction or operation before April 2021 • Request for construction funding demonstrates that environmental, engineering and right-of-way will be ready by the time funds are requested • Agency is capable of on-going O&M costs	• Reduce regional VMT per capita • Increase multi-modal or alternative travel choices • Advances the use of electric and other zero-emission vehicles • Project exists within at least one of the Green Region Plan program areas.
TDM Innovations Grant	$750,000 Awards of $25,000-$150,000 per project	• El Dorado, Placer, Sacramento, Yuba, Yolo and Sutter Counties • Must match 11.47% of award with non-federal funds • Program must be active within 2 years of an agreement being signed • Include a detailed project budget and how funding will be used • Must demonstrate link between project and grant program's goal to reduce SOV trip and miles • Demonstrate how the project will serve underserved or insecure communities • Demonstrate creativity and appeal to a broad audience	• Innovative and Uniqueness of Project (40pts) • Potential for project to reduce motor vehicle trips and miles (15pts) • Target/Market Audience Development (15pts) • Description of plan to measure VMT reductions, data collection/analysis and project modification/ adaptability (25pts) • Budget & project cost/participant (5pts)
Regional Active Transportation Program	$11,664,000 ($439,560 Statewide) Amount given and to how many projects will vary depending on applicants	• Projects must first complete in Statewide ATP program before being eligible for smaller MPO programs • Must match 11.47% of award with non-federal funds	• Disadvantaged communities • Potential to increase users (biking/walking) • Public participation and planning • Potential to reduce crashes (fatalities and injuries)
Metropolitan Transportation Improvement Program	Varies based on available federal and state funds	• Projects must be included in the Metropolitan Transportation Plan (MTP) • Application opportunity every odd year	• Prioritized alongside other submitted projects. Funds are allocated based off prioritization.

State Funding Programs

The State Highway Account is essentially a bank account that funds a variety of California programs for transportation and traveler mobility purposes. The SHA receives its funds from the State Base Excise Tax and the Federal Highway Trust Fund. Some of these programs include:

Highway Safety Improvement Program (HSIP): HSIP funds are administered by Caltrans. Caltrans-initiated safety projects are eligible for HSIP funding if they are participating with a local agency. These projects typically included updated traffic signals or other projects that lend themselves to cost sharing between agencies. The application for HSIP funding must come from the local agency who is partnering with Caltrans on a safety project.

Senate Bill 1 (SB-1): SB-1 is the Road Repair and Accountability Act of 2017, which confirmed a legislative packaged that invests $54 billion over the next decade to fix roads, freeways, and bridges across California, while also addressing safety, congestion, accessibility, economic developed, air-quality and land use issues. Caltrans will receive roughly half of the allotted SB-1 funds, receiving $26 billion for state-maintained transportation projects. The California Transportation Commission administered the funds and evaluates funding allocation.

Additional programs that are relevant to Smart Region projects have been identified in **Table 6**.

Table 6 – State Transportation Funding Opportunities

Program	Important Dates	Funding Information	Criteria
State/ Regional/ Interregional Transportation Improvement Program (STIP/RTIP/ ITIP)	• Multi-year CIP • Cycle begins in odd-numbered years with the release of fund estimate in July. • December 15th of odd-numbered years the ITIP/RTIP/STIP is submitted • Next opportunity for this funding will be July 2019	• Local agencies work with their MPO to get their projects included in the RTIP for nomination	• Must include a Project Study Report (PSR) or an equivalent for non-State Highway projects • Caltrans/Regional consultations for projects are to be included in the STIP/RTIP/ITIP • Evaluated on how the project aligns with furthering regional objectives, particularly for Sustainable Communities Strategies • STIP Guidelines
California Transportation Commission Active Transportation Program (CTC ATP)	• Distributed annually	• 40% of funds go to MPO's in urban areas • 10% of funds go to small urban or rural communities and awarded by the Commission on a competitive basis • The remaining 50% is competitively distributed on a statewide basis	• Selected through a competitive process and meet one or more ATP program goals. • Minimum funding request is $250,000 • ATP Guidelines

Federal Grant/ Pilot Funding Programs

Many federal programs distribute money directly to the State, which distributes the funds based on local policies or award programs. One example of this type of funding is described above in the State Highway Account which receives a portion of its funding from federal programs. Other programs are described below.

Surface Transportation Block Grant Program (STBG): The STBG is an approved funding program through at least 2020. Infrastructure-based ITS capital improvements, including the installation of vehicle-to-infrastructure communication equipment, are eligible for the grant. In addition, operational improvements (including capital and operations costs) for traffic operations facilities, environmental measures, and some parking strategies are eligible. The project must be identified in a Statewide Transportation Improvement Program (STIP) and be aligned by long range Metropolitan Transportation Plans. Federal share is generally 80% although there are stipulations that allow for a full 100% share or as low as 50% federal share and is determined by project type per 23 U.S.C. 120.

Better Utilizing Investments to Leverage Development (BUILD) Grants: The BUILD program has replaced the Transportation Investment Generating Economic Recover (TIGER) grant program and grants are awarded on a competitive basis for projects with significant regional or local impacts. These grants are designed to benefit surface transportation systems while providing further support to rural communities. A greater share of BUILD grants will be awarded to projects located in rural areas. $1.5 billion dollars has been made available for BUILD grants through September 2020. BUILD funds may cover up to 80% of project costs in urban areas and 100% of project costs in rural areas. During the 2018 cycle, the maximum project award is $25 million and a single state cannot receive more than $150 million. The application deadline for BUILD grants is late July of each year.

The Nationally Significant Freight and Highway Projects (INFRA) Program: The INFRA Grants program provides dedicated, discretionary funding for projects that address critical issues facing our nation's highways and bridges. In 2018 approximately $1.5 billion in INFRA Grants will be awarded to projects across the country.

Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD): ATCMTD is a competitive grant program that funds projects related to many ITS objectives. The grant serves to fund installation of transportation technologies that can improve efficiency, safety, and system performance. A state, local, transit, or Municipal Planning Area (MPA) agency is eligible to apply. In addition, a multijurisdictional group can apply with a signed agreement. A maximum of $60 million is available each fiscal year through 2020. A 50% minimum local match is required. Single project awards will not exceed $12 million and there will be between 5 and 10 grants awarded. Applications are invited during the Spring of each year.

Transportation Infrastructure Finance and Innovation Act (TIFIA): TIFIA is not a grant or traditional funding program but is a credit assistance program awarded to qualified projects of regional or national significance. TIFIA credit assistance is available to federal ITS projects of at least $15 million and the credit assistance is limited to 33% of the total eligible project costs.

Other Funding Types

Other funding opportunities that the County could utilize to help support their ITS Program include:

Safety/Emergency Projects/Initiatives: Partnering with other departments or emergency/safety agencies to include ITS components or to identify additional data that can be obtained from emergency/safety service systems could be mechanisms used to expand the ITS program or data that is available. An example might be a project to upgrade the radio network of the Police Department, or dynamic emergency vehicle routing.

Establishing Open Funding Streams: Some states and MPOs have developed alternative methods for financing congestion reduction efforts, including ITS projects. Supplemental traditional funding sources could include: tolling, local/regional sales tax measures, or other fees; and developing partnerships with private industry.

Public/Private Partnerships (P3s): P3s can provide alternative funding sources for transportation projects when a public agency enters into a partnership/agreement with a third party private company. Essentially, the public agency brings in a private-sector firm who provides development, operation, and financing mechanisms for the transportation project. P3s have become more popular as public resources become more limited and the demand for improved transportation systems continues to increase. There are benefits and limitations to engaging in a public/private partnership, so it is important to weigh those factors prior to P3 implementation.

OPERATIONS AND MAINTENANCE

To effectively operate and maintain the various project elements and projects identified in this Implementation Plan, Sacramento County must be adequately staffed and prepared to sustain the system after it is deployed. Operations and maintenance procedures are essential to define the appropriate staffing levels, training, operational processes, and maintenance plans necessary to sustain an effective system.

Staffing

Staffing serves the operations side of the Implementation Plan. The successful implementation of operations strategies is largely dependent on providing appropriate staffing relative to the increase in operational capabilities.

Sacramento County has seen steady population growth over the last few decades. The last decade in which there was a decrease in overall population was from 1910 to 1920. Since then, the County has experienced steady growth, and its growth rate from 2016 to 2017 was approximately 3.27%.

Sacramento County has experienced rapid development and population growth and anticipates that this growth will continue into the future. While growth in Sacramento County is a positive, the County must make sure that it is planning for the projected growth as it takes on more projects, expands its infrastructure and services, and offers more to residents and visitors.

The County is aware of its growing population and is looking to improve its transportation and ITS networks in various ways. They are looking to increase staff to better serve the proposed developments in the area.

Sacramento County's traffic operations and maintenance staff consists of:

- One (1) Senior Civil Engineer;
- Two (2) Associate Civil Engineers;
- One (1) Assistant Civil Engineer; and
- One (1) Engineering Technician.
- Additionally, traffic signal maintenance is provided by 21 technicians and supervisors, and a Senior Maintenance Manager.

To date, there has not been clear recognition of the staff time and costs associated with traffic signal and ITS projects. Inventory of transportation assets in the County has been steadily increasing without a corresponding increase in staff to operate and maintain them. This has created a situation where the County is understaffed for operations as well as for maintenance of the traffic signal and ITS network infrastructure. The County receives signal maintenance support from several technicians and supervisors, but it should be noted that these technicians also maintain approximately 80,000 street lights throughout the County. In addition to maintaining these street lights, technicians are also in charge of County USA markings. Several of the technicians providing signal maintenance support for the County also serve as supervisors, which further limits the amount of available staff to actually perform maintenance work.

Staffing the Smart Region Program

Sacramento County should follow a well-crafted staffing plan that addresses five key objectives:

1. Ensure appropriate staffing levels based on increasing and aging assets;
2. Ensure the organization employs staff with the requisite knowledge, skills, ability, and other characteristics in the appropriate positions when needed;
3. Ensure that the organization adapts to changes internally and externally;
4. Provide a systematic approach for human resource management; and
5. Provide a shared vision of human resource functions.

Table 7 provides recommended ratios for the number of devices or signals to warrant one staff person for small, medium, and large jurisdictions based on the total number of devices or signals the jurisdiction should operate and maintain. Operations staff are responsible for daily monitoring and use of transportation management assets. Engineers are responsible for conducting analysis of system performance and developing solutions. Maintenance staff are responsible for preventative and routine servicing of field assets.

Table 7 – Staffing Ratios for Operations and Maintenance

Sacramento County Total Values	Number Of:	Small	Medium	Large
County signals: 512	Signals	< 50	50 – 200	> 200
County ITS devices*: 229	Devices	< 100	100 – 300	> 300
Recommended Staffing Ratios**	**Number Of:**	**Small**	**Medium**	**Large**
Operations	Devices	25 : 1	50 : 1	75 : 1
Engineer	Devices	100 : 1	100 : 1	100 : 1
Maintenance/Technicians	Signals	40 : 1	40 : 1	40 : 1
Maintenance/Technicians	Devices	100 : 1	100 : 1	100 : 1

** ITS devices include: vehicle detection devices, CMS/EMS, CCTV cameras, HAR, RWIS, ramp meters and miles of fiber.*

*** Using ITE recommendations for staffing ratios per device from Traffic Control Systems Operations – Installation, Management and Maintenance which recognizes the difference between large, medium, and small agency size ratios. Values were verified to be consistent with other more recent sources such as Traffic Signal Operations and Maintenance Staffing Guidelines (FHWA-HOP-09-006) and other agency publications around the country.*

Based on the guidelines, Sacramento County is considered a large agency.

Table 8 provides a summary of the existing and future number of devices and staff recommendations to support the desired infrastructure and functionality envisioned through this Plan. As shown, recommended staff under full build out conditions includes up to 10 ITS operations staff and 19 ITS/signal maintenance staff based on the recommended staffing ratios.

Table 8 – Staffing Recommendations for Sacramento County

Sacramento County	# of ITS Devices*	Operations Staff – Devices (75:1)	Engineering Staff – Devices (100:1)	Traffic Signals**	Maintenance Staff – Signals (40:1)	Maintenance Straff – Devices (100:1)	Total Maintenance Staff
Existing Conditions	229	4	3	512	13	6	19
Full Buildout	693	10	7	512	13	6	19

** ITS devices include: Closed Circuit Television Cameras, Changeable Message Signs, miles of fiber (1 mile of fiber is equivalent to 1 device), and communication hubs.*

*** Traffic signals encompass traffic lights, controllers, battery back-up, video or loop detection system, EVP/TSP, copper signal interconnect, ethernet switches.*

Staffing Considerations

County officials have indicated that they do not believe that existing operations and maintenance staffing levels are sufficient to manage the County's existing traffic signals, ITS infrastructure, central systems, and communications network. One specific need identified by the County included a full time TOC Systems Manager to help manage these assets, systems, and networks. The County identified a need for more technicians with IT and networking expertise as well as experience working with newer Smart Region technologies like DSRC and 5G wireless communications.

Based on common industry standards and the ITE recommendations referenced above, current County staffing levels require more staff to operate and maintain existing County transportation system. Adding additional traffic signals, ITS infrastructure, and/or Smart Region functionality desired by the

County and identified within this Plan will require additional operations and maintenance staff to be hired by the County. As part of the Smart Region project, the County should monitor existing staffing levels and make program and organizational adjustments to better align with County needs and priorities. In addition to the staffing levels recommended in **Table 8,** the County should consider additional staff to be added for monitoring special events and peak hour operations. In other agencies around the country, on-call staff has filled this role. The typically recommended staffing is at least one on-call operator and one on-call manager. These roles can be fulfilled both remotely or on site at the agency TOC. Though the roles can be fulfilled remotely, it helps to be at the agency TOC to get a better overall sense of operations, especially in cases where there are special events happening. In some cases, a local police officer or other public agent has been brought on to be trained as an operator and to provide additional assistance to an operator or on call manager.

There are regional staffing structures for operations and maintenance that are being recommended to SACOG to help support individual local agencies and their ability to support Smart Region initiatives. These regional structures may alleviate some of the need for additional staffing at the County level, although it is recommended that each individual agency evaluate their own staffing needs prior to adding and integrating additional equipment and infrastructure.

When planning for additional or adjusted staffing to account for Smart Region improvements, the County should consider the following:

- **Heightened Skill Set** – Central management systems are undergoing fundamental changes, including the introduction of more sophisticated technologies, a shift to integrated operations (multiagency, multimodal), and improvements to customer service capabilities. Increasing demand requires more employees and the necessary knowledge, skills, and abilities to handle the demand. In many cases, personnel required to manage multijurisdictional systems have an Information Technology background and skill set that includes network management, software development, database administration, and application troubleshooting. Although engineering skill sets or a professional license may be warranted for specific activities such as signal timing plan development, an engineer may not always be necessary to fulfill other agency functions. Each agency should consider a combination of personnel skill sets as they relate to the individual agency requirements to fulfill operational functions.
- **Redundant Support Structure** – It will be important to foster and maintain staff skills and redundancy through greater training and cross-training so that there is more than one person with the knowledge and skill set required to operate and maintain ITS equipment and systems.
- **Central System Management Architecture** – Another major factor that has a significant impact on staff planning is whether the central management system operations function out of a traditional TMC with workstations and a video wall, or if the central management system is operated on a virtual basis with a few City offices having permissions-level access to certain parts of the system.

Configuration Management Plan

Configuration Management (CM) is a series of processes and procedures that create a holistic approach to effectively control system change. A Configuration Management Plan (CMP), when put

into action, will help agency develop and maintain components of a transportation management system and provide visibility and traceability of the system's performance, function, and physical attributes. As changes to the system are proposed, a CM process provides a consistent approach to identifying, evaluating, and implementing them in a way that considers impacts to the entire system and minimizes potential adverse effects of uncoordinated change.

Proper configuration management enables an organization to answer the following questions:

- What is the process for making changes to the system?
- Who made a change to the system?
- What changes were made to the system?
- When were the changes made?
- Why were the changes made?
- Who authorized the changes?
- How potential changes will impact other systems/components?

A CMP should have the following elements:

An **Introduction** that details the purpose of the document, the background of the agency network and system for which the CMP is being developed, the nature of changes that occur in the system, and a list of references used in preparation of the document.

A **System Overview** that provides a description of the transportation system and data network that is accounted for in the CMP, including critical software and hardware components and network connections.

A detailed description of the **Configuration Management Components** of the CM process:

- **Organization and Responsibilities** – details key positions in the configuration management system and lists their responsibilities. This might include identification of a Configuration Management Control Board, which often has the decision-making function of reviewing and approving or rejecting all requested changes for hardware, software, and documentation that are under CM control.
- **Configuration Identification** – identification of individual hardware, software, and document components (Documents might include plans sets and drawings, software maintenance agreements, product warranties, and other guiding documents or contracts) that are under CM control and the process for identifying the configuration status of each. Proper configuration identification answers the following questions: What is the configuration of the system? What are the components of the system? What are the versions of the system components?
- **Configuration Change Control** – establishes mechanisms that will help ensure the integrity of the system in light of changes that are made to the configuration status of components. Configuration change control identifies and maintains configuration baselines for CM components and the overall system and documents a change control process to be followed.

- **Configuration Status Reporting** – a status record of all items in the infrastructure baseline, thus providing traceability of all changes to the infrastructure. While Change Control considers the process for identifying and making changes, Status Reporting documents configuration status and how and why the system has arrived in its current state.

A **Configuration Management Process** that depicts and outlines the specific sequence of CM activities to identify, evaluate, test, approve, and implement proposed configuration changes to system components. This process will be used in all circumstances where system components are being added, altered, or removed, and it can support system and device lifecycle planning and maintenance planning.

Once a CM program has been established and accepted by the staff (as documented in the CM plan), the program must be used on future system upgrades and new initiatives. For example, Requests for proposals should include language consistent with the CM plan, and contracts for consultants, contractors, and developers can include expectations for how they conduct themselves in accordance with the program.

Maintenance Plan

Planning for ITS operations and maintenance costs is a critical component when developing an implementation project. Operation and maintenance of ITS technologies and systems extends beyond simply keeping the equipment working. The County will need to maintain ITS devices and systems and will require appropriate training to serve in that role. Reacting to emergency failure conditions, maintaining accurate maintenance logs, and conducting preventative maintenance programs all require fully-trained staff. Maintenance of ITS devices will require an allocation of funds within the County budget. A maintenance management system can also be used to track failures and decrease the time needed to repair the failures.

The maintenance plan identifies the criteria for replacement and preventative maintenance and the need for ongoing support for ITS devices and systems. The number of devices and systems that need to be maintained throughout the County will increase in the near-term based on the programmed ITS infrastructure projects. These devices and systems need to be appropriately maintained and effectively operated to provide accurate, reliable, and timely information

The following three maintenance types are included in this section to recommend maintenance activities based on general guidelines for each type of device, rather than required activities, to allow the County to identify areas where maintenance activities could be introduced based on resource availability:

- **Preventative Maintenance** – What to do to prevent failure – This encompasses a set of checks and procedures performed at scheduled intervals including inspection, record keeping, cleaning, and replacement.
- **Responsive Maintenance** – What to do when something fails – This is the initial reply by field maintenance staff to an ITS subsystem or malfunctioning device. Response maintenance includes

minor maintenance activities, major maintenance activities, and major rehabilitation/upgrade activities.

- **End-of-Life Replacements and Upgrades** – What to do when something cannot be fixed – This can be required if the device has experienced frequent malfunctions, failures, or has reached end-of-life and it is more cost-effective to replace the technology rather than continue to maintain it.

Roles and responsibilities, maintenance guidelines, and requirements of the ITS group maintenance staff should be updated to include preventative maintenance, responsive maintenance, and replacement of ITS devices and systems

Preventative Maintenance

Preventative maintenance is performed to ensure the reliability and longevity of the mechanical and electrical operations of the system and will reduce equipment failures, response maintenance, road user costs, and liability exposure. Preventative maintenance involves repetitive upkeep to allow devices and systems to operate efficiently and effectively to maximize the operating lifespan of ITS devices. Preventative maintenance includes minor and major maintenance needs, making the frequency of maintenance an important consideration.

The preventative maintenance activities and frequency varies by device, device components, and system, which are outlined in **Table 9**. The County can refer to this table when incorporating new signals, new ITS infrastructure, or new staff. The County should review and revise the preventative maintenance procedures on an annual basis to ensure new issues are being addressed and equipment is being properly maintained.

Table 9 – Preventative Maintenance Recommendations

Intersection PM Checklist	Recommended Interval
Interior Cabinet Check	
Clean Cabinet Interior Check controller lamp and door switch Check filter Check door fit and gasket Check locks and hinges Check/verify for cabinet timing and log sheet Check field block terminal connections Signal controller battery backup check	Annual
Check conflict monitor indications Check all detectors	Quarterly
Exterior Cabinet Field Check	
Check condition of cabinet exterior Check all signal indications Check all pedestrian indications Check pole conditions and hand hole covers	Annual
Check all signal head back plates and visors Check alignment of signals and pedestrian heads Check condition of pull boxes and lids	Quarterly
Intersection Field Check	

Intersection PM Checklist	Recommended Interval
Visual check of all traffic signs at intersection Visual check of intersection luminaries	Monthly
Visual check of all traffic loops	Quarterly
Visual check of other traffic system related cabinets	Annual
Typical CCTV Checklist Items	
Visual check of assembly CCTV receiver Video transmitter Fiber distribution unit Cabinet equipment Pole or exterior condition	Annual
Typical Message Sign Check List Items	
Field intersection Sign panel Pull boxes Cabinet exterior Cabinet interior Re-lamping	Every six-months

Responsive Maintenance

ITS devices and systems have specific maintenance requirements per the manufacturer's maintenance manual of each device. There are three types of maintenance that ITS devices require to fulfill their intended design for operations and lifecycle:

- **Minor Maintenance** – Minor maintenance includes tasks which can be carried out without large scale testing or the use of heavy equipment. It includes visual inspections and checking of many items, elementary testing, cleaning, lubricating, rebooting/resetting, and minor repairs that can be carried out with hand tools or portable instruments.
- **Major Maintenance** – As well as all items normally done under minor maintenance, major maintenance also includes extensive testing, overhauling and replacement of components, which may require a scheduled power outage and the use of bucket trucks or other heavy equipment.
- **Major Rehabilitation** – Major rehabilitation or complete replacement is contemplated for devices that experience frequent or recurring malfunctions or failures.

Table 10 identifies a rule-of-thumb frequency of minor and major maintenance and major rehabilitation for a range of ITS devices that the County may be implementing. These guidelines should be reviewed and updated annually to reflect actual needs for County facilities.

Table 10 – ITS Device and Network Communications Maintenance Guidelines

Equipment	Minor Maintenance	Major Maintenance	Major Rehabilitation
Traffic Signal Systems			
Cabinets	26 weeks	2-5 years	10 years
Signal Heads	26 weeks	2-5 years	10 years
Electronics	13 weeks	N/A	N/A
Traffic Signal Controller	26 weeks	2-5 years	10-15 years
Poles	26 weeks	5 years	15 years
CCTV Camera Systems			
PTZ Units	26 weeks	1 years	3 years
Changeable Message Signs			
Sign Case	-	26 weeks	1.5 years
Protective Devices	26 weeks	1 year	2 years
Pixels, Modules and Drivers	-	26 weeks	3 years
Controllers	-	26 weeks	3 years
Vehicle Detection Systems			
Cabinets	-	26 weeks	10 years
Power Supply	26 weeks	5 years	10 years
Emergency Vehicle Preemption (EVP) / Transit Signal Priority (TSP)	26 weeks	2-5 years	10 years
Loop Detection (per approach)	26 weeks	1 year	5 years
Video Detection (per intersection)	26 weeks	1 year	5 years
Travel Time Readers (per location)	26 weeks	1 year	5 years
Pedestrian Detection (per intersection)	26 weeks	1 year	5 years
Grounding	-	2-5 years	10 years
Controllers	-	26 weeks	3 years
Telecommunication Systems			
Fiber Optic Cable Plant	1 year	5 years	25 years
Communication Switches (field)	26 weeks	1 year	3 years
Wireless Radio Spread Spectrum	26 weeks	4 years	10 years
TMC Equipment			
Servers	26 weeks	1 year	2 years
Communication Switches (TMC/Hub)	26 weeks	1 year	3 years
Rack Equipment	-	1 year	2 years
Workstations	26 weeks	2 years	2 years
Workstation Displays	26 weeks	1 year	3 years
Uninterruptable Power Supply	1 year	5 years	10 years

Data source: Recommended Practice for Operations and Management of ITS (ITE Publication); and International Municipal Signal Association (IMSA) Preventative Maintenance of Traffic Signal Equipment Program.

Development or integration of a maintenance tracking system would be beneficial to keep an inventory of maintenance activities that have occurred on each device. The County's responsive maintenance tracking should consist of the following maintenance activities:

- Failure detection;
- Work order creation;
- Dispatched resources;
- Response activities;

- Diagnosis;
- Interim repairs; and
- Work order close out.

This tracking will allow the County to identify devices that are not reliable or accurate or have had frequent malfunctions. The tracking will also allow the County to identify appropriate cases for technology replacements where maintenance of an existing technology may be costlier than upgrading to a newer technology. Developing periodic reports and then reviewing those reports are critical to being able to identify frequently failing devices for replacement.

End-of-Life Replacements and Upgrades

End-of-life replacement strategies and upgrades are an important aspect of technology projects because equipment and infrastructure needs to be maintained and/or replaced in a routine manner. Equipment replacement is required if a device has exceeded its life expectancy, either through a sunsetting of manufacturer servicing or a failure in legacy equipment. Equipment upgrades are required when additional functionality is needed that cannot be provided by legacy equipment. This section provides information about what Sacramento County's replacement needs are, recommended equipment lifecycle timeframes, and mechanisms available for procurement and maintenance.

Agency Replacement Needs

Sacramento County should establish an inventory of modernized, supplemental traffic and ITS equipment for replacement of devices in the field as they reach end-of-life or become broken. A typical method for establishing an inventory is to keep 10% of existing field devices for each type. A proper inventory of devices and spare parts that can be accessed to conduct routine and emergency maintenance also needs to be built into the County's budget cycle. As an example, for every 100 cameras deployed across the transportation network, the County should have at a minimum ten (10) cameras in inventory to be able to be responsive and make repairs/replacements when needed.

Lifecycle Replacement

To adequately prepare for necessary infrastructure updates in the future, the County should consider the estimated lifespan of its infrastructure. Lifecycle replacement mechanisms will need to be developed to stay up-to-date on equipment replacement needs and emerging technology availability. **Table 11** should be used as a reference tool for Sacramento County so that equipment remains current and performs at an optimal level.

Table 11 – Anticipated Technology Lifecycle Timeframes

Equipment	Anticipated Lifecycle Timeframe (Years)
Traffic Signal Systems	
Cabinets	20
Signal Heads	20
Electronics	10
Traffic Signal Controller	15
Poles	50
CCTV Camera Systems	
PTZ Units	10
Changeable Message Signs	
Sign Case	10
Protective Devices	10
Pixels, Modules and Drivers	6
Controllers	6
Vehicle Detection Systems	
Cabinets	20
Power Supply	20
Emergency Vehicle Preemption (EVP) / Transit Signal Priority (TSP)	10-15
Loop Detection (per approach)	5-15
Video Detection (per intersection)	10
Pedestrian Detection (per intersection)	10
Grounding	25
Controllers	7
Telecommunication Systems	
Fiber Optic Cable Plant	25
Communication Switches (field)	5-8
Wireless Radio Spread Spectrum	20
TMC Equipment	
Servers	5
Communication Switches (TMC/Hub)	5-8
Rack Equipment	5
Workstations	5
Workstation Displays	5
Uninterruptable Power Supply	20

Agency Replacement Strategy

The County should consider conducting a full inventory of all existing ITS equipment currently installed. Once completed, considering the date of installation of all existing ITS equipment and the expected lifespan of each device according to **Table 10**, the County can initiate a replacement strategy to proactively procure and upgrade/replace legacy equipment. Based on the current number of County maintenance staff, recommendations for replacements of equipment are as follows:

- 25 controller cabinets per year
- 25 traffic signal controllers per year
- 15 CCTV cameras per year
- 25 video detection units per year
- 5 miles of fiber optic cable per year

- 25 communications switches per year
- 1 communication hub switch and equipment per year

PERFORMANCE METRICS

Performance metrics are used to evaluate and demonstrate the effectiveness of Sacramento County's implementation projects in addressing local and regional goals and objectives. Recommended data types, data sources, and calculations to evaluate performance of projects are provided in **Table 12**. As projects are delivered, Sacramento County can use these metrics as a guideline to evaluate projects.

Table 12 – Performance Metrics to Perform Project Evaluations

Objective	Performance Metric	Data Type	Source	Calculation
Improve Access to Traffic Data	Increase Capacity of Communications Network	Fiber/Wireless/Bandwidth Usage	TMC System	Measure communications network capacity before and after ITS device deployment
	Reduced Downtime	System Errors/Failure	System Operations	Compare Downtime Incident Occurrences before and after project implementation
	Reduced Public Complaints	Public Complaints	TMC, TOC and other Operator Records	Compare the amount of public complaints related to inconsistency/unreliability from before and
Automate and optimize traffic operations to maintain lower staffing levels	Reduced Travel Time and Delay	Travel Time	Agency TMC	Travel time in minutes between Point A and Point B prior to and after project implementation along transit corridors
	Reduce Response Time to Device Failures	Response Time	TOC and Dispatch Records	Measure reduction in response times before and after project implementation
	Reduced Public Complaints	Public Complaints	TMC, TOC and other Operator Records	Compare the amount of public complaints related to inconsistency/unreliability from before and after implementation project

Objective	Performance Metric	Data Type	Source	Calculation
Expand transit connections and operations	Reduced Travel Time and Delay	Travel Time	Agency TMC	Travel time in minutes between Point A and Point B prior to and after project implementation along transit corridors
	Increased Transit Ridership	Sales/Revenue	Transit TMC and Transit Provider Records	Count ridership levels before and after project implementation, calculate percentage change
Accommodate **smart** transportation **strategies** for urban, suburban, and rural communities	Reduced Travel Time	Travel Time	Agency TMC	Travel time in minutes between Point A and Point B prior to and after project implementation
	Increased Transit Ridership	Sales/Revenue	Transit TMC and Transit Provider Records	Count ridership levels before and after project implementation, calculate percentage change
	Incident detection by CCTV cameras	CCTV Images	Agency TMC	Count incidents that are detected via CCTV camera before being identified by public
	Accurate Travel Time Estimates (particularly focused on rural and suburban communities w/ commuting needs)	Travel Times	Agency TMC	Compare travel times estimated and actual travel times to verify accuracy for those commuting into urban centers from rural or suburban communities
Prepare for **smart** region **infrastructure** adapting to new technology	Number of hours (in 6-month intervals) of continued education or training completed by staff	Training Hours	CE courses, Vendor Training Seminars, etc.	Count hours staff spent attending new technology trainings or pursuing certifications
	System Readiness for CV/AV Technology Integration	CV/AV Technology (Device and Data)	TMC System	When applicable, monitor CV/AV technology integration and compare qualitatively or quantitively with other region's technology integration experiences
	Increase Capacity of Communications Network	Fiber/Wireless/Bandwidth Usage	TMC System	Measure communications network capacity before and after ITS device deployment

Objective	Performance Metric	Data Type	Source	Calculation
Reduce user frustration by providing **consistency and reliability**	Reduced Downtime	System Errors/Failure	System Operations	Compare Downtime Incident Occurrences before and after project implementation
	Reduced Public Complaints	Public Complaints	TMC, TOC and other Operator Records	Compare the amount of public complaints related to inconsistency/ unreliability from before and after implementation project
	Reduce Response Time to Device Failures	Response Time	TOC and Dispatch Records	Measure reduction in response times before and after project implementation
	Increase percent of field device that are operational	Operational Devices	Asset Management System	Calculate percent of devices that are operational based on total devices in the inventory. Compare that figure to the same percentage ratio prior to implementation project
Proactively improve transportation system **safety**	Reduced vehicle-to-vehicle crashes	Crash Records	Crash Record System	Calculate percentage change of crashes before and after implementation
	Reduced vehicle-to-bicycle crashes	Crash Records	Crash Record System	Calculate percentage change of crashes before and after implementation
	Reduced vehicle-to-pedestrian crashes	Crash Records	Crash Record System	Calculate percentage change of crashes before and after implementation
	Reduced Safety Incidents Involving Transit Operations	Transit Incident Records	Transit TMC and Transit Provider Records	Count amount of safety incidents involving transit operations after

Objective	Performance Metric	Data Type	Source	Calculation
Improve **traveler information** and dissemination to public and within region	Reduced vehicle traffic (congestion) due to CMS Message	Traffic Volume	Agency TMC	Difference between Pre/Post CMS Traffic Volumes on Corridor and Alternate Corridor
	Increased Social Media Presence via Agency Managed Apps/Websites	Social Media Posts and Push Notifications (Facebook, twitter)	PR/PIO Records	Track social media outputs, compare to posts prior to implementation strategies
	Increased Partnerships between Third Party Data Companies and Public Agencies	Partnerships	Institutional Policies/Documents	Count the number of private party /public agency data sharing agreements that have occurred since implementing strategies
	Increased 511 Inputs (on all available platforms)	Website Updates, Radio Updates, and Push Notifications	511 System/Records	Count traveler information inputs that are sent out through 511 systems and compare it to counts prior to implementation
	Increased 511 Usage/Subscriptions	App Download/Website Usage	App/Website Management	Count of 511 website views
Emergency / disaster preparedness	Improved Emergency Response Time	Travel Time	Agency TMC	Time between initial notification to first responder arrival
	Improved Incident Clearing Times	Incident Response and Clearing Times	Agency TMC	Compare time it takes to respond to and clear an incident before and after project implementation

NEXT STEPS

The outcome of this Technology Implementation Plan is a roadmap of prioritized projects that Sacramento County can follow to systematically implement technology projects that achieve local and regional objectives through expansion of infrastructure, integration of systems and subsystems, and deployment and readiness for emerging technologies. The appendices of this Plan contain supporting information on project priority development, costs, project details, and other information that are essential to moving projects into development and deployment.

Sacramento County's Technology Implementation Plan is a dynamic and flexible set of projects that contribute to SACOG's broader Smart Region Plan. The projects set forth are a mix of infrastructure, operations and institutional projects that are adaptable to changing needs and evolving technologies. This plan and the associated tools should remain a living set of resources that staff can update as projects are implemented or expanded, agency priorities change, or other changes occur that impact the region or Sacramento County. The projects identified in this plan can and should be modified, or priorities adjusted, to accommodate changing priorities, emerging technology opportunities, other construction and development projects, or other initiatives that influence the guidance and recommendations provided in this Plan. In addition, it is particularly important to maintain a process to update the Plan because of the deployment phasing methodology used.

Plan Components to Update

- **Deployment Phasing** – It will be particularly important to update the Plan to reflect projects have been completed. Priorities across projects may also change, and should be reflected in the document. As time goes by and projects change in priority, updating the project list will provide an opportunity to evaluate if new projects are available based on emerging technology, increased staffing levels, and so on.
- **Funding Opportunities** – Funding opportunities are always changing. Existing programs or grants may expire, while new ones may emerge. It is imperative that funding opportunities are kept current to maximize the opportunity to utilize new funding sources. In addition, it will continue to be important to leverage emerging opportunities for third party or private sector support.
- **Equipment Replacement Strategies** – The success of this Plan is largely based on ensuring that all equipment continues to work effectively and efficiently. Legacy equipment should be continuously updated or replaced to accommodate emerging technology and enhanced system functionality.
- **Operations and Maintenance** – Adequate staffing levels allow for optimal functionality. As the plan grows and progresses, staffing levels must continue to reflect the need for sustaining a functioning system.

APPENDIX A – EXISTING CONDITIONS

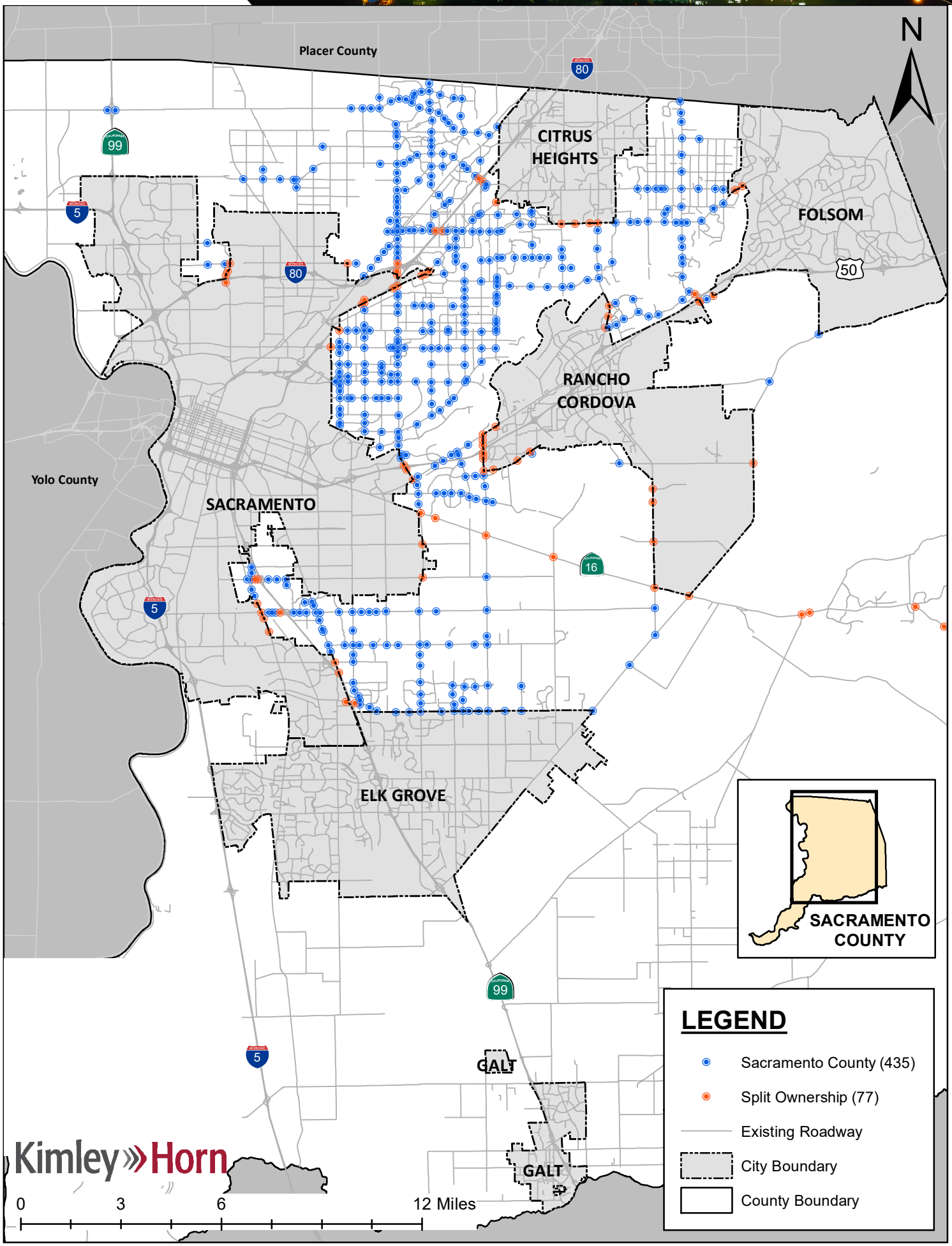


EXHIBIT 1 - EXISTING TRAFFIC SIGNAL NETWORK

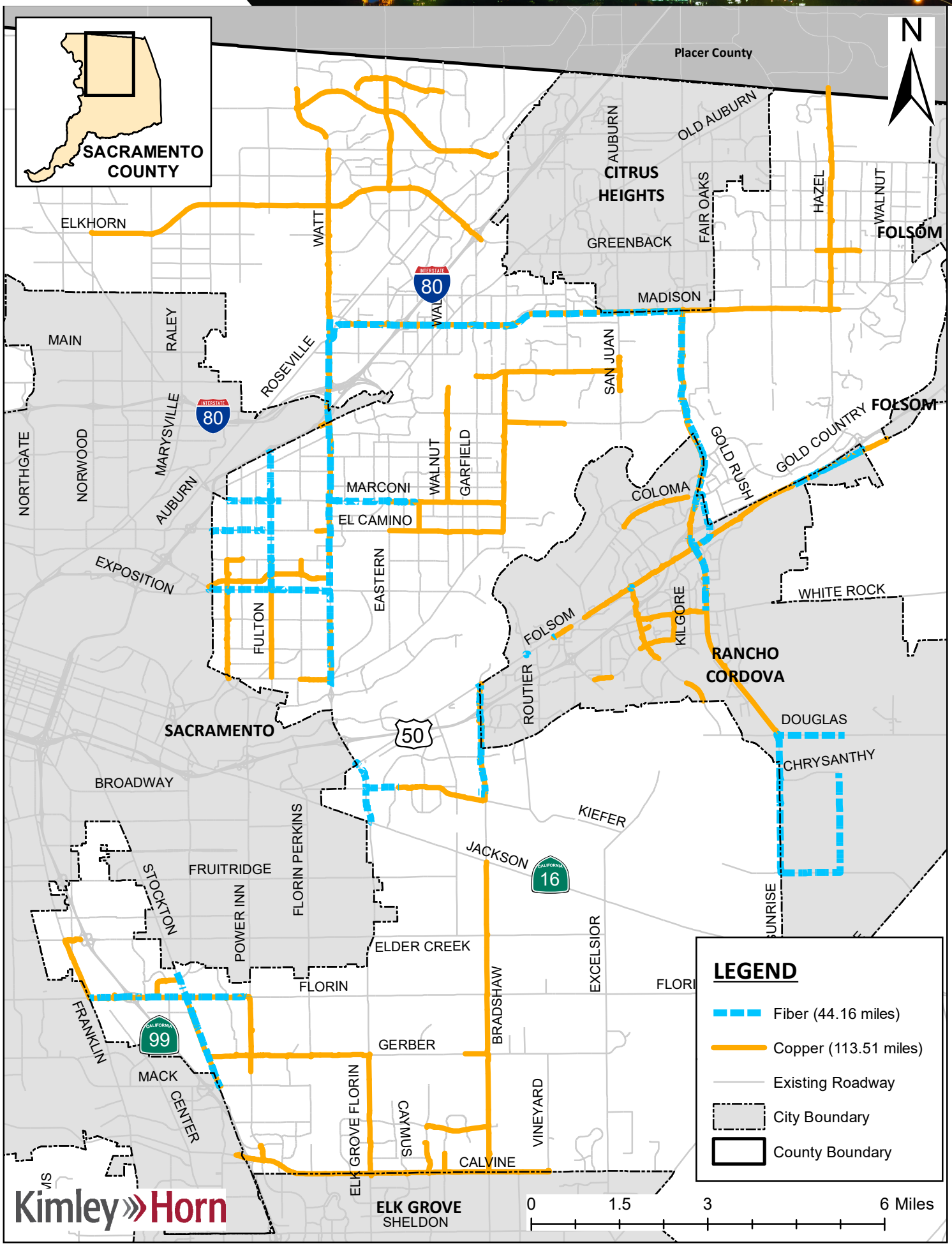


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EXHIBIT 2 - EXISTING COMMUNICATIONS NETWORK

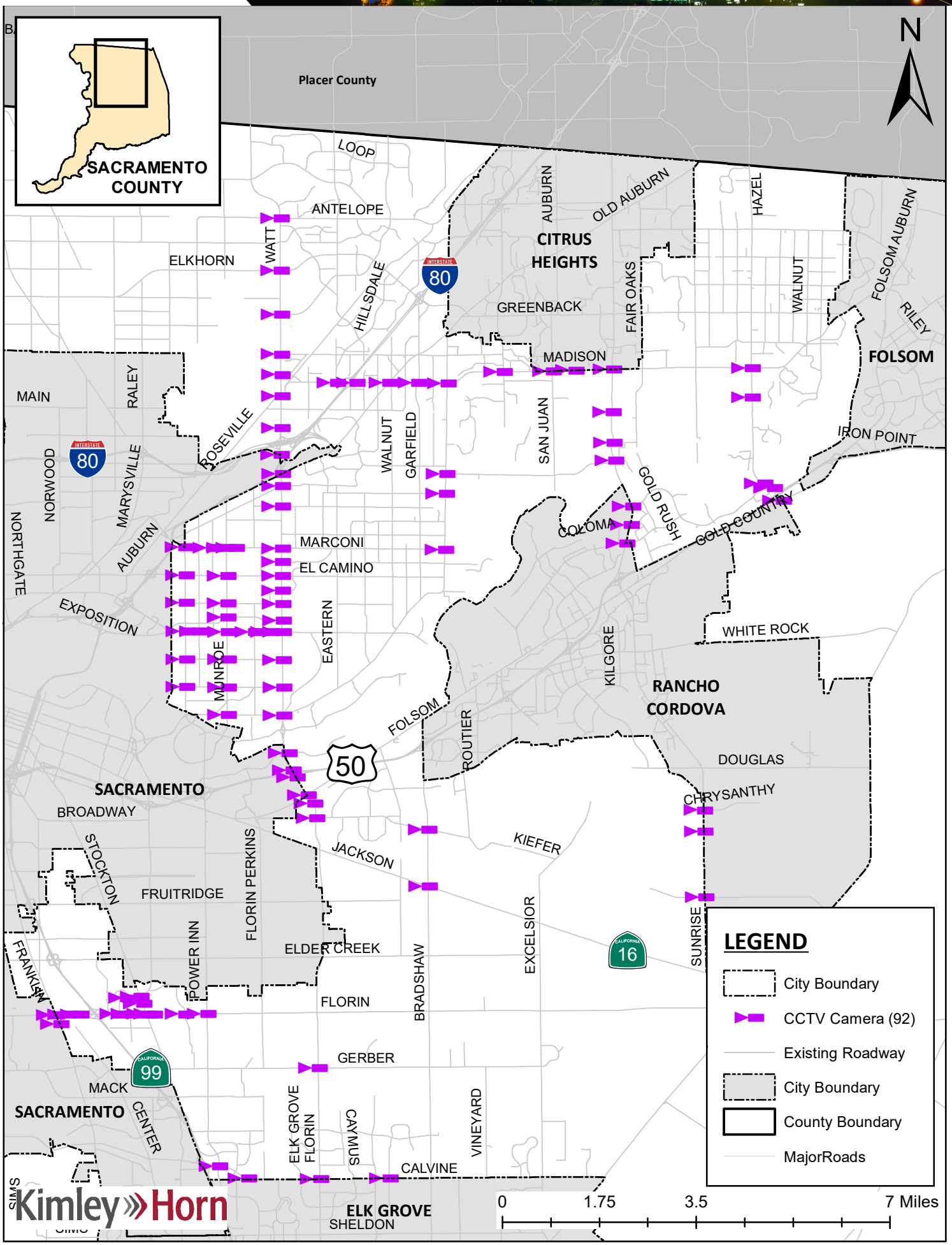

EXHIBIT 3 - EXISTING CCTV CAMERA NETWORK

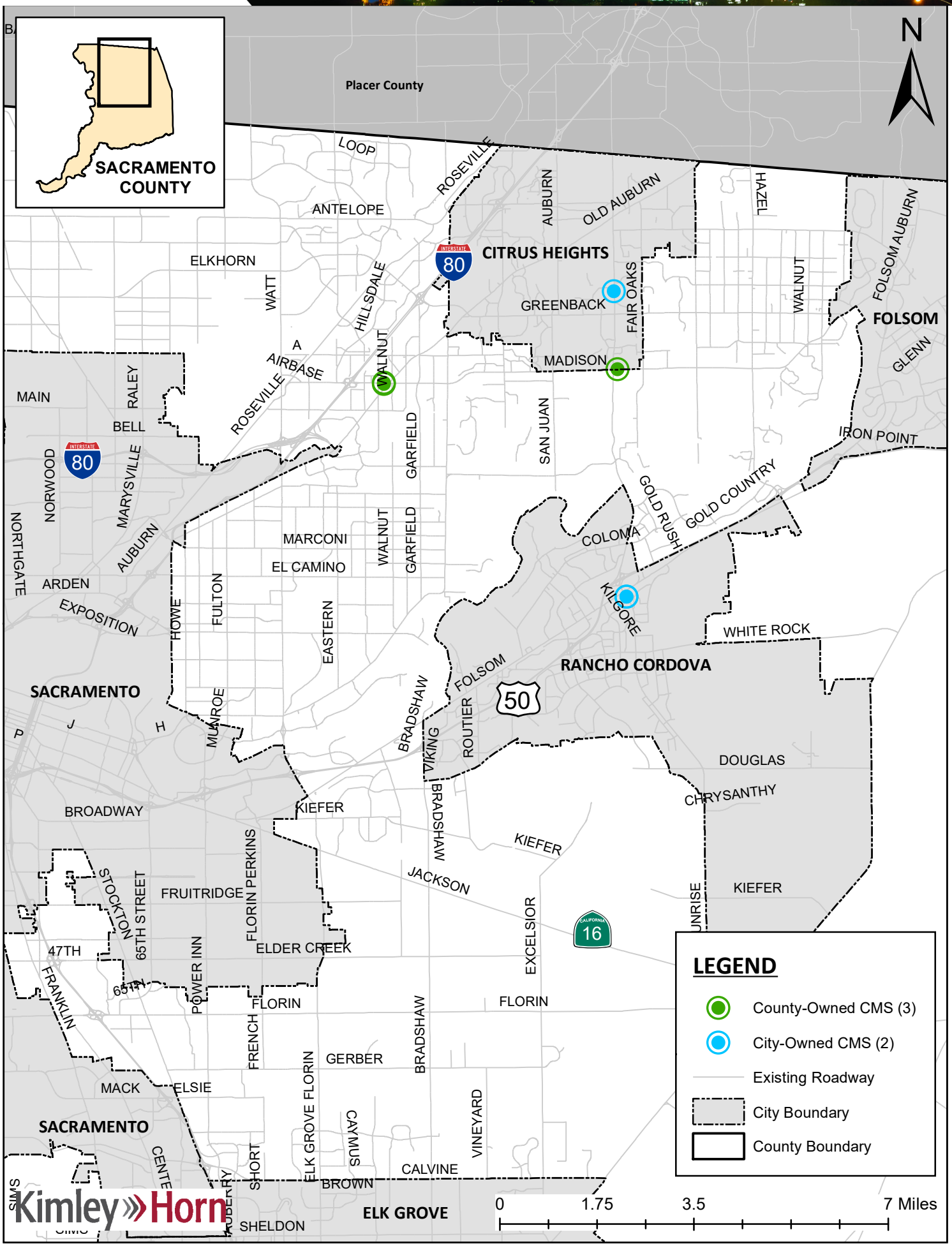

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EXHIBIT 4 - EXISTING CMS

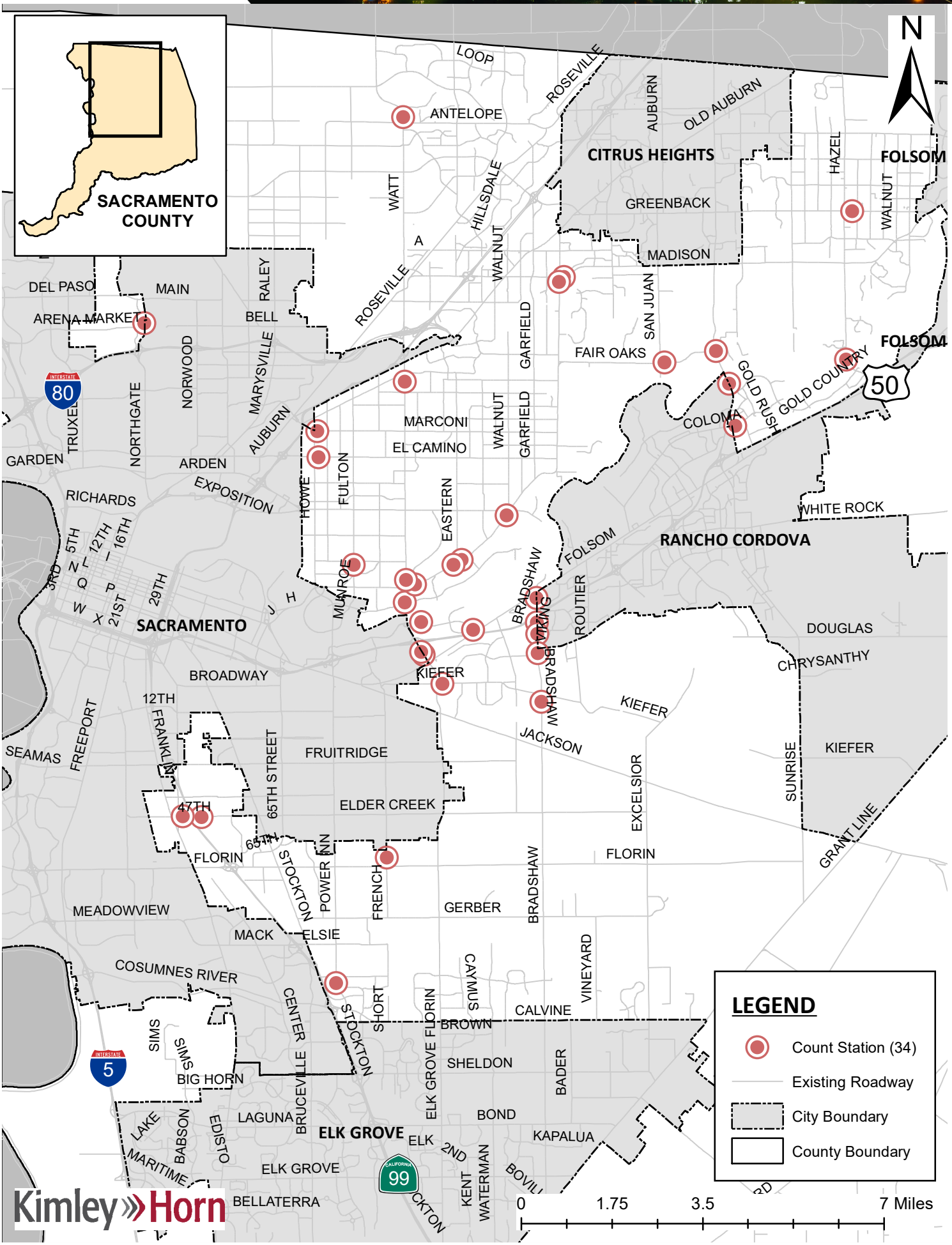

EXHIBIT 5 - EXISTING COUNT STATIONS

APPENDIX B – FIBER BUILDOUT AND INFRASTRUCTURE PROJECTS

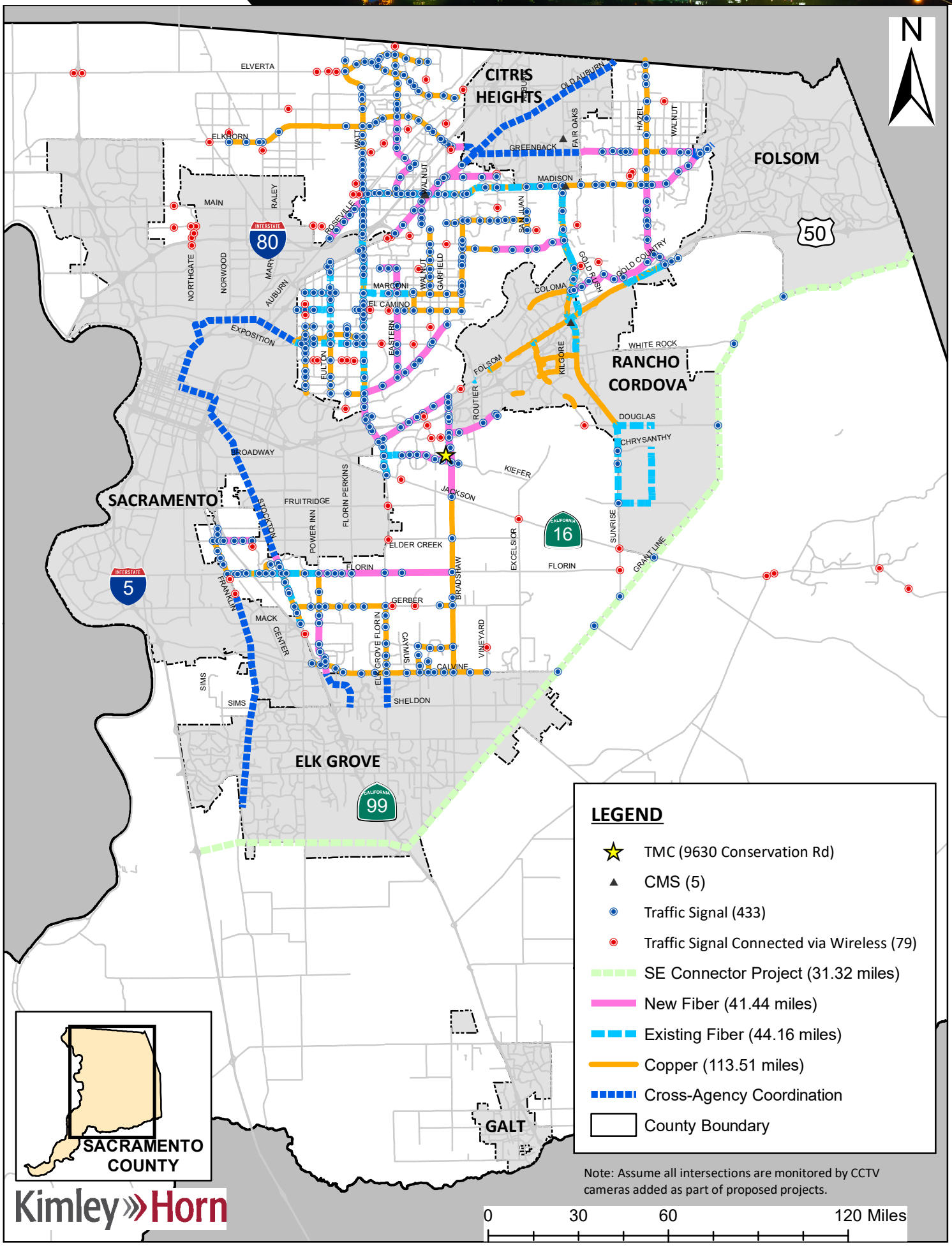

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EXHIBIT 8 - FUTURE TRAFFIC SIGNAL AND COMMUNICATIONS NETWORK

APPENDIX C – STRATEGY SUMMARY SHEETS

Strategy # –This is the identification number by strategy.

Title – This is the title of strategy.

Description – This is a succinct description of the strategy for context.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve a variety of needs.

Scope/Limits – This is a succinct summary of what is included in the strategy and/or locations (if applicable) of where the strategy would apply.

Considerations – This is a bullet listing of other strategies that are relevant for the City to reference during implementation or could be packaged together to be implemented in a larger strategy in a particular timeframe.

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

Strategy ID #1

Improve Existing Communications Capabilities

Strategy Description – Eliminate communications gaps and expand communications network along key traffic corridors. Utilize copper/fiber or wireless technologies to achieve more robust communications coverage. Connect communications to devices and traffic signals along the key corridors for remote monitoring and control. This includes upgrading communications from legacy copper or T1 leased lines to more robust agency-owned infrastructure such as fiber or wireless.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Baseline communications infrastructure (Need D1)
- Robust coverage to acquire real-time conditions (Need D2)
- Reliable communications to prevent downtime (Need D3)
- Adequate bandwidth in communications to support data sharing (Need D6)
- High-resolution traffic data for real-time operational decision making (Need D7)
- CV/AV technology readiness (Need D16)
- Improve traffic operations (Need O3)
- Promote and support Vision Zero (Need I4)

Scope/Limits – Gaps in the communications system for Sacramento County were identified using the existing ITS infrastructure. Several signal locations were identified as having no connection to the County TMC. Connecting these signals was the highest priority in implementing this strategy. New fiber was added to connect signals to the overall network. For signal locations with no fiber backbone nearby, wireless connections were recommended. Additionally, a fiber replacement of the existing copper around the area of the TMC was recommended for additional capacity and bandwidth as the County prepares for future connections to other agencies. The list below includes an overall summary of the upgrades suggested as part of this strategy:

- 34 miles of new fiber
- 4 miles of new fiber to replace existing copper
- 79 traffic signals connected via wireless

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #1 – Improve Existing Communications Capabilities
- ID #6 – Replace End-Of-Life/Legacy Equipment with Modernized and Updated Equipment
- ID #9 – Signal Controller Upgrades for Future Intersections
- ID #12 – Improve Signal Timing Along Transit Corridors

- ID #14 – Deploy New CMS Equipment
- ID #17 – Deploy Connected Vehicle Infrastructure

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Deploy projects that connect to the central system (e.g. TMC)
- Existing infrastructure supporting subsequent projects should be functional

Strategy ID #2

Deploy New Video Vehicle Detection and CCTV Equipment

Description – Deploy new video detection and CCTV equipment at signalized intersection locations that do not have current detection and video capabilities available. Video detection equipment will require devices to be mounted on all mast arms or overhanging one pole location to be able to view all legs of the intersection, depending on the type of technology procured. CCTV equipment will require devices to be mounted on one pole location to be able to view all legs of the intersection and, as feasible as possible, to view to the next intersection location. Video detection will be able to detect vehicles, bicycles, and pedestrians in zones set up by the traffic operations center to support signal timing plan implementation. Also, depending on the type of technology procured, video detection may be able to collect real-time turning movement counts to support more real-time signal timing adjustments required. Additional detection can support more traffic-responsive signal timing to detect the main street and side streets more effectively. CCTV video will provide real-time streaming video to allow traffic operations centers to view road network conditions and to share information about real-time conditions with partner departments, such as public safety, that may need to respond to an incident or event. The new CCTV will need to be integrated into the agency's central management system for viewing and control.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Robust coverage to acquire real-time conditions (Need D2)
- High-resolution traffic data for real-time operational decision making (Need D7)
- CV/AV technology readiness (Need D15)
- Improve traffic operations (Need O3)
- Promote and support Vision Zero (Need I4)
- Expand Connected Corridor model (Need I5)

Scope/Limits – Video detection and CCTV cameras will be provided at all intersection that currently have loop detectors or no detection. As an order of magnitude estimate, assume video detection will be installed at all intersections with existing or new CCTV cameras within Sacramento County. The list below includes an overall summary of the upgrades suggested as part of this strategy:

- 245 new video detection cameras
- 193 new CCTV cameras

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #1 – Improve Existing Communications Capabilities
- ID #6 – Replace End-Of-Life/Legacy Equipment with Modernized and Updated Equipment

- ID #9 – Signal Controller Upgrades for Future Intersections
- ID #12 – Improve Signal Timing Along Transit Corridors
- ID #14 – Deploy New CMS Equipment
- ID #17 – Deploy Connected Vehicle Infrastructure

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Establish baseline communications network
- Close communications gaps

Strategy ID #3

Third-Party Archived Data

Description – Acquisition of third-party data on a regional level for archived speed data on the transportation network for planning purposes. Sacramento County can leverage this regional strategy and use this third-party data in combination with data using existing data collection procedures for analysis or planning purposes within the County transportation network.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Use data to support planning purposes (Need D14)
- Leverage and bolster private sector traveler information services (D16)

Scope/Limits – County-wide. Planning level costs includes Sacramento County staff time only to provide regional support for third-party archived data and to implement the use of third-party data in agency's planning and operations.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #4 – Third-Party Real-Time Data

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Gain regional support to acquire third-party data on a regional level.
- Incorporate the use of third-party archived data in planning and operations

Strategy ID #4

Third-Party Real-Time Data

Description – Acquisition of third-party data on a regional level for real-time speed data on the transportation network for real-time operations purposes. Sacramento County to leverage this regional strategy and use this third-party data in combination with data using existing data collection procedures for analysis or planning purposes within the County transportation network.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Use data to support planning purposes (Need D14)
- Leverage and bolster private sector traveler information services (D16)

Scope/Limits – County-wide. Planning level costs includes Sacramento County staff time only to provide regional support for third-party archived data and to implement the use of third-party data in agency's planning and operations.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #3 – Third Party Archived Data

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Gain regional support to acquire third-party data on a regional level.
- Incorporate the use of third-party real-time data in operations

Strategy ID #5

Perform ATMS Data Back Up

Description – Establish an agency ATMS data backup method and location to be able to store an archive of the ATMS system in the event of an outage or breach. Anticipated to be performed by the Sacramento County IT Department. It is important to establish a physically separate location for this back up data to not create a single-failure-point for the ATMS system management.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Reliable communications to prevent downtime (Need D3)
- Reliable network security (Need I1)

Scope/Limits – The scope of work includes establishing ATMS backup procedures and purchase of additional TOC equipment to support ATMS backup.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #6 – Replace End-Of-Life/Legacy Equipment with Modernized and Updated Equipment

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Revisit ATMS back-up procedures of Sacramento County TOC
- Work with IT department to come up with necessary back-up procedures, staff time required and equipment necessary for the back-up functionality
- Purchase additional servers and other equipment as required
- Extend ATMS back-up access through VPN, laptops, phone and tablets to have redundant access

Strategy ID #6

Replace End-Of-Life/Legacy Equipment with Modernized and Updated Equipment

Description – Establish an inventory of modern equipment that can be used to replace field devices upon their failure or end-of-life. Keeping a modern inventory will ensure that replacements are up-to-date and that in the event of an existing device reaching end-of-life, the device can be quickly replaced with stock equipment.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Maintainable infrastructure and assets (Need D4)
- Programmatic planning for assets and maintenance of assets (Need D6)
- Use data to support planning purposes (Need D14)

Scope/Limits – Inventory of supplemental, modernized field devices includes but is not limited to traffic signal controllers, controller cabinets, Closed Circuit Television Cameras, Video Cameras, and Changeable Message Signs. The recommended number of devices to maintain is 10 percent of the total number of each device.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #1 – Improve Existing Communications Capabilities
- ID #9 – Signal Controller Upgrades for Future Intersections
- ID #12 – Improve Signal Timing Along Transit Corridors
- ID #14 – Deploy New CMS Equipment
- ID #17 – Deploy Connected Vehicle Infrastructure

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Establish a functional baseline communications network
- Close any communications gaps

Strategy ID #7

Establish Central Regional Video Management System

Description – Establish a central regional video management system that allows all agencies to view all agency CCTV streaming video for real-time operations. This regional video system would need to link to each individual agency video system, whether integrated into their ATMS or as a separate stand-alone system. The regional video system will need to be managed and maintained by one agency, preferably SACOG.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- High-resolution traffic data for real-time operational decision making (Need D7)
- Sharing of camera images to support pre-trip, en-route, and incident management (Need D8)
- Share data between agencies that share a corridor (Need D10)
- Use data to support planning purposes (Need D14)
- CV/AV technology readiness (Need D15)
- Integrate central systems and subsystems (Need O1)
- Improve traffic operations (Need O3)
- Improve incident coordination across jurisdictions with public safety (O8)
- Promote and support Vision Zero (Need I4)

Scope/Limits – County-wide. Planning level costs include improvements required at Sacramento County TOC to allow video sharing with regional video system. This includes upgrade to County's video server and communications improvements between Sacramento County TOC and regional video system. This does not include costs to establish core center to center communications between the agencies.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #3 – Perform ATMS Data Back-Up
- ID #6 – Replace End-Of-Life/Legacy Equipment with Modernized and Updated Equipment
- ID #10 – Share CCTV with Individual Agencies
- ID #11 – Share CCTV with Agency Public Traveler Information Platforms
- ID #18 – SOPs for Incident Management and Response

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Baseline communications infrastructure within Sacramento County
- Develop regional communications plan
- Establish center to center communications

- Establish regional data sharing policy guidelines
- Establish regional CCTV sharing agreements

Strategy ID #8

Utilize Existing Agency Asset Management System

Description – Utilize existing agency asset management system to maintain existing information for all agency assets related to transportation technology.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Reliable equipment functionality to prevent downtime (Need D3)
- Maintainable infrastructure and assets (Need D4)
- Programmatic planning for assets and maintenance of assets (Need D6)
- Interactive Regional GIS based Inventory (Need D13)
- Standard operating and maintenance procedures for incident management (Need O6)
- Share regional operation and maintenance responsibilities (Need O7)

Scope/Limits – Sacramento County currently has an existing system for asset inventory and maintenance activity tracking but have not been fully utilizing it. The scope of work includes Sacramento County's transportation operations and maintenance group to explore capabilities of the existing system, and revise operations and maintenance procedures as necessary to maximize the functionalities of the asset management system.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #6 – Replace End-Of-Line/Legacy Equipment with Modernized and Updated Equipment

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Explore full functionality of the agency owned asset management system
- Revise the existing operations and maintenance procedures if necessary
- Utilize existing agency asset management system is day to day operations and maintenance

Strategy ID #9

Signal Controller Upgrades for Future Functions

Description – Upgrade traffic signal controllers to support ATSPM software deployment and collection of high-resolution traffic condition data as well as future connected vehicle infrastructure. This may also include upgrading detection for this specific purpose if detection is not already available at signalized intersections.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Reliable equipment functionality to prevent downtime (Need D3)
- Maintainable infrastructure and assets (Need D4)
- Programmatic planning for assets and maintenance of assets (Need D6)
- Interactive Regional GIS based Inventory (Need D13)
- CV/AV technology readiness (Need D15)
- Integrate central systems and subsystems (Need O1)
- Improve traffic operations (Need O3)

Scope/Limits – Controller upgrades will be added to locations that are not currently running 2070 controllers. A total of 229 controllers will need to be upgraded as part of this strategy.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #1 – Improve Existing Communications Capabilities
- ID #2 – Deploy New Vehicle Detection and CCTV Equipment
- ID #12 – Improve Signal Timing Along Transit Corridors
- ID #14 – Deploy New CMS Equipment
- ID #17 – Deploy Connected Vehicle Infrastructure

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Upgrade traffic signal controllers in conjunction with video detection and CCTV upgrades
- Upgrade traffic signal controllers at critical locations that may benefit with CV/AV readiness.

Strategy ID #10

Share CCTV with Individual Agencies

Description – CCTV streaming video images should be shared between agencies through a robust communications center-to-center network. Shared control of CCTV may not be desirable or feasible but could be considered through this center-to-center asset viewing capability.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- High-resolution traffic data for real-time operational decision making (Need D9)
- Sharing of camera images to support pre-trip, en-route, and incident management (Need D8)
- Share data between agencies that share a corridor (Need D10)
- CV/AV technology readiness (Need D15)
- Improve traffic operations (Need O3)
- Improve incident coordination across jurisdiction with public safety (Need O8)
- Improve notification and alerts to travelers (Need O9)
- Promote and support Vision Zero (Need I3)
- Expand Connected Corridor model (Need I5)

Scope/Limits – A network will be set up on a regional basis to share CCTV imagery between agencies. Individual agencies can utilize the data collected through CCTV cameras to build a more robust network and support traffic management across connected corridors.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #2 – Deploy New Video Detection and CCTV Equipment
- ID #3 – Third Party Real-Time Data
- ID #5 – Perform ATMS Data Back Up
- ID #7 – Establish Central Regional Video Management System
- ID #11 – Share CCTV with Agency Public Traveler Information Platforms
- ID #13 – Real-Time Data Connection between transit and Transportation Agencies

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Establish CCTV Sharing Agreements between the individual agencies.
- Deploy modernized CCTV cameras at identified locations
- Establish an inventory of supplemental CCTV cameras

Strategy ID #11

Share CCTV with Agency Public Traveler Information Platforms

Description – Establish screen shot or streaming link of CCTV images to agency website or other agency-owned applications (such as 511) for public traveler information purposes. A CCTV management will need to be established to, for example, cut feeds as necessary if incident management monitoring warrants zooming in on the lane restrictions.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Sharing of camera images to support pre-trip, en-route, and incident management (Need D8)
- Improve notification and alerts to travelers (Need O9)

Scope/Limits – A network will be set up on a regional basis to share CCTV imagery between agencies. These images will be analyzed and information relevant to the public traveler will be extracted accordingly.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #2 – Deploy New Video Detection and CCTV Equipment
- ID #4 – Third Party Real-Time Data
- ID #5 – Perform ATMS Data Back Up
- ID #7 – Establish Central Regional Video Management System
- ID #10 – Share CCTV with Individual Agencies
- ID #13 – Real-Time Data Connection between Transit and Transportation Agencies

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Establish CCTV Sharing Agreements between the individual agencies.
- Deploy modernized CCTV cameras at identified locations
- Establish an inventory of supplemental CCTV cameras

Strategy ID #12

Improve Traffic Signal Timing Along Transit Service Corridors

Description – Complete signal optimization plans along key transit routes that need updates to consider transit mobility needs and, if existing, transit signal priority. Signal timing plans need to be developed based on current traffic turning movement counts, developed modeling outputs and ultimately uploaded into the signal controllers. Before and after evaluation of the corridor is recommended to ensure greater accuracy in the final signal timing plan. Use performance metrics to analyze throughput and coordinate light rail preemption where necessary with traffic signal operations.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Reduce impact of light rail preemption on traffic mobility (Need D9)

Scope/Limits – Develop traffic signal timing coordination plans along all corridors with controller upgrades. Sacramento County can develop signal optimization plans for corridors that run adjacent to or intersect Sacramento RT light right transit corridors. Once signal optimization plans are developed at these locations, the County can prioritize bus transit corridors for retiming based on recommendations from Sacramento RT.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #9 – Signal Controller Upgrades for Future Functions

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Establish a functional baseline communications network.

Strategy ID #13

Real-Time Data Connection between Transit and Transportation Agencies

Description – Establish connection between transit and transportation agencies for sharing data related to transit services. The purpose is for transportation agencies to organize traffic operations to accommodate transit services through collected data, such as vehicle location and on-time schedule performance that can better support the coordination of transit mobility and traffic mobility. This strategy specifically addresses transit signal priority needs and light rail transit needs for better mobility.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Share data between agencies that share a corridor (Need 10)
- Encourage travel mode shift (Need D11)
- Real-time traveler information (Need D12)
- Improve traffic operations (Need O3)
- Improve notification and alerts to travelers (Need O9)

Scope/Limits – Develop inter-agency agreements to share real-time data collected through video detection and CCTV cameras.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #2 – Deploy New Video Detection and CCTV Equipment
- ID #4 – Third Party Real-Time Data
- ID #5 – Perform ATMS Data Back Up
- ID #7 – Establish Central Regional Video Management System
- ID #10 – Share CCTV with Individual Agencies
- ID #11 – Share CCTV with Agency Public Traveler Information Platforms

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Establish CCTV Sharing Agreements between the individual agencies.
- Deploy modernized CCTV cameras at identified locations
- Establish an inventory of supplemental CCTV cameras

Strategy ID #14

Deploy New CMS Equipment

Description – Deploy new CMS equipment at key locations within the agency jurisdiction either at new locations or as a new function for the agency. CMS equipment will require devices to be mounted on a cantilever or pole, or and possibly over the travel lane. CMS provides the traveling public with an en-route message that provides real-time traffic information to improve travel decision. The CMS will need to be integrated into the agency's central management system to post messages.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Real-time traveler information (Need D12)
- Improve notification and alerts to travelers (Need O9)

Scope/Limits – Deploy or upgrade CMS at key strategic decision locations to relay traveler information. A total of 5 CMS are suggested to be replaced as part of this strategy.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #1 – Improve Existing Communications Capabilities
- ID #2 – Deploy New Vehicle Detection and CCTV Equipment
- ID #9 – Signal Controller Upgrades for Future Functions
- ID #12 – Improve Signal Timing Along Transit Corridors
- ID #17 – Deploy Connected Vehicle Infrastructure

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Establish a baseline communications network

Strategy ID #15

GIS-Shared Map Development for Asset Management

Description – Create a GIS-shared map where every agency can update their assets to stay up-to-date on operational availability of key corridors throughout the region. This shared map will be accessible via password-protected internet access and assigned to designated staff at each agency to update and maintain their respective inventory of information. Regular upkeep of this shared map will be required, particularly as ICM and other multi-jurisdictional operations become incorporated into agency functions.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Interactive regional GIS-based inventory (Need D13)

Scope/Limits – The GIS-shared map will be set up on a regional basis to share information of each agency's asset inventory. Sacramento County will need to hire or designate staff dedicated to updating this information to the network.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- Strategy ID #8 – Utilize Existing Agency Asset Management System

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Collect inventory information from existing agency asset management system
- Establish communications to departments deploying new equipment or performing equipment upgrades

Strategy ID #16

Increase Staffing Levels to Improve Real-Time Operations

Description – Establish new staffing levels to support the operations and maintenance of the transportation network and Smart Region initiatives. Offered in the plan are ratios of devices to the number of staff required to operate or maintain those devices per ITE guidelines. The agency should consider potential IT or Traffic Engineering staff for the implementation of Smart Region initiatives such as data access/sharing and project management of infrastructure implementations. Consider additional staff, such as data analysts, as needs arise. The agency will need to consider reallocating or hiring new staff to support operations and maintenance to implement Smart Region strategies.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Improve traffic operations (Need O3)
- Staffing for traffic operations (Need O4)

Scope/Limits – Focus staffing efforts on providing adequate IT and project management staffing to support real-time operations and analysis processes

Considerations – There are no other strategies that should also be considered in conjunction with this strategy.

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Consider staffing and training needs as Sacramento County develop their funding plan.

Strategy ID #17

Deploy Connected Vehicle Infrastructure

Description – Deploy CV equipment (DSRC radios or equivalent) at signalized locations or other key locations using agency-owned infrastructure. This strategy would initiate a pilot program (with option to extend) of key corridors that supports agency-owned CV technology and would require procuring CV equipment that would need to be installed at signalized intersections along priority corridors by the agency. Expansions to this pilot program would be assumed upon completion of pilot project. This strategy does not include the push of specific CV data to vehicles using the system but rather, makes the CV infrastructure available for agencies or the region to utilize when CV software and data become more robust and available.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- CV/AV technology readiness (Need #15)

Scope/Limits – Deploy CV infrastructure at all City traffic signals.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #1 – Improve Existing Communications Capabilities
- ID #2 – Deploy New Vehicle Detection and CCTV Equipment
- ID #9 – Signal Controller Upgrades for Future Functions
- ID #12 – Improve Signal Timing Along Transit Corridors

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Implementation of new signal controllers should be CV infrastructure ready.

Strategy ID #18

SOPs for Incident Management and Response

Description – Develop standard operating procedures for the use of infrastructure and collaboration required between agencies to support incident management and response including TOC responsibilities. SOPs should be organized around NIMS procedures and account for TIM Coalition coordination responsibilities. Establishing formal SOPs related to incident management will improve the response time and clearance time of incidents in the region or along key corridors.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Standard operating and maintenance procedures for incident management (Need O6)
- Improve incident coordination across jurisdictions and with public safety (Need O8)

Scope/Limits –. If past operating documentation do not exist, begin doing so countywide. Share this information on a regional level to establish SOPs.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #10 – Share CCTV with Individual Agencies
- ID #11 – Share CCTV with Agency Public Traveler Information Platforms
- ID #23 – SOPs for ICM Corridor

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Document operating procedures.
- Share documentation to all agencies and collaborate to develop SOPs.

Strategy ID #19

Establish CAD System and TOC Connections for Automated Alerts/Notifications

Description – Establish filtered CAD system access from agency TOCs to see when incidents are restricting lanes and warrant traffic management measures. This strategy will involve communications between the public safety network and the agency TOC, the CAS system will need to be filtered to anonymous data for lane restriction and location information only, and separate monitors and servers will be required at the agency TOC, because CAD will not be integrated into the agency's ATMS system for viewing.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Improve incident coordination across jurisdictions and with public safety (Need O8)

Scope/Limits – Integrate Sacramento County Sheriff CAD system with Sacramento County ATMS system and TOC. This scope of work includes software integration to update Sacramento County Sheriff CAD system and Sacramento County ATMS system to allow data push from sheriff CAD system to ATMS system and view the data in ATMS interface. The scope includes purchase, installation, configuration and integration of servers and software required at Sacramento County TOC.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #10 – Share CCTV with Individual Agencies
- ID #11 – Share CCTV with Agency Public Traveler Information Platforms
- ID #13 – Real-Time Data Connection between Transit and Transportation Agencies
- ID #18 – SOPs for Incident Management and Response
- ID #21 – Shared Access to Radio Communications
- ID #24 – SOPs for ICM Corridor
- ID #27 – Integrate CAD into 511

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

Strategy ID #20

Agency Use of Connected Vehicle Infrastructure

Description – With CV infrastructure established, this strategy is for the individual agency to push CV information to vehicles using the CV infrastructure deployed at signalized intersections or other key areas. The information provided to vehicles could include signal timing green countdown, bicycle and pedestrian notification, emergency vehicle approaching notification, intersection collision avoidance information, and other types of real-time notifications. The CV infrastructure will also collect information from vehicles valuable for traffic operations, such as real-time speeds, volumes, vehicle type, and other data.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- High-resolution traffic data for real-time operational decision making (D7)
- CV/AV technology readiness (Need D15)
- Improve notification and alerts to travelers (Need O9)
- Expand Connected Corridor model (Need I5)

Scope/Limits – This strategy would apply to all connected ITS infrastructure at the County.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #17 – Deploy Connected Vehicle Infrastructure

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Deploy connected vehicle infrastructure at signalized intersections – this is accounted for at every intersection with a planned controller upgrade.
- Filter and analyze the data collected from CV infrastructure to determine relevant information to vehicle users.
- Communicate the filtered and analyzed data to vehicles.

Strategy ID #21

Shared Access to Radio Communications

Description – Sacramento Regional Radio Communication System (SRRCS) is a region-wide public safety communications system resulting from a twenty-year partnership of many governmental jurisdictions that have collaborated to develop and operate a public safety communication network. Sacramento County Department of Technology (DTech) embarked on the multi-year project to replace the current SRRCS system in 2012 and is estimated to finish in 2019. When completed, any radio system that is P25 compliant will be able to communicate with SRRCS members. As part of this strategy, provide Sacramento County Traffic Operations, TOC staff and Maintenance groups P25 compliant radios to communicate with Sacramento County Sheriff, Sacramento County Fire department and other participating public safety agencies in the region.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Improve incident coordination across jurisdictions and with public safety (Need O8)
- Shared access to radio communications (Need I7)

Scope/Limits – Procurement of one (1) radio transceiver unit in City TOC.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #18 – SOPs for Incident Management and Response
- ID #26 – Regional Modernized CAD Integration

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Other agencies must procure radios separately

Strategy ID #22

Establish Agency Network Security Policies and Standards

Description – Establish network security policies and standards related to access to the ATMS system, device data, archive/back-up systems, and access from outside entities such as regional maintenance contract maintainers or vendors testing equipment. This would be established in the form of a standard operating procedure or formal policy developed by the agency and used at the agency's TOC to outline access to systems.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Reliable network security (Need I1)

Scope/Limits – Sacramento County will need to document their procedures on network security and ultimately establish a standard operating procedure to be used and revised in the future.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #5 – Perform ATMS Data Back Up
- ID #23 – Train Staff on Network Security

Strategy ID #23

Train Staff on Network Security

Description – Network security training will be a requirement for personnel involved in using, accessing, or securing the agency's ATMS system or technologies. This will involve an agency requirement for IT to update security training on a regular basis. This will also involve in procurement specifications that the vendor/firm providing new technology provide training on the new functionality and security standards involved in that new technology. The agency's IT department will need to stay involved in keeping these policies and procedures up to date with current security requirements on the agency enterprise system.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Reliable network security (Need I1)

Scope/Limits – Sacramento County will need to consider placing staff through technology training tracks and/or encourage staff to pursue certifications.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #5– Perform ATMS Data Back Up
- ID #23 – Establish Agency Network Security Procedures and Standards

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Agency must have a defined set of security procedures and standards in order to train staff

Strategy ID #24

SOPs for ICM Corridor

Description – Develop Standard Operating Procedures (SOPs) for the use of infrastructure and collaboration required between agencies to support operations and incident management of an ICM corridor including responsibilities for the agency TOCs, public safety agencies, and regional resources. Establishing formal SOPs related to an ICM corridor is a follow-on activity to developing a concept of operations for a corridor.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Standard operating and maintenance procedures for incident management (Need O6)
- Expand Connected Corridor model (Need I5)

Scope/Limits – Within Sacramento County limits, Auburn Boulevard (for I-80), Folsom Boulevard (for US 50), Stockton Boulevard (for SR 99) and Franklin Boulevard (for SR 99) are ICM corridors. This strategy includes developing SOPs with Caltrans, SACOG and other local agencies for the use of infrastructure and collaboration required between agencies to support operations and incident management of an ICM corridor. Within the scope of this strategy, only Sacramento County staff time estimated to be spent in developing SOPs is included. Each ICM corridor may need a separate SOP or a master SOP could be developed for all ICM corridors within the SACOG region. However, the timing of ICM corridor implementation will vary and separate SOPs might be needed each ICM corridor. It is assumed that existing regular ITS partnership meetings in SACOG region will be used for discussions related to developing SOPs for the following ICM corridors.

- Develop SOP for I-80 ICM Corridor
- Develop SOP for US 50 Corridor
- Develop SOP for I-5/99 Corridors

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #18 – SOPs for Incident Management and Response

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Support Caltrans to establish an ICM Corridor
- Approve planned improvements on ICM corridor within County's jurisdiction
- Participate in SACOG ITS partnership meetings to develop SOPs for the ICM corridors

Strategy ID #25

Communications Sharing to Support ICM Strategies

Description – Eliminate communications gaps that exist along key ICM corridors for which there is a concept of operations and agency responsibilities developed. This strategy considers fiber or other communications media sharing of existing fiber infrastructure to support access to agency field devices along an ICM corridor. Utilize copper/fiber or wireless technologies in order to achieve more robust communications coverage (i.e. using dark fiber not currently in use). Consider this strategy for Caltrans and County agencies as they may have communications reaching through multiple City jurisdictions that could support City build out of a communications network as related to an ICM corridor.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Standard operating and maintenance procedures for incident management (Need O6)
- Expand Connected Corridor model (Need I5)

Scope/Limits – Currently the existing fiber connects Sacramento County with City of Sacramento and City of Rancho Cordova. The existing fiber has potential to connect with Caltrans District 3 TMC, but the fiber terminations and connections are not set up correctly. This strategy includes establishing fiber connections / terminations to allow data transfer between Caltrans District 3 TMC and Sacramento County TOC. This will support communication network as relates to and ICM corridor.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #24 – SOPs for ICM Corridor

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Develop a regional communications master plan

Strategy ID #26

Regional Modernized CAD Integration

Description – Integrate CAD systems across all public safety agencies across the region. This would involve a significant software integration process to upgrade or replace CAD systems with all public safety agencies to use the same CAD system. This strategy aims to modernize the CAD systems used in the region to allow for more data integration in between agency systems as well as more functionality provided to public safety dispatch and responders.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Consistent CAD systems across public safety agencies (Need I6)

Scope/Limits – Integrate Sacramento County Sheriff CAD system with Sacramento County ATMS system and TOC and other agency TOCs. This scope of work includes software integration to update agency ATMS systems to allow data push from sheriff CAD system to ATMS system and view the data in ATMS interface. The scope includes purchase, installation, configuration and integration of servers and software required at all agencies.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #27 – Integrate CAD into 511
- ID #19 – Establish CAD System and TOC Connections for Automated Alerts/ Notifications

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Updated ATMS system for Sacramento County Sheriff CAD and Sacramento County

Strategy ID #27

Integrate CAD Into 511

Description – Establish filtered CAD system to be integrated with the region's 511 system to automatically publish lane restriction information as it is entered into the local agency's CAD systems. This strategy will involve communications between the public safety network and the CARS database directly via the regional communications network or internet-based communication.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Consistent CAD systems across public safety agencies (Need I6)

Scope/Limits – This strategy would require County integration with Sacramento County Sherriff CAD as well as integration with regional 511 agency.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #19 – Establish CAD System and TOC Connections for Automated Alerts/ Notifications
- ID #26 – Regional Modernized CAD Integration

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- CAD system integration between Sacramento County and Sacramento County Sherriff CAD.

Strategy ID #28

Improve Existing Communications Capabilities for Interregional Connectivity

Description – Eliminate communications gaps that exist along corridors that would be required to connect to the regional communications network. This includes upgrading communications from legacy copper to more robust agency-owned infrastructure such as fiber. If the agency TOC is not already connected to the regional communications network, this strategy would incorporate the required active electronics or communications necessary to share information in a center-to-center capability with STARNET or would upgrade that equipment as needed. The purpose of this strategy is to share data between agencies that share a corridor.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Baseline communications infrastructure (Need D1)
- Robust coverage to acquire real time conditions (Need D2)
- Reliable communications system to prevent downtime (D3)
- Adequate bandwidth in communications to support data sharing (Need D5)
- Share data between agencies that share a corridor (Need D10)
- Integrate central systems and subsystems (Need O2)
- Improve traffic operations (Need O3)
- Improve incident coordination across jurisdictions with public safety (Need O8)
- Expand Connected Corridor model (Need I5)

Scope/Limits – STARNET was designed to provide a data and video exchange network and an institutional framework to enable shared data and video using agency-owned fiber network and internet connections. However, all the improvements planned as part of STARNET are not currently not in operation. Currently the existing fiber connects Sacramento County with City of Sacramento and City of Rancho Cordova. The existing fiber has potential to connect with Caltrans District 3 TMC, but the fiber terminations and connections are not set up correct. This strategy includes the following scope of work to allow data sharing between Sacramento County and agencies that share a corridor with Sacramento County.

- Fix fiber terminations at Sacramento County TOC to allow data transfer between Caltrans District 3 TMC;
- Establish fiber communications with Sacramento County and City of Citrus Heights;
- Establish fiber communications with Sacramento County and City of Folsom;
- Establish fiber communications with Sacramento County and City of Elk Grove;
- Establish fiber communications with Sacramento County and Regional Transit; and
- Equipment upgrades at Sacramento County TOC to allow data and video sharing.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #1 – Improve Existing Communications Capabilities
- ID #6 – Replace End-Of-Life/Legacy Equipment with Modernized and Updated Equipment
- ID #9 – Signal Controller Upgrades for Future Intersections
- ID #12 – Improve Signal Timing Along Transit Corridors
- ID #14 – Deploy New CMS Equipment
- ID #17 – Deploy Connected Vehicle Infrastructure

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Establish a baseline communications network
- Develop regional communication master plan
- Establish center-to center communications to support regional communication

APPENDIX D - PRIORITIZATION SUMMARY

Table 1: Prioritization Summary

Project ID/ Priority No.	Strategy Description	Address multijurisdictional networking	Adapt to new technology	Improve reliability and consistency of driver trips	Safety	Improve traveler information and dissemination	Disaster preparedness	Contribute to operational and institutional efficiency	Enhances major corridors	Extent that project achieves local objectives	Other projects rely on this project	Total Strategy Score Compared to Objectives
		10	13	10	13	10	5	10	10	14	5	100
1	**ALONG HAZEL AVE FROM COUNTY LIMIT TO MADISON AVE, ALONG GREENBACK LN FROM FAIR OAKS BLVD TO CITY LIMIT (FOLSOM), ALONG MADISON AVE FROM MCKAY ST TO CITY LIMIT (FOLSOM):** -Enhanced communication infrastructure through installation of fiber optic cable (11 signals) -Connection to isolated traffic signals via wireless (3 signals) -Deploy vehicle video detection (21 signals) -Deploy CCTV cameras (29 locations) -Upgrade CMS (1 location) -Update signal timing (21 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (21 signals)	3	3	3	3	2	2	2	3	2	3	65.25
2	**ALONG S WATT AVE FROM FOLSOM BLVD TO ELDER CREEK RD, ALONG BRADSHAW RD FROM FOLSOM BLVD TO JACKSON RD, ALONG OLD PLACERVILLE RD FROM BRADSHAW RD TO SYSTEMS PKWY, ALONG GOETHE RD FROM MAYHEW RD TO BRADSHAW RD, ALONG KIEFER BLVD FROM THORNHILL DR TO PAST BRADSHAW RD, ALONG MAYHEW RD FROM FOLSOM BLVD TO GOETHE RD:** -Enhanced communication infrastructure through installation of fiber optic cable (new or replace existing copper signal interconnect) (13 signals) -Connection to isolated traffic signals via wireless (6 signals) -Deploy vehicle video detection (15 signals) -Deploy CCTV cameras (26 locations) -Update signal timing (21 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (15 signals)	3	3	2	2	2	2	3	2	3	4	64.25
3	**ALONG GRANT LINE RD FROM JACKSON RD TO CALVINE RD, ALONG JACKSON RD FROM EXCELSIOR RD TO COUNTY LIMIT, ALONG SUNRISE BLVD FROM CHRYSANTHY BLVD TO JACKSON RD, AT DOUGLAS RD AND SUNRISE BLVD:** -Connection to isolated traffic signals via wireless (8 signals) -Deploy vehicle video detection (4 signals) -Deploy CCTV cameras (26 locations) -Update signal timing (4 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (4 signals)	3	1	1	1	2	1	2	3	2	3	46
4	**ALONG EL CAMINO AVE FROM ETHAN WAY TO FAIR OAKS BLVD, ALONG COTTAGE WAY FROM HOWE AVE TO WATT AVE, ALONG ALTA ARDEN EXPY FROM HOWE AVE TO WATT AVE, ALONG ARDEN WAY FROM ETHAN WAY TO FAIR OAKS BLVD, ALONG HURLEY WAY FROM HOWE AVE TO WATT AVE, ALONG NORTHROP AVE FROM HOWE AVE TO WATT AVE, ALONG SIERRA BLVD FROM HOWE AVE TO FULTON AVE, ALONG FAIR OAKS BLVD FROM FULTON AVE TO EL CAMINO AVE, ALONG HOWE AVE FROM EL CAMINO AVE TO FAIR OAKS BLVD, ALONG FULTON AVE FROM EL CAMINO AVE TO FAIR OAKS BLVD, AT TOWER AVE AND FULTON AVE, ALONG WATT AVE FROM EL CAMINO AVE TO BUTANO DR, ALONG EASTERN AVE FROM EL CAMINO AVE TO FAIR OAKS BLVD, AT WALNUT AVE AND COTTAGE WAY:** -Enhanced communication infrastructure through installation of fiber optic cable (new or replace existing copper signal interconnect) (8 signals) -Connection to isolated traffic signals via wireless (11 signals) -Deploy vehicle video detection (16 signals) -Deploy CCTV cameras (51 locations) -Update signal timing (21 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (15 signals)	3	2	1	1	2	2	2	3	1	2	45.75

Project ID/ Priority No.	Strategy Description	Address multijurisdictional networking	Adapt to new technology	Improve reliability and consistency of driver trips	Safety	Improve traveler information and dissemination	Disaster preparedness	Contribute to operational and institutional efficiency	Enhances major corridors	Extent that project achieves local objectives	Other projects rely on this project	Total Strategy Score Compared to Objectives
		10	13	10	13	10	5	10	10	14	5	100
5	**ALONG HAZEL AVE FROM MADISON AVE TO FOLSOM BLVD, ALONG SUNRISE BLVD FROM GOLD COUNTRY BLVD TO COLOMA RD, ALONG GOLD COUNTRY BLVD FROM SUNRISE BLVD TO HAZEL AVE, ALONG COLOMA RD FROM SUNRISE BLVD TO GOLD COUNTRY BLVD, ALONG FOLSOM BLVD FROM HAZEL AVE TO CITY LIMIT (FOLSOM), ALONG GRANT LINE RD FROM PRAIRIE CITY RD TO WHITE ROCK RD:** -Enhanced communication infrastructure through installation of fiber optic cable (new or replace existing copper signal interconnect) (13 signals) -Connection to isolated traffic signals vis wireless (3 signals) -Deploy vehicle video detection (19 signals) -Deploy CCTV cameras (19 locations) -Upgrade CMS (1 location) -Update signal timing (19 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (19 signals)	2	2	1	2	2	1	2	2	2	1	45
6	**ALONG N LOOP BLVD FROM ELVERTA RD TO DON JULIO BLVD, ALONG ELVERTA RD FROM DUTCH HAVEN BLVD TO ANTELOPE RD, ALONG ANTELOPE RD FROM WATT AVE TO ROSEVILLE RD, AT ROSEVILLE RD AND DALY AVE, ALONG ELKHORN BLVD FROM 32ND ST TO DIABLO DR, ALONG DON JULIO BLVD FROM WATT AVE TO N LOOP BLVD, AT DUDLEY BLVD AND PALM ST, ALONG PEACEKEEPER WAY FROM DUDLEY BLVD TO WATT AVE, ALONG BELL AVE FROM WINTER ST TO FORCUM AVE, ALONG ROSEVILLE AVE FROM CITY LIMIT (SACRAMENTO) TO WATT AVE, ALONG WATT AVE FROM CENTER CT LN TO ROSEVILLE AVE, ALONG WALERGA RD FROM COUNTRY RUN WAY TO MADISON AVE, AT DIABLO DR AND BETWEEN LANCELOT DR AND WOODFOREST DR:** -Enhanced communication infrastructure through installation of fiber optic cable (new or replace existing copper signal interconnect) (3 signals) -Connection to isolated traffic signals vis wireless (11 signals) -Deploy vehicle video detection (53 signals) -Deploy CCTV cameras (75 locations) -Update signal timing (50 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (50 signals)	1	2	2	2	2	2	2	1	2	1	43.75
7	**ALONG ELDER CREEK RD FROM S WATT AVE TO BRADSHAW RD, ALONG FLORIN RD FROM POWER INN RD TO BRADSHAW RD, ALONG GERBER RD FROM POWER INN RD TO BRADSHAW RD, ALONG CALVINE RD FROM POWER INN RD TO VINEYARD RD, ALONG ELK GROVE FLORIN RD FROM GERBER RD TO CALVINE RD, ALONG VINTAGE PARK DR FROM WATERMAN RD TO BRADSHAW RD, ALONG WATERMAN RD FROM VINTAGE PARK DR TO CALVINE RD, ALONG KINGSBRIDGE DR FROM VINTAGE PARK DR TO CALVINE RD, AT VINEYARD RD AND W SAVONA DR:** -Enhanced communication infrastructure through installation of fiber optic cable (new or replace existing copper signal interconnect) (8 signals) -Connection to isolated traffic signals vis wireless (4 signals) -Deploy vehicle video detection (14 signals) -Deploy CCTV cameras (40 locations) -Update signal timing (10 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (14 signals)	2	1	1	2	2	2	2	1	2	2	41.75
8	**ALONG WATT AVE FROM ROSEVILLE RD TO AUBURN BLVD, ALONG MADISON AVE FROM ROSEVILLLE RD TO AUBURN BLVD, ALONG AUBURN BLVD FROM NORRIS AVE TO CITY LIMIT (CITRIS HEIGHTS), AT GARFIELD AVE AND VERNER AVE, ALONG GREENBACK LN FROM DIABLO DR TO GARFIELD AVE, ALONG GREENBACK LN FROM GARFIELD AVE TO CITY LIMIT (CITRIS HEIGHTS):** -Enhanced communication infrastructure through installation of fiber optic cable (new or replace existing copper signal interconnect) (9 signals) -Connection to isolated traffic signals vis wireless (3 signals) -Deploy vehicle video detection (15 signals) -Deploy CCTV cameras (28 locations) Upgrade CMS (2 locations) -Update signal timing (14 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (14 signals)	1	2	2	1	1	1	2	2	2	2	40.5

Project ID/ Priority No.	Strategy Description	Address multijurisdictional networking	Adapt to new technology	Improve reliability and consistency of driver trips	Safety	Improve traveler information and dissemination	Disaster preparedness	Contribute to operational and institutional efficiency	Enhances major corridors	Extent that project achieves local objectives	Other projects rely on this project	Total Strategy Score Compared to Objectives
		10	13	10	13	10	5	10	10	14	5	100
9	**ALONG WATT AVE FROM FAIR OAKS BLVD TO FOLSOM BLVD, ALONG FOLSOM BLVD FROM WATT AVE TO BRADSHAW RD, AT LA RIVIERA DR AND SALMON FALLS DR, AT AMERICAN RIVER DR AND MILLS RD:** -Enhanced communication infrastructure through installation of fiber optic cable (new or replace existing copper signal interconnect) (11 signals) -Connection to isolated traffic signals vis wireless (2 signals) -Deploy vehicle video detection (12 signals) -Deploy CCTV cameras (13 locations) -Update signal timing (6 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (6 signals)	2	1	2	1	2	2	2	2	1	2	40
10	**ALONG MARTIN LUTHER KING JR BLVD FROM 41ST AVE TO 47TH AVE, ALONG 47TH AVE FROM FRANKLIN BLVD TO STEINER DR, ALONG FRANKLIN BLVD FROM 47TH AVE TO CITY LIMIT (ELK GROVE), ALONG FLORIN RD FROM FRANKLIN BLVD TO POWER INN RD, ALONG 65TH ST FROM FLORIN RD TO STOCKTON BLVD, ALONG STOCKTON BLVD FROM CITY LIMIT (SACRAMENTO) TO 65TH ST, ALONG STOCKTON BLVD FROM 65TH ST TO CITY LIMIT (ELK GROVE), ALONG GERBER RD FROM STOCKTON BLVD TO POWER INN RD, ALONG POWER INN RD FROM FLORIN RD TO CITY LIMIT (ELK GROVE), ALONG CALVINE RD FROM CITY LIMIT (ELK GROVE) TO POWER INN RD:** -Enhanced communication infrastructure through installation of fiber optic cable (new or replace existing copper signal interconnect) (5 signals) -Connection to isolated traffic signals vis wireless (4 signals) -Deploy vehicle video detection (25 signals) -Deploy CCTV cameras (36 locations) -Update signal timing (24 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (24 signals)	2	1	1	2	2	1	2	2	1	2	39.5
11	**ALONG AUBURN BLVD FROM BELL ST TO WATT AVE, ALONG MARCONI AVE FROM HOWE AVE TO FAIR OAKS BLVD, AT HOWE AVE BETWEEN SHAW ST AND BURNEY WAY, ALONG FULTON AVE FROM AUBURN BLVD TO EL CAMINO BLVD, ALONG WHITNEY AVE FROM WATT AVE TO WALNUT AVE, ALONG WATT AVE FROM AUBURN BLVD TO EL CAMINO BLVD, ALONG WALNUT AVE FROM WINDING WAY TO EL CAMINO BLVD, ALONG CYPRESS AVE FROM WALNUT AVE TO FAIR OAKS BLVD, ALONG FAIR OAKS BLVD FROM LINCOLN AVE TO EL CAMINO BLVD, ALONG EASTERN AVE FROM WHITNEY AVE TO MARCONI AVE, AT MISSION AVE AND DONNIE LYN WAY:** -Enhanced communication infrastructure through installation of fiber optic cable (new or replace existing copper signal interconnect) (5 signals) -Connection to isolated traffic signals vis wireless (3 signals) -Deploy vehicle video detection (19 signals) -Deploy CCTV cameras (37 locations) -Update signal timing (19 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (19 signals)	1	1	2	2	2	1	2	1	1	1	35.75
12	**AT WINDING WAY AND PASADENA AVE, ALONG WALNUT AVE FROM AUBURN AVE TO WINDING WAY, AT DEWEY DR AND LINDA SUE WAY, ALONG COYLE AVE FROM AUBURN AVE TO DEWEY DR, ALONG MADISON AVE FROM AUBURN BLVD TO FAIR OAKS BLVD, AT DEWEY DR BETWEEN ST JAMES DR AND WILL ROGERS DR, ALONG WINDING WAY FROM GARFIELD AVE TO SUNRISE BLVD, ALONG FAIR OAKS BLVD FROM WAYSIDE LN TO SUNRISE BLVD, ALONG SUNRISE BLVD FROM MADISON AVE TO FAIR OAKS BLVD, AT FAIR OAKS BLVD AND VIA DE PALMAS LN:** -Enhanced communication infrastructure through installation of fiber optic cable (new or replace existing copper signal interconnect) (10 signals) -Connection to isolated traffic signals vis wireless (4 signals) -Deploy vehicle video detection (20 signals) -Deploy CCTV cameras (37 locations) -Upgrade CMS (1 location) -Update signal timing (20 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (20 signals)	0	1	2	2	2	1	2	0	1	1	30.75

Project ID/ Priority No.	Strategy Description	Address multijurisdictional networking	Adapt to new technology	Improve reliability and consistency of driver trips	Safety	Improve traveler information and dissemination	Disaster preparedness	Contribute to operational and institutional efficiency	Enhances major corridors	Extent that project achieves local objectives	Other projects rely on this project	Total Strategy Score Compared to Objectives
		10	13	10	13	10	5	10	10	14	5	100
13	**ALONG ELKHORN BLVD FROM MARYSVILLE BLVD TO 16TH ST, AT DRY CREEK RD AND G ST, AT RIO LINDA BLVD AND M ST, ALONG NORTHGATE BLVD FROM N MARKET BLVD T CITY LIMIT (SACRAMENTO), AT DEL PASO RD AND BLACKROCK DR, ALONG N MARKET BLVD FROM GATEWAY PARK BLVD TO NORTHGATE BLVD:** -Connection to isolated traffic signals vis wireless (13 signals) -Deploy vehicle video detection (12 signals) -Deploy CCTV cameras (16 locations) -Update signal timing (12 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (12 signals)	0	1	1	1	1	1	1	0	1	0	18.75

APPENDIX E - COST ASSUMPTIONS

Table 1: Cost Summary

Infrastructure Projects - Improve Existing Communications Capabilities													
Project ID	Strategies Addressed	Project Description	Wireless Signals	Video Detection	Updated Signal Timing	Controller Upgrade	Intersection Fiber Equipment Upgrade	CCTV	CMS	Communication (Miles)		Connected Vehicle Technology	Planning Level Cost
										New	Replace		
Communication Gap Closures, Communications Equipment Upgrade, Upgrade to Fiber													
1	D1, D2, D3, D4, D5, D7, D9, D15, O3, I4	ALONG HAZEL AVE FROM COUNTY LIMIT TO MADISON AVE ALONG GREENBACK LN FROM FAIR OAKS BLVD TO CITY LIMIT (FOLSOM) ALONG MADISON AVE FROM MCKAY ST TO CITY LIMIT (FOLSOM)	3	21	21	21	21	29	1	4.22	0.00	21	$ 6,021,000.00
2		ALONG S WATT AVE FROM FOLSOM BLVD TO ELDER CREEK RD ALONG BRADSHAW RD FROM FOLSOM BLVD TO JACKSON RD ALONG OLD PLACERVILLE RD FROM BRADSHAW RD TO SYSTEMS PKWY ALONG GOETHE RD FROM MAYHEW RD TO BRADSHAW RD ALONG KIEFER BLVD FROM THORNHILL DR TO PAST BRADSHAW RD ALONG MAYHEW RD FROM FOLSOM BLVD TO GOETHE RD	6	15	15	15	15	26	0	2.58	3.50	15	$ 4,836,000.00
3		ALONG GRANT LINE RD FROM JACKSON RD TO CALVINE RD ALONG JACKSON RD FROM EXCELSIOR RD TO COUNTY LIMIT ALONG SUNRISE BLVD FROM CHRYSANTHY BLVD TO JACKSON RD AT DOUGLAS RD AND SUNRISE BLVD	8	4	4	4	4	12	0	0.00	0.00	4	$ 591,000.00
4		ALONG EL CAMINO AVE FROM ETHAN WAY TO FAIR OAKS BLVD ALONG COTTAGE WAY FROM HOWE AVE TO WATT AVE ALONG ALTA ARDEN EXPY FROM HOWE AVE TO WATT AVE ALONG ARDEN WAY FROM ETHAN WAY TO FAIR OAKS BLVD ALONG HURLEY WAY FROM HOWE AVE TO WATT AVE ALONG NORTHROP AVE FROM HOWE AVE TO WATT AVE ALONG SIERRA BLVD FROM HOWE AVE TO FULTON AVE ALONG FAIR OAKS BLVD FROM FULTON AVE TO EL CAMINO AVE ALONG HOWE AVE FROM EL CAMINO AVE TO FAIR OAKS BLVD ALONG FULTON AVE FROM EL CAMINO AVE TO FAIR OAKS BLVD AT TOWER AVE AND FULTON AVE ALONG WATT AVE FROM EL CAMINO AVE TO BUTANO DR ALONG EASTERN AVE FROM EL CAMINO AVE TO FAIR OAKS BLVD AT WALNUT AVE AND COTTAGE WAY	11	16	15	15	16	51	0	5.33	0.00	15	$ 6,947,000.00
5		ALONG HAZEL AVE FROM MADISON AVE TO FOLSOM BLVD ALONG SUNRISE BLVD FROM GOLD COUNTRY BLVD TO COLOMA RD ALONG GOLD COUNTRY BLVD FROM SUNRISE BLVD TO HAZEL AVE ALONG COLOMA RD FROM SUNRISE BLVD TO GOLD COUNTRY BLVD ALONG FOLSOM BLVD FROM HAZEL AVE TO CITY LIMIT (FOLSOM) ALONG GRANT LINE RD FROM PRAIRIE CITY RD TO WHITE ROCK RD	3	19	19	19	16	19	1	5.45	0.00	19	$ 6,684,000.00
6		ALONG N LOOP BLVD FROM ELVERTA RD TO DON JULIO BLVD ALONG ELVERTA RD FROM DUTCH HAVEN BLVD TO ANTELOPE RD ALONG ANTELOPE RD FROM WATT AVE TO ROSEVILLE RD AT ROSEVILLE RD AND DALY AVE ALONG ELKHORN BLVD FROM 32ND ST TO DIABLO DR ALONG DON JULIO BLVD FROM WATT AVE TO N LOOP BLVD AT DUDLEY BLVD AND PALM ST ALONG PEACEKEEPER WAY FROM DUDLEY BLVD TO WATT AVE ALONG BELL AVE FROM WINTER ST TO FORCUM AVE ALONG ROSEVILLE RD FROM CITY LIMIT (SACRAMENTO) TO WATT AVE ALONG WATT AVE FROM CENTER CT LN TO ROSEVILLE RD ALONG WALERGA RD FROM COUNTRY RUN WAY TO MADISON AVE AT DIABLO DR AND BETWEEN LANCELOT DR AND WOODFOREST DR	15	53	50	50	52	75	0	4.13	0.00	50	$ 9,349,000.00
7		ALONG ELDER CREEK RD FROM S WATT AVE TO BRADSHAW RD ALONG FLORIN RD FROM POWER INN RD TO BRADSHAW RD ALONG GERBER RD FROM POWER INN RD TO BRADSHAW RD ALONG CALVINE RD FROM POWER INN RD TO VINEYARD RD ALONG ELK GROVE FLORIN RD FROM GERBER RD TO CALVINE RD ALONG VINTAGE PARK DR FROM WATERMAN RD TO BRADSHAW RD ALONG WATERMAN RD FROM VINTAGE PARK DR TO CALVINE RD ALONG KINGSBRIDGE DR FROM VINTAGE PARK DR TO CALVINE RD AT VINEYARD RD AND W SAVONA DR	4	14	10	10	14	40	0	3.95	0.00	10	$ 5,264,000.00

Infrastructure Projects - Improve Existing Communications Capabilities													
Project ID	Strategies Addressed	Project Description	Wireless Signals	Video Detection	Updated Signal Timing	Controller Upgrade	Intersection Fiber Equipment Upgrade	CCTV	CMS	Communication (Miles)		Connected Vehicle Technology	Planning Level Cost
										New	Replace		
Communication Gap Closures, Communications Equipment Upgrade, Upgrade to Fiber													
8	D1, D2, D3, D4, D5, D7, D9, D15, O3, I4	ALONG WATT AVE FROM ROSEVILLE RD TO AUBURN BLVD ALONG MADISON AVE FROM ROSEVILLLE RD TO AUBURN BLVD ALONG AUBURN BLVD FROM NORRIS AVE TO CITY LIMIT (CITRIS HEIGHTS) AT GARFIELD AVE AND VERNER AVE ALONG GREENBACK LN FROM DIABLO DR TO GARFIELD AVE ALONG GREENBACK LN FROM GARFIELD AVE TO CITY LIMIT (CITRIS HEIGHTS)	3	15	14	14	15	28	2	3.31	0.00	14	$ 4,729,000.00
9		ALONG WATT AVE FROM FAIR OAKS BLVD TO FOLSOM BLVD ALONG FOLSOM BLVD FROM WATT AVE TO BRADSHAW RD AT LA RIVIERA DR AND SALMON FALLS DR AT AMERICAN RIVER DR AND MILLS RD	2	12	6	6	6	13	0	3.97	0.00	6	$ 4,435,000.00
10		ALONG MARTIN LUTHER KING JR BLVD FROM 41ST AVE TO 47TH AVE ALONG 47TH AVE FROM FRANKLIN BLVD TO STEINER DR ALONG FRANKLIN BLVD FROM 47TH AVE TO CITY LIMIT (ELK GROVE) ALONG FLORIN RD FROM FRANKLIN BLVD TO POWER INN RD ALONG 65TH ST FROM FLORIN RD TO STOCKTON BLVD ALONG STOCKTON BLVD FROM CITY LIMIT (SACRAMENTO) TO 65TH ST ALONG STOCKTON BLVD FROM 65TH ST TO CITY LIMIT (ELK GROVE) ALONG GERBER RD FROM STOCKTON BLVD TO POWER INN RD ALONG POWER INN RD FROM FLORIN RD TO CITY LIMIT (ELK GROVE) ALONG CALVINE RD FROM CITY LIMIT (ELK GROVE) TO POWER INN RD	4	25	24	24	25	36	0	2.78	0.00	24	$ 5,154,000.00
11		ALONG AUBURN BLVD FROM BELL ST TO WATT AVE ALONG MARCONI AVE FROM HOWE AVE TO FAIR OAKS BLVD AT HOWE AVE BETWEEN SHAW ST AND BURNEY WAY ALONG FULTON AVE FROM AUBURN BLVD TO EL CAMINO AVE ALONG WHITNEY AVE FROM WATT AVE TO WALNUT AVE ALONG WATT AVE FROM AUBURN BLVD TO EL CAMINO AVE ALONG WALNUT AVE FROM WINDING WAY TO EL CAMINO AVE ALONG CYPRESS AVE FROM WALNUT AVE TO FAIR OAKS BLVD ALONG FAIR OAKS BLVD FROM LINCOLN AVE TO EL CAMINO AVE ALONG EASTERN AVE FROM WHITNEY AVE TO MARCONI AVE AT MISSION AVE AND DONNIE LYN WAY	3	19	19	19	19	37	0	1.24	0.00	19	$ 3,345,000.00
12		AT WINDING WAY AND PASADENA AVE ALONG WALNUT AVE FROM AUBURN BLVD TO WINDING WAY AT DEWEY DR AND LINDA SUE WAY ALONG COYLE AVE FROM AUBURN BLVD TO DEWEY DR ALONG MADISON AVE FROM AUBURN BLVD TO FAIR OAKS BLVD AT DEWEY DR BETWEEN ST JAMES DR AND WILL ROGERS DR ALONG WINDING WAY FROM GARFIELD AVE TO SUNRISE BLVD ALONG FAIR OAKS BLVD FROM WAYSIDE LN TO SUNRISE BLVD ALONG SUNRISE BLVD FROM MADISON AVE TO FAIR OAKS BLVD AT FAIR OAKS BLVD AND VIA DE PALMAS LN	4	20	20	20	16	37	1	4.29	0.00	20	$ 6,058,000.00
13		ALONG ELKHORN BLVD FROM MARYSVILLE BLVD TO 16TH ST AT DRY CREEK RD AND G ST AT RIO LINDA BLVD AND M ST ALONG NORTHGATE BLVD FROM N MARKET BLVD T CITY LIMIT (SACRAMENTO) AT DEL PASO RD AND BLACKROCK DR ALONG N MARKET BLVD FROM GATEWAY PARK BLVD TO NORTHGATE BLVD	13	12	12	12	12	16	0	0.00	0.00	12	$ 1,353,960.00
Unit totals			$ 426,600.00	$ 8,820,000.00	$ 1,071,720.00	$ 2,473,200.00	$ 5,197,500.00	$ 7,542,000.00	$ 225,000.00	$ 36,116,685.00	$ 831,600.00	$ 2,061,000.00	**$ 64,766,960.00**