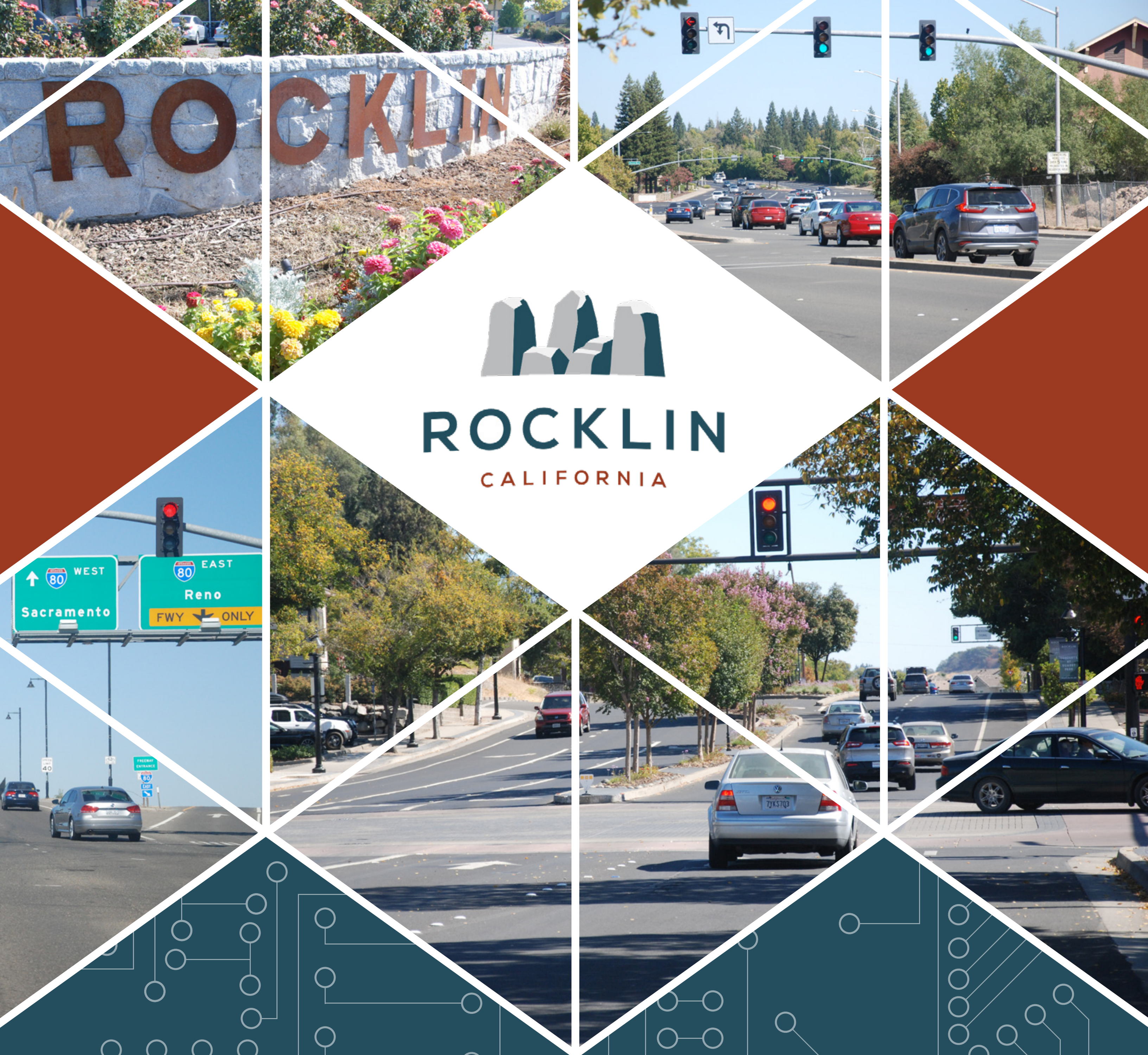

FINAL ITS MASTER PLAN

City of Rocklin, California

December 21, 2018

Kimley»Horn
Expect More. Experience Better.

ITS MASTER PLAN

City of Rocklin, California

December 21, 2018

Prepared by:

Kimley»Horn

555 Capitol Mall #300
Sacramento, California 95814
Phone: (916) 858-5800

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EXECUTIVE SUMMARY

The City of Rocklin is a vibrant city that has experienced 300% population growth since 1990. As such, the City recognizes the importance of a resilient transportation network that supports efficient and safe operations and maintenance. Unique to the City are the significant challenges it experiences on its roadways because of its location at the intersection of I-80 and Highway 65. Additionally, the City experiences traffic congestion due to regional shopping centers in the City and in neighboring Roseville, as well as due to the regional nature of Rocklin's Sierra College campus and William Jessup University.

With an eye toward innovative technologies, the City desires a plan to enable adoption and integration of transportation management tools into the existing and planned transportation system to relieve these traffic management challenges. Rocklin's Intelligent Transportation System (ITS) Master Plan builds on previously identified goals and policies established in the City's *General Plan* and *Strategic Plan* to envision a system that provides the tools to meet the City's transportation operational and management needs.

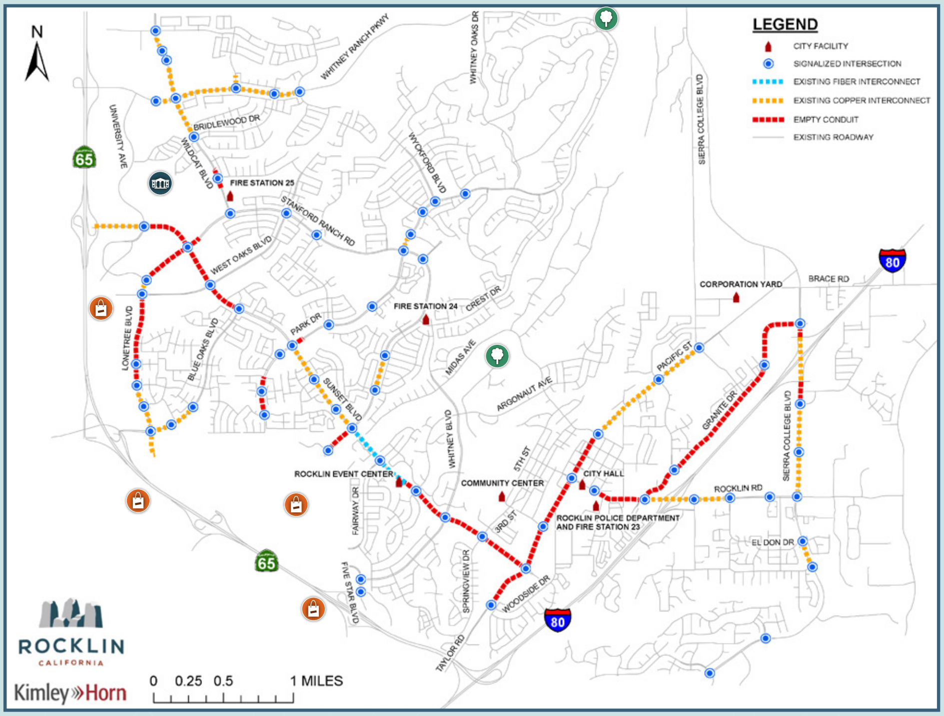
Vision

The City of Rocklin's ITS vision was developed through discussions with City Public Services staff and input provided by other internal City stakeholders and is intended to clearly define the ITS program moving forward from 2018. **The following mission statement is inspired by the City's identified *General Plan* goals and *Strategic Plan* actions, and represents the vision for this *Master Plan:***

Implement technology to foster a **safe, efficient,** and **reliable** community-focused **transportation network** that includes **multimodal traffic operations** improvements to **encourage** and **enhance** a sustainable **quality of life** for the **City of Rocklin**.

Existing Traffic Signal Network

Exhibit ES-1 – *Depicts the City's existing traffic signal network.*



ITS Goals and Objectives

The ever-changing nature of technologies requires the City to develop ITS goals and objectives that enhance the longevity and sustainability of the system while being independent of any specific technology. This ITS Master Plan will play a pivotal role in positioning the City to better maintain system infrastructure, to prepare for the adoption of new technologies, to ensure the sustainability of the transportation network, and to develop TOC operations. Goals and objectives expand the City's vision statement and address the environment, shortcomings, and needs to achieve the vision. The envisioned goals for this Master Plan are summarized here:

Table ES-1 – *System Goals*

A	Establish ITS Program and Policies
B	Conduct evaluation of the existing City transportation network
C	Improve traffic operations on major corridors
D	Position City for implementation of future emerging ITS technologies
E	Identify potential project candidates for future growth of ITS network
F	Develop an informal plan for collaboration with neighboring and regional jurisdictions, systems, policies, and protocols
G	Develop system access opportunities to provide public with timely and meaningful traveler information

System Gaps

The City does not have an established ITS. As such, there are significant gaps inhibiting the system from addressing operational and management goals.

Table ES-2 – *System Gaps*

1	No existing ITS deployment policies
2	No coordinated traffic signals
3	No collaboration with adjacent agencies for traffic operations across jurisdictions
4	Missing foundational network to support future ITS opportunities
5	Lack of transportation management tools on priority corridors
6	Minimal ability to monitor and manage regional pass-through traffic

Technology Overview & Evaluation

The following table presents technical information about various ITS technologies that have been identified to specifically address the City's system goals and gaps.

Table ES-3 – *ITS Technologies Addressing System Goals and Gaps*

TECHNOLOGY	GOALS ADDRESSED	GAPS ADDRESSED
Fiber-optic Communication	A, B, C, D, E, F, G	1, 2, 3, 4, 5, 6
Wireless Based Interconnect	A, B, C, D	1, 2, 3, 4
Copper Based Interconnect	B, C, E	1, 2, 4, 5, 6
GPS-Based Time Source Receiver	B, C	2, 5
Traffic Signal Controller Upgrades	A, B, C, D, E	1, 4, 5
Closed Circuit Television (CCTV) Cameras	A, C, E, F, G	1, 2, 3, 5, 6
Dynamic Message Signs (DMS)	A, G	1, 5
Vehicle Detection Systems	D, F, G	1, 4, 5, 6
Third-Party Data Providers	A, C, F, G	1, 3, 5, 6
Traffic Operation Center (TOC)	A, B, C, D, E, F, G	1, 2, 3, 4, 5, 6

ITS Deployment

The following strategies and recommended prioritization are based on the City's conveyed needs and will aid in the phasing of future ITS deployments and implementation of new technologies.

Table ES-4 – *Summary of ITS Deployment Strategies*

	STRATEGY	DEPLOYMENT TIMELINE
1	Deploy Traffic Signal Coordination Along Primary Corridors	Near-Term (1-4 Years)
2	Conduct Evaluation of Traffic Signal Controller and Central System Vendors	Near-Term (1-4 Years)
3	Establish Communication Trunk Lines	Near-Term (1-4 Years)
4	Evaluate and Establish Origin-Destination Data Collection	Near-Term (1-4 Years)
5	Install Communications to City's Corporation Yard and Establish TOC	Mid-Term (5-8 Years)
6	Integrate all Traffic Signals into TS Network	Mid-Term (5-8 Years)
7	Deploy Closed Circuit Television (CCTV) Cameras	Mid-Term (5-8 Years)
8	Establish Communication Link to City of Roseville and Caltrans for Cross-Jurisdictional Traffic Management	Mid-Term (5-8 Years)
9	Evaluate and Deploy Connected Vehicle Roadside Technology	Mid-Term (5-8 Years)
10	Implement Redundant Wireless Backhaul	Long-Term (8+ Years)
11	Deploy Dynamic Message Signs (DMS)	Long-Term (8+ Years)
12	Deploy Communication Upgrades	Long-Term (8+ Years)

Table ES-5 – *Final Implementation*

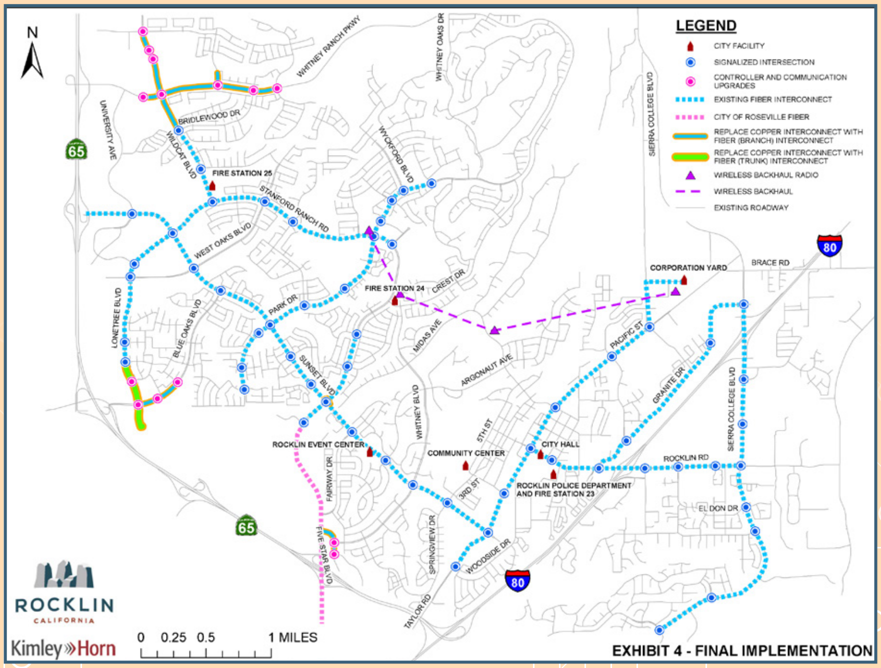


TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF EXHIBITS

I. INTRODUCTION

A. Background

Located in southwest Placer County near the foothills of the Sierra Nevada Mountains and just over 20 miles northeast of the City of Sacramento, the City of Rocklin is a vibrant city that has experienced large growth over the past several decades. This population growth is in the magnitude of 300% since 1990. However, with no annexation or large developments anticipated, the City is shifting from a focus of growth to long-term sustainability. As such, the City recognizes the importance of a resilient transportation network that supports efficient and safe operations and maintenance. Unique to the City are the significant challenges it experiences on its roadways because of its location at the intersection of I-80 and Highway 65. These two primary regional routes carry significant regional (Sacramento area commuters) and interstate (I-80 to/from Nevada and points east) vehicle volumes which have been observed to routinely result in cut-through traffic on local roads when congestion occurs on these freeways. In addition to commuters traveling to Sacramento, the City experiences traffic congestion due to regional shopping centers in the City and in neighboring Roseville, as well as due to the regional nature of Sierra College and William Jessup University. To address these traffic management needs, the City desires a robust system of transportation management tools to address the current and future operational needs.

As for the future needs, in the past few years there has been an exponential increase in the introduction of new technology-based transportation products and services. This rapid evolution has included the introduction of smart phone apps, mainstream adoption of electric vehicles, the introduction of autonomous vehicles to our roadways, as well as a variety of online route and trip planning services. As has been the experience with many technology advances (internet, smart phones, social media, etc.), these emerging transportation technologies are resulting in a myriad of complex benefits and challenges that are just beginning to be understood. With an eye toward these new technologies, the City needs a plan to enable adoption and integration of these elements into the existing and planned transportation system.

The City's *General Plan*[1] identifies the two following goals relating to its transportation network:

» Goal for Transportation System: To create a balanced and coordinated transportation system which utilizes all transportation modes efficiently and promotes sound land use.

» Goal for City and Regional Street System: To provide a safe and well-maintained system of streets that meets community needs.

For each of the goals, the City identifies policies that would achieve these circulation goals. The City later expanded on the General Plan goals through the development of objectives and supporting actions included in the *Strategic Plan*[2]. The Intelligent Transportation System (ITS) Master Plan builds on these previously identified goals and policies to envision a system that provides the tools to enable the City to meet the stated transportation operational and management needs.

B. Stakeholder Participation

A stakeholder outreach meeting was conducted on October 9, 2017 to provide attendees a background of the City's ITS, to identify ITS needs, to outline ITS goals and objectives, to provide an assessment of existing conditions and new technologies, and to outline the overall Plan Update process. Fourteen people representing various City departments attended the Stakeholder Workshop meeting. Departments with staff attending included the City Manager, Public Services, Economic and Community Development, Parks and Recreation, Police, and Central Services. The presentation material, and meeting notes from the stakeholder meeting are provided in **Appendix A**.

1. *City of Rocklin General Plan (October 2012),* City of Rocklin, *https://www.rocklin.ca.us/post/general-plan.*

2. *Rocklin Strategic Plan (2015-2020),* City of Rocklin, *https://www.rocklin.ca.us/sites/main/files/file-attachments/strategic_plan_final.pdf.*

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II. VISION, GOALS, & OBJECTIVES

A. Vision

The City of Rocklin's Intelligent Transportation System (ITS) vision was developed through discussions with City Public Services staff and input provided by other internal City stakeholders and is intended to clearly define the establishing of an ITS program moving forward from 2018. The following mission statement is inspired by the City's identified *General Plan goals and Strategic Plan* actions, and represents the vision for this *Master Plan:*

Implement technology to foster a safe, efficient, and reliable community-focused transportation network that includes multimodal traffic operations improvements to encourage and enhance a sustainable quality of life for the City of Rocklin.

B. Goals and Objectives

The ever-changing nature of technologies requires the City to develop ITS goals and objectives that enhance the longevity and sustainability of the system while being independent of any specific technology. Project and organizational improvements included in this Master Plan will provide how to achieve the above vision. This Master Plan will play a pivotal role in positioning the City to better maintain system infrastructure, to prepare for the adoption of new technologies, to ensure the sustainability of the transportation network, and to develop TOC operations.

Goals and objectives expand the City's vision statement and address the environment, shortcomings, and needs to achieve the vision. Together, the goals and objectives serve as the basis for strategies and tactics to plan and implement ITS projects. Goals are more comprehensive than objectives, and they break the vision into more manageable and tangible segments. Objectives are detailed and specific so they may provide a means of measuring whether the implemented ITS network meets the City's goals and needs. **Figure 1** provides the hierarchy of the project vision, goals, and objectives.

Figure 1 – *Vision, Goals, and Objectives Flow*

Table 1 summarizes the envisioned goals and objectives for this Master Plan. These goals and objectives are derived from the vision stated above and facilitate the identification of implementation strategies by establishing manageable and tangible statements. Specific ITS projects and solutions that address these goals and objectives are presented later in this document.

Table 1 – *Master Plan Goals and Objectives*

GOAL		OBJECTIVES
A	Establish ITS Program and Strategies	» Engage stakeholders to gather existing and future traffic management needs » Develop strategies to guide deployment of a sustainable ITS network
B	Conduct evaluation of the existing City transportation network	» Inventory existing infrastructure » Identify and evaluate existing system gaps » Prepare strategies to close gaps
C	Improve traffic operations on major corridors	» Implement ITS elements and tools to more effectively manage and operate traffic signals » Develop prioritized list of implementable projects
D	Position City for implementation of future emerging ITS technologies	» Establish process for evaluating new technologies that arise » Develop list of traffic management needs against which to evaluate new technologies
E	Identify potential project candidates for future growth of ITS network	» Develop project limits, project elements, and planning level costs for possible ITS equipment deployments » Establish backbone infrastructure to support foundational communications network for ITS and TOC expansion » Identify potential funding sources, including grants and developer's fees, for the installation of ITS elements.
F	Develop an informal plan for collaboration with neighboring and regional jurisdictions' systems, policies, and protocols	» Engage neighboring stakeholders to initiate local and regional collaboration » Regularly participate in monthly SACOG ITS Partnership Meetings » Collaborate with SACOG's Smart Region Sacramento project to enhance regional consistency with ITS architecture and the use of emerging technologies
G	Develop system access opportunities to provide public with timely and meaningful traveler information	» Research effectiveness of regional agency traveler information mediums » Document industry-wide trends and emerging user tendencies » Identify type of information and dissemination options

III. EXISTING ITS DEPLOYMENTS

The following is a summary of the inventory of the ITS program as of April 2018:

A. Communications Network

The City's existing communications network consists of a combination of fiber-optic and copper communications media that are currently not utilized for traffic signal interconnect purposes. See **Exhibit 1** for a map depicting the existing communications deployments.

While the City's signals are not interconnected, the City has a significant amount of infrastructure for future traffic signal and ITS communications. The existing communication infrastructure includes 8 miles of empty conduit, 7.5 miles of legacy copper signal interconnect (not active), and 0.6 miles of fiber optic cables used for communications to a closed-circuit television (CCTV) camera at the intersection of Stanford Ranch Road and Sunset Drive. Most of the existing empty conduit has been placed under the City's policy to require projects (private and public) to include conduit when performing street improvements.

B. Traffic Signals & Cameras

The City of Rocklin currently has seventy-one (71) traffic signals, with the majority located on key arterials and collectors. Figure 1 shows the locations of the existing traffic signals. Over past several years, Public Services has standardized the traffic signals to Type 170E traffic signal controllers with Bitrans 200CA Software, operating with battery backup systems. All City intersections run in full- or semi-actuated, free operation and are not coordinated. One reason that the City's signalized intersections are not coordinated is that there is no active interconnect system, or other means for time-syncing. Additionally, the existing controllers do not currently have the required modules to allow for communication to the signal. As there is no existing interconnect, the City does not have a central traffic signal control system.

The City has two closed circuit television (CCTV) cameras. Besides the previously mentioned CCTV camera at Stanford Ranch Road and Sunset Drive, there is an additional CCTV camera located at the traffic signal at the Fire Station 25 driveway. The City is able to view the camera via a communication connection at the fire station.

Exhibit 1 depicts the City's existing traffic signal network.

CITY OF ROCKLIN - ITS MASTER PLAN

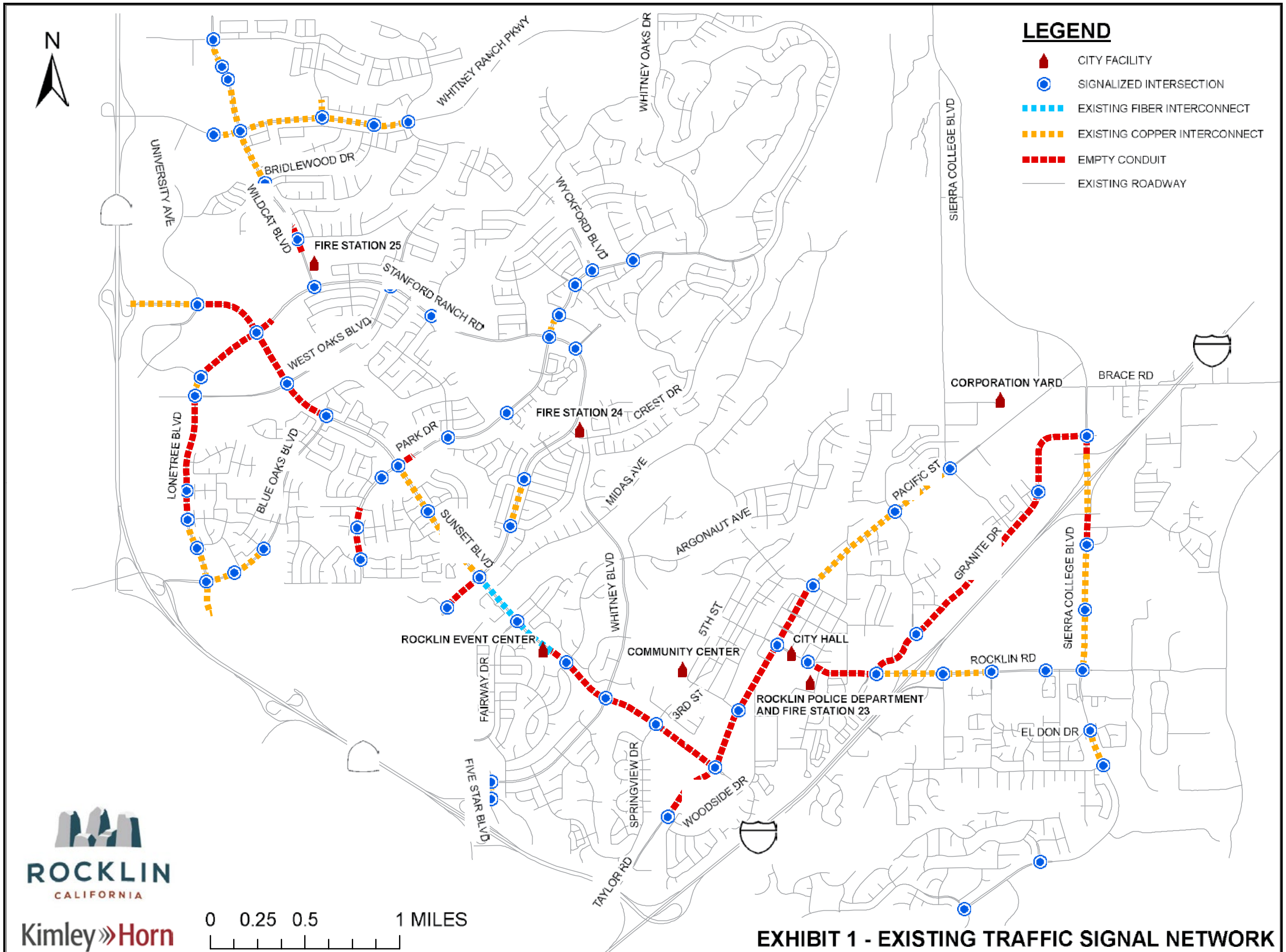

EXHIBIT 1 - EXISTING TRAFFIC SIGNAL NETWORK

IV. EVALUATION OF SYSTEM GAPS

Goals and objectives were previously discussed as an elaboration of the City's ITS vision and to address the environment, shortcomings, and needs to achieve the vision. The goals and objectives serve as the means to measure and evaluate the effectiveness of the City's ITS, as well as identify gaps that prevent the City from meeting its transportation priorities. Per the discussions in the previous sections, the City does not have an established intelligent transportation system. As such, there are significant gaps inhibiting the system from addressing operational and management goals. Comparing the current state of the City's existing ITS network against the City's overall goals and objectives, a gap analysis was completed to identify potential areas for enhancement and additions to existing system components. The following discussion provides a breakdown of this gap analysis. Gaps have been identified and are accompanied by envisioned solutions that can potentially address the gaps and improve the City's overall ITS infrastructure in a manner consistent with the previously established ITS goals and objectives.

GAP: NO EXISTING ITS DEPLOYMENT STRATEGIES

As the City currently has little to no existing ITS equipment, the City has not previously established strategies for the planning or installation of these elements. The City must develop strategies focused on the City's transportation management and operational needs.

Envisioned Solutions

» Standardize future communication and ITS deployments

» Deploy NTCIP compliant central system and Advanced Traffic Controllers (ATC) to prepare for integration of future technology advances (e.g. connected vehicles, automated traffic signal performance measures)

» Create Standard Operating Procedures that define the activities and duties to be carried out by Engineering and Maintenance staff

Associated ITS Goals

» Establish ITS Program and Strategies

» Conduct Evaluation of the Existing City Transportation Network

» Position City for Implementation of Future Emerging ITS Technologies

GAP: NO COORDINATED TRAFFIC SIGNALS

General Plan Policy C-22 identifies the need to "Interconnect traffic signals…where financially feasible and warranted to provide flexibility in controlling traffic movements." During a traffic study conducted for the Whitney, Argonaut, and Midas (WAM) area, a signal coordination analysis was performed for the Stanford Ranch Road, Sunset Boulevard, and Pacific Street corridors which showed implementation of coordination would significantly decrease congestion and improve travel times. Other key signalized corridors within the City would likely see similar benefits from the implementation of coordination and ITS elements.

Envisioned Solutions

» Identify key corridors that can benefit from a coordinated signal system

» Interconnect all traffic signals, and establish a Traffic Operations Center to provide remote operations and management of system

» Develop time-based signal timing coordination as an interim solution until signal interconnect is established

Associated ITS Goals

» Establish ITS Program and Strategies

» Conduct Evaluation of the Existing City Transportation Network

» Improve Traffic Operations on Major Corridors

» Identify potential project candidates for future growth of ITS network

GAP: NO COLLABORATION WITH ADJACENT AGENCIES FOR TRAFFIC OPERATIONS ACROSS JURISDICTIONS

As many Rocklin residents utilize the City's main corridors to connect to I-80 and SR-65, congestion and delay at the City borders is dependent on operations of Caltrans and City of Roseville facilities. The City does not have communications and data sharing policies in place to facilitate and manage traffic across jurisdictions.

Envisioned Solutions

- Engage neighboring agencies to create a joint plan for sharing of traffic data and traveler information
- Establish communication connections to Caltrans and City of Roseville.
- Deploy cross-jurisdictional traffic management projects (e.g. coordinate signals on corridors that transverse two jurisdictions)
- City staff to attend SACOG ITS Partnership Meetings

Associated ITS Goals

- Establish ITS program and strategies
- Develop an informal plan for collaboration with neighboring and regional jurisdictions' systems, policies, and protocols
- Develop system access opportunities to provide public with meaningful traveler information

GAP: LACK OF TRANSPORTATION MANAGEMENT TOOLS ON PRIORITY CORRIDORS

The City lacks an existing communication network, central traffic signal control system, or other core backbone network elements that would allow for expansion and/or integration of future ITS technologies (e.g. connected vehicles).

Envisioning

- Identify locations/corridors where communication can be added to create communication rings
- Identify existing copper lines that can be converted to single-mode fiber-optic
- Require new developments and capital improvement projects with planned roadways and traffic signals to install new conduit and fiber-optic infrastructure

Associated ITS Goals

- Conduct evaluation of the existing City transportation network
- Position City for implementation of future emerging ITS technologies
- Identify potential project candidates for future growth of ITS network

GAP: MINIMAL ABILITY TO MONITOR AND MANAGE REGIONAL PASS-THROUGH TRAFFIC

Based on previous traffic evaluations, the City has observed regional traffic using local City streets as alternate routes to I-80 and SR-65. The layering-on of regional traffic decreases operational efficiency, and results in undesired wear on local roadways. The City does not have CCTV cameras, detection, or have traveler information devices (i.e. dynamic message signs) to monitor operations related to regional traffic.

Envisioned Solutions

- » Identify tools that can collect origin-destination data
- » Assess current technologies available that can provide traveler information to drivers such as Dynamic Message Signs (DMS), and third-party app integration
- » Deploy cross-jurisdictional traffic management projects (e.g. coordinate signals on corridors that transverse two jurisdictions)
- » Identify traffic incident sharing opportunities with neighboring agencies

Associated ITS Goals

- » Improve traffic operations on major corridors
- » Develop informal plan for collaboration with neighboring and regional jurisdictions' systems, policies, and protocols
- » Develop system access opportunities to provide public with timely and meaningful traveler information.

Table 2 below provides a summary of the overall ITS system goals while **Table 3** summarizes the ITS system gaps.

Table 2 – *System Goals*

A	Establish ITS Program and Policies
B	Conduct evaluation of the existing City transportation network
C	Improve traffic operations on major corridors
D	Position City for implementation of future emerging ITS technologies
E	Identify potential project candidates for future growth of ITS network
F	Develop an informal plan for collaboration with neighboring and regional jurisdictions, systems, policies, and protocols
G	Develop system access opportunities to provide public with timely and meaningful traveler information

Table 3 – *System Gaps*

1	No Existing ITS Deployment Policies
2	No Coordinated Traffic Signals
3	No Collaboration with Adjacent Agencies for Traffic Operations Across Jurisdictions
4	Missing Foundational Network to Support Future ITS Opportunities
5	Lack of Transportation Management Tools on Priority Corridors
6	Minimal Ability to Monitor and Manage Regional Pass-Through Traffic

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V. ITS TECHNOLOGY OVERVIEW & EVALUATION

The transportation industry is poised to experience rapid changes in the coming years with the emerging development of connected vehicles and autonomous vehicles (CV/AV). The introduction of CV/AV will profoundly impact how public agencies establish, operate, and maintain their roadway networks. Additionally, there is movement toward "Smart Cities", where agencies are exploring opportunities to integrate, share, and process data available from various modes (transit, freight, pedestrians, etc.) to create more efficient and effective operations. As such, many public agencies are establishing traffic management networks that can be expandable for incorporation of ever-evolving technologies, and that prepare them for an environment that is data driven.

At the same time, with constrained municipal budgets and lean staffing, public agencies have shifted the focus of traffic network capital investments toward sustainability and efficiency. The use of traffic operations and management tools has allowed agencies to effectively utilize already limited capital and staff resources.

The following discussion presents technical information about various ITS technologies that have been identified to specifically address the City's system goals and gaps. For each technology, an overview is first provided, followed by a discussion of typical capital costs associated with implementation, and the feasibility of implementing each technology (including how the technology addresses the City's ITS goals and gaps).

Fiber-Optic Communication

Fiber optic cables are made of glass fibers and transmit information using light. Single-mode fiber optic cables are most commonly used in new traffic signal interconnect networks to provide the capability to transmit large amounts of data (typically 1-10 gigabits/second) over long distances. This characteristic is often desired as agencies add traffic monitoring devices with higher bandwidth demands, like closed circuit television (CCTV) cameras. An Ethernet-based, fiber optic traffic signal network allows agencies greater ability to manage and operate system elements, as well as deploy robust equipment that can easily facilitate future expansion.

For traffic signal interconnect, the use of fiber optic cable with high strand counts is common for primary communication routes, also known as the "trunk" line or backbone. 96-strand, 144-strand, and 288-strand fiber optic cables are examples of cables with high fiber strand count. Installing large capacity fiber cables prepares cities for future expansion and technology deployments. Extra fibers also provide agencies with the ability to share spare fiber strands with other City departments (e.g., Information Technology), neighboring agencies for cross-jurisdictional communication and traffic management, and private telecom companies (i.e., leasing fiber).

Laterals, called "branch" lines, are spliced with the trunk line and terminate into individual controller cabinets. These branch cables are typically smaller (i.e., 12-strand). Generally, the type of cables used will be dependent on specific needs, size of the communication network (extent and distance), and required bandwidth.

While the benefits of fiber are very attractive, initial implementation can be cost prohibitive. A fiber optic system requires the installation of fiber optic cable, conduit, pull boxes, Ethernet switches, fiber termination panels, and splice closures. Additionally, traffic signal controllers must be IP-addressable to be integrated into a fiber network, and the City of Rocklin's existing controllers are not.

Costs:

Planning level cost for installation of one (1) mile of new fiber optic communications is between $450k-$600k. Typical furnish and install costs for the various elements in a fiber network are as follows:

- Fiber Optic Cables: $3 to $12 per lineal foot
- Conduit (Two 3-inch): $40 to $65 per lineal foot
- Fiber Switch: $3000 to $5000 each
- Termination Panel: $500 each
- Fiber Optic Splice Closure: $750 each
- Fiber Splicing and Testing: $100 to $400 per splice
- Pull Box/Vault: $2000 to $4500 each

Feasibility:

The City of Rocklin has already installed a short segment of fiber along Sunrise Boulevard to service a traffic monitoring camera. The City also has over 15 miles of existing conduit (empty or containing copper signal interconnect), and much of the existing infrastructure is along the City's key corridors where primary fiber trunk lines would be desired. This existing infrastructure can be utilized to install new fiber cables, which would greatly reduce costs as conduit installation is generally the largest cost item for fiber implementation. Existing pull boxes along the corridor will need to be evaluated and potentially upgraded to larger boxes to facilitate fiber installation and splicing. Additionally, to meet minimum bend radius requirements for fiber optic cables, existing conduit sweeps into pull boxes will need to be examined and replaced as necessary. Bends in conduit should be less than 45 degrees to avoid damage to fiber cables. Conduit sweeps can be replaced in conjunction with pull box upgrades.

Since there is a significant amount of existing underground infrastructure that can be utilized, establishing fiber optic communications would greatly benefit the City by enabling remote traffic signal operations and traffic management. Fiber would also position the City for future expansion, and adoption of future technologies like automatic traffic signal performance measure (ATSPM) systems and CV/AV.

Wireless Based Interconnect

Wireless based interconnect allows for remote communications without the need for physical infrastructure such as conduit and cabling. Wireless interconnect uses radios to operate on licensed or unlicensed bands on the UHF radio spectrum. The radios are available in IP and serial communications, and they have sufficient bandwidth capabilities to transmit video streams. The most common radio frequencies used are 900 MHz, 2.4 GHz, and 5.8GHz. The characteristics of each frequency are:

- 900 MHz: A lower frequency that can lead to better radio signal over longer distances and is less impacted by obstacles (e.g., trees) in the line-of-sight. However, this frequency provides the smallest bandwidth (less than 50 Mbps).
- 2.4 GHz: This frequency provides a balance of bandwidth (up to 300 Mbps) and signal loss due to obstructions.
- 5.8 GHz: As the highest frequency, it provides the greatest bandwidth capabilities (up to 867 Mbps) but is most dependent on clear line-of-sight.

As alluded to in each description, all wireless technology is dependent upon line-of-sight between radio installation. Radios are best used for interconnect applications along straight corridors with minimal obstructions. Wireless is very useful for making connections to traffic signals or other equipment located near backbone communications where the cost of installing hardwire communications along even a short segment is not cost effective. Wireless is also beneficial as a secondary, redundant communication path to a primary fiber optic backbone. As an example, installation of wireless high-bandwidth radios at two high points (e.g., existing building or communication tower) to span a gap where installation of fiber is not feasible.

Costs:

Anticipated furnish and install cost for a wireless radio installation ranges from $2500 to $6000.

Feasibility:

Due to the City's topography, consisting of rolling hills that may restrict line-of-sight, extensive use of wireless interconnect is not recommended. Instead, wireless interconnect will likely be limited to closing short gaps to isolated intersections to connect to a fiber backbone.

At the same time, the City's topography may be useful as there may be opportunities to investigate establishing relay communication sites at multiple high points in the City to bridge gaps in hardwire communications. Presently, it is assumed that Sunset Boulevard would likely be the only communication backbone between the north and west sides of the City to either the Corporation Yard or City Hall. As such, a backup wireless backhaul using relay stations may be desirable to create a path of communications from traffic signal infrastructure in the Rocklin High School area of the City, up over Crest Drive and Clover Valley, and down to the Corporation Yard. Additionally, this wireless link could provide redundancy in the event of a fiber break along Sunset Boulevard.

Copper Based Interconnect

The use of twisted-pair copper cables for signal interconnect was the industry standard amongst public agencies prior to the adoption of fiber optic cable. Legacy copper-based interconnect uses 1200-baud frequency shift keying (FSK) communications to connect a master controller to adjacent local controllers. The master controller sends commands to the local controllers regarding which timing plan to run. Overall communication abilities are limited in these types of systems.

More recently, agencies have been converting existing copper systems to Ethernet-over-Copper (EoC) using new devices with combined Ethernet switch and Ethernet extender capabilities. This approach is a cost-effective solution to agencies who desire enhanced control of their network and enhanced bandwidth, and who already have existing copper cables in place. EoC has shorter distance and lower bandwidth capabilities compared to fiber systems, but is a very effective means for implementing IP-based communications in systems with smaller data demands.

Cost:

Expected capital cost to furnish and install an Ethernet-over-Copper device is between $2500 and $3500. Installation of new copper interconnect is not recommended, but deployment of EoC would rely on existing copper cables. As such, no additional underground infrastructure costs are anticipated.

Feasibility:

The City of Rocklin has 7.5 miles of existing copper signal interconnect located along various corridors throughout the City. This existing copper interconnect can be leveraged and utilized until it can be replaced with fiber. Or, the City may realize the EoC sufficiently supports your bandwidth needs.

Existing copper that is along key trunk line corridors (i.e., Sunset Boulevard) should be replaced with fiber as opposed to converting to EoC. This is because EoC has lower bandwidth capabilities and would limit the backbone communications. On the other hand, converting to EoC along ancillary corridors with few traffic signals and traffic monitoring elements will be a cost-effective interim solution until funding is available to convert the corridor to fiber.

GPS-Based Time Source Receiver

GPS-based time source receivers are small Universal Time based devices that receive time signals from atomic clocks of the United States National Institute of Standards broadcast on the Global Positioning System (GPS). Using the time information transmitted from the time source receivers, traffic signal controllers along coordinated corridors maintain accurate time, thereby preventing time drift. However, compared to the previously discussed technologies, GPS-based time source receivers do not provide any communication abilities.

A GPS-based time source receiver is a cost-effective alternative to enabling traffic signal coordination along a corridor without installing costly communications infrastructure. There are obvious limitations in this option since the equipment is only used to sync the time clock of every controller; but it does not provide any ability to communicate between controllers, or to remotely monitor the controllers. Most traffic signal controllers are equipped with the necessary communications port to connect with the time source receiver

Cost:

Typical furnish and install cost for a GPS-based time source receiver is $500 to $750.

Feasibility:

The deployment of GPS-based time source receivers is a cost-effective and quickly implementable solution to address the City's desire to improve operations along key corridors using signal timing coordination. The City of Rocklin currently has a McCain GPS-based time source receiver deployed at one City signal. The remaining Type 170E controllers have unused RS232 communication interfaces and no additional equipment would be needed to install GPS-based time source receivers at those locations. Since installation only involves connecting the receivers to the existing controllers, work can be completed by City staff. As the City deploys more permanent communication to signals, GPS-based time source receivers can be salvaged and redeployed along other corridors where coordination is desired.

Traffic Signal Controller Upgrades

Traffic signal operating capabilities are dependent upon the type and capacity of the controller that is being used. Recently, the City has standardized the traffic signals to McCain Type 170E traffic signal controllers with Bitrans 200CA Software. The Type 170 controller is a reliable industry-standard controller, originally developed by Caltrans in the late 1970s, that has been used in variety of applications from traffic signal control to freeway monitoring systems. However, with the advent of greater computing processing and software capabilities, the Type 170 controller is extremely limited compared to current controller standards.

Currently, the industry is moving toward the use of Advanced Traffic Controllers (ATC) based on national open architecture standards. The open architecture platform will provide flexibility for software and hardware development as new technologies and applications emerge. ATC controllers have been designed for the anticipated future transportation environment where data will be aggregated and processed from real-time detection systems, traffic signals, transit vehicles, dynamic message signs, freight, and freeway systems to improve operations across all modes. Controller manufacturers have produced ATC controllers in both NEMA and Type 2070 versions.

Cost:

Traffic signal controller and associated software costs vary depending on the type of controller and software desired. Controllers will typically run around $5000-$6000 each, which includes furnishing and installation as well as software implementation for the individual controller. Additional modules such as automated performance measures and adaptive signal timing would be purchased as add-on features. Total cost of implementing traffic signal controller upgrades across and entire network will be contingent upon the number of new controllers needed.

Feasibility:

Since the City of Rocklin has existing Caltrans Standard Type 332 controller cabinets, converting to a Type 2070 ATC will require little to no modifications to the existing cabinets. Converting to an ATC controller will provide the City with the ability to implement traffic control features like traffic responsive or adaptive signal timing, real-time detection systems, and automated performance monitoring. Additionally, deployment of ATC controllers will position the City for maintaining consistency with regional ITS architecture related to SACOG's Smart Region initiative, as well as ready the City for the use of emerging technologies.

Closed Circuit Television Cameras

Closed Circuit television (CCTV) cameras are the "eyes" in the field use by operations staff to remotely monitor traffic flow at intersections and along key corridors. CCTV cameras located at key intersections and typical congestion points provide traffic management personnel the ability to monitor traffic conditions in real time and make effective decisions to address disruptions. The deployment of CCTV cameras is generally limited to either fixed or Pan/Tilt/Zoom (PTZ) cameras. As the name implies, fixed camera locations utilize a CCTV camera set to view one desired direction. PTZ cameras have the capability to change their viewing areas based on user control. The use of fixed cameras typically requires several cameras to cover the same viewing area as a single PTZ camera; however, a single PTZ camera cannot provide the continuous coverage area that a series of fixed cameras can provide. When deploying CCTV cameras, the following considerations should be considered:

- A high bandwidth communications connection is required for transmitting video from CCTV cameras to a central location
- PTZ cameras require a communication data link from a central control station to operate the PTZ functions
- An operator at a Traffic Operations Center to actively monitor video from CCTV cameras and to operate PTZ cameras is highly desirable to receive the greatest operational benefit

Cost:

The cost for CCTV cameras ranges from $4000-$6000 per camera. Typically, costs can reach up to $10,000 including installation and cabling. A video management system (VMS) is required on a central server to view and control cameras; however, many traffic signal central systems already have VMS functionality built-in so a separate VMS standalone is not generally required unless an agency desires advanced features or video storage, or does not have a central system. Other costs will depend on installation requirements: whether a separate new pole will be needed, power and communication cables and conduits, and the cost for an operator at the TOC to actively monitor and/or operate the CCTV camera.

Feasibility:

The City currently has two PTZ CCTV cameras: one at the intersection of Stanford Ranch Road and Sunset Boulevard, and one at Fire Station 25 driveway. Installation of new CCTV cameras at key areas of congestion is recommended to provide the City the ability to quickly and proactively assess and address operations issues. CCTV cameras near I-80 and SR-65 will be useful to the City to identify impacts to local streets due to freeway incidents.

The expanded use of CCTV cameras is only feasible if the City establishes an Ethernet-based communication network based on high-bandwidth communications. As the City establishes and expands fiber to its signalized intersections and corridors, the deployment of CCTV cameras should occur at key locations. In addition to traffic operation needs, feedback from other cities that have deployed CCTV cameras has shown other internal City departments (i.e., Police) may desire and benefit from access to viewing traffic monitoring cameras to assist with emergency response activities. Policies regarding video sharing and storage will need to be established by the City.

Dynamic Message Signs (DMS)

Dynamic Message Signs (DMS) allow agencies to post traffic messages to motorists regarding advanced information of downstream traffic conditions, special event notifications, major incident warnings, alternate/diversion routes, as well as construction and real-time travel time information. DMS are available in various sizes, pixel spacing, and color display capabilities depending on the type of messages or images an agency desires to provide. Most DMS currently available can display graphics (i.e., traffic maps, freeway shields) in addition to text messages.

Cost:

The cost of implementing new DMS depends on the desired display matrix sizes, the controllers for each unit, and the cabling and conduit network needed to bring power and communication to the signs. Furnishing, installing, and integrating one DMS can range from $20,000 for a roadside mounted (two wood posts) DMS to $150,000 for an overhead DMS mounted on a cantilevered steel sign structure. Most traffic signal control systems can directly integrate DMS without customized software.

Feasibility:

The City experiences regular cut-through traffic related to I-80 and SR-65, so DMS installations would be useful for conveying traveler information regarding freeway system incidents and congestion. Additionally, DMS could be used to provide estimated travel times along primary corridors to encourage travelers to utilize those routes as opposed to cutting through on local roads. The placement and frequency of DMS within the City's network should be well coordinated to ensure each location provides several key features including access to desirable alternate routes, ease of access to existing or proposed communications media (i.e., fiber optic cable), potential for cross-jurisdictional use, and sensitivity to adjacent land uses.

The City of Rocklin currently has a city ordinance that restricts the use of digital signage for advertising. Further investigation is required to identify if installation of DMS will violate the ordinance, and if it does, the City will need to modify the ordinance accordingly to enable DMS deployment.

Vehicle Detection Systems

Vehicle Detection Systems monitor traffic conditions through the detection of vehicle speeds, presence, classification, and volumes. Reliable traffic data collection is vital to traffic signal operation, congestion monitoring/identification, traffic management plan development, and many other traffic operation activities.

Detection of vehicle speeds, volumes, and presence has most commonly been accomplished with in-pavement inductive loops. More recently, cities and state agencies have been deploying non-intrusive detectors that do not require construction activities in the roadway surface. The following are brief descriptions of the more frequently used detection technologies:

- **Inductive Loops –** Inductive detector loops are the industry standard technology for roadway detection and have been for the last half century. Inductive loops consist of a series of coiled loops placed in the roadway's surface to create an electromagnetic field around the wire which can detect when a metallic object (e.g., vehicle or bicycle) passes through the electromagnetic field and causes a disturbance in the field. A single loop can capture vehicle presence, and volume data; but, two loops spaced twenty feet apart, allows for the collection of speed and vehicle classification data.

  Compared to other detection systems, loop detection is not affected by weather and other environmental factors; however, loop detector installation does require saw cutting the roadway pavement surface, resulting in higher installation and maintenance impacts such as lane closure, traffic control, and decreased pavement life.

  The installation and operation of inductive detector loops require several different elements. Detector loop installation alone can cost up to $700 per loop and require a controller for collecting vehicle data. A complete system will also include detector cards, costing about $750 each. In addition, the cost of the detector lead-in cables (DLCs) at up to $3 per linear foot will contribute to the total costs of installing inductive detector loop systems.

- **Radar Detection –** Radar detection is a non-intrusive, roadside technology that relies on microwave radar technology to detect, monitor, and measure vehicle traffic without installing equipment in the roadway. When a vehicle passes through the detection zone and contacts the wave, it causes a shift in the frequency that is relayed back to the radar.

  Radar detectors are mounted directly over lanes of travel or on a roadside structure. A single unit can provide multi-lane coverage and has the capability to collect volumes, average vehicle speeds, occupancy, and classification counts. Radar is generally resistant to inclement weather; however, some models do have issues in heavy fog or when installed on steel bridges. Another consideration for radar detection is that high truck volumes can reduce the accuracy of the system due to occlusion.

  Installation of a stand-alone radar station on an existing structure can cost up to $9,000. Costs will increase approximately $6,000-$8,000 if a new pole and foundation needs to be installed.

- **Video Detection –** Using fixed cameras, a Video Image Detection System (VIDS) analyzes video to produce traffic data. Easy to modify and customize, user defined zones identify the areas where detection is needed. A single camera can provide detection over multiple lanes, including separate detection zones in one lane. The VIDS can detect vehicle presence, occupancy, vehicle speed, classification (by vehicle length), bicycles, and traffic incidents. An additional feature of VIDS is that video captured by the system can also be used for traffic monitoring viewing by traffic operations personnel. Typically, one fixed camera is installed per intersection approach; but for large approaches, two cameras may be necessary. As an alternate to use the of multiple fixed cameras to cover an intersection, there is a manufacturer, Gridsmart, which utilizes a camera with fish eye optics to provide detection for an entire intersection.

  While VIDS can provide a large amount of traffic data, there are factors that must be considered prior to installation to ensure a reliable system. First, environmental factors like rain, snow, fog, night, shadows, and dirt on the camera lens can decrease performance of the system by degrading the video quality. Additionally, if the camera is not installed in a place that provides optimal viewing of traffic, occlusion will prevent the system from seeing all vehicles passing through the detection zone(s), which degrades data accuracy. Lastly, VIDS can be affected by movement when mounted on structures that may sway or vibrate due to wind; however, VIDS manufacturers have incorporated video stabilization capabilities that mitigate camera movement issues.

  Installing video detection will require the purchase and installation of cameras, video processor, and video detection power and communication cables. Costs of each camera fall within the range of $4,000-$5,000, which typically includes installation and software. Video detection cables will cost around $2 per linear foot. Like radar detection, should a separate pole and foundation be needed, an additional $6,000-$8,000 can be expected. If there is a desire to view the video feed for real-time traffic monitoring there must be an established communication connection to the intersection.

- **Bluetooth –** Bluetooth protocol is a widely used, open standard, wireless (2.4 GHz radio band) technology for exchanging data over short distances. The technology is frequently embedded in mobile telephones, Global Positioning Systems (GPS), computers, and in-vehicle applications such as navigation systems. Each Bluetooth device uses a unique electronic identifier known as a Media Access Control (MAC) address. If a Bluetooth-equipped device is in discover mode, it can be anonymously detected by a roadside mounted detector. The detector will record and log the MAC address, time of detection, and location. Utilizing the data collected, a network of Bluetooth devices can determine origin-destination (O-D) data for travel demand modeling, real-time travel time traveler information, and for evaluating systemwide performance measures.

  The use of Bluetooth MAC addresses for travel time monitoring typically only requires one roadside installation to capture the unique address of Bluetooth devices traveling in all directions of flow, with an approximate detection range of 300 feet. An issue with Bluetooth technology is that some Bluetooth applications have been known to only capture 5-7% of traffic, so extended data collection may be required to collect adequate data samples. Other applications have reported 15-20% which is a reasonable sample size for travel time and O-D calculations. Required level of capture is dictated by how the data is used and how accurate it needs to be.

  Typical Bluetooth installations cost approximately $1,500-$2,500 per location, which includes only the equipment and installation costs. A new pole and foundation for mounting the equipment will be required. Recurring licensing fees and yearly data validation costs will also be required. With these integration and implementation costs considered, Bluetooth detection can total $8,000 to $10,000 per location.

Feasibility:

Since the City has not deployed the latest full-feature traffic signal controllers or established a communication network with a central traffic signal system, extensive use of vehicle detection systems beyond those utilized for traffic signal detection are not recommended at this time. Improved and expanded intersection detection providing the ability to collect volumes may be useful in instances where advanced traffic control like adaptive signal timing is desired. However, those deployments will still be dependent on controller upgrades and established communications.

In the future, once the City has established a strong traffic operations network, vehicle detection systems can provide the City with traffic data that will be useful for planning, traffic analysis, and operations. Collecting data could be utilized by City transportation planners to evaluate traffic demands, and inform long-term planning efforts and infrastructure investments. However, with the development of reliable third-party traffic data providers (discussed in next section), the need for cities to maintain equipment for collecting data is becoming less attractive. However, use of detection systems is still very critical when collecting real-time traffic data for use in adaptive and traffic responsive signal timing, detecting incidents, and measuring congestion.

Regarding Bluetooth, due to concerns with sample sizes and reliability of data, it is not recommended for the City to deploy Bluetooth readers. Instead, a more feasible alternative is to utilize data aggregated by third-party providers (see below).

Third-Party Traffic Data Providers

There are private companies that collect, process, and analyze location data from mobile phones, GPS navigation devices, fitness tracking devices, and passenger and freight vehicles. Data analytics and metrics available from the third-party providers include origin-destination, travel speeds, corridor travel time, and estimated roadway volumes. Agencies can pay for access to web-based applications to generate transportation analyses without the need to conduct data collection activities. Some providers offer historical and real-time data (e.g., INRIX), while others only provide historical data (e.g., StreetLight Data).

The use of private traffic data services can be a good supplement or replacement to a planning agency's existing traffic information system. It offers dynamic data that reflects a very large sample pool that can be implemented in various ways. Important to note, however, for privacy reasons, information is not given as raw data. Planning agencies must use the private company's web-based applications to query the information of interest through search functions, and the data will be output accordingly.

Cost:

Costs associated with implementing traffic data services are on a case-by-case basis and can widely vary. Costs are mainly attributed to system implementation/integration costs, amount of data requested, and recurring data purchasing costs. If this data is intended to be utilized for real-time operations, an agency must also consider the costs required to implement the new data source into their existing operational environment and must understand available data limitations. The recurring cost to obtain the data will typically be paid on a recurring basis and the cost level will vary based upon the type and amount of data desired.

Feasibility:

Third-party data services are a very cost-effective alternative to deploying City-owned data collection stations which the City would need to operate and maintain. Third-party data is an extremely viable option for the City of Rocklin to evaluate origin-destination data for both internal traffic and pass-through traffic. As identified in previous studies, local and regional traffic utilize local streets during congestion on I-80 and SR-65. Third-party data and analytics will provide the City with the ability quantify traffic trends. Additionally, for internal City traffic circulation, the City could use the third-party analytics to conduct traffic analyses like the recent “Whitney-Argonaut-Midas Study” which evaluated trip distribution along the primary arterials and local roads using Bluetooth technology.

Traffic Operations Center (TOC)

A Traffic Operations Center (TOC) is the primary interface to the City’s ITS elements including the traffic signal system, CCTV cameras, communication hubs, and other ITS network devices. Using a dedicated communication network and a central management system, City staff has the ability to operate and control field devices from a remote location. Typical TOCs with full operational capabilities typically contain the following elements:

- System control software for traffic signals, CCTV cameras, and other traffic management equipment;
- Server equipment for traffic operations central system;
- Monitors or video wall display to observe camera feeds;
- Communication equipment (e.g., telephones, radio);
- Workstation area that can accommodate at least two or more operators; and
- Additional meeting area with conference

Cost:

The scale of TOCs can vary greatly based on the anticipated usage and staffing. TOCs can range from one workstation located at a City traffic engineer desk to a large TOC staffed 24-hours a day, 7-days a week. The key cost component of the TOC is the procurement and installation of a traffic signal central system with typical costs between $300,000 and $600,000, including procurement of new traffic signal controllers. Costs associated with the potential TOC components include:

- ATMS - $100,000 to $125,000
- Workstation - $2,000 to $4,000
- Server Equipment – $25,000 to $40,000
- Licensing - $500 to $1,000 per intersection
- Traffic Operations Center Build-Out including Meeting Area - $25,000 to $60,000
- Annual Software Maintenance Agreement - $10,000 to $15,000 per year

Note that the figures presented above only include capital costs and does not include any field equipment. Overall costs for implementing a TOC will also include on-going staffing for operations and maintenance, which can represent significant costs depending on the desired day-to-day operations of the TOC.

Feasibility:

A TOC is necessary to provide the City with the ability to remotely operate and manage traffic operations. Based on the current staffing and traffic signal management processes of the City, a large-scale TOC is not appropriate. Instead, direct communications to the City's Corporation Yard with one or more workstations would be the most effective for the City of Rocklin. From workstations, City maintenance and traffic engineering staff would access the ITS network elements. In lieu of creating a dedicated TOC space, an additional workstation with a connection to a large monitor could be installed in a conference room or empty office for use during special events or emergencies.

Summary

Table 4 provides a summary of the technologies, and associated project goals and gaps (per **Table 2** and **Table 3**) that are anticipated to be addressed by implementing elements described above.

Table 4 – *ITS Technologies' Associated System Goals and Gaps*

TECHNOLOGY	GOALS ADDRESSED	GAPS ADDRESSED
Fiber-optic Communication	A, B, C, D, E, F, G	1, 2, 3, 4, 5, 6
Wireless Based Interconnect	A, B, C, D	1, 2, 3, 4
Copper Based Interconnect	B, C, E	1, 2, 4, 5, 6
GPS-Based Time Source Receiver	B, C	2, 5
Traffic Signal Controller Upgrades	A, B, C, D, E	1, 4, 5
Closed Circuit Television (CCTV) Cameras	A, C, E, F, G	1, 2, 3, 5, 6
Dynamic Message Signs (DMS)	A, G	1, 5
Vehicle Detection Systems	D, F, G	1, 4, 5, 6
Third-Party Data Providers	A, C, F, G	1, 3, 5, 6
Traffic Operation Center (TOC)	A, B, C, D, E, F, G	1, 2, 3, 4, 5, 6

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VI. DEPLOYMENT STRATEGIES & PRIORITIZATION

Using the groundwork established by the City's ITS vision, goals, objectives, and gaps, prioritized implementation strategies will be a critical guide for the creation of a sustainable ITS infrastructure. The strategies must consider the most effective approach to identify when to deploy a technology or improvement, how to proceed with the deployment, and where to implement project elements. The following strategies and recommended prioritization are based on the City's conveyed needs and should be used to direct the phasing of future ITS deployments and implementation of new technologies. The proposed strategies are separated into near-term (1- to 4-years), mid-term (5- to 8-years), and long-term (more than 8-years). However, the intent of the strategies is not to be a rigid set of requirements; instead, the City should periodically reevaluate its evolving priorities and adjust these strategies as necessary.

A. Near-Term Implementation

The near-term strategies are intended to establish a strong foundational network on which the City can continue to expand. Near-term strategies aim to address the City's highest and most pressing needs while considering the level of effort to complete.

1. ***Deploy Traffic Signal Coordination Along Primary Corridors***
   As identified in the "Whitney-Argonaut-Midas Study", operations along the City's signalized corridors could be improved through the implementation of traffic signal coordination. Signal timing coordination can quickly be established along each of the City's primary corridors through the deployment of updated signal timing and the installation of GPS-based Time Source Receivers. Traffic signal controllers will not need to be upgraded to accept the receivers. The use of GPS receivers and coordination timings will be a cost-effective near-term solution until a more extensive ITS network can be established.

2. ***Conduct Evaluation of Traffic Signal Controller and Central System Vendors***
   To prepare for establishing a more robust and comprehensive ITS network capable of advanced traffic control, the City should conduct an evaluation of available traffic signal system vendors. The evaluation should include the development of functional requirements that define how the system will be used and what capabilities the system must have to meet the City's needs. The FHWA System Engineering process should be followed for the development of the functional requirements and the evaluation of available traffic signal controller systems.

   The City should convert to a Type 2070 ATC controller to provide the City with the ability to implement traffic control features like traffic responsive or adaptive signal timing, real-time detection systems, and automated performance monitoring. Additionally, deployment of ATC controllers will position the City for maintaining consistency with regional ITS architecture related to SACOG's Smart Region initiative, as well as ready the City for the use of emerging technologies.

3. ***Establish Communication Trunk Lines***
   After the City has established traffic signal coordination along primary arterials (Strategy #1 above), the City should install communications along Sunset Boulevard, Sierra College Boulevard, Pacific Street, and Rocklin Road. While there are some gaps, there is a significant amount of existing communication conduit along these four corridors that can be utilized. These communication lines will form the backbone of the City's network and can be used to operate signal coordination until a connection is established to a Traffic Operations Center (TOC) anticipated to be located at City Hall or the Corporation Yard. Fiber optic technology is recommended to provide the City with high bandwidth capabilities to facilitate future expansion. However, if funding constraints exist, Ethernet-over-Copper (EoC) should be considered where there is existing copper and there may not be heavy bandwidth needs. It should be noted, as corridors are upgraded to Ethernet-based communications, the traffic signal controller will need to be upgraded based on the result of Strategy #2 above.

4. ***Evaluate and Establish Origin-Destination Data Collection***
   The City should evaluate the use of Bluetooth/Wi-fi detection technology, or utilizing a third-party "big data" provider. Based on stakeholder input, traffic passing through the City and internal cut-through traffic on local streets are important concerns. Stakeholders have expressed interest in tools that would quantify the amount of pass-through and cut-through traffic. The data could be used to identify solutions to address congestion related to these types of trips. The City should consider partnering with Caltrans and City of Roseville to establish an O-D data collection network to evaluate key alternate routes of travel through the City for Highway 65 and I-80.

B. Mid-Term Implementation

After the near-term activities have been completed and the base of a fully connected communication network has been created, focus can be placed on expanding the City's traffic operations and management capabilities. Recommended project solutions may be in the form of stand-alone projects or as part of other capital improvement projects.

5. ***Install Communications to City's Corporation Yard and Establish TOC***
   Having established trunk lines along the main signalized corridors in near-term projects, and having developed central system functional requirements, the City will be equipped to deploy a TOC at the Corporation Yard (or other location as specified). The TOC will allow City engineering and operations staff to effectively monitor and manage the emerging ITS network. A secondary TOC or workstation located at City Hall or an Emergency Operations Center should be considered for potential use during emergencies. If the central system is integrated into the City's IT network which has virtual desktop infrastructure, separate workstations will not be necessary, instead specific users will be granted rights to access the system.

6. ***Integrate all Traffic Signals into ITS Network***
   The City should expand communications and controller upgrades to all signals. Fiber optic technology is recommended to provide the City with high bandwidth capabilities to facilitate future expansion. However, if funding constraints exist, Ethernet-over-Copper (EoC) should be considered where there is existing copper and there may not be heavy bandwidth needs.

7. ***Deploy Closed Circuit Television (CCTV) Cameras***
   An assessment of key intersections and areas of congestion should be conducted to plan locations for CCTV camera deployments. After identifying desired cameras installation locations, cameras can be deployed as part of other capital or traffic signal improvements projects, or as a stand-alone CCTV camera implementation project.

8. ***Establish Communication Link to City of Roseville and Caltrans for Cross-Jurisdictional Traffic Management***
   A significant number of trips within the City originate or end at I-80 and SR-65, and these access points near the City borders are key congestion areas. Improving operations of the roadways and signals at these boundaries depends on collaboration between the City of Rocklin, City of Roseville, and Caltrans. As such, establishing communications and data sharing between the agencies is extremely important to facilitate cooperative, efficient traffic management. The agencies will need to discuss and document protocols, policies, and plans for joint operations at the agency right-of-way boundaries.

9. ***Evaluate and Deploy Connected Vehicle (CV) Roadside Technology***
   Current industry projections estimate autonomous vehicles will be fully operational on roadways within the next four years. Additionally, most major auto manufacturers have reported the introduction of self-driving vehicles by 2021 or sooner. Through the near-and mid-term strategies above, the City will establish a robust communications network, upgrade traffic signals, and implement a central traffic control system with the ability to interact with self-driving vehicles but will not have the communication interface in place yet. The City will need to evaluate and establish the latest roadside technology (e.g., Dedicated Short Range Communications, 5G mobile technology) that allows for communication between vehicles and City infrastructure. This roadside technology can also allow for Signal Phasing and Timing (SPaT) implementation where traffic signals interact with mobile devices on vehicles to collect vehicle data for use in signal timing coordination. During the evaluation of connected vehicle roadside technology, the City should engage with auto manufacturers to explore opportunity to jointly deploy and integrate CV technology elements.

C. Long-Term Implementation

Long-term strategies include approaches to complete the build-out of the traffic signal network and prepare for further management capabilities.

10. Implement Redundant Wireless Backhaul

Network redundancy mitigates loss in communications to ITS elements in the event of a failure in one portion of the system. Redundancy is provided through a network where each element is connected by at least two paths of communication. Additionally, network equipment is provided with the capability to detect communication loss in a primary path and reroute transmissions to a secondary path.

As previously discussed, it is expected that Sunset Boulevard will be the only feasible trunk line between the northwest portion of the City and the TOC at the Corporation Yard. To provide network redundancy, a wireless backhaul should be implemented. Relay stations placed at multiple high-points in the City will allow for a secondary connection to the TOC in the event there is a disruption to communications along Sunset Boulevard.

11. Deploy Dynamic Message Signs (DMS)

As with the CCTV deployment, an assessment for potential DMS locations should be conducted. DMS could be particularly useful to address pass-through and cut-through traffic by providing information about incidents on I-80 or SR-65, estimated travel times, alternate route information, and congestion alerts. The locations of the DMS should be based on O-D information (Strategy #4) and at locations drivers must decide between alternate paths of travel. As discussed in the technology section above, the City will need to evaluate whether DMS are subject to the City's digital signage ordinance prior to deployment.

12. Deploy Communication Upgrades

At this time, replacing all copper and finalizing redundant communications should take place to create a uniform and flexible communications system. Hardwire connections to the signals is preferred, but wireless connections should be evaluated based on cost-effectiveness.

Table 5 provides a summary of the ITS deployment strategies and their prioritization into near-term, mid-term, or long-term timeframes.

Table 5 – *Summary of ITS Deployment Strategies*

STRATEGY	DEPLOYMENT TIMELINE		
1. Deploy Traffic Signal Coordination Along Primary Corridors	**Near-Term (1-4 Years)**		
2. Conduct Evaluation of Traffic Signal Controller and Central System Vendors	**Near-Term (1-4 Years)**		
3. Establish Communication Trunk Lines	**Near-Term (1-4 Years)**		
4. Evaluate and Establish Origin-Destination Data Collection	**Near-Term (1-4 Years)**		
5. Install Communications to City's Corporation Yard and Establish TOC		**Mid-Term (5-8 Years)**	
6. Integrate all Traffic Signals into ITS Network		**Mid-Term (5-8 Years)**	
7. Deploy Closed Circuit Television (CCTV) Cameras		**Mid-Term (5-8 Years)**	
8. Establish Communication Link to City of Roseville and Caltrans for Cross-Jurisdictional Traffic Management		**Mid-Term (5-8 Years)**	
9. Evaluate and Deploy Connected Vehicle Roadside Technology		**Mid-Term (5-8 Years)**	
10. Implement Redundant Wireless Backhaul			**Long-Term (8+ Years)**
11. Deploy Dynamic Message Signs (DMS)			**Long-Term (8+ Years)**
12. Deploy Communication Upgrades			**Long-Term (8+ Years)**

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VII. PROJECT IMPLEMENTATION

The projects listed in this section have been identified to directly address the City of Rocklin's ITS priorities and needs. The projects presented are placed into near-term and mid-term categories with consideration of the City's primary corridors and technological goals. Note that the order in which the projects are presented does not necessarily correlate to the order they should be implemented. Appropriate phasing of these projects should be evaluated as funds become available to make sure to not disregard the possibility of a mid-term project being deployed with a near-term project. The City should ultimately consider this section as a list of projects that may be grouped as deemed appropriate.

A. Specific Projects

The following are the types of projects that can be implemented by the City. Each project includes a description of the type of work to be completed as well as assumptions for determining the planning level costs for project development and capital. The near- and mid-term implementation projects are presented in **Exhibit 2** and **Exhibit 3**. **Exhibit 4** demonstrates the complete network resulting from the implementation of the individual communication projects. Furthermore, the existing and proposed CCTV and DMS network are shown in **Exhibit 5**. **Table 6** provides a summary of the various ITS projects provided in this section.

Traffic Signal Coordination – As noted in the implementation strategies discussion, the City desires to quickly deploy signal timing coordination on major corridors to encourage drivers to utilize signalized corridors and reduce cut-through traffic. The key corridors identified for coordination are Sunset Boulevard, Sierra College Boulevard, Pacific Street, Rocklin Road, and Stanford Ranch Road. The signal coordination projects will include deployment of GPS-based time source receivers and development of signal timing coordination plans.

Traffic Signal Controller and Central System – To establish which traffic signal controllers and central system will be deployed by future projects, the first ITS network project proposed is the development of functional and technical requirements meeting the City's traffic management needs. Cost for the development of system requirements assumes 85 hours of senior staff level work.

Using the requirements developed for the traffic signal controllers and central system, the City should next conduct an evaluation of traffic signal system vendors to determine which system to use. The central system evaluation costs are based on an estimated effort of 120 hours of senior level staff and 100 hours of junior staff support.

While procurement of a central system is paired with the deployment of a TOC in mid-term implementation projects (see **Table 6**), the City may consider proceeding with the procurement in conjunction with the evaluation of available traffic signal controller software.

Communication Network Installation and Upgrades – The City of Rocklin currently does not have a central traffic signal control system or existing traffic signal interconnect. However, as denoted in the existing conditions section above, the City does have existing infrastructure that can be leveraged for future ITS communications. Table 6 presents the list of communication network projects. The layout of the overall network when fully built is illustrated in **Exhibit 4.**

As part of the near-term implementation, proposed network projects will install a 144-strand fiber-optic cable as the City's trunk line. The trunk line will traverse through the City's main corridors acting as the network's communication backbone. These corridors are Sunset Boulevard, Pacific Street, Rocklin Road, and Sierra College Boulevard. At each intersection along the route, the trunk line will be spliced with a 12-strand drop cable to provide connection into the traffic signal cabinet. The 12 fiber strands will then be terminated inside the cabinet using a fiber termination panel.

As part of the mid-term implementation, communications will be established to all City signals. To build on the near-term primary backbone, trunk line fiber-optic cables are proposed along Park Drive and Lonetree Boulevard. The Pacific Street trunk line will be extended to connect to the City's Corporation yard. Branching off the network's trunk line will be 24-strand fiber-optic branch lines. Fiber-optic branch cables are proposed to be installed along all other signalized corridors where there are a lower number of signalized intersections. Similarly to the trunk line corridors, the branch lines will connect with signalized intersections by splicing to a 12-strand drop cable.

In conjunction with fiber communication deployments, upgrades to the signal controllers are necessary to integrate the signals into the network. Furthermore, to accommodate the new fiber-optic infrastructure, each traffic signal cabinet will need to be furnished with the appropriate fiber equipment such as a fiber termination panel, fiber switch, and pre-determined cable assembly.

Planning level costs for new fiber communication in existing empty conduit is per mile of installed fiber. Where existing empty conduit does not exist, costs include the installation of two 3-inch conduits, new fiber optic cable, pull boxes placed every 400-feet, two splice boxes per corridor, and two fiber switches.

In anticipation of funding constraints, several mid-term projects include Ethernet-over-Copper (EoC) implementation on ancillary corridors where there is existing copper interconnect. These include the northern portion of Wildcat Boulevard, Whitney Ranch Parkway, the southern portion of Lonetree Boulevard, and the southern portion of Blue Oaks Boulevard. At EoC locations, the only required improvements will be the installation of a EoC switch and the replacement of the traffic signal controller. In long-term implementation projects, the EoC corridors will be converted to fiber-optic communications.

Origin-Destination Data Collection – To determine which type of O-D technology deployment best fits the needs of the City of Rocklin, a research study is proposed to review currently available products (e.g. Bluetooth, WiFi, third-party data). The study assumes 60 hours for both senior and junior level staff.

Based on the results of the O-D technology evaluation, a project is proposed to sufficiently provide data covering all the major entry/exist points in the City, as well as key locations to determine traffic patterns along the City's roadway network. The cost shown for the deployment of O-D data collection tools is based on the installation of 20 Bluetooth readers or the purchase of third-party data for 2 or 3 years.

Traffic Operations Center (TOC) Projects – After establishing the communication trunk lines in near-term implementation projects, the first set of mid-term projects focus on establishing a TOC from which City staff can operate ITS elements. Implementation of a TOC is critical to the development of the City's traffic and communication network, setting the stage for all future traffic management activities. **Table 6** includes five projects required for the implementation of a TOC.

The first project is the evaluation and design of a TOC at either City Hall, the Police Department, or the Corporation Yard. Costs for this effort assumes 60 hours of senior staff level work and 80 hours of junior staff work. In conjunction with the TOC site evaluation can be the development of TOC standard operating procedures (SOP) and functional requirements, and the procurement of the central traffic control system. The effort for the development of the TOC SOP and functional requirements includes 85 hours for a senior staff person.

Assuming the TOC is to be located at the City's Corporation yard, the last TOC project is to connect the trunk line along Pacific Street to the Corporation Yard.

CCTV Camera Installations – Expanding the City's CCTV network will provide City staff with greater ability to remotely monitoring and manage signal operations. The City currently has only two existing CCTV cameras installed, and as part of mid-term implementation projects, locations where CCTV cameras would be beneficial have been identified (see **Table 6**). For project deployment efficiencies, the City should consider pairing CCTV camera installations with the implementation of communication projects. The following are the locations of the proposed CCTV cameras:

- Sunset Boulevard and W. Stanford Ranch Road
- Sunset Boulevard and Park Drive
- Sunset Boulevard and Whitney Boulevard
- Sunset Boulevard and Pacific Street
- Lonetree Boulevard and Blue Oaks Boulevard
- Wildcat Boulevard and Whitney Ranch Parkway
- Pacific Street and Rocklin Road
- Rocklin Road and Granite Drive
- Rocklin Road and Sierra College Boulevard
- Sierra College Boulevard and Granite Drive
- Stanford Ranch Road and Park Drive
- Pacific Street and E. Midas avenue
- Rocklin Road and Aguilar Road
- Sierra College Boulevard and Bass Pro Road
- Sunset Boulevard and Blue Oaks Boulevard
- Lonetree Boulevard and Redwood Drive
- Wildcat Boulevard and Ranch View Drive

Planning level costs for the installation of CCTV cameras include the cost for each CCTV camera plus one video encoder each. The costs assume that the CCTVs will be installed on an existing traffic signal pole, therefore the cost of a new pole and foundation is not factored into the planning level cost.

Cross-Jurisdictional Traffic Management Projects – Establishing the ability to communicate with adjacent jurisdictions like the City of Roseville and Caltrans will provide the ability to manage traffic operations across jurisdictional boundaries. To facilitate the sharing of data, the City of Rocklin will need to develop a set of policies and protocols for what data will be shared and how it will be used. The protocols will also need to determine roles and responsibilities of each agency for shared traffic management activities. To develop these protocols, it is estimated that a project of 80 hours of senior staff and 40 hours of junior staff will be needed.

Once the necessary policies are in place, the City of Rocklin will need to establish communication connections to the partnering agencies. A communication project is proposed to establish a fiber communication link between the cities of Rocklin and Roseville on Stanford Ranch Road. The City of Roseville currently has fiber optic communications on Stanford Ranch Road north of SR-65. The proposed project will install City of Rocklin fiber to the Roseville signal at Stanford Ranch Road and Highland Park Drive. This project will also include utilization of City of Roseville fiber to establish communications to the two City of Rocklin signals on Five Star Boulevard.

Connected Vehicle Roadside Technology – As the development of connected and autonomous vehicle technology is still developing, the City will need to perform an evaluation of the latest roadside technology (e.g., Dedicated Short Range Communications, 5G mobile technology) to determine which will provide the best interface between the City's infrastructure and self-driving vehicles. The study assumes 80 hours for senior level staff and 40 hours for junior level staff.

The results of the roadside technology evaluation will determine the type of device to be installed at each signalized intersection. The primary focus of the equipment will be to allow the traffic signals and vehicles to communicate with each other; as such, the costs shown in **Table 6** for the deployment of connected vehicle roadside technology assumes the installation of one device per intersection. The project may be expanded to include roadside elements to other City infrastructure based on the current needs. The City may consider partnering with a vendor or automobile manufacturer to reduce the cost of deployment.

Redundant Wireless Backhaul Project – A redundant wireless backhaul project will provide a secondary communications path to close key communication gaps within the City's proposed network. Creating multiple paths of communication throughout the City will provide added security in the event of a failure at any point in the network. Increasing redundancy of the network will also provide the City with larger network capacity and will increase the overall sustainability of the system.

The near-term implementation projects propose to expand the City's existing network through hard-wire installation of fiber-optic trunk and branch lines. As part of the long-term redundancy project, implementation of wireless backhaul radio is proposed to close the communication ring between the TOC and various proposed fiber-optic lines. Traffic signals will be integrated onto this ring, enabling them to communicate with each other as well as bringing information back to the TOC. The ring will establish a minimum of two paths of communication from any point in the network back to the primary TOC.

Wireless backhaul equipment would be installed at the intersection of Park Drive and Stanford Ranch Road to be the main point of connection to signals in the northwest portion of the City in the event communication fails along Sunset Boulevard. Due to Rocklin's topography, two intermediate radio towers are proposed at the Fire Station 24 and Antelope Canal water towers to limit line-of-sight obstructions with the TOC. The new wireless connection will provide the TOC with the capability to automatically reroute communications in the event of point failures.

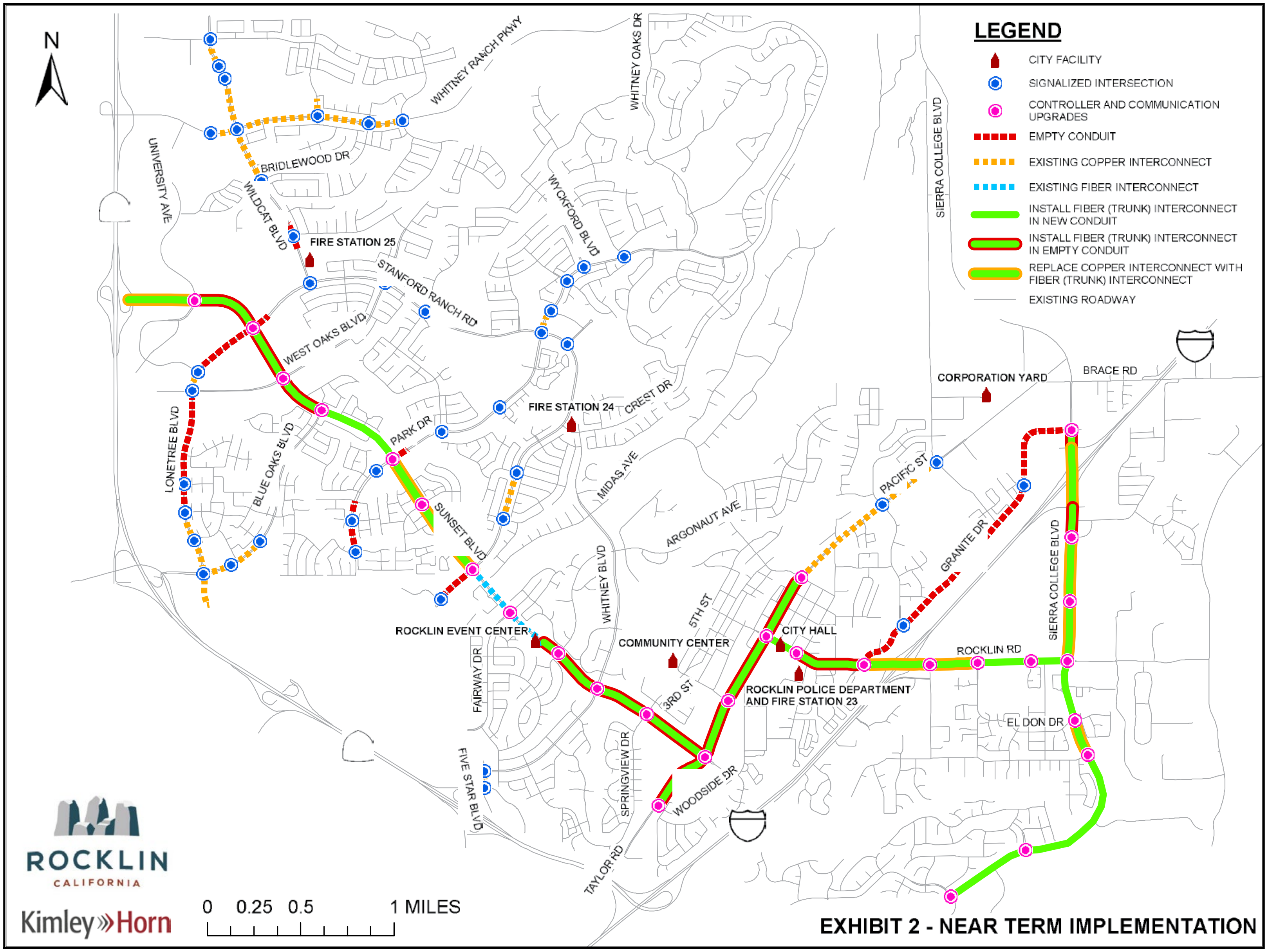
Planning level costs for the installation of wireless backhaul radios include the cost for each point-to-point wireless radio system and antenna. The costs assume that the radios will be installed on existing City structures, therefore the cost of a new pole and foundation is not factored into the planning level cost.

Dynamic Message Signs – Long-term implementation projects include the installation of DMSs at primary gateways and decision points throughout the City. **Table 6** lists DMS projects that have been strategically chosen to inform travelers of alternative routes available in response to an incident, special event, or unusual delay. The following are the locations of the proposed DMSs:

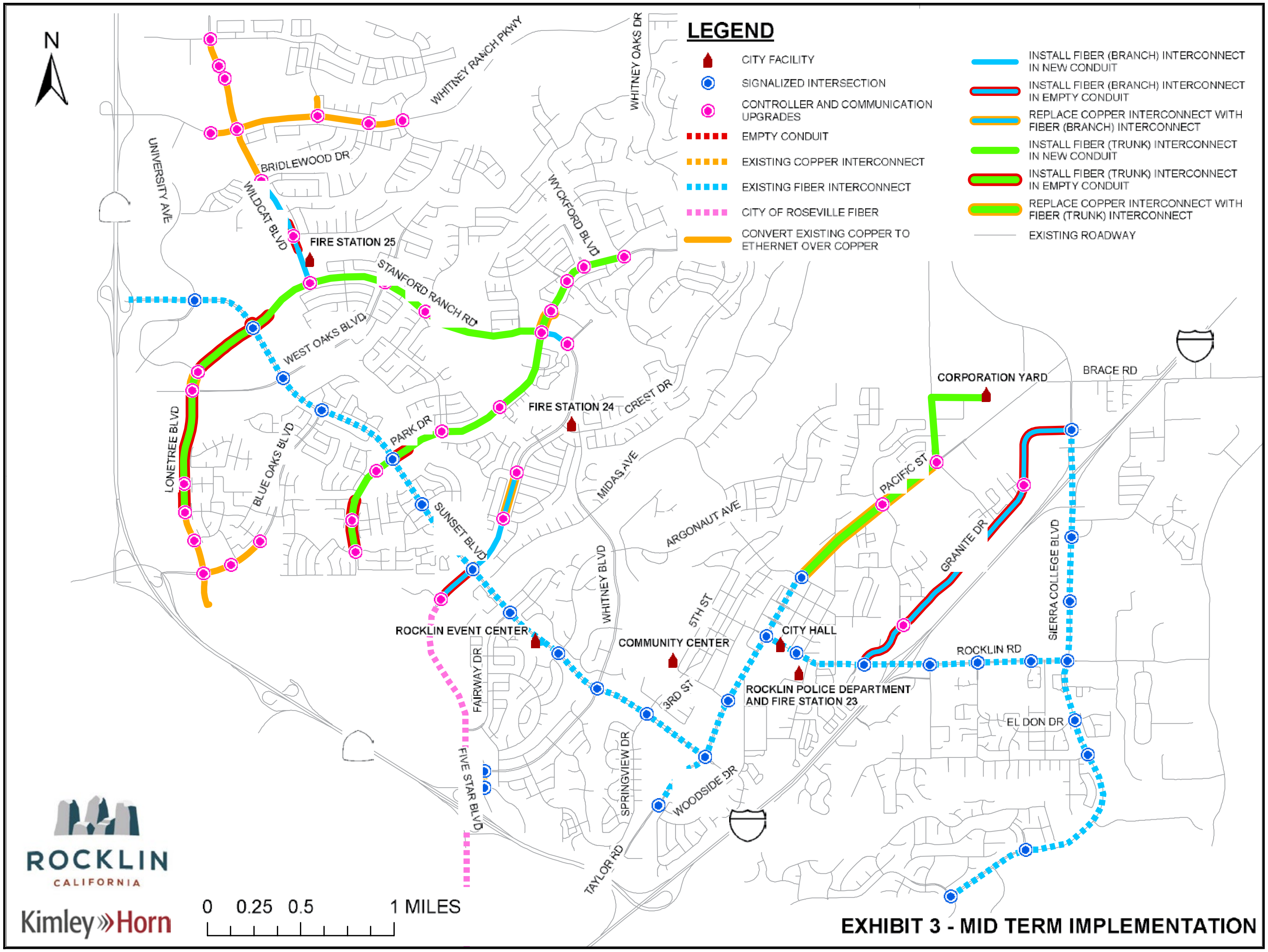
» Eastbound Whitney Ranch Road just west of Wildcat Boulevard
» Eastbound Sunset Boulevard just east of SR-65
» Eastbound Blue Oaks Boulevard just west of Lonetree Boulevard
» Northbound Park Drive just south of Sunset Boulevard
» Southbound Park Drive just north of Stanford Ranch Road
» Southbound Stanford Ranch Road just north of Sunset Boulevard
» Northbound Pacific Street just south of Sunset Boulevard
» Eastbound Rocklin Road just west of I-80
» Northbound Sierra College Boulevard just south of I-80

Planning level costs for the installation of DMSs include the cost for each sign, a controller, and a new DMS cabinet.

CITY OF ROCKLIN - ITS MASTER PLAN



CITY OF ROCKLIN - ITS MASTER PLAN



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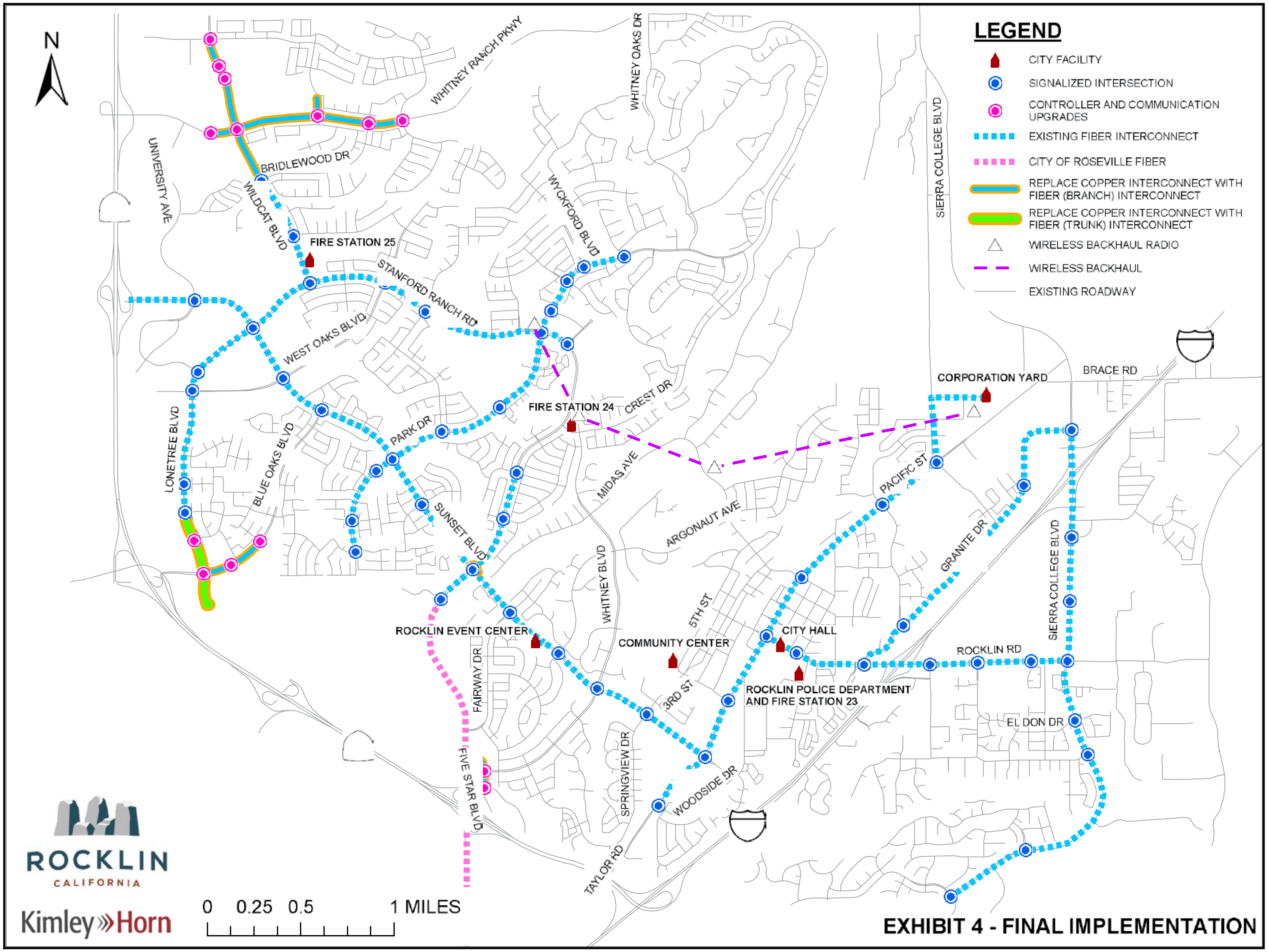

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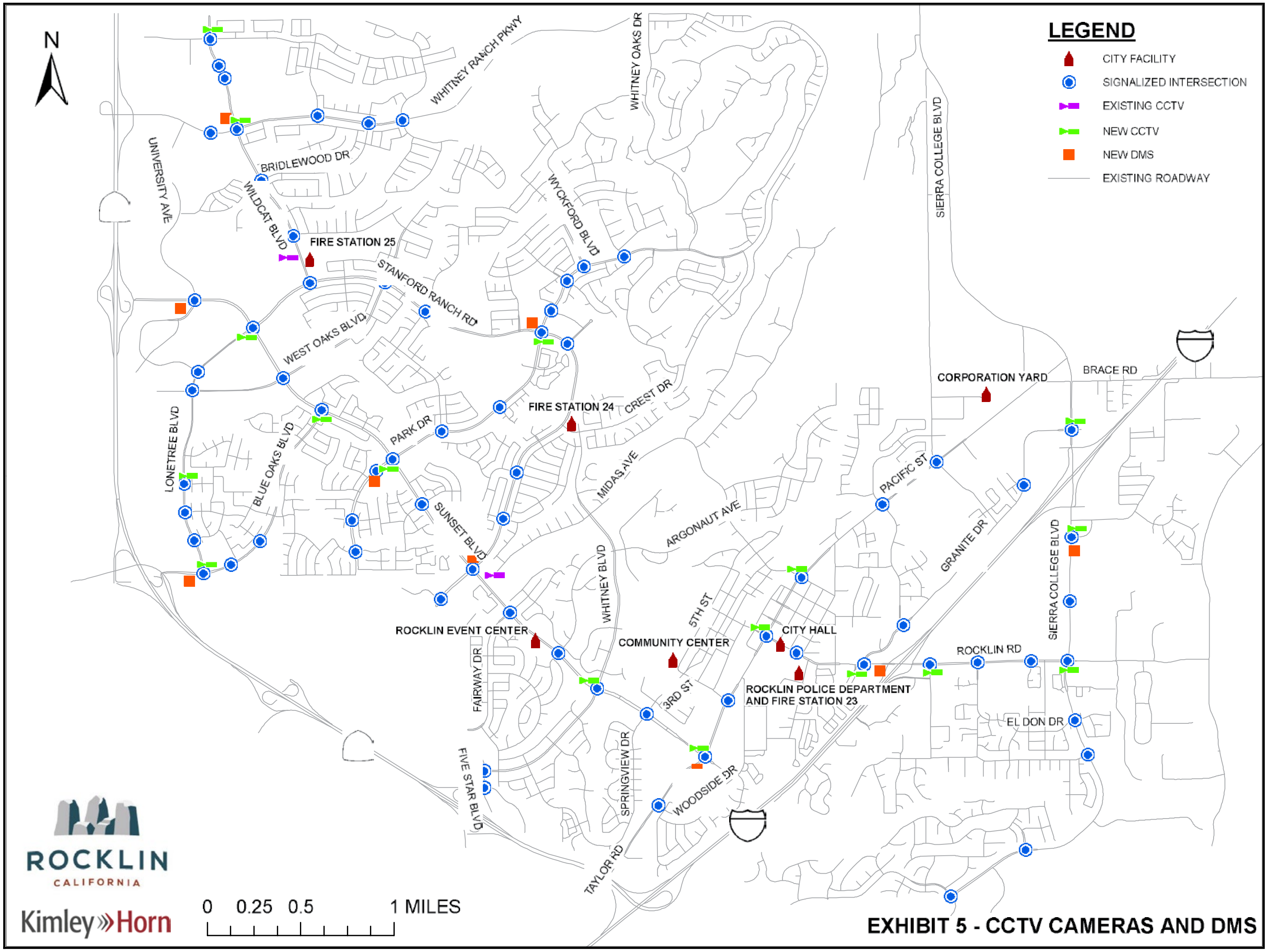

EXHIBIT 5 - CCTV CAMERAS AND DMS

Table 6 – *Project List*

Project No.	Project Description	GPS-Based Time Source Receiver	Updated Signal Timing	Controller Upgrade	Intersection Fiber Equipment Upgrade	CCTV	DMS	Communication (Miles)			Ethernet over Copper (Per Intersection)	Wireless Communication		Connected Vehicle Technology	Planning Level Cost
								New	In empty	Replace		Backhaul	Intersection		
Near-Term Implementation															
Traffic Signal Coordination															
1	Sunset Boulevard - University Avenue to Springview Drive - 12 Signals	12	12												$ 46,200.00
2	Sierra College Boulevard - Granite Drive to Scarborough Drive - 8 Signals	8	8												$ 30,800.00
3	Pacific Street - Woodside Drive to E. Midas Avenue - 5 Signals	5	5												$ 19,300.00
4	Rocklin Road - Rocklin Fire Station 23 to Havenhurst Circle - 5 Signals	5	5												$ 19,300.00
5	Stanford Ranch Road - Cobblestone Drive to Plaza Drive - 3 Signals	3	3												$ 11,600.00
Evaluation of Traffic Signal Controller and Central System Vendors															
6	Develop City-wide needs and controller functional requirements	Not Applicable													$ 20,000.00
7	Perform FHWA System Engineering Process to evaluate available traffic signal controller systems	Not Applicable													$ 44,000.00
Communication Trunk Line Installation															
8	Sunset Boulevard - I-65 to Park Drive - New 144-Strand SMFO			5	5			0.5	1.0	0.4					$ 615,000.00
9	Sunset Boulevard - Park Drive to Pacific Street - New 144-Strand SMFO			8	8				1.7	0.7					$ 558,400.00
10	Pacific Street - Woodside Drive to E. Midas Avenue - New 144-Strand SMFO			4	4				1.5						$ 328,900.00
11	Rocklin Road - Pacific Street - Sierra College Boulevard - New 144-Strand SMFO			5	5			0.7	0.4	0.6					$ 661,800.00
12	Sierra College Boulevard - Granite Drive to Rocklin Road - New 24-Strand SMFO			4	4				0.3	1.0					$ 295,800.00
13	Sierra College Boulevard - Rocklin Road to Scarborough Drive - New 24-Strand SMFO			4	4			1.6		0.2					$ 1,017,800.00
Origin-Destination Data Collection															
13	Evaluate usage of Bluetooth/Wi-Fi detection technology versus third-party provider for data collection	Not Applicable													$ 23,460.00
14	Deploy O-D data collection system	Not Applicable													$ 57,500.00

Table 6 – *Project List (continued)*

Project No.	Project Description	GPS-Based Time Source Receiver	Updated Signal Timing	Controller Upgrade	Intersection Fiber Equipment Upgrade	CCTV	DMS	Communication (Miles)			Ethernet over Copper (Per Intersection)	Wireless Communication		Connected Vehicle Technology	Planning Level Cost
								New	In empty	Replace		Backhaul	Intersection		
Mid-Term Implementation															
Establish Traffic Operations Center															
15	TOC Site Evaluation	Not Applicable													$ 27,000.00
16	TOC Standard Operating Procedures and Functional Requirements	Not Applicable													$ 22,000.00
17	TOC at Corporation Yard	Not Applicable													$ 35,000.00
18	Procure Central System	Not Applicable													$ 350,000.00
19	Pacific Street - E. Midas Avenue to Delmar Avenue to City of Rocklin Corporate Yard - New 144-Strand SMFO			2	2			0.6		1.0					$ 544,900.00
Integrate all Traffic Signals into ITS Network															
20	Granite Drive - Rocklin Road to Sierra College Boulevard - New 24-Strand SMFO		2	2	2				1.8						$ 344,300.00
21	Blue Oaks Boulevard - Van Buren Way to Lonetree Boulevard - Ethernet over Copper		3	3							3				$ 55,500.00
21	Lonetree Boulevard - Blue Oaks Boulevard to Redwood Drive - Ethernet over Copper		3	3							3				$ 55,500.00
22	Lonetree Boulevard - Redwood Drive to Sunset Boulevard - New 24-Strand SMFO		4	4	4				1.1	0.1					$ 291,200.00
23	W. Stanford Ranch Road - Sunset Boulevard to Darby Road - New 24-Strand SMFO		3	3	3			1.0	0.1						$ 648,900.00
24	Wildcat Boulevard - W. Stanford Ranch Boulevard to Bridlewood Drive - New 24-Strand SMFO		2	2	2			0.5	0.1						$ 345,400.00
25	Wildcat Boulevard - Bridlewood Drive to Ranch View Drive - Ethernet over Cable		4	4							4				$ 74,100.00
26	Whitney Ranch Parkway - Caviata Way to Old Ranch House Road - - Ethernet over Cable		4	4							4				$ 74,100.00
27	Park Drive - Quarry Way to Cameron Drive - New 144-Strand SMFO		10	10	10			1.9	0.1	0.1					$ 1,338,000.00
28	Stanford Ranch Road - Park Drive to Victory Lane - New 24-Strand SMFO		1	1	1			0.1							$ 79,600.00
29	Stanford Ranch Road - Cobblestone Drive to Plaza Drive - New 24-Strand SMFO		3	3	3			0.3	0.2	0.3					$ 321,700.00

Table 6 – *Project List (continued)*

Project No.	Project Description	GPS-Based Time Source Receiver	Updated Signal Timing	Controller Upgrade	Intersection Fiber Equipment Upgrade	CCTV	DMS	Communication (Miles)			Ethernet over Copper (Per Intersection)	Wireless Communication		Connected Vehicle Technology	Planning Level Cost
								New	In empty	Replace		Backhaul	Intersection		
Deploy Closed Circuit Television (CCTV) Cameras															
30	Sunset Boulevard and Lonetree Boulevard - Install CCTV					1									$ 11,500.00
31	Sunset Boulevard and Blue Oaks Boulevard - Install CCTV					1									$ 11,500.00
32	Sunset Boulevard and Park Drive - Install CCTV					1									$ 11,500.00
33	Sunset Boulevard and Whitney Boulevard - Install CCTV					1									$ 11,500.00
34	Sunset Boulevard and Pacific Street - Install CCTV					1									$ 11,500.00
35	Lonetree Boulevard and Blue Oaks Boulevard - Install CCTV					1									$ 11,500.00
36	Lonetree Boulevard and Redwood Drive - Install CCTV					1									$ 11,500.00
37	Wildcat Boulevard and Stanford Ranch Road - Install CCTV					1									$ 11,500.00
38	Wildcat Boulevard and Whitney Ranch Parkway - Install CCTV					1									$ 11,500.00
39	Wildcat Boulevard and Ranch View Drive - Install CCTV					1									$ 11,500.00
40	Stanford Ranch Road and Park Drive - Install CCTV					1									$ 11,500.00
41	Pacific Street and Rocklin Road - Install CCTV					1									$ 11,500.00
42	Pacific Street and E. Midas Avenue - Install CCTV					1									$ 11,500.00
43	Rocklin Road and Granite Drive - Install CCTV					1									$ 11,500.00
44	Rocklin Road and Aguilar Road - Install CCTV					1									$ 11,500.00
45	Rocklin Road and Sierra College Boulevard - Install CCTV					1									$ 11,500.00
46	Sierra College Boulevard and Bass Pro Road - Install CCTV					1									$ 11,500.00
47	Sierra College Boulevard and Granite Drive - Install CCTV					1									$ 11,500.00
Cross-Jurisdictional Traffic Management															
48	Develop Information Sharing Protocols with City of Roseville and Caltrans	Not Applicable													$ 25,000.00
49	Connect with City of Roseville Fiber on Stanford Ranch Road and Expand Fiber to Five Star Boulevard			2	2			0.43			2				$ 292,300.00
Deploy Connected Vehicle Roadside Technology															
50	Evaluate Connected Vehicle Roadside Technology	Not Applicable												12	$ 24,840.00
51	Deploy Connected Vehicle Roadside Technology at Signalized Intersections													71	$ 408,300.00

Table 6 – *Project List (continued)*

Project No.	Project Description	GPS-Based Time Source Receiver	Updated Signal Timing	Controller Upgrade	Intersection Fiber Equipment Upgrade	CCTV	DMS	Communication (Miles)			Ethernet over Copper (Per Intersection)	Wireless Communication		Connected Vehicle Technology	Planning Level Cost
								New	In empty	Replace		Backhaul	Intersection		
Long-Term Implementation															
Implement Redundant Wireless Backhaul															
52	Install Backhaul Wireless Radio Connection											4			$ 46,000.00
Deploy Dynamic Message Signs (DMS)															
48	Westbound Whitney Ranch Road just west of Wildcat Boulevard - Install DMS						1								$ 28,800.00
49	Eastbound Sunset Boulevard just east of SR-65 - Install DMS						1								$ 28,800.00
50	Eastbound Blue Oaks Boulevard just west of Lonetree Boulevard - Install DMS						1								$ 28,800.00
51	Northbound Park Drive just south of Sunset Boulevard - Install DMS						1								$ 28,800.00
52	Southbound Park Drive just north of Stanford Ranch Road - Install DMS						1								$ 28,800.00
53	Southbound Stanford Ranch Road just north of Sunset Boulevard - Install DMS						1								$ 28,800.00
54	Northbound Pacific Street just south of Sunset Boulevard - Install DMS						1								$ 28,800.00
55	Eastbound Rocklin Road just west of I-80 - Install DMS						1								$ 28,800.00
56	Northbound Sierra College Boulevard just south of I-80 - Install DMS						1								$ 28,800.00
Deploy Communication Upgrades															
53	Blue Oaks Boulevard - Lonetree Boulevard to Sunset Boulevard - New 24-Strand SMFO				3			0.8		0.4					$ 544,200.00
54	Lonetree Boulevard - Redwood Drive to Cortina Circle - New 24-Strand SMFO				3					0.5					$ 108,700.00
55	Wildcat Boulevard - Bridlewood Drive to Ranch View Drive - New 24-Strand SMFO				5					0.8					$ 175,600.00
56	Whitney Ranch Parkway - Caviata Way to Old Ranch House Road - New 24-Strand SMFO				5					1					$ 208,700.00
57	Stanford Ranch Road - Darby Road to Park Drive - New 24 - Strand SMFO							0.6							$ 339,100.00
58	Stanford Ranch Road - Victory Lane to Cobblestone Drive - New 24 - Strand SMFO							0.8							$ 452,100.00
59	Five Star Boulevard - Whitney Boulevard to Destiny Drive - Ethernet over Copper and Wireless Based Interconnect			2							2		2		$ 38,000.00

APPENDIX A

Stakeholder Meeting Materials

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Kimley»Horn

Meeting Notes

Re: **Stakeholder Workshop**
City of Rocklin ITS Master Plan

Date: October 9, 2017, 9:00 am – 11:00 am

Attendees: Rick Horst (City Manager)
Laura Webster (ECD)
Marc Mondell (ECD)
Brian Graves (Central Services)
Karen Garner (Parks and Recreation)
Michael Young (Central Services)
Jason Johnson (Central Services)
Keith Jukes (Public Services)
Naz Lazar (Public Services)
Chief Chad Butler (Police)
David Mohlerbrok (Public Services)
Justin Nartker (Public Services)
Jordan Pinkham (Public Services)
Matt McClure (Public Services)

Randy Durrenberger (Kimley-Horn)
Ryan Dole (Kimley-Horn)
Matt Weir (Kimley-Horn)

The following is a summary of the primary comments offered as part of this meeting:

1. **Vision/Goals/Objectives**
   - Remove "citizen-focused". Consider changing to community focused or excluding all together.
   - Remove "residents" so the vision statement ends with "…for the City of Rocklin."
   - Revise vision, goals, and objectives for consistent terminology and format with City Strategic Plan
   - Goals/Objectives – Add that City desires to optimize capacity of existing roadways

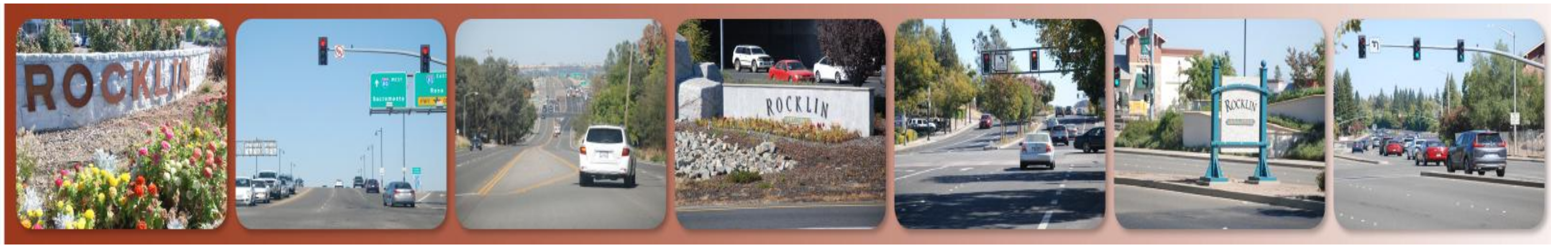
2. **Existing Conditions**
   - Existing operational concerns:
     - Consider ITS that will facilitate collaboration with Roseville and Caltrans to and from Highway 65
     - Prioritized corridors are Sunset, Pacific, Granite, Rocklin, and Sierra College.
   - On Existing Conditions Map, change schools to a separate layer/symbol, the schools are not a city facility.
     - It was noted that while the schools do impact traffic patterns, this ITS Master Plan is not addressing potential traffic mitigation strategies like redistricting. Instead, this plan will focus on use of operational and maintenance tools and technologies.
     - Add William Jessup and Sierra College to map
   - IT – There is a movement toward cloud-based network as opposed to agency owned cabling due to cost and maintenance.
   - City currently requires that developers install empty conduit along main corridors (no longer required along residential streets).

3. **Implementation Strategies**
   - Focus should be utilizing smart technology to reduce need for costly roadway infrastructure
   - Leverage partnerships to generate revenue based on benefit provided to partners
     - Need to have a good roadmap so developers contribute to costs of impacts.
     - Focus on Business Triangle
     - How to get external entities (i.e. Costco in Loomis) to pay for their impact to Rocklin
     - Potential to lease dark fiber to third parties
   - Start with local needs then expand out to external (i.e. neighboring agencies)
   - How can system address "pass-through" traffic issues? Plan should discuss.
   - Identify opportunities for how ITS system influence driver behavior, like through education or messaging.
   - Plan/ITS system must be adaptable (i.e. accommodate or adjust for future I-80 and Hwy 65 improvements)
   - Establish a policy that requires future capacity improvements to include specific smart technology

Stakeholder Workshop

Intelligent Transportation System (ITS) Master Plan

October 9, 2017



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Agenda

- Background – Plan Process
- Vision, Goals, and Objectives
- Existing Conditions Assessment
- Technologies and Implementation Strategies
- Stakeholder Input Discussion

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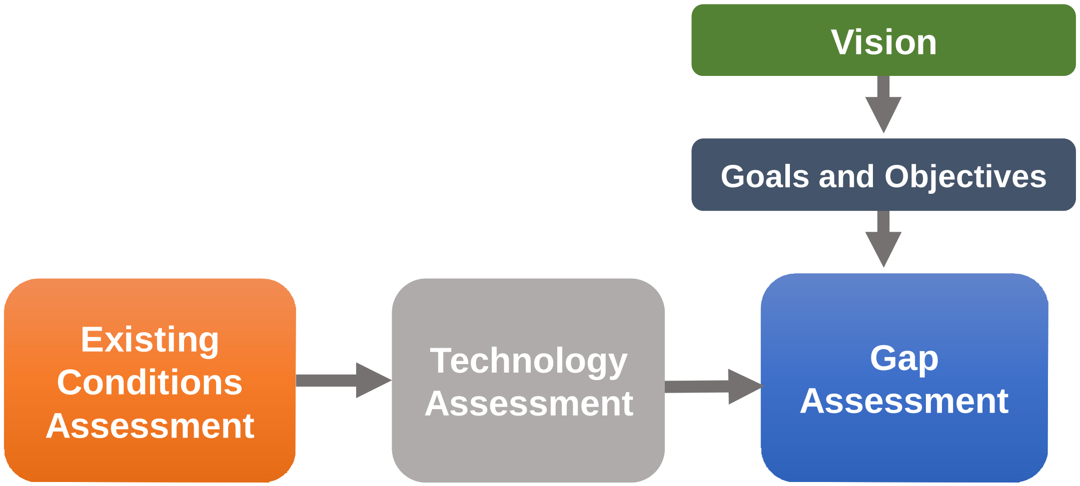
Background – Plan Process



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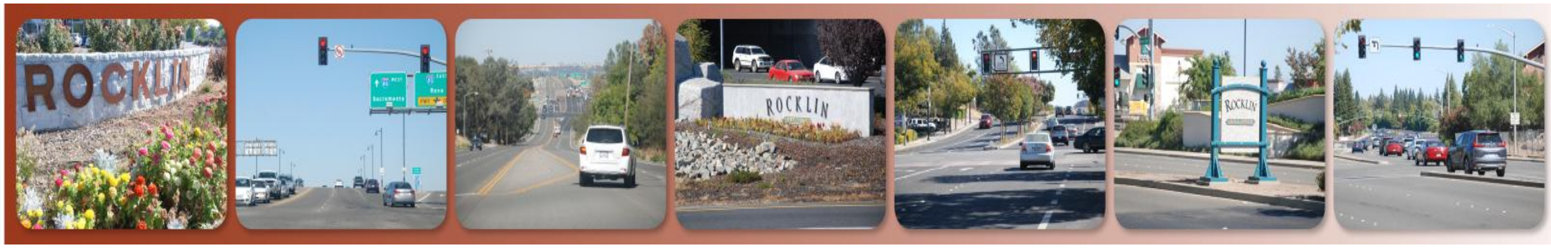
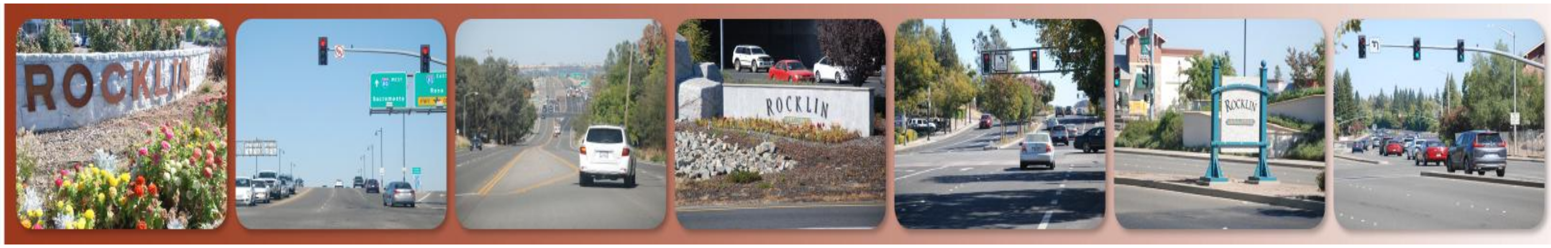


Background – Plan Process



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Agenda

- Background – Plan Process
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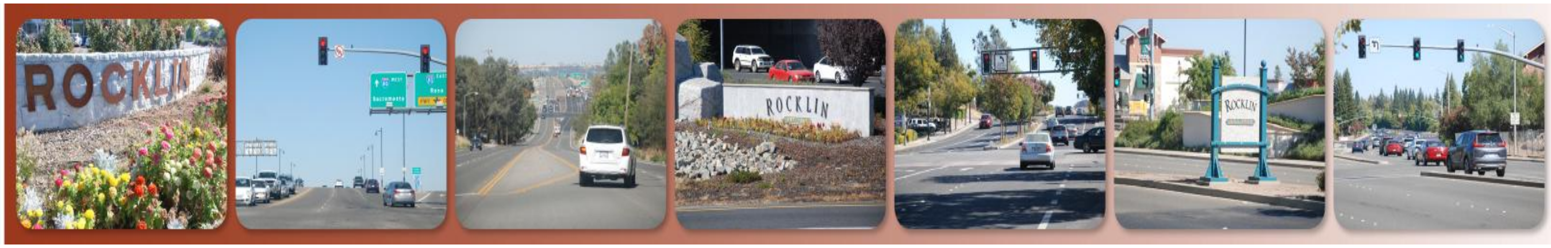

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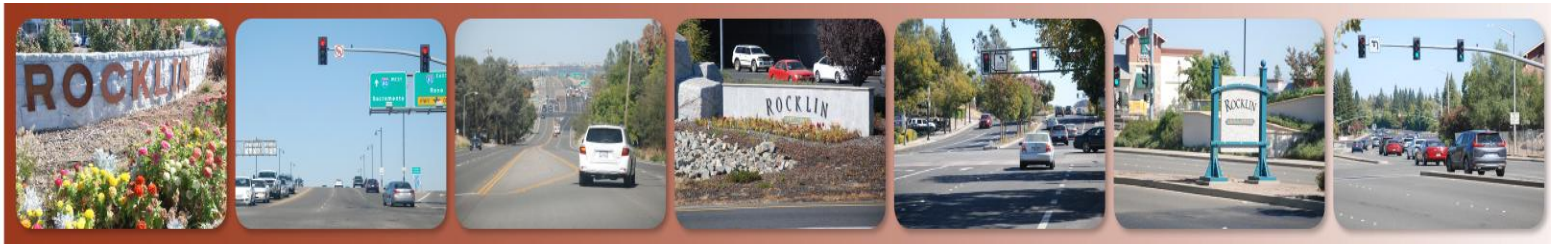
Vision, Goals, and Objectives

- Vision - Overarching summary statement that defines the focus and direction of the City's ITS program
- Goals – Break vision into more manageable and tangible segments
- Objectives – Specific project purposes acting as means of measuring and accomplishing goals



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Vision

To develop a safe, efficient, and reliable <u>citizen-focused transportation network</u> that includes <u>multimodal traffic operations improvements</u> to encourage and enhance a <u>sustainable quality-of-life</u> for City of Rocklin residents.

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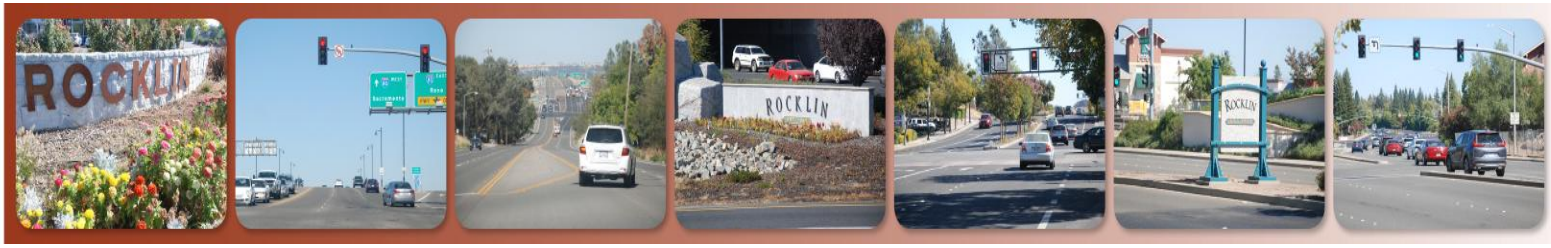
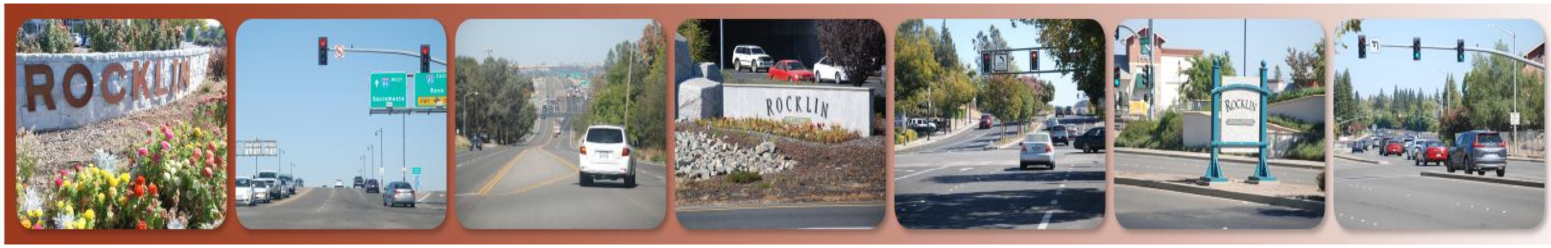


Goals and Objectives

Goal	Objectives
Establish ITS program and policies	• Engage stakeholders to gather existing and future traffic management needs • Develop policies to guide deployment of a sustainable ITS network
Conduct evaluation of the existing City transportation network	• Inventory existing infrastructure • Identify and evaluate existing system gaps • Prepare strategies to close gaps
Improve traffic operations on major corridors	• Implement ITS elements and tools to more effectively manage and operate traffic signals • Develop prioritized list of implementable projects
Position City for implementation of future emerging ITS technologies	• Establish process for evaluating new technologies that arise • Develop list of traffic management needs against which to evaluate new technologies



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Goals and Objectives (Cont.)

Goal	Objectives
Identify potential project candidates for future growth of ITS network	• Develop project limits, project elements, and planning level costs for possible ITS equipment deployments • Establish backbone infrastructure to support foundational communications network for ITS and TOC expansion • Identify potential funding sources, including grants and developer's fees, for the installation of ITS elements.
Develop an informal plan for collaboration with neighboring and regional jurisdictions'' systems, policies, and protocols	• Engage neighboring stakeholders to initiate local and regional collaboration • Regularly participate in monthly SACOG ITS Partnership Meetings • Collaborate with SACOG's Smart Region Sacramento project to enhance regional consistency with ITS architecture and the use of emerging technologies
Develop system access opportunities to provide public with timely and meaningful traveler information	• Research effectiveness of regional agency traveler information mediums • Document industry-wide trends and emerging user tendencies • Identify type of information and dissemination options

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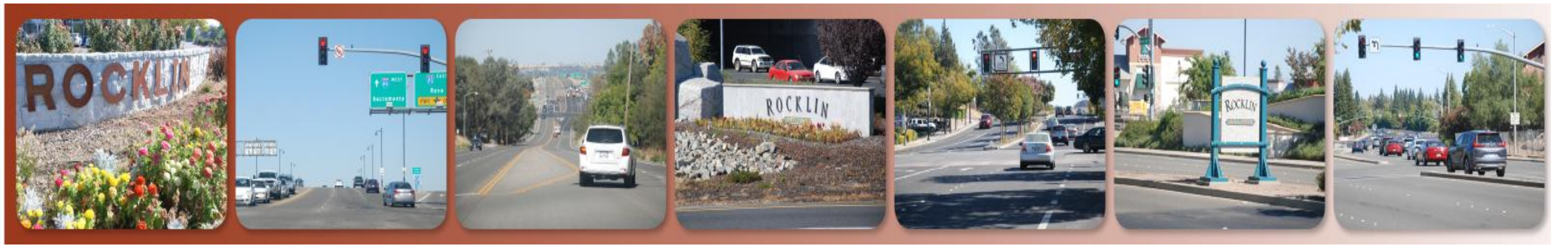

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Agenda

- Background – Plan Process
- Vision, Goals, and Objectives

➢ Existing Conditions Assessment

- Technologies and Implementation Strategies
- Stakeholder Input Discussion

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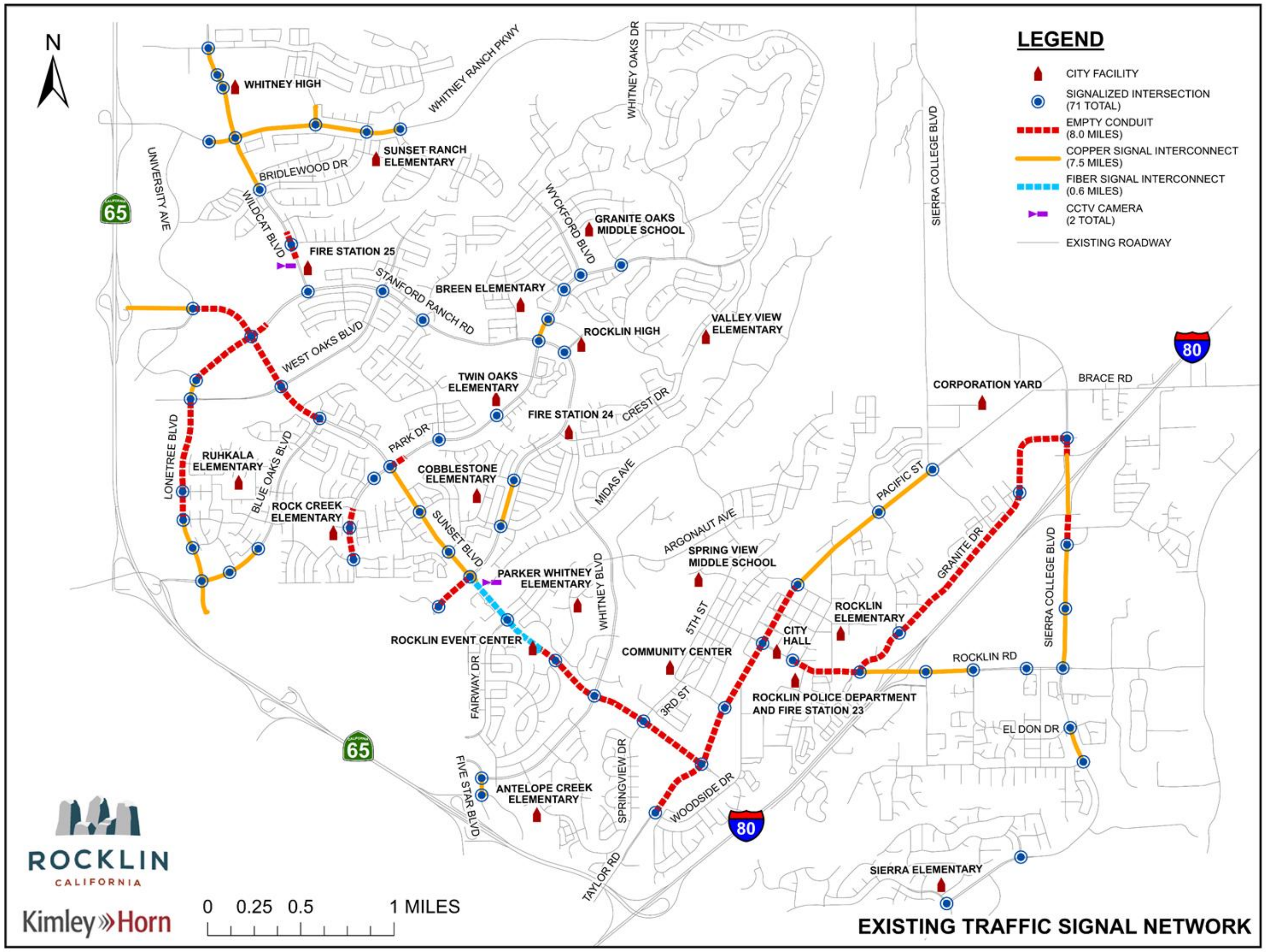
CITY OF ROCKLIN - ITS MASTER PLAN



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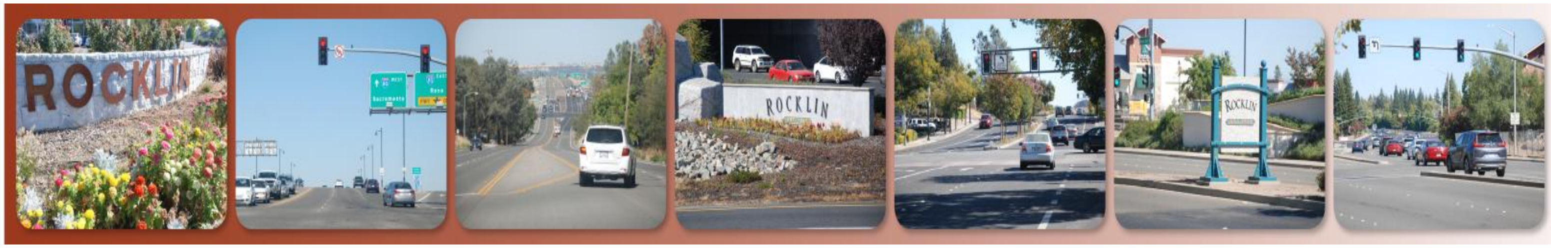

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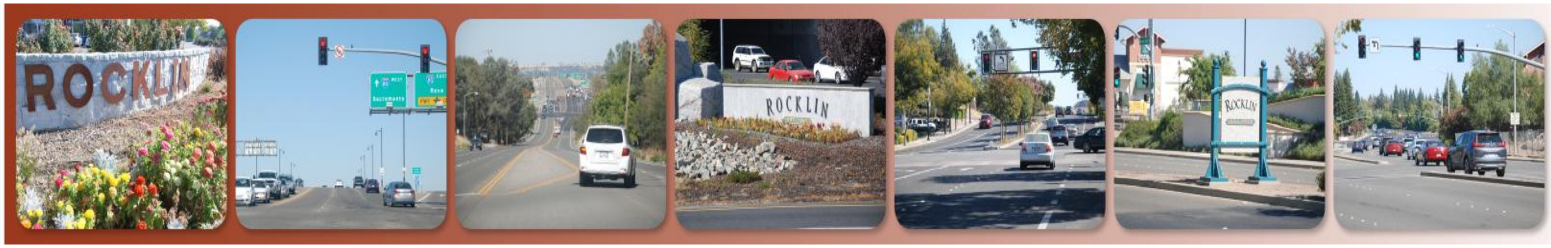

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Technology Assessment

- Goal – Evaluate existing and future technologies and compare against City needs/goals/objectives
- Current (mature) ITS elements
- Emerging and Future ITS elements
- Collaboration with SACOG Smart Region Sacramento Plan

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Implementation Strategies

- Identify Projects and Deployment Strategies
- Develop planning level cost estimate
  - Include costs for project development, capital, operations, and maintenance
- Prioritize projects based on need and funding
- Document potential funding sources

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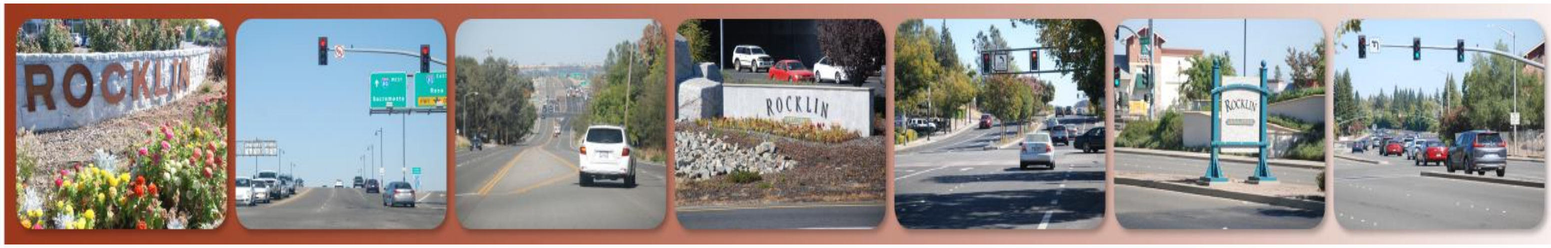

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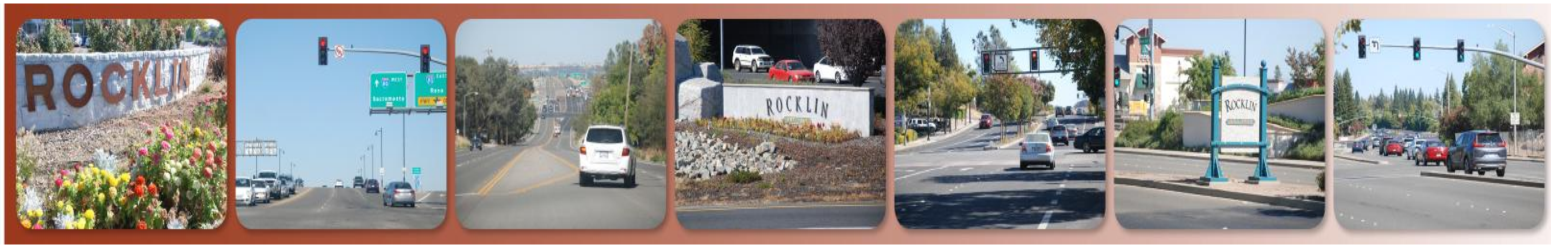

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Stakeholder Input Discussion

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